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A REGULAÇÃO DA ENERGIA EM PORTUGAL

ERSE ENTIDADE REGULADORA DOS SERVIÇOS ENERGÉTICOS

A REGULAÇÃO DA ENERGIA EM PORTUGAL

2007
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Ana Figueiredo, Paulo Oliveira

COLABORAÇÃO
Manuela Luís

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NOTA DE ABERTURA

A ERSE completa no início de 2017 duas décadas de vida durante as quais ajudou a implementar e a desenvolver a regulação independente do setor energético em Portugal, o qual passou por profundas mutações e atravessa de novo um período de mudança estrutural que terá implicações para todos os agentes do setor, incluindo o regulador.

A regulação económica justifica-se pela necessidade de corrigir as falhas de mercado decorrentes da existência de externalidades, das estratégias anti-competitivas das empresas que beneficiam de poder de mercado ou daquelas que operam como monopólios naturais e, finalmente, das distorções que podem resultar da existência de informação imperfeita ou assimétrica.

O papel do regulador é acompanhar a dinâmica do setor, nomeadamente o desenvolvimento dos mercados energéticos, e antecipar desafios futuros, o que muitas vezes se consolida na emergência de novos instrumentos de regulação económica.

Nesse sentido, a atividade regulatória que a ERSE tem desenvolvido no decurso dos seus quase 20 anos de atividade constitui um *"benchmark"* da regulação setorial em Portugal. Este desempenho é fruto do envolvimento, da competência, da dedicação e da forte coesão da sua equipa técnica. Por isso se torna tão importante esta Coletânea que reúne uma pequena parte da reflexão que todos os dias é feita pelos colaboradores da ERSE em matérias tão distintas como a regulação setorial e a construção do mercado interno europeu, a promoção da concorrência, o desenvolvimento do mercado e a proteção dos consumidores, não descurando os estudos prospetivos e o enquadramento da regulação no contexto da política energética.

A ERSE tornou-se ao longo destes 20 anos numa instituição emblemática e de referência ao nível da regulação nacional e internacional. Não tenho dúvidas que assim continuará, na prossecução de objetivos tão importantes como a proteção dos consumidores, sobretudo dos mais vulneráveis, e a defesa do respeito pelas obrigações de serviço público, consolidando assim o seu importante papel na afirmação contínua da Regulação em Portugal.

Vitor Santos

Presidente do Conselho
de Administração da ERSE

A REGULAÇÃO DA ENERGIA EM PORTUGAL: UM SOBREVOO SOBRE A ÚLTIMA DÉCADA E UM OLHAR SOBRE OS DESAFIOS FUTUROS

Vitor Santos

Presidente do Conselho
de Administração da ERSE

1. Introdução[1]

O início da regulação independente no setor da energia em Portugal data de fevereiro de 1997, com a publicação dos estatutos da ERSE, já prevista na legislação básica do setor elétrico de 1995 e na primeira diretiva europeia do mercado interno de eletricidade (1996). A regulação surgiu com o início da reprivatização das empresas de eletricidade e com a liberalização do mercado de eletricidade, assumindo o regulador um papel neutro e independente face aos agentes e operadores do setor e ao próprio Estado (à época, acionista maioritário nas empresas de energia).

A princípio, a regulação concretizou a arquitetura de relacionamentos entre os vários agentes do setor, compatibilizando os novos produtores independentes (e depois os consumidores "não vinculados") com o legado do setor elétrico de serviço público, incorporado no fornecedor incumbente. Simultaneamente, a regulação assumiu a definição da regulação económica dos operadores e do fornecedor incumbente tendo por finalidade a satisfação das necessidades dos consumidores de energia elétrica e o equilíbrio económico-financeiro das empresas reguladas em condições de gestão eficiente.

Ao longo dos já quase 20 anos de regulação de energia em Portugal, o papel da regulação tem vindo a ganhar novos contornos e a desenrolar-se num contexto de mudança.

Logo nos primeiros anos, a regulação da energia estendeu-se às regiões autónomas dos Açores e Madeira e ao setor do gás natural. Depois, assistiu à reorganização do setor no sentido da desverticalização (separação do fornecimento face à operação das redes) e à liberalização do retalho, com o aparecimento de novos operadores na comercialização de energia aos clientes finais.

No setor elétrico, em 2007, concretizou-se o projeto do mercado ibérico de eletricidade – MIBEL – e um ano antes foi garantido o direito de escolha de fornecedor a todos os consumidores em Portugal continental. Em 2010, esse direito de escolha foi concretizado para os consumidores de gás natural e já em 2015 foram lançadas as bases do mercado ibérico de gás natural.

[1] Retoma-se neste ponto a abordagem apresentada em: Santos, V. (2015), "O papel do regulador da energia", Portugalglobal, Setembro, pp. 19-20.

O peso do Estado acionista nas empresas incumbentes foi-se diluindo, tendo praticamente desaparecido com o processo de privatizações. E a liberalização dos mercados de eletricidade e de gás natural acelerou-se nos últimos anos estando já mais de dois terços dos consumidores fornecidos por comercializadores em mercado livre.

Ao mesmo tempo, o setor da energia tem vindo também a beneficiar da evolução tecnológica quer na produção e nas redes, quer no consumo. A produção de energia tornou-se económica em pequena escala e de forma dispersa, a partir da energia solar ou eólica. A produção de energia elétrica a partir de recursos renováveis, com exceção das grandes centrais hídricas, cresceu fortemente em Portugal, de 2% para 30% do consumo em 15 anos, com especial destaque para a energia eólica.

A eficiência energética assumiu finalmente um papel importante junto dos decisores públicos, empresas e consumidores domésticos, sendo um eixo de desenvolvimento prioritário no setor.

Neste contexto de mudança permanente, a regulação do setor energético adaptou-se e evoluiu, de modo a dar resposta aos novos desafios. Tornou-se mais integrada no plano regional e europeu, promovendo com os reguladores homólogos a harmonização de regras no espaço europeu; aperfeiçoou-se nos métodos, para se adequar às mudanças externas e manter a orientação para a eficiência; focou-se mais na supervisão do funcionamento do mercado e do comportamento dos seus agentes e operadores; aproximou-se mais dos consumidores num esforço de promoção da sua participação ativa no mercado de energia.

Apesar das mudanças no setor e na sua regulação, o regulador continua a promover os seus princípios básicos que são a proteção dos consumidores quanto a preços e qualidade de serviço, a promoção da concorrência e da eficiência da utilização dos recursos, a existência de condições de equilíbrio económico e financeiro dos operadores de serviço público, em condições de gestão eficiente, e a garantia do cumprimento das obrigações de serviço público por estes operadores e demais agentes do setor.

Após esta breve passagem pelas decisões estruturantes da ERSE ao longo das suas duas décadas de existência, vamos concentrar agora a nossa análise nos grandes temas da última década e nos grandes desafios para o futuro.

2. A integração de mercados: a construção de um mercado único europeu

A integração de mercados tem duas dimensões complementares: o investimento em infraestruturas e a harmonização regulatória. Não faz sentido reforçar as interligações e, depois, preservar sistemas regulatórios completamente distintos de cada um dos lados das fronteiras mantendo assim barreiras ao acesso a esses mercados.

A existência de uma rede energética interligada contribui para a segurança de fornecimento, facilita a integração de mercados, eliminando as barreiras à entrada e promovendo a concorrência, e viabiliza a existência de preços mais acessíveis e a melhoria da qualidade de serviço em benefício dos consumidores.

Apesar do esforço de harmonização regulatória e do investimento em infraestruturas a nível europeu, existem ainda, em muitos aspetos relevantes, 28 sistemas regulatórios nacionais que se aplicam a mercados que não têm, em muitos casos, massa crítica ou dimensão estratégica para tornar exequível, eficiente e eficaz o processo de liberalização.

Em 2007, Portugal e Espanha procederam à criação do MIBEL (Mercado Ibérico de Eletricidade) na linha da experiência percursora desenvolvida pela Nordpool[2]. A criação do MIBEL foi uma decisão unilateral dos dois Estados Ibéricos que deve ser perspetivada como um passo intermédio para a consolidação do mercado interno da eletricidade. O reforço da capacidade de interligação e a progressiva harmonização regulatória registadas entre os dois Estados Ibéricos no decurso dos últimos dez anos permitiu uma integração progressiva dos dois mercados com reflexos positivos na qualidade de serviço, na promoção da concorrência e nos preços da energia.

Na sequência dos estudos técnicos elaborados pelos dois reguladores ibéricos, os governos de Portugal e de Espanha têm vindo a desenvolver esforços para a implementação de um Mercado Ibérico de Gás Natural, tendo sido publicada legislação nos dois países que sustenta esse processo.

A plataforma de mercado organizado (hub) no âmbito do Mercado Ibérico do Gás Natural, iniciou, em 16 de dezembro de 2015, a negociação de produtos de gás natural, um processo que vem introduzir transparência de preços e maior liquidez ao mercado ibérico de gás natural.

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[2] Processo de integração dos mercados elétricos da Noruega, Suécia, Finlândia e Dinamarca.

O arranque desta plataforma de negociação constitui um importante passo na integração progressiva dos mercados de gás natural de Portugal e de Espanha e na construção do Mercado Interno do Gás Natural.

A integração dos mercados grossistas de gás natural de Portugal e Espanha passa ainda pelo desenvolvimento de diversos mecanismos visando o aprofundamento da plataforma de mercado organizado, pela eliminação das tarifas na interligação[3] e pela definição do modelo de governação do MIBGAS.

Não obstante estes desenvolvimentos, a Península Ibérica continua a ser uma ilha energética num contexto em que o trânsito de energia elétrica e de gás natural com os restantes países europeus, através dos Pirenéus, continua a ser muito pouco expressivo devido à insuficiente interligação instalada.

Na sequência da aprovação do regulamento relativo às orientações para as infraestruturas energéticas transeuropeias[4], foi divulgada em 2013 a primeira lista dos «projetos de interesse comum» (PIC) que beneficiarão de procedimentos acelerados de licenciamento e melhores condições regulamentares, podendo ser ainda objeto de apoio financeiro[5]. O regulamento prevê ainda que os projetos sejam objeto de uma análise custo-benefício que evidencie os benefícios supranacionais e preveja a possibilidade de imputação de custos transfronteiras[6].

Ainda a este respeito, deve sublinhar-se a Declaração de Madrid, de 4 de março de 2015, em que foi adotado um compromisso entre os governos de Portugal, Espanha e França e ainda a Comissão Europeia e o Banco Europeu de Investimento no sentido de se desenvolverem as interligações de gás natural e eletricidade para reforçar a integração do mercado interno de energia, impulsionando desta forma, a criação do MIBGAS e permitindo, igualmente, a consolidação do MIBEL

A implementação dos Códigos de Rede tanto no setor elétrico como no setor do gás natural por parte de todos os países da União Europeia constitui igualmente um desafio importante para a atividade de regulação da ERSE. Neste contexto, destaca-se a aplicação

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3 Algumas medidas foram já tomadas unilateralmente para reduzir este obstáculo: eliminação das tarifas de saída de Portugal para Espanha e redução da tarifa de saída de Espanha para Portugal.

4 Regulamento (UE) nº 347/2013.

5 Em 2015, foi anunciada uma segunda lista de PIC.

6 Foram definidos objetivos específicos para o sector elétrico: a capacidade instalada de interligação mínima deverá corresponder a 10% da capacidade instalada de produção em 2020; em 2016, a Comissão apresentará um relatório sobre as medidas necessárias para alcançar o objetivo de 15% até 2030.

da regulamentação europeia dos códigos de interoperabilidade, de atribuição de capacidade e de balanço, que muito contribuirão para o desenvolvimento do MIBGAS e do Mercado Interno de Energia, bem como a aplicação da regulamentação europeia para a transparência e integridade do mercado grossista de energia (REMIT), com o reporte obrigatório de transações de energia a desenvolver-se em 2016. Neste domínio, será necessário dar sequência ao trabalho efetuado por todos os reguladores nacionais e pela Agência de Cooperação dos Reguladores da Energia (ACER).

A ACER e o Conselho Europeu de Reguladores de Energia (CEER), organizações das quais a ERSE é membro, concluíram em 2014 um processo de reflexão relacionado com os desafios que os mercados energéticos europeus enfrentam na próxima década. O documento "*Energy Regulation: A Bridge to 2025 Conclusions Paper*, de 19 de setembro de 2014, chama a atenção para a necessidade fundamental das entidades reguladoras se envolverem no processo regulamentar europeu, para o tema dos «projetos de interesse comum», para a questão do reforço do papel dos consumidores nas problemáticas dos mercados energéticos e para as consequências da política energética ao nível da integração das renováveis nos mercados grossistas de eletricidade.

3. Promoção da concorrência no mercado

A profunda reorganização do sector energético baseado na existência de monopólios públicos verticalmente integrados para um modelo de funcionamento focalizado na separação entre monopólios naturais e atividades competitivas, teve presente as seguintes preocupações: garantir o acesso não discriminatório às redes, bem como a regulação económica eficiente dos monopólios naturais e a introdução de novos instrumentos de mercado que permitam potenciar a concorrência nos segmentos competitivos da cadeia de valor. A ação da supervisão e da monitorização de mercados, complementada pela aplicação do regime sancionatório, visa reduzir os desvios comportamentais dos agentes e os incumprimentos regulamentares. Deve ainda sublinhar-se que a intervenção no domínio da concorrência deve efetuar-se pela regulação setorial em cooperação com a Autoridade da Concorrência.

3.1. Supervisão dos mercados grossistas

Com a publicação do Regulamento UE n.º1227/2011, mais comumente referido como REMIT, o quadro regulamentar europeu passou a estabelecer regras sobre a transparência do mercado grossista de energia, tanto de eletricidade como de gás natural[7].

Algumas das regras, das práticas e das preocupações que levaram à adoção do REMIT tinham já expressão nos regulamentos nacionais relativos ao mercado elétrico e ao mercado de gás natural como é o exemplo do uso da informação privilegiada, entre nós referida como "factos relevantes".

Outras situações, como a monitorização e a cooperação entre as autoridades de supervisão de outros setores da vida económica e de outros Estados membros da UE, tiveram um enquadramento muito concreto com iniciativas como o MIBEL e a constituição de um Conselho de Reguladores, que integra os reguladores setoriais e financeiros dos dois países ibéricos com uma grande preocupação em monitorizar o funcionamento dos mercados.

Em certo sentido, poderá mesmo dizer-se que a experiência ibérica no setor elétrico antecipou uma parte substantiva do quadro regulamentar adotado pelo REMIT. Nesse contexto, os operadores económicos a atuar na península ibérica puderam, de forma mais efetiva, integrar nos seus modelos de negócio e na operação do dia-a-dia o quadro operativo do REMIT.

A supervisão do funcionamento dos mercados de eletricidade e do gás natural, tanto no referencial retalhista, como no referencial grossista, é um objetivo estratégico e estatutário da ERSE e temo-lo feito de forma continuada também de há largos anos a esta parte.

Não será demasiado relembrar a enorme importância de termos mercados transparentes e com um funcionamento pautado pela integridade das transações neles operadas. Este é um objetivo centrado em trazer benefícios ao consumidor de energia, mas convirá relembrar que os operadores económicos também beneficiam de um mercado com tais características. A partilha de benefícios é, aliás, uma forte inspiração para os trabalhos de implementação do REMIT.

7 Não é demais lembrar que estas regras, tratando-se de um regulamento europeu, são lei portuguesa, sem necessidade de transposição.

3.2. O processo de liberalização dos mercados retalhistas

A extinção das tarifas reguladas de venda a clientes finais para os consumidores domésticos, iniciada com um primeiro limiar de extinção em 1 de julho de 2012 e completada em 31 de dezembro de 2012, conduziu a uma transformação importante nos mercados retalhistas de gás natural e eletricidade em benefício dos consumidores, em particular no segmento doméstico.

Estas mudanças ocorreram em duas dimensões complementares muito relevantes. Em primeiro lugar, com a liberalização do mercado, os consumidores passaram a beneficiar do acesso a ofertas inovadoras de serviços e produtos. Observa-se uma tendência para o aparecimento de serviços integrados, como a venda de eletricidade, gás natural ou combustíveis, prestação de serviços de energia, sistemas de miniprodução ou mobilidade elétrica. Esta multiplicidade de opções – que podem incluir ofertas individuais de eletricidade ou gás, ofertas duais ou pacotes de serviços – está bem refletida na informação relativa ao funcionamento do mercado liberalizado onde se pode verificar que o número de ofertas alternativas ascende a 99 na eletricidade e a 31 no gás natural. Para além das estratégias de diferenciação do produto valorizadas pelos consumidores, a mudança da tarifa regulada para o mercado livre é incentivada pela existência de descontos que podem ascender a 15% no caso das ofertas duais.

Estas transformações acentuaram o nível de concorrência no segmento doméstico e deram visibilidade ao mercado liberalizado, tendo como consequência direta um crescimento acelerado do consumo no mercado livre que ascendia no final de 2015 a 89% do consumo total em Portugal continental.

A existência de nove comercializadores no gás natural e de dezasseis operadores no setor elétrico contribuiu para uma redução progressiva do grau de concentração em ambos os mercados.

As novas estratégias de diferenciação do produto suscitam uma questão relevante: como compatibilizar a oferta de novos serviços integrados bem acolhidos pelos consumidores que valorizam a diversidade com o aumento do poder de mercado das empresas induzido pela maior complexidade das ofertas no mercado? A título ilustrativo, aqui ficam algumas iniciativas regulatórias que podem contribuir para que as novas estratégias de comercialização se reflitam num benefício líquido para o consumidor:

» disseminação de informação, cooperando em rede com as associações de consumidores que têm uma relação de proximidade com os consumidores;

» atualização e disponibilização de informação aos consumidores de eletricidade e de gás natural sobre preços das ofertas comerciais praticadas, bem como de ferramentas informáticas de apoio aos consumidores na escolha de comercializador. Inclui-se, neste âmbito, a disponibilização na página da internet da ERSE de simuladores que asseguram informação objetiva aos consumidores de eletricidade e de gás natural para fazerem as suas opções de consumo de forma consciente e adequada;

» "descodificação" da complexidade das ofertas através de "chaves" que clarifiquem os seus conteúdos como é o caso da ficha contratual padronizada;

» identificação das estratégicas comerciais dos operadores (low cost; focados no preço; serviços integrados);

» imposição de obrigações de informação aos comercializadores que permitam identificar claramente os serviços que estão associados ao fornecimento de energia, distinguindo o que é próprio do fornecimento e o que são serviços adicionais e deixando claro que o fornecimento de energia não pode depender da contratação desses serviços;

» facilitar o aparecimento de novos agentes vocacionados para a intermediação[8] entre o consumidor e o mercado elétrico, entre o consumidor e as tecnologias, entre o consumidor e os mercados financeiros ou até entre o consumidor e os comercializadores[9].

Os consumidores especialmente suscetíveis às falhas de mercado devido a carência económica, falta de informação ou outras barreiras, têm beneficiado de uma discriminação positiva por parte da ERSE de forma a assegurar a efetiva prestação das obrigações de serviço público num contexto de mercado liberalizado.

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[8] Como é o caso, entre outros, dos agregadores, empresas de serviços de energia e auditores energéticos.

[9] Um exemplo interessante da intermediação entre os consumidores e os comercializadores são as ações de *collective switching* como as que a DECO tem promovido no âmbito da promoção dos chamados leilões de energia.

4. A proteção dos consumidores: informação, regulamentação, supervisão e aplicação do regime sancionatório

De forma a assegurar o reforço e a consolidação do mercado retalhista, a ERSE tem atuado em quatro vertentes: desenvolvimento de ações de informação e formação junto dos consumidores sobre o processo de liberalização, adaptação dos regulamentos às novas circunstâncias suscitadas pela liberalização, reforço das ações de supervisão e monitorização de mercados e aplicação do regime sancionatório.

Para além do empenhamento reforçado nas áreas da informação aos consumidores e apoio à tomada de decisão, a ERSE intensificou as ações de monitorização e supervisão do funcionamento do mercado nas suas diferentes dimensões, designadamente no que se refere a preços no mercado retalhista e grossista, práticas comerciais e contratuais, bem como no âmbito do processo de mudança de comercializador.

O reforço da informação aos consumidores consolidou-se também através da publicação, em 2015, dos primeiros relatórios de qualidade de serviço que incluem os comercializadores em mercado, o que permite aos consumidores terem acesso a mais e melhor informação nesta exigente fase do processo de liberalização dos setores elétrico e do gás natural.

Simultaneamente, os regulamentos aplicáveis aos comercializadores regulados passaram a ser extensíveis, com as devidas adaptações, aos comercializadores de mercado em temas relevantes como sejam as obrigações de informação, as condições contratuais e a divulgação de ofertas.

A consolidação do processo de liberalização do setor energético exige uma regulação económica eficiente das atividades que têm a natureza de monopólios naturais, o que implicou alterações muito expressivas na regulação dos segmentos da cadeia de valor potencialmente competitivos (produção e comercialização) que são objeto de uma regulação *ex-post*, concretizada através da supervisão e da aplicação do regime sancionatório.

Na sequência do trabalho que vem sendo desenvolvido desde 2013, ano da aprovação do Regime Sancionatório do Setor Energético, a ERSE reforçou as atividades de inspeção e auditoria que, conjuntamente com a tramitação de denúncias recebidas, a instauração e instrução de processos sancionatórios e a aplicação das correspondentes sanções traduzem o exercício das competências de fiscalização e *enforcement* conferidas pelos Estatutos e pelo Regime Sancionatório do Setor Energético. Assim, desde a entrada em vigor daquele diploma, até ao final de 2015, foram abertos vinte e seis (26) processos de contraordenação, tendo sido deduzidas treze (13) notas de ilicitude, nove (9) decisões de condenação e dois (2) arquivamentos. De entre as decisões condenatórias, cinco (5) aplicaram coimas efetivas. No total, até 31 de dezembro de 2015, ERSE aplicou coimas no valor de 7.537.500 euros.

5. Regulação económica

A eficiência na prestação do serviço público de fornecimento de eletricidade e gás é inequivocamente determinada por uma regulação eficaz num contexto de existência de monopólios naturais nas infraestruturas de redes e de barreiras à entrada no setor energético devidas, entre outros, às economias de escala e aos riscos e incerteza que caraterizam o funcionamento destes mercados.

Uma regulação transparente, estável e previsível permite reduzir o risco e a incerteza, estimulando decisões eficientes e criando um ambiente favorável à redução do custo de financiamento.

5.1. Diferenciação horária e tarifas dinâmicas

No paradigma "clássico" de funcionamento do setor elétrico, a produção segue a procura de acordo com um fluxo de energia de sentido único em que um sistema de produção centralizada e flexível se adaptava a uma procura variável e com uma componente de imprevisibilidade que poderia ser expressiva. A emergência das energias renováveis, com estrutura de custos fixos elevados e uma produção descentralizada de pequena dimensão, tornou necessária a valorização de mecanismos de flexibilidade, incentivando o armazenamento e a gestão da procura.

Face a estas circunstâncias, um dos focos da inovação na regulação tem estado concentrado na valorização da flexibilidade quer da oferta quer da procura. Em Portugal já existem alguns mecanismos de gestão da procura como é o exemplo do regime de interruptibilidade e as tarifas com diferenciação por período horário. Cerca de 60% do consumo em Portugal beneficia já de tarifas com quatro períodos horários, a que acrescem cerca de 20% do consumo que têm acesso a tarifas bi ou tri-horárias. Deve sublinhar-se que se trata de uma situação que nos coloca numa posição muito avançada no contexto da União Europeia.

A ERSE introduziu em 2015 a obrigação de realização de projetos piloto de tarifas dinâmicas no acesso às redes, previstos para 2016. A introdução de métodos “critical peak” e tarifas dinâmicas “em tempo real” serão os novos instrumentos. Estudos demonstram que as tarifas dinâmicas permitem responder melhor aos períodos críticos de ponta da rede, com um potencial de redução do consumo muito superior ao das tarifas com diferenciação horária. Isto deve-se ao facto dos períodos críticos serem definidos mais próximo da sua ocorrência, o que possibilita a adoção de períodos de ponta mais curtos e permite maior diferenciação de preços entre períodos, transmitindo sinais preço mais fortes quando comparado com as tarifas com diferenciação por período horário.

5.2. Incentivar o acesso ao mercado de novos entrantes

Face às vantagens competitivas das empresas incumbentes do setor elétrico e do gás natural, a ERSE tem vindo a tomar decisões de regulação que visam minimizar as barreiras à entrada daí resultantes. A título ilustrativo, apresentamos seguidamente alguns mecanismos que foram desenvolvidos tendo presente esta preocupação.

No setor do gás natural foram introduzidos dois mecanismos que visam promover o acesso ao mercado dos novos entrantes de menor dimensão: o mecanismo de incentivo às trocas reguladas de gás natural e as tarifas de curtas durações e de curtas utilizações. Para além de facilitar o acesso ao mercado, estes mecanismos promovem uma utilização mais intensiva do terminal e das redes, contribuindo assim para uma redução dos custos unitários e das tarifas de acesso.

O mecanismo de incentivo às trocas reguladas visa fomentar a existência de trocas reguladas de GNL entre o comercializador detentor dos contratos em regime de take-or-pay, celebrados em data anterior à publicação do Decreto-Lei nº 140/2006, de 26 de julho, e os comercializadores entrantes, no âmbito da sua atividade de comercialização a clientes. De uma forma simples, este mecanismo assegura o acesso competitivo pelo terminal de Sines de um comercializador que tenha uma carteira de clientes que consuma uma quantidade de gás natural equivalente aproximadamente a 4 navios de 70 000 m3 de gás natural liquefeito.

As tarifas de curtas durações e de curtas utilizações tornam mais abrangente o leque de opções tarifárias disponíveis, oferecendo mais flexibilidade a consumidores industriais e a comercializadores cujas atividades se adequem a estes perfis de utilização das redes de alta pressão.

Adicionalmente para o setor do gás natural importa também mencionar o novo desenho de tarifas de entrada e saída e de alocação de capacidade nas grandes infraestruturas de alta pressão do sistema de gás natural, que contribui para facilitar a troca de gás natural entre agentes de mercado no ponto virtual de balanço (dentro da rede de transporte) facilitando a otimização do aprovisionamento de gás natural e promovendo a integração do mercado português com o espanhol no quadro do MIBGAS e com o Mercado Interno da Energia (MIE). Como consequência destas alterações o mercado português é aprovisionado de diversas origens, designadamente (i) GNL de diversos mercados internacionais como Nigéria, Argélia, Qatar, Trinidad Tobago e mais recentemente gás de xisto dos Estados Unidos da América, (ii) GN da Argélia no âmbito de contratos internacionais e (iii) e GN adquirido em mercados organizados no centro da Europa. Estas novas regras de tarifas de entrada e saída e de alocação de capacidade anteciparam em vários anos os códigos de redes europeus de alocação de capacidade e de tarifas, facilitando a entrada de novos agentes no mercado e a diversidade de aprovisionamento de gás natural e promovendo e antecipando a harmonização de regras no espaço europeu.

A legislação do setor elétrico estabelece que o Comercializador de Último Recurso (CUR) deve adquirir toda a energia elétrica produzida pelos produtores em regime especial (PRE). Em Agosto de 2011, a ERSE alterou a regulamentação, separando as funções do CUR de compra de energia para os seus clientes e de compra e venda da energia da PRE. Para além disso, a ERSE estabeleceu ainda a existência de um mecanismo regulado de venda da energia da PRE – os "leilões da PRE" – que visam, por um lado, estabilizar as condições da sua colocação em mercado e, por outro lado, servir como ferramenta de aprovisionamento e cobertura do risco de preço aos comercializadores em regime de mercado.

5.3. Regulação "por incentivos"

A ERSE tem incentivado as empresas a desenvolverem processos mais eficientes e a tomar as decisões economicamente mais racionais, com vista à diminuição dos custos, à melhoria da qualidade de serviço e à contenção tarifária.

Nesse quadro, a ERSE tem vindo a adotar uma regulação "por incentivos" para quase todos os segmentos da cadeia de valor das atividades reguladas. A "regulação por incentivos" condiciona a obtenção dos proveitos ao cumprimento de metas definidas para diminuir custos[10] ou, ainda, na prossecução de outros objetivos, tais como melhorar a qualidade de serviço, reduzir as perdas nas redes ou promover investimentos inovadores cujos benefícios gerem externalidades positivas no meio envolvente. Os resultados da regulação por incentivos, aplicada pela ERSE, têm sido visíveis tanto na melhoria da qualidade de serviço, como na diminuição dos custos das atividades reguladas. Para além disso, a ERSE tem vindo a proceder a ajustamentos a este mecanismo de forma a garantir uma melhor distribuição dos ganhos decorrentes desta forma de regulação entre empresas reguladas e consumidores.

6. Promoção de estratégias empresariais sustentáveis e focadas na qualidade de serviço

A regulação económica dos monopólios naturais baseada em incentivos tende a estimular as empresas reguladas a privilegiarem a eficiência económica em detrimento de outros objetivos relevantes como sejam a eficiência energética, o desempenho ambiental ou a qualidade de serviço. Esta circunstância suscitou a necessidade de estabelecer sistemas de incentivos focados na prossecução de objetivos multidimensionais e mais abrangentes que contribuam para que as empresas reguladas protagonizem estratégias empresariais inspiradas nos princípios da sustentabilidade e da responsabilidade social.

6.1. Descarbonização da sociedade[11]

Uma das questões que, desde sempre, esteve presente no desenho dos sucessivos modelos regulatórios adotados pela ERSE é a seguinte: Como promover a eficiência no consumo de energia elétrica? As tarifas devem constituir um sinal incentivador de comportamentos típicos de racionalidade económica, induzindo um uso racional da energia elétrica e de outros recursos associados. Para tal, as tarifas devem:

» recuperar todos os custos “eficientes” associados a cada atividade;

» ter variáveis de faturação que transmitam sinais de preço corretos aos consumidores;

» ter estruturas de preços aderentes aos custos marginais ou incrementais.

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[10] Será de referir, a título ilustrativo, que os custos operacionais (OPEX) são regulados por Price-Cap e os investimentos relativos à rede de transporte do setor elétrico são regulados através do mecanismo dos custos de referência aos quais são fixadas metas de eficiência.

[11] Retoma-se neste ponto a abordagem apresentada em: Santos, V (2008), Eficiência energética, regulação e (in) formação, in: Ribeiro, F., *A energia da razão, por uma sociedade com menos CO_2*, Gradiva.

Para além disso, como vimos anteriormente, a "regulação por incentivos" condiciona a obtenção dos proveitos ao cumprimento de metas definidas para a redução das perdas nas redes.

Mas, sendo assim, a questão que ocorre suscitar imediatamente é a seguinte: porquê estabelecer um outro tipo de mecanismo que complemente os incentivos induzidos pelo sinal preço?

A evolução na regulação e liberalização dos mercados da eletricidade e do gás natural tem levado a uma maior eficiência no lado da oferta de energia. No entanto, no que respeita ao lado da procura, continuam a existir inúmeras barreiras ao aumento da eficiência no consumo de energia, nomeadamente quanto à participação das empresas de energia em atividades de eficiência energética. O reconhecimento da existência de diversas barreiras à adoção de equipamentos e hábitos de consumo mais eficientes por parte dos consumidores, bem como a eventual existência de externalidades ambientais não refletidas nos preços, justifica a implementação de medidas de promoção da eficiência no consumo. As barreiras e falhas de mercado, que dificultam ou impedem a tomada de decisões eficientes por parte dos agentes económicos, suscitam a necessidade de desenvolver um instrumento complementar que contribua para minimizar as distorções acabadas de referir:

- externalidades ambientais;
- diferenças entre preços de abastecimento e os custos marginais;
- défice de informação e elevados custos de transação associados;
- períodos de retorno longos e taxas de desconto elevadas;
- desalinhamento de interesses entre os agentes ou restrições financeiras dos consumidores.

O Plano de Promoção da Eficiência no Consumo de Energia Elétrica (PPEC), promovido pela ERSE, visa promover a redução do consumo de energia elétrica bem como iniciativas que permitam uma redução dos custos de fornecimento, sem que isso envolva necessariamente a redução de consumos, nomeadamente a transferência de consumos em períodos de horas de ponta e/ou cheias para períodos de vazio. São igualmente consideradas medidas que visem a disseminação de informação e a divulgação de boas práticas ao nível da utilização da eletricidade; trata-se de medidas que, embora não tenham impactos diretos mensuráveis, são indutoras de comportamentos mais racionais e fundamentados num melhor conhecimento das opções que conduzem a utilizações mais eficientes de energia elétrica.

6.2. Qualidade de serviço

Temos vindo a assistir a uma melhoria sustentada na continuidade de serviço ao longo da última década na sequência, em 2002, quer da publicação, pela primeira vez, do Regulamento da Qualidade de Serviço (RQS), quer da introdução no Regulamento Tarifário da ERSE do incentivo à melhoria da qualidade serviço na rede de distribuição em média tensão.

Estes fatores, conjugados com um planeamento adequado dos investimentos e das ações de manutenção realizadas, contribuíram decisivamente para uma melhoria da qualidade de serviço em Portugal nos últimos anos[12], verificando-se uma evolução do desempenho das redes elétricas em termos de continuidade de serviço para patamares bastante superiores aos que se encontravam estabelecidos nos RQS em vigor antes da revisão efetuada em 2014.

Apesar das melhorias claras, a evidência empírica existente também demonstra que é necessário continuar com os esforços para manter a tendência atual de melhoria da qualidade de serviço de forma a garantir a convergência sustentada para os níveis de qualidade médios europeus.

O RQS em vigor, em Portugal continental, antes do processo de revisão de 2014 foi aprovado em 2006. Desde então, o setor passou por alterações significativas, em especial as decorrentes do processo de liberalização, incluindo o número e a abrangência dos comercializadores em atuação no mercado. De resto, no atual quadro de extinção de tarifas reguladas em Portugal continental, os comercializadores de mercado vão passar a beneficiar de quotas de mercado crescentes, pelo que se tornou premente refletir sobre as obrigações dos comercializadores de mercado e de último recurso retalhistas.

[12] A duração anual da totalidade das interrupções sentidas pelos clientes em Baixa Tensão passaram de 600 minutos, em 2001, para 145 minutos em média nos últimos 3 anos (2013 –2015).

Com a alteração dos estatutos da ERSE efetuada em 2012, a aprovação do Regulamento da Qualidade de Serviço do Setor Elétrico (RQS SE) passou a ser da sua competência.

Nesse âmbito, a ERSE identificou três eixos estratégicos:

» adequar os níveis de exigência da qualidade de fornecimento de energia elétrica ao nível de desempenho e maturidade tecnológica alcançados pelas redes e infraestruturas atuais;

» aprofundar o atual quadro de partilha de responsabilidades entre os operadores e os utilizadores das redes elétricas;

» adequar o regulamento à liberalização do mercado.

Em janeiro de 2014 entrou em vigor o novo Regulamento da Qualidade de Serviço que introduziu as seguintes alterações:

» fixação de padrões gerais e individuais mais exigentes no sentido de acompanharem a evolução positiva que se tem verificado no desempenho da continuidade de serviço das redes;

» redução das assimetrias regionais através de um incentivo à recuperação dos clientes pior servidos;

» obrigatoriedade da monitorização e publicitação de informação relativa às interrupções breves, procurando assim responder às preocupações manifestadas pelos clientes industriais.

7. O futuro do setor energético e os novos desafios da regulação

O setor da energia atravessa um período de mudanças estruturais que apontam para uma visão de futuro bastante diferente do cenário atual quer para os operadores e agentes do setor quer para os consumidores.

Muitos dos procedimentos tendem para uma harmonização de regras que facilitam a participação dos agentes nos mercados dos vários países da UE. As diretivas europeias impuseram também o modelo da desverticalização do setor (com a separação dos operadores de redes face à produção e comercialização) e da liberalização dos segmentos da produção e comercialização (de que é exemplo o fim das tarifas reguladas para clientes finais).

A inovação tecnológica ao nível da produção de energia elétrica aponta para uma redução significativa da escala económica dos projetos, viabilizando a produção local de energia a partir de fontes renováveis como a energia fotovoltaica ou eólica. Em Portugal passámos de pouco mais de 200 produtores há poucos anos para cerca de 20 000, em virtude de iniciativas como a microprodução de energia. Enquanto os projetos anteriores apareceram ao abrigo de programas governamentais de incentivo às renováveis, com atribuição de subsídios essencialmente pagos pelas tarifas do setor, os novos investimentos já começam a ser auto sustentáveis sem subsídios, potenciando largamente o seu aparecimento.

As redes de energia incorporam cada vez mais inovação, sendo mais automatizadas e permitindo melhores níveis de qualidade de serviço. Essas redes têm que se adaptar ao novo paradigma de mercado, mais dinâmico e com mais agentes ativos.

A inovação afeta também a forma de consumir energia. São exemplos os novos usos de energia elétrica e de gás natural em desenvolvimento na área da mobilidade de pessoas e mercadorias ou os sistemas inteligentes de monitorização de consumos e de produção, com gestão integrada de recursos de energia (microgrids, smart homes). Essa inovação traz também novos serviços aos consumidores, que podem ser associados ao fornecimento de energia ou ser fornecidos em separado.

Em consequência desta mudança de paradigma do setor elétrico, as responsabilidades e os desafios dos vários agentes e operadores da cadeia de valor do setor estão sob pressão de mudança.

Aos agentes de mercado é solicitada a participação em mercados de âmbito mais alargado do que o nacional, de que o MIBEL é um exemplo concreto, assim como a intervenção nas discussões no plano regional/europeu.

Os consumidores poderão ser mais ativos no mercado, utilizando as suas próprias instalações de consumo e produção para prestar serviços ao sistema e às redes. Esta participação será fomentada através do acesso a mais informação sobre o consumo e produção e sobre os preços no mercado. A tomada de decisões eficientes pelos consumidores poderá ser fonte de grandes poupanças de recursos pelo sistema energético e de contenção de custos.

Com a liberalização do mercado, os comercializadores passaram a beneficiar de um ambiente propício à apresentação de ofertas inovadoras de serviços e produtos. Observa-se uma tendência para o aparecimento de serviços integrados, como a venda de eletricidade e gás natural ou combustíveis, prestação de serviços de energia, sistemas de miniprodução ou mobilidade elétrica.

A prestação de serviços de energia aos consumidores residenciais e às empresas é assegurada por uma nova camada de empresas no setor, que podem atuar em conjunto com os comercializadores ou autonomamente. Estes serviços poderão vir a incluir a agregação de pequenos produtores ou consumidores na relação com os operadores de redes com vista à prestação de serviços à rede e ao sistema. Alguns dos novos negócios da internet e dos serviços estão a estender-se à área da energia, associando a gestão da energia a um serviço mais amplo de gestão de informação em casa ou nas empresas. A maior complexidade que se anuncia no mercado de energia traz novos problemas aos consumidores. As empresas do setor são por isso chamadas a atuar como intermediárias dessa complexidade, assegurando a satisfação do consumidor e minimizando o esforço pedido a este para participar no mercado.

O planeamento e operação das redes e das infraestruturas de eletricidade incorporam um contexto de maior incerteza neste período de mudanças estruturais no setor energético. A complementaridade e cooperação entre os gestores de sistema regionais e também entre os diferentes operadores de rede, quer de transporte quer de distribuição, é um desafio que assume maior importância face aos desenvolvimentos do setor.

O setor elétrico está cada vez mais interrelacionado com o setor do gás natural e até com o setor financeiro, com a sofisticação dos instrumentos de mercado utilizados na contratação de produtos e serviços de energia, além do problema mais tradicional do acesso a financiamento.

O desenho do mercado elétrico, e dos instrumentos e mecanismos nele previstos, deve ser revisto de modo a proporcionar o ambiente favorável à concretização dos desenvolvimentos do mercado e à incorporação de nova tecnologia e inovação. É necessário colocar permanentemente a questão essencial sobre se o mercado está a proporcionar os resultados esperados pelos consumidores, em termos de nível e qualidade de serviços e de preços.

Importa encontrar meios adequados para incorporar mais energia renovável nas redes, promovendo simultaneamente a eficiência económica global do sistema elétrico e a segurança de abastecimento de médio prazo.

A inovação nas tecnologias e nos serviços é uma característica constante do setor energético. No entanto, interessa refletir sobre o modelo regulatório e de organização do setor no sentido da sua capacidade de promover e lidar com essa inovação, em benefício dos consumidores do presente e do futuro.

Num modelo liberalizado e desverticalizado como o do setor elétrico, as decisões finais dos consumidores e dos agentes do mercado dependem da consistência e do alinhamento dos sinais económicos que são transmitidos nos vários segmentos da cadeia de valor. A regulação setorial e os operadores das redes e gestores do sistema são centrais na definição destes sinais económicos a que o mercado e os consumidores são expostos, pelo que importa procurar que os sinais induzam comportamentos adequados no sentido da concretização dos objetivos da política energética (descarbonização, eficiência e racionalidade no uso da energia).

Importa perceber se, na visão apresentada sobre o futuro do setor elétrico, a inovação e a tecnologia vão promover a inclusão dos consumidores, sobretudo os menos capacitados, ou se se vão constituir como novas barreiras à perceção e à participação no mercado de energia.

CAPÍTULO 1

A REGULAÇÃO SETORIAL E A CONSTRUÇÃO DO MERCADO INTERNO EUROPEU

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A REGULAÇÃO SETORIAL E A CONSTRUÇÃO DO MERCADO INTERNO EUROPEU

Integração Europeia nos Domínios da Energia: da origem à auspiciosa "União Energética"

Filipe Matias Santos

Resumo

O presente artigo visa proporcionar uma breve visão panorâmica do movimento europeu de integração nos domínios da energia. O caminho percorrido tem ponto de partida no período pós segunda guerra mundial, em dois dos três Tratados fundadores das Comunidades Europeias (Tratados CECA e EURATOM), assinala a Carta Europeia da Energia (1991), e o respetivo Tratado (1994), desenhados na sequência da queda do muro de Berlim. Seguidamente, descreve o essencial dos três «pacotes energéticos» europeus (1996-98, 2003 e 2009), que visam a criação de um mercado interno da energia (no quadro do qual foi instituído o MIBEL), bem como a extensão do *acquis communautaire* a países não membros da União Europeia, numa ótica pan-Europeia, por via do Tratado que institui a Comunidade da Energia (2006). Por fim, depois de registar a consagração da energia como competência partilhada entre a União Europeia e os Estados-Membros, no Tratado de Lisboa (2007), é perspetivada a estratégia lançada pela Comissão Europeia para o estabelecimento de uma efetiva "União Energética".

Palavras-chave

Direito Europeu da Energia - Pacotes Energéticos - União Energética.

Introdução

A 25 de fevereiro de 2015 foi lançada, pela Comissão Europeia, a estratégia para o estabelecimento da União da Energia, que constitui assumidamente uma das prioridades da atual Comissão.

A energia passa, por esta via, a fazer parte do núcleo de setores estratégicos que integra os quatro processos fundamentais de integração europeia em curso, a par da União dos Mercados de Capitais, do Mercado Único Digital e da União Económica e Monetária (que inclui a União Bancária), ainda que este último se encontre num patamar mais aprofundado. A União Energética integra, assim, um movimento mais amplo, caracterizado pelo aprofundamento da integração de mercados, pelo reforço da regulação no quadro de regras harmonizadas, por uma maior partilha de competências no plano europeu e pelo aumento de poderes decisórios das Instituições da União Europeia.

Não obstante os desenvolvimentos entretanto conhecidos, designadamente as consultas públicas lançadas a 15 de julho de 2015, com o denominado “Summer package” e, mais recentemente, a 16 de fevereiro de 2016, com o “Sustainable energy security package”, é prematuro antecipar os contornos que a União Energética irá assumir.

Em todo o caso, independentemente das vicissitudes inerentes ao processo político desencadeado, este é o tempo certo para revisitar o caminho de integração europeia já percorrido nos domínios da energia, por forma a melhor compreender o sentido e alcance a que poderá assumir a política energética europeia.

Este artigo visa, pois, proporcionar uma visão panorâmica do movimento europeu de integração nos domínios da energia, da origem deste movimento até aos nossos dias, por forma a melhor perspetivar os possíveis contornos da União Energética que está em formação.

1. A Energia no início da integração europeia

O ideário da unidade europeia, sendo uma elaboração com raízes antigas, renasce no período pós II Guerra Mundial para assegurar uma ação solidária na reconstrução da Europa, instrumental à paz, e como tentativa de resposta imediata ao estado em que se encontravam as economias nacionais e à ameaça política que a Rússia soviética representava para as democracias ocidentais[1].

Alguns passos foram dados, logo nos anos 40, em diferentes domínios. No plano económico assistiu-se à criação da Organização para a Cooperação Económica Europeia (OECE)[2] – a atual Organização para a Cooperação e Desenvolvimento Económico (OCDE) – que, ao tempo do *European Recovery Programme* (Plano Marshall), tinha justamente como objetivos o relançamento económico, a eliminação gradual de restrições ao comércio e a instituição de uma União Europeia de Pagamentos (que veio a ser aprovada mais tarde). No plano da defesa comum foi, então, criada a União Ocidental – depois, União da Europa Ocidental (UEO) – e, mais tarde, em aliança com os EUA e o Canadá, a NATO/OTAN, baseada no Tratado do Atlântico Norte[3].

Os receios de perda de soberania, comuns a vários Estados, e a posição do Reino Unido, que já então integrava a Commonwealth[4], impediram que no pós-guerra fossem registados maiores avanços no plano da integração europeia. Ainda assim, no plano político foi criado o Conselho de Europa[5] visando a proteção dos direitos humanos, o qual veio a aprovar em Roma, a 4 de novembro de 1950, a Convenção Europeia dos Direitos do Homem[6].

No plano energético os primeiros passos são dados logo na década seguinte, concretamente em 1952 – ainda antes da instituição da Comunidade Económica Europeia (CEE) – com a criação da Comunidade Europeia do Carvão e do Aço (CECA), e mais tarde, em 1957, conjuntamente com a CEE, com a constituição da Comunidade Europeia da Energia Atómica (CEEA), também designada por EURATOM.

Comunidade Europeia do Carvão e do Aço (CECA)

No dia 9 de Maio de 1950, propulsionado por Jean Monnet, Robert Schuman, então Ministro dos Negócios Estrangeiros francês, apresentou uma proposta (Declaração Shuman) que

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1 *Vide* Ana Maria Guerra Martins – *Manual de Direito da União Europeia*, Almedina, 2014, pp.57-71; André Gonçalves Pereira, Fausto de Quadros – *Manuel de Direito Internacional Público*, 3.ª Edição, Almedina, 2001, pp. 576-582, 583-588, 595-602, 603-626

2 A OCDE, então designada por Organização para a Cooperação Económica Europeia (OECE), foi instituída por Convenção celebrada em Paris em 1948 – Diário do Governo n.º 174, I Série, de 28/07/1961.

3 Tratado assinado em Washington, DC a 4 de abril de 1949, por 12 Estados fundadores, entre os quais Portugal.

4 "É imperioso construir uma espécie de Estados Unidos da Europa (...) *Nós, Britânicos, temos a nossa própria "Commonwealth" de Nações*" – cf. «Discurso de Winston Churchill» (pronunciado em Zurique, a 19 de setembro de 1946, *60 anos de Europa* – os grandes textos da construção europeia, Gabinete em Portugal do Parlamento Europeu, pp. 15.

5 Organização internacional fundada a 5 de maio de 1949, sendo a mais antiga instituição europeia em funcionamento.

6 http://www.conventions.coe.int/

levou à subordinação do conjunto da produção franco-alemã de carvão e de aço a uma instituição europeia supranacional, numa organização aberta à participação dos outros países da Europa, lançando as bases do que é hoje a União Europeia[7].

A Comunidade Europeia do Carvão e do Aço (CECA), destinada a organizar a livre circulação do carvão e do aço, bem como o livre acesso às fontes de produção, instituída em julho de 1952[8], assumiu à data a maior importância no domínios energético, atenta a relevância que o carvão assumia, enquanto matéria-prima, na produção de eletricidade. Ao abrigo desta primeira Comunidade, diferentes Estados europeus aceitaram renunciar a parte da sua soberania nacional, em setores da economia particularmente importantes, em benefício de uma instituição europeia supranacional. Destarte, no âmbito da CECA, foi instituída a Alta Autoridade como um órgão de decisão independente dos Estados-Membros, sem prejuízo das atribuições do Conselho e da Assembleia, que ficou mandatada para atuar no interesse geral da Comunidade, sem receber ordens. Complementarmente, um Tribunal próprio passou a assegurar o controlo do Direito na interpretação e aplicação do Tratado e dos regulamentos de execução. Através desta Comunidade foi dado o primeiro grande passo para a integração europeia. Por isso mesmo, a CECA é reconhecida como a primeira das Comunidades Europeias[9].

Comunidade Europeia da Energia Atómica (EURATOM)

O sucesso verificado com a constituição da CECA, num quadro de crise energética europeia, levou a que a Assembleia desta Comunidade propusesse a extensão dos poderes desta organização a outras formas de energia. Contudo, por razões políticas e atentos os receios associados ao possível uso militar da energia nuclear, os seis Estados fundadores (Alemanha, Bélgica, França, Itália, Luxemburgo e Países Baixos) acabaram por preferir fundar, a 25 de março de 1957, uma nova Comunidade: a CEEA (Comunidade Europeia da Energia Atómica), também designada por EURATOM.

Esta comunidade foi criada, juntamente com a Comunidade Económica Europeia (CEE), pelo Tratado de Roma, tendo por objetivo o desenvolvimento da energia nuclear europeia e a garantia do seu uso regular e equitativo, numa altura em que a energia nuclear era vista como a que maior relevância assumiria no futuro[10]. Para tanto, o Tratado estabelece

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7 *Os grandes textos da construção europeia*, Gabinete em Portugal do Parlamento Europeu, pp. 24-25.
8 Tratado que institui a Comunidade Europeia do Carvão e do Aço, assinado a 18 de abril de 1951, entrou em vigor em 25 de julho de 1952.
9 Kim Talus – EU Energy Law and Policy, A Critical Account, Oxford, 2013, pp. 15.
10 Kim Talus – EU Energy Law and Policy, A Critical Account, Oxford, 2013, pp. 15.

dois organismos próprios, a Agência de Aprovisionamento e o Serviço de Salvaguardas. A CEEA teve sempre competências no domínio da energia nuclear limitadas aos fins civis, designadamente para desenvolver a utilização pacífica da energia nuclear, para evitar a proliferação de armas nucleares, coordenar os programas de investigação dos Estados-Membros e facilitar e assegurar o fornecimento e a utilização de combustíveis nucleares. Todavia, perante insuficiências normativas e a subsistência de divergências nacionais acentuadas, nem sempre esta Comunidade logrou alcançar os intentos de integração inicialmente planeados. A EURATOM subsiste, hoje, com uma natureza jurídica distinta face à União Europeia, e continua a contribuir no âmbito dos conhecimentos, das infraestruturas e do financiamento da energia nuclear, garantindo o abastecimento de energia nuclear no âmbito de um sistema de controlo centralizado.

2. As décadas de permeio

As décadas seguintes ficaram marcadas pelas crises do petróleo[11]. A primeira, em 1973, desencadeada num contexto de *deficit* de oferta que teve como pano de fundo o conflito israelo-árabe (Guerra do Yom Kippur) e o posicionamento da Organização dos Países Produtores de Petróleo (OPEP) face à posição tomada pelos Estados Unidos da América[12].

Esta crise levou a fundação da Agência Internacional da Energia, sedeada em Paris, com o propósito de auxiliar na coordenação de uma resposta coletiva às grandes ruturas no abastecimento de petróleo através da libertação de *stocks* de petróleo de emergência para os mercados[13], bem como um sistema de emergência no seio Comunitário baseado na limitação da utilização do gás natural[14] e o estabelecimento de obrigações de notificação à Comissão, por parte dos Estados-Membros, relativas a consumos, importações, investimentos e preços energéticos[15].

[11] Ainda assim, antes disso, as instituições comunitárias já haviam adotado a Diretiva n.º 68/414/CEE, de 20 de dezembro, que obriga os Estados-Membros da CEE a manterem um nível mínimo de existências de petróleo bruto e/ou de produtos petrolíferos.

[12] José Carlos Vieira de Andrade, Rui de Figueiredo Marcos (coord.) – *Direito do* Petróleo, Faculdade de Direito de Coimbra, Instituto Jurídico, Coimbra, 2013, pp. 26-34; Flávio G. I. Inocêncio – *A Organização dos Países Exportadores de Petróleo: o caso de Angola*, Chiado Editora, 2015.

[13] José Carlos Vieira de Andrade, Rui de Figueiredo Marcos (coord.) – *Direito do* Petróleo, Faculdade de Direito de Coimbra, Instituto Jurídico, Coimbra, 2013, pp. 29-30; Flávio G. I. Inocêncio – A Organização dos Países Exportadores de Petróleo: o caso de Angola, Chiado Editora, 2015.

[14] Diretiva do Conselho 75/404, de 13 de Fevereiro de 1975, relativa à limitação da utilização de gás natural nas centrais elétricas (que viria a ser revogada pela Diretiva do Conselho 91/148/CEE, de 18 de março de 1991).

[15] Obrigações que acresceram às previstas no Regulamento (CEE) n.º 1056/72 do Conselho, de 18 de maio de 1972 relativas aos projetos de investimento de interesse comunitário nos sectores do petróleo, do gás natural e da eletricidade.

A segunda crise, já nos anos 80, verificou-se no contexto da guerra entre dois dos maiores produtores de petróleo, o Irão e o Iraque, e conduziu à redução da produção e, consequentemente, ao aumento dos preços.

Apenas no final da década de 1980 a promoção da integração dos mercados energéticos nacionais num verdadeiro mercado interno da energia passou a estar na agenda do Conselho da União Europeia. A Comissão Europeia publicou, em 1988, um primeiro Livro Verde sobre a implementação do mercado interno da energia[16]. O documento postulava que a abertura à concorrência entre elétricas do espaço europeu permitiria alcançar ganhos de eficiência, baixar os preços para os consumidores e aumentar a competitividade para a indústria, impulsionando o crescimento económico e a melhoria do bem-estar social. Para tanto foram identificadas medidas concretas. A primeiro consistia na harmonização de regras e normas técnicas, na abertura dos mercados públicos e na remoção de barreiras fiscais. Depois, a necessidade de aplicação efetiva das normas do Tratado em matéria de concorrência ao direito da energia. A terceira medida envolvia procurar um equilíbrio satisfatório entre a competitividade da energia e as questões ambientais. Por fim, era defendida a necessidade de adoção pelo Conselho de regras específicas em matéria energética[17].

Todavia, os Estados-Membros recusaram a introdução de qualquer referência explícita a competências energéticas no Ato Único Europeu, que teve por objetivo o relançamento do processo de construção europeia com vista a concluir a realização do mercado interno. Mais tarde, na Conferência Intergovernamental de Roma de 1990, que procedeu à assinatura do Tratado de Maastricht, recusaram acrescentar normas relativas à "política energética comum", tendo-se ficado pelo reconhecimento de que a criação de um mercado comum implicava medidas nos domínios da energia.

De outro passo, surgiram casos que evidenciaram barreiras ao comércio transfronteiriço de energia entre Estados-Membros. Exemplo paradigmático é o interesse de Portugal na aquisição de energia nuclear produzida pela EDF - Électricité de France, que esbarrou nos preços cobrados por Espanha pelo transporte[18] (*pancaking*). O que contribuiu para o ambiente político mais recetivo à integração dos mercados energéticos que, como veremos, terá tradução, sobretudo, no Tratado de Lisboa que consagra a energia como uma competência partilhada entre a União e os Estados-Membros.

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[16] COM/88/238.

[17] Per Ove Eikeland – *The Long and Winding Road to the Internal Energy Market – Consistencies and inconsistencies in EU policy*, FNI Report 8/ 2004.

[18] Angus Johnston, Guy Block – *EU Energy Law*, Oxford, 2012, pp. 15-16.

3. Os três «pacotes energéticos» europeus

A inexistência, até ao Tratado de Lisboa, de previsão expressa nos Tratados não impediu, contudo, as instituições comunitárias de adotarem medidas nos domínios da energia, socorrendo-se de disposições referentes à concorrência e ao ambiente[19]. O caminho trilhado na energia acabou por seguir o movimento liberalizador iniciado no setor das telecomunicações[20].

O «primeiro pacote» energético europeu

Na sequência da aprovação de Diretivas relativas à transparência dos preços e ao trânsito de eletricidade e gás natural nas grandes redes[21], foram aprovadas as primeiras Diretivas que estabelecem regras comuns para o mercado de eletricidade e do gás natural: a Diretiva n.º 96/92/CE do Parlamento Europeu e do Conselho de 19 de dezembro, e a Diretiva 98/30/CE do Parlamento Europeu e do Conselho de 22 de junho.

Partindo de uma realidade assente em empresas públicas monopolistas verticalmente integradas, as Diretivas que integram o designado «primeiro pacote» vieram fixar os *basic requirements* para a abertura à concorrência e o fim dos monopólios de importação de gás[22].

Estas Diretivas procuraram garantir a criação de sistemas transparentes e não discriminatórios de autorizações para novas instalações de produção e de instalações de gás natural, a separação (*unbundling*) contabilística (e da gestão, no caso dos operadores da rede de transporte de eletricidade[23]) das atividades de produção, transporte e distribuição, a fim de evitar discriminações, subsidiações cruzadas e distorções da concorrência.

Foi também imposto, ainda que de forma limitada, o acesso de terceiros às redes (*TPA – third party access*), de forma não discriminatória, que permitisse aos consumidores elegíveis

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[19] Lourenço Vilhena de Freitas – *Direito Administrativo da Energia*, AAFDL, 2013, p. 11, Carla Amado Gomes - «O Regime Jurídico da produção de electricidade a partir de fontes de energia renováveis: aspectos gerais», *Cadernos O Direito*, n.º 3, 2008, p. 73; Carla Amado Gomes, Tiago Antunes – «O Ambiente e o Tratado de Lisboa: uma relação sustentada», *A União Europeia segundo o Tratado de Lisboa* (aspetos centrais), Coord. Nuno Piçarra, Almedina, 2011, pp. 205-233.

[20] Pedro Gonçalves – *Regulação, Eletricidade e Telecomunicações*, Coimbra Editora, 2008, pp. 70-91, Vítor SANTOS – «A Regulação do Setor Energético em Portugal: Balanço e Novos Desafios», *A Regulação da Energia em Portugal 1997-2007*, Entidade Reguladora dos Serviços Energéticos, 2008, pp. 17-26.

[21] Diretiva 90/377/CEE do Conselho, de 29 de junho de 1990, que estabeleceu um processo comunitário que assegure a transparência dos preços no consumidor final industrial de gás e eletricidade, e as Diretivas 90/547/CEE do Conselho, de 29 de outubro, e 91/296/CEE do Conselho, de 31 de maio.

[22] Christopher W. Jones – *EU Energy Law*, The Internal Energy Market, Vol. I, Claeys & Castels, 2006, pp. 8-11.

[23] Artigo 7.º, n.º 6 da Diretiva.

adquirirem energia (inclusive transfronteiriça) junto dos produtores e aprovisionadores (que estariam, por esta via, sujeitos à concorrência). No setor elétrico, os Estados-Membros podiam, contudo, estabelecer que o acesso de terceiros fosse regulado ou negociado, bem como a adoção de um modelo de comprador único, entendido como a pessoa coletiva que, na rede em que se encontra estabelecida, era responsável pela gestão unificada do sistema de transporte e/ou pela compra e venda centralizadas de eletricidade.

O «segundo pacote» energético europeu

O «segundo pacote» energético europeu data de 2003 e integra as Diretivas n.º 2003/54/CE e n.º 2003/55/CE, ambas do Parlamento Europeu e do Conselho, de 26 de junho, que estabelecem regras comuns para o mercado interno da eletricidade e do gás natural, revogando as anteriores, bem como o Regulamentos (CE) n.º 1228/2003, de 26 de junho, e n.º 1775/2005, de 28 de setembro, relativos às condições de acesso à rede para o comércio transfronteiriço de eletricidade e às condições de acesso às redes de transporte de gás natural, respetivamente.

Estas Diretivas vieram estabelecer regras comuns para o mercado interno da eletricidade e do gás natural, promovem o aprofundamento do percurso já trilhado pelas anteriores Diretivas, aprofundando o *unbundling*, o acesso às redes por terceiros e o caminho liberalizador promotor da concorrência, inclusive transfronteiriça, através de mercados competitivos, seguros e ambientalmente sustentáveis, nos quais os agentes atuem com transparência e sem discriminações. Em contraponto, por estarem em causa serviços de interesse económico geral[24], são reforçadas preocupações em torno da segurança do abastecimento e permite-se expressamente que os Estados-Membros imponham obrigações de serviço público (*public services obligations*) e de proteção dos consumidores, podendo designar comercializadores de último recurso (CUR) por forma a garantir a proteção dos consumidores economicamente vulneráveis[25].

Assim, concretizando, este «segundo pacote» veio impor um calendário para abertura dos mercados, em condições de reciprocidade. O *unbundling* passou a exigir a separação jurídica dos operadores das redes de transporte e de distribuição, pelo menos no plano

[24] Vital Moreira – «Regulação Económica, Concorrência e Serviços de Interesse Geral», *Estudos de Regulação Pública – I*, Coimbra Editora, 2004, pp. 547-563, Pedro Gonçalves – *A concessão de serviços públicos*, Almedina, 1999, pp. 36 e 37; Pedro Gonçalves, Licínio Lopes MARTINS – «Os Serviços Públicos Económicos e a Concessão no Estado Regulador», *Estudos de Regulação Pública – I*, Coimbra Editora, 2004, pp. 198-224.

[25] Sobre a comercialização de último recurso *vd.* Filipe Matias Santos – «O comercializador de último recurso no contexto da liberalização dos mercados de eletricidade e gás natural», *Revista de Concorrência e Regulação*, Ano V, n.º 18, abril – junho 2014, pp. 90-115.

jurídico, da organização e da tomada de decisões, das outras atividades não relacionadas com o transporte ou com a distribuição (forçando a fragmentação empresarial, ainda que permitindo uma constelação de entidades dentro do mesmo grupo económico), bem como a adoção de Códigos de Conduta. O acesso de terceiros às redes (*TPA*) passou a ter de ser sempre regulado, com exceção do armazenamento subterrâneo.

Adicionalmente, foram estas Diretivas que vieram estabelecer a obrigação de os Estados-Membros designarem Entidades Reguladoras totalmente independentes dos interesses do sector da eletricidade e do gás natural, que garantissem, pelo menos, a não discriminação, uma concorrência efetiva e o bom funcionamento do mercado. De entre as competências especificadas, veio prever-se que as Entidades Reguladoras dispusessem de poderes em matérias tarifárias.

No que respeita ao setor elétrico, este «pacote» reflete o reforço da influência política dos movimentos ambientalistas iniciada na década de 90 (Rio, 1992 e Quioto, 1997), bem como as dificuldades no acesso às fontes energéticas primárias. A aposta passou pelo desenvolvimento de fontes de energia renovável na produção de eletricidade (Diretiva 2001/77/CE, de 27 de setembro), pelos processos de co-geração (Diretiva 2004/8/CE, de 11 de fevereiro)[26].

No setor gasista passou a exigir-se o estabelecimento de critérios objetivos e não discriminatórios, tornados públicos, a cumprir quando a construção e/ou exploração de instalações de gás natural, ou um pedido de autorização para o fornecimento de gás natural esteja dependente de atos permissivos a praticar pelo Estado; exigindo-se ainda abertura dos mercados e reciprocidade, bem como direito de acesso a terceiros através de acesso regulado e negociado.

Foi neste quadro que foram estabelecidos *fora* neutrais e informais que passaram a constituir, até aos dias de hoje, plataformas de discussão e de troca de experiências[27] e que, no plano regional em que Portugal se insere, foi celebrado o Acordo para a Constituição do Mercado Ibérico da Energia (MIBEL)[28].

[26] Susana Tavares da Silva – *Direito da Energia*, Coimbra Editora, 2011, pp. 80-81.

[27] O primeiro Forum sobre eletricidade (European Electricity Regulatory Forum) teve lugar, em Florença em 1998 (Florence Forum), e o segundo, sobre o gás natural (European Gas Regulatory Forum), em Madrid, em 1999 (Madrid Forum).

[28] Também designado por Acordo de Santiago de Compostela. *Vd.* Resolução da Assembleia da República n.º 33-A/2004, de 20 de abril. Sobre o MIBEL *vd.* Susana Tavares da SILVA - «MIBEL: o início do embuste», Revista do Centro de Estudos de Direito do Ordenamento, do Urbanismo e do Ambiente, n.º 14, 2004, pp. 31 e ss., Susana Tavares da SILVA – «O Mibel e o mercado interno da energia», Temas de Direito da Energia, n.º 3, Almedina, 2008, pp. 279-307, Gustavo Rochette - «O Mercado Ibérico de Energia Elétrica: O Mercado de Derivados Energéticos e as Implicações do Real Decreto 216/2014 em Portugal», DaeDe, Working Papers Direito da Energia, n.º 1 de 2015.

O «terceiro pacote» energético europeu

Por fim, foi aprovado um «terceiro pacote» energético europeu que integra as Diretivas n.º 2009/72/CE e 2009/72/CE, ambas de 13 de julho, que estabelecem regras comuns para o mercado interno da eletricidade e do gás natural, o Regulamento n.º (CE) 713/2009, de 13 de julho, institui a Agência de Cooperação dos Reguladores de Energia (ACER), e os Regulamentos n.º (CE) 714/2009 e n.º 715/2009, também de 13 de julho, que estabelecem as condições de acesso à rede para o comércio transfronteiriço e instituem a Rede Europeia dos Operadores da Rede de Transporte de eletricidade (REORT - eletricidade) e gás natural (REORT – gás natural), geralmente designados pelos acrónimos ENTSO-E[29] e ENTSOG[30].

O «terceiro pacote», além de revelar preocupações com a eficiência energética/gestão da procura e com a proteção da produção descentralizada (no que respeita à energia elétrica), coloca um maior enfoque na proteção dos consumidores de energia e nos direitos destes (conservando a possibilidade de serem estabelecidas obrigações de serviço público), procedendo ainda a um aprofundamento das disposições que visam evitar discriminações, subsidiações cruzadas e distorções da concorrência, prosseguindo o caminho liberalizador na senda da criação do mercado interno[31].

O novo enquadramento veio obrigar à adoção de novas medidas no sentido do reforço da disciplina da separação das atividades de produção e comercialização relativamente à operação das redes de transporte – como meio para atingir o estabelecimento de um mercado energético interno na União Europeia integrado que permita a implementação de uma concorrência de mercado mais eficaz, sem subsidiações cruzadas. O aprofundamento do *unbundling* passa por exigir a separação patrimonial dos operadores das redes de transporte (*full ownership unbunbling*), ainda que permita a adoção de modelos alternativos (*Independent System Operator* (ISO) e *Independent Transmission Operators* (ITO), sob condição da sujeição a uma regulação mais intrusiva. O *full ownership unbunbling* implica a supervisão contínua dos conflitos de interesses no que respeita aos acionistas e membros dos órgãos de administração e fiscalização dos operadores das redes de transporte, impedindo que as partes com interesses na comercialização e/ou produção de eletricidade e/ou gás natural de exercerem influência sobre aqueles operadores. Não obstante, a separação patrimonial não ser exigida aos operadores das redes de

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29 European Network of Transmission System Operators for Electricity.
30 European Network of Transmission System Operators for Gas.
31 Filipe Matias Santos - «Regulação e Proteção dos Consumidores de energia», *I Congresso de Direito do Consumo*, Almedina, coord. Jorge Morais Carvalho, Almedina, 2016, pp. 229-258.

transporte, estes ficam obrigados à independência no plano jurídico, da organização e da tomada de decisões face a outras atividades, bem como à elaboração de um programa de conformidade.

Destaca-se, também, o reforço da independência dos reguladores nacionais, que passam a ter de ser pessoas juridicamente distintas e funcionalmente independentes não só das empresas, mas também de qualquer entidade pública, e a imposição de um alargamento significativo das suas competências regulatórias no eixo relacional entre o Estado e o mercado. Os reguladores nacionais, conservando poderes em matéria tarifária e no âmbito das questões relacionadas com as interligações, ganharam competências relativamente aos planos de investimento dos operadores das redes nacionais, de supervisão dos mercados, bem como de *enforcement*, incluindo poderes sancionatórios dissuasivos, superando a lógica de *naming and shaming*. Além disso, as Entidades Reguladoras, em articulação estreita com a ACER, passaram a desempenhar um papel relevante nos domínios das infraestruturas energéticas transeuropeias (designadamente no que respeita aos Projectos de Interesse Comum (PIC)[32] no âmbito do mecanismo *Connecting Europe Facility* (CEF)), na articulação dos planos de investimento nacionais com os planos de desenvolvimento das redes à escala comunitária ("10-year network development plan"), bem como na elaboração das orientações-quadro, no âmbito da ACER, relativas aos Regulamentos da UE, designados por Códigos de Rede (*Network Codes*) relativos a questões transfronteiriças ou à integração do mercado.

Posteriormente, por força do Regulamento (UE) n.º 1227/2011, de 25 de outubro, relativo à integridade e à transparência nos mercados grossistas da energia (REMIT), complementado pelo Regulamento de Execução (UE) n.º 1348/2014 da Comissão, de 17 de dezembro[33], foram estabelecidas regras sobre a integridade e transparência dos mercados grossitas de energia, que impõem aos participantes do mercado o registo junto das Entidades Reguladoras nacionais, a quem cabe a supervisão dos mercados grossitas, a publicação de informações privilegiadas (eliminando assimetrias informativas) e o registo de transações, incluindo ordens de negociação realizadas no mercado grossista de energia e de dados fundamentais de mercado (*data collection*), comunicando à ACER (que partilha informações com as Entidades Reguladoras nacionais) contratos e transações realizadas, prevendo-se ainda a punição do abuso de informação e da manipulação de mercado.

[32] Regulamento (UE) n.º 347/2013 do Parlamento europeu e do Conselho, de 17 de abril de 2013, relativo às orientações para as infraestruturas energéticas transeuropeias.

[33] Regulamento relativo à comunicação de dados que dá execução ao artigo 8.º, n.ºs 2 e 6, do Regulamento (UE) n.º 1227/2011 do Parlamento Europeu e do Conselho relativo à integridade e à transparência nos mercados grossistas da energia.

A transparência, integridade e liquidez dos mercados visa, justamente, promover a confiança dos investidores e a formação regular dos preços em benefício último dos consumidores.

4. Dimensões externas: Carta da Energia e Comunidade da Energia

Paralela e complementarmente ao aprofundamento das regras plasmadas no direito da União Europeia, que têm em vista a criação de um mercado interno da eletricidade e do gás natural, a União Europeia e os Estados-Membros que a integram, deram ainda outros passos no domínio da energia tendo presente, designadamente, a segurança do abastecimento.

Assim, na sequência da queda do muro de Berlim e do desmembramento da União Soviética, a 17 de dezembro de 1991, foi assinada por países da OCDE, da Europa Central e da antiga União Soviética, a Carta Europeia da Energia que, mais tarde, a 17 de dezembro de 1994[34], levou à celebração do Tratado da Carta da Energia[35], que protege os investimentos diretos estrangeiros no setor energético realizados por um privado de qualquer Estado signatário realizados no território de um qualquer outro Estado signatário, submetendo os litígios à arbitragem internacional do investimento.

Seguindo o princípio da "nação mais favorecida" ou o tratamento concedido aos seus próprios investidores (segundo o regime mais favorável), os investidores estrangeiros das partes contratantes podem ficar protegidos contra os mais importantes riscos políticos no país recetor[36]. Em matéria de resolução de diferendos entre um investidor e uma parte contratante, em certas condições, o investidor pode optar por recorrer à arbitragem internacional (*Convention on the Settlement of Investment Disputes between States and Nationals of other States* (ICSID), tanto pela Convenção de Washington quanto pelo Mecanismo Complementar, arbitragem *ad hoc* segundo as UNCITRAL Rules ou Centro de Arbitragem da Câmara de Comércio de Estocolmo)[37]. Para além de prever

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[34] Recentemente, em 2015 esta Carta foi atualizada pela denominada nova "International Energy Charter".

[35] Tratado assinado, em Lisboa, pelo conjunto dos signatários da Carta de 1991, com exceção dos Estados Unidos e do Canadá, destinado a promover a cooperação industrial Leste-Oeste prevendo garantias jurídicas em domínios como os investimentos, o trânsito, o comércio e a resolução de litígios. Foi ainda assinado, na mesma data, o Protocolo relativo à eficiência energética e aos aspetos ambientais associados.

[36] Giuliana Magalhães Rigoni – «A Regulamentação dos Investimentos Internacionais no Tratado da Carta da Energia», *Revista da Faculdade de Direito da UFMG*, Belo Horizonte, nº 51, jul. – dez., 2007, p. 116-129.

[37] Manuel P. Barrocas – «A Arbitragem na União Europeia, 10º Congresso Internacional do Direito da Energia», Instituto Brasileiro de Estudos do Direito da Energia, São Paulo, setembro 2015; Giuliana Magalhães Rigoni – «A Regulamentação dos Investimentos Internacionais no Tratado da Carta da Energia», *Revista da Faculdade de Direito da UFMG*, Belo Horizonte, nº 51, jul. – dez., 2007, p. 116-129.

um conjunto de mecanismos jurídicos de proteção do investimento e de resolução de conflitos, o Tratado da Carta da Energia regula, ainda, o livre comércio de materiais e de produtos energéticos, a facilitação do seu transporte e, por fim, a eficiência energética e a proteção do ambiente.

Adicionalmente[38], no rescaldo dos conflitos armados ocorridos, enquanto instrumento de política externa de apoio à integração progressiva dos países dos Balcãs Ocidentais[39], a União Europeia estendeu o *acquis communautaire* nos domínios da energia (eletricidade e gás natural) a um conjunto de países que não são membros da União Europeia, por força do Tratado que institui a Comunidade da Energia[40] (em vigor desde julho de 2006) que cria um mercado integrado do gás natural e da eletricidade na Europa do Sudeste, sem fronteiras internas entre as Partes, proibindo geralmente direitos aduaneiros e restrições quantitativas à importação e exportação de energia. Para tanto o Tratado estabelece a aplicação do acervo comunitário no conjunto dos Estados signatários do Tratado, ainda que de forma diferida no tempo, em matéria de energia, ambiente, concorrência e energias renováveis, bem como no respeito por normas comunitárias de âmbito geral relativas a sistemas técnicos, por exemplo no domínio dos transportes ou da conexão transfronteiriça.

Tendo sido criada no seio dos países do Sudeste Europeu, na sequência de negociações encetadas em 2008 e concluídas em dezembro de 2009, em 2010 e 2011 verificou-se a adesão, respetivamente, da Moldávia[41] e da Ucrânia[42] à Comunidade da Energia, que deixou assim de ter por referencial os Balcãs Ocidentais e passou a centrar-se na aplicação do direito europeu da energia a Estados não membros da União Europeia. A comprová-lo, confirmando que a criação do mercado energético Pan-Europeu está em marcha, atente-se que a Noruega, a Turquia, a Geórgia e a Arménia adquiriram o estatuto de observadores, que lhes permite assistir às reuniões dos órgãos da Comunidade da Energia.

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[38] Existem outros programas e parceria, como INOGATE, operacional desde 1996, que envolve a União Europeia e onze Estados da Europa de Leste, Cáucaso e Ásia central, e a União para o Mediterrâneo (que teve na origem a Parceria Euro-Mediterrânica), que constitui uma comunidade de países que circundam o Mar Mediterrâneo e que cooperaram, entre outros domínios, na área da energia.

[39] À data eram partes contratantes Albânia, Bósnia Herzegovina, Bulgária, a Croácia, a Macedónia, a Roménia, o Kosovo, a Sérvia e o Montenegro.

[40] *Vd.* Decisão do Conselho de 29 de maio de 2006, relativa à celebração pela Comunidade Europeia do Tratado da Comunidade da Energia (2006/500/CE).

[41] *Vd.* Protocolo relativo à adesão da República da Moldávia à Comunidade da Energia, celebrado em Viena a 27 de março de 2010.

[42] *Vd.* Protocolo relativo à adesão da Ucrânia à Comunidade da Energia, celebrado em Sofia a 24 de setembro de 2010.

5. Perspetivas sobre a "União Energética"

Não obstante os avanços obtidos ao longo do percurso descrito, é consabido que o objetivo da criação de um verdadeiro mercado interno nos setores da eletricidade e gás natural está longe de alcançado. Com efeito, apesar do sucesso dos Estados-Membros e da União Europeia na garantia da concretização da segurança do abastecimento desde as crises petrolíferas dos anos 1970, subsistem no seio da União Europeia vinte e oito políticas energéticas nacionais que, porque incapazes de gerar sinergias suficientes, podem acarretar sobrecustos excessivos. Paralelamente, os *blackouts* sucessivos (ainda que controlados e temporalmente espaçados)[43], os riscos de segurança do abastecimento, materializados pelas interrupções temporárias no aprovisionamento de gás natural de 2006 e 2009 verificadas em alguns Estados-Membros da Europa de Leste, e a recente crise na Ucrânia, assim como a vulnerabilidade evidenciada pelo *energy stress test*[44] realizado em 2014, vieram «despertar» a União Europeia para a necessidade urgente de promover e concretizar, finalmente, uma política energética europeia comum[45].

Tratado de Lisboa

Os primeiros passos decisivos foram dados em 2007 com a aprovação do Tratado de Lisboa, que veio atribuir, de forma inovadora, significativas competências à União Europeia em matéria energética[46]. Por força do Tratado sobre o Funcionamento da União Europeia, a

[43] Por todo o mundo são conhecidos *blackouts*, sendo alguns dos historicamente mais conhecidos os ocorridos no Noroeste dos Estados Unidos, em 1965, e na Argentina, em 1976. Mais recentemente, é assinalável a crise elétrica da Califórnia ocorrida no início deste século (conhecida por *Western U.S. Energy Crisis of 2000 and 2001*) – cf. James .L. Sweeney – «The California Electricity Crisis – Lessons for the Future», *The Bridge*, Volume 32, Number 2, Summer 2002, pp. 23-31 – bem o «apagão» ocorrido em 2003, quando perto de 50 milhões de pessoas de oito Estados dos Estado Unidos e do Canadá ficaram sem energia elétrica. *V.g.* Kim Talus – *EU Energy Law and Policy*, A Critical Account, Oxford, 2013, pp. 2; João J. E. Santana, Maria José Resende – *Refletir Energia*, ETEP – Edições Técnicas e Profissionais, 2006, pp. 147-149, No continente europeu são de assinalar o *blackout* que em 2003 afetou toda a Itália (com exceção das ilhas da Sardenha e Elba), por um período de 12 horas, e parte da Suíça, por 3 horas, afetando um total de 56 milhões de consumidores. Três anos mais tarde, já depois do episódio ocorrido em 2005 em Moscovo, no dia 4 de novembro de 2006 ocorreu um *blackout* de dimensão europeia, com origem na Alemanha (um operador da rede de distribuição alemão decidiu desligar uma linha de alta tensão no Norte da Alemanha para permitir a passagem de um navio num canal), que veio a afetar mais de 15 milhões de clientes por mais de duas horas. Este *blackout* acabou por ter um efeito em cascata que, em 28 segundos, fez-se sentir a nordeste, na Polónia, a oeste, em França, Bélgica, Países Baixos e Luxemburgo, e em Espanha, Portugal e Marrocos a sudeste. Para além disso, numa ótica estritamente nacional, o sul de Portugal, incluindo Lisboa, sofreu uma situação de *blackout* a 9 de maio de 2000, durante cerca de duas horas.

[44] COM(2014) 654 final

[45] Sobre a União Energética *vd.* Sami Andoura, Jean-Arnold Vinois (Foreword by Jacques Delors) – *From the European Energy Community to the Energy Union*, a policy proposal for the short and the long term, Studies and Reports, Notre Europe, Jacques Delors Institute, janeiro de 2015; Leigh Hancher, Adrien de Hauteclocque, Małgorzata Sadowska – *Report from Vienna Forum on European Energy Law*, 13 March 2015, Vienna; Rafael Leal-Arcas – «The creation of a European Energy Union», *European Energy Journal*, Volume 5, Issue 3, August 2015

[46] O projeto de Tratado que estabelecia uma Constituição para a Europa já incluía, inovatoriamente, a consagração de uma política comum para a energia.

energia passou a ser considerada uma matéria de competências partilhada entre a União e os Estados-Membros[47]. Nos termos do seu Título XXI, são fixados como principais objetivos da política energética da União: garantir o funcionamento do mercado da energia, garantir a segurança do aprovisionamento energético; promover a eficácia energética e as economias de energia, bem como o desenvolvimento de energias novas e renováveis, e fomentar a interligação das redes energéticas[48]. Para além disso, a energia surge especificada a propósito das medidas de política económica e da criação e desenvolvimento de redes transeuropeias[49].

Estratégia para o estabelecimento da União da Energia

Tendo presente as novas bases jurídicas relativas à energia[50], em resposta aos inúmeros desafios que persistem[51], a Comissão Europeia lançou a 25 de fevereiro de 2015 a estratégia para o estabelecimento de uma efetiva União Energética[52], que inclui um *roadmap*, de modo a completar o mercado interno europeu da eletricidade e do gás natural[53]. Segundo a apresentação inicial, a União Energética procura dar uma resposta mais efetiva a três objetivos há muito definidos para a política energética da União Europeia: segurança do aprovisionamento, sustentabilidade e competitividade. A conceção da União da Energia é centrada em cinco dimensões que se reforçam mutuamente: segurança energética, solidariedade e confiança; integração do mercado interno da energia; eficiência energética enquanto contributo para a moderação da procura de energia; descarbonização da economia; e investigação, inovação e competitividade energéticas[54]. Vejamos *brevitatis causae* em que se traduz cada uma destas dimensões.

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[47] Artigo 4.º, n.º 2, al. i) do Tratado de Funcionamento da União Europeia (TFUE).

[48] Artigo 194.º do TFUE. Estes objetivos não afetam o direito de os Estados-Membros determinarem as condições de exploração dos seus recursos energéticos, a sua escolha entre diferentes fontes energéticas e a estrutura geral do seu aprovisionamento energético, sem prejuízo da alínea c) do n.º 2 do artigo 192.º. do TFUE.

[49] Artigos 122.º e 170.º do TFUE.

[50] Sem prejuízo, de outras disposições, como as relativas ao ambiente.

[51] O relatório recorda que a União Europeia (o maior importador de energia do mundo) sofre de excessiva dependência face ao exterior em matéria energética, importando 53% da sua energia, com um custo anual de cerca de 400 mil milhões de euros e seis dos seus Estados-Membros dependem de um fornecedor externo único (Rússia) para todas as suas importações de gás; 75% do parque habitacional europeu é ineficiente do ponto de vista energético; 94% dos transportes dependem de produtos petrolíferos (90% dos quais importados) e os preços grossistas da eletricidade e do gás na Europa são, respetivamente, 30% e 100% mais elevados do que nos Estados Unidos – *Vd.* Comunicação da Comissão ao Parlamento Europeu e ao Conselho "Estratégia europeia de segurança energética", COM(2014)30; Comunicação da Comissão ao Parlamento Europeu e ao Conselho "Eficiência energética e a sua contribuição para a segurança energética e o quadro político para o clima e a energia para 2030", COM(2014)520.

[52] COM(2015) 80 final.

[53] Comunicação da Comissão Europeia ao Parlamento Europeu, ao Conselho, ao Comité Económico e Social Europeu, ao Comité das Regiões e ao Banco Europeu de Investimentos – "Energy Union Package", COM(2015) 80 final.

[54] COM(2015) 80 final, pp. 1-4.

A segurança do abastecimento visa, justamente, reduzir a dependência energética da União Europeia face a Estados terceiros (sobretudo a fornecedores únicos), promovendo um espírito de solidariedade entre os Estados-Membros (*solidarity clause*), fazendo melhor uso dos recursos endógenos e apostando na diversificação dos recursos e fontes de aprovisionamento dos diferentes Estados-Membros. Neste âmbito prevê-se uma possível avaliação de agregação voluntária da procura para aquisição coletiva de gás natural durante uma crise e nos casos em que os Estados-Membros dependam de um fornecedor único, prevendo-se que nos acordos intergovernamentais com países terceiros passem a ser avaliados *ex ante* e que a União fale a uma só voz nas negociações.

A realização do mercado interno implica que a energia possa circular livremente na União Europeia (como uma «quinta liberdade»), sem barreiras técnicas ou normativas que o obstaculizem – promovendo o cumprimento estrito das regras (*enforcement*) – por forma a que os fornecedores possam competir e oferecer melhores preços, otimizando todo o potencial das energias renováveis. Para tanto prevê-se que o mercado elétrico seja redesenhado, disponha de mais interconexões entre Estados-Membros e seja mais verde e responsável (abolição de subsídios nocivos ao ambiente).

A eficiência energética procura diminuir as necessidades de procura e, consequentemente, de importação, permitindo ainda reduzir as emissões de CO_2[55] e promover uma maior preservação dos recursos energéticos endógenos. A eficiência energética é repensada e perspetivada como uma fonte de energia que pode competir com a produção (substituindo-a parcialmente).

A transição para uma economia de baixo carbono implica que a produção distribuída de energia, incluindo a renovável, possa ser injetada de forma fácil e eficiente nas redes, promovendo a liderança tecnológica da União Europeia na nova geração de renováveis e na mobilidade elétrica, favorecendo as exportações da indústria europeia.

Por fim, a liderança tecnológica, potenciada pela investigação e inovação energéticas ao nível da produção elétrica através de fontes de energias renováveis, do armazenamento de eletricidade, da exploração não convencional de gás natural (*vg. shale gas*), ou do transporte de energia e meios de informação e comunicação – aumentará os níveis de

[55] O objetivo consiste, numa primeira fase, em reduzir as emissões de gases com efeito de estufa em pelo menos 40% até 2030 em relação aos níveis de 1990. Adicionalmente, prevê-se a restauração do Comércio Europeu de Licenças de Emissões e aumentar o investimento em fontes de energia renovável.

competitividade, que se poderão traduzir no aumento significativo das exportações, em crescimento económico e criação de emprego.

Para cumprimento destes objetivos estão previstas quinze grandes medidas, que incluem a imposição da aplicação integral e rigorosa do cumprimento da legislação em vigor nos setores da energia e conexos, a diversificação do aprovisionamento de gás natural (revisão do atual regulamento relativo à segurança do aprovisionamento de gás, preparação da estratégia para o gás natural liquefeito (GNL), incrementar o acesso a fornecedores alternativos, nomeadamente do corredor meridional do gás, do Mediterrâneo e da Argélia, transparência e conformidade dos acordos intergovernamentais com a legislação da EU, apoio à execução de grandes projetos de infraestruturas, aprofundamento do quadro regulamentar instituído (incluindo o reforço das competências e independência da ACER). Incluem, ainda, o aprofundamento das estratégias regionais de integração do mercado como parte importante da transição para um mercado da energia plenamente integrado à escala da UE, aumentar a transparência dos custos e dos preços da energia, reforço das medidas de eficiência energética e descarbonização (nomeadamente nos setores do imobiliário e dos transportes), atento o quadro estratégico para o clima e a energia no horizonte de 2030, incremento das energias renováveis (incluindo uma nova política para a biomassa e os biocombustíveis sustentáveis), a aprovação da estratégia europeia para a investigação e a inovação em matéria de energia (incluindo um Plano Estratégico Europeu para as Tecnologias Energéticas), bem como o reforço da utilização dos instrumentos de política externa (incluindo a cooperação no domínio energético entre a UE e os países terceiros).

O "Pacote de Verão"

Dando sequência à iniciativa política inicial, a 15 de julho de 2015, a Comissão Europeia apresentou o denominado "Summer package", que consiste em duas propostas legislativas e duas comunicações não legislativas. No plano legislativo prevê-se a revisão do regime de Comércio Europeu de Licenças de Emissão (EU Emissions Trading System ou EU ETS)[56], por alteração da Diretiva n.º 2003/87/CE, de 13 de outubro, medida focada no combate às mudanças climáticas e na descarbonização da sociedade. Adicionalmente, está prevista a revisão das regras de rotulagem em matéria de Eficiência Energética[57], por revogação da Diretiva n.º 2010/30/UE, de 19 de maio, por forma a promover não só a redução das emissões, mas também alcançar poupanças aos consumidores, e reduzir a dependência da UE relativamente às importações de combustíveis fósseis.

[56] 2015/148 (COD).
[57] COM(2015) 341 final.

As comunicações não legislativas, intituladas "Capacitar os consumidores de energia" [*Delivering a New Deal for Energy Consumers*][58] e "Nova configuração do mercado da energia" [*New Energy Market Design*][59], colocam em consulta estratégias específicas. A primeira propõe eixos de ação que permitam aos consumidores obviarem aos obstáculos que os impedem de fazer uma utilização plena do mercado interno da energia, assente em três pilares: melhor informação, maior poder de escolha e maior nível de proteção (o que implica, designadamente faturação e regras de publicidade mais claras, ferramentas fiáveis de comparação de preços, poder de negociação através de regimes coletivos), bem como *enforcement* no âmbito nacional. A segunda comunicação não legislativa lança uma consulta pública relativa ao modo como deve funcionar o mercado da eletricidade, incluindo uma nova configuração do mercado europeu de energia elétrica, por forma a otimizar a gestão dos recursos, tirando maior partido da concorrência transnacional, permitindo a produção descentralizada de energia elétrica, incluindo para consumo próprio, e apoiando a criação de empresas de serviços energéticos inovadoras, tendo presentes os objetivos climáticos.

Pacote sobre segurança energética sustentável

Mais recentemente, após o balanço realizado na comunicação sobre o "Estado da União da Energia", de 18 de novembro de 2015[60], e celebração do Acordo de Paris[61], a Comissão apresentou, a 16 de fevereiro de 2016, um novo pacote denominado "*Sustainable energy security package*". Este pacote, para além de introduzir Comunicações designadamente sobre a estratégia da UE para o "aquecimento e a refrigeração" e para o "gás natural liquefeito e de armazenamento de gás", propõe a adoção de um novo Regulamento e de uma nova Decisão do Parlamento e do Conselho, que substituam o Regulamento (UE) n.º 994/2010, do Parlamento Europeu e do Conselho, de 20 de outubro, relativo a medidas destinadas a garantir a segurança do aprovisionamento de gás, e a Decisão n.º 994/2012/UE do Parlamento Europeu e do Conselho, de 25 de outubro de 2012, relativa à criação de um mecanismo de intercâmbio de informações sobre acordos intergovernamentais entre Estados-Membros e países terceiros no domínio da energia.

As comunicações apresentam o gás natural liquefeito como uma alternativa enquadrável na melhor gestão do aprovisionamento a partir de fontes externas (diversificação das

[58] COM(2015) 339 final.
[59] COM(2015) 340 final.
[60] Relatório que, volvidos nove meses, revela os progressos realizados desde a adoção da Estratégia-quadro da União da Energia – cf. COM(2015) 572 final.
[61] Tratado alcançado no âmbito da Convenção-Quadro das Nações Unidas sobre a Mudança do Clima. Vd. Decisão (UE) 2016/590 do conselho de 11 de abril de 2016.

fontes, dos fornecedores e das vias de aprovisionamento), e sublinham que tem de ser feita uma aposta na moderação da procura, sobretudo por via da eficiência energética dos edifícios (cujo aquecimento e arrefecimento consomem metade da energia na União), bem como através do aumento da produção renovável.

As propostas legislativas visam prevenir e gerir situações de interrupções de aprovisionamento, reforçando a resiliência da União nos domínios energéticos, promovendo uma mudança da abordagem nacional para o campo regional, envolvendo os países membros da Comunidade da Energia, seguindo um princípio de solidariedade em caso de crise e de transparência e conformidade com o direito da União dos acordos intergovernamentais que sejam celebrados com países terceiros, através de um processo de verificação *ex ante* a cargo da Comissão Europeia.

Conclusão

A energia esteve presente na génese do movimento de integração europeia por via de dois dos três Tratados originais. Com efeito, quer o Tratado que institui a Comunidade Europeia do Carvão e do Aço (Tratado CECA), quer o Tratado que institui a Comunidade Europeia da Energia Atómica (EURATOM) refletem a centralidade das questões energéticas no processo inicial de integração europeia.

Paradoxalmente, a essencialidade do setor energético ajuda a explicar, igualmente, a relutância dos Estados-Membros na transferência de competências nos domínios da energia para entidades supranacionais (reserva de soberania). No seio comunitário o setor energético foi tido como um sector especial, tendencialmente excluído das regras do mercado e tradicionalmente sujeito a um maior intervencionismo estatal, vertido na criação de empresas públicas monopolistas verticalmente integradas – verdadeiros «campões nacionais» – e/ou na planificação vinculante de empresas privadas.

O movimento de integração comunitária do setor teve apenas início na década de 90, visando a criação de um mercado interno nos setores da eletricidade e do gás natural, o que veio determinar a abertura destes setores à concorrência, sob regulação pública setorial, impondo o progressivo abandono do modelo até então existente. O movimento liberalizante imposto por via Comunitária procurou aumentos de eficiência, conduziu à desintegração (*splitting up*) e, mais recentemente, ao *unbundling* dos monopólios verticalmente integrados, instituindo mercados concorrenciais na produção e no fornecimento, no qual os agentes gozam do direito de livre acesso (*open-acess*), transparente e não discriminatório às redes de transporte e de distribuição (*non-discriminatory third-party access to networks*), que permaneceram como monopólios naturais regulados[62].

Não obstante terem sido aprovados no domínio europeu – para além da Carta Europeia da Energia (1991)[63] e do respetivo Tratado (1994)[64] – três «pacotes» energéticos europeus (1996-98, 2003 e 2009), e de a energia ter, entretanto, por força do Tratado de Lisboa (2007), passado a constituir matéria de competência partilhada entre a União e os Estados-Membros, o objetivo da criação de um verdadeiro mercado interno nos setores da eletricidade e gás natural está longe de alcançado.

Foi em resposta aos inúmeros desafios que persistem que a Comissão Europeia apresentou a estratégia para o estabelecimento de uma efetiva «União Energética», de modo a completar o mercado interno europeu da eletricidade e do gás natural[65].

As medidas já apresentadas indiciam avanços profícuos no sentido da integração de mercados, potenciando o aumento da concorrência e, concomitantemente, o reforço da sua resiliência, num quadro de redução do impacto ambiental, de diversificação das fontes de aprovisionamento e de maior transparência e solidariedade entre os Estados-Membros, bem como de maior participação dos consumidores na organização dos mercados. É expectável que, no plano da governação, se verifique um reforço das competências da ACER, incluindo poderes para tomar decisões diretas vinculativas e para a supervisão de entidades *supra* nacionais, incluindo poderes de *enforcement*. A União da Energia distinguir-se-á, ainda, de outras iniciativas, como a Comunidade da Energia, por consagrar não um alargamento, mas sim uma verdadeira e efetiva integração europeia dos domínios da energia. Não obstante, o ambicioso plano de construir uma verdadeira União da Energia não parece poder ser reduzido às medidas propostas. Falta conhecer, designadamente, a reforma das Diretivas que integram o «terceiro pacote», o que poderá ditar o verdadeiro sentido e alcance desta União.

Noutro campo, importa assinalar que este movimento unificador convive com um outro de natureza fragmentária, designadamente ao nível da produção (cada vez mais

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[62] Filipe Matias Santos – «O comercializador de último recurso no contexto da liberalização dos mercados de eletricidade e gás natural», *Revista de Concorrência e Regulação*, Ano V, n.º 18, abril – junho 2014, pp. 90.

[63] Assinada em Haia, em 17 de dezembro de 1991.

[64] Decisão 98/181/CE, CECA e Euratom do Conselho e da Comissão, de 23 de setembro de 1997, relativa à conclusão pelas Comunidades Europeias do Tratado da Carta da Energia e do Protocolo da Carta da Energia relativo à eficiência energética e aos aspetos ambientais associados.

[65] Comunicação da Comissão Europeia ao Parlamento Europeu, ao Conselho, ao Comité Económico e Social Europeu, ao Comité das Regiões e ao Banco Europeu de Investimentos – "Energy Union Package", COM(2015) 80 final.

concorrencial e descentralizada, *maxime* por recurso às fontes renováveis e à auto-produção) e da comercialização (em face da liberalização e complexificação da oferta e da participação dos consumidores), bem como com o aumento dos fluxos nas redes e interligações, o que terá de envolver maiores responsabilidades dos agentes nacionais, designadamente no quadro da cooperação europeia.

A União Energética implicará, em qualquer caso, o reforço da integração europeia, firmado num quadro de maior partilha de competências e do reforço de poderes decisórios das Instituições da União Europeia, em articulação e cooperação com os reguladores nacionais. O essencial será perceber se este movimento de integração será apenas sequencial ou introduzirá verdadeiros elementos inovadores disruptivos.

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A responsabilidade das pessoas coletivas em processos contraordenacionais

Cláudia Cruz Gonçalves Guedes

Resumo

O presente artigo enquadra o ilícito de mera ordenação social enquanto censura de natureza social e administrativa cujo fundamento é a necessidade de sancionar comportamentos ilícitos mas axiologicamente neutros, em especial, os praticados por entidades setoriais especializadas.

Concretamente, debate-se a responsabilidade das pessoas coletivas em processo contraordenacional que, sendo diversa da responsabilidade em processo penal, decorre do previsto no artigo 7.º, n.º 2 do Regime Geral das Contraordenações e é, em especial, prevista pelo artigo 37.º do Regime Sancionatório do Setor Energético. A pessoa coletiva é responsabilizada pelos factos praticados pelos seus trabalhadores, no exercício das suas funções, quando atua por conta desta, sendo essa responsabilidade da pessoa coletiva apenas excluída quando o agente atue contra ordens ou instruções expressas daquela. A culpa da pessoa coletiva afere-se pela sua responsabilidade em evitar a conduta infratora e não pela sua atitude interna.

Palavras-chave

Contraordenações - Pessoas coletivas - Regime Sancionatório do Setor Energético, aprovado pela Lei n.º 9/2013, de 28 de janeiro (RSSE) - Regime Geral das Contraordenações, aprovado pelo Decreto-Lei n.º 433/82, de 27 de outubro, na versão mais recente dada pela Lei n.º 109/2001, de 24 de dezembro (RGCORD).

Introdução

Em processo contraordenacional, a responsabilidade das pessoas coletivas decorre, de modo geral, do disposto no artigo 7.º, n.º 2 do Regime Geral das Contraordenações (RGCORD), que determina a imputação da responsabilidade quando praticada pelos órgãos da pessoa coletiva. No Regime Sancionatório do Setor Energético (RSSE) a responsabilidade da pessoa coletiva foi especialmente prevista no artigo 37.º, sendo imputada à pessoa coletiva quando os factos tiverem sido praticados, no exercício das respetivas funções, em seu nome ou por sua conta, pelos titulares dos seus órgãos sociais, mandatários, representantes ou trabalhadores. Em ambos os casos, essa responsabilidade apenas será excluída quando o agente atue contra ordens ou instruções expressas da pessoa coletiva.

As contraordenações são uma medida de proteção da legalidade, justificam-se pela necessidade de sancionar comportamentos ilícitos mas axiologicamente neutros[1], por não terem necessariamente censura ético-moral. Esta natureza justifica também uma maior flexibilidade na análise dos pressupostos da imputação, e têm como fundamento a necessidade de aplicação de sanções a entidades que atuam em setores especializados. São uma forma de regulação da economia, uma vez que impõem deveres aos agentes que atuam no mercado, especificamente do setor energético, garantem níveis de qualidade de serviço e de relações entre as entidades e entre estas e os consumidores.

1. A responsabilidade das pessoas coletivas

A responsabilidade contraordenacional da pessoa coletiva tem assento no artigo 7.º do RGCORD, que tem sido interpretado de forma extensiva pela doutrina, incluindo também no conceito de órgão os trabalhadores ao serviço da pessoa coletiva, desde que atuem por conta desta. Esta interpretação é mais consonante com a opção tomada no artigo 37.º, n.º 2 do RSSE, que veio consagrar expressamente que "*são responsáveis pelas contraordenações previstas na presente lei quando os factos tiverem sido praticados, no exercício das respetivas funções, em seu nome ou por sua conta, pelos titulares dos seus órgãos sociais, mandatários, representantes ou trabalhadores*".

Este modo de imputação da responsabilidade é comumente denominado pela doutrina como "imputação funcional", uma vez que se trata de uma imputação operada pela

[1] Cf. Parecer do Conselho Consultivo da Procuradoria Geral da República n.º P000112013, de 06 de maio de 2013.

existência de relação entre a pessoa singular e a pessoa coletiva, sendo o funcionário da pessoa coletiva um verdadeiro representante desta enquanto atua por conta, em nome e no interesse desta, excecionando-se a situação em que o trabalhador atue contra ordens ou instruções expressas.

Refere Paulo Pinto de Albuquerque, a propósito do Regime Geral das Contraordenações que "*Trata-se de um modelo de imputação funcional. A jurisprudência tem alargado o sentido da expressão "órgão no exercício das funções" no RGCO, nela incluindo os trabalhadores ao serviço da pessoa colectiva ou equiparada, desde que atuem no exercício das suas funções ou por causa delas (...). O órgão ou representante da pessoa colectiva pode também ser responsável pela infracção cometida por um funcionário ou empregado desta se tiver um dever de vigilância sobre este e omitir essa vigilância.*" [2].

Sobre a pessoa coletiva impende um dever de vigilância sobre os seus órgãos e trabalhadores. Enquanto dever que recai sobre o órgão da pessoa coletiva, a omissão desse dever de vigilância sobre o funcionário é suscetível *per se* de constituir contraordenação[3].

A pessoa coletiva, enquanto organização, faz-se representar pelos titulares dos seus órgãos e trabalhadores, sendo que uns e outros atuam em nome desta, no seu interesse e no exercício das suas funções. Necessariamente, a pessoa coletiva pratica atos por interposta pessoa já que não podem ser os seus órgãos de administração a intervir em todas as decisões, tomadas no dia-a-dia.

Nessa medida, se os atos praticados por qualquer daqueles representantes consubstanciam a prática de contraordenações, essa prática é imputável à pessoa coletiva, sendo portanto esta responsabilizada pelas contraordenações, sem prejuízo da responsabilidade singular do trabalhador, funcionário ou administrador.

Tem sido discutido, tanto na doutrina como na jurisprudência, se seria necessário individualizar o comportamento da pessoa singular a fim de o imputar à pessoa coletiva. Acontece que numa estrutura empresarial pode não ser possível identificar a pessoa que concretamente atuou ou deveria ter atuado no caso concreto. Assim, bastará que

[2] Paulo Pinto de Albuquerque, Comentário do Regime Geral das Contra-Ordenações, à Luz da Constituição da República Portuguesa e da Convenção Europeia dos Direitos do Homem, Universidade Católica Portuguesa, 2011, pág. 53.

[3] Neste sentido, Frederico Costa Pinto, O direito de mera ordenação social e a erosão do princípio da subsidiariedade da intervenção penal, in Revista Portuguesa de Ciência Criminal, ano 7, 1997, pág. 7 a 100.

se apure que uma ou várias pessoas singulares ligadas funcionalmente à pessoa coletiva cometeram a infração, ainda que não seja possível conhecer com certeza quem.

De resto, outra solução implicaria inevitavelmente a desresponsabilização da pessoa coletiva em muitas situações em que não fosse possível conhecer a pessoa singular que concretamente praticou a infração.

O conceito extensivo de autor previsto no artigo 16, n.º 1 do RGCORD, justifica também a imputação da infração à pessoa coletiva desde que exista um nexo causal entre o comportamento desta e o tipo de ilícito, mesmo que não se identifique a pessoa singular que em concreto agiu ou deveria ter agido, sendo este o único meio de evitar lacunas de punibilidade.

Germano Marques da Silva admite, em qualquer caso, que se prescinda da identificação da pessoa singular quando "*o tribunal pode comprovar que o ato foi praticado por um órgão representante ou pessoa com autoridade para exercer o controlo, sem o que não poderia ocorrer nos termos concretos que foram realizados, mas que não seja possível individualizar de entre aqueles quem foi o agente do ato*".[4]

Por outro lado, em situações de comissão por omissão, seria quase sempre impossível saber quem deveria ter atuado. Pense-se na situação de uma qualquer obrigação que recaia sobre a pessoa coletiva no sentido de praticar um determinado comportamento para evitar a prática da infração. Se a pessoa coletiva não emitiu qualquer ordem aos seus trabalhadores para que atuassem, não pode saber-se quem teria tido efetivamente a obrigação de o fazer.

Em suma, a imputação da responsabilidade à pessoa coletiva não fica dependente da imputação a um indivíduo em concreto, bastando somente saber que o infrator foi alguém que atuava por conta da pessoa coletiva, no seu interesse e no exercício das suas funções. Não é necessário identificar a pessoa singular que concretamente atuou ou deveria ter atuado no caso concreto, sendo suficiente que exista um nexo entre o comportamento que pode ser imputado à pessoa coletiva e o tipo ilícito objetivo.

[4] Germano Marques da Silva, "Responsabilidade Penal das Pessoas Colectivas – alterações ao Código Penal introduzidas pela Lei n.º 59/2007, de 4 de Setembro", *in* Revista do CEJ, Jornadas sobre a revisão do Código Penal, n.º 8, 2008

2. As ordens ou instruções expressas

Não obstante a imputação da responsabilidade à pessoa coletiva pela contraordenações praticadas pelos seus representantes, esta ficará excluída nas situações em que o representante da pessoa coletiva atue contra ordens ou instruções expressas daquela, como é determinado pelo artigo 37.º, n.º 3 do RSSE.

Concretamente, para afastar a responsabilidade da pessoa coletiva em processo contraordenacional, é necessário que o agente infrator atue contra ordem expressa da pessoa coletiva, que conheça a ordem e que esta lhe tenha sido diretamente dirigida, por quem de direito, não podendo consubstanciar-se numa mera sugestão ou recomendação e não podendo ter caráter genérico.[5]

Como refere Paulo Pinto de Albuquerque *"Havendo uma relação de trabalho, o empregador é responsável pela infracção cometida pelo empregado, no âmbito desta relação [...]. O empregador pode ser uma pessoa singular ou colectiva. O fundamento da responsabilidade é este: o empregado está sob orientação do empregador, pelo que este responde pela contra-ordenação, mesmo que não conheça nem possa conhecer o cometimento da infracção pelo empregado."* [6]

No Acórdão da Relação de Coimbra, de 27 de junho de 2012, processo n.º 1351/11.4T2AVR.C1, foi entendido que *"a empresa titular do estabelecimento tem de ser responsabilizada pela verificação, em concreto, do dever de diligência dos seus funcionários [...] o entendimento oposto levaria ao absurdo de, emitindo a sede da multinacional, uma norma abstrata, dirigida aos seus agentes, em circular com centenas de cláusulas de letra miúda, ficasse automaticamente desresponsabilizada da sua implementação prática, precisamente nos locais onde surge com mais candente a necessidade de proteção dos bens jurídicos tutelados pela norma – os estabelecimentos de venda ao público/consumidor final [...]".*

Ora, ordens ou instruções expressas são aquelas – e só aquelas – que são dadas num caso concreto, diretamente a um determinado funcionário, para agir no quadro de uma situação casuística, sendo a responsabilidade da pessoa coletiva apenas afastada

[5] Neste sentido, Germano Marques da Silva, Responsabilidade Penal das Pessoas Coletivas e dos Seus Administradores e Representantes, Editora Verbo, 2009.

[6] Paulo Pinto de Albuquerque, Comentário do Regime Geral das Contra-Ordenações, à Luz da Constituição da República Portuguesa e da Convenção Europeia dos Direitos do Homem, Universidade Católica Portuguesa, 2011, pág. 49.

se esse mesmo funcionário decidiu agir em sentido diverso/contrário ao que lhe foi transmitido /ordenado nesse determinado caso concreto.

De todo o modo, diga-se que, tendo em atenção a estrutura organizativa de uma empresa se afigura que, podem ser aceites instruções com algum grau de generalidade, desde estas sejam facilmente apreendidas e encaminhem o trabalhador de forma clara, da maneira como deve agir em determinada circunstância, de modo apto a garantir a exclusão do risco da prática de ilícitos.

A propósito desta interpretação veja-se o defendido no acórdão do Tribunal da Relação de Lisboa, salientando que a desresponsabilização da pessoa coletiva por atuação "contra ordens" é excecional e apenas em *casos limite*[7]. E no mesmo sentido, também o Tribunal da Relação do Porto, considerou que *"Pretender que a ação de um trabalhador não se repercute na esfera jurídica da empresa para quem trabalha (a quem se encontra subordinada juridicamente), quando executa as funções para que foi contratado ou de que foi incumbido é cremos uma aberração jurídica nos tempos que correm, pois equivale a considerar que se a "ação é boa e dá lucro" é da empresa, se "é má e é lesiva" é do trabalhador.*

É que o órgão não tem mãos, não anda, não tem atividade material, mas serve-se do agente para "agir" para "fazer", e em cuja ação executa a vontade do órgão, vontade essa que é a da pessoa coletiva, e a torna responsável. Assim vista, a atuação do trabalhador repercute-se esta na esfera jurídica da arguida tornando-a responsável." [8]

No mesmo sentido, o Acórdão do Tribunal da Relação de Coimbra de 17-05-2007, processo n.º 573/06.4TTCBR.C1, e ainda Paulo Pinto de Albuquerque para quem a responsabilidade da pessoa coletiva deve ser excluída se o agente atua no exercício das suas funções, mas contra ordens expressas da pessoa coletiva e acrescenta *"sendo insuficiente que a pessoa coletiva instrua os empregados no sentido de procederem com o máximo cuidado"*[9].

O Tribunal Constitucional, através do Acórdão n.º 322/2014, foi claro ao reiterar que "*a imputação de um facto a um agente tem por referente legal e dogmático um conceito extensivo de autoria de matriz causal, conceito este segundo o qual é considerado autor*

7 Tribunal da Relação de Lisboa, 23-02-2010, processo n.º 141/09.9TBVFC.L1-5.

8 Tribunal da Relação do Porto, 16-01-2013, processo n.º 5454/11.7TBMAI.P1.

9 Paulo Pinto de Albuquerque, Comentário do Regime Geral das Contra-Ordenações, à Luz da Constituição da República Portuguesa e da Convenção Europeia dos Direitos do Homem, Universidade Católica Portuguesa, 2011, pág. 53.

de uma contraordenação todo o agente que tiver contribuído causal ou cocausalmente para a realização do tipo, ou seja, que haja dado origem a uma causa para a sua realização ou que haja promovido, com a sua ação ou omissão, o facto ilícito, podendo isso ocorrer de qualquer forma [cfr. Frederico Lacerda da Costa Pinto, em "O ilícito de mera ordenação social", na Revista Portuguesa de Ciência Criminal, Ano 7, Fasc. 1, pág. 25-26]. [...] Esta construção é uma decorrência lógica da existência no direito de mera ordenação social de normas de dever, cujo incumprimento é sancionado com coimas. Se o sistema impõe deveres a um leque alargado de destinatários é porque lhes reconhece capacidade para os cumprir e também para os violar. Daí que, apurando-se a violação do dever legalmente estabelecido os destinatários do mesmo serão responsáveis por essa violação. "O critério de delimitação da autoria neste tipo de ilícito não é o do domínio do facto, mas sim o da titularidade do dever" [Frederico Lacerda da Costa Pinto na ob. cit., pág.48]."

No mesmo acórdão, o Tribunal Constitucional refere ainda que *"É nesta lógica que, em casos como este, a regra de imputação colocada pelo conceito extensivo de autor conduzirá à responsabilização da entidade dirigente titular do dever de garante sempre que se tenha verificado o resultado [a inobservância do dever] que ela se encontrava legalmente incumbida de evitar. Impendendo sobre a entidade patronal, o dever legal de garantir o cumprimento das regras respeitantes aos tempos de condução, pausas e tempos de repouso e ao controlo da utilização de tacógrafos, na atividade de transporte rodoviário, ela é contraordenacionalmente responsabilizável, nos termos previstos no diploma em análise, não apenas nas hipóteses em que, por ação sua, tiver originado diretamente o resultado antijurídico, mas ainda no contexto de uma contribuição omissiva, causal ou cocausalmente promotora do resultado típico presumida, quando a infração é cometida pelo condutor que se encontra ao seu serviço."*.

Recentemente, por Acórdão de 26/05/2015 [processo n.º 206/14.5YUSTR.L1-5], veio o Tribunal da Relação de Lisboa, por recurso a entendimentos expressos no Acórdão do Tribunal Constitucional nº 99/2009, citado pela Relação de Évora [de 11/07/2013, Proc. nº 82/12.2YQSTR.E1], reiterar a jurisprudência anterior: *"[...] a regra de imputação objetiva colocada pelo conceito extensivo de autor conduzirá à responsabilização dos superiores hierárquicos titulares do dever de garante sempre que estes, por ação ou omissão, hajam promovido ou facilitado a execução do facto ilícito dentro da pessoa coletiva.*

A responsabilidade contraordenacional do titular do dever de garante pode ocorrer por este não ter evitado, não ter dificultado ou não ter criado as condições em que seria mais arriscado para o autor material cometer o ilícito".

Portanto, de acordo com o *supra* exposto, as ordens ou instruções expressas passíveis de afastar, e apenas em *casos limite*, a responsabilidade da pessoa coletiva têm de ser ordens expressas e concretas dirigidas a um determinado comportamento, que sejam facilmente apreendidas e encaminhem o trabalhador de forma clara, da maneira como deve agir em determinada circunstância, de modo apto a garantir a exclusão do risco da prática de ilícitos.

3. A Imputação subjetiva

A imputação da responsabilidade às pessoas coletivas nunca pode dispensar a apreciação da culpa e da imputação subjetiva. Ora, em primeiro lugar há que ter presente a diferença entre o processo penal e o processo contraordenacional. Como tem sido defendido pelo Tribunal Constitucional[10], o processo contraordenacional diferencia-se qualitativa e quantitativamente do processo criminal.

No direito de mera ordenação social, como defende Paulo Pinto de Albuquerque[11], a culpa da pessoa coletiva mede-se pela sua responsabilidade em evitar a conduta infratora e não pela sua atitude interna, ao invés do que sucede no âmbito do direito penal.

E, como sublinha Frederico Costa Pinto, no campo contraordenacional o agente não pode beneficiar de qualquer atenuação da coima quando sobre o mesmo recai a responsabilidade profissional de conhecer os bens jurídicos protegidos pelo direito contraordenacional e as regras que os protegem[12].

Paralelamente, importa ainda salientar que *"o dolo não pressupõe ou implica qualquer "intenção" especial*", como, aliás, o Tribunal Constitucional já teve ocasião de afirmar por mais do que uma vez [cf. por exemplo, o Acórdão n.º 474/09, em que se afirma que "*o tipo contra-ordenacional em causa não é [...] integrado por qualquer um dos chamados «requisitos de intenção»* ", sublinhando-se a circunstância de, recorrendo à palavras de Figueiredo Dias[13], não se tratar aqui de tipos de ilícito construídos "*de tal forma que uma*

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[10] Acórdãos n.ºs 158/92, 659/2006, 313/2007, 99/2009 e 405/2009, todos disponíveis em www.tribunalconstitucional.pt.

[11] Paulo Pinto de Albuquerque, Comentário do Regime Geral das Contra-Ordenações à luz da Constituição da República e da Convenção Europeia dos Direitos do Homem, Universidade Católica Editora, 2011, pág. 67.

[12] Frederico Costa Pinto, "O direito de mera ordenação social e a erosão do princípio da subsidiariedade da intervenção penal", in Revista Portuguesa de Ciência Criminal, ano 7, ano 7, 1997, pág. 7 a 100 e José Veloso, Erro em Direito Penal, Lisboa, 1993

[13] Jorge Figueiredo Dias, Direito Penal - Parte Geral - Questões Fundamentais; A Doutrina Geral do Crime, Tomo I, 2ª edição, Coimbra Editora, pág. 380.

certa intenção surge como uma exigência subjectiva que concorre com o dolo do tipo ou a ele se adiciona e dele se autonomiza" – Acórdão n.º 87/2010 [Plenário], de 3 de março].

Em matéria contraordenacional (que em muitas matérias é contraposto ao direito penal), a jurisprudência do Tribunal Constitucional em situações em que está *"em causa o cumprimento de regras específicas"* que os visados não podem "*em consciência, deixar de conhecer [...] o incumprimento dos deveres que para eles decorrem [...] na ausência de motivos justificativos, que neste caso não foram apresentados, ser-lhes imputado a título de dolo"* – Acórdão n.º 87/2010 [Plenário], de 3 de março.

Aliás, em matéria contraordenacional, quando estão em causa deveres específicos, pode mesmo aceitar-se, em certos casos, que *"o nível de representação suposto pelo dolo do tipo, conclui-se" por "não ter adotado as providências adequadas"* – Tribunal Constitucional, Acórdão n.º 345/2013 [Plenário], de 18 de junho.

Mesmo em Direito Penal, "[...] *dolo corresponde ao conhecimento e à vontade de praticar um certo acto que é tipificado na lei como crime*"[14]. Por maioria de razão, sendo este o dolo exigido em Direito Penal, não podemos querer exigir uma construção de dolo mais exigente, no domínio do Ilícito de Mera Ordenação Social. Significa isto que o tipo subjetivo incide sobre o facto descrito no tipo objetivo. Pelo que o dolo (da imputação subjetiva) é o dolo do facto típico.

É, por isso, que a jurisprudência refere um "[...] *princípio de congruência entre o tipo objectivo e o tipo subjectivo de ilícito doloso*"[15].

O conhecimento[16] de que se fala em relação aos elementos essenciais do facto típico será uma consciência de algum modo difusa, não sendo preciso que o agente *esteja a pensar, no momento concreto em que o faz, nos elementos do crime*[17]. Consequentemente, o dolo que tem de se provar é o *dolo-do-tipo* e não qualquer *dolus malus*[18].

[14] Teresa Beleza, Direito Penal, 2.º volume, AAFDL, pág. 166.

[15] Acórdão do Tribunal da Relação de Évora, 14/06/2005, Processo 863/05-1 (disponível em www.dgsi.pt).

[16] Como defende Eduardo Correia "*Esta concepção psicológica, que aliás apela para o aspecto da representação ou da determinação como elemento da vontade, não pode, porém, como magistralmente demonstrou Beleza dos Santos, ser aceite.* [...] *querendo o facto criminoso, o agente revela claramente, com uma conduta que traduz bem a sua personalidade, que lhe não repugna a produção desse facto, contrário ao direito, de que ele directamente suscita a produção"* - Eduardo Correia, Direito Criminal I (Reimpressão), Livraria Almedina, Coimbra, 1971, pág. 375-376.

[17] Teresa Beleza, Direito Penal, 2.º volume, AAFDL, pág. 168-169.

[18] Jorge de Figueiredo Dias, O Problema da Consciência da Ilicitude em Direito Penal, 4.ª Edição, Coimbra Editora, 1995, pág. 155 e seguintes.

Tudo ponderado, há duas conclusões a retirar. A primeira é que estando perante um ilícito contraordenacional, a culpa da pessoa coletiva mede-se pela sua responsabilidade em evitar que tivessem sido praticados os factos que constituem o ilícito e por não ter tomado as providências necessárias a esse fim; a segunda, é que o dolo incide sobre o facto típico objetivo, levando em consideração a posição da pessoa coletiva enquanto agente especializado, podendo e devendo conhecer as normas próprias da atividade que desenvolve e, bem assim, o facto ter contribuído adequadamente, por ação e omissão, para a realização do facto ilícito.

Ora, aqui chegados e tendo estabelecido qual é o tipo de dolo que deve ser exigido em processo de contraordenação, resta determinar qual a forma adequada de fazer prova desse dolo.

Antes de mais, diga-se que não há nenhuma autoridade administrativa ou judiciária que consiga produzir prova direta do dolo, ou da culpa[19] do agente. Apenas o próprio agente pode depor sobre as suas intenções no momento da prática da infração, sendo que esse depoimento é livre e será valorado de acordo com as regras da experiência. Contudo, é sempre admissível que se retirem ilações relativamente a elementos subjetivos a partir *de outros elementos* objetivos, que são aqueles que podem ser demonstrados pela autoridade.

As mais das vezes, o aplicador do Direito tem de firmar os factos relativos a *elementos subjetivos,* através da forma da prática dos *elementos objetivos*[20]. A ilação em causa é, pois, perfeitamente lícita. Nas palavras de Cavaleiro de Ferreira *"quando um facto, como*

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19 Cf. Manuel Cavaleiro de Ferreira, *Lições de Direito Penal,* Parte Geral I, Editorial Verbo, 4.ª Edição, Lisboa, 1992, pág. 297: "[…] *os actos psíquicos são de difícil comprovação por terceiros; não se comprovam em si mesmos, mas mediante ilações.*"
Expressamente referindo que a presunção judicial é meio adequado à prova da *culpa*, cf. os seguintes acórdãos: do Tribunal da Relação de Lisboa, de 23/01/1997: "*É em sede de determinação da culpa em acidentes de viação que o recurso a regras de experiência ou prova de primeira aparência tem o seu campo de aplicação por excelência* […].", e do Tribunal da Relação de Évora de 18/03/2004: "[…] *nos termos do artigo 487º, nº 1 do Código Civil, incumbe ao lesado provar a culpa do autor da lesão* […], *tal regra deve ser entendida* cum grano salis, *sob pena de ser lançado sobre o lesado um ónus por vezes incomportável. Deve, assim, aceitar-se a chamada prova de primeira aparência [presunções simples, também chamadas de judiciais ou de experiência].*".

20 Cf. o seguinte exemplo da utilização de presunção naturais para fixar a culpa: acórdão do Tribunal da Relação de Coimbra de 15/05/2001: "*A condução sob uma taxa de alcoolémia de 2,1 gr/l no sangue traduz a violação clara das mais elementares regras de prudência com que deve ser encarada a diligência de um bom pai de família, figura que deve ser reconduzida à do condutor medianamente diligente, atento e respeitador das regras estradais que visam manter a segurança rodoviária, podendo concluir-se, por isso, com toda a segurança, que houve culpa daquele* […]. *Assim, a consideração da elevada alcoolização do condutor, desacompanhada de qualquer prova de um comportamento delituoso do condutor lesado, impõe a presunção natural de culpa daquele e consequente assunção da responsabilidade no processo causal do acidente.*".

efeito, não possa ser atribuído senão a uma causa – facto indiciante – o indício diz-se necessário, e o seu valor probatório aproxima-se do da prova directa".[21]

Num sistema de prova livre, em que não existe uma prévia vinculação entre a prova de um facto e um certo meio de prova, e em que vigora a livre apreciação da prova, a demonstração jurídica de que um determinado comportamento foi praticado de forma dolosa, pode e deve ser feita com base em qualquer facto e através de qualquer meio de prova que permita, em termos de experiência comum, afirmar que o significado normal e plausível de uma certa forma de atuação é a de que o agente quis intencionalmente tal facto.

O nível de vigilância que a pessoa coletiva teve sobre os seus funcionários pode também ser averiguado, para o conhecimento do dolo, sendo um indício de dolo, a título de exemplo, no que respeita ao elemento volitivo, se a vigilância não era efetiva, especialmente nas ações que possam violar diretamente direitos de consumidores.

O dolo contraordenacional é congruente com o tipo objetivo, devendo extrair-se que se determinado comportamento ilícito foi praticado e pode ser imputado à pessoa coletiva, sabendo esta que esse comportamento era ilícito e lhe era exigível que o tivesse evitado, e não o fez, então agiu com dolo, ainda que eventual, em particular quando estamos perante agentes especializados que têm o dever de conhecer as normas próprias do setor em que atuam.

Conclusão

De todo o exposto deve concluir-se antes de mais que no direito das contraordenações, ao contrário do que sucede no direito penal, a regra é que são as pessoas coletivas as responsáveis pela prática das contraordenações cometidas pelos seus representantes, sendo que essa responsabilidade não se restringe aos seus órgãos de administração mas, pelo contrário, abrange todas as pessoas que agem por conta da pessoa coletiva, no exercício das suas funções.

Por outro lado, a imputação da responsabilidade à pessoa coletiva não fica dependente da imputação a um indivíduo em concreto, bastando apenas que exista um nexo entre o comportamento que pode ser imputado à pessoa coletiva e o tipo ilícito objetivo.

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[21] Cavaleiro de Ferreira, Curso de Processo Penal, Vol. II, Lisboa, 1956, pág. 290. No mesmo sentido vide Germano Marques da Silva, Curso de Processo Penal, II, 4.ª edição, Lisboa, 2008, pág. 115.

Relativamente às ordens ou instruções expressas que são passíveis de afastar a responsabilidade da pessoa coletiva, conclui-se que a pessoa singular tem de atuar contra ordens expressas da pessoa coletiva e será necessário que conheça a ordem e que esta lhe tenha sido diretamente dirigida, no quadro de um determinado comportamento, por quem de direito, tentando reduzir ao mínimo o risco da prática de ilícito. Não podendo, assim, consubstanciar-se numa mera sugestão ou recomendação, ainda que se possa admitir algum grau de generalidade.

Por fim, a culpa contraordenacional mede-se pela responsabilidade da pessoa coletiva em evitar que tivessem sido praticados os factos que constituem o ilícito objetivo e pelo comportamento omissivo da pessoa coletiva na adoção das providências necessárias a esse fim; e, especialmente, enquanto agente especializado, a pessoa coletiva tem a obrigação de conhecer as normas próprias da atividade que desenvolve e de contribuir adequadamente, por ação e omissão, para evitar a realização do facto ilícito.

O dolo contraordenacional incide sobre o facto típico objetivo, sendo congruente com o tipo objetivo, e devendo extrair-se que se um determinado comportamento ilícito foi praticado e pode ser imputado à pessoa coletiva, sabendo esta que esse comportamento era ilícito e lhe era exigível que o tivesse evitado, e não o fez, então agiu com dolo, ainda que eventual, em particular quando estamos perante agentes especializados que têm o dever de conhecer as normas próprias do setor em que atuam.

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Estruturas e Desafios da Regulação do Setor da Energia em Portugal e na Europa

Jorge Esteves e José Braz

Referências de publicação

Energía: Desarrollos Regulatorios en Iberoamérica, ARIAE 2008, Capítulo 4, pag. 63 - 74; Biblioteca Vivitas de Economía y Empresa.

Resumo

O presente artigo foi originalmente apresentado em 2008, durante o Encontro Anual da Associação de Reguladores Ibero-americanos de Energia. Começando por referir o enquadramento legislativo europeu e a experiência europeia de partilha de experiências entre os reguladores europeus de energia, aprofunda os princípios, valores, atribuições, e estrutura que permitem à ERSE estar em condições para responder aos desafios que se colocam à regulação do setor energético em Portugal e na Europa.

Palavras-chave

Regulação de Energia - Setor Elétrico.

1. Enquadramento legislativo europeu

As primeiras diretivas europeias dos mercados internos da eletricidade e do gás natural foram publicadas, respetivamente, em Dezembro de 1996 e em Junho de 1998. Em 2003, ambas foram revogadas pelas segundas diretivas do mercado interno da energia, que atualmente ainda se encontram em vigor.

Em Setembro de 2007, a Comissão Europeia lançou em discussão pública o 3º Pacote Europeu de Legislação sobre os Mercados de Eletricidade e Gás, que pretende garantir aos consumidores europeus as vantagens e os benefícios de um mercado de energia verdadeiramente competitivo. Este 3º Pacote é constituído por um conjunto de cinco documentos, quatro dos quais alteram as duas Diretivas 2003/54/CE e 2003/55/CE, o Regulamento (CE) 1228/2003, relativo às condições de acesso às redes para comércio transfronteiriço de eletricidade, e o Regulamento (CE) 1775/2005, relativo às condições de acesso às redes de transporte de gás natural. O quinto documento que constitui o 3º Pacote é um novo Regulamento europeu que estabelece a criação da ACER, Agência para a Cooperação dos Reguladores de Energia.

A evolução do enquadramento legislativo Europeu teve um impacto muito significativo na organização das atividades do sector energético nos países europeus. O quadro 1 apresenta, a título de exemplo, a evolução sofrida pelo sector elétrico.

Quadro 1 - Evolução do enquadramento legislativo europeu das diferentes atividades do sector elétrico

		DIRECTIVA 1996	DIRECTIVA 2003
Produção	Monopólio	Autorização (Concurso)	Autorização (Concurso)
Transporte **Distribuição**	Monopólio	Acesso Regulado Acesso Negociado Comprador Único	Acesso Regulado
Comercialização	Monopólio	Livre	Livre
Consumidores	Sem Escolha	Escolha para Elegíveis (≈ 1/3)	Todos Não-Residenciais (2004) Todos (2007)
Separação T/D	Nenhuma	Contabilística	Legal
Comércio Transfronteiriço	Monopólio	Negociado	Regulado
Regulação	Monopólio	Pouco Harmonizada	Forte e Harmonizada

Por sua vez, o 3º Pacote Europeu de Legislação sobre os Mercados de Eletricidade e Gás apresenta como aspetos mais relevantes, propostas para:

- Separação efetiva das atividades de transporte em relação à produção e à comercialização;
- Harmonização dos poderes e do grau de independência dos reguladores nacionais;
- Estabelecimento de uma instituição que promova a cooperação entre os reguladores europeus: Agência para a Cooperação dos Reguladores (Nacionais) da Energia;
- Criação de um mecanismo visando melhorar a coordenação das operações de rede, da segurança do abastecimento e das condições em que se processam as trocas transfronteiriças;
- Criar condições para que haja mais transparência no funcionamento dos mercados energéticos;
- Reciprocidade e aprofundamento da solidariedade.

A Competitividade, a Segurança do Abastecimento e a Sustentabilidade são os três princípios que norteiam toda a atividade de regulação do sector energético na Europa. A interação entre estes três princípios levam ao conjunto de desafios que é necessário vencer (Figura 1).

Figura 1 - Desafios da regulação do sector energético na Europa

Assim, a interação entre a Competitividade e a Segurança de Abastecimento orienta as preocupações com a Independência da Regulação, as perspetivas para o Investimentos nas Infraestruturas e a necessidade da Integração dos Mercados. Por sua vez, a necessidade do desenvolvimento urgente das Renováveis, da Descarbonização e da Eficiência Energética surge naturalmente da interação entre a Segurança de Abastecimento e a Sustentabilidade.

Finalmente, a interação entre a Competitividade e a Sustentabilidade justificam as preocupações atuais com as "Smart Grids", o "Smart Metering" e a Gestão do Lado da Procura ("Demand Side Management").

2. Associativismo dos Reguladores Europeus de Energia

O mercado europeu de energia caracteriza-se, essencialmente, por:

- Liberdade de investimento e comércio em todo o espaço comunitário;
- Acesso regulado às infraestruturas (redes de transporte e de distribuição e terminais de GNL);
- Liberdade de escolha de fornecedor atribuída a todos os consumidores.

Na criação desse mercado único, a cooperação entre autoridades reguladoras nacionais assume um papel fundamental, sobretudo nas questões relativas ao comércio transfronteiriço de energia, tendo o associativismo dos reguladores de energia sido considerado decisivo em termos de partilha de informação e de boas práticas.

Assim, em Março de 1997, as autoridades reguladoras nacionais de Portugal, Espanha e Itália deram início a uma cooperação informal através de reuniões periódicas e da organização de grupos de trabalho conjuntos. Em Maio de 1998 organizam o Fórum Europeu de Regulação de Eletricidade (Fórum de Florença) e, em Setembro de 1999, o Fórum Europeu de Regulação de Gás Natural (Fórum de Madrid), onde se reúnem os principais atores europeus dos dois sectores.

O alargamento da experiência de cooperação entre os reguladores de energia europeus permitiu criar, em Março de 2000, o Conselho dos Reguladores Europeus de Energia (CEER), através de um Memorando de Entendimento entre as autoridades reguladoras de energia de países europeus. Tendo entretanto aderido mais cinco países, em Junho de 2003, o CEER torna-se numa associação sem fins lucrativos.

A experiência positiva do trabalho desenvolvido pelo CEER leva a que, por decisão da Comissão Europeia (CE) de Novembro de 2003, seja instituído o Grupo de Reguladores Europeus de Eletricidade e de Gás Natural (ERGEG), órgão formal de consulta da CE. Envolvendo autoridades reguladoras nacionais de energia de vinte e nove países (os vinte sete da União Europeia, a Noruega e a Islândia), prevê-se uma nova evolução da estrutura associativa dos reguladores de energia europeus com a proposta da CE para a criação da Agência para a Cooperação dos Reguladores de Energia (ACER), prevista no 3º Pacote Europeu de Legislação sobre os Mercados de Eletricidade e Gás.

Figura 2 - As vinte e nove autoridades reguladoras nacionais de energia do espaço europeu

Apesar das muitas características comuns, as autoridades reguladoras nacionais de energia do espaço europeu apresentam também muitas características diversas. Antes de tudo, em cada espaço nacional, estas entidades assumem responsabilidades em domínios que podem ser diferentes. Assim, em Portugal e em Espanha, respetivamente, a Entidade Reguladora dos Serviços Energéticos (ERSE) e a "Comisión Nacional de Energía" (CNE) assumem a responsabilidade de regular unicamente o sector da energia. Por sua vez, nos Países Baixos, a "Dienst uitvoering en toezicht Energie" (DTE) assume funções na regulação de energia e como autoridade de concorrência. Na Irlanda e na Noruega, respetivamente, a "Commission for Electricity Regulation" (CER) e o "Norges vassdrags- og energidirektorat" (NVE) têm a responsabilidade de regular o sector energético e o sector das águas. Outro caso diferente é o da Alemanha, onde a "Bundesnetzagentur" (BNetzA) tem responsabilidades regulatórias nos domínios da energia, das telecomunicações, dos correios e da ferrovia.

As entidades reguladoras do sector energético europeu apresentam também graus de independência muito diferentes face aos seus governos nacionais, que se reflete no modo de inserção da entidade reguladora na estrutura do Estado, no modo como são nomeados ou exonerados os seus titulares, nas competências que lhes são atribuídas, na sua autonomia financeira e nas incompatibilidades de exercício de funções dos seus titulares. Estas diferenças levam a que as vinte e nove entidades reguladoras apresentem poderes de atuação e de decisão muito diferentes em cada um dos países.

3. Desafios da Regulação e a resposta da ERSE

Os principais desafios a que os Reguladores de Energia Europeus têm de responder são:

» Coexistência de sectores em Monopólios e em Concorrência;

» Organização de Mercados Grossistas eficientes;

» Organização de Mercados Retalhistas eficientes;

» Garantia da Fiabilidade do Sistema;

» Garantia da Segurança de Abastecimento;

» Garantia da Qualidade de Serviço;

» Cumprimento das obrigações de serviço público (p.e.: serviço universal no sector elétrico);

» Promoção do interesse público (Energias Renováveis, Cogeração, Eficiência Energética);

» Incentivos à otimização das infraestruturas existentes;

» Incentivos à otimização da expansão do sistema;

» "Governance" dos mercados Regionais, tendo em vista a criação do Mercado Interno da Energia em todo o espaço europeu.

Coordenada com a Comissão Europeia, a resposta dos Reguladores Europeus da Energia passa por um modelo de regulação em cooperação, com um incentivo a uma intervenção ativa de todos os atores do sector, sejam eles os operadores das redes, os produtores, os comercializadores grossistas e retalhistas, a indústria ou os consumidores.

Tendo a responsabilidade da regulação dos sectores do gás natural e da eletricidade em Portugal, a atividade da ERSE preocupa-se em manter o equilíbrio de três interesses que deverão ser harmonizados: o interesse geral, o interesse dos consumidores e o interesse das entidades reguladas. As suas principais atribuições, enquanto grandes linhas de orientação para cumprimento dos seus objetivos e finalidade, estão identificadas com sendo:

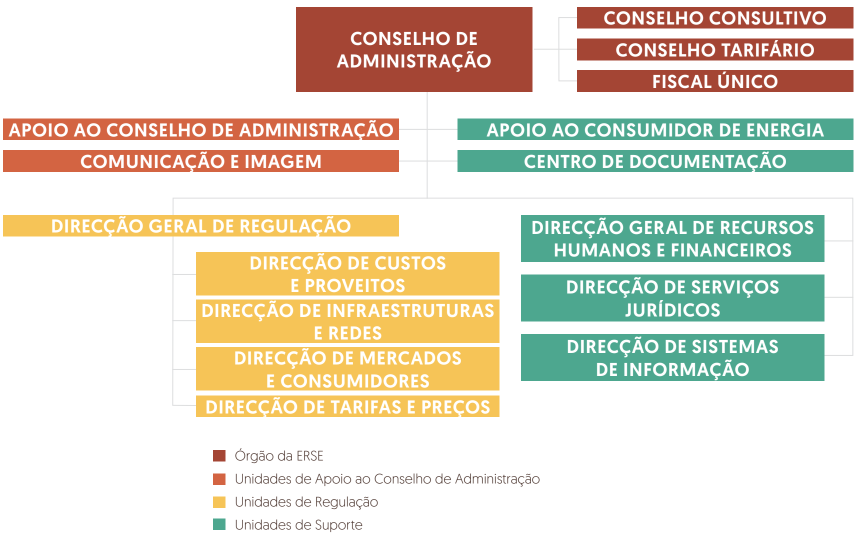
» Proteger os direitos e interesses dos consumidores em relação a preços, serviços e qualidade de serviço.

- Criar condições para o funcionamento eficiente e concorrencial dos mercados energéticos e contribuir para melhorar a eficiência das atividades sujeitas a regulação.
- Assegurar a objetividade das regras da regulação e a transparência das relações comerciais entre operadores e entre estes e os consumidores.
- Contribuir para a progressiva melhoria das condições técnicas, económicas e ambientais nos sectores regulados estimulando, nomeadamente, a adoção de práticas que promovam a utilização eficiente dos recursos energéticos e a existência de padrões adequados de qualidade de serviço e de defesa do meio ambiente.
- Promover a utilização eficiente de energia e a melhoria do desempenho ambiental das empresas reguladas.
- Verificar o cumprimento das obrigações de serviço público nos sectores regulados.
- Promover a informação e o esclarecimento dos consumidores de energia, podendo exigir das entidades reguladas o envio de informação relativa ao exercício das suas atividades.

No sector da energia, a ERSE partilha competências no âmbito da promoção/supervisão da concorrência com a Autoridade da Concorrência e no âmbito da promoção/supervisão dos Mercados organizados com a Comissão de Mercados de Valores Mobiliários.

A Figura 3 apresenta o organograma da ERSE.

Figura 3 - Organograma da ERSE



O Conselho de Administração da ERSE é o órgão colegial responsável pela definição e pelo acompanhamento da atividade reguladora da ERSE, sendo composto por um presidente e dois vogais, nomeados por resolução do Conselho de Ministros por um prazo de cinco anos.

Com um número máximo possível de dois mandatos e incompatibilidades durante e depois do mandato por dois anos, os membros do Conselho de Administração não podem ser exonerados, de modo a assegurar a independência da sua atuação.

Ao Conselho de Administração da ERSE compete:

» Definir a orientação geral da ERSE e acompanhar a sua execução;
» Aprovar os regulamentos externos e internos necessários ao exercício das suas funções;
» Elaborar pareceres sobre aspetos específicos.
» Tomar as decisões necessárias para a concretização dos objetivos e que respondam às obrigações;
» Dirigir a atividade da Entidade Reguladora.

De referir a importância da autonomia financeira da ERSE, cuja atividade é financiada a partir das tarifas e não depende do Orçamento do Estado, embora o seu orçamento anual esteja sujeito à aprovação do Ministro da tutela (Economia e Inovação).

Um valor orientador da atividade da ERSE passa pelas regras claras, simples e públicas do processo de tomada de decisão e pelo envolvimento sistemático dos seus órgãos consultivos – o Conselho Consultivo e o Conselho Tarifário.

O Conselho Consultivo da ERSE, constituído pelos representantes das entidades que constam do Quadro 2, intervêm nos processos e emite pareceres não vinculativos sobre:

» Plano de Atividades e Orçamento anual;
» Relatório de Atividades e de Contas anual;
» Parecer da ERSE sobre os Padrões de Segurança da Produção e do Sistema de Transporte;
» Revisão dos Regulamentos da responsabilidade da ERSE (com exceção do Regulamento Tarifário);
» Regras de acesso do sistema elétrico não vinculado;
» Propostas relativas aos Padrões de Segurança e de qualidade do transporte e distribuição do gás natural;
» Outros assuntos submetidos pelo Conselho de Administração.

Quadro 2 - Entidades cujos representantes constituem o Conselho Consultivo da ERSE

Ministro da Economia, que preside (1)
Ministro das Finanças (1)
Ministro do Ambiente e do Ordenamento do Território (1)
Membro do Governo que tutele a defesa do consumidor (1)
Associação Nacional de Municípios (1)
Instituto do Consumidor (1)
Direção Geral da Energia e Geologia (1)
Instituto do Ambiente (1)
Conselho da Concorrência (1)
Entidades titulares de licença vinculada de produção de eletricidade (1)
Entidades titulares de licença não vinculada de produção de eletricidade (1)
Entidade concessionária da RNT (1)
Entidade titular de licença vinculada de distribuição de energia elétrica em MT e AT (1)
Entidades titulares de licença vinculada de distribuição de energia elétrica em BT (1)
Entidade titular da concessão de serviço público de transporte de GN (1)
Entidades concessionárias das redes de distribuição regional (1)
Titulares de licença de distribuição de serviço público de gás (1)
Associações de defesa do Consumidor (2)
Clientes não vinculados de eletricidade (1)
Grandes consumidores industriais de GN (1)
Consumidores de GN para produção de eletricidade (1)
Governo Regional dos Açores (1)
Governo Regional da Madeira (1)
Empresas do sistema elétrico da Região Autónoma dos Açores (1)
Empresas do sistema elétrico da Região Autónoma da Madeira (1)
Consumidores da Região Autónoma dos Açores (1)
Consumidores da Região Autónoma dos Madeira (1)

Por sua vez, o Conselho Tarifário da ERSE, constituído pelos representantes das entidades que constam do Quadro 3, intervêm nos processos e emite pareceres não vinculativos sobre as propostas de Tarifas e Preços e de revisões dos Regulamentos Tarifários dos sectores elétrico e do gás natural.

Quadro 3 - Entidades cujos representantes constituem o Conselho Tarifário da ERSE

Entidade concessionária da RNT (1)
Entidade titular de licença vinculada de distribuição de energia elétrica em MT e AT (1)
Entidades titulares de licença vinculada de distribuição de energia elétrica em BT (1)
Entidade titular da concessão do transporte de gás natural através da rede de alta pressão (1)
Entidades concessionárias de distribuição regional de gás natural (1)
Entidades licenciadas para distribuição de gás em regime de serviço público (1)
Clientes não vinculados de eletricidade (1)
Grandes consumidores industriais de GN (1)
Associações de Defesa do Consumidor (3)
Instituto do Consumidor (1)

A competência, a cooperação e a transparência são os três valores orientadores da atividade da ERSE.

A transparência na atividade da ERSE pode ser observada através de:

» Envolvimento de todos os interessados no processo de regulação; disponibilização de informação que permita a participação dos agentes de forma informada no processo de regulação;

» Regras claras, simples e públicas do processo de tomada de decisão; envolvimento sistemático dos órgãos consultivos da ERSE – Conselho Consultivo e Conselho Tarifário;

» Apresentação de relatórios à Assembleia da República;

» Plano de Atividades discutido por todos os interessados no Conselho Consultivo da ERSE (o que permite garantir a previsibilidade das ações do Regulador);

» Promoção da transparência através da publicação de documentos de caracterização dos sectores regulados;

» Realização de processos de consulta pública, incluindo Audições Públicas abertas à participação de todos os interessados;

» Processos de regulamentação que se iniciam com um Anúncio de Proposta de Regulamentação, que coloca em discussão as principais matérias a regulamentar e calendariza as diferentes fases do processo;

» Análise e resposta a todos os comentários enviados à ERSE no âmbito de processos de consulta pública; publicação de documentos justificativos das decisões tomadas;

- Organização de conferências e seminários sobre assuntos relativos à regulação dos sectores regulados;
- Disponibilização de informação na página da ERSE na Internet e de uma "Newsletter" de subscrição voluntária (www.erse.pt).

Um exemplo de como ocorre a participação expressa de todos os interessados no processo de decisão da ERSE pode ser observado no procedimento instituído de aprovação de alterações regulamentares.

Assim, de modo a possibilitar a participação de todos os interessados, a ERSE lança processos de Consulta Pública, tornando previamente públicos os textos dos projetos de alteração dos regulamentos, através da sua página Web. No mesmo sentido, a ERSE comunica expressamente o processo às entidades reguladas e às associações de consumidores. Por sua vez, o Conselho Consultivo (ou o Conselho Tarifário) é convocado e emite um Parecer sobre os projetos de alteração dos regulamentos. As entidades reguladas, as associações de consumidores e todos os interessados participam no processo de aprovação dos regulamentos através do envio de comentários e sugestões, submetidos durante a Consulta Pública e através de intervenções durante a Audição Pública que conclui o processo de Consulta Pública.

Após a aprovação dos Regulamentos, a ERSE publica um documento contendo os comentários e sugestões recebidos (com a identificação do seu autor, salvo se este expressamente o não permitir), justificando as sugestões aceites e as não incluídas.

O segundo valor orientador da atividade da ERSE, a cooperação com todas as entidades interessadas no processo de regulação, passa pelo trabalho conjunto realizado com:

- Associações de consumidores e empresas reguladas;
- Entidades da Administração Pública, designadamente a Direção Geral de Energia e Geologia e o Instituto do Consumidor;
- Outras entidades reguladoras nacionais;
- Entidades reguladoras estrangeiras, particularmente a "Comisión Nacional de Energía" de Espanha e a "Commission de Régulation de l´Energie" da França, tendo em vista, com a primeira, a construção e supervisão do MIBEL e do MIBGÁS e com as duas o Mercado Regional do Sudoeste da Europa da Eletricidade e do Gás Natural;
- Conselho dos Reguladores Europeus de Energia (CEER);
- Grupo dos Reguladores Europeus de Eletricidade e Gás Natural (ERGEG);

- Associação de Reguladores Ibero-Americanos de Energia (ARIAE);
- Entidades reguladoras dos Países com Língua Oficial Portuguesa, através da recém-constituída Associação de Reguladores de Energia dos Países de Língua Oficial Portuguesa (RELOP);
- Instituições internacionais, em particular ao nível comunitário;
- Universidades e centros de investigação.

Finalmente, a orientação sobre a competência na atividade da ERSE concretiza-se através de:

- Formação interdisciplinar dos seus colaboradores;
- Colaboração com Universidades e centros de investigação;
- Participação ativa nos grupos de trabalho do CEER e do ERGEG;
- Estudo das melhores práticas internacionais de regulação;
- Aposta em sistemas de informação modernos.

Conclusões

Num período extremamente dinâmico de construção do Mercado Europeu da Energia, fundamentado na Competitividade, Segurança de Abastecimento e Sustentabilidade, com um ordenamento jurídico nacional que foi sendo adaptado à evolução do quadro jurídico comunitário, com a ERSE a desempenhar um papel muito ativo no processo associativo dos Reguladores Europeus de Energia e na interação entre os desenvolvimentos nacionais e europeus, tendo em consideração a diversidade de características dos Reguladores Europeus de Energia e dos desafios que se colocam à regulação do sector da energia, a opção assumida, ao nível europeu, foi a de um modelo de regulação em que a Comissão Europeia, as entidades reguladoras nacionais e a sua estrutura associativa desenvolvem a sua atividade em cooperação com todos os intervenientes do sector da energia.

Ao desafio que este modelo de regulação representa, a ERSE responde com a transparência, a competência e o espírito de cooperação com que exerce as suas atribuições, assumindo a sua independência e norteando as suas decisões pelo equilíbrio entre o interesse geral da sociedade, o dos consumidores e o das entidades reguladas.

A partilha de informação e de experiências entre os Reguladores Ibero-Americanos de Energia, permitida por um fórum como a ARIAE, é mais um instrumento de disseminação de boas práticas, que permite à ERSE e a todos aqueles que têm o privilégio de nele participar, consolidar e fundamentar o seu trabalho.

ERGEG South-West Electricity REM: First Achievements and Market Coupling

José Capelo, Jorge Esteves, Hélder Milheiras, PedroTorres

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Abstract

In Spring 2006, the European Regulators' Group for Electricity and Gas (ERGEG), decided to launch the Regional Initiatives, towards a competitive Single European Energy Market, creating three gas and seven electricity Regional Energy Markets (REMs), namely the South-West Electricity Regional Energy Market (ERGEG SW Electricity REM), comprising the existing Iberian market, MIBEL, and France.

To implement this regional market the very first priority task is to deal with cross border capacity issues namely harmonizing capacity allocation and congestion management methods.

The "Explicit Auction method" is being currently applied to the interconnection between France and Spain, where capacity is allocated on annual, quarterly, monthly and daily basis through explicit auctions held by transmission system operators.

In the "Implicit Auction method", capacity allocation results from the daily market with a single market price if there is enough cross border capacity. When cross border capacity is not enough, prices will be different and cross border exchange will be limited to the available capacity. In this case the remaining demand will be met by bids from its own area - the "Market Splitting".

MIBEL applies a mix of Explicit Auctions, held jointly by both TSOs, and Implicit Auctions held under the daily and intraday Iberian power exchange. During the first months of implementation, Market Splitting has applied most of the time, resulting in a MIBEL with two different prices and with a congested interconnection between the two countries.

The "Market Coupling Method" can be treated as an evolution of the "Implicit Auction Method" when there are different interconnected areas with two or more different power exchanges and two or more possible price areas.

This paper also presents the first achievements of the ERGEG South-West Electricity REM and future Market Coupling, explaining the existing congestion management methods.

Keywords

ERGEG Regional Initiatives - MIBEL - Explicit Auctions - Market Splitting - Cross-border Capacity Allocation.

1. ERGEG Regional Initiatives

According to the European Commission, the main barrier to the establishment of a Single European Energy Market results from existing difficulties in integrating different national electricity and gas markets.

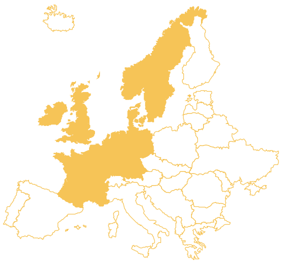
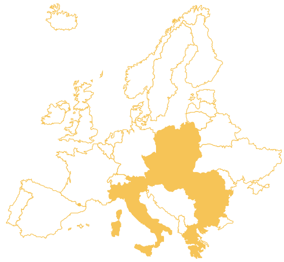
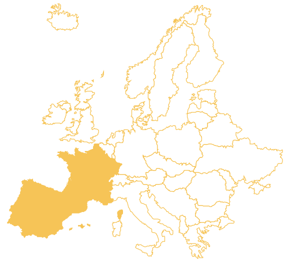
In order to overcome this barrier, in Spring 2006, the European Regulators' Group for Electricity and Gas (ERGEG), decided to launch the Regional Initiatives, creating three gas and seven electricity Regional Energy Markets (REMs). The creation of these REMs was set as a first step towards a competitive Single European Energy Market.

The ERGEG Regional Initiatives aims at identifying and implementing practical solutions to overcome barriers to competition and trade within each one of the regions and it was assumed that the involvement of stakeholders is crucial to its success, being set up in a way that ensures stakeholders are effectively engaged.

Bringing together regulators, the European Commission, Member State governments, companies and other relevant parties, the ERGEG Regional Initiatives are focused on developing and implementing solutions to improve the way in which regional energy markets develop.

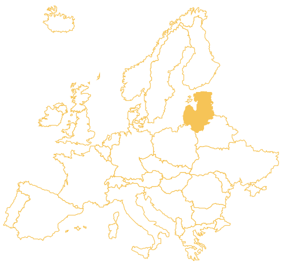
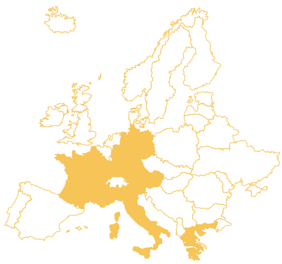
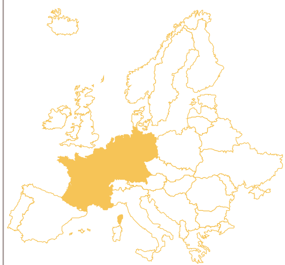
Figures 1 and 2 identify the three ERGEG Gas and the seven ERGEG Electricity REMs.

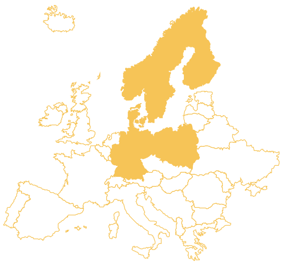
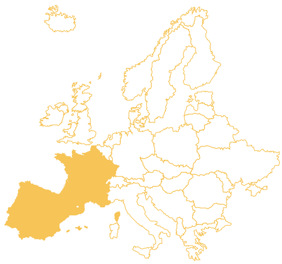
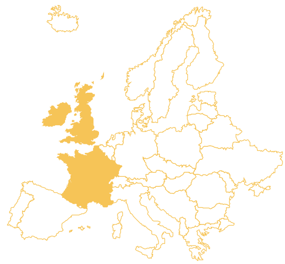
Figure 1 - The three ERGEG Gas REMs

GRI North-West Region	GRI South South-East Region	GRI South Region
		
Belgium, Denmark, France, Germany, Great Britain, Ireland, Northern Ireland, Norway (observer), Netherlands, Sweden	Austria, Bulgaria, Czech Republic, Greece, Hungary, Italy, Poland, Romania, Slovakia, Slovenia	France, Spain, Portugal

Source: ERGEG

Figure 2 - The seven ERGEG Electricity REMs

ERI Baltic Region	ERI Central-East Region	ERI Central-South Region	ERI Central-West Region
			
Estonia, Latvia, Lithuania	Austria, Czech Republic, Germany, Hungary, Poland, Slovakia, Slovenia	Austria, France, Germany, Greece, Italy, Slovenia	Belgium, France, Germany, Luxembourg, Netherlands

ERI Northern Region	ERI South-West Region	ERI France – UK - Ireland Region
		
Denmark, Finland, Germany, Norway, Poland, Sweden	France, Spain, Portugal	France, United Kingdom, Ireland

Source: ERGEG

2. ERGEG South-West Electricity Rem

A. SW Electricity REM structure

In spring 2006, the ERGEG launched the Electricity Regional Initiative (ERI), comprising seven electricity Regional Energy Markets (REMs), as an interim step to creating a single electricity market in Europe.

The seven regions have similar goals (integrating fragmented national electricity markets into regional markets) but their priorities and achievements reflect their different regional concerns. An overall monitoring process at EU level ensures that progress towards a single EU market is not hampered, and that there is convergence and coherence across the regions.

The South-West electricity REM aims at integrating the electricity markets of France and the Iberian Peninsula (MIBEL) into one electricity regional market.

The Spanish Energy Regulator, Comision Nacional de Energia (CNE) leads the South-West electricity REM activity.

Similar to the structure ruling all other ERGEG REMs, during 2007, the energy regulators from France, Spain and Portugal decided on one working structure for the ERGEG SW Electricity REM. Supervised by the SW RCC – Southwest Regional Coordination Committee, meeting forum of the three energy regulators, the ERGEG SW Electricity REM presents three other participation levels:

» Technical SW RCC – The Technical SW Regional Coordination Committee with technical experts from the three national regulatory authorities.
» Southwest IG – The SW Implementation Group involving the Technical SW RCC plus technical experts from the three national Transmission System Operators (TSO) and from the existing power exchanges entities (the PXs, OMEL, OMIP and Powernext).
» Southwest SG – The Stakeholders Group involving the Southwest IG and all interested stakeholders.

B. SW Electricity REM Action Plan for 2007 -2009

In June 2007, the Action Plan for the SW Electricity REM for the period 2007-2009 was approved, with a mission of implementing a European regional electricity market in the Southwest region.

To achieve that goal, regulators stressed the importance of the Iberian Electricity Market (MIBEL) and the strong need of continuous developments in cross border interconnections namely between Spain and France.

During 2007, two SW RCC meetings, three Technical SW RCC meetings, one SW IG meeting and another from the SW SG were organised.

Table I presents the priorities stated at the Action Plan for 2007- 2009 at the SW Electricity REM.

Table I - Priorities for the ERGEG SW electricity REM 2007 – 2009 Action Plan

Priority I: Interconnections	Interconnections and availability of transmission capacity (S) Cooperation with the European coordinator appointed by the EC
Priority II: Transparency	Analysis of convergence in transparency and information management (M)
Priority III: Cross-border congestion management	Cross-border capacity calculation (M) Improvements in long term and medium term explicit auction mechanisms (S and L) Implementation of day-ahead market coupling (L)
Priority IV: Compatibility of the rules	Analysis of the compatibility of the rules of MIBEL and French markets (L)
Regulatory gap	Administrative procedures for the changing of legislation in force in each country (S)

Short term: (S) Medium term: (M) Long term: (L)

Source: ERGEG

For each one of the 2007 - 2009 priorities, the SW Electricity REM Action Plan (1) details what documents are to be produced, when they are to be produced and who is responsable for their preparation.

C. ERGEG SW Electricity REM Achievements

Some achievements in the SW Electricity REM can be already identified (February 2008).

Resuming the main initial achievements of the SW Electricity REM, participants of the high level group meeting (European Commission, governments, national regulators, electricity and gas transmission system operators, power exchanges) agreed to cooperate further towards the integration of the three national markets for gas and electricity.

Objectives will be achieved by increasing the interconnection capacity between the three countries concerned, by implementing efficient congestion management methods and through concrete actions such as market coupling between MIBEL and the Centre West Region which could be combined with a single auction office for annual and monthly capacity rights.

In a more detailed way, the progress made on the different issues are:

- Electricity interconnection ES/FR: the European coordinator, Mr. Mario Monti, was appointed in September 2007 and delivered an interim report in December 2007. In October 2007, during the first Stakeholder Group meeting for the region, all stakeholders stated that they are ready to cooperate with the European Coordinator at his request. With full support of the group members, he should be able to deliver a full report by June 2008. In parallel, the Spanish and French governments are committed to take a decision on increasing interconnection capacity by the same date.
- Improving transparency in the electricity cross-border capacity calculation: TSOs committed themselves to produce, for the next IG meeting, common proposals for optimising and increasing the transparency of cross-border capacity calculation.
- Capacity allocation and congestion management: TSOs have been requested by regulators to implement "quick-win" improvements as soon as possible. Improvements in long and medium term explicit auction mechanisms will be implemented. In addition, all stakeholders encouraged and expressed commitment for the implementation of market coupling as soon as possible.
- Market coupling for electricity: all stakeholders have encouraged regulators to implement market coupling as soon as possible. An adhoc task force has been set up to deal with concrete problems in implementing market coupling between MIBEL and the Centre West region as identified by TSOs and Power Exchanges.

3. European Cross Border Capacity Allocation / Congestion Management Methods

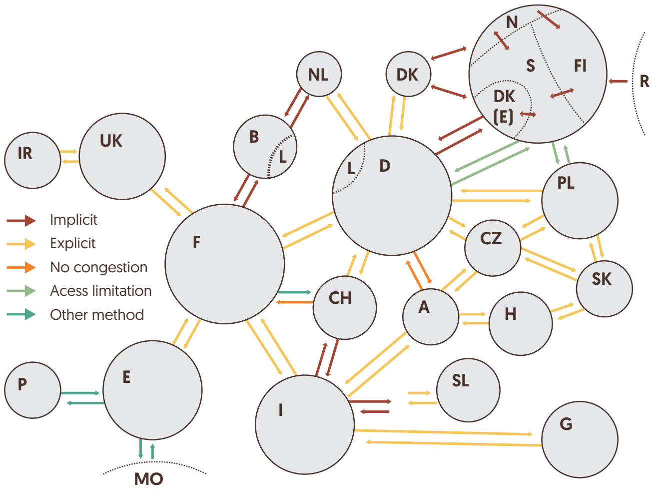
A. Existing congestion management methods in Europe

All over Europe there are different approaches regarding congestion management and cross border management related issues.

Figure 2 presents an overview over the different existing congestion management methods on June 2007, published by ERGEG at the "Compliance with Electricity Regulation 1228/2003 – An ERGEG Monitoring Report", [2].

Figure 2 does not illustrate the current situation in the interconnection between Portugal and Spain, since another MIBEL implementation step took place on July 1st, and since then, the interconnection between Portugal and Spain is subjected to specific rules, according to which, in a first stage, cross border capacity is allocated based on "implicit auction" through the existing Iberian daily market (currently operated by OMEL). In a near future, explicit auctions will take place, being held jointly by transmission system operators (TSOs) on annual, quarterly and monthly basis.

Figure 3 - Existing congestion management methods, June 2007 [2]



Source: ERGEG

B. Capacity Explicit Auctions

Under the "Explicit Auction method", the allocation of cross border capacity is developed by TSOs and is independent from commercial cross border exchanges that might take place in power exchange or bilateral agreements.

Interconnection capacity rights granted previously at Explicit Auctions allow users to be sure of having a certain interconnection transmission capacity value allocated. This allocated capacity, also known as physical transmission rights (PTR), can be seen as an insurance policy, since the PTR holder has the guarantee that he can use that capacity whenever he needs it.

"Explicit Auction method" is a very simple one and it is used worldwide, being currently the method applied to the interconnection between France and Spain.

According to a study held in November 2007 by three consultant entities, Frontier Economics, Consentec and IAEW, for the German regulatory authority (BNetzA) [3], "capacity explicit auction" is a very effective method for capacity allocation for different horizons, such as monthly or annual.

C. Capacity Implicit Auctions / Market Splitting

In the "Implicit Auction method", cross-border capacity is allocated through daily market (spot market), operated by a single market operator. The different areas associated with bids do not need to be the same as operating areas of each TSO.

Under the "Implicit Auction capacity allocation method", if available cross border capacity is enough to meet cross border exchanges resulting from daily and intraday market, prices in different zones will be the same, with lower price bids' generating units supplying higher price bids' load demand.

On the contrary, if cross border capacity is not enough, there will be different prices at different zones, with cross border exchange limited to the available capacity. The remaining demand will be met by bids from generation at its own area. This is what is commonly known as "Market Splitting", because two or more different prices will be attained in the same market.

The price differential that is attained, during the "Market Splitting" situation, reflects both, the congestion cost incurred by the higher price area consumers to buy the same power supplied to consumers in the lower price area, and the cost of energy in each different area.

The referred study held by "Frontier Economics, Consentec / IAEW" came to the conclusion that the "Implicit Auction method" is the best method for cross border capacity allocation in the short term (day ahead).

Nord Pool was the first electricity market to adopt the "Market Splitting method", which in general is based on the principle of a single power exchange with several different price areas. At Nord Pool, there are five different operating areas from four different countries (Finland, Sweden, Norway and Denmark). These five areas can be split in seven different price areas: Finland (1), Sweden (1), Norway (3) and Denmark (2).

For the time being and since July 2007, Portugal-Spain interconnection has been allocated by an "Implicit Auction" at the MIBEL with a generalized situation of Market Splitting.

D. Market Coupling

The "Market Coupling Method" can be treated as an "Implicit Auction Method" evolution, applied both for congestion management and cross border capacity allocation when there are different interconnected areas with two or more different power exchanges and two or more possible price areas. It allows combining areas where "Implicit Auction", "Market Splitting" and "Explicit Auction" are applied.

In "Market Coupling", if enough cross border capacity is available, prices will be the same in all areas that are being coupled, being different whenever there occurs a cross border congestion. In this last situation, cross border exchange is limited to available capacity and the remaining demand is met by the local generation.

The very first time this method was applied in Europe was in November 2006, with the coupling of three European PXs: Powernext (France), APX (Netherlands and BelPpex (Belgium). These three markets together are responsible for almost 25% of European Power Exchange transactions.

The ERGEG Central-West Electricity REM plans to extend this trilateral market coupling to their neighbor countries, Germany and Denmark.

4. Coordinated Cross Border Capacity Allocation at the Interconnection Between Portugal and Spain Applied at Mibel

A. Rules in Force at MIBEL

The coordinated cross border capacity allocation rules for the Interconnection between Portugal and Spain, approved by the MIBEL Council of Regulators, is based on a mix of Explicit Auctions, held jointly by both TSOs, and Implicit Auctions held under the daily and intraday Iberian power exchange (operated presently by OMEL).

The present rules in force, [4] - [6], comply with the principle set down by the European Regulation 1228/2003 [7], regarding third party access to the networks and European cross border electricity exchange. These rules were written based on the principles of transparency, efficiency and effectiveness, and are market based.

The adopted model for this coordinated mechanism consists of applying the Market Splitting method to the daily and intraday market, on a day-ahead basis, following a previous stage where Explicit Auctions are held by TSOs to grant capacity physical transmission rights (PTRs). These auctions take place annually, quarterly and monthly.

In order to achieve an optimized allocation of cross border capacity, the "use it or get paid for it" rule is applied. Under this rule, market players holding PTRs granted by previous auctions must opt between:

- Schedule quantities resulting from previous bilateral physical agreements, using their own PTRs.
- Free their PTRs for the Implicit Auction that is implicit at the spot market, having the right of getting a financial reward for the used PTRs which is calculated based on the product of the price differential (if existing) by the amount of the capacity they free for the market.

B. MIBEL Explicit and Implicit Auctions

According to the existing rules set by both countries, [4] and [5] (and their equivalent in the Spanish legislation), Explicit Auctions (long term allocation method) will cover different time horizons - annual, quarterly and monthly with a distribution of capacity of 15% for each time horizon.

In the short term, the remaining 55% available capacity will be allocated through the daily and intraday market sessions, in the perspective of an Implicit Auction with application of the market splitting, when necessary.

For the time being, only Portugal has already approved the detailed procedures for the Explicit Auctions [6], with approval by the Spanish government being expected in order to allow the MIBEL Explicit Auctions implementation.

For this reason, from the 1st July 2007 all the available interconnection capacity has been allocated in an Implicit Auction basis associated to the daily and intraday spot market.

C. Coordination between explicit auctions and short term allocation

In order to ensure a proper coordination between short and long term capacity allocation phases and to maximize the available capacity, each day, before the closure of daily market (day ahead), each market participant, that has been granted physical transmission rights for cross border capacity at a previous stage, must send a notification to the TSOs scheduling the cross border energy quantities he wants to transmit by the interconnection, resulting from existing physical bilateral agreements. The participants not wishing to use their PTRs previously allocated, must free this capacity having the right to be financially rewarded, based on the product of the price differential (if market splitting happens) and the amount of capacity they free to the market.

Both the free capacity and the non-allocated capacity in explicit auctions will be offered in the daily market and allocated by implicit auction (and market splitting if necessary).

D. Coordinated Redispatch

After the confirmation and scheduling of cross border exchanges, whenever real time congestions occurs, both TSOs must adopt all the coordinated redispatch actions necessary to ensure that the scheduled program in the interconnection would not be affected. Each TSO is responsible for performing all the necessary changes to their own area's programme to fulfill the adopted coordinated actions.

E. Cross border congestion rents

In accordance to what is set in the Portuguese regulation, detailed in coordinated rules for cross border capacity allocation [4] – [6], congestion rents, resulting from explicit auctions and price differences between areas should be used to:

- Compensate PTR holders that provide capacity to the daily market.
- Compensate market participants that had their scheduled exchanges canceled or reduced following cross border capacity curtailment.
- Compensate the importing country in the amount resulting from the product of reduced capacity by price differential.

Any remainder revenue should be equally split for each country, with the obligation for each TSO to apply these revenues to cover redispatch costs, to finance transmission investments necessary to avoid future cross border congestions and to reduce transmission tariffs.

5. Future Market Coupling at the Sw Electricity Rem

Besides the MIBEL imperfections and the need for stronger interconnections between Spain and France, SW Electricity REM is extremely dependent of the implementation of a Market Coupling between MIBEL (OMEL/future OMI) and the French (Powernext) power exchanges.

Market Coupling at the SW Electricity REM is considered an important mean for ensuring a real implementation of a competitive Electricity South-West regional market.

Conclusions

To establish a Single European Electricity Market and overcome the existing difficulties in integrating different national electricity markets, European energy regulators decided to implement seven regional markets including the South-West Electricity REM comprising Portugal, Spain and France.

In order to become an effective and competitive regional market it is necessary to invest in stronger interconnections and to harmonize cross border management rules.

Besides that, the most effective way to achieve a competitive and single South-West electricity regional market is to couple the two power exchanges - MIBEL and the Powernext through a Market Coupling procedure.

In Market Coupling, if enough cross border capacity is available, prices will be the same in the three areas, being different whenever congestion occurs in any cross border. In this case, cross border exchange will be limited to available capacity and the remaining demand will be met by local generation.

However, further discussion is needed since the regulators and stakeholders will have to come to an agreement on several issues such as harmonization of legal rules, operation and congestion management proceedings and market design.

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Biographies

José Capelo (b. 1956) received his degree in electrical engineering from Instituto Superior Técnico, Technical University of Lisbon, Portugal in 1980.

From 1980 to 2000, he taught at Instituto Superior Técnico, as Assistant of the Department of Electrical and Computers Engineering.

In 1999, he joined ERSE, the Portuguese energy regulatory authority, in the Dispatch and Network Division.

Jorge Esteves (b. 1958) received his engineering degree, M.Sc. and Ph.D. in electrical engineering from Instituto Superior Técnico, Technical University of Lisbon, Portugal in 1983, 1986 and 1992, respectively.

From 1983 to 2004, he reached the position of Assistant Professor with Instituto Superior Técnico, Technical University of Lisbon.

From 1983, he has been a research member of the Centro de Automática of the Technical University of Lisbon.

In 2004, he joined Instituto Superior de Engenharia de Lisboa as Coordinator Professor. Also in 2004, he joined ERSE, the Portuguese energy regulatory authority, as director of the Dispatch and Network Division.

Hélder Milheiras (b. 1973) received his degree in electrical engineering from Instituto Superior Técnico, Technical University of Lisbon, Portugal in 1997, and concluded his MBA lecture part in 2005.

After graduation, in 1997, he joined ERSE, the Portuguese energy regulatory authority in the Dispatch and Network Division.

Pedro M. C. Torres (b. 1978) received the undergraduate (5 year) and Master degrees, respectively in Electrical and Computers Engineering and in Engineering and Management of Technology from the Technical University of Lisbon (2001 and 2004).

Presently he is with the Infrastructures and Networks Division of ERSE, the Portuguese Energy Regulator.

Previously he was with REN, the Portuguese Transmission System Operator (2001-2006).

His topics of research include system operation, quality of service, electricity markets modeling and simulation, energy markets integration and renewable energies.

Os poderes de regulação, de regulamentação, de supervisão e de fiscalização da ERSE no quadro das ARI

Maria João Pinheiro

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Resumo

O fenómeno de criação de entidades reguladoras independentes reporta ao princípio liberal da separação de poderes, todavia a lógica que alicerçou a construção do estado regulador não se confinou à crescente (des) intervenção pública. Na sua conceção clássica o Direito Administrativo germinou e floresceu dentro de uma lógica de unidade da administração que atribuía ao governo ou ao titular supremo do poder executivo a responsabilidade por toda a administração pública.

O governo assim entendido foi gozando de amplos poderes de intervenção e intercessão administrativa, sobre a generalidade dos órgãos e entidades públicas. Foi nesta relação intima entre a unidade da administração pública assegurada pelo órgão de topo do executivo e a sua responsabilidade política perante o parlamento, que o Direito Administrativo se foi configurando ao longo dos últimos anos.

Todo este paradigma foi sendo progressivamente abalado e o surgimento de autoridades administrativas independentes, quebrando o laço aparentemente indelével de unidade

intra-administrativa, contribuiu para a rotura do modelo clássico de administração pública, operando uma transformação a que alguma doutrina designa de passagem de um modelo piramidal de administração pública para um modelo policêntrico.

Neste texto, a par do breve retrato das autoridades administrativas independentes, procurar-se-á estudar a sua especialidade face ao restante elenco administrativo.

Palavras-chave

ERSE - Regulação - Direito Administrativo - Energia.

Introdução

O termo "regulação" encerra cariz ambivalente: por um lado, designa um estado de equilíbrio e de regularidade no funcionamento de um sistema ou mecanismo; por outro lado, aponta para o estabelecimento de regras (regulamentos) a serem observadas num determinado comportamento ou situação, tendo precisamente como objetivo garantir ou repor o equilíbrio e/ou a regularidade do seu funcionamento.

Tradicionalmente o Direito Administrativo brotou e prosperou dentro de "uma lógica de unidade da administração que faz do governo ou do titular supremo do poder executivo o responsável por toda a administração pública".

O governo assim entendido foi gozando de amplos poderes de intervenção e intercessão administrativa, sobre a generalidade dos órgãos e entidades públicas. Foi nesta relação intima entre a unidade da administração pública assegurada pelo órgão de topo do executivo e a sua responsabilidade política perante o parlamento, que o Direito administrativo se foi configurando ao longo dos últimos duzentos anos.

Todo este paradigma foi sendo progressivamente abalado e o surgimento de autoridades administrativas independentes, quebrando o laço aparentemente indelével de unidade intra-administrativa, contribuíram para a rotura do modelo clássico de administração pública, operando uma transformação a que alguma doutrina designa de passagem de um modelo piramidal de administração pública para um modelo policêntrico.

O objetivo deste relatório é o retrato da Entidade Reguladora dos Serviços Energéticos, identificando a sua natureza, explorando o seu fundamento jus-constitucional e estudando o seu regime jurídico.

Neste esforço interpretativo procurar-se-á igualmente refletir o passado, compreender o presente e ponderar o futuro da regulação independente em Portugal.

1. Noção de Estado Regulador

Na sua conceção tradicional e idealizada por Adam Smith, a economia de mercado não carecia de regulação estadual, a concorrência funcionava como a mão invisível que regulava de forma natural os mecanismos da economia. O regresso recente ao paradigma da economia de mercado, depois de uma longa fase de forte regulamentação estadual direta na economia, significa desde logo a revalorização da economia privada, da concorrência e do mercado. No final do século passado sob a chamada onda liberal foi-se assistindo a uma tentativa de libertação do poder centralizador do estado. De um excesso de intervencionismo público passou-se à euforia da liberalização dos setores.

Na experiência Portuguesa, a um primeiro momento liberalizador, seguiu-se já nos anos 90 do séc. XX e sob a influência decisiva do direito da união europeia, um processo de alargamento da economia de mercado; o movimento caracterizou-se sobretudo pela privatização, a abertura à iniciativa económica privada de atividades que antes se encontravam sob reserva pública e de sectores correspondentes a serviços públicos económicos.

Para Pedro Gonçalves[1], "Associada a todo esse complexo processo de reconfiguração das missões e da posição do Estado, e até para o explicar, impôs-se uma nova gramática, que acomodava e explicava o movimento sobre o mote da diversificação dos graus de responsabilidade públicas ". O equilíbrio que se encontrou posteriormente favoreceu uma nova composição do papel do estado, que se apelidou de estado de garantia, aquele que correspondeu a um compromisso entre o estado social e o estado liberal. O conceito de garantia aparece ligado a dever ou a uma incumbência que permanece na esfera do Estado, de acautelar a realização de certos fins de interesse público.

É neste quadro que se situa o objetivo do estado de garantia de assegurar uma articulação eficiente e justa entre a realização do interesse público e dos interesses privados.

A regulação desempenha o papel principal do novo modelo de intervenção pública na economia e nos mercados, surgindo como o instrumento por excelência de efetivação da responsabilidade de garantia.

[1] Cfr. Pedro Gonçalves, "Reflexões sobre o Estado Regulador e o Estado Contratante", Coimbra Editora, 2013, p.49 e ss.

Em suma, o "Estado regulador" contemporâneo caracteriza-se essencialmente pela desintervenção do Estado em relação à atividade económica, com a extinção ou redução substancial do papel do Estado empresário, do Estado produtor e do Estado prestador de serviços aos cidadãos. Mas o Estado regulador não é caracterizado somente pela desintervenção económica do Estado, é também igualmente marcado pela crescente desgorvernamentalização da atividade reguladora. E as autoridades reguladoras independentes nascem como expressão dessa desgovernamentalização da regulação.

2. Autoridades de regulação – Autoridades Administrativas Independentes

Etimologicamente o conceito de regulação gira em torno de duas ideias fundamentais: o estabelecimento e a implementação de regras, de normas e a manutenção ou garantia de funcionamento equilibrado de um sistema[2].

No que respeita à regulação pública, ela compreende não obstante a ambiguidade do conceito, tanto a faculdade de definição de normas de conduta como o poder de as aplicar e fazer cumprir.

O que leva os autores a afirmar que a regulação compreende três poderes típicos do Estado: um poder normativo, um poder executivo, um poder para judicial, que podem coexistir ou não numa única entidade.

O que se altera em relação ao conceito de regulação pública tradicional é que atualmente não se pretende impor determinados fins exteriores ao próprio mercado e contra as regras deste (regulação lesiva do mercado), nova ordem do mercado exige que a regulação adquira um novo conteúdo, assente em princípios diferentes, "conforme ao mercado", visando fomentá-lo e defendê-lo. Os fins, os objetivos passam a ser os que resultam do funcionamento do mercado, aberto e transparente, visando a regulação tão só fixar regras gerais e garantir a sua aplicação de uma forma neutra e independente.

Em síntese, afirma-se que o conceito de regulação tem subjacente a ideia de uma nova forma de relação entre o Estado e a sociedade, que colhe a sua fonte numa visão "sistémica" da mesma[3].

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2 Cf. Vital Moreira, Auto-Regulação profissional e administração pública, Almedina, Coimbra, 1997, p. 43 e ss.
3 Cfr. Marie-José Guédon, Les autorités administratives indépendantes, L.G.D.J., Paris, 1991, p.21. citada por Vital Moreira e Maria Fernanda Maças, Autoridades Reguladoras Independentes, Estudo e Projecto de Lei-Quadro, Almedina, p. 15

Na Europa, a figura das autoridades reguladoras independentes veio a ser compreendida num contexto mais amplo das "autoridades administrativas independentes" (AAI), de cunho francês, a qual integra outras entidades públicas independentes, porém com outras funções que não a regulação económica. Aí se integram por exemplo também as entidades criadas de certos direitos fundamentais, como na área do audiovisual, da proteção de dados pessoais informatizados e outros.

Uma característica que acompanha o aparecimento de tais entidades reside no seu desenvolvimento desordenado, uma vez que a sua instituição não é o resultado de uma intervenção legislativa que, de forma unitária e coerente, estabeleça um desenho orgânico e estrutural comum. Não obstante as dificuldades apontadas, é possível destacar alguns critérios ou elementos que concorrem, segundo a melhor doutrina, para a identificação destas entidades.

Quanto ao objeto existem duas áreas de incidência muito distintas. O campo de eleição inicial das autoridades administrativas independentes foi, por um lado, a garantia de alguns direitos fundamentais – tipicamente, a regulação dos meios audiovisuais, o acesso a documentos administrativos e o controlo da informatização de dados-, e, por outro lado, a regulação de algumas esferas da área económica, principalmente o mercado dos valores mobiliários, as instituições de crédito, os seguros e a defesa da concorrência. Mais recentemente a intervenção das AAI tem-se manifestado na regulação de setores das indústrias de rede e de prestação de serviços públicos, no seguimento da crescente liberalização dos serviços públicos, como a água, o gás, a eletricidade, as telecomunicações e os transportes.

Como referimos, o surgimento e consequente incremento das chamadas autoridades independentes alistam num "*fenómeno de crescente desconfiança institucional e societária*"[4] em relação à aptidão da Administração Pública em poder assegurar, de um modo isento, a tutela de certos bens jurídicos especialmente qualificados.

Tal suspeição motivou o legislador a criar determinadas figuras jurídicas investidas em funções de consulta, vigilância e regulação, cujas estruturas jurídicas foram desenhadas de modo a serem relativamente imunes em relação a excessos de ingerência política por parte do poder executivo. E nas palavras do Professor Blanco de Morais[5] "*Os órgãos*

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4 Para esta matéria Cfr. Carlos Blanco de Morais, "Autoridades Administrativas Independentes na Ordem Jurídica Portuguesa", p. 102

5 Ob. Cit. p. 102

com as características descritas começaram por constituir um instituto de génese ocasional, destinado a criar enclaves enclausurados, próprios de uma administração separada, que, tendo sido originariamente vocacionada para a tutela de certos direitos fundamentais, se expandiu ulteriormente para o campo da fiscalização e regulação económica e financeira."

Pedro Costa Gonçalves[6], referindo-se à regulação administrativa, recorda-nos que esta categoria de institutos se integra na categoria da regulação pública e adianta que em termos gerais a regulação associa-se a um sistema de *influenciação, de orientação e de controlo de processos e de comportamentos ou condutas de pessoas; esse sistema pode revelar-se de uma forma positiva (na feição de comandos, diretrizes ou recomendações) ou de uma forma negativa (na veste de proibições, limitações ou advertências),* mas traduz em qualquer caso, uma ação de alguém que está de fora, o estado regulador situa-se numa posição de um "*estranho*" no exercício efetivo da atividade regulada; "*interfere", intervém* apenas para definir as regras de desenvolvimento da atividade, bem como para implementar e fiscalizar a verificação de tais regras.

A chamada articulação entre regulação e mercado conduz a apresentar o "direito de regulação" como uma disciplina jurídica do mercado e da economia, como o novo direito público da economia, o qual pela natureza sumativa desta exposição não nos é permitido explanar. Podemos sumariamente descrever o tipo e a natureza das autoridades administrativas conhecidas, optando por dividir a sua análise aos chamados "espaços administrativos abertos" e aos "espaços administrativos fechados", tal como definido por José Lucas Cardoso[7].

Quanto aos primeiros e mais característicos dos sistemas anglo-saxónicos é frequente a existência de algumas estruturas que apesar de integradas na Administração Pública, ocupam-se em geral da administração de serviços públicos, não constituem poder executivo, em sentido absoluto. Poder-se-á concluir que este tipo de estruturas constituirá tradição secular britânica e constitui ancestral comum aos sistemas britânico e norte-americano.

Os chamados espaços administrativos fechados, que nasceram do absolutismo e viajaram até ao "Estado moderno ou europeu", geograficamente localizados na Europa, foram igualmente permeáveis ao aparecimento de estruturas organizatórias, instituídas por

[6] Para aprofundamento deste tema Cfr. Pedro Costa Gonçalves, Reflexões sobre o Estado Contratante e o Estado Regulador", p. 95

[7] Cfr. José Lucas Cardoso, "Autoridades Administrativas Independentes e a Constituição" p. 179 e ss

via da lei ordinária e incumbidas predominantemente de tarefas subsumíveis à função administrativa do Estado mas de dependência atenuada.

Em síntese e ao contrário dos *Quango* britânicos que representam uma categoria especial de relacionamento entre a sociedade e o poder politico, e das *Independent Regulatory Agencies* norte-americanas, as autoridades administrativas independentes instituídas na europa continental, constituíram um fenómeno de organização interna do poder politico estadual que foi motivada pela necessidade de reformular a imagem do Estado perante a sociedade civil.[8]

3. Estado de Direito e Princípio da Legalidade Administrativa

Como ensina Figueiredo Dias, a lei serve de fundamento ao exercício de outros poderes do Estado: «a administração deve obedecer à lei», «os tribunais estão sujeitos à lei». Neste sentido se afirma que o «poder vem da lei» e que não há exercício legítimo do poder público sem fundamento na lei. A refração desta ideia no que respeita à administração do Estado e dos poderes regionais e locais consubstancia-se vulgarmente no princípio da legalidade da administração.

Este é sem dúvida um dos principais e mais importantes princípios aplicáveis à Administração Pública, que aliás, foi consagrado como princípio geral de Direito Administrativo antes que a Constituição, o mencionasse explicitamente (Cfr art. 266º/2 CRP e art. 124º/1-d CPA).

O princípio da legalidade impõe que os órgãos e agentes da Administração Pública só possam agir no exercício das suas funções com fundamento na lei e dentro dos limites por ela impostos. Surge determinado de uma forma positiva, define-se o percurso possível da Administração Pública, define-se o que deve ou não deve fazer e não apenas aquilo que ela está proibida de fazer.

O princípio da legalidade cobre e abarca todos os aspetos da atividade administrativa, e não apenas aqueles que possam consistir na lesão de direitos ou interesses dos particulares. A lei não constitui apenas um limite à atuação da Administração sendo também um primus fundamento da ação administrativa.

8 A conceção foi descrita por José Lucas Cardoso, Ob. Cit p. 187

Como ensinou Marcello Caetano, a administração tem de ocorrer à satisfação das necessidades do todo. Como o todo é constituído pelas partes, ou seja, as pessoas, são estas que sentem as necessidades, é nelas que se refletem os interesses a que a satisfação de tais necessidades dá lugar. Assim, a atividade administrativa traduz-se "numa infinidade de resoluções individuais respeitantes aos casos concretos que se lhe apresentam na vida quotidiana", que deverá ser desenvolvida de forma organizada e a evitar a discricionariedade. Nas palavras deste Professor, "o desenvolvimento da atividade administrativa, segundo normas jurídicas gerais corresponde, pois, a uma dupla necessidade: de justiça para os cidadãos e de eficiência para a própria administração".

No âmbito do Estado Social de Direito, o conteúdo do princípio da legalidade abrange não apenas o respeito da lei, em sentido formal ou em sentido material, mas a subordinação de Administração Pública, a todo o bloco geral.

Todos os tipos de comportamento da Administração Pública, a saber: o regulamento, o ato administrativo, o contrato administrativo, os simples factos jurídicos. A violação da legalidade por qualquer desses tipos de atuação gera ilegalidade. Tradicionalmente o princípio da legalidade comporta duas modalidades: (i) Aparência de lei, consiste em que nenhum ato de categoria inferior à lei pode contrariar a lei, sob pena de ilegalidade; (ii) Reserva de lei, consiste em que nenhum ato de categoria inferior à lei pode ser praticado sem fundamento na lei.

Quanto aos efeitos distinguem-se dois efeitos negativos, i) nenhum órgão da Administração, mesmo que tenha sido o autor da norma jurídica aplicável, pode deixar de respeitar e aplicar normas em vigor; ii) qualquer ato da administração que num caso concreto viole a legalidade vigente é um ato ilegal, e portanto inválido (nulo ou anulável, conforme os casos). Efeitos positivos é a presunção de legalidade dos atos da Administração. Isto é, presume-se em princípio, que todo o ato jurídico praticado por um órgão da administração é conforme à lei até que se venha porventura a decidir em contrário.

O princípio da legalidade comporta três exceções, assentes na teoria do estado de necessidade, na teoria dos atos políticos, o no poder discricionário da Administração. A teoria do estado de necessidade, prescreve que em circunstâncias excecionais, em verdadeira situação de necessidade pública, a Administração Pública, se tanto for exigido pela situação, fica dispensada de seguir o procedimento estabelecido para circunstâncias normais e pode agir sem formalidades processuais, mesmo que isso implique o sacrifício de direitos ou interesses dos particulares.

Quanto à teoria dos atos políticos, ela não é em rigor uma exceção ao princípio da legalidade. Para os seus defensores os atos de conteúdo essencialmente político, os atos materialmente correspondentes ao exercício da função política – chamados atos políticos ou atos do governo –não são suscetíveis de recurso contencioso perante os Tribunais Administrativos.

Quanto à natureza e âmbito do Princípio da legalidade, a Administração Pública, por vezes, atua como autoridade, como poder, surgindo a impor sacrifícios aos particulares; a esta administração chama a doutrina alemã, administração agressiva, porque de certa forma "agride" os direitos e interesses dos particulares.

Noutros casos, a Administração Pública surge como prestadora de serviços ou de bens, nomeadamente quando funciona como serviço público. Aqui a Administração não agride a esfera jurídica dos particulares, mas pelo contrário, protege-a ou amplia-a.

Há autores, nomeadamente Sérvulo Correia, que defendem que tratando-se da promoção do desenvolvimento económico e social ou da satisfação das necessidades coletivas, o princípio da legalidade deverá ceder como fundamento da administração da ação administrativa, alicerce cuja génese se considerada facilmente inteligível - não deverá haver limites à produção do bem.

De facto o princípio da legalidade nasceu como limite à ação da Administração Pública; a sua função era a de proteger os direitos e interesses dos particulares. E embora o princípio da legalidade continue a desempenhar essa função, o certo é que se conclui entretanto que não basta o íntegro cumprimento da lei por parte da Administração Pública para que simultaneamente se verifique o respeito integral dos direitos subjetivos e dos direitos legítimos dos particulares.

A regulamentação legal da atividade administrativa por vezes é declarada outras vezes é indeterminada. Algumas vezes a lei vincula totalmente a Administração e esta não tem qualquer margem dentro da qual possa exercer uma liberdade de decisão, descrevendo-se o ato administrativo como um ato vinculado.

Outras vezes, a lei praticamente nada diz, nada regula, e deixa uma grande margem de liberdade de decisão à Administração Pública. E é a Administração Pública que tem de decidir, ela própria, segundo os critérios que em cada caso entender mais adequados à prossecução do interesse público, é a chamada discricionariedade da administração.

Vinculação e discricionariedade são assim, as duas formas típicas pelas quais a lei pode modelar a atividade da Administração Pública. Os Professores Marcelo Rebelo de Sousa e André Salgado de Matos[9] apontam os seguintes fatores influenciadores do grau de densidade exigido:

I) Incidência da atuação administrativa habilitada na esfera social (quando há afetação de direitos, liberdades e garantias o grau deve ser maior p.ex.);

II) Previsibilidade da atuação administrativa independentemente da previsão legal (quanto maior a imprevisibilidade, maior deve ser a densificação);

III) Grau de legitimidade democrática da administração normativamente habilitada (será exigida menor densificação se a administração habilitada estiver "especialmente legitimada do ponto de vista democrático-representativo" – algumas matérias da competência d administração autónoma)

Este princípio prende-se com a questão da "abertura das normas", ou seja, com o tema da vinculação e da discricionariedade da Administração. O poder discricionário da Administração, não constitui, de modo nenhum, uma exceção ao princípio da legalidade, mas um modo especial de configuração da legalidade administrativa. Com efeito, só há poderes discricionários onde a lei os confere como tais. E, neles, há sempre pelo menos dois elementos vinculativos por lei – a competência e o fim.

O instituto jurídico da discricionariedade administrativa é um instituto antigo e sempre foi entendido como uma faculdade legal do poder público, imune ao controle judicial. Nasceu no Conselho de Estado da França e desenvolveu-se por toda Europa Continental, fazendo-se presente no Direito Público europeu do século XVIII. Um dos pilares da construção do poder discricionário da administração pública surgiu após a Revolução Francesa em que os poderes constituídos foram criados e separados para que fossem independentes e harmoniosos entre si, humanizando mais a sociedade.

Esta separação de Poderes foi vital para a democracia e esse equilíbrio de forças foi suficiente para acabar com o Estado Absolutista, em que o poder centralizador do Monarca sufragava o direito alheio. Com o fim do arbítrio que constituía a base do governo despótico, surgiram os princípios da legalidade, da soberania do povo e da

[9] Marcelo Rebelo de Sousa e André Salgado Matos, "Direito Administrativo Geral", Tomo I e Tomo II, 3ª Edição D. Quixote, p. 68 e ss

separação de poderes como fundamento de outras formas de governo, vinculados ao espírito e à Lei.[10]

Por este fundamental princípio da legalidade, o poder público começou a conviver com limites, sendo o poder limitado pelo próprio poder, para evitar abusos. Naquela época, o poder executivo da França participava na elaboração das Leis, quando exercia uma faculté d'empêcher através do direito de veto suspensivo.

A partir das ideias de John Locke, Jean-Jacques Rousseau e Immanuel Kant entre outros, assiste-se à instituição da supremacia do poder legislativo, invertendo-se os conceitos anteriores, ficando estabelecido que a Lei era a voz do povo, pronunciada pelos seus representantes no parlamento.

Nessa vertente, John Locke defendeu o primado da lei, invocando a subordinação do governo ao poder legislativo. Para Locke o poder legislativo, mesmo na sua condição de superioridade, estava sujeito a certas condições ou limites de exercícios. Jean-Jacques Rousseau, refletindo sobre o princípio da legalidade administrativa, partiu da ideia de inalienabilidade e indivisibilidade da soberania, identificada com o exercício da vontade geral, tendo em vista o bem comum ou o interesse público, sendo a lei o substrato de atuação do Rei, fundamento sob o qual este atua e encontra os seus poderes, considerando-se assim o poder legislativo o coração do Estado.

O terceiro percussor de uma conceção liberal do princípio da legalidade administrativa, Immanuel Kant, fundador de uma filosofia crítica que investigava as condições de objetividade do saber (a primeira versão de "Crítica da Razão Pura" é de 1781), defendia que a verdadeira expressão da soberania correspondia "a vontade coletiva do povo". Essa tendência fortificada da lei como vontade suprema do povo adensou-se nos séculos XIX e início do XX, em que aos poderes executivo e judiciário estava vedada a iniciativa legislativa, estabelecida pelo poder legislativo.

Como referido numa primeira fase da história do direito público, o monarca representante do povo e senhor das razões, passou a ser chefe do então novo poder executivo, limitado pela lei, criada por um também poder (legislativo) novo, livre e autónomo. Esta vinculação da Administração Pública à lei constituiu um importante avanço para o Direito Público e para toda a humanidade, que passou a se submeter às regras legais e não à tirania do soberano.

[10] Montesquieu, partindo do pressuposto de que a liberdade consiste no "direito de fazer tudo aquilo que as leis permitem."

Conclui-se que a Administração Pública, bem como os demais poderes legalmente constituídos para agir são obrigados a elaborar atos discricionários, suportados por lei como condição de validade do juízo de valor, dentro de uma escolha livre de conveniência e de oportunidade. O chamado poder discricionário, portanto, é excecional e está vinculado à lei, que por não ter condição de prever todas as situações, com alguma objetividade e em tese, delega ao administrador público a competência de promover um juízo particular de escolha sobre determinado assunto.

Aliás, no campo filosófico, Hegel já considerava a Constituição como o "espírito de um povo", sendo "algo de incriado, embora produzido no tempo", tendo cada povo "a constitucionalização, que lhe convém e se lhe adequa".

Atualmente o principio da legalidade encontra consagração constitucional na Constituição da República Portuguesa que no seu Artº 2 n.º 2 do seu Artigo 266.º determina que "Os órgãos e agentes administrativos estão subordinados à Constituição e à lei e devem atuar, no exercício das suas funções, com respeito pelos princípios da igualdade, da proporcionalidade, da justiça, da imparcialidade e da boa fé". A sagração do princípio da legalidade no Artigo 3.º do Código do Procedimento Administrativo, determina que os órgãos da Administração Pública devem atuar em obediência à lei e ao direito, dentro dos limites dos poderes que lhes estejam atribuídos e em conformidade com os fins para que os mesmos poderes lhes foram conferidos.

Este é um princípio com várias vertentes e que levanta inúmeras questões. Primeiramente importa distinguir dois dos seus fundamentos naturais, o fundamento garantístico, que visa assegurar que a atuação administrativa ocorra em termos previsíveis para os cidadãos, assegurando igualmente o princípio da segurança jurídica e o fundamento democrático, que propende a assegurar que a atuação administrativa não ocorre à margem da legitimidade democrática. Em segundo lugar, é necessário tratar separadamente cada uma das suas dimensões: preferência de lei e reserva de lei. A preferência de lei, na sua formulação original significa que a Administração não pode atuar contra legem e em caso de conflito entre ato administrativo e lei, ocorre o primado da lei.

No entanto, com a transformação do estado liberal para o estado social, o primado da lei foi sendo atenuado pela crescente importância das Constituições e pela influência direta do direito da União Europeia. Afirmando-se com segurança que a lei deixou de constituir a charneira da atividade administrativa; tal função é agora assegurada por toda a ordem jurídica globalmente considerada. É este entendimento lato da expressão "lei" que foi acolhido pelo Código do Processo Administrativo, no seu art.3º.

Assim, constituem indiciadores de legalidade da atuação da Administração: a Constituição, o direito internacional, o direito da União Europeia, a lei ordinária, regulamentos e costume interno para quem o aceite como fonte de Direito. Atualmente assiste-se a um generalizado movimento ampliado de mudança de paradigma a que alguns autores apelidam de "crise" do direito administrativo clássico. E assim numa formulação, pensada para o direito italiano, mas que também se aplica no caso português, Pedro Gonçalves escreveu num artigo recente o seguinte: pode afirmar-se que "o Principio da legalidade [administrativa] não goza [...] de muito boa saúde".

Há algum tempo que a doutrina vem observando que o princípio da legalidade "enquanto predeterminação legislativa da ação administrativa está fatalmente destinado a retroceder" e a ver-se substituído por um "princípio de autonomia funcional da Administração". A chamada vocação estratégica da administração abandonou o estrito cumprimento da lei e o seu escopo principal passou a ser o da produção de resultados, falando-se a propósito, de uma "legalidade de resultado". Poder-se-á sintetizar que atualmente se procura a união perfeita entre legalidade e eficiência. O Estado, ao reduzir ou até suprimir a sua intervenção reguladora, transfere para a sociedade civil o poder de criar normas jurídicas reguladoras de certas atividades, "desestatizando" e, assim, "desregulando", no sentido de substituir a regulação estadual existente, expressa numa disciplina normativa publica, por uma auto-regulação. Em Portugal, das três modalidades auto-regulativas: privada, sem qualquer intervenção pública; privada com intervenção pública e por entidades públicas infra-estaduais – o legislador seguiu, preferencialmente, o modelo de uma regulação pública por autoridades independentes, numa forma que se aproxima desta última modalidade.

O grande tópico prudencial colocado pelo fenómeno hodierno de regulação pública, obrigatória por lei, de conflitos, entre as entidades públicas ou particulares, prestadoras de serviços públicos e os cidadãos utilizadores desses serviços, através de autoridades reguladoras independentes criadas pelo Estado, é o da compatibilização entre a garantia legislativa de funcionamento de uma economia de mercado comum num Estado Social de Direito protetor dos consumidores e a defesa pelo Estado Administrador do interesse público e do bem comum.

A doutrina aponta, a este propósito, à tendência institucional para submeter a Administração a uma disciplina de princípios e de regras gerais, acolhendo uma "normatividade principialista", e propendendo para a substituição de um "Direito de regras" para um Direito de princípios.

A eficácia e a eficiência são objetivos que prevalecem sobre o mero cumprimento formal e estrito da lei, em busca de resultados que melhor satisfaçam as necessidades coletivas públicas. Pedro Gonçalves reconhece, no entanto, que vai ganhando força um "princípio de autonomia funcional da Administração", como uma consequente "retracção do princípio da legalidade administrativa". Defende o mesmo autor que cada vez mais a Administração procura dar satisfação às necessidades sociais através de critérios de eficiência e de eficácia, em vez do cumprimento escrupuloso da lei.

Referindo-se ao princípio da legalidade, Paulo Otero identifica a existência de uma certa flexibilidade pela Administração Pública do sentido de vinculação à lei. O aparecimento das entidades administrativas independentes e a sua exclusão da responsabilidade direta ou indireta do Governo contribuiu de forma significativa para o enfraquecimento do princípio da legalidade administrativa, permitindo alguma ingerência das normas de direito privado na função administrativa. Esta teoria também não ficará isenta de controvérsia se a confrontarmos, designadamente, com o dever de realização do interesse público, matéria cuja análise não se enquadra no âmbito deste estudo.

Identificar-se-á como uma das consequências mais imediatas dessa alteração de carácter sistémico uma certa "distipicização dos atos administrativos"[11]. Apesar desta descaraterização surgir como uma ocorrência de espectro mais alargado, o direito administrativo da regulação já a conhece. Definindo-a Cimellaro como uma certa marginalização da legalidade.

De facto ensina a doutrina clássica que os atos administrativos são atos típicos, ou seja devem corresponder a uma determina consistência normativa. A exigência da tipicidade explica-se pela natureza do poder que se exerce por intermédio dos atos administrativos: ou seja os atos administrativos clássicos limitam-se a dar execução a leis. Em medidas variadas, as leis do direito administrativo da regulação apresentam desvios relativamente ao princípio da tipicidade, autorizando as entidades reguladoras a praticar atos administrativos atípicos, no entanto como referido atrás e sublinhado por Pedro Gonçalves em literatura diversa, com o princípio da legalidade dos atos administrativos vai pressuposta uma dimensão substancial, conexa com a tipicidade e não uma mera exigência de habilitação formal para agir por via da autoritária.

Para finalizar sublinha-se que, efetivamente, o direito administrativo da regulação ostenta traços muito claros de autoridade e de imperium, com entrega às entidades reguladoras de poderes musculados, característicos dos poderes de supervisão e regimes sancionatórios.

[11] A expressão é de Pedro Costa Gonçalves

4. Problemática jus-constitucional das Autoridades Reguladoras Independentes

Vital Moreira e Maria Fernanda Maças defenderam no seu estudo sobre autoridades reguladoras independentes que "As autoridades administrativas independentes suscitam diversos problemas quanto à sua adequação aos princípios constitucionais do Estado de Direito democrático". Defendem os autores que as dúvidas de ordem jurídico-constitucional que a criação das autoridades administrativas suscita resultam na sua natureza "sui generis", que ainda integrando o conceito genérico de administração estadual, gozam de um estatuto específico de independência em face do Executivo.

Essa independência poderá perigar os alicerces basilares dos sistemas administrativos baseados nos princípios da subordinação da administração ao Executivo e da responsabilização deste perante a Assembleia da República - o garante da legitimidade democrática. A Administração tradicional assentava num esquema unitário, concomitante com estruturas pluralistas e diversificadas indispensáveis para a realização das tarefas próprias da atividade administrativa. Essas estruturas articuladas e ligadas entre si funcionavam de forma sincrónica na prossecução do interesse público.

A originalidade que a criação das autoridades independentes representa, na evolução recente do modelo tradicional de administração, reside no facto de se tratar de autoridades públicas de natureza administrativa, mas não se integrarem em nenhuma das categorias de direito administrativo existente: dispõem de um estatuto de independência orgânica e funcional sem equivalente no quadro da organização administrativa tradicional. Parece flagrante que a independência assegurada a estas entidades não se coaduna com o sistema administrativo típico europeu, assente nos princípios da hierarquia e superintendência dos órgãos superiores relativamente aos inferiores. Na verdade, a obediência ao princípio da separação de poderes, confere-lhes legitimidade democrática indireta. E Karl Larenz, defendeu que "Entre os princípios ético-jurídicos aos quais a interpretação deve orientar-se, cabe uma importância acrescida aos princípios elevados a nível constitucional" Estes são, sobretudo, os princípios e decisões valorativas que encontram expressão na parte dos direitos fundamentais da Constituição, quer dizer, a prevalência da "dignidade da pessoa humana". Na lei Portuguesa o respaldo constitucional para a criação de Entidades Reguladoras Independentes assenta no Artigo 267.ºda CRP.

Um dos problemas interpretativos da natureza jurídica de regulação assenta de facto na questão da retração do princípio da legalidade administrativa. Esta questão passa, desde logo, pela autocontenção do legislador e pela devolução às entidades reguladoras de significados poderes de regulamentação normativa. Frequentemente trata-se de regulamentos independentes, ou seja regulamentos emitidos a partir de uma norma jurídica em branco. Significando que a lei atribui ao próprio regulamento a definição do seu conteúdo.

Não podendo ser emitidos sem base legal, os regulamentos independentes têm intrínseca uma liberdade de definição de conteúdo normativo. O regulamento independente é considerado por parte da doutrina como um concorrente com a legislação.

A figura do regulamento administrativo não é exclusiva do direito administrativo da regulação, mas quase. Na realidade a atribuição de poderes dessa natureza às reguladoras significa a criação de uma cadeia de problemas normativos, pois à alegada ausência de legitimidade democrática dos reguladores, juntar-se-á a inusitada capacidade legislativa, matéria de reserva do poder legislativo.

5. Poderes de regulamentação e de regulação

Na introdução a este capítulo, recupera-se uma passagem de um texto do Prof. Vital Moreira, inserido numa coletânea intitulada "A Mão Visível – Mercado e Regulação ", que, referindo-se a entidades reguladoras sectoriais, dispôs o seguinte: " (...) muitos acreditaram que a regulação sectorial e a existência de entidades reguladoras específicas eram fenómenos transitórios, que naturalmente haveriam de se extinguir quando esses sectores tivessem passado a reger-se pelas regras comuns da economia de mercado, ficando então submetidas somente à jurisdição geral das autoridades de defesa da concorrência". E mais à frente acrescenta o seguinte: "O prognóstico não se realizou nem está perto de o ser, sendo hoje evidente que as autoridades sectoriais de regulação não estão a prazo".

Parece-nos que esta afirmação, proferida no ano 2002, se mostrou profética, considerando a publicação da Lei n.º 67/2013, de 28 de Agosto, que aprovou a Lei-quadro das entidades reguladoras independentes ("lei-quadro").

Esta lei, cujo ensaio geral já tinha ocorrido há uns anos, resultou numa imposição da troika e do programa de ajustamento para conferir às diferentes atividades económicas um quadro de regulamentação harmonioso e estabilizado, adaptando as diferentes entidades reguladoras independentes às orientações da União Europeia.

Com a aprovação deste regime, as entidades administrativas independentes com funções de regulação da atividade económica dos sectores privadas, público e cooperativo passam a estar abrangidas por um enquadramento geral que vem uniformizar algumas das suas características.

Esta lei aplica-se a várias entidades reguladoras do sector económico e do sector financeiro, como o ICP-ANACOM (que passa a designar-se Autoridade Nacional de Comunicações), a ERSE e a CMVM, bem como à Autoridade da Concorrência. Excluídos do seu âmbito de aplicação estão o Banco de Portugal e a Entidade Reguladora para a Comunicação Social.

É garantido às entidades reguladoras a autonomia administrativa e financeira, bem como de gestão, a independência orgânica, funcional e técnica, possuir órgãos, serviços, pessoal e património próprios e ter poderes de regulação, regulamentação, supervisão, fiscalização e sanção de infrações.

As entidades reguladoras terão, como órgãos obrigatórios, um conselho de administração e uma comissão de fiscalização ou fiscal único. Cabe ao ministro da área de atividade indicar os membros para o conselho de administração da entidade reguladora, que serão designados pelo Conselho de Ministros, após audição da comissão competente da Assembleia de República. Estabelece-se que os mandatos dos membros do conselho de administração terão a duração de seis anos, sem possibilidade de renovação consecutiva.

A determinação da sua remuneração ficará a cargo de uma comissão de vencimentos junto de cada entidade reguladora, atendendo-se a critérios de conjuntura económica e tendo o vencimento mensal do Primeiro – Ministro como valor de referência –, mas não como limite.

De forma geral, a lei-quadro veio i) consagrar a independência das entidades reguladoras no exercício das suas funções, afastando-se a superintendência ou a tutela governamental, ii) disciplinar o regime das receitas e da contabilidade das entidades, determinando-se que os resultados líquidos podem ser utilizados em benefício do sector, iii) estabelecer um amplo regime de incompatibilidades para titulares de órgãos, titulares de cargos de direção e trabalhadores das entidades reguladoras.

6. Poderes de supervisão e de fiscalização

Nos termos dos seus Estatutos, aprovados pelo Decreto-Lei n.º 97/2002, de 12 de abril, na redação do Decreto-Lei n.º 84/2013, de 25 de junho, a Entidade Reguladora dos Serviços

Energéticos (ERSE) é a entidade responsável pela regulação dos setores da eletricidade e do gás natural (cfr. artigo 1.º, n.º 3).

Como entidade reguladora reconhecida na Lei-quadro das entidades administrativas independentes com funções de regulação da atividade económica e regendo-se pelos seus princípios e normas, a ERSE goza, entre outros, de poderes de fiscalização, devendo, no exercício desses poderes, efetuar pontualmente inspeções, auditorias e outras ações de fiscalização, quer em execução de planos previamente aprovados, quer sempre que se verifiquem circunstâncias que indiciem perturbações no seu setor de atividade, nomeadamente a violação das leis, regulamentos e demais normas aplicáveis às atividades sujeitas à sua regulação (cfr. artigo 3.º, n.º 3, al. d) da Lei n.º 67/2013, de 28 de Agosto, e artigos 1.º, n.º 1; 3.º, n.º 2, al. e); 40.º, n.º 3, als. a) e b) e 42.º da Lei-Quadro anexa à mesma).

Adicionalmente, também os Estatutos da ERSE determinam que esta, no exercício dos seus poderes de fiscalização, é competente para a realização de inspeções, auditorias e outras ações de fiscalização a todas as entidades intervenientes no Sistema Elétrico Nacional (SEN) e no Sistema Nacional de Gás Natural (SNGN) que exerçam atividades sujeitas à sua regulação, no quadro das suas atribuições (cfr. artigos 1.º, n.º 2 e 14.º).

A esta competência genérica acresce o dever de proceder regularmente à inspeção dos registos de queixas apresentadas junto dos operadores sujeitos à sua regulação, podendo ordenar a investigação das situações reclamadas naquelas entidades ou na própria ERSE, relativamente às matérias que integrem as suas competências (cfr. artigo 21.º dos Estatutos da ERSE).

As inspeções realizadas pela ERSE operam como instrumentos de verificação das práticas seguidas pelas entidades reguladas, visando assegurar, entre outros: (i) a verificação do cumprimento das disposições legais e regulamentares aplicáveis; (ii) recolher informação sobre o relacionamento comercial e contratual com os consumidores; (iii) selecionar elementos que fundamentem a aprovação de medidas de natureza regulamentar e (iv) analisar situações que possam motivar a formulação de recomendações com vista a atuações mais conformes ao cumprimento da regulamentação vigente.

Os poderes de fiscalização da ERSE encontram-se, ainda, especificamente previstos como mecanismo de controlo da aplicação e do cumprimento dos diversos regulamentos, designadamente no I) Sistema Elétrico Nacional, no Regulamento de Acesso às Redes e às Interligações (RARI); no Regulamento de Relações Comerciais (RRC); no Regulamento

Tarifário (RT); no Regulamento da Qualidade de Serviço (RQS); no Regulamento de Operação das Redes (ROR), e (ii) no Sistema Nacional de Gás Natural, Regulamento do Acesso às Redes, às Infraestruturas e às Interligações do Setor do Gás Natural (RARII); no Regulamento de Relações Comerciais (RRC); no Regulamento Tarifário (RT); no Regulamento da Qualidade de Serviço do Setor do Gás Natural (RQS) e no Regulamento de Operação das Infraestruturas (ROI).

Dispõem, ainda, os mencionados regulamentos do Sistema Elétrico Nacional que a verificação da prossecução dos princípios gerais consagrados naqueles seja assegurada pela existência de mecanismos de auditoria para o seu acompanhamento e verificação, a serem desenvolvidos por entidades externas que pautem a sua atuação por elevados níveis de qualidade e critérios de independência, diretamente contratadas pelas entidades reguladas e de acordo com o conteúdo e os critérios de seleção previamente aprovados pela ERSE, na sequência de proposta apresentada pelas primeiras, resultando na elaboração de relatórios enviados à ERSE e disponibilizados nas páginas da Internet das entidades responsáveis pela sua promoção.

Por seu turno, no âmbito do Sistema Nacional de Gás Natural, compete à ERSE fixar as normas e os procedimentos aplicáveis às ações de fiscalização previstas e necessárias nos termos dos regulamentos aplicáveis, a realizar diretamente ou mediante uma terceira entidade.

Adicionalmente, a ERSE, por forma a assegurar o exercício das suas funções de fiscalização, pode igualmente contratar terceiros para a realização de auditorias ou outras tarefas necessárias ao exercício de tais funções (cfr. artigo 57.º dos Estatutos da ERSE).

No exercício dos seus poderes de fiscalização, é ainda aplicável à ERSE o regime de inspeção e auditoria dos serviços do Estado (cfr. artigo 5.º, n.º 3, al. e) da Lei-Quadro anexa à Lei n.º 67/2013, de 28 de Agosto), gozando as pessoas ou entidades que, em seu nome, desempenhem funções de fiscalização, de um conjunto de prerrogativas e de um regime de incompatibilidades e impedimentos que permitem o exercício das funções atribuídas no respeito dos princípios da autonomia técnica, da proporcionalidade e do contraditório (cfr. artigo 13.º dos Estatutos da ERSE e artigos 10.º, 11.º, 12.º, 16.º, 20.º e 21.º do Decreto-lei n.º 276/2007, de 31 de julho).

Como decorre dos seus Estatutos, a ERSE tem como atribuições principais, entre outras, proteger os direitos e os interesses dos consumidores e velar pelo cumprimento, por parte dos agentes do setor, das obrigações estabelecidas na lei e nos regulamentos aplicáveis aos setores regulados (cfr. artigo 3.º, n.º 2, als. a) e c) dos Estatutos da ERSE).

A atividade de fiscalização da ERSE permite a obtenção de informação objetiva e fiável sobre o desempenho das entidades reguladas, bem como da efetiva e conforme implementação por parte daquelas das leis, regulamentos e demais normativos aplicáveis, proporcionando, deste modo, a segurança razoável de que as atribuições específicas da ERSE serão atingidas.

Conclusão

Vimos que o "Estado regulador" contemporâneo se caracteriza essencialmente pela desintervenção do Estado em relação à atividade económica, com a extinção ou redução substancial do papel do Estado empresário, do Estado produtor e do Estado prestador de serviços aos cidadãos.

O Estado passou a entregar-se essencialmente às tarefas de regulação das atividades privadas, visando assegurar entre outras coisas a prestação de "serviços de interesse económico geral".

As autoridades reguladoras independentes são a expressão da referida desgovernamentalização da regulação, e para assegurar a regulação dos mercados, as Autoridades Reguladoras Independentes são dotadas de poderes adequados os quais variam em função dos sectores a regular.A principal crítica levantada pela existência das autoridades reguladoras independentes, respeita à sua legitimidade em termos dos princípios do Estado de Direito democrático, nomeadamente a separação de poderes.

Na realidade, a independência orgânica e funcional das autoridades reguladoras independentes coloca-as essencialmente fora da órbita governamental relativamente à conceptualização clássica de separação de poderes.

Num esforço de mitigar as fragilidades apontadas em termos jus-constitucionais a este novo instrumento jurídico, foi publicada uma Lei-quadro com o objetivo de harmonizar os regimes das várias entidades reguladoras existentes e de sossegar os espíritos mais inquietos dos principais críticos desta nova dimensão do direito administrativo clássico - o direito da regulação.

A questão da independência parece-nos mais do foro lexical, as entidades reguladoras não são totalmente independentes e apesar de tudo como vimos integram a Administração Pública, numa categoria especial, a administração independente, e as suas decisões responsabilizam o Estado.

Estas apenas são administrativamente independentes, pelo que alguns pensadores entre eles Vital Moreira já apelidou esta Lei-quadro de "bastante conservadora".

Ao direito administrativo da regulação devem ser associadas poderes, até há pouco desconhecidos na sua conceção tradicional de direito administrativo. A este catálogo pertencem as competências para a resolução de litígios que são atribuídos a todos os reguladores nos termos desta lei-quadro.

Os críticos desta Lei-quadro consideram-na uma oportunidade perdida para criar uma lei moderna que satisfizesse as expetativas dos mais exigentes.

De fora desta lei ficou, efetivamente, o discutido projeto de submeter a escolha dos reguladores independentes a uma comissão de sábios na dependência da Assembleia da República, ou a sua nomeação por concurso público como defendido por alguns.

O estatuto remuneratório que constitui um dos calcanhares de Aquiles dos mais céticos ficou também talvez remediado mas não resolvido.

Para finalizar, parece pacifico concluir-se à luz da modernidade administrativa que as entidades reguladoras independentes constituem uma importante evolução das democracias ocidentais, conferem estabilidade a determinadas políticas públicas e asseguram uma sã concorrência em determinados sectores de atividade, através da sua mão visível.

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O Princípio da Igualdade no Setor Elétrico

Maria João Lucas

Artigo baseado no trabalho elaborado no âmbito da cadeira de Metodologia Jurídica do Curso de Mestrado em Ciências Jurídico-Financeiras, 2013-2014, da Faculdade de Direito da Universidade de Lisboa

Resumo

O princípio da igualdade enquanto princípio enformador de todo o ordenamento jurídico, está presente necessariamente no Sistema Elétrico Nacional (SEN). Constituindo-se a eletricidade como um bem essencial para que todos e todas possam viver com dignidade é imperativo que não seja, por si só, um fator de exclusão social e de empobrecimento da população.

O contexto de crise económica e financeira que se vive em Portugal e no seio da UE tem motivado e justificado a criação de algumas discriminações positivas, as quais decorrem da obrigação de diferenciar imposta, paradoxalmente, pelo princípio da igualdade. O SEN tem seguido de perto a evolução do contexto e sem descurar, os limites de necessidade, adequação e proporcionalidade, criou disposições que podemos considerar como consubstanciando discriminações positivas.

Palavras-chave

Igualdade - Eletricidade - Liberalização - Discriminação Positiva.

Introdução

O setor energético é na maioria das vezes apreciado na sua vertente económico-financeira descorando-se a vertente mais humanista do mesmo, daí considerarmos oportuno e útil apresentar esta visão.

Nesse sentido, elegemos tratar o princípio da igualdade por ser transversal aos diversos domínios da vida do ser humano, e ser a eletricidade um bem essencial cujo fornecimento tem caráter universal. Na abrangência de ambos se encontra uma similitude que os aproxima e não permite que se dissociem.

O presente artigo assenta em dois capítulos, no primeiro é feito um brevíssimo enquadramento do Princípio da Igualdade e o segundo capítulo, é destinado ao setor elétrico e centrado nas discriminações positivas, que foram sendo criadas com vista a promover uma efetiva igualdade entre os diversos consumidores.

Sublinha-se que se trata de um trabalho datado e que desde essa altura até ao presente ocorreram alterações legislativas e regulamentares, como é o caso, nomeadamente do Decreto-Lei n.º 138-A/2010, de 28 de dezembro que foi alterado e republicado em anexo ao Decreto-Lei n.º 172/2014, de 14 de novembro, do Regulamento das Relações Comerciais, aprovado pelo Regulamento n.º 561/2014, de 22 de dezembro.

1. O Princípio da Igualdade

O princípio da igualdade encontrou uma evolução conceptual que acompanhou a própria História da Humanidade. Isto porque o ser humano muda consoante o tempo e o espaço em que se encontra, desenvolve-se, cresce, aperfeiçoa-se, progride, não é pois um ser indiferente ao que lhe é externo, nem ao seu próprio interior. O entendimento da igualdade esteve desde sempre no centro do pensamento humano, embora com contornos diferentes. Na Antiguidade Clássica, como acontecia na Grécia Antiga, somente os cidadãos podiam participar na vida política da *polis*, incluindo-se apenas os homens livres e maiores de 21 anos, ficando excluídos do conceito de cidadão tanto os estrangeiros, como os escravos, as mulheres e as crianças. A Idade Média, considerada um período controverso da história da humanidade, é caracterizada por uma grande hierarquização social, com privilégios e riqueza para poucos e obrigações e trabalho para muitos. Existia, pois, uma forte estratificação de classes, baseada no privilégio do nascimento, que punha em causa a igualdade de tratamento e a igualdade de oportunidades logo à nascença. Com a Idade Moderna ocorreram profundas transformações na ordem jurídica, política, económica e social, fundamentais para o desenvolvimento de um novo conceito de igualdade e também de liberdade, que constituem um dos pilares da democracia.

De acordo com o Prof. Gomes Canotilho " [...] a radicação da ideia da necessidade de garantir o homem no plano económico, social e cultural, de forma a alcançar um fundamento existencial-material, humanamente digno, passou a fazer parte do património da humanidade."[1]

O princípio da igualdade constitui um dos elementos estruturantes do constitucionalismo. De acordo com o Prof. Jorge Miranda, a importância fundamental do princípio da igualdade teve reconhecimento desde logo no constitucionalismo português, sendo disso exemplo as Bases da Constituição aprovadas pelas Cortes Gerais Extraordinárias e Constituintes da Nação Portuguesa, de 9 de Março de 1821, que no seu artigo 11.º proclama solenemente que a "lei é igual para todos". O princípio manteve-se ao longo de todo o constitucionalismo e é, por isso, sem surpresas que, na atual Constituição da República Portuguesa (CRP) se consagra o Princípio da Igualdade no artigo 13.º inserido na Parte I, destinada aos Direitos e Deveres Fundamentais. *"1 - Todos os cidadãos têm a mesma dignidade social e são iguais perante a lei. 2 – Ninguém pode ser privilegiado, beneficiado, prejudicado, privado de qualquer direito ou isento de qualquer dever em razão de ascendência, sexo, raça, língua, território de origem, religião, convicções políticas ou ideológicas, instrução, situação económica, condição social ou orientação sexual."*

São inúmeros os artigos da CRP em que podemos encontrar referência a este princípio, como seja em matéria de habitação, saúde, trabalho, educação, casamento, justiça, participação política, segurança social, *inter alia.*

A Constituição assume como prioridade do Estado a promoção da "justiça social, assegurar a igualdade de oportunidades e operar as necessárias correcções das desigualdades na distribuição da riqueza e do rendimento, nomeadamente através da política fiscal" (alínea b) do artigo 81º).

A igualdade proclamada no artigo 13.º da CRP é, nas palavras do Prof. Jorge Miranda e do Prof. Rui Medeiros[2] uma «igualdade jurídico-formal» abrangendo quaisquer deveres

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1 CANOTILHO, José Joaquim Gomes, *in* Direito Constitucional, p. 425.
2 MIRANDA, Jorge e MEDEIROS,Rui, *in* Constituição da República Anotada- Tomo I

existentes na ordem jurídica portuguesa. A igualdade formal reconduz-se a um conceito capaz de abarcar todos os conteúdos possíveis de igualdade material.

Mas porque existem desigualdades de facto, reais e efectivas, de vária ordem, implica que o poder político e a sociedade civil "criem ou recriem oportunidades e as condições que a todos permitam usufruir dos mesmos direitos e cumprir os mesmos deveres.". É considerada, pela Prof.a Maria da Glória Garcia[3], a igualdade de natureza material como uma construção.

Assim, enquanto formalmente só existe uma igualdade, materialmente há tantas quantas as simbioses possíveis de situações comparadas e critérios valorativos.

A igualdade enquanto conceito comparativo pressupõe uma comparação que, segundo a Prof.a Maria da Glória Garcia, exige pelo menos três elementos: duas situações ou objectos que se comparam em função de um aspecto que se destaca do todo e que serve de termo de comparação. Relativamente ao conceito valorativo a que o princípio da igualdade apela não deve ser um critério de valores subjectivos, mas, pelo contrário, um critério de valores retirado do quadro de valores vigentes numa sociedade, interpretados objectivamente.

O sentido primário da norma constitucional é negativo, porque consiste na vedação de privilégios (situações de vantagem não fundada) e de discriminações (situações de desvantagem). Os privilégios ou as discriminações podem ser meramente indirectas.

Mais rico e exigente é, nas palavras do Prof. Jorge Miranda, o sentido positivo do princípio, que compreende: - tratamento igual de situações iguais, - tratamento desigual de situações desiguais, mas substancial e objectivamente desiguais e não criadas ou mantidas artificialmente pelo legislador, - tratamento em moldes de proporcionalidade das situações relativamente iguais ou desiguais e que, consoante os casos, se converte para o legislador ora em mera faculdade, ora em obrigação, - tratamento das situações não apenas como existem mas também como devem existir, e – consideração do princípio não como uma "ilha", antes como princípio a situar no âmbito dos padrões materiais da Constituição.[4]

Por seu lado, a jurisprudência constitucional portuguesa distingue três dimensões no controlo do respeito pelo princípio da igualdade: a proibição do arbítrio, a proibição de discriminação e a obrigação de diferenciação.

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[3] GARCIA, Maria da Glória, *in* Estudos sobre o Principío da Igualdade.

[4] MIRANDA, Jorge e MEDEIROS, Rui, ob. cit., p. 223.

O princípio da igualdade de tratamento e de não discriminação é também um dos princípios fundamentais do Direito da União Europeia, sendo além disso um dos direitos fundamentais cujo respeito é garantido pelo Tribunal de Justiça da União Europeia (TJUE). Este princípio aparece no direito da UE por duas vias. Por um lado, o direito originário formaliza o princípio numa série de disposições expressamente destinadas a proteger a igualdade de tratamento em determinadas matérias. E, por outro lado, o direito derivado desenvolve o seu conteúdo através das normas estabelecidas sob essas bases jurídicas.

Como refere Casanova[5], desde meados da década passada, o TJUE desenvolveu uma jurisprudência muito ambiciosa em termos de proteção do princípio geral da igualdade de tratamento do artigo 19.º TFUE e as suas diferentes manifestações.

2. A igualdade no SEN

A Lei dos Serviços Públicos Essenciais (LSPE) aprovada pela Lei n.º 23/96, de 26 de julho, considera a eletricidade como um serviço público essencial devido ao carácter fundamental que assume na vida quotidiana, sendo imprescindível garantir a existência de um serviço universal que assegure o fornecimento em condições de qualidade e continuidade e proteja o utente em matéria de tarifas e preços.[6]

O legislador não se comprometeu com uma explicação do conceito de "serviços públicos essenciais", optando por limitar o seu âmbito de aplicação através da enumeração que faz no n.º 2 do artigo 1.º do diploma.[7]

Refere ainda o artigo 5.º da LSPE que a prestação do serviço não pode ser suspensa sem pré-aviso adequado, salvo caso fortuito ou de força maior. É o chamado princípio de continuidade que está presente no preceito e que consiste num serviço prestado de forma permanente, contínua e fiável. Este princípio é depois concretizado no Regulamento das Relações Comerciais (RRC)[8] e no Regulamento da Qualidade de Serviço (RQS)[9], ambos do Sector Elétrico. Esta questão é tanto mais importante quanto o facto de vivermos um contexto de crise em que muitas pessoas em dificuldade se deparam com o dilema de

[5] CASANOVA, Milán Requena, La tutela judicial del principio general de igualdade en la Unión Europea: una jurisprudência expansiva baseada en una jerarquia de motivos discriminatórios, in Revista de Derecho Comunitario Europeo, n. º 40, 2011, p.769.
[6] SIMÕES, Fernando Dias; ALMEIDA, Mariana Pinheiro *in* Lei dos Serviços Públicos Essenciais, Anotada e Comentada, p. 25.
[7] *Idem* p. 13
[8] RRC alterado e republicado pelo Regulamento n.º 468/2012, de 12 de novembro
[9] RQS aprovado pelo Regulamento n.º 455/2013, de 29 de novembro.

aquecer-se ou comer "*heat or eat*", parecendo viver num conto de Charles Dickens. Não obstante a falta de estatísticas e de estudos relevantes, é do conhecimento público que tem havido um aumento de interrupções do fornecimento de electricidade motivados pela falta de pagamento. Esta situação embora sem dados estatísticos a suporta-la é mencionada, em termos genéricos, no Relatório da Qualidade de Serviço do Sector Eléctrico 2012, onde se pode ler que "Existem determinados factos imputáveis ao cliente que originam a interrupção do fornecimento, sendo o mais comum a falta de pagamento das faturas de eletricidade."[10]

O princípio da igualdade entendido no sentido de procura da harmonia geral, de uma ideia mais vasta de justiça, assume uma função dinâmica e social num quadro amplo de solidariedade intra e intergeracional.

I. Discriminação positiva no sector eléctrico

O princípio da igualdade adquire, pois, o significante papel de motor de uma igualdade jurídico-material idealizada, que se projecta no futuro, uma igualdade que se procura promover, impondo, algo paradoxalmente, ao poder político, a obrigação de diferenciar – discriminações positivas.[11] Esta obrigação de diferenciar, é dirigida a compensar uma desigualdade de oportunidades fáctica. Para a Prof.a Maria Glória Garcia, as medidas de discriminação positiva exigem "um sentido de justiça e de solidariedade social fortemente entretecido e aprofundado [...] sendo que são as actuais gerações que sofrem a acção discriminatória positiva"[12]. Existe um certo risco na adoção destas medidas, no sentido em que elas poderão porventura exercer o efeito contrário ao pretendido, *ié*, uma situação de discriminação negativa. Por forma a evitar tal situação, a Prof.a Maria Glória Garcia defende ainda "que se encontrem limites para tais discriminações ou preferências, uma vez que, por seu intermédio, se pode violar o princípio da igualdade que as tornou necessárias", pelo que, "se deve entender que o princípio da igualdade só impõe discriminações positivas quando estas correspondam a um consenso social generalizado, forjado no uso consciente da liberdade, renovada diariamente no seu fundamento último, a dignidade humana".[13].

Na verdade, o contexto de crise económica e financeira tem motivado e justificado, algumas discriminações positivas, no seio do SEN.

[10] Relatório da Qualidade de Serviço do Sector Eléctrico 2012, ERSE, de outubro de 2013, p. 83
[11] GARCIA, Maria Glória F.P., *in* Estudos sobre o Princípio da Igualdade, Coimbra, 2005, p.21
[12] *Idem*, p. 25
[13] *Idem*, p.26

2.1. Clientes economicamente vulneráveis

Nos últimos anos, surge pela primeira vez, no âmbito do mercado interno de energia eléctrica, a menção a cliente vulnerável na Diretiva 2003/54/CE do Parlamento Europeu e do Conselho, de 26 de junho, que estabelece as regras comuns para esse mercado interno.[14]

O seu aparecimento neste momento resultou do facto de estar em curso a liberalização do mercado de electricidade e nesta altura se incluírem no processo os clientes domésticos, considerados como tal aqueles que compram electricidade para consumo doméstico próprio, excluindo actividades comerciais ou profissionais.[15]

Posteriormente, a Directiva 2009/72/CE, de 13 de julho, que revogou a anterior, veio impor que cada Estado-Membro definisse o conceito de cliente vulnerável [16], sem se comprometer com uma definição. Em 2009, apenas 10 dos 27 Estados-Membros previam tarifas sociais para clientes vulneráveis e apenas em 8 deles se utilizava normalmente o termo "cliente vulnerável".[17]

Em função deste tipo de dados, a Comissão declara a sua intenção de apoiar "os Estados-Membros na definição do conceito de vulnerabilidade económica dos consumidores e de quais são as suas causas, prestando orientações e facilitando o intercâmbio de boas práticas".[18] O Parlamento Europeu, na sua Resolução de 22 de maio de 2012, considera que o conceito de consumidor vulnerável deve incluir, além da noção de vulnerabilidade endógena (identificada como permanente), a situação dos consumidores que estejam numa situação de vulnerabilidade (identificada como temporária).[19]

Nesse particular, o Estado português definiu clientes economicamente vulneráveis como sendo as pessoas singulares que se encontram em situação de carência económica e que, tendo o direito de acesso ao serviço essencial de fornecimento de energia elétrica, devem ser protegidas, nomeadamente no que respeita a preços, recorrendo a um critério de elegibilidade que coincide com as prestações atribuídas pelo sistema de segurança social. O conceito encontra-se definido no n.º 1 do artigo 2.º do Decreto-Lei n.º 138-A/2010, de 28

[14] Ver considerando 2 e 24, e o n.º 5 do artigo 3.º da Diretiva n.º 2003/54/CE do Parlamento Europeu e do Conselho, de 26 de junho.
[15] Ver n.º 10 do artigo 2.º da Diretiva 2003/54/CE do Parlamento Europeu e do Conselho, de 26 de junho.
[16] Ver n.º 7 do artigo 3.º da Diretiva 2009/72/CE, do Parlamento Europeu e do Conselho, de 13 de julho.
[17] Parecer do Comité Económico e Social Europeu sobre "A pobreza energética no contexto da liberalização e da crise económica", (211/C 44/09), ponto 6.1.
[18] Comunicação da Comissão, "Fazer funcionar o mercado interno de energia", de 15 de novembro de 2012, p. 13.
[19] Resolução do Parlamento Europeu, de 22 de maio de 2012, sobre "Uma estratégia de reforço dos direitos dos consumidores vulneráveis", (2011/2272(INI)), (2013/C 264 E/03).

de dezembro. E mais refere no n.º 2 do mesmo preceito legal que "[...] são considerados clientes economicamente vulneráveis os que se encontram nas seguintes situações: *a) Os beneficiários do complemento solidário para idosos; b) Os beneficiários do rendimento social de inserção; c) Os beneficiários do subsídio social de desemprego; d) Os beneficiários do primeiro escalão do abono de família; e) Os beneficiários da pensão social de invalidez."*

2.1.1. Tarifa Social

Para os clientes economicamente vulneráveis foi criada uma tarifa social, que é calculada mediante a aplicação de um desconto na tarifa de acesso às redes em baixa tensão normal[20], nos termos a definir no regulamento tarifário aplicável ao sector eléctrico. Adicionalmente, o diploma estabelece que os clientes economicamente vulneráveis que podem beneficiar de uma tarifa social serão inevitavelmente consumidores domésticos, que sejam titulares de um contrato de fornecimento de energia eléctrica para a sua habitação permanente e que possam satisfazer as suas necessidades mínimas, mas essenciais, de energia eléctrica, o que fundamenta a introdução de alguns limites na sua utilização, mais precisamente na potência contratada. Neste sentido, prevê-se que uma das condições para a atribuição da tarifa social seja a potência contratada não ultrapassar os 4,6 kVA. Cada cliente economicamente vulnerável apenas pode beneficiar da tarifa social num único ponto de ligação às redes de distribuição de energia eléctrica em baixa tensão.

O valor do desconto é fixado pela ERSE e o cálculo realizado de acordo com o estabelecido nos n.ºs 3 a 5 do artigo 3.º do Decreto-Lei supra identificado. A ERSE prevê que o número de beneficiários das prestações sociais anteriormente indicadas, seja para 2014, de cem mil consumidores.[21]

De forma a assegurar que a tarifa social seja aplicável a todos os clientes independentemente do seu comercializador, esta será aplicada através de um desconto na tarifa de acesso às redes em baixa tensão normal, devendo os comercializadores explicitar este desconto nas facturas dos seus clientes vulneráveis. A tarifa social foi igualmente reflectida no artigo 226.º do RRC.

Face à atual conjuntura verificou-se a necessidade de adoptação de medidas adicionais e complementares de protecção dos consumidores, em especial dos mais vulneráveis.

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[20] Baixa Tensão Normal (BTN) – são os fornecimentos ou entregas em Baixa Tensão com a potência contratada inferior ou igual a 41,4 kVA. – Alínea d) do n.º 1 do artigo 3.º do RRC.

[21] Documento explicativo das Tarifas e Preços para a energia eléctrica e outros serviços em 2014, ERSE, dezembro de 2013, p. 125

Essas medidas exigem um sentido de justiça e de solidariedade social apurado e consubstanciam uma obrigação de diferenciar tendo como objectivo compensar desigualdades de oportunidades existentes.

2.1.2. Apoio Social Extraordinário ao Consumidor de Energia (ASECE)

Nesse seguimento, criou-se o ASECE, destinado às pessoas singulares que se encontrem em situação de beneficiar do regime da tarifa social de electricidade. Este apoio social extraordinário ao consumidor de energia, foi criado pelo Decreto-Lei n.º 102/2011, de 30 de setembro. Os custos com a aplicação do ASECE são suportados pelo Estado. A tarifa social e o ASECE são cumuláveis, a primeira como referimos corresponde a um desconto na tarifa de acesso às redes e o ASECE compreende um desconto no preço do fornecimento de energia.

2.1.3. Prazo de pagamento

No sentido de promover uma maior igualdade entre pessoas com situação económica distinta, foi definido um prazo mais alargado para os clientes economicamente vulneráveis procederem ao pagamento da sua factura de electricidade. É fixado um prazo de 20 dias úteis, a contar da data de apresentação da factura aos clientes em BTN, em lugar da regra geral de 10 dias úteis, conforme dispõe o artigo 236.º o RRC.

2.1.4. Pré-aviso

Outra das medidas adotadas para proteger o utente nas situações de mora, que justifiquem a suspensão do serviço, é a necessidade de pré-aviso, por escrito, a efectuar pelo comercializador ou comercializador de último recurso, com uma antecedência mínima de 15 dias úteis (em contraposição com os 10 dias úteis para a generalidade dos consumidores), nos termos do disposto no n.º4 do artigo 238.º do RRC.

2.1.5. Pagamento fraccionado

Recentemente foi publicada a Diretiva n.º 17/2013, de 23 de setembro, sobre os acertos de facturação baseada em estimativa de consumo que pretende estabelecer a existência de pagamentos fraccionados que ponderem, de forma equilibrada, as vulnerabilidades dos consumidores de energia em Portugal, o legítimo exercício ao direito de mudança de comercializador e, em paralelo, a sustentabilidade dos sectores regulados.

2.1.6. Liberalização do mercado/CUR

A liberalização do mercado energético em Portugal Continental processa-se com a saída do mercado regulado para o chamado mercado livre ou concorrencial, onde operam vários comercializadores de energia eléctrica. Por outras palavras, significa passar do comercializador de último recurso[22] (EDP Serviço Universal e algumas Cooperativas que operam em regiões geograficamente definidas e de muito pequena dimensão cuja identificação pode ser consultada no *site* da ERSE) para um dos comercializadores em regime de mercado (acessível igualmente no *site* da ERSE), mas também com a obrigatoriedade de que os novos contratos de fornecimento de energia eléctrica sejam celebrados em regime de preços livres. A última extinção de tarifas reguladas ocorreu no dia 31 de dezembro de 2012, com o término das tarifas para todos e todas os/as consumidores/as de energia, incluindo os pequenos/as consumidores/as, isto é, os/as consumidores/as de eletricidade com potência contratada até 10,35 kVA. O fim das tarifas reguladas significa que os preços de venda de eletricidade aos/às consumidores/as finais deixam de ser fixados pela ERSE e passam a ser definidos pelo mercado.

A expectativa era a de que os preços baixassem à medida que a competitividade aumentava entre aqueles operadores económicos. Contudo, a abertura dos mercados de energia não reduziu os preços de energia para os cidadãos/ãs. Pelo contrário, 60% constataram um aumento dos preços do seu fornecedor de energia e apenas 3 a 4% uma diminuição, ao passo que 8% mudaram de fornecedor. A energia é o sector em que os consumidores mais gastam (5,7% do orçamento), principalmente na electricidade (2,1%).[23] O Comité Económico e Social Europeu (CESE) lembra[24] que os preços de energia estão a aumentar de forma contínua: entre 2011 e 2012, o preço da electricidade aumentou 6,6% na UE, sobretudo em Chipre (+21%), na Grécia (+15%), em Itália (+11%), na Irlanda e em Portugal (+10%), na Bulgária, em Espanha e na Polónia (+9%).

O processo de extinção de tarifas reguladas é acompanhado pela adopção de "mecanismos de salvaguarda"[25] dos clientes finais economicamente vulneráveis, designadamente a

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[22] Os comercializadores de último recurso são as entidades titulares de licença de comercialização, que no exercício da sua actividade estão sujeitos à obrigação da prestação universal do serviço de fornecimento de energia eléctrica, garantindo a satisfação das necessidades dos respectivos clientes, enquanto forem aplicáveis as tarifas reguladas ou, após a sua extinção, as tarifas transitórias, bem como o fornecimento dos clientes economicamente vulneráveis, nos termos legalmente definidos. – artigo 12.º, n.º 1 do RRC.

[23] 2.º Painel de Avaliação Anual dos Mercados de Consumo – 2009, acessível em http://ec.europa.eu/consumers/consumer_research/editions/docs/4th_edition_scoreboard_pt.pdf

[24] Parecer do CESE sobre "Acção coordenada a nível europeu para prevenir e combater a pobreza energética" (parecer de iniciativa), (2013/C 341/05).

[25] Ver 7.º parágrafo do preâmbulo e artigo 1.º n.º 1 do Decreto-Lei n.º 75/2012, de 26 de março.

possibilidade de serem fornecidos por um comercializador de último recurso. O mecanismo enunciado encontra-se refletido no n.º 2 do artigo 205.º do RRC que aqui se reproduz "*2 - Os comercializadores de último recurso são obrigados a fornecer energia eléctrica aos clientes economicamente vulneráveis, definidos nos termos do disposto no n.º 1 do artigo 226.º, que optem por ser abastecidos através de um comercializador de último recurso.*"

O CESE vem ainda identificar os grupos sociais mais vulneráveis como sendo os grupos com menores rendimentos: pessoas com mais de 65 anos, famílias monoparentais, desempregados ou os dependentes de prestações sociais.[26] Encontramos uma vez mais situações de igualdade formal mas de desigualdade material, ou seja, todos/as iguais perante a liberalização do mercado de energia, mas com condições desiguais nesse mesmo mercado. Resultando imperativo um tratamento desigual para situações que se apresentam desiguais e justificando o surgimento das denominadas discriminações positivas.

2.2. Clientes prioritários

Os clientes prioritários são aqueles que prestam serviços de segurança ou saúde fundamentais à comunidade e para os quais a interrupção do fornecimento de energia elétrica causa graves alterações à sua atividade. Excluem-se todas as instalações que, pertencendo a estes clientes, não servem os fins que justificam o seu caráter prioritário. O RQS[27] enumera no artigo 63.º os clientes prioritários em: "*a) Estabelecimentos hospitalares, centros de saúde ou entidades que prestem serviços equiparados; b) Forças de segurança e instalações de segurança nacional; c) Bombeiros; d) Proteção civil; e) Clientes que se encontrem nas condições das alíneas d) e e) do artigo anterior; f) Equipamentos dedicados à segurança e gestão de tráfego marítimo ou aéreo; g) Instalações penitenciárias*".

O reduzido número de clientes prioritários registados, que se verifica há vários anos, levou a ERSE a dispensar a iniciativa do cliente para fazer o registo. No sentido de minorar os danos resultantes de interrupções de fornecimento, está previsto que os operadores das redes mantenham um registo dos clientes prioritários, de modo a que seja possível o restabelecimento mais rápido em caso de avaria ou o pré-aviso individualizado de interrupção nas situações em que tal é possível. Quando a avaria implique deslocação, a chegada à instalação deve ocorrer no prazo de 3 horas enquanto o prazo para os restantes clientes é de 4 horas.

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26 Parecer do CESE sobre "A Pobreza energética no contexto da liberalização e da crise económica", [211/C 44/09].

27 Regulamento n.º 455/2013, de 29 de novembro, que aprova o Regulamento da Qualidade de Serviço.

O Relatório da Qualidade de Serviço do Sector Elétrico 2012, publicitado pela ERSE em outubro de 2013, apresenta a expressão numérica dos clientes prioritários em Portugal.

2.3. Clientes com necessidade especiais

Consideram-se clientes com necessidades especiais os enunciados no n.º 1 do artigo 62.º do RQS, a saber: "*Clientes com limitações no domínio da visão - cegueira total ou hipovisão; com limitações no domínio da audição – surdez total ou hipoacusia; com limitações no domínio da comunicação oral; clientes para os quais a sobrevivência ou a mobilidade dependam de equipamentos cujo funcionamento é assegurado pela rede elétrica e para os clientes que coabitem com pessoas nas condições acabadas de referir no ponto anterior*".

Os operadores das redes de distribuição ficam obrigados a manter atualizado um registo dos clientes com necessidades especiais. Contudo, a solicitação deste registo é voluntária e da exclusiva responsabilidade do cliente. O procedimento do registo e suas implicações estão previstos no artigo 65.º do RQS.

Havendo uma avaria na alimentação individual da instalação é de 3 horas o prazo para a deslocação até à instalação de um cliente com necessidades especiais dependente de equipamento médico, em detrimento das 4 horas aplicáveis aos restantes clientes.

Os clientes com necessidades especiais encontram-se igualmente retratados estatisticamente no Relatório da Qualidade de Serviço do Sector Elétrico 2012, constatando-se que o seu número aumentou em relação ao ano anterior, em particular o daqueles com limitações da mobilidade.

2.4. Quotas e alternância de género

Não poderíamos deixar de evocar e de nos congratularmos com a Lei-quadro das Entidades Reguladoras[28] ao definir que no provimento do cargo de presidente do conselho de administração deve ser garantida a alternância de género e no provimento dos vogais deve ser assegurada a representação mínima de 33 % de cada género.

Esta iniciativa do legislador mostra-se extremamente oportuna e adequada, dado que, actualmente, das 9 entidades reguladoras a que se aplica o diploma, apenas uma é

[28] Lei n.º 67/2013, de 28 de agosto, que aprova a Lei-quadro das Entidades Reguladoras.

presidida por uma mulher (Autoridade Nacional de Comunicações – ICP - ANACOM), não existe nenhuma mulher a exercer o cargo de Vice-Presidente e dos 20 lugares de vogal, somente 3 estão preenchidos por mulheres (Comissão do Mercado de Valores Mobiliários – CMVM; Instituto de Seguros de Portugal – ISP; e Instituto da Mobilidade e dos Transportes, I. P. - IMT). Somos forçados a concluir que a regulação é uma actividade marcadamente masculina - "musculada" - para estereotipar a questão.

Podemos estabelecer um paralelismo entre as Entidades Reguladoras e a Administração Pública Central (directa e indirecta) e constatar que a passagem do tempo não tem contribuído para alterar o paradigma dos cargos de direcção estarem entregues aos homens, pese embora o facto de existirem mais mulheres, pelo menos, no universo da Administração Pública Central[29].

Das doze áreas críticas enunciadas pela Plataforma de Acção de Pequim, 1995, uma refere-se expressamente à questão do acesso ao poder e no processo de tomada de decisão, afirmando que "a autonomia e afirmação das mulheres e a sua participação plena (...) são fundamentais para se alcançar a igualdade, o desenvolvimento e a paz".[30] No mundo, as mulheres encontram-se presentes em cerca de 10% a 20% de empregos de direcção e administração, sendo que este valor é inferior a 20% no sector da manufactura.[31] Apesar do generalizado movimento de democratização na maioria dos países, as mulheres estão largamente sub-representadas em quase todos os níveis do governo, sobretudo ao nível de ministérios e outros órgãos executivos, e os progressos foram escassos no que respeita ao cumprimentos dos objectivos aprovados pelo Conselho Económico e Social que visavam atingir 30% de mulheres em postos de decisão em 1995. A reduzida proporção de mulheres entre os responsáveis pela tomada de decisão económica e política aos níveis local, nacional, regional e internacional resulta de barreiras tanto estruturais como ideológicas que devem ser superadas através de medidas de acção positiva.[32]

II. Pobreza Energética

Embora em Portugal ainda não seja utilizada a expressão "pobreza energética", este conceito é já recorrentemente utilizado e plasmado nos documentos das várias instituições comunitárias.

[29] Sínteses estatísticas apresentadas trimestralmente pela Direção-Geral da Administração e do Emprego Público (DGAEP).

[30] Estratégias Internacionais para a Igualdade de Género, A Plataforma de Ação de Pequim (1955-2005), CIDM-PCM, Lisboa, 2005, p. 11

[31] Direitos Humanos, Discriminação contra as mulheres: A Convenção e o Comité, N.º 22, Ficha Informativa, Rev. I, Nações Unidas, p. 6.

[32] Estratégias Internacionais para a Igualdade de Género, A Plataforma de Acção de Pequim (1955-2005), CIDM-PCM, Lisboa, 2005, p. 136 a 144.

Consciente de que o contexto de crise económica conjugado com a liberalização do mercado de energia torna mais evidente o cenário de pobreza energética, o CESE redige, em 14 de julho de 2010, um parecer exploratório sobre esta problemática.[33] Neste parecer, o CESE sugere que a UE adopte uma definição comum e de carácter geral susceptível de ser ulteriormente adaptada a cada Estado-Membro. Avançando, no ponto 1.4, com uma definição de pobreza energética no sentido de a considerar como "a dificuldade ou a incapacidade de manter a casa de habitação em condições adequadas de temperatura e de dispor de outros serviços energéticos essenciais a um preço razoável." Em parecer posterior, de 6 de setembro de 2013[34], vem clarificar que o CESE aplica o termo "pobreza energética" para se referir à condição social influenciada por factores externos e internos.

Na verdade, apenas a França, a Eslováquia e o Reino Unido possuem uma definição de pobreza energética. A nível mundial existem 1,2 mil milhões de pessoas que ainda não têm acesso à electricidade e 2,8 mil milhões continuam a aquecer-se ou a cozinhar com madeira e outros tipos de biomassa. A pobreza energética mata física e socialmente e afecta 50 milhões de pessoas.

Tendo em conta o contexto económico, financeiro e social houve já vários Estados-Membros, que resolveram adoptar aquilo a que chamaram de "Trégua invernal" e que consiste num determinado período do ano e até um limite definido de consumo, não ser interrompido o fornecimento às famílias que não podem pagar as suas facturas. Esta iniciativa foi implementada pelo Reino Unido, pela França e mais recentemente na região da Catalunha, em Espanha. Em Portugal não existe ainda uma medida deste género, contudo, foram criadas outras no sentido de promover e defender a igualdade entre os/as consumidores de energia elétrica. Estas medidas não são soluções para a pobreza mas medidas para recuperar a saúde e a dignidade, e facilitar o acesso a um bem essencial que cada vez mais parece um luxo.

[33] Parecer do CESE sobre "A Pobreza energética no contexto da liberalização e da crise económica", (211/C 44/09).
[34] Parecer CESE sobre "Acção coordenada a nível europeu para prevenir e combater a pobreza energética" (parecer de iniciativa), (2013/C 341/05).

Conclusão

A igualdade é a pedra angular de toda a sociedade democrática que aspira à justiça social e à realização dos direitos humanos. A igualdade inspirou e moveu as pessoas no passado e continuará a fazê-lo no futuro.

O conceito de igualdade não consiste unicamente em assegurar o mesmo tratamento a todos e a todas. É muito mais do que isso, uma vez que a igualdade de tratamento das pessoas que não se encontram na mesma situação contribuirá para perpetuar a injustiça, em vez de a eliminar. Como diria Amartya Sen «Todas as reformas e mudanças que têm em vista o reforço da justiça exigem a realização de apreciações comparativas, e não somente uma imaculada definição d'"a sociedade justa" (ou d'"as instituições justas").[35]».

A verdadeira igualdade terá de resultar de esforços desenvolvidos para corrigir e lutar contra as desigualdades. Esta noção mais vasta de igualdade fundamenta e preside à criação de algumas discriminações positivas, necessárias, adequadas e proporcionais, no ordenamento jurídico português e naturalmente no setor energético.

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A avaliação de benefícios e a conciliação de interesses nas questões ambientais

Pedro Costa, Patrícia Lages, Jaime Vogado, José Afonso e Pedro Roldão

Resumo

A experiência da ERSE na melhoria do desempenho ambiental dos setores regulados debateu-se, ao longo dos anos, com dois desafios principais: a conciliação de interesses, por vezes divergentes, e a avaliação dos benefícios atingidos. Este artigo pretende explanar as opções seguidas pela ERSE para resolver ou minorar estas duas dificuldades, destacando-se: i) os bons resultados conseguidos com a realização de parcerias entre as empresas, organizações não-governamentais de ambiente (ONGA), entidades públicas, universidades e centros de investigação e ii) o trabalho desenvolvido no âmbito de um painel de avaliação, que conjugou a representação e o diálogo entre os diversos interesses e especialistas na área do ambiente.

Palavras-chave

Desempenho Ambiental - Setor Elétrico - Setor do Gás Natural - Regulação - ERSE - Conciliação de Interesses - Benefícios Ambientais - Avaliação de Resultados - PPDA - Ambiente.

Introdução

O setor energético está fortemente interligado com as matérias ambientais. A ERSE, enquanto entidade reguladora dos setores da eletricidade e do gás natural, incorpora as questões ambientais nas suas atribuições, desde logo em termos estatutários, mas também na sua atividade. Efetivamente, em complemento à sua atividade basilar de regulação económica destes setores, a ERSE tem atribuições acessórias em matéria ambiental.

O presente artigo discute a experiência da ERSE nestas matérias, iniciando com um breve historial do instrumento regulatório utilizado, os Planos de Promoção do Desempenho Ambiental (PPDA), os quais tiveram aplicação ao setor elétrico e ao setor do gás natural. Posteriormente são explicadas duas dificuldades encontradas ao longo da execução dos PPDA, a necessidade de conciliar interesses e a de avaliar benefícios ambientais. O artigo prossegue com duas soluções encontradas, a promoção de parcerias com entidades externas às empresas reguladas e a criação de um painel de avaliação, concluindo com uma síntese da evolução histórica orientada para o futuro.

1. História dos PPDA

A concretização das obrigações estatutárias da ERSE em questões ambientais, designadamente a contribuição para a melhoria do desempenho ambiental das empresas que operam nos setores regulados e a utilização eficiente dos recursos, iniciou-se logo em 1999, primeiro ano de regulação económica das empresas da responsabilidade da ERSE. O modelo escolhido evoluiu ao longo dos anos, sendo os PPDA o principal instrumento utilizado. Nesta secção apresentam-se as quatro gerações de evolução dos PPDA.

Geração 0 – 1999 a 2001

Alguns tipos de regulação económica criam incentivos à melhoria da eficiência económica das empresas, permitindo que se apropriem dos ganhos de eficiência que obtiverem. Nestes casos, as empresas têm tendência para reduzir custos, incluindo em medidas de proteção ou valorização ambiental.

Este efeito é especialmente visível nas formas de regulação por preço máximo, o que sucedeu logo desde 1999 para a atividade de distribuição de energia elétrica em Portugal Continental. Para mitigar este risco, o primeiro Regulamento Tarifário (ERSE, 1998) previa que os custos com questões ambientais fossem avaliados separadamente do "preço máximo", sendo custos aceites *a posteriori* e sujeitos a uma avaliação caso a caso pela ERSE.

Geração I – 2002 a 2005

No primeiro período de regulação (1999-2001), as empresas não apresentaram custos com proteção ou valorização ambiental que pretendessem ver reconhecidos para efeitos tarifários (ERSE, 2001). Toda a regulação era uma novidade que obrigou a adaptações profundas nas empresas[1], pelo que é provável que tenha havido uma menor disponibilidade para o enquadramento das questões ambientais na regulação económica. Por outro lado, o Regulamento Tarifário não apresentava detalhes sobre o tipo de custos com medidas de proteção ou valorização ambiental que poderiam ser aceites.

Assim, para o período de regulação seguinte (2002-2004) a ERSE alterou o Regulamento Tarifário: foi criada a figura de Plano de Promoção da Qualidade Ambiental (PPQA), a apresentar obrigatoriamente pelas empresas[1], contendo um conjunto de ações a desenvolver para a melhoria do seu desempenho ambiental e os custos, avaliados pela ERSE *a posteriori*, passaram a ter por base relatórios de execução anuais a apresentar pelas empresas.

Estas alterações criaram um quadro mais previsível, contribuindo assim para que a EDP Distribuição e a REN – Rede Elétrica Nacional apresentassem os respetivos PPQA com um leque alargado de medidas. Todavia, continuava por especificar que tipo de medidas eram aceites pela ERSE. Os primeiros PPQA foram assim espaço de aprendizagem para as empresas e para a ERSE, tendo sido aprovadas medidas de minimização de impactes ambientais associados às atividades das empresas, dando preferência a medidas voluntárias, ou seja, que não resultassem do cumprimento de obrigações legais ou regulamentares. Ainda assim, a ERSE aceitou custos com medidas que, apesar de não serem voluntárias, pretendiam resolver passivos ambientais. Nestas situações, os custos aceites corresponderam a 50% do total. O apoio a medidas não voluntárias tinha, à data, o exemplo dos contratos de adaptação ambiental seguidos pela administração central em que se concedeu a determinados setores tempo para adaptação às obrigações legais.

Geração II – 2006 – 2008

Partindo da experiência anterior, a ERSE atualizou as regras (ERSE, 2005) criando os PPDA que vigoraram no triénio 2006-2008 no setor elétrico. As principais alterações foram: alteração da designação de PPQA para PPDA, para que o foco fosse o desempenho ambiental das empresas; alargado o âmbito de aplicação às regiões autónomas, uma vez que a ERSE tinha entretanto visto as suas competências estendidas a estas regiões; definição de tetos máximos orçamentais aceites para efeitos tarifários para cada empresa, i.e., cada empresa passou a conhecer *a priori* o montante máximo para o seu PPDA; reforço das obrigações de divulgação de informação ao público.

No triénio 2006-2008 foram executados PPDA da EDA – Electricidade dos Açores, EDP Distribuição, EEM – Empresa de Electricidade da Madeira e REN – Rede Elétrica Nacional.

Em 2006, a ERSE publicou a regulamentação aplicável ao setor do gás natural, tendo desde logo sido prevista a figura do PPDA, em tudo semelhante à do setor elétrico na versão geração II (ERSE, 2006). Tal como sucedera no setor elétrico, as empresas do setor do gás natural necessitaram de tempo para adaptação à nova regulação. Acresce ainda

[1] Os PPQA eram aplicáveis à REN – Rede Elétrica Nacional e à EDP Distribuição.

a maior dificuldade em identificar medidas de minimização de impactes ambientais diretos resultantes das atividades reguladas neste setor. Estes fatores contribuíram para que somente quatro empresas tenham executado PPDA no biénio que incluiu os anos gás 2008-2009 e 2009-2010 (REN Atlântico, REN Armazenagem, REN Gasodutos e Sonorgás).

Geração III – 2009-2011

A geração III dos PPDA, aplicável apenas ao setor elétrico, teve como principais objetivos (ERSE, 2008): i) promover a apresentação de medidas inovadoras; ii) escolha das melhores medidas através da concorrência entre as medidas de todas as empresas; iii) promoção de parcerias com agentes externos ao setor elétrico, designadamente organizações não governamentais de ambiente (ONGA); iv) criação de um painel de avaliação para apoiar a ERSE nas decisões respeitantes aos PPDA, painel que reuniu representantes dos três principais grupos de interesses abrangidos pelos PPDA (empresas, associações de consumidores, ONGA) e personalidades de reconhecido mérito científico na matéria.

No triénio 2009-2011 foram executados PPDA da EDA, EDP Distribuição, EEM e REN – Rede Elétrica Nacional.

A experiência desta geração de PPDA, em especial os resultados obtidos com as parcerias e com o painel de avaliação, são o objeto de análise deste artigo.

Conforme referido, os PPDA avançaram mais tardiamente no setor do gás natural, acabando por ser suspensos em julho de 2010, em resultado da consulta pública sobre a proposta de novas regras e reconhecendo que os impactes ambientais das infraestruturas de gás natural são inferiores aos do setor elétrico (ERSE, 2011). Por este motivo, os PPDA de geração III não foram aplicados no setor do gás natural.

Resultados alcançados

Os documentos da ERSE sobre os relatórios anuais de execução fornecem uma visão detalhada dos resultados alcançados entre 2002 e 2011[2]. O último balanço feito pela ERSE foi apresentado no Seminário de 2010[3].

Entre 2002 e 2011, as empresas dedicaram a questões ambientais, ao abrigo dos PPDA, cerca de 75 milhões de euros, tendo sido aceites para efeitos tarifários cerca de 72

[2] Informação disponível em http://www.erse.pt/pt/desempenhoambiental/ppda.

[3] http://www.erse.pt/pt/desempenhoambiental/ppda/seminariosppda/Documents/PPDA_8%20anos%20_Apresentacao.pdf

milhões de euros. Este valor corresponde a uma média anual de 7,5 milhões de euros, conduzindo a um peso médio na fatura de um cliente final inferior a 0,2%.

As medidas desenvolvidas pelas empresas focaram-se nas seguintes temáticas:

» Integração paisagística: intervenções de passagem de rede aérea a rede subterrânea em áreas urbanas com valor patrimonial ou ambiental. Estas medidas tiveram peso orçamental expressivo por incluírem obras significativas no terreno. No PPDA 2009 – 2011 é de destacar a evolução para uma parceria com especialistas na área da paisagem, de que resultou um manual de boas práticas que passou a ser aplicado.

Figura 1 - Integração paisagística em área urbana (antes e após) no Barreiro

Antes:

Resultado Final:

» Avifauna: estudos de avaliação do impacte das linhas elétricas na avifauna, efetuados no terreno[4], bem como aplicação e avaliação de medidas minimizadoras. Foi neste tema que desde o início se estabeleceram parcerias entre empresas, ONGA e a autoridade nacional para a conservação da natureza. Embora não seja possível quantificar os benefícios alcançados, é certamente a área onde as parcerias produziram melhores resultados, em especial por terem contribuído para fazer perdurar no tempo os efeitos dos PPDA.

[4] Estudos disponíveis em http://www.erse.pt/pt/desempenhoambiental/ppda/sectorelectrico/Paginas/Documentacao.aspx

Figura 2 - Exemplos de soluções de proteção da avifauna

- **Gestão de corredores de linhas:** medidas que permitiram minimizar os impactes dos corredores de linhas elétricas e melhorar a biodiversidade característica das faixas. Foi realizado um manual de boas práticas e desenvolvidos casos piloto em todo o país.

- **Outras medidas**, designadamente relativas a resíduos, gestão ambiental, formação, campos eletromagnéticos, mobilidade e divulgação pública.

2. Os interesses envolvidos

O preço da energia tem sido considerado como o aspeto que mais influencia a satisfação dos consumidores de energia. Outros aspetos estão tipicamente associados à qualidade de serviço, quer do ponto de vista da continuidade do fornecimento, quer do relacionamento e atendimento comerciais (Comissão Europeia, 2005).

Ainda que os consumidores possam ter preocupações ambientais (aceitação das energias renováveis ou da redução da dependência de combustíveis fósseis), a dimensão ambiental surge pelo seu eventual impacto no preço da energia. Nesse sentido, importa ainda realçar que, conforme mencionam Antunes, Santos, & Lobo (2003), as estratégias ambientais das empresas refletem o estádio de consideração das questões ambientais na sociedade.

Efetivamente, as questões ambientais no setor da energia são por vezes apenas discutidas na perspetiva dos gastos incorridos (por exemplo em políticas de incentivos a energias renováveis ou em atividades internas às empresas), descurando a perspetiva dos seus benefícios, tanto os ambientais como os de outras vertentes, nomeadamente a económica (e.g. redução de custos por redução do consumo de recursos) ou a social (e.g. criação de emprego).

A esta visão acresce o facto de por vezes existirem diferentes escalas temporais entre custos e benefícios, o que limita a perceção do ciclo de vida da intervenção ambiental. Ou seja, enquanto os custos de determinada intervenção ambiental podem ser imediatamente incorridos pelas empresas e, portanto, percebidos pelos consumidores, os seus efeitos podem fazer-se sentir apenas mais tarde, podendo passar despercebidos.

Os PPDA evidenciaram em diversas situações que interesses aparentemente contraditórios afinal não o eram. Em algumas medidas foram as preocupações ambientais que conduziram a melhores soluções de exploração e mais eficientes. Como exemplo, destaca-se:

» Redução da mortalidade da avifauna por eletrocussão e colisão em linhas elétricas, com benefícios na continuidade de serviço, qualidade da energia e económicos, por redução da frequência de interrupções.

» Substituição, nas faixas de proteção de linhas elétricas, de vegetação arbórea aí existente por vegetação arbustiva e autóctone, evitando intervenções de manutenção mais frequentes e onerosas.

Figura 3 - Intervenção em faixas de proteção de linhas elétricas (recuperação de vegetação autóctone no polje de Mira-Minde)

» Otimização da iluminação pública para proteção de avifauna, com redução de consumo.

Figura 4 - Intervenção em iluminação pública para proteção da avifauna (antes e após) na Madeira (SPEA, 2012)

- Criação de parcerias para o desenvolvimento de inovações tecnológicas para proteção da avifauna.
- Experimentação de parcerias locais com proprietários como forma de intervenção na gestão de faixas de proteção, que, após os PPDA, são utilizadas em novos projetos (Diário de Leiria, 2015).

3. Valorizar benefícios ambientais

As questões ambientais envolvem uma multiplicidade de temáticas, da poluição local de recursos hídricos ou da atmosfera a fenómenos de acidificação ou às alterações climáticas, com diferentes escalas geográficas. Do mesmo modo, as atividades humanas, e as atividades do setor energético em particular, podem impactar o ambiente de distintas maneiras em diferentes áreas, resultando a avaliação de impactes num processo complexo.

As medidas propostas pelas empresas nos seus PPDA revelaram essa mesma diversidade, conforme descrito anteriormente, respondendo àqueles que são os impactes do setor, mas dificultando o processo de seleção de medidas. Havendo restrições orçamentais, é necessário, por exemplo, decidir entre uma medida de proteção da avifauna, uma medida de recuperação de um ecossistema ou uma de minimização da produção de resíduos. Uma vez que não é possível comparar diretamente os benefícios ambientais das medidas (redução da mortalidade da avifauna vs. melhoria da biodiversidade vs. redução do consumo de recursos e dos impactes na saúde, por exemplo), a escolha torna-se subjetiva e difícil.

Se a avaliação de impactes ambientais é, já por si, uma tarefa complexa, a sua valorização económica ganha um grau de dificuldade acrescido, em especial quando se pretende comparar projetos com descritores muito diferentes, como sucedeu nos PPDA, com intervenções em domínios tão distintos como a avifauna, o enquadramento paisagístico ou a gestão ambiental. Em Santos, Martinho, & Antunes (2001)[5] conclui-se que as estimativas económicas obtidas com os métodos utilizados para valorização económica de impactes ambientais não devem ainda ser interpretadas como resultados rigorosos, mas antes como valores indicativos.

Dada a dificuldade apontada, não era possível nos PPDA utilizar análises do tipo custo benefício que garantissem a eficiência económica das medidas adotadas, isto é, não se podia afirmar que determinadas medidas obteriam os melhores benefícios ambientais com os menores custos. Em alternativa, foram adotadas análises do tipo custo-eficácia destinadas a quantificar o custo de atingir determinado objetivo e a reunir informação que facilitasse análises futuras. Todavia, esta opção revelou ainda assim não ser isenta de dificuldades, nomeadamente na construção e interpretação dos indicadores custo-eficácia.

4. Painel de avaliação

O Painel de Avaliação foi criado com a revisão das regras dos PPDA para o período regulatório 2009-2011, com o objetivo de auxiliar a ERSE na tomada de decisões informadas e justas e potenciando a qualidade dos programas (ERSE, 2008). Importa referir que o envolvimento das partes interessadas no apoio à tomada de decisão é uma prática instituída na ERSE desde logo através dos seus órgãos consultivos, o Conselho Consultivo e o Conselho Tarifário.

O Painel integrou como membros um representante de cada um dos três grupos de partes interessadas e duas personalidades de reconhecido mérito científico na área do ambiente. As partes interessadas são as entidades que podem submeter os PPDA, associações de consumidores de âmbito nacional e de interesse genérico, e ONGA de âmbito nacional. As personalidades de reconhecido mérito científico incluem uma designada pelos representantes referidos anteriormente e outra designada pela ERSE[6]. Esta constituição visou a transparência e a consideração, a todo o momento, dos diversos pontos de vista relevantes (ERSE, 2008).

5 Este trabalho, desenvolvido para a ERSE e incluído num trabalho mais vasto, apresenta e discute diversos resultados alcançados em estudos sobre avaliação económica, com destaque para o projeto ExternE.

6 Despacho n.º 22282/2008, de 28 de agosto, que aprova as alterações às regras aplicáveis aos Planos de Promoção do Desempenho Ambiental do sector elétrico.

O Painel emitia parecer obrigatório, justificado e conclusivo, não vinculativo para a ERSE, nas seguintes situações:

- Análise dos PPDA apresentados, nomeadamente quanto à aceitabilidade e ordenação das medidas propostas;
- Análise dos Relatórios de Execução, designadamente quanto à demonstração dos méritos ambientais e à aceitabilidade dos custos para efeitos tarifários;
- Ações de monitorização ambiental a intervenções dos PPDA, incluindo méritos ambientais associados à medida monitorizada, verificação da adequabilidade da medida para ser incluída no PPDA e recomendações.

Os trabalhos do Painel foram intensos, tendo envolvido a realização de 14 reuniões de trabalho e visitas de monitorização a 13 medidas, de que resultou a emissão de oito pareceres[7].

Figura 5 - Ações de monitorização no terreno

Na fase de análise dos PPDA submetidos pelas empresas, o Painel foi um local de encontro e debate dos vários interesses, procurando integrar o que são necessariamente valorizações subjetivas, auxiliando a ERSE na escolha das medidas a apoiar. Daqui resultou, por exemplo, a aprovação de financiamento parcial a medidas que, embora com mérito, revelaram ter benefícios extra ambientais que não poderiam ser considerados nos PPDA.

[7] Os pareceres emitidos pelo Painel de Avaliação dos PPDA podem ser consultados em http://www.erse.pt/pt/desempenhoambiental/ppda/sectorelectrico/Paginas/PPDASELPaineldeAvaliacao.aspx.

Durante a fase de execução, o acompanhamento do Painel nos momentos de avaliação dos relatórios anuais de execução e na monitorização otimizou o andamento dos trabalhos. Como exemplo, refira-se o apontar de desvios face aos objetivos pretendidos em algumas intervenções de integração paisagística, oportunamente transmitidos às empresas para correção.

O Painel foi um importante fórum de discussão, dedicado e permanente, promotor da conciliação de interesses. Este aspeto aliado ao reconhecido mérito científico dos especialistas convidados forneceu credibilidade aos PPDA e aumentou o nível de exigência.

5. Parcerias

Desde os primeiros PPQA que surgiram medidas relativas à avifauna com parcerias entre empresas, Instituto para a Conservação da Natureza e ONGA. Da experiência de 2002-2005 concluiu-se que as referidas medidas atingiram os objetivos propostos, com diversas mais valias, destacando-se:

» Verificou-se, através de reuniões com empresas e parceiros (ICN, Quercus e SPEA), uma aproximação de culturas distintas e uma compreensão dos problemas com que a empresa e o parceiro lidam. As parcerias contribuíram para que entidades que habitualmente se consideravam adversárias passassem a trabalhar em conjunto para a proteção da avifauna.

» Foram estabelecidos contactos entre pessoas das empresas e dos parceiros que se mantiveram para além da parceria, contribuindo para que algumas medidas tenham perdurado além dos PPDA.

» Contrariamente a muitas medidas, em que se verificava com frequência um atraso na execução, as parcerias contribuíram para o cumprimento dos prazos. Se os montantes envolvidos nos PPDA são relativamente reduzidos do ponto de vista das empresas, o mesmo não sucede para os parceiros, uma vez que os serviços prestados pelas ONGA tinham contrapartidas financeiras significativas nos seus orçamentos, contribuindo para que estas funcionassem como catalisador de execução das medidas.

» As ONGA, ao estabelecerem parcerias com a EDP Distribuição e com a REN, contribuíram para a difusão de conhecimento entre as empresas.

Partindo desta experiência, as regras dos PPDA para 2009-2011 incluíram as parcerias como fator de valorização, ou seja, as medidas candidatas que apresentassem parcerias teriam uma classificação superior.

Os PPDA 2009-2011 incluíram 33 medidas aprovadas, sendo que 18 medidas resultavam de parcerias com várias entidades. O Painel de Avaliação dos PPDA reconheceu a importância das parcerias ao recomendar "Um maior esforço no sentido da constituição de parcerias com entidades externas, em especial nas áreas técnicas e interdisciplinares, tornando mais eficaz a resposta aos problemas que se colocam às empresas." (Painel de Avaliação dos PPDA, 2008, p. 2).

Conclusão

A regulação é um exercício permanente de calibração dos incentivos dados às empresas, cabendo a estas, na autonomia da sua gestão, escolher o caminho a trilhar, o qual, inevitavelmente, tem efeito no desempenho ambiental.

O legislador, tendo presente esta realidade, desde cedo (1995) atribuiu responsabilidades ambientais à ERSE, designadamente contribuir para a melhoria do desempenho ambiental das empresas reguladas e para o uso eficiente de recursos. A ERSE, numa altura em que a sensibilidade social para as questões ambientais e a própria política de ambiente ainda não tinham o fulgor de hoje, abriu espaço na primeira regulamentação publicada para o setor elétrico para que os custos com medidas de proteção ambiental fossem considerados autonomamente dos restantes custos sujeitos ao desafio de melhoria da eficiência. Pretendia-se que a melhoria de eficiência não tivesse como efeito secundário a degradação do desempenho ambiental. Até 2001, as empresas responderam com timidez, levando a ERSE a reforçar o tema, criando expressamente a figura de plano para a promoção do desempenho ambiental.

Entre 2002 e 2011 os PPDA cresceram e contribuíram para melhorar o desempenho ambiental das empresas com ações específicas desenvolvidas no terreno. Mas, talvez mais importante que as ações em si, foi o contributo que deram para o acelerar de tendências e a mudança de cultura dentro das empresas, tendo as parcerias desempenhado um papel fundamental. Ainda que sejam resultados difíceis de medir, o acompanhamento feito permitiu observar o aproximar de linguagens e um entendimento mútuo das realidades e complexidades de áreas que se julgavam em lados opostos. O Painel de Avaliação foi um importante fórum de discussão e conciliação de interesses e que contribuiu para melhorar os PPDA.

A par da evolução referida, foram sendo tomadas opções políticas de apoio à produção em regime especial que, no curto prazo, representavam custos a suportar pelos consumidores, custos que se vinham juntar a outros custos de opções políticas que faziam crescer de ano para ano os custos de interesse económico geral (CIEG). A realidade económica e social portuguesa também vinha sofrendo alterações significativas, culminando em 2011 com o Programa de Apoio Económico e Financeiro acordado entre as autoridades portuguesas, a União Europeia e o Fundo Monetário Internacional, o qual conduziu a medidas de redução de custos no setor energético e aumento da fiscalidade a suportar pelos consumidores, destacando-se a subida do IVA.

Assim, quando no final de 2010 e em 2011 a ERSE colocou em discussão pública as novas regras para os PPDA do setor do gás natural e do setor elétrico, respetivamente, surgiram diversos comentários, incluindo dos Conselhos Consultivo e Tarifário, que mostravam uma menor disposição para suportar encargos com medidas na área do ambiente, contribuindo assim para a decisão da ERSE de suspender a aplicação deste instrumento.

A conciliação de interesses e o peso dado a cada um deles é, como é natural, influenciada pelo contexto. Sendo hoje o enquadramento económico e social distinto do de 2011, poderá ser oportuno repensar como pode a ERSE retomar os incentivos à melhoria do desempenho ambiental das empresas reguladas, mais concretamente dos operadores de infraestruturas em regime de monopólio. Neste exercício importa aprender com a experiência dos PPDA, o que não significa necessariamente replicá-los tal qual no futuro, mas refletir sobre formas de dinamização do conhecimento e dos atores relevantes, com vista ao estabelecimento de um quadro de participação e colaboração que permita a experimentação de soluções para o desafio da melhoria do desempenho ambiental do setor energético.

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CAPÍTULO 2

PROMOÇÃO DA CONCORRÊNCIA, DESENVOLVIMENTO DO MERCADO E PROTEÇÃO DOS CONSUMIDORES

CAPÍTULO 2

PROMOÇÃO DA CONCORRÊNCIA, DESENVOLVIMENTO DO MERCADO E PROTEÇÃO DOS CONSUMIDORES

O Regime Sancionatório do Setor Energético

Ana Luísa Joaquim

Resumo

Com o presente trabalho convida-se o leitor a uma breve análise do conjunto de poderes sancionatórios e regras procedimentais introduzidos pela Lei n.º 9/2013, de 28 de janeiro, no plano contraordenacional, em virtude da violação de normas no âmbito do setor energético (eletricidade e gás natural), percorrendo, em traços gerais, o seu âmbito de aplicação, o procedimento, as contraordenações e sanções aplicadas e o regime dos recursos, e traçando uma perspetiva histórica, desde as Diretivas Europeias que estabeleceram regras comuns para o mercado interno da eletricidade e do gás natural, com o "*enforcement*" dos poderes das autoridades reguladoras nacionais, até à atual aplicação de sanções efetivas às entidades que atuam nos dois setores pela Entidade Reguladora dos Serviços Energéticos.

Palavras-chave

Entidade Reguladora dos Serviços Energéticos - Regime Sancionatório do Setor Energético - Poderes Sancionatórios - Contraordenações.

Introdução

As alterações das relações ocorridas no mercado energético (da Eletricidade e do Gás Natural), fortemente impulsionadas pelas diretrizes europeias para a implementação do mercado interno de energia, foram o motor do regime sancionatório instituído pela Lei n.º 9/2013, de 28 de março, num setor que há muito reclamava os meios de atuação adequados a punir e dissuadir os comportamentos infratores dos seus intervenientes.

1. Os Poderes Sancionatórios da ERSE – Génese Comunitária e Nacional

A Entidade Reguladora dos Serviços Energéticos (ERSE), criada pelo Decreto-Lei n.º 187/95, de 27 de julho, iniciou funções como regulador do setor elétrico nacional, com os estatutos aprovados pelo Decreto-Lei n.º 44/97, de 20 de fevereiro. Só posteriormente, por via do Decreto-Lei n.º 97/2002, de 12 de abril[1], que aprovou os novos estatutos da ERSE, o âmbito da regulação foi alargado ao setor do gás natural, dando cumprimento ao disposto no Decreto-Lei n.º 14/2001, de 27 de janeiro, e à Resolução do Conselho de Ministros n.º 154/2001, de 19 de outubro, que vieram prever a aplicação de mecanismos regulatórios ao setor do gás natural.

Nos termos dos estatutos aprovados em 2002, a ERSE dispunha de competências para processar contraordenações e aplicar coimas e sanções acessórias no caso de infração de determinadas normas da legislação dos setores regulados (cfr. n.ºs 1 dos artigos 11.º e 18.º do Decreto-Lei n.º 97/2002, de 12 de abril), mas o facto de não se prever uma tipificação adequada das contraordenações e os montantes das coimas aplicáveis serem relativamente baixos, limitava fortemente o exercício do poder sancionatório pela Entidade Reguladora[2].

A ineficácia das disposições dos estatutos da ERSE em matéria sancionatória veio acentuar-se quando aquelas se mantiveram inalteradas apesar da publicação do pacote legislativo composto pelos Decretos-Leis n.ºs 29/2006 e 30/2006, ambos de 15 de fevereiro[3], que vieram estabelecer as bases gerais da organização e funcionamento do sistema elétrico nacional e do sistema nacional de gás natural, bem como as bases gerais aplicáveis ao exercício das atividades naqueles sistemas, e desenvolvidas pelos Decretos-Leis n.º 172/2006, de 23 de agosto, e n.º 140/2006, de 26 de julho, conjunto de diplomas que operou a transposição para o ordenamento jurídico nacional do Segundo Pacote Energético, que integrava as Diretivas n.ºs 2003/54/CE e 2003/55/CE, do Parlamento Europeu e do Conselho, de 26 de junho de 2003[4].

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1 Posteriormente alterado pelo Decreto-Lei n.º 200/2002, de 25 de setembro.

2 Atente-se que, no setor do gás natural, o artigo 18.º, n.º 1 do Decreto-Lei n.º 97/2002, de 12 de abril, que previa a possibilidade da ERSE aplicar coimas e sanções acessórias, remetia para os Decretos-Leis n.ºs 183/95, 184/95 e 185/95, todos de 27 de julho, e estes diplomas legais respeitavam exclusivamente ao setor elétrico. Já no setor da eletricidade, o poder sancionatório da ERSE previsto no artigo 11.º, n.º 1 do Decreto-Lei n.º 97/2002, de 12 de abril, que lhe atribuía o processamento de contraordenações e aplicação de determinadas coimas e sanções acessórias a infrações previstas em diversas disposições dos citados Decretos-Leis n.ºs 183/95, 184/95 e 185/95, extinguiu-se quando tais diplomas foram revogados pelo Decreto-Lei n.º 172/2006, de 23 de agosto (artigo 79.º).

3 Os Decretos-Leis n.ºs 29 e 30/2006 previam que o regime sancionatório aplicável às suas disposições e às constantes de legislação complementar seria estabelecido em diploma específico (artigos 76.º e 70.º, respetivamente).

4 O Tribunal de Contas, no seu Relatório de Auditoria n. º 21/2007 ("Auditoria à Regulação do Sector Energético"), disponível para consulta em http://www.tcontas.pt/, refletia as mencionadas ineficácias (p.45).

Em 2009, foi aprovado o Terceiro Pacote Energético, composto pelas Diretivas n.ºs 2009/72/CE e 2009/73/CE, do Parlamento Europeu e do Conselho, de 13 de julho de 2009, que vieram estabelecer as regras comuns para o mercado interno da eletricidade e do gás natural, respetivamente, e que, revogando as diretivas que integravam o referido Segundo Pacote Energético, prevê, entre o mais, o alargamento das competências das entidades reguladoras nacionais, designadamente em matéria sancionatória, em especial através da aplicação direta de sanções efetivas que tenham um efeito dissuasor de comportamentos infratores por parte dos intervenientes nos mercados regulados[5].

O Terceiro Pacote Energético foi transposto para a ordem jurídica nacional pelos Decretos-Leis n.ºs 77/2011 e 78/2011, ambos de 20 de junho, que procederam à alteração dos Decretos-Leis n.ºs 30/2006 e 29/2006, de 15 de fevereiro, reforçando as competências sancionatórias da ERSE mas continuando sem definir o regime sancionatório do setor energético e remetendo tal concretização para diploma específico.

Também em 2011, foi celebrado, no âmbito do Programa de Assistência Financeira e Económica a Portugal por parte da Comissão Europeia, do Banco Central Europeu e do Fundo Monetário Internacional, o Memorando de Entendimento sobre as Condicionalidades de Política Económica, no qual se estabeleceram diversos compromissos para os setores da eletricidade e do gás, nomeadamente a transposição integral do Pacote de Energia da União Europeia para a legislação nacional, com particular enfâse ao reforço dos poderes da autoridade reguladora nacional e, em especial, à necessidade do estabelecimento do regime sancionatório do setor energético.

Neste contexto, a alteração operada aos estatutos da ERSE pelo Decreto-Lei n.º 212/2012, de 25 de setembro, apesar de passar a prever disposição autónoma dedicada aos *“Poderes Sancionatórios”* [artigo 19.º], continuava a remeter o respetivo regime sancionatório para diploma autónomo, cujo processo de aprovação legislativa se encontrava entretanto já em curso[6].

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[5] De destacar na matéria que nos ocupa são os Considerandos 37 e 38 e os artigos 36.º e 37.º da Diretiva 2009/72/CE e os Considerandos 33 e 34 e os artigos 40.º e 41.º da Diretiva 2009/73/CE, na medida em que versam sobre os objetivos gerais e as obrigações e competências das entidades reguladoras. De acordo com os n.ºs 4 dos citados artigos 37.º e 41.º, compete aos Estados membros assegurar que as entidades reguladoras nacionais são dotadas de competências que lhes permitam exercer de modo eficiente e rápido as suas obrigações, devendo para o efeito ter, entre outras, a competência para emitir decisões vinculativas relativas a empresas de eletricidade e de gás natural e para aplicar ou propor a um tribunal competente a aplicação de sanções efetivas, proporcionadas e dissuasivas àquelas mesmas empresas que não cumpram as suas obrigações, bem como para solicitar informações relevantes e proceder a inquéritos adequados.

[6] Proposta de Lei n.º 88/XII, cujo processo de aprovação pode ser consultado em https://www.parlamento.pt/ActividadeParlamentar/Paginas/DetalheIniciativa.aspx?BID=37208.

2. O Regime Sancionatório do Setor Energético

Em 28 de janeiro de 2013, foi publicada a Lei n.º 9/2013[7], que veio estabelecer o Regime Sancionatório do Setor Energético (RSSE) e que, entrando em vigor em 27 de fevereiro do mesmo ano, operou a materialização do poder sancionatório da ERSE.

2.1. Competências sancionatórias e âmbito de aplicação

Nos termos do mencionado regime, a ERSE deverá processar e punir as infrações à legislação e regulamentação cuja aplicação ou supervisão lhe compete, bem como de todas as suas determinações, estando sujeitas aos seus poderes sancionatórios todas as entidades intervenientes no Sistema Elétrico Nacional e no Sistema Nacional de Gás Natural[8] (cfr. artigo 2.º, n.ºs 1 e 3).

No exercício das competências sancionatórias que lhe são atribuídas, a ERSE deve apreciar todos os factos suscetíveis de constituírem infrações que cheguem ao seu conhecimento, quer por via do exercício dos seus poderes de supervisão e fiscalização, quer através das denúncias que registe (cfr. artigo 3.º, n.º 1, 1.ª parte), nomeadamente, através do formulário aprovado e disponibilizado pela própria na sua página eletrónica (cfr. artigo 9.º, n.º 4), quer ainda as que lhe sejam comunicadas por outras entidades públicas, devendo, também, participar às autoridades competentes as infrações legais ou regulamentares de que tome conhecimento no exercício das suas funções, tanto mais que o processo contraordenacional não excluí a eventual responsabilidade civil e criminal dos agentes (cfr. artigos 2.º, n.º 2, 38.º e 9.º, n.º 3).

Relativamente aos factos que tome conhecimento por denúncia, a ERSE procederá em conformidade com os elementos disponibilizados, sendo aberto processo de contraordenação sempre que a denúncia estiver devidamente fundamentada e arquivadas as demais[9] (cfr. artigo 3.º, n.ºs 1, 5 e 6). Porém, se daqueles elementos não resultarem

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7 Diário da República, 1.ª Série – N.º 19 – 28 de janeiro de 2013.

8 Ao abrigo do RSSE, podem ser responsabilizadas pela prática contraordenacional pessoas singulares e/ou pessoas coletivas ou equiparadas, mesmo quando os factos tiverem sido praticados por agentes, no exercício das suas funções e em representação daquelas, só podendo a responsabilidade ser excluída quando aqueles atuem contra ordens ou instruções expressas da sua representada (cfr. artigo 37.º).

9 "*O arquivamento de uma denúncia implica que, a não ser que surjam novos elementos de prova de relevo, o denunciante se encontra limitado quanto ao direito de apresentar outra denúncia sobre os mesmos factos durante um determinado período de tempo.*", anotação ao artigo 8.º da Lei da Concorrência, Comentário Conimbricense, Almedina, 2013, p. 81.

fundamentos bastantes à abertura de processo de contraordenação, deverá a ERSE dar conhecimento ao autor da mesma desse facto e dos seus fundamentos e fixar um prazo para que este apresente as suas observações por escrito, findo o qual fica na faculdade da ERSE apreciar ou não outros elementos que lhe sejam apresentados (cfr. artigo 3.º, n.ºs 2 e 3).

Se o autor da denúncia apresentar as suas observações em prazo e a ERSE entender que dessas observações não resulta nenhum novo elemento, declara a denúncia sem fundamento relevante ou não merecedora de tratamento prioritário, através de decisão expressa, da qual cabe recurso para o Tribunal da Concorrência, Regulação e Supervisão (cfr. artigo 3.º, n.º 4).

2.2. Do processo e do procedimento contraordenacional

O RSSE começa por prever a aplicação subsidiária do Regime Geral do Ilícito de Mera Ordenação Social ao processo contraordenacional relativo a infrações energéticas (cfr. artigo 4.º). Porém, quanto aos prazos, prestação de informações, notificações, segredos de negócio, prova, publicidade e acesso ao processo e prescrição, este regime vem prever normas próprias.

Fixa-se o prazo supletivo de 10 dias úteis para a prática de qualquer ato no processo sancionatório e os prazos que forem determinados por lei ou por decisão da ERSE podem ser prorrogados, por igual período, desde que tal seja fundadamente requerido antes do termo do prazo e sem intuito meramente dilatório (cfr. artigo 6.º).

Quanto às notificações, deverão ser realizadas por carta registada dirigida ao visado pelo processo e seu mandatário, quando constituído, presumindo-se feitas no terceiro e sétimo dia útil seguinte ao do registo, conforme sejam realizadas em Portugal ou no estrangeiro, respetivamente, contando o prazo a partir do dia útil seguinte ao da data da notificação (cfr. artigo 8.º).

Os pedidos de elementos solicitados pela ERSE devem respeitar um conjunto de requisitos, nomeadamente, a indicação da base jurídica habilitante, do objetivo e fundamento do pedido, a qualidade do destinatário e prazo de resposta, bem como indicação do dever de identificar informação confidencial e de que o incumprimento do pedido constitui falta de colaboração com a ERSE (cfr. artigo 7.º).

De resto, a prova[10] proveniente de processos de supervisão ou outros sancionatórios pode ser utilizada em processo de contraordenação em curso ou a instaurar, desde que a entidade que a disponibilizou haja sido previamente esclarecida pela ERSE dessa possibilidade[11] (cfr. artigo 23.º).

O processo contraordenacional segue aqui a regra geral da publicidade[12], exceto quando a ERSE determine, oficiosamente ou a requerimento do visado, a sujeição a segredo de justiça quando a tutela dos interesses da investigação ou dos direitos do visado assim o justifiquem. Porém, o âmbito de tal determinação esgota-se com a decisão final, que deve ser objeto de publicação na página eletrónica da ERSE e identificar e caracterizar a infração, a norma violada e a sanção aplicada (cfr. artigos 24.º, 34.º, n.º 3 e 52.º).

Note-se porém, que os segredos de negócio deverão ser acautelados pela ERSE no decurso de todo o processo contraordenacional, sendo assegurado às entidades a que os mesmos se referem a oportunidade de se pronunciarem, bem como a possibilidade de disponibilizarem cópia não confidencial dos documentos que contenham tais informações, expurgadas das mesmas, competindo à ERSE apreciar dos fundamentos dos pedidos de confidencialidade que lhe sejam dirigidos (cfr. artigo 22.º).

O acesso ao processo encontra-se garantido ao visado e a qualquer pessoa que demonstre interesse legítimo na sua consulta, sempre mediante requerimento, sem prejuízo da determinação pela ERSE da sujeição a segrego de justiça, na salvaguarda dos interesses de investigação, caso em que o acesso é vedado ao visado até à notificação da nota de ilicitude (cfr. artigo 25.º).

No que respeita aos prazos de prescrição do procedimento de contraordenação[13] e da sanção fixa-se em 3 anos (no caso de contraordenações leves) e em 5 anos (no caso de

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[10] No regime sancionatório do setor energético é admitida toda a prova que não seja proibida por lei que, regra geral, é apreciada segundo as regras da experiência e livre convicção da ERSE.

[11] A questão da compatibilidade entre a prova adquirida em procedimento de supervisão e/ou em processo de contraordenação e o direito da entidade visada a não produzir prova contra si mesma – princípio *nemo tenetur se detegere* – tendo sido objeto de larga discussão na doutrina nacional que deu origem, inclusivamente, a um dossier temático no primeiro número da Revista de Concorrência e Regulação (ano I, n.º 1, 2010), encontra-se, à data, sanada. Nesse sentido *vide* o Acórdão n.º 461/2011, de 11/10/2011, do Tribunal Constitucional (Processo n.º 366/11 – 2.ª Secção) que decidiu "*julgar não inconstitucional a interpretação normativa que resulta da conjugação dos artigos 17.º, n.º 1, alínea a), 18.º e 43.º, n.º 3, da Lei n.º 18/2003, no sentido de obrigar o Arguido, em processo contra-ordenacional, a revelar, com verdade e de forma completa, sob pena de coima, informações e documentos à Autoridade da Concorrência*".

[12] No caso do pedido, documentos e informações apresentados para efeitos de dispensa ou de redução da coima, vigora a regra da confidencialidade, só sendo acessíveis a terceiros sob autorização do visado (cfr. artigo 43.º).

[13] Este prazo suspende-se enquanto a decisão da ERSE for objeto de recurso judicial ou quando a ERSE remeter o processo ao Ministério Público por indícios de responsabilidade criminal, no prazo máximo de 3 anos.

contraordenações graves e muito graves) contados da data em que a infração se tiver consumado ou da data em que se torna definitiva ou que transita em julgado a decisão que determinou a sua aplicação, respetivamente (cfr. artigo 39.º).

Do inquérito

Em sede de inquérito, que pode ser aberto oficiosamente ou na sequência de denúncia, a ERSE promoverá todas as diligências de investigação necessárias à determinação da existência de infração e dos seus agentes, assim como à recolha de prova (cfr. artigo 9.º, n.ºs 1 e 2).

As diligências de investigação e recolha da prova a realizar pela ERSE poderão passar por recolha de declarações da entidade regulada, demais envolvidos e quaisquer pessoas cujo conhecimento dos factos seja considerado pertinente; pedidos de elementos; buscas, exames, recolhas e apreensões de valores, objetos e documentos[14] e selagem das instalações ou equipamentos onde possam encontrar-se tais elementos, sendo que, nos dois últimos casos, é necessária decisão da autoridade judiciária competente proferida em quarenta e oito horas após requerimento fundamentado apresentado pela ERSE, podendo esta fazer-se acompanhar por entidade policial e que, quando ocorridas no exterior, deverão ser realizadas por funcionários da ERSE credenciados para o efeito (cfr. artigo 10.º).

São ainda conferidos poderes para a realização de buscas domiciliárias[15], sempre que se verifique fundada suspeita de que existam no domicílio de pessoas particulares provas da prática de atos suscetíveis de enquadrar uma contraordenação, diligência que deverá ser sempre precedida de despacho de autorização pelo juiz de instrução competente, obtido através de requerimento apresentado pela ERSE, e com as condicionantes impostas na busca em escritório de advogado ou consultório médico (cfr. artigo 11.º).

Da transação e do arquivamento mediante imposição de condições

O regime sancionatório do setor energético veio consagrar mecanismos de simplificação e celeridade do processo contraordenacional, sob o escopo da eficácia da atuação da

[14] Com as condicionantes previstas no artigo 12.º do RSSE.

[15] "*A entrada no domicílio dos cidadãos durante o dia não está constitucionalmente limitada ao processo penal, ao contrário do que a Lei Fundamental determina relativamente à entrada durante a noite (cfr. números 2 e 3 do artigo 34.º) ou à ingerência na correspondência ou nas comunicações privadas (cfr. n.º 4 do artigo 34.º). Está é sujeita a especiais exigências. Antes de mais, uma exigência de proporcionalidade (artigo 18.º, n.º 2, da Constituição) que, embora geral, se revela aqui de uma especial acuidade, atenta a medida em que está aqui em jogo a intimidade da vida privada e familiar das pessoas (...).*", anotação ao artigo 19.º da Lei da Concorrência, Comentário Conimbricense, Almedina, 2013, p. 218.

entidade reguladora, como *"Afloramentos do princípio da oportunidade em processo sancionatório"* [16] e que, sob a tutela do princípio da legalidade, permitem, quando utilizados, pôr fim ao processo de contraordenação antecipadamente[17].

Neste espírito, o procedimento de transação no inquérito, fixado no artigo 14.º do RSSE, prevê que tanto o visado como a ERSE podem tomar a iniciativa para encetar conversações com vista à eventual apresentação de proposta de transação.

Antes do início das conversações, o visado terá, porém, de ser informado dos elementos essenciais da imputação que lhe é dirigida e, uma vez concluídas, ser-lhe-á fixado prazo para apresentar a sua proposta de transação que constituirá o reflexo escrito do resultado das conversações e cujo acesso a terceiros está vedado, salvo autorização do próprio.

Recebida a proposta de transação, a ERSE pode rejeitá-la, com base em falta de fundamento, por decisão não suscetível de recurso, ou aceitá-la, caso em que elabora e notifica a competente minuta ao visado, que deve confirmá-la no prazo fixado pela ERSE. Ultrapassado esse prazo sem manifestação do acordo pelo visado a proposta de transação tem-se por revogada e a respetiva minuta por ineficaz.

Com a confirmação do visado e o pagamento da coima, a minuta da transação convola-se em decisão definitiva condenatória, não podendo os factos voltar a ser apreciados pela ERSE como contraordenação à luz do RSSE nem objeto de impugnação judicial pelo visado.

Paralelamente ao inquérito, o artigo 15.º do RSSE prevê o procedimento do arquivamento mediante imposição de condições que, podendo, à semelhança do procedimento de transação, partir da iniciativa do visado ou da ERSE, implica a imposição de condições ao visado que, não obstante não consubstanciar uma confissão por parte deste, torna obrigatório o cumprimento dos compromissos assumidos.

No entanto, os compromissos propostos pelo visado e a assumir deverão ser suscetíveis de eliminar os efeitos decorrentes das infrações em causa e têm, antes da aprovação, de ser objeto de divulgação, para que terceiros interessados possam pronunciar-se acerca dos mesmos.

No caso de decisão de arquivamento mediante a aceitação de compromissos e a imposição de condições, cuja verificação compete à ERSE, a esta assiste a faculdade de

[16] Citando Raul Soares da Veiga, "*Legalidade e oportunidade no Direito Sancionatório das entidades reguladoras*", *in* Direito Sancionatório das Autoridades Reguladoras, Coimbra Editora, 2009, pp.164.

[17] Estes procedimentos foram erigidos à semelhança dos introduzidos com o novo regime da concorrência, aprovado pela Lei n.º 19/2012, de 8 de maio [cfr. artigos 22.º e 23.º (na fase de inquérito) e 27.º e 28.º (na fase de instrução)].

poder reabrir o processo caso ocorra uma alteração substancial da situação de facto em que a decisão se fundou, bem como quando as condições não sejam cumpridas ou a decisão de arquivamento haja sido fundada em informações falsas, inexatas ou incompletas.

Terminado o inquérito nos termos dos procedimentos acima discriminados, a ERSE põe fim ao processo, com decisão condenatória, na sequência de transação, ou arquiva o processo mediante a imposição de condições, decidindo, nos demais casos, sempre que conclua pela existência de uma probabilidade séria de vir a ser proferida decisão condenatória, dar início à instrução, através de notificação de nota de ilicitude ao visado pelo processo, ou proceder ao arquivamento, se das investigações não for possível concluir pela probabilidade séria de tal decisão (cfr. artigo 16.º).

Da instrução

Caso o inquérito termine com notificação de nota de ilicitude ao visado pelo processo, nesta será fixado prazo razoável para que aquele se pronuncie por escrito sobre todos os factos invocados e demais elementos com relevo para o processo, podendo requerer outros meios de prova, incluindo uma audição oral (cfr. artigos 17.º, n.ºs 1 e 2 e 18.º).

A ERSE pode fundamentadamente recusar os meios de prova requeridos pelo visado quando considere que não são relevantes e/ou realizar outras diligências complementares de prova no decurso da instrução, desde que o visado seja notificado para se pronunciar sobre os elementos resultantes de tais diligências e os mesmos não alterem substancialmente os factos inicialmente imputados ou a sua qualificação, caso em que a ERSE deverá emitir nova nota de ilicitude (cfr. artigo 17.º, n.ºs 3 a 6).

À semelhança do previsto na fase de inquérito, também na fase de instrução o processo pode ser concluído através de decisão final de condenação em procedimento de transação ou mediante arquivamento com imposição de condições (cfr. artigo 21.º, n.º 3, al. b) e c)), aplicando-se o disposto no artigo 19.º e no artigo 20.º do RSSE.

O procedimento contraordenacional termina com a adoção de uma decisão final pelo conselho de administração da ERSE que, além dos casos acima referidos, ou declara a existência da prática de uma contraordenação, acompanhada de admoestação ou da aplicação de uma coima e, eventualmente, demais sanções, ou ordena o arquivamento do processo sem a imposição de condições (cfr. artigo 21.º, n.º 3, al. a) e d)).

Assiste ainda à ERSE, em qualquer momento do processo contraordenacional, sempre que as investigações realizadas indiciem que os atos que são objeto do processo estão na iminência de provocar um prejuízo grave e irreparável ou de difícil reparação para os setores regulados ou para os consumidores, ordenar preventivamente, por período não superior a 90 dias, salvo prorrogação devidamente fundamentada, a imediata suspensão da prática dos referidos atos, para tal ouvindo o visado. Poderá igualmente ordenar quaisquer outras medidas provisórias necessárias à imediata reposição do cumprimento das leis ou regulamentos aplicáveis que se mostrem indispensáveis ao efeito útil da decisão a proferir no processo (cfr. artigo 26.º).

2.3. Contraordenações e sanções

A Lei n.º 9/2013, de 28 de janeiro, estabelece uma tipificação bipartida de comportamentos ilícitos, puníveis a título de tentativa e negligência[18], subsumíveis a contraordenações energéticas no Sistema Elétrico Nacional e no Sistema Nacional de Gás Natural, recorrendo à tradicional qualificação de contraordenações muito graves, graves e leves, qualificação que influencia diretamente o limite da coima a aplicar e que poderá atingir, respetivamente, 10%, 5% ou 2% do volume de negócios realizado no exercício imediatamente anterior à decisão final[19], no caso de o visado ser uma pessoa coletiva, ou 30%, 20% ou 5% da remuneração anual auferida no exercício das suas funções, no caso de o visado ser uma pessoa particular[20] (cfr. artigos 28.º, 29.º, 30.º e 32.º, n.ºs 2 a 7).

Na determinação da medida da coima são ainda considerados, entre outros, a duração da infração e o seu impacto na atividade do setor regulado, os benefícios patrimoniais e não patrimoniais retirados e a tentativa de eliminação e reparação dos prejuízos causados, o grau de participação e a gravidade da conduta, a situação económica do visado, os antecedentes em outros processos contraordenacionais da ERSE e a colaboração prestada a esta Entidade Reguladora[21] (cfr. artigo 32.º, n.º 1).

Considerando-se a infração de reduzida gravidade, e desde que sanável e não danosa para o setor regulado em causa, para os consumidores e para a atividade regulatória da

[18] Sobre a condenação por conduta negligente, veja-se a Sentença, de 05 de janeiro de 2016, proferida nos autos de Recurso n.º 227/15.0YUSTR, que correram termos no 1.º Juízo do Tribunal da Concorrência, Regulação e Supervisão, disponível em http://www.erse.pt/pt/psancionatorios/decisoesERSE/Documents/2014_04_Senten%C3%A7a%20TCRS.pdf.

[19] Se o visado estiver no primeiro ano de atividade, o limite é fixado em € 1.000.000,00 para as contraordenações muito graves, € 500.000,00 para as contraordenações graves e € 150.000,00 para as contraordenações leves (cfr. artigo 32.º, n.º 5).

[20] Estes limites poderão ser majorados caso o visado obtenha um benefício económico com a prática da infração que seja superior ao limite máximo da coima, podendo elevar-se até ao montante do benefício, com a limitação de um terço do limite máximo abstratamente aplicável (cfr. artigo 32.º, n.º 8).

[21] Os critérios enunciados no n.º 1 do artigo 32.º do RSSE não sendo taxativos, constituem um guia na delicada atividade de ponderação de um alargado espectro de fatores a serem considerados na aplicação de uma coima a um caso concreto.

ERSE, poderá ser proferida ao visado uma admoestação escrita, que finaliza o processo e impede que os mesmos factos voltem a ser apreciados (cfr. artigo 34.º).

Por outro lado, a prática de uma contraordenação muito grave, com dolo, depois de condenação por qualquer outra infração, ou a prática de qualquer infração, depois da condenação por contraordenação muito grave ou grave, com dolo, e desde que entre as duas infrações não tenha ocorrido o prazo de prescrição da primeira, implica a punição como reincidente, sendo o montante da coima a aplicar elevado para o dobro (cfr. artigo 31.º).

Caso a ERSE considere que a gravidade da infração e a culpa do infrator o justificam, ao visado podem ainda ser aplicadas, em simultâneo com a coima, sanções acessórias, que podem consistir na interdição, pelo prazo de dois anos, do exercício de qualquer atividade no âmbito dos setores regulados, no caso de pessoa coletiva, ou na interdição do exercício de cargo de administração ou de funções de direção nas entidades intervenientes nos setores regulados, no caso de pessoa singular, bem como a publicação integral da decisão final de condenação proferida pela ERSE ou, caso esta seja objeto de impugnação judicial, da decisão judicial transitada em julgado, para além do extrato da decisão na página da Internet da Entidade Reguladora (cfr. artigo 35.º).

À ERSE assiste ainda a faculdade de aplicar sanções pecuniárias compulsórias, num montante não superior a 5% da média diária do volume de negócios no ano imediatamente anterior à decisão, por cada dia de atraso, a contar da data da notificação, no acatamento de decisão da ERSE que imponha uma sanção ou ordene a adoção de medidas determinadas (cfr. artigo 36.º).

2.4. Dispensa ou redução da coima

Um dos novos poderes sancionatórios conferidos à ERSE pela Lei n.º 9/2013, de 28 de janeiro, é o de poder conceder a dispensa de aplicação de coima ou, ponderadas as circunstâncias e o interesse público a proteger, reduzir até 50% o montante da coima que seria aplicada[22], desde que o visado assim o requeira e cumpra cumulativamente as condições elencadas no artigo 40.º do RSSE e que se traduzem, no essencial, numa postura de confissão e colaboração plena e contínua, sob o fito da reconstituição da situação infratora e da reparação dos danos causados (cfr. artigo 33.º).

[22] Este instrumento encontra paralelismo com o instituído com o novo regime da concorrência, aprovado pela Lei n.º 19/2012, de 8 de maio (cfr. artigos 70.º e 75.º a 79.º), cujo procedimento consta do Regulamento n.º 1/2013, de 3 de janeiro, do Conselho da Autoridade da Concorrência.

Relativamente a este novo instituto, em 4 de março de 2014, entrou em vigor o Regulamento n.º 87/2014 da ERSE[23] que, em cumprimento do disposto no artigo 42.º do RSSE, estabelece o regime procedimental da tramitação daquele pedido, que deve ser formalizado mediante requerimento dirigido à ERSE, realizado por escrito ou substituído por declarações orais, devendo conter todas as informações relevantes e todos os elementos de prova disponíveis, sem prejuízo da posterior indicação ou junção dos obtidos apenas após a sujeição do pedido.

Caso o pedido não se encontre devidamente instruído mas indique o mínimo de informação considerada essencial, a ERSE pode conceder prazo razoável para que o mesmo seja completado, o que, a não se verificar, implica a sua rejeição. Bem assim, caso a ERSE verifique, antes da decisão final, o não preenchimento das condições previstas no artigo 40.º do RSSE, concede ao requerente prazo razoável para que este apresente, por escrito, as suas observações, e se a apreciação da ERSE se mantiver, o requerente pode ainda: retirar o seu pedido e os respetivos elementos de prova, solicitar que os mesmos sejam considerados para efeitos de colaboração no âmbito do processo de contraordenação ou solicitar, caso o pedido tenha por objeto a dispensa de coima, que o mesmo seja considerado para efeitos de redução da coima.

Por regra, a decisão final da ERSE é tomada com a decisão que se segue à conclusão da fase de instrução do processo de contraordenação e, sem prejuízo do sentido daquela, a cooperação prestada pelo requerente é considerada para efeitos da determinação da medida da coima.

2.5. Recursos

Das decisões proferidas pela ERSE no âmbito do processo de contraordenação, que não sejam de mero expediente ou de arquivamento, cabe recurso, a interpor no prazo de 30 dias úteis contados da notificação da decisão condenatória final, com efeito, em regra, meramente devolutivo[24], para o Tribunal da Concorrência, Regulação e Supervisão (cfr. artigos 46.º e 49.º).

No que concerne ao condicionamento da atribuição de efeito suspensivo ao recurso à prestação de caução pelo visado, no caso de decisões que apliquem coimas, foi

[23] Diário da República, 2.ª Série – N.º 43 – 3 de março de 2014.

[24] Caso a decisão final condenatória seja acompanhada de coima, o recorrente pode requerer, com a interposição do recurso, o seu efeito suspensivo, desde que demonstre que o pagamento da coima, naquela fase, lhe causa prejuízo considerável e se mostre disponível para prestar caução em substituição.

recentemente colocada em crise a constitucionalidade material dos preceitos previstos nos n.ºs 4 e 5 do artigo 46.º do RSSE[25], por alegada violação do direito à tutela jurisdicional efetiva, do princípio da presunção de inocência e do princípio da proporcionalidade, consagrados nos artigos 20.º, n.º 5, 32.º, n.º 2 e 18.º, n.º 2, todos da Constituição da República Portuguesa, respetivamente, encontrando-se a questão para apreciação do Tribunal Constitucional[26].

O recurso deverá ser dirigido à ERSE que, em prazo idêntico, o remeterá, juntamente com os autos do processo de contraordenação, ao Ministério Público, podendo também juntar alegações, outros elementos e oferecer meios de prova. O Tribunal poderá, ouvidos os demais intervenientes, decidir por despacho, sem realização de audiência de julgamento, podendo também reduzir ou aumentar a coima, bem como a sanção pecuniária compulsória imposta pela ERSE (cfr. artigos 49.º e 50.º, n.º 1).

No caso de recurso de decisões interlocutórias ou de medidas cautelares, o prazo de recurso é de 20 dias úteis (cfr. artigos 47.º e 48.º).

Das sentenças e despachos do Tribunal da Concorrência, Regulação e Supervisão cabe recurso para o Tribunal da Relação competente, que decide em última instância, sem prejuízo de eventuais recursos extraordinários (cfr. artigo 51.º).

3. Três anos de aplicação prática do RSSE

No dia 27 de fevereiro de 2016, decorreram três anos sobre a entrada em vigor da Lei n.º 9/2013, de 28 de janeiro, traduzidos na aplicação prática do Regime Sancionatório do Setor Energético pela Entidade Reguladora dos Serviços Energéticos.

Neste período, a ERSE disponibilizou na sua página eletrónica um formulário de denúncia que, como meio de transmissão de factos direto, impulsionou o número de denúncias recebidas, das quais algumas foram reencaminhadas às autoridades competentes (Ministério Público, Direção-Geral do Consumidor, ASAE, Instituto de Seguros de Portugal e Direção Geral de Energia e Geologia), por não recaírem na sua esfera de competência.

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[25] Autos de Recurso n.º 52/16.1YUSTR, que correm termos no 1.º Juízo do Tribunal da Concorrência, Regulação e Supervisão.

[26] À semelhança do artigo 84.º, n.ºs 4 e 5 do Novo Regime Jurídico da Concorrência e do artigo 67.º, n.º 5 dos Estatutos da Entidade Reguladora da Saúde, que prevendo normas idênticas, foram declarados materialmente inconstitucionais pelo mesmo Tribunal da Concorrência, Regulação e Supervisão.

Paralelamente, neste triénio, a ERSE procedeu à abertura de processos sancionatórios[27], sempre que considerou existirem indícios da prática de contraordenações puníveis, essencialmente, nos termos do RSSE[28], tendo já declarado a existência da prática de diversas contraordenações nos setores regulados e aplicado coimas aos infratores[29].

Dos recursos interpostos das decisões de condenação proferidas pela ERSE para o Tribunal da Concorrência, Regulação e Supervisão, serão de reter, ao momento, por mais relevantes, as seguintes questões: *(i)* confirmação da imputação subjetiva a título negligente[30]; *(ii)* legalidade do limite máximo de 10% do volume de negócios realizado no exercício imediatamente anterior à decisão final proferida na determinação da medida da coima[31]; *(iii)* confirmação da não prorrogabilidade do prazo de 30 dias úteis para interposição de recurso e *(iv)* (in)constitucionalidade do condicionamento da atribuição de efeito suspensivo ao recurso de decisões que apliquem coimas à prestação de caução[32].

Conclusão

O Regime Sancionatório do Setor Energético, operando a materialização dos poderes sancionatórios da ERSE e definindo os aspetos processuais e a tipificação das contraordenações energéticas, implementou maior eficiência na instrução dos processos, num setor em que a complexidade técnica das matérias e a regulamentação abundante pressupõem um conhecimento mais especializado e, por outro lado, potenciou a garantia do direito de defesa dos visados na fase sancionatória, inclusive com a consagração de mecanismos processuais mais expeditos legitimados pelo consenso com os visados, assim representando um passo essencial no desenvolvimento das atribuições da ERSE, na promoção da eficiência e racionalidade do mercado interno da eletricidade e do gás natural.

[27] Cujos temas versam, essencialmente, sobre a proteção dos direitos e interesses dos consumidores (relacionamento e qualidade do serviço comercial, atendimento telefónico eficaz, comunicação de leituras, faturação e não disponibilização do Livro de Reclamações); proteção dos clientes finais economicamente vulneráveis (tarifas sociais e ASECE); obrigações de serviço público (interrupção injustificada do fornecimento) e mercado liberalizado e concorrencial (independência dos operadores, mudança de comercializador, práticas comerciais desleais e cedência ilícita de gás natural a terceiros).

[28] Note-se que o Decreto-Lei n.º 57/2008, de 26 de março, que estabelece o regime jurídico aplicável às práticas comerciais desleais das empresas nas relações com os consumidores (artigos 19.º, n.º 1 e 21.º, n.º 5), e o Decreto-Lei n.º 156/2005, de 15 de setembro, que prevê a obrigatoriedade de existência e disponibilização do livro de reclamações em todos os estabelecimentos de fornecimento de bens ou prestação de serviços (artigos 6.º, n.º 1, alínea b) e 11.º, n.º 1, alínea h), atribuem poderes sancionatórios à ERSE, enquanto entidade reguladora setorial.

[29] Cujos extratos das decisões finais se encontram disponíveis em http://www.erse.pt/pt/psancionatorios/decisoesERSE/Paginas/index.aspx.

[30] Sentença, de 05 de janeiro de 2016, proferida dos autos de Recurso n.º 227/15.0YUSTR, que correram termos no 1.º Juízo do Tribunal da Concorrência, Regulação e Supervisão, disponível em http://www.erse.pt/pt/psancionatorios/decisoesERSE/Documents/2014_04_Senten%C3%A7a%20TCRS.pdf

[31] *Idem* nota 30.

[32] *Idem* nota 25.

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Can Structural Models be Useful to Understand the Electricity Wholesale Markets? An Application to Spain

Vítor Marques,[1] Adelino Fortunato[2], Isabel Soares[3],

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Abstract

The aim of this study is to analyse the behaviour of agents in the Spanish electricity market during the period of January 1999 to June 2007 before Iberian Electricity Market was started. Our main questions are: i] did market power occur? ii] what kind of long term strategies have been adopted?

New Empirical Industrial Organization aims to infer the causes of high levels of market power. However, the capacity to exercise market power and anti-competitive strategies take shape in the form of two related trends which only partially cancel each other out: i] electricity production can be based on "anti-competitive" strategies, ii] this natural tendency

[1] ERSE, The results and comments presented in this paper are entirely the authors' responsibility and do not reflect the official opinions of ERSE or other institution. email vmarques@erse.pt

[2] University of Coimbra. email: adelino@fe.uc.pt;

[3] University of Porto, CEP UP. email: isoares@fep.up.pt

to exercise market power and the fact that electricity is an essential commodity, make this sector extremely regulated. In a pioneering study Wolfram (1999), concludes that prices were much higher than marginal costs, demonstrating the existence of market power. This study also points in this direction. The paper shows that the average high mark-up in the period was very likely due to the implementation of anti-competitive strategies, even though with limited consequences on prices due to the stranded costs compensation.

Keywords

Electricity - Structural Model - Market Power - Uniform Price Market.

Introduction

The aim of this study is to analyse the behaviour of agents in the Spanish electricity market during the period of January 1999 to June 2007 before Iberian Electricity Market was started. Our main questions are:

- Did market power occur?
- What kind of long term strategies have been adopted?

The analysis is carried out in the framework of structural models. This framework is based on the causal relationships between related variables, explained by economic theory. They are, in general terms, expressed by the resolution of a system of equations, thus implying economic equilibrium. Structural models provide a heuristic approach about market economic relationships and they also allow for the answer to other questions, namely the calculation of price elasticity of demand.

Section 2 presents the organization of the Spanish wholesale market. The methodological approaches are presented in section 3. This section includes the survey of the various methodological approaches, and presents the particularities used: the research is carried out through the structural model methodology, and the results are confronted with the direct estimations of the main variables. The structural model has two equations, one for demand and another for profit. The price elasticity of demand is estimated in section 4 through the first equation. The behavioral factor is estimated in section 5 through the profit maximization function.

1. Framework

The former Spanish wholesale market is a Uniform Price Auction (UPA) Market. In these markets, the generator which sells the marginal quantity defines the system marginal price. This price is paid each hour to all producers with accepted bids. This market presents a strong regulatory framework. The main regulatory drivers were the stranded costs compensations (CTC), (from 1998 (Ley 54/1997), until 2006 (Real Decreto-ley 7/2006), with a decreasing influence in producers income over this period).

This market was highly concentrated. Endesa and Iberdrola represented about ¾ of the supply in the wholesale market. But their importance tended to decrease (75% in 2002 and 60% in 2006).

2. Methodological aspects

2.1. The games

The market for power generation is very much like a market with Cournot strategies and capacity constraints (Kreps and Scheinkman, 1983). Within this framework, the quantities correspond to the decision variable. Even when the price is assumed as a strategically variable, the results of the strategies are similar to the Cournot game due to the capacity constraints in that kind of market (see Wolak and Patrick, 1997). Starting with the Nash-Cournot solution and reprising the Cowling-Waterson formula (1976), the Lerner index and the strategies developed by companies can be correlated using the θ[4] index[5]:

$$\frac{P - (\overline{Cmg})}{P} = \frac{\overline{\theta} HHI}{|\epsilon|} = \lambda \qquad (1)$$

In which $\overline{Cmg}$ is the weighted marginal cost for the industry, HHI the Herfindahl-Hirschman index and λ the factor measuring the level of market power, i.e. which corresponds to the Lerner index. In this case, the Lerner index is directly related to the level of concentration and also related to the firms' conjectural variations. In this context, if $\overline{\theta} = \frac{1}{HHI}$, perfect collusion is verified; when $\overline{\theta} = 0$, Cournot behaviour is verified r and, finally, when $\overline{\theta} = 1$, a perfectly competitive market prevails.

4 See, for example, Chern and Just (1980) and Bresnahan (1982)

5 This equation is based on the assumption that all companies share the same behavioral factor.

The interpretation of the producers' behavior done through the conjectural variation methodology presents some particularities. The conjectural variation methodology is a static methodology in which agents act according to expectations regarding the dynamic responses of competitors. Notwithstanding, this methodology can be applied in the present case because the "games" which occur each hour in a UPA market, like the former Spanish wholesale market, are similar to a repeated game, (see, Fabra and Toro, 2005). And, as referred Perloff et al. (2007, p. 109): "..., the theory of repeated games provides a game-theoretic basis for estimating static market conduct for conjectural variation models". The issues relating to the interpretation of the value deserve special attention.

2.2. The structural model

On the basis of the structural models, equilibrium exists in which the economic agents maximise their economic profits taking the demand and cost function into account.

In our case, the chosen model corresponds to the system of equations of monthly demand and supply, in the Spanish wholesale spot market (daily and intra-day) for the specified period. Therefore, the application of the structural model materialises in this present case in the resolution of the following system:

$$\begin{cases} Q_t = \alpha_1 + \gamma\, P_t + \phi\, Z_t\, P_t + \beta\, Z_t + \Sigma_{i=1}^{n}\, \beta_i\, D_{ti} + u_{t1} \\ P_t = \alpha_2 + \Sigma_{j=1}^{m}\, \beta_j\, W_{tj}\, - \theta(\gamma + \phi Z_t)\, Q_t + u_{t2} \end{cases} \qquad (2)$$

Where:

- t, is the time factor related to the month.
- Z_t, is the exogenous variable which allows the demand function to change its slope, i.e., which allow to rotate.
- D_{ti} are explicative variables of the demand function.
- W_{tj}, are exogenous explicative marginal cost variables.
- θ is the behavioral parameter, interpreted through the conjectural variation methodology: between 0 (Bertrand or perfect competitive strategy) and $\frac{1}{HHI}$ (perfect collusion).

Finally, so as to be able to estimate the Lerner index , we apply the following equation based on the derivative of the second equation:

$$\frac{\bar{\theta}HHI}{|\epsilon|} = \lambda \tag{3}$$

It is important to note that the need to estimate exogenous explicative variables, in the majority of cases underlying economic relations, meant that monthly data had to be used, naturally focussing on the analysis of medium- and long-term equilibriums and strategies.

In order to identify separately the cost component from the strategic component, we have to choose a variable which rotates the demand function in the face of an external shocks rather than moving in parallel: $\theta\ (\gamma + \phi\ Z_t)$, being Z_t is the rotation variable.

2.3. A model extension

It has to be highlighted that this methodology was tardily used in wholesale electricity markets (Wolfram (1999), Hjalmarsson (2000)), due to the fact that assumptions (functional form, economical model, among others) constrain the results (Corts (1989)).

This is the reason why it was given a particular attention to the knowledge of the analyzed market and to the definition of control methods. Therefore, we use data that makes it possible to estimate with some accuracy the marginal cost incurred. This allows the application of the structural model to obtain market power and to test for the behavioural variable, comparing the results with an almost direct estimate of these variables. Parallel to this, following the work of Genesove and Mullin (1998), the estimation of the price elasticity of demand based on a linear demand function is tested. The demand function is not only expressed as a linear functional form but it is also expressed as three other functional forms (logarithmic, exponential and quadratic).

Subsequently, the following regression is solved, based on the Lerner index, in order to estimate the behaviour factor λ:

$$P_t = \frac{(cmg_t)}{(-\lambda + 1)} + \mu_{t4} \tag{4}$$

In which cmg_t represents the marginal cost (that we estimate as an external variable) for month *t*.

In order to estimate θ, equation [5] is applied:

$$\theta = \frac{|\epsilon|}{HHI}\lambda \qquad [5]$$

2.4. A brief description of the market organization

OMEL[6] is the operator of the wholesale market, which is divided into the daily and the intraday market. In the daily market, the electricity producers submit bids to sell quantities of electricity on an hourly basis for the day after at a minimum price and buyers [distributors, retailers and eligible consumers] submit hourly bids to buy electricity at a maximum price.

The publication of Royal Decree 5/2005 ended the obligation to transact all energy in the market regime on the wholesale market.

In the intraday market the final calculations are made in order to adjust supply and demand. Another source of income for producers comes from compensation for the availability of declared production.

The final price of the electricity traded on the wholesale market, before distribution, comes mainly from the daily and intraday markets which represent 70% to 80% of this price.

2.5. Definition of the demand function

2.5.1. Variables of the demand function

Diesel consumption was chosen as the independent variable for the price of electricity, because it better reflects the characteristics of the economic activity in Spain in the recent years. In addition, the seasonal nature of this variable is very similar to that of electricity consumption. The trend for the consumption of gas oil and electricity developed in a parallel manner up to February 2006, although diesel fuel consumption appears more volatile.

[6] Before the beginning of MIBEL, OMEL was the acronym for: Compañia Operadora del Mercado Español de Electricidad, S.A.

Electricity and diesel fuel growth rate consumption were higher than growth rate of GDP due to the increased purchasing power in Spain and from the absence of any change in the productive structure. (Mendiluce, et al., 2009). Moreover, some studies have shown that consumption of diesel in Spain evolved differently from that of other fuels, with a much lower price elasticity of demand, a characteristic which it shares with electricity consumption (González-Marrero, et al., 2008).

Two variables were chosen reflecting annual seasonal nature of electricity demand: the number of overnight stays in hotels and monthly temperature difference in comparison with the average monthly figures. In the structural model the last referred variable was used to "rotate" the demand function.

The doubts raised by the introduction of this variable led to the use of the Wald test for the deletion of the model explanatory variables, proving that there is a relationship between the variables "Overnight Stays" and "Temperature Difference ".

The variables chosen for the electricity demand equation in the daily and intraday markets are:

» Number of overnight stays in hotels each month, "Overnight stays".

» Difference between the average monthly temperature and annual average temperature, "Temperature Difference".

» Diesel fuel consumed in each month, "Diesel".

» Amount of electricity traded in the daily and intraday markets each month, "Amount of electricity."

» Average price of electricity traded in the daily and intraday markets each month, "Electricity Price".

In addition to these variables, a dummy variable must also be considered, which represents the change in the regulatory framework for these markets.

2.5.2. Stationarity of demand function

The stationarity of each variable is tested using the ADF (Augmented Dick Fuller) unit root test, with the order of the test chosen by taking into account the combined analysis of Akaike and Schwartz information criteria.

Seasonal variations are analysed without trend, whilst the remainder are analysed with trend. Given its specific nature, the price variable is analysed with and without trend

The variables are characterized as follows in terms of integration:

- “Amount of electricity” and “Price of electricity” are I (1).
- “Diesel”, “Temperature Difference” and “Overnight Stays” are I (0).

Since there are two variables I (1) in the model, the stationarity analysis is carried out through testing the existence of a co-integration relationship.

The test for the existence of a co-integration relationship between the variables follows Johansen’s methodology (Johansen, 1988).

The statistics[7] enable the H0 hypothesis of the non-existence of a co-integration relationship to be rejected, meaning that the H0 hypothesis for the existence of more than one co-integration relationship also cannot be accepted. Thus, one can consider that the variables “Price of electricity” and “Amount of electricity” are co-integrated, i.e.: $Q_t - P_t \sim I(0)$. How those variables can be cointegrated, when in the short and medium term the electricity demand and its price varies inversely? The reason is that in the long-term, those variables increase proportionally: the demand for electricity has been satisfied by recourse to more expensive production technologies or by conventional fossil fuel technologies which have tended to become more expensive due to the fossil fuel limited reserves.

2.5.3. Instrumental variable

Once the variables incorporated in the demand models have been defined, it is important to ensure the orthogonality of the model. A test for endogeneity was held in the first equation, since different variables underscored an economic relationship with one another, “Electricity Price”, “Overnight Stays” and “Diesel”. It was considered “Temperature Difference” as an exogenous variable.

Moreover, in structural models identification requires compliance with the rank condition. An initial group of instrumental variables must be constituted which respect the following

7 Eigen value and trace test statistics

restrictions: on the one hand, they must not be correlated with the "Amount of electricity", dependent variable in the first equation, but with "Electricity Price". On the other hand, they will include the exogenous variables in the second equation (see Reiss and Wolak, 2005). The following variables were defined into this group:

- » The average monthly price (Eur/bbl) of Brent crude "Oil Price", with 3 months lags.
- » The average monthly price (Eur/t) of coal "Coal Price", with 3 and 12 months lags.
- » The average monthly hydro electrical productivity, "Hydro".
- » In the section related to the definition of the second equation, the reasons for choosing those variables are explained.
- » A second group of instrumental variables was defined, related to diesel consumption. We chose the instrumental variables that capture the seasonality and the economic activity:
- » The "Diesel" consumption, with 12 months lags.
- » The monthly trend for the industrial production index, "Industrial Production", and the estimated of monthly GDP, "GDP".

The inclusion of instrumental variables with lags allows us to consider the short-term adjustments, thus taking the dynamic nature of the model. The results of the statistical T_2 Wu-Hausman Test reject the hypothesis of the non endogeneity of the model.

Even outside the theoretical framework of structural models, the confirmed existence of endogeneity in the demand function requires the application of the Two-Stage Least Square method. The instrumental variables chosen are those previously referred to.

Bearing in mind the significant number of instrumental variables, the overestimation of the model was tested. The results allowed us not to reject the null hypothesis of all the instrumental variables being exogenous.

2.6. The demand function in the structural model context

Two events characterised the wholesale electricity market during the period under analysis: the introduction of combined cycle natural gas plants from in 2004 and the various changes in legislation which led to a sharp fall in the amounts of electricity traded since March 2006.

Thus, both in the application of the structural model as in the other case, the models were tested for 4 separate periods: January 1999 to June 2007; January 1999 to February 2006; January 1999 to December 2003; January 2004 to June 2007.

The impact of the changes in the framework of the daily and intraday markets since March 2006 onwards is analysed with the inclusion of a dummy variable.

The "rotation" variable is the "Temperature Difference" variable.

Therefore, based on equation (2) and assuming a linear demand function, the demand function will be given by, (model 1):

$$Q_t = \alpha + \beta_1 P_t + \beta_2 \text{ Diesel}_t + \beta_3 \text{ DifTemp}_t + \beta_4 \text{ Stays}_t + \beta_5 \text{ DifTemp}_t P_t + \epsilon_t \quad (6)$$

Where:

Q_t, is "Amount of electricity" variable, in the month t.

P_t, is "Electricity Price" variable, in the month t.

Diesel_t, is "Diesel" variable in the month t.

DifTemp_t, is "Temperature Difference" variable in the month t.

Dorm_t, is "Overnight Stays" variable in the month t.

However, most of the variables are not significant when the model is presented in this way. Thus, we opted for a model in which the variable Temperature Difference is only included as a rotation variable (model 2):

$$Q = \alpha + \beta_{1a} P_t + \beta_{2a} \text{ Diesel}_t + \beta_{3a} \text{ Stays}_t + \beta_{4a} \text{ DifTemp}_t P_t + \epsilon_t \quad (7)$$

The chosen model is shaded in orange. The analyses beyond December 2003 don't present significant results. This is not surprising given that since 2004, the framework of Spanish electricity market has changed several times, and the market could not be considered, even in long-term perspective, as being in equilibrium.

The structural model is then applied to "Model 2", for the period between January 1999 and December 2003.

Table 1 - Comparison of the results of the regression "models 1 and 2" (January 1999 to December 2003)

	Model 1		Model 2	
	Estimate	t test [Prob.]	Estimate	t test [Prob.]
Constant	3620.7	0.1803 [0.858]	874.3508	0.3112 [0.757]
Pt	-1298.1	-0.3188 [0.751]	-735.5126	-3.1054 [0.003]
Dormt	4.9648	0.7977 [0.430]	5.6684	1.7674 [0.084]
Dieselt	0.0064399	2.3929 [0.021]	0.0067753	6.4709 [0.000]

From equation (7) two parameters were obtained that are essential for the model as a whole: the inverse of the slope of demand function and the price elasticity of demand. The second parameter stems from the following equation:

$$\frac{\frac{dQ_t}{dP_t}}{\frac{Q_t}{P_t}} = (\beta_1 + \beta_4 \, (\overline{DifTemp}) \, \frac{\overline{P}}{\overline{Q}} \qquad (8)$$

In which $\frac{\overline{P}}{\overline{Q}}$, is the ratio of the average market prices and quantities traded and $\overline{DifTemp}$, is the average temperature differences. In this case, $\frac{\frac{dQ_t}{dP_t}}{\frac{Q_t}{P_t}} = -0.0933$.

2.7. Price elasticity of demand inside and outside the structural model

The demand function is defined outside the structural model in the strictu-senso. The functional forms considered in the work of Genesove and Mullin (1998) are presented (linear, exponential, quadratic and exponential). The equations were adapted in order to take into account independent variables other than price.

The general functional form is given by equation (9)

$$Q_{t(p)} = \beta(\alpha - P_t)^{\gamma} + \epsilon_t \qquad (9)$$

In which, β measures the size of the market demand, α is the maximum willingness to pay, Pt is the price and γ is the convexity index. α tends to infinity and $\frac{\gamma}{\alpha}$ is a constant.

2.7.1. Results

As in the previous section, the results were only considered whenever the level of significance of the variable price is equal to or less than 5%. For each case, the selection criterion is the degree of significance of the variable "price electricity"[8].

The figures for the different functional forms are similar, between -0.089 and -0.099. The value calculated for the structural model with a linear equation, falls within this interval.

Those values are close to the values generally associated with the elasticity of demand in the electricity sector, around 10% [see Borenstein, Bushnell and Knittel (1999) or Patrick and Wolak (1997)]. For the Spanish electricity sector, and also for hourly data, Alcalde et al (2002) defined 3% as the average elasticity of demand in 1998, and Khün and Machado (2003) estimated that the elasticity of demand was between 1.5% and 9% in 2001.

3. Optimal equation

Due to problems of identification, the optimal equation must include the demand rotation component. Thus, the second equation of the system (2) has the following representation:The second parameter stems from the following equation:

$$P_t = \alpha_2 + \sum_{i=1}^{n} \beta_j Cmg_j + \beta_8 Q_t - \lambda \left(\frac{1}{(\beta_1 + \beta_4 \, DifTemp)} \right) Q_t + \epsilon_t \qquad (10)$$

The Cmg_j variables represent the factors required to calculate the marginal cost. The last variable is the rotation variable for the demand function whose parameters were defined solving the demand equation. The coefficient of this variable corresponds to the behavioral variable. The marginal cost of the system is defined by the production costs of the power plant which define the closing price of the market.

8 The presentation of the statistical tests is out of the scope of the present paper.

The power plants with conventional technologies which set the closing price are the coal and fuel oil power plants, natural gas combined cycle power plants and hydro plants. Thus, the variables chosen to estimate the average marginal cost of the system are:

» The average monthly price, EUR/bbl, of Brent oil with 3 months lag, which represents the cost of natural gas combined cycle power plants and the cost of fuel oil power plants. It is common practice for natural gas supply contracts to index their prices to the price of oil or its derivatives, with time lag between 3 and 6 months.

» For coal power plants, the monthly average price of coal with a 3 months lag, Eur/t, in order to reflect the stock management policy.

» Hydro coefficient.

The last variables are exogenous to the model, having been included as instrumental variables in the previous equation. We chose variables that are directly related to a theoretical system marginal cost, because this is not necessarily the real marginal cost incurred. In practice, the marginal cost of the system will also depend on technical constraints and company strategies. These factors should be included into the behavioral variable λ. Thus, equation (10) can be rewritten as follows:

$$P_t = \alpha_2 + \beta_5\, Oil_{t-3} + \beta_6\, Coal_{t-3} + \beta_7\, Hydr_t + \beta_8\, Q_t - \bar{\theta} \left(\frac{1}{(\beta_1 + \beta_4\, DifTemp)} \right) Q_t + \epsilon_t \qquad (11)$$

Whereby:

Oil_{t-3} , is the average monthly price of Brent crude lagged 3 months.

$Coal_{t-3}$, is the average monthly Coal API # 2 NW Europe lagged 3 months.

$Hydr_t$, is the hydro inflows in the month t.

$\bar{\theta}$, is the behavioral variable.

3.1. Stationarity of the supply equation

The ADF test perfomed ponted out that “Hydro index inflows” is the only stationary variable which defines the marginal cost.

The variable prices of oil and coal are integrated of order 1. Using the Johansen approach, and a VAR model of order 1, as indicated by the information criteria, the statistics[9] allow the rejection of the H0 hypotheses for the non-existence of one and two co-integration relationships, and point out that the H0 hypothesis for the existence of more than two co-integration relationships cannot be accepted.

Thus, two co-integration vectors exist which support the relationship already demonstrated between the price and amount of electricity variables $P_t - Q_t \sim I(0)$; as well as the co-integration relationship between coal and oil prices: $Oil_{t-3} - Coal_{t-3} \sim I(0)$.

3.2. Instrumental variables

As part of the structural model, equation (11) is solved with a two-stage least-squares model. The identification of this equation requires that the exogenous variables defined in the other equation should be considered instrumental variables: "Overnight Stays", "Diesel" and "Temperature Difference". The latter can already be found indirectly in equation of the demand variable rotation. So instead we used the average monthly temperature. This variable may also serve as an instrumental variable for the hydro inflows.

Testing for the overestimation of the model does not reject the null hypothesis that all instrumental variables are exogenous.

3.3. Behavioral parameter

We tested several models for different instrumental variables. The chosen model presents a level of significance lesser than 10% for the rotation variable of the demand, which can be interpreted as robust by the statistical tests conducted.

For 48 observations (up to December 2003), the variables are not very significant; especially those related to fuel prices. However, when we extend the series until February 2006 (72 observations), all variables become more significant. It can equally be observed that considering a longer period of time does not alter the coefficient attributed to the rotation variable, which enables the behavioural factor to be defined. This value lies at around 0.054, indicating a competitive market.

[9] Eigen value and trace test statistics

Table 2 - Chosen regression

	January 1999 – December 2003		January 1999 – December 2003	
	Coefficient	T-ratio [Prob.]	Coefficient	T-ratio [Prob.]
Constant	-4.5369	-0.75148 [0.457]	0.81635	-1.9208 [0.061]
Oil price (-3)	0.010074	0.2825 [0.779]	-0.039856	-1.9571 [0.054]
Coal price (-3)	0.049354	0.3497 [0.728]	0.14786	4.8609 [0.000]
Hydro	-2.3575	-2.4650 [0.018]	0.053211	2.4592 [0.016]
Amount of elecricity	0.0006352	1.7757 [0.083]	0.0002727	1.7863 [0.079]
Variable of rotation	0.053596	1.7591 [0.086]	0.053211	2.4592 [0.016]

3.4. Lerner index in the period 1999-2003

Having estimated the behavioral factor for the analyzed period (about 0.0535) and the price elasticity of demand (-0.0933), it remains to define the Herfindahl Index, HHI, in order to estimate the Lerner index solving equation (3). The Herfindahl Index was calculated by economic group based on data from OMEL and the Ministerio de Industria, Turismo y Comercio. Register that this index was only calculated for conventional producers, i.e., the power plants with positive environmental externalities (special regime) were not considered because payment of their production was formed independently of market prices.

The average HHI weighted by the production is equal to 30.5%. Applying equation (3), the Lerner index is 17.4%.

The associated Lerner index it is relatively high, despite the fact that the estimation of the producers' behaviour approaches a Bertrand game. We can conclude that given the conditions of the wholesale Spanish electricity market, namely the rigidity of demand and the high concentration, the discretion enjoyed by producers to get a high mark-up is wide.

It is important to note that during the period in the Iberian Peninsula market structure for energy production did not result from competitive pressures, but from the structure of the existing market before liberalisation. Furthermore, the technologies for producing electricity are shared by producers, and the efficiency of electricity producers is more dependent on the portfolio of technologies than on the efficiency of the power plants. In this case, it is assumed that there is not an endogenous relationship between market concentration and the marginal costs.

4. Estimation of the behaviour outside the structural model

4.1. Marginal cost calculation

The definition of marginal cost is one of the main difficulties for the implementation of structural models. This is why we also estimate the cost function outside the model.

The marginal cost of a market can reflect the structure of the production costs for this market or only corresponds to the marginal cost of the electricity generating power station that has sold electricity at the highest price, which corresponds to the marginal power station. The latter type of market corresponds to the UPA Market and it is the kind of market that has been operating in Spain. In this kind of market, the marginal cost of the market is very close to the cost variable for the power station which sets the market price. In monthly terms, marginal cost corresponds to the weighted average for the amounts traded at any given hour in the marginal cost schedule:

$$Cmgt = \frac{\sum_{h=1}^{n} Cmg_h Q_h}{\sum_{h=1}^{n} Q_h} \tilde{=} \frac{\sum_{h=1}^{n} Cv_h Q_h}{\sum_{h=1}^{n} Q_h} \qquad [12]$$

in which Cmgt is the weighted marginal cost of the market in the month *t*, *n* is the number of hours *h*, is the month *t*, Cmg_h is the marginal cost of the market at the hour h, is the cost variable for the marginal power station the hour h and is the amount traded on the market at the hour *h*.

OMEL provides the amounts traded on the daily and intraday markets. In this way, the variable Q_h equation [12] is known. However, the definition of variable is based on a set of assumptions that can be grouped into:

- Definition of the variable cost function associated with the type of marginal plant.
- Definition of parameters required to calculate the variable cost.

The information provided by OMEL does not establish with certainty what type of power plant defines the system marginal cost. It was necessary to develop a set of assumptions[10] that allows to associate different technologies and consequently different functions of the variable costs to the nomenclature presented by OMEL for the source of energy that sets the system marginal price (following Borenstein, et al., 2002; Steiner, 2000; Wolfram, 1999, among others). In short, in any case, only four types of technology define the market price during the period under review: oil-fired power plant, coal power plants, combined-cycle natural gas power plants and hydro plants. In parallel with the technologies that define the market price, it is important to set the variable cost function of marginal technologies.

The variable cost of a thermal power plant will depend on four factors: its load, its efficiency for that load, the heating value of the fuel consumed and the price of the fuel. Assuming that the central i, which sets the market price at full capacity, the function of the variable i, which sets the market price at full capacity, the function of the variable cost at a determined hour, h, of this power plant, Cv_{hi}, is defined as follows[11]: traded at any given hour in the marginal cost schedule:

$$Cv_{hi} = Pcomb_j \times \phi_{combj} \times \eta_i + O\&M \tag{13}$$

Where, $Pcomb_j$ corresponds to the price of fuel *j*, ϕ_{combj} is the calorific value of fuel *j*, is the efficiency of the central and *O&M* the maintenance and operation variable costs.

Regarding the price of fuel consumed, this depends largely on the acquisition policy of the producer. Furthermore, we have to refer the particular case of the coal consumed in Spain. Much of this coal is domestic and less competitive than imported coal, obliging the subsidization of its consumption by the Spanish government.

Meanwhile, the case of hydro power plants must be highlighted. The variable costs of these plants are close to zero, and are merely related to maintenance and operation costs. In periods when the level of reservoirs is automatically reset, i.e. in periods of strong hydro inflows, which in the Iberian Peninsula represent some periods of the winter or spring, the value of the water held in reservoirs is almost zero. However, in other periods, it becomes a scarce resource, which value corresponds to the cost of the replaced technology.

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10 Is has to be higjlighted that the *assumptions were made in order to not underestimate the variables costs and, therefore, overestimate the mark-up. The presentation of these assumptions is out the scope of this paper.*

11 During the analysed period, CO_2 costs were not yet recovered.

There is an important set of unknowns in the setting the price of fuel. In order to overcome this situation, we follow three approaches for calculating the monthly variable cost.

1. For production valued at the cost of the conventional power plants, the production costs are calculated on the basis of the average market prices for the fuels and the standard values for O&M costs and efficiency. Production from hydroelectric plants is valued at the production costs for the plants (O&M costs), with the exception of months in which hydro inflows is significantly below the average for the "dry" period of the water resources year, which are valued at the cost of the fuel oil plants. This approach is referred to as "marginal cost (a)".

2. The previous point also applies except for hydroelectric production, which is valued at the cost of the fuel oil power plants, with the exception of months in which hydro inflows significantly is above the average for the "wet" period, which are valued at the production cost of the hydroelectric plants. This approach is referred to as "marginal cost (b)".

3. For production valued at the cost of conventional power plants or combined cycle natural gas plants, the production costs are defined on the basis of costs verified in Portugal for equivalent technologies during the same period. The production of hydroelectric plants is valued as the first case. This approach is referred to as "marginal cost Portugal".

4.2. Behavioral factor

At this section the regression (4) is solved for each cost function in order to estimate the Lerner index λ, and, consequently, in order to define the behavioral factor $\overline{\theta}$, the equation (5) is also solved.

4.2.1. Lerner index for 1999-2003

Whatever the cost function considered, periods when the marginal cost of the market approaches the market price succeed to periods when the marginal cost is significantly lower than the market price[12]. This is known and has been already analyzed in other studies (see Fabra and Toro, 2005).

12 The presentation of the evolution of the Lerner indexes is out of the scope of the present paper.

The evolution of the Lerner index can easily be associated with various external events. The increase in the Lerner index since 2001 coincides with the threat by the European Union to prevent Spain from maintaining the CTC payments. With the disappearance of this threat, the Lerner Index was seen to fall. Later, the entry of the new combined cycle natural gas power plants whose importance can be highlighted from 2004 onwards and which were not governed by the CTCs, coincides with a rise in this index.

After solving equation (4), the results point out that the Lerner indexes have high values, between 0.41 ("marginal cost Portugal" cost function) and 0.20 ("marginal cost (b)" cost function) for the 1999-2003 period. Their interpretation requires the resolution of equation (5).

4.2.2. Definition of the behavioral variable for 1999-2003

When we defined the price elasticity of demand for different functional forms, we concluded that only for the 1999 – 2003 period equation (5) can be solved. In section 2.4 we determined the HHI, being the average value 30.5%. With regard to price elasticity of demand, the estimated values in section 1.6.1 are very similar regardless of functional form chosen. We applied the results obtained for the linear functional form: -0.0886.

Table 3 - Variable behavior for linear demand function period 1999-2003

Marginal cost (a)	Marginal cost (b)	Marginal cost (b) Without Nov.01_Feb.02	Marginal cost Portugal
0.119	0.060	0.056	0.126

It should be recalled that the closer $\bar{\theta}$ is to 1, the closer we are to finding strategic behaviour of the Nash-Cournot type, whereas when it is closer to 0, the agents are closer to a competitive situation. Therefore, despite the high mark-up, one cannot, apparently, prove the existence of an anti-competitive behavior, using the conjectural variation methodology.

However, during the period under review the producers of electricity in Spain were framed by CTC, a scheme that was applied whenever the market price was less than 36 €/MWh. If the market price was higher than 36 €/MWh, the increased revenue would be deducted from the amounts of CTC established annually.

The CTC were organized similarly to contracts for difference, whose revenues were defined as functions that decrease with market prices. Therefore, if the CTC were applied to all quantities traded, the profit wouldn't grow with the market prices.

To define the function maximizing the profits of a producer i, we reformulated the profit function in a market with CTC given by Fabra and Toro (2005), as follows:

$$\pi_i = P(Q,D)_{qi} - C_i\,(q_i\,, W) + q_{iCTC}\,(CTC_{ui} + 36 - P(Q,D)) \tag{14}$$

Being, q_{iCTC} the quantities framed by the contracts and CTC_{ui} the income per MWh produced that are allocated to producer i through the *CTC*.

If qiCTC = qi, that is, if the quantities traded framed by CTCs, qiCTC, are equal to the quantities traded in the market, the maximization of the equation (14) results in:

$$CTC_{ui} + 36 = \frac{dC_i\,(q_i\,, W)}{dQ_i} \tag{15}$$

In this case, any strategy for maximizing profit is independent of the price and we simply need to equate the marginal cost of production at added of 36 € / MWh, which corresponds to equal the marginal revenue (implicit in the scheme prior to the liberalization) and the marginal cost.

The weight of the power plants framed by CTC in total production fell sharply from 2002, with the entry of new plants (Vives, 2006).

Thus, in practice qiCTC < q, that is, the quantities traded framed by CTCs, qiCTC, are lower than those traded in the market which are independent of this mechanism. Assuming qiCTC as a constant, in this case, the profit maximization function result as follows:

$$P + \theta_i\,\frac{dP}{dQ}\,(q_i - q_{iCTC}) = \frac{dC_i\,(q_i\,, W)}{dq_i} \tag{16}$$

Rearranging this equation, we obtain the following relationship:

$$\frac{(P - Cmg_i)}{P} = \frac{\left(s_i - \frac{qiCTC}{P}\right)\theta_i}{|\epsilon|} \tag{17}$$

This results in the following equation:

$$\frac{(P - \overline{Cmg_i})}{P} = \frac{\left(\sum_i^n s_i^2 - \frac{q_i CTC}{Q} s_i\right)\theta_i}{|\epsilon|} = \frac{\overline{\theta}\left(HHI - \sum_i^n s_i^2 - \frac{q_i CTC}{Q} s_i\right)}{|\epsilon|} = \frac{\overline{\theta}_{CTC}\, HHI_{CTC}}{|\epsilon|} \qquad (18)$$

The parameter HHI_{CTC} is the difference between the market share of each company and the weight of their respective products framed by the CTC in the total production, multiplied by their market shares. Thus, this parameter is the Herfindahl index net of the weight of the power plants that give no benefit to producers, whenever they developed a strategy to manipulate the market price. It is smaller, the greater the weight of the energy produced by plants covered by the CTC.

We defined an average value for HHI_{CTC} considering, for simplicity, that the production of plants not covered by the CTC is proportional to its capacity as the weight of the production of these plants is the same for all companies. The average value thus found for this parameter was 1.71%.

Thus, accepting a broad interpretation of HHI_{CTC} and the relation (5), we can apply the following equation:

$$\overline{\theta}_{CTC} = \frac{\lambda|\epsilon|}{HHI_{CTC}} \qquad (19)$$

The obtained values are between values that indicate the existence of Cournot strategies, which correspond to the unit, and values that indicate the existence of pure strategy of collusion, match $\frac{1}{HHI}$.

Table 4 - Variable behavior by cost function considering the CTC period 1999-2003

Marginal cost (a)	Marginal cost (b)	Marginal cost (b)	Marginal cost Portugal
2.12	1.08	1.00	2.25

The results obtained now clearly indicate that producers behaviors are “somewhere” between the Cournot behavior and the pure collusive behavior. This results are consistent with what some authors argue (see for exemple Vives, 2006) that after the suspicion on the part of producers that from 1999 the payments of CTC could not be made, they may have developed strategies to increase the mark-up implicit in the market price.

Conclusions

In the case of the former Spanish wholesale electricity market, the structural methodology allowed for interesting results, similar to those obtained outside this methodological framework and assuming different functional forms.

New Empirical Industrial Organization aims to infer the causes of high levels of market power. However, the capacity to exercise market power and anti-competitive strategies should not be confused, as this study demonstrates in terms of electricity production. They take shape in the form of two related trends which only partially cancel each other out. On the one hand, electricity production can be based on “anti-competitive” strategies, even at relatively low levels of concentration, due to the price elasticity of demand below the unit, the difficulty in storing the product and the fact that it is a capital-intensive sector. On the other hand, this natural tendency to exercise market power and the fact that electricity is an essential commodity, make this sector extremely regulated, including in economies that are more open to private initiatives, limiting the actions of economic agents (sometimes by anticipating the future actions of the regulators).

In that sense, in a pioneering study Wolfram (1999), concludes, in the case of the former English and Wales market at the end of the 1990s, that prices were much higher than marginal costs, demonstrating the existence of market power. However, this difference was less than was to be expected, given the structure of the English market at the time. Fears of State intervention in the wholesale market can explain the “lower” mark-up. This study also points in this direction. The average Lerner index is high, although it is expected to be much higher considering market structure.

However, at that time the Spanish electricity sector was framed by CTC, which would, nevertheless, turn the average Lerner index lower, since profit maximization function of the producers was independent from price strategies. The paper shows that the average high mark-up in the period was very likely due to the implementation of anti-competitive strategies, even though with limited consequences on prices due to the stranded costs compensation.

Therefore, in the Spanish case, the opening of the market without the prior increase in the number of market players did not, by itself, prevent manipulation.

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Security of supply and capacity support mechanism

André Rocha

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Disclaimer: The analysis and comments presented in this paper are entirely the author's responsibility and should not be associated to the official opinions of ERSE.

Abstract

The approach in this case study was to briefly analyze the Portuguese situation in what concerns to security of supply and capacity support mechanisms, in the short and long term. Firstly, the evolution of both peak load and generation capacity in Portugal are analyzed and put together with their future estimates. Simple indicators to evaluate the security of supply are analyzed and some considerations about the generation mix are carried out. Afterwards, the capacity support mechanism in Portugal is briefly described, while trying to perceive the existence of weak points and identifying possible opportunities for improvements in the design of the mechanism.

Keywords

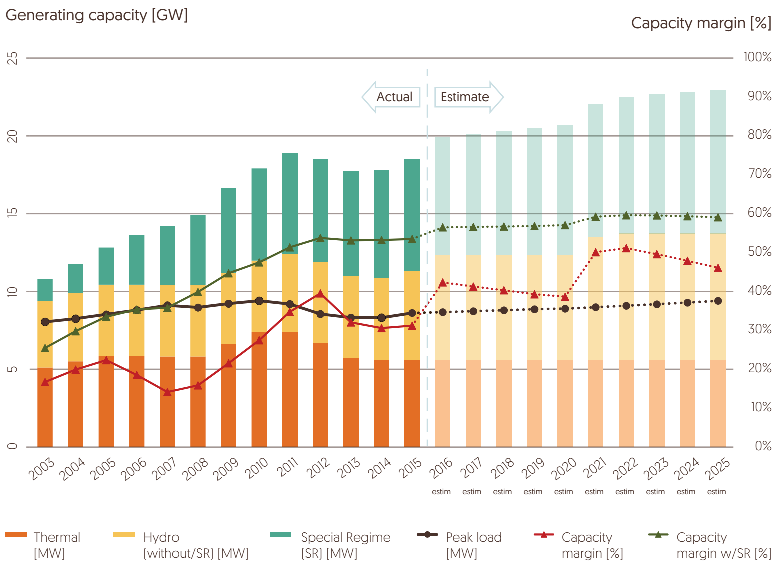
Competition in Electricity Generation - Security of Supply - Capacity Mechanism.

1. Introduction

The competition in electricity generation changes the dynamics for new investments. Under a monopoly the generation capacity is administered by the vertically integrated company through a central planning process, which determines the technologies and size of new generation units. With a cost of service regulation, this process enables the utility to recover investment costs, including a return on equity. In competitive electricity markets, the timing, size and technology of new generation investments is driven more by expectations of market prices and resulting profits. As a consequence electricity generation became a more risky business, with centralized planning being replaced by decentralized private investment decisions. In this context, doubts about security of supply have arisen, because the system reliability would probably not be fully sustained by competitive market prices. This lead some countries to implement incentives to ensure generation availability (short and medium term) and to support new investment in generation facilities (long term). In line with this concepts, a capacity support mechanism was introduced in Portugal since 2010. This paper includes a general description of this mechanism and a simple analysis of security of supply in Portugal.

2. Evolution of peak demand and generation capacity of electricity in Portugal

The following figure presents the evolution of thermal, hydro and special regime[1] generation capacity in Portugal, alongside with the peak load from 2003 to 2015. The estimates for future years until 2025 are also included, using the base scenario presented in the National Development and Investment Plan of the Electricity Transmission Network for 2016-2025 [1].



Source: REN [1], [2]

[1] In this paper the Special Regime generation corresponds to the plants that are not conventional thermal or hydroelectric plants (under the Ordinary Regime). Generally, the Special Regime generation is covered by feed-in tariffs (some exceptions may exist) and includes wind, mini-hydro, solar, biomass, waste, photovoltaics and cogeneration.

The capacity margin presented in the previous figure is defined as the remaining generation capacity in relation to the peak load. It is calculated as follows:

$$\text{Capacity Margin [\%]} = \frac{\text{Generation Capacity in MW} - \text{Peak Load in MW}}{\text{Generation Capacity in MW}}$$

Two generation capacities are considered for the calculation of the capacity margin: (i) only the dispachable thermal and hydro capacity and (ii) all technologies, including special regime generation, which is mainly non-dispachable capacity (renewables and cogeneration).

The peak loads until 2015 are the actual and for future years (2016 to 2025) the estimates for winter season in a base scenario for consumption[2] were considered [3].

From the analysis of the figure it can be concluded that:

- Considering the total generation capacity, the capacity margin is high. This occurs mainly due to back-up capacity being installed while the penetration of renewables is increasing;
- The capacity margin provided by dispachable plants increased significantly between 2007 and 2012, but then decreased until 2014, despite the decrease of peak load due to the decommissioning of old fuel plants;
- Security of supply in Portugal is highly dependent on hydro plants. This is not as critical, as the peak demand in Portugal occurs in winter, typically in January, February or December, when the inflows to hydro plants are higher and the levels of dams are usually stabilized in the upper half. The winter is also characterized by strong wind production, which attenuates this effect. A significant percentage of new capacity in Portugal will be reversible hydro plants (up to 80% of new hydro capacity between 2016 and 2025), giving the renewables, particularly wind generation, an augmented importance in terms of security of supply. However, a dependence on climacteric conditions will always exist when considering this capacity for security of supply purposes. It must also be noted that no new additional thermal capacity, neither decommissioning of existing thermal plants was considered in this scenario;

[2] This paper does not include analysis for extreme and low probability demand scenarios.

» The peak load has raised at a slower rate than the available conventional generation capacity. From 2015 onwards, the estimations for the evolution of peak load and conventional capacity (thermal and hydro) will lead to capacity margins between 35% and 50%.

3. Brief overview of the Portuguese capacity mechanism

Primarily, it must be distinguished that in Portugal the generation capacity is divided in the following groups, with respect to the remuneration schemes:

1. Power plants owned by the former incumbent (a small part of capacity was ceded until 2014 to other agents due to horizontal concentration), which were under PPAs (Power Purchase Agreement) until 2004. These plants actually bid their offers in the market but are subject to compensation mechanisms that ensure them the economical benefits that would have been obtained with the PPAs, if they were not attained through the revenues of the market[3];

2. Power plants still with PPAs, whose market participation is managed by a Public Commercial Agent, who is responsible for the compensation of the differences in the revenues obtained in the market environment and the ones calculated through the PPAs[4];

3. Special Regime generation, which do not participate in the market and are remunerated through feed-in tariffs;

4. Other Ordinary or Special Regime power plants not included in groups 1, 2 or 3, which bid their offers in the market.

Only some plants under the point 4 abovementioned are eligible to participate in the Portuguese capacity support mechanism. In its beginning, this capacity mechanism was designed in the context of a proposal from the Council of Regulators of the Iberian Market, which intends to promote an adequate level of harmonization between Portugal and Spain, in order to avoid distortions in the framework where agents decide their investments in generation capacity.

3 The costs with this mechanism are passed to consumers through access tariffs.
4 Equal to the previous footnote.

The Portuguese capacity mechanism is imposed by law and the prices to remunerate the available capacity have been determined by the Government, without a market mechanism, but taking into account generation technologies. The capacity mechanism entered into force in 2010 and was revised in 2012, which included a partial suspension for thermal plants during the Financial Assistance Program to Portugal.

The capacity mechanism currently in force[5] comprises the following incentives:

» Incentive to generation availability of thermal capacity, which is intended to ensure the short-term security of supply (usually referred as firmness). This incentive is applicable to existent thermal capacity and is secured by the thermal plant owners while the respective operating license takes effect;
» Incentive to investment in hydro capacity, which is intended to ensure the security of supply in the long term (usually referred as adequacy). It is applicable to a limited set of new hydro power plants (defined in the legal diploma mentioned in footnote 5) and is secured by the hydro plant owner for the first ten years of operation of the plant.

Both incentives are based on payments to net available capacity, with a fixed price for thermal plants and different prices for the eligible hydro plants. The remuneration for each plant is only materialized after a yearly check of the actual capacity available, which takes into account the capacity declaration of the plants, as well as the results of the available tests performed by the System Operator[6].

The costs with the capacity mechanism are included in the calculation of the revenues of the System Operator, which are recovered through the tariff of Global Use of the System (included in the Access Tariffs) supported by all consumers.

4. Weak points and possible improvements of the capacity mechanism in Portugal

In the design of a capacity mechanism the following ideas should be considered in order to promote efficient generation investments, as well as to try to induce market response to capacity needs. These ideas and principles may also be considered for future improvements of the Portuguese capacity support mechanism:

5 Established by Portaria no. 251/2012, of 21st August.
6 The availability tests are performed under the procedures defined in Portaria no. 172/2013, from 3rd May.

1. Relation between capacity payments and evolution of market prices - the promotion of efficient investments will contribute to better functioning of the market, reducing the marginal cost of peak plants, as well as possibly mitigating market power. Although these mechanisms should not cause distortions in the market prices, the need to implement or review capacity mechanisms may come from market indicators that can be related with capacity issues: (i) abnormally high market prices may indicate short-term scarcity of capacity and these mechanism should prevent this situation, though preventing highly volatile market prices; (ii) abnormally low market prices may indicate short-term excess of capacity;

2. Strategic behavior of agents, especially those with higher market power – the effect in market prices may not be fully connected to the prices offered by the new capacity. As the producer surplus of a company with high generation share may be severely affected by a new entrant, particularly if it is able to reduce the market price in several hours, a strategy to recover that producer surplus may be put in place;

3. Capacity payment should reflect the opportunity cost of the investments – if the capacity payment is determined in capacity markets or in public auctions, that can be dependent on the generation technology, the opportunity cost is incorporated by the agents in the price offered. However, if it results from an administrative decision this is not ensured;

4. Reliability is also dependent on technology diversity – different capacity payments per technologies are desirable because the fixed costs, lifetime, yearly hours and ability to recover the costs in market are different for each technology. This will also promote a more heterogeneous generation mix;

5. Uncertainty in capacity payments – if the mechanisms have strong administrative dependence to calculate and materialize the payments, a greater risk is perceived by investors and the effectiveness of the mechanism may be reduced;

In Portugal the capacity mechanism may lack for considering these issues. As it started recently and currently less than 30% of the Ordinary Regime generation capacity is benefiting (due to other compensation mechanisms), possible long term effects can arise, such as too homogeneous generation mix (with a high share of hydro), scarcity of dispachable capacity or low competition in the generation activity. Also the strong dependence from administrative decisions introduce high uncertainty in the legal and economic framework for new capacity investments. On the other hand, free riding[7] has been mitigated since the costs with this mechanism are charged in access tariffs, particularly in the price of a component derived by peak energy consumption, giving a correct economic signal.

Additionally, in the way to the Internal Market, the European framework for the electric sector may evolve to an harmonization on capacity support mechanisms or even to an approach to security of supply on a Regional or European basis. Currently, the policies for the development of transmission networks is focused on obtaining a minimum level of interconnection capacity (10%), either for security of supply reasons and to maximize the capability to collect generation from renewable sources. Though, in this scenario of Regional approach, the security of supply will have to be assessed taking into account not only the evolution of generation capacity, but also the evolution of network interconnection capacities between the involved countries.

In a longer time horizon, the role in security of supply of demand flexibility is other area for further investigation. If users do respond to price signals, especially when these signals are strong enough to properly reflect the effects of capacity constraints, the role of demand flexibility should be envisaged and encouraged in the scope of security of supply. Moreover, demand flexibility may have other significant positive effects, mainly those related to network savings (reduce network capacity and though network investments, reduce network losses);

Conclusions

In Portugal, the capacity support mechanism entered into force in 2010, to promote an adequate evolution of generation capacity in the short and long term, that ensure security of supply levels that cannot be guaranteed by the normal functioning of the wholesale electricity market and by the previous framework for the activity of electricity generation.

As other compensation mechanisms still exist for approximately 70% of the Portuguese Ordinary Regime generation, only the 30% benefit from the capacity support mechanism in place and though its effectiveness is dependent on this share. At the beginning, this mechanism is supposed to induce availability of existent capacity and investments in new capacity, regardless of the technology (hydro or thermal). However, the changes introduced in the mechanism in 2012 directed the firmness issue to thermal capacity and

[7] Particularly by those consumers that may significantly influence peak load and, simultaneously, require higher levels of security and quality of supply.

the adequacy issue to hydro capacity, which can lead to an increased unbalance between thermal and hydro capacity in the long term. This may raise some concerns on security of supply, considering the dependence on climacteric conditions of hydro generation in Portugal and the old age of some thermal power plants.

With respect to the costs with the capacity mechanism, currently they are being charged to peak load consumers through the Access Tariffs, which can be considered a cost-reflective approach.

The introduction of the capacity mechanism in Portugal also intended to harmonize the framework where Iberian agents decide their investments in generation capacity, in order to avoid distortions between Portugal and Spain. This can be seen as a first step for a wider approach to security of supply issues that may evolve for a European or Regional perspective. However this wider approach must consider not only the generation capacity of the concerned countries, but also the capacity of network interconnections between them.

Some weak points and principles for possible improvements of the Portuguese capacity mechanism were pointed out. Particularly, the lack of a market mechanism to define the price of capacity payments and the need to envisage the relevance of demand flexibility on security of supply are aspects for further analysis in future developments.

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As Competências das Entidades Reguladoras Setoriais na Área da Resolução Alternativa de Litígios – O Caso da ERSE

Eugénia Alves

Artigo baseado na Dissertação de Mestrado, apresentada com o mesmo título, na Faculdade de Direito da Universidade Nova de Lisboa, em março de 2014, sob a orientação do Professor Doutor Jorge Morais Carvalho e da Professora Doutora Vera Eiró.

Resumo

A ERSE integra a chamada Administração Pública independente. Quando exerce os seus poderes de regulação, de regulamentação, de supervisão e de fiscalização, bem como as suas competências sancionatórias, estaremos perante funções formal e materialmente administrativas. Mas se o Terceiro Pacote Energético aponta, por um lado, para um reforço da independência dos poderes das entidades reguladoras nacionais, por outro lado, incumbe os Estados-membros de assegurarem medidas para a proteção dos consumidores, incluindo a existência de mecanismos independentes para o tratamento de reclamações e a resolução de litígios, expressamente classificados como extrajudiciais. Na Resolução Alternativa de Litígios (RAL), a ERSE não decide, não impõe, assiste e ajuda, imparcialmente, as partes em litígio a encontrarem uma solução para o caso concreto.

Palavras-chave

Regulação - Poderes - Litígios - Mediação.

Introdução

Ao lado da regulação dita económica, vigiando e corrigindo o funcionamento do mercado, a regulação pública, da responsabilidade última do Estado, abraça também a missão de proteger os direitos dos consumidores e utentes dos serviços de interesse económico geral. Este tipo de regulação social, em conjunto com a regulação económica, ditam um novo modelo de relacionamento entre o Estado e a sociedade e o mercado, através do qual o Estado deixa de intervir diretamente no mercado como operador e prestador de serviços, mas continua a ser o responsável pela garantia da prossecução do interesse público.[1] Crescem, neste âmbito, as preocupações das entidades reguladoras setoriais em relação aos interesses particulares dos consumidores, disponibilizando-lhes informação sobre os seus direitos, prevenindo conflitos e ajudando na sua resolução.

Importa, neste contexto, circunstanciar, desde logo, a integração das entidades reguladoras setoriais, no caso em apreço a ERSE, na organização administrativa do Estado, visando compreender que espécie de pessoa coletiva pública é a ERSE e que tipo de funções é chamada a exercer, analisando as suas atribuições e competências em face do princípio constitucional de separação de poderes (capítulo 2). O Capítulo 3 será dedicado a uma identificação dos meios utilizados na resolução extrajudicial de conflitos, em especial a mediação, a conciliação e a arbitragem. Uma vez caracterizada a ERSE enquanto pessoa coletiva pública e apresentados os principais elementos que compõem a chamada RAL, procura-se suscitar uma discussão sustentada sobre a atuação da ERSE na resolução extrajudicial e voluntária de conflitos emergentes das relações comerciais e contratuais estabelecidas com os consumidores de energia (Capítulo 4).

1. Enquadramento da ERSE na Organização Administrativa do Estado

Diogo Freitas do Amaral define organização administrativa do Estado como o "modo de estruturação concreta que, em cada época, a lei dá à Administração Pública, de um dado

[1] Pedro Costa Gonçalves (2013, pp.11-16) qualifica-o de "Estado Regulador e de Garantia".

país".[2] A teoria geral da organização administrativa do Estado assenta em três grupos de ideias: o conhecimento dos elementos que compõem essa mesma organização, onde se integram os conceitos de pessoa pública e de serviço público; os sistemas de organização possíveis ou consagrados e os princípios constitucionais que regulam a organização administrativa.[3]

Entre as várias categorias de pessoas coletivas públicas, conceito nem sempre consensual na doutrina, podemos encontrar três grandes tipos: as pessoas coletivas públicas de população e território, como sejam o próprio Estado, as Autarquias locais e as Regiões Autónomas; as do tipo institucional, onde se incluem os institutos públicos e as entidades públicas empresariais; as do tipo associativo, correspondendo às associações públicas.[4]

A ERSE é uma pessoa coletiva pública, assim qualificada pela própria lei. É de tipo institucional, dotada de personalidade jurídica e de autonomia administrativa, financeira e patrimonial. A atribuição de um estatuto de independência às entidades reguladoras, como a ERSE, suscita a inevitável questão de saber onde se inserem as mesmas, no quadro da organização administrativa do Estado.

Na administração direta, os fins do Estado são prosseguidos pelos seus próprios órgãos ou serviços, que se submetem ao poder hierárquico do Governo.[5] Na administração indireta, a realização dos fins do Estado fica a cargo de entidades dotadas de personalidade jurídica, mas sujeitas à orientação e superintendência do Governo.[6] O substrato institucional das entidades administrativas em apreço poderia conduzir-nos à sua inclusão na administração indireta do Estado, subsumindo-as à figura de instituto público.[7] Vital Moreira e Fernanda Maçãs sustentam que dado o caráter independente das entidades reguladoras, a sua existência importa uma derrogação do regime comum dos institutos públicos, designadamente pela ausência de superintendência por parte do poder executivo e pela reduzida tutela a que se submetem.[8] A existência de independência orgânica e funcional tem vindo a favorecer o conceito de administração independente, como uma nova espécie de Administração Pública.

[2] Diogo Freitas do Amaral, 2012, p.749.
[3] *Idem*, pp.749-750
[4] *Idem*, p.756
[5] José Lucas Cardoso, 2007, p. 18.
[6] *Idem*.
[7] João Caupers (2009, p. 124) parece integrar os institutos reguladores na administração indireta ou instrumental do Estado, ainda que mais à frente (pp.220-223) defenda que as mesmas entidades dispõem de um estatuto de autonomia em relação ao Governo.
[8] Vital Moreira e Fernanda Maçãs (2003, pp. 258-260), na nota justificativa do projeto de lei-quadro sobre os institutos públicos.

Em suma, a ERSE assume-se como uma entidade administrativa, de natureza institucional, integrada na Administração Pública, mas com características de independência orgânica e funcional perante o poder executivo. Desenvolve uma atividade que visa a realização de fins diretamente atribuídos ao Estado, ainda que específicos.[9] Exerce uma função formal e materialmente administrativa, no âmbito da qual executa e implementa regras jurídicas aprovadas pelo poder legislativo, sem prejuízo da identificação de poderes "quase legislativos", através da aprovação de regulamentos ou ainda de poderes "quase judiciais". A natureza definitiva das decisões da ERSE, apenas impugnáveis judicialmente, bem como dos poderes de investigação, de inspeção e sancionatório, convergem ainda na classificação da ERSE como "autoridade pública". A estabilidade dos mandatos dos dirigentes da ERSE, os seus conhecimentos técnicos e o reconhecimento do seu profissionalismo contribuem para a defesa de uma certa neutralização, procurando escapar à influência das maiorias partidárias no âmbito do poder político. A eficácia e a eficiência são objetivos que prevalecem sobre o mero cumprimento formal e estrito da lei, em busca de resultados que melhor satisfaçam as necessidades coletivas públicas.[10]

A concentração dos poderes descritos e outros num só organismo administrativo suscita a sua compatibilidade constitucional, desde logo no quadro da organização do poder político, baseada no princípio da separação e interdependência de poderes.[11] As competências das entidades reguladoras independentes que protagonizam esta questão conduzem à necessidade de comparação entre o poder regulamentar e a função legislativa, por um lado, e da função administrativa com a função jurisdicional, por outro lado. A aprovação de regulamentos encontra-se delimitada pelas correspondentes normas habilitantes, não constituindo qualquer ameaça à reserva do poder legislativo.[12] Se a criação do direito pertence ao legislador, aos tribunais cabe a interpretação e a aplicação do direito.[13] A função jurisdicional é conferida pela Constituição da República Portuguesa aos tribunais, cabendo-lhes designadamente a resolução de conflitos de interesses públicos e privados. Todavia, também a função administrativa pode integrar a resolução de conflitos de interesses e a fronteira entre estas duas funções nem sempre é fácil de alcançar. Alguma doutrina situa certas atividades das entidades administrativas independentes "a meio caminho" entre as duas funções.[14] Vital Moreira chegou a considerar

[9] O artigo 81.º da Constituição da República Portuguesa, em especial as alíneas f) e i), atribui ao Estado, respetivamente o dever de assegurar o funcionamento eficiente dos mercados e o dever de garantir a proteção dos direitos e interesses dos consumidores.

[10] Pedro Gonçalves (2008a, p.29) defende, por esta razão, uma certa retração do princípio da legalidade administrativa.

[11] Artigos 2.º e 111.º da Constituição da República Portuguesa.

[12] Neste sentido, Marcelo Rebelo de Sousa e André Salgado de Matos, 2008, pp. 138 e 139.

[13] Para Maria Lúcia Amaral (2005, p.159), o cerne da separação de poderes reside nesta afirmação. O artigo 209.º da Constituição da República Portuguesa elenca as várias categorias de tribunais.

[14] Neste sentido, Vital Moreira e Fernanda Maçãs, 2003, pp.40 e 41.

as mesmas entidades como instâncias parajudiciais que, de algum modo, podem constituir uma alternativa ao poder jurisdicional, legitimando a sua atuação na independência e na imparcialidade. Marcelo Rebelo de Sousa e André Salgado de Matos referem a existência de uma "zona cinzenta" entre as duas funções, classificando esta prática da Administração como "atos administrativos judicativos".[15] Já Pedro Gonçalves considera a resolução de litígios da responsabilidade das entidades reguladoras independentes uma competência de natureza administrativa, que pretende servir um interesse público, ainda que o mesmo possa trazer benefício para os interesses privados presentes no litígio.[16] Neste contexto, Maria Fernanda Maçãs identifica uma diversidade de tipos de litígios regulatórios decorrentes quer de relações jurídico-administrativas quer do direito privado, inserindo neste último domínio os litígios entre consumidores e as entidades reguladas.

No caso particular da ERSE, a imposição de uma compensação aos consumidores de energia por incumprimento de padrões de qualidade de serviço, a resolução de litígios entre o operador da rede de transporte e empresas verticalmente integradas ou o julgamento de ilícitos de mera ordenação social, constituem procedimentos suscetíveis de ser indiciados como fazendo parte da função "jurisdicional". Mas em todas estas "decisões" a última palavra pertencerá sempre aos tribunais, de competência comum ou especial, consoante a natureza do ato da ERSE em causa, sempre como única instância de recurso para a atuação desta entidade reguladora.

2. A Resolução Alternativa de Litígios

A resolução alternativa de litígios (RAL), na expressão inglesa ADR, surge nos Estados Unidos da América na sequência de movimentos que visavam um acesso universal à justiça e de crítica ao sistema jurídico existente.[17] Aparecem por força da incapacidade de resposta dos tribunais judiciais, designadamente a alguns litígios emergentes das relações entre particulares. Os tribunais foram instituídos como a sede socialmente legítima para a resolução de litígios, fruto do próprio princípio do Estado de Direito. Sabe-se, no entanto, que o recurso a meios alternativos, como a mediação e a arbitragem, precedem historicamente o funcionamento dos tribunais.[18] Em Portugal, a institucionalização dos meios de RAL, em

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15 Marcelo Rebelo de Sousa e André Salgado Matos (2008, p. 137) classificam estes atos administrativos judicativos como um híbrido de atos administrativos e jurisdicionais.

16 Pedro Gonçalves (2008b, p.48) chama-lhes "poderes administrativos novos".

17 Foi o caso do pensamento *Critical Legal Studies* seguido na Universidade de Harvard, na década de 1970, conforme refere Sílvia Barona Vilar, 1999, p. 44.

18 Neste sentido, Luís Melo Campos, 2008, p. 9.

particular da mediação de conflitos, tem lugar no último decénio do século XX, também como consequência da procura de respostas à crise da justiça, quer pela quantidade e morosidade dos processos judiciais, quer pela necessidade de serem encontradas soluções adequadas a certos conflitos.[19] Este movimento em defesa da RAL, em vários países da Europa e nos Estados Unidos da América começou a ter eco nas próprias instâncias normativas da União Europeia, sendo as mais recentes iniciativas concretizadas através da Diretiva 2013/11/UE do Parlamento Europeu e do Conselho, de 21 de maio, relativa à RAL de consumo e do Regulamento (UE) 524/2013, do Parlamento Europeu e do Conselho, também de 21 de maio, sobre a RAL de consumo em linha. A referida diretiva foi já transposta para o ordenamento jurídico português mediante a Lei n,º 144/2015, de 8 de setembro, pretendendo assegurar que os consumidores possam apresentar voluntariamente queixas junto de entidades que façam uso de procedimentos de RAL.

As características apontadas à grande maioria dos meios de RAL são a voluntariedade, a consensualidade e a procura da conciliação dos interesses das partes em diferendo, ressalvando-se o caráter adjudicatório da arbitragem voluntária, decorrente da decisão atribuída a um terceiro (o árbitro). A fronteira concetual entre os vários meios de RAL nem sempre é fácil de traçar, mas procurar-se-á neste capítulo autonomizar os meios mais frequentemente utilizados: a mediação, a conciliação e a arbitragem.

Mediação

Apenas a Lei n.º 29/2013, de 19 de abril, que veio estabelecer os princípios gerais aplicáveis à mediação realizada em Portugal, bem como os regimes jurídicos da mediação civil e comercial, dos mediadores e da mediação pública, inclui uma definição explícita do conceito de mediação.[20] Trata-se de um processo organizado de resolução de litígios, no qual as partes envolvidas são as únicas responsáveis pela obtenção de uma solução para o seu diferendo, por acordo, ainda que assistidas por um terceiro imparcial. É costume a doutrina distinguir mediação facilitadora de mediação interventora, consoante o mediador não tenha ou tenha a possibilidade de propor soluções às partes no decorrer do processo. Os defensores de uma participação mais ativa do mediador fazem ressaltar que as propostas do mediador não põem em causa o poder de decisão[21], que caberá

[19] Mariana França Gouveia, 2012, p. 28.

[20] O artigo 2.º, alínea a) define mediação como "a forma de resolução de litígios, realizada por entidades públicas e privadas, através da qual duas ou mais partes em litígio procuram voluntariamente alcançar um acordo com assistência de um mediador de conflitos".

[21] Este caráter mais interventivo é considerado por outros como sendo já conciliação, na medida em que propõe soluções. A este respeito, Dário Moura Vicente (2005, p. 390) situa a fronteira entre mediação e conciliação na diferença de grau de intervenção do terceiro, respetivamente menor e maior.

sempre e unicamente às partes. Para garantir a confidencialidade, um dos princípios estruturantes do processo de mediação, o mediador precisa de ser independente, imparcial e neutral em relação às partes, não devendo deter qualquer interesse pessoal ou profissional, direto ou indireto e económico no conflito ou sobre qualquer uma das partes.[22] Podem ser diversos os papéis desempenhados pelo mediador de conflitos: um gestor do processo; um legitimador do processo e do que nele se decide; um facilitador da comunicação entre as partes e um educador, principalmente quando as partes acusam uma insuficiência de experiência negocial.[23]

Em resumo, a mediação é um procedimento de RAL que assenta na vontade das partes, ainda que assistidas por um terceiro (o mediador) independente e imparcial. Visa restabelecer o relacionamento entre as partes, quebrado pelo litígio e é, em regra, confidencial. O domínio das partes não impede que o mediador possa propor ou sugerir opções de solução para o litígio, cabendo às partes a última palavra.

Conciliação

A conciliação é um meio de RAL, voluntário, pois assenta na autonomia da vontade das partes e pretende conduzi-las à obtenção de um acordo como forma de resolver o conflito que as opõe. Qualquer tentativa para definir o conceito de conciliação passa habitualmente pela comparação deste procedimento com o da mediação.

Para muitos autores, é na proposta de soluções que reside a principal diferença entre a conciliação e a mediação, esta última mais facilitadora do diálogo entre as partes, com vista à obtenção do acordo, mas sem sugerir soluções.[24] Em sentido diverso, Catarina Frade reconhece no conciliador um papel menos ativo do que o conferido ao mediador.[25] De acordo com este entendimento, na conciliação caberá ao terceiro apenas conduzir as partes no processo de restabelecimento do contacto, sem sugerir qualquer solução concreta para o litígio.

Em suma, a conciliação é um procedimento de RAL, voluntário que procura aproximar as partes com vista à obtenção de um acordo sobre a resolução do litígio. O terceiro

22 Neste sentido, veja-se nomeadamente os artigos 21.º, 30.º e 35.º da Lei n.º 78/2001, de 13 de julho (julgados de paz) e o n.º 2.1 do Código Europeu de Conduta para Mediadores (tradução portuguesa disponível em (http://www.dgpj.mj.pt/sections/gral/mediacao-publica/mediacao-anexos/codigo-europeu-de/).

23 Luís Melo Campos, 2008, p. 14.

24 Cf. Joana Paixão Campos, 2009, p. 8.

25 Catarina Frade, 2003, pp. 107-128.

que assiste as partes até pode dispor de poder de decisão sobre o caso concreto, mas enquanto conciliador apenas deve proporcionar a harmonização das partes, sem recomendar ou propor uma solução.

Arbitragem

A arbitragem distingue-se dos restantes meios de RAL pelo seu caráter adjudicatório, pois atribui a um terceiro (o árbitro) o poder de decidir qual a solução para um litígio, vinculativa para ambas as partes. Estas características tornam a arbitragem o mecanismo de RAL mais próximo do sistema judicial tradicional, salvo no que se refere à vontade das partes como pressuposto da arbitragem, no caso de esta ser voluntária.

São conhecidas duas espécies de arbitragem voluntária: a arbitragem *ad hoc* e a arbitragem institucionalizada. Diz-se *ad hoc* quando o tribunal arbitral é constituído especificamente para dirimir um determinado litígio, extinguindo-se após a decisão arbitral. A arbitragem institucionalizada pressupõe a existência de uma entidade, habitualmente uma pessoa coletiva de direito privado, que, com caráter de permanência, organiza e realiza a atividade de arbitragem voluntária, regendo-se por um regulamento próprio. A existência jurídica e o funcionamento dos centros de arbitragem institucionalizada dependem de autorização do Ministério da Justiça, obedecendo ao disposto no Decreto-Lei n.º 425/86, de 27 de setembro.

A manifestação da vontade das partes traduz-se na celebração da convenção de arbitragem cujo efeito é a constituição de uma jurisdição alternativa ao tribunal judicial.[26] A convenção de arbitragem pode apresentar-se sob uma de duas modalidades: o compromisso arbitral que tem por objeto um litígio atual e a cláusula compromissória, que incide sobre litígios que eventualmente decorram de uma relação jurídica. Na procura da interpretação mais conforme ao espírito do legislador, alguns autores[27] consideram que a convenção de arbitragem, inserida em contratos (cláusula compromissória) celebrados com consumidores finais, deve permitir a escolha por parte do consumidor entre propor ação judicial ou recorrer à arbitragem.

Este entendimento poderá ter estado na origem da figura da arbitragem necessária aplicável aos conflitos de consumo emergentes da prestação dos chamados serviços

[26] Para Paula Costa e Silva (2009, pp. 34-36) a alternatividade subjacente à RAL só existe na comparação entre tribunais judiciais e tribunais arbitrais, enquanto meios funcionalmente equivalentes.
[27] Neste sentido, Mariana França Gouveia, 2012, p.110-112.

públicos essenciais, introduzida pela Lei n.º 6/2011, de 10 de março.[28] De acordo com o estabelecido no artigo 15.º, nº 1 da lei dos serviços públicos essenciais: "Os litígios de consumo no âmbito dos serviços públicos essenciais estão sujeitos a arbitragem necessária quando, por opção expressa dos utentes que sejam pessoas singulares, sejam submetidos à apreciação do tribunal arbitral dos centros de arbitragem de conflitos de consumo legalmente autorizados".

São pressupostos da aplicação desta forma apelidada de arbitragem necessária: a existência de litígios emergentes de uma relação de consumo; no âmbito da prestação de um serviço público essencial; que o litígio seja submetido à intervenção de um dos centros de arbitragem de conflitos de consumo devidamente autorizados, já previamente existentes; mediante a opção expressa do consumidor, assim entendido nos termos do disposto no artigo 2.º da lei de defesa do consumidor.[29]

Esta decisão legislativa não é de todo consensual, questionando-se, desde logo, a obrigação de recurso à forma de arbitragem prevista. A submissão de um litígio à arbitragem não deve impedir o acesso aos tribunais judiciais, enquanto direito constitucionalmente consagrado, sem prejuízo de ser legalmente conferida à decisão arbitral valor equivalente ao da sentença judicial. Discute-se ainda a compatibilidade da obrigação de recurso perante o regime da arbitragem voluntária, seguido pelos referidos centros de arbitragem de conflitos de consumo. Na situação em apreço, apenas o consumidor beneficia do princípio da voluntariedade, basilar da correspondente forma de arbitragem, assentando na convenção celebrada entre as partes.[30]

Pode concluir-se que apenas a arbitragem voluntária deve ser identificada como procedimento de RAL, baseada na vontade das partes envolvidas. O recurso obrigatório aos centros de arbitragem de conflitos de consumo, por vontade unilateral do consumidor, ainda apresenta muitas dúvidas, tanto mais que, uma vez submetido o litígio ao tribunal arbitral seguir-se-á o regime previsto para a arbitragem voluntária.

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[28] Esta lei procedeu à terceira alteração à Lei n.º 23/96, de 26 de julho, que criou no ordenamento jurídico alguns mecanismos destinados a proteger os utentes de serviços públicos essenciais.

[29] Lei n.º 24/96, de 31 de julho, alterada pela Lei n.º85/98, de 16 de dezembro, pelo Decreto-Lei n.º 63/2003, de 8 de abril e pela Lei n.º 10/2013, de 28 de janeiro.

[30] Paula Costa e Silva (2009, p. 114) denomina estes casos de "arbitragem putativamente voluntária", manifestando a sua posição no sentido de a competência de um tribunal arbitral dever fundar-se na vontade das partes, através da celebração da convenção de arbitragem, o que não sucede quando uma das partes é constrangida a aceitar uma determinada jurisdição arbitral.

3. As Competências da ERSE na Resolução Alternativa de Litígios

O artigo 20.º dos estatutos[31] da ERSE estabelece o seguinte:

1. "No exercício das suas competências em matéria de resolução de conflitos entre os operadores sujeitos à regulação da ERSE, ou entre eles e os seus clientes ou terceiros, cabe à ERSE:

   a) Efetuar ações de conciliação e mediação ou promover o recurso à arbitragem sempre que tal esteja previsto na lei ou mediante solicitação dos interessados;

   b) Tomar conhecimento das queixas dos clientes e adotar as providências necessárias, nos termos da lei."

Em complemento, o artigo 22.º dos mesmos estatutos prevê:

1. "Compete à ERSE fomentar a arbitragem para a resolução de litígios emergentes dos contratos entre as entidades intervenientes nos setores regulados e os comercializadores no âmbito do fornecimento de energia, assegurando aos consumidores os meios para a sua realização.

2. A arbitragem referida no número anterior tem a natureza prevista no artigo 15.º da Lei n.º 23/96, de 23 de julho, e segue, subsidiariamente, os termos da lei da arbitragem voluntária previstos na Lei n.º 63/2011, de 14 de dezembro."

De acordo com estes preceitos estatutários, as competências da ERSE no domínio da RAL parecem assentar em duas grandes atividades. Por um lado, a realização de ações de mediação e conciliação e, por outro lado, a promoção do recurso à arbitragem.

Analisemos primeiramente as razões que motivaram a lei à inclusão da mediação e da conciliação entre as competências da ERSE. Na procura de tais causas foram identificados, designadamente, diretrizes do direito europeu da energia, disposições legais e regulamentares nacionais, bem como uma experiência acumulada pela ERSE de intervenção no domínio da RAL.

[31] Aprovados em anexo ao Decreto-Lei n.º 97/2002, de 12 de abril, com as últimas alterações introduzidas pelo Decreto-Lei n.º 84/2013, de 25 de junho, que também procedeu à sua republicação.

No primeiro grupo de situações, encontram-se a Diretiva 2009/72/CE e a Diretiva 2009/73/CE, ambas de 13 de julho de 2009 e relativas, respetivamente, aos mercados internos de eletricidade e de gás natural. As citadas diretivas europeias determinam a adoção pelos Estados-membros de mecanismos independentes para a resolução de conflitos com os consumidores, os quais devem ser transparentes, simples, baratos e de natureza extrajudicial.

Em sede de transposição dos ditames europeus para o ordenamento jurídico nacional, destacam-se as últimas alterações introduzidas às chamadas leis-base[32] dos setores da eletricidade e do gás natural, respetivamente pelo Decreto-Lei n.º 215-A/2012, de 8 de outubro e pelo Decreto-Lei n.º 230/2012, de 26 de outubro. Estes diplomas reiteram os direitos dos consumidores de energia sobre o recurso a procedimentos independentes e acessíveis de resolução de conflitos, como ainda obrigam os comercializadores a disponibilizar e a especificar os meios a utilizar para o efeito nas próprias condições contratuais.

Sobre a experiência da ERSE como entidade que intervém na RAL salienta-se como facto relevante a adoção de um regulamento sobre a mediação e a conciliação de conflitos realizadas pela ERSE.[33] Este regulamento veio assim estabelecer as regras aplicáveis aos procedimentos de mediação e conciliação de conflitos emergentes do relacionamento comercial e contratual, estabelecido nomeadamente entre os consumidores de eletricidade e de gás natural e os prestadores destes serviços, fixando as várias fases do processo de resolução de conflitos (iniciativa, avaliação preliminar, instrução e cessação). O mesmo regulamento permitiu ainda a inscrição da ERSE enquanto entidade que intervém na resolução de conflitos de consumo junto do então Instituto do Consumidor[34], ao abrigo do sistema de registo voluntário criado pelo Decreto-Lei n.º 146/99, de 4 de maio e regulamentado através da Portaria n.º 328/2000, de 9 de junho.

Sobre a legitimidade da ERSE na realização de ações de mediação e de conciliação de conflitos, entra-se inevitavelmente na discussão sobre a aplicação do princípio da legalidade administrativa. Parece reconhecer-se que o aparecimento das entidades administrativas independentes tem contribuído para o enfraquecimento daquele princípio, permitindo alguma ingerência das normas de direito privado na função administrativa.[35]

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[32] Decreto-Lei n.º 29/2006 e Decreto-Lei n.º 30/2006, ambos de 15 de fevereiro, complementados respetivamente pelos Decretos-Lei n.º 172/2006 e n.º 140/2006.

[33] Aprovado pelo Conselho de Administração da ERSE através do Despacho n.º 22 674-A/2002, de 29 de janeiro (Diário da República, 2.ª série, n.º 244).

[34] Este Instituto foi integrado na administração direta do Estado, com a designação de Direção Geral do Consumidor, através da Resolução do Conselho de Ministros n.º 39/2006, de 30 de março, no âmbito do Programa de Reestruturação da Administração Central do Estado.

[35] Paulo Otero, 2011, pp. 317-323.

Assim, sempre com subordinação à lei, permite-se, deste modo, uma intervenção de entidades administrativas no relacionamento inter-privados. Esta teoria também não ficará isenta de controvérsia se a confrontarmos, designadamente, com o dever de realização do interesse público.

São muitas as querelas em redor da supremacia ou não do interesse público sobre os interesses dos privados, com a ressalva devida à proteção de direitos fundamentais dos cidadãos, onde se pode incluir, por exemplo, a confidencialidade da informação prestada ao abrigo de um procedimento de mediação ou de conciliação de conflitos.[36]

Nem sempre se consegue distinguir com a devida clareza as funções cometidas à ERSE, sem embargo de nos seus diversos papéis aquela entidade reguladora surgir funcionalmente estruturada em diferentes serviços. Ao abrigo da sua função administrativa a ERSE pode, por vezes, determinar que uma certa prática desenvolvida pelas entidades reguladas cesse os seus efeitos. Esta prática estaria a afetar os direitos individualmente considerados de alguns consumidores, mas também o interesse público subjacente à garantia de satisfação de necessidades coletivas e essenciais associadas ao consumo de energia.[37] Neste contexto, as reclamações apresentadas individualmente pelos consumidores lesados fundamenta a abertura dos correspondentes processos, através dos quais a ERSE interage com as partes e procura soluções particularmente aplicáveis a cada situação, sem que possa impô-las às partes.

Paralelamente, em face da inobservância de ditames regulamentares, a ERSE aprova, enquanto entidade administrativa, medidas que visem a correção de uma conduta irregular da entidade regulada objeto de reclamação.

Partindo desta separação de processos, poder-se-á então afirmar que a ERSE, na sua qualidade de mediador ou conciliador de conflitos entre os prestadores de serviços de fornecimento de energia e os seus consumidores, não estará a desempenhar uma função estritamente administrativa, no sentido de prática de atos administrativos, unilaterais, no exercício do poder administrativo.

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[36] A título de exemplo veja-se o Acórdão do Tribunal da Relação de Lisboa Proc. 2061/08.5PFLRS-A.L1-3], de 19 de outubro de 2011, disponível em http://www.dgsi.pt/jtrl.nsf/33182fc732316039802565fa00497eec/4b4398308c95655a8025792f004bb1d8?OpenDocument

[37] Esta afirmação surge inspirada nas Diretivas n.º 10/2012, de 5 de julho e n.º 7-A/2013, de 14 de maio, através das quais a ERSE veio a determinar a compensação aos consumidores de eletricidade lesados com irregularidades no funcionamento dos contadores multi-tarifa e posterior incumprimento dos deveres de informação previstos. A Diretiva n.º 7-A/2013 veio a ser impugnada judicialmente pela EDP Distribuição, S.A., correndo ainda os seus termos no tribunal administrativo competente.

Também já anteriormente se inferiu que a atuação da ERSE na RAL não se pode qualificar como função jurisdicional. O poder judicial não pode inclusivamente ser partilhado.[38]

É neste âmbito que se pretende situar a ERSE na esfera da mediação e da conciliação de conflitos, emergentes do relacionamento comercial e contratual em que assenta a prestação do serviço de fornecimento de eletricidade e de gás natural.

Paralelamente, a ERSE recebe da lei e dos seus próprios estatutos o dever de fomentar a arbitragem para a resolução de litígios decorrentes de relações jurídicas que se submetem ao Direito privado. A introdução da figura da arbitragem necessária, no âmbito da lei dos serviços públicos essenciais, reflete-se diretamente nas disposições legais especificamente aplicáveis aos setores de eletricidade e de gás natural.[39] Neste sentido, a ERSE tem estabelecido protocolos com os centros de arbitragem de conflitos de consumo existentes, tendo em vista a disseminação e recolha de informação relevante para a proteção dos direitos e interesses dos consumidores de energia, mas também a recíproca colaboração em matéria de resolução de conflitos.

Conclusão

As diversas competências atribuídas à ERSE colocam-na entre a realização dos deveres públicos propriamente ditos e a proteção dos direitos e interesses dos consumidores de energia, principalmente para com aqueles que, com menor liberdade e capacidade negocial enfrentam dificuldades no acesso aos serviços essenciais de fornecimento de eletricidade e de gás natural.

As assimetrias de informação e a complexidade técnica associada ao setor energético reclamam uma permanente vigilância do funcionamento do mercado, intervindo quando necessário, seja através do poder regulamentar, seja *a posteriori* na supervisão e na punição de comportamentos contrários à lei.

Em simultâneo, com maior ou menor protagonismo, a ERSE é diariamente chamada a participar de forma direta na vida dos consumidores de energia, ajudando-os na (re) conciliação com os seus prestadores de serviços e a garantir a satisfação regular e contínua das suas necessidades essenciais de eletricidade e de gás natural.

[38] Maria Lúcia Amaral (2005,p.155), numa interpretação que faz do princípio de separação de poderes, defende que só o poder judicial não pode ser um poder partilhado, enquanto os poderes legislativo e executivo devem ser inclusivamente controlados reciprocamente.

[39] Veja-se como exemplo o disposto no artigo 53.º, n.º 5 do Decreto-Lei n.º 215-A/2012.

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Energy, innovation and competition: how public policies coordination may contribute to a new energy model

Eduardo Teixeira[1] and Isabel Salavisa[2]

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Abstract

This paper is focused on the electricity market in Portugal but its main assertions regarding the industry are fairly replicable for the rest of the EU and other network industries. Recent developments in electricity showed two main trends: a relative success in vertical unbundling with an almost unchanged horizontal concentration; and a decrease in direct R&D expenditure across Europe.

In policy terms, change in the energy industry is taking place by combining a market efficiency approach (competition policy) with a long run dynamic efficiency approach (innovation policy). Although there is a general consensus on the fact that an effective

[1] ERSE, Rua Dom Cristóvão da Gama, 1 – 3.º, 1400-113 Lisbon, Portugal; eteixeira@erse.pt
[2] ISCTE-IUL, DINÂMIA-CET, Av. Forças Armadas, 1649-026 Lisbon, Portugal; isabel.salavisa@iscte.pt

strategy to redesign industry has to take into account the interdependencies of both approaches and aim at coordinating them in the framework of a coherent public policy, academic research in this area is still relatively scarce.

Due to the dramatic changes underway in the energy sector (renewable – RES- mainly) and its implications (system coordination, smart grids, electric vehicles), the measure of innovation cannot rely upon the conventional indicators based on R&D expenditure. Rather, it has to draw on the investment as a whole. Thus, in this paper the RES deployment is considered as a proxy to innovation in the sector and as the main focus of an innovation oriented energy policy.

The research in this paper follows some recent developments in the study of the structural change in the energy sector industrial organization along with the research more oriented to the innovation policies in the field of energy. The methodology consists of the critical assessment of policy results, both in market competition and industrial innovation.

The main conclusions of this paper point to the lack of evidence of a deterministic effect of competition policies, specially the model of liberalization, in the success of innovation policies in the energy industry. Nevertheless, some positive scale effects could be identified, suggesting that more concentrated market structures, through higher revenues, might affect innovation in a positive way. A positive effect of government actions in innovative activities is also suggested. Conversely, the impact on competition of innovation renewable oriented policies is not clear-cut in a European perspective. Taking the Iberian example, the paper concludes that policy coordination in the fields of innovation and competition might have a positive impact in promoting a new energy model.

Keywords

Energy Sector - Renewable Energies - Innovation Policy - Competition Policy - Policy Coordination.

1. The energy market in transition

The use of energy represents in today's world one of the main issues in human behaviour, with important consequences on the sustainable use of global resources. Until the 1970's, energy consumption grew almost with no restrictions once the price signals and externalities were not a significant driver to consumption decisions. However, the oil shocks and an increasing discussion on limited energy resources and global consequences of energy consumption on climate changes moved the discussion of strategic energy industry organization to a turning point.

Economies increasingly dependent on energy consumption for economic growth were particularly exposed to geopolitical crisis in energy sourcing and also to macroeconomic effects in their trade balance. This fact, together with environmental concerns, gave a new momentum to endogenous and renewable energy resources in the context of the energy industry redesign. New energy strategies oriented to sustainable economic growth are now a driver and a consequence of technological innovation. Likewise, process innovations are faced as a way to promote increased efficiency in the energy industry.

Although this change applies to the energy industry as a whole, the sectors with a higher dependency on network infrastructures were the ones in the restructuring process to be in the spotlight, due to their monopolistic structure. In fact, in the electricity and gas sectors in developed countries, namely in the European Union [EU], which use massive transmission and distribution infrastructures [grids], the model of vertically integrated monopolistic companies has been in transition into a competition in activities which are not natural monopolies. The electricity market, due to its own characteristics and broader consumption impacts is a clear-cut example in the energy restructuring process.

One of the main characteristics of deregulation model is the vertical unbundling of activities. The rationale was to separate those activities in which the market is not economically the more efficient approach from those that can benefit from the competition process. Due to the heavy investments needed and a cost structure which is scale determined, network activities are identified as natural monopolies[3], whereas generation and supply activities are considered competition areas.

Therefore, the energy industry restructuring process [Nakada, 2005], in particular in electricity, is relying on the following main characteristics:

» Clear separation of transport and distribution activities, which are considered to be natural monopolies and have to follow the rule of legal or ownership unbundling from generation and supply activities;

[3] Cost structures under natural monopolies verify the following property: $C[q1+q2] < C[q1]+C[q2]$, with C being the cost associated to provide qi. This means that the cost function is sub-addictive.

» Definition of the concept of third party access (TPA) to networks, with non-discriminatory tariffs commonly set under independent regulated mechanisms;

» Opening the generation and supply activities to competition with the abolishment of legal barriers to entry.

In this context of vertical unbundling of activities and market opening to competition it is also important to have an assessment of social welfare gains and losses from a new dynamics in the industry. In this sense it is clearly important to ensure that a vertical monopoly structure is not replaced by a new industrial organization in which companies may exert market power and retain the vast majority of economic surplus in spite of security of supply, investment levels and innovation. Therefore, the role of public policies of competition should include institutional arrangements and policy coordination fundamentals in order to address global challenges. Clearly, one of main concerns is to ensure a model in which short term market efficiency (a central concept in competition policy) and long term dynamic efficiency (a basic feature of innovation policy) are properly dealt with.

Although some academic discussions and the policy decisions point to the net positive benefit from the unbundling process, another perspective (Nardi, 2010) outlines the need for further economic evidence and proposes an empirical analytical approach to this issue, mainly with the concern of global policy coordination, including concerns with the macroeconomic effects of energy consumption, energy independence and climate change.

As this paper focus on the electricity market as a pragmatic example of energy restructuring process and this process is partly a consequence of the sustainable development debate, the example of Portugal is straightforward. In fact, the Portuguese energy sector is characterized by a heavy foreign dependency of the energy consumption (with substantial repercussion in the country's trade balance) and this consumption has relied mainly on fossil fuel usage (with environmental consequences).

Energy policy developments in Portugal have been shaped by EU perspective of internal energy market as core of policy design. As EU set a global objective of reducing the energy dependency, improvements in energy usage efficiency were a clear purpose in order to reduce the energy intensity of the economy. Significant improvements in EU global energy efficiency were achieved from 1995 to 2008, with distinct evolutions across sectors – impressive in industry, agriculture and services and less significant in transport and household.

In Portugal, although the global energy policy goals were in line with EU policy targets, the national energy intensity index proved to be diverging from Europe until 2005. The growth of energy consumption was the main driver of the Portuguese performance in 1995-2005, namely in the end user subsector, fostering high levels of energy dependency. In fact, apart from hydro electricity generation and other renewable sources, Portugal imports all of the remaining primary energy consumed, with the largest part of it being oil.

As a result of that, Portugal adopted a strategy of energy diversification, especially with the introduction of natural gas in the country in the beginning of the 1990's and, afterwards, with the strong political will to ensure higher levels of energy efficiency and significant penetration of renewable[4] and endogenous sources. This goal (reduction of energy dependency) was considered one of main targets in the national energy strategy, pointing to a switch in the energy model towards a more economic and environmentally sustainable energy industry.

In the case of natural gas, its introduction permitted also some achievements in terms both of greenhouse gas (GHG) emissions and environmental sustainability according to the national compromises under Kyoto, through its lower emissions of carbon dioxide (CO_2), and fuel diversification. By the end of the 1990s, a strong investment in gas fired electricity generation plants suited to substitute old and heavy polluting fuel-oil plants took off, contributing to obtain efficiency gains and lower CO_2 emissions.

The contribution to a higher penetration of renewable energy sources (RES) is mainly based on wind, which alone accounts for nearly 50% of the renewable sources growth throughout the decade 2000-2009.

In terms of market arrangements, the Portuguese electricity market follows the EU framework for the internal energy market: full ownership unbundling of transmission network and legal unbundling of distribution networks; TPA and use of networks (transmission or distribution) under regulated tariffs set by and independent regulatory authority.

Competition issues follow institutional arrangements under which structural conditions (ex-ante regulation) are mostly set by the energy regulatory authority, following the legal framework, and behavioural aspects of competition are mostly scrutinized by the national competition authority, who also decides on mergers and acquisitions in the industry upon non-binding advice of the energy regulatory authority.

[4] Renewable sources in this classification include traditional hydro electricity generation and new resources such as wind, solar and geothermal power.

2. Combining the two perspectives: competition and innovation

NeocClassical competition models take the efficiency subject in a quite static approach since they consider the short run resource allocation for setting the equilibrium.

Perfect competition equilibrium is based on several previous conditions that can be summarized as follows: (i) free entry and exit from the market; (ii) each and all market participants are not able to influence price formation; (iii) all consumers are price takers; (iv) atomicity in both demand and supply side of the market; and (v) homogeneous product and perfect non-asymmetric information. Therefore, to prove the existence of a competitive market equilibrium one should demonstrate that all market participants have no means of affecting price (market power) - which is not a minor task -, analyze entry and exit conditions, verify the atomicity of both supply and demand and, moreover, determine the conditions of substitutability of the product. All these features are part of market definition.

Since all those preconditions are seldom simultaneously verifiable, imperfect competition is the most common situation, and, considering the Pareto's efficiency definition for a perfectly competitive market, the level of efficiency would also be suboptimal. Nevertheless, in some specific situations, perfect competition as defined in the mentioned preconditions, is not the optimal equilibrium, as referred previously in regard to natural monopolies, due to sub-addictive cost functions. Consequently, the geographical scope of the market definition is a critical part of competition assessments.

Both for legal (license procedure) and economic reasons (investment level and economies of scale), entering the energy market is not totally free and the number of suppliers is usually small. In terms of product substitutability, energy consumption, regardless of its type, is considered to have a low substitution effect, at least in the short run. This leads to a situation of inelastic demand and price being set by the supply side of the market.

In addition, there are significant transaction costs associated with energy transmission and often energy sources are located away from demand, all of that contributing to the relevance of the geographical market definition in energy. Due to its physical characteristics, once storage is not possible, electricity demand curve is even more inelastic with price being set by the supply side.

Therefore, energy markets in general, and electricity in a more specific way, are characterized by a monopolistic structure. However, a monopolist structure of the market does not necessarily imply a situation of exerted market power, either by the presence of self-regulation or explicit independent regulation of the market. So, the linkage between economic efficiency and perfect competitive markets does not occur in all situations.

Natural monopolies are a particular case of a monopolistic market, in which optimal efficiency level is obtained with a single monopolistic company, due to sunk costs in infrastructure deployment and strong economies of scale. Nevertheless, the presence of strong economies of scale in part of the value chain does not justify a monopolistic structure in all of the vertical organization of the market and technological changes might erode the fundamentals for a natural monopoly existence.

When assessing competition, it's important to retain how we measure it. Market shares (and the corresponding Herfindahl–Hirschman Index - HHI), number of market participants or the Lerner index, widely in use in the industrial organization literature and also in the electricity market characterization, are suitable to assess the existence of so-called market power conditions. Since electricity has a quasi-null substitutability in the short run, traditional competition indicators might be considered as good proxies to effective competition level in this industry.

A dynamic efficiency approach when applied to the electricity industry has led to the debate on how innovation may contribute to a significant change in the organizational paradigm of this market. It is clear from the environmental consequences of energy consumption and structural dependency of some countries on imported energy that a major shift in the model is to occur.

Since a significant part of the electricity market organization is relying on its technological characteristics, innovation is seen as a decisive contribution to change the energy model. This is so either by reducing barriers to entry (through lower individual investment requirements or new energy sources) or improving the efficiency in electricity generation (higher electricity outcome with the same primary energy input and vice-versa).

As a result of these technological features and the need for an energy model shift, innovation policy in the industry has a clear rationale and is expected to induce efficiency in the long run. In any case, once the energy industry is far from the perfect information concept, public policy in this area should promote a balanced incentive for research and development and knowledge dissemination (Sagar and Zwaan, 2005).

Electricity industry is a technological complex system, both because of the need for real time coordination of decisions or the need to manage different generation technologies.

This complexity, in addition to the massive investment required to tackle it, contributes to a path-dependency effect in the sector's innovation and new technologies' deployment. In fact, historical analyses of the electricity industry do not provide impressive examples of radical changes in the technological paradigm. Most commonly, innovation is oriented to upgrade existing generation technologies or to introduce new energy technologies along with existing and consolidated ones.

Gallagher et al (2006) have systematized the concept of innovation in the energy industry in the so-called ETI (energy technology innovation) process. Under this process, technological changes contribute to expand the world energy resources and contribute to a sustainable development and policy outcomes are evaluated through a set of proposed fundamental indicators. However, global policy results, as highlighted by Noaillya and Batrakovab (2010) in the specific case of energy-efficient innovations in the Dutch building sector, are also dependent on policies' internal characteristics such as their scope, time consistency and coordination with other policy instruments. Results from the analysis of different policy instruments in the Netherlands in terms of energy efficiency show that discontinuities in other specific policy measures, such as the energy policy, is harmful for innovation in this area. The Danish example in promoting new energy sources, extensively analyzed by Buen (2005), is considered to be a sound example of how the policy consistency and coordination endorse better results. A similar analysis carried out for the UK (Foxon and Pearson, 2006) points to the same direction.

Since consistency and coordination of policies are significant factors for policy' results and path-dependencies are present in energy technological improvements, some features of the energy industry restructuring process have a clear-cut impact on ETI. In fact, Markard and Truffer (2006) stressed the fact that the liberalization process is a driver of process and supply side innovation in energy, also contributing to reduce the adverse effect of path dependencies. Their work suggests that the first reaction from incumbents in electricity generation was to resist to innovation, but new challenges brought about by liberalization made them more prone to adopt new management processes and cost reduction efforts and, therefore, to innovate, at least in terms of process innovation.

The energy market structure itself has its effects on innovation and innovation also has its effects on the dynamics of market structure. The classical Schumpeterian approach to innovation sustains that companies with market power have higher incentives to innovate. Artés (2009) performed a cross-industry survey using data for Spanish companies in order to estimate the relationship between market power and innovation. His work delivered some evidence that competition level does affect the decision to promote innovation (trough

R&D investment] but is uncertain about the level of investment. This led to the argument that market power will influence long-run decisions but are neutral for short-run ones.

On the other hand, Vives (2008) stresses that the theoretical assertion on the existence of a positive relation between the number of firms and the individual R&D expenditure is not always true and that the empirical evidence shows that in some specific situations an increase in competitive pressure promotes a higher innovation outcome (measured through firms' R&D effort]. This empirical evidence suggests an inverted U-shaped relationship between competition and innovation.

Specifically for the energy industry, the work by Nakada (2005) relating the level of concentration in the energy market with the investment in R&D for lower carbon dioxide emissions has already suggested the existence of a critical level of market concentration under which R&D expenditure is maximized. In this sense, the relation between the two variables was suggested to follow the mentioned inverted-U shape. In this regard one might argue that innovation and R&D expenditure in energy markets are not exactly the same concept, but the work of Jamasb and Pollit (2008) clearly stressed that R&D expenditure represents a central role in innovation for all of the activities in the electricity industry – from generation to retail supply.

As this paper is focused on the structural market conditions in electricity, features such as those contributing to reduce barriers to entry or unbundling of activities are central in terms of competition policy. This is an approach substantially different from the traditional anti-trust competition policy, quite focused on the behavioural aspects of competition. Therefore, we might have two levels of competition policy in the electricity market – market model policy (ex-ante competition regulation) and competitive behaviour policy (ex-post competition regulation). Drawing on Vives' paper, we suggest that some specific attention should be paid to variables describing the structural market conditions when assessing competition and, moreover, that inducing competition through the removal of barriers to entry the market should also have a positive impact on the innovation process.

Once considering the structural competition features of the market as the first level of competition policy and considering the inverted U-shape relationship between competitive pressure and innovation, acting upon market structural conditions is likely to have a positive effect on innovation. Therefore, the conceptual boundary between market policy and innovation policy might be difficult to draw clearly.

3. Evidence on innovation and competition in energy

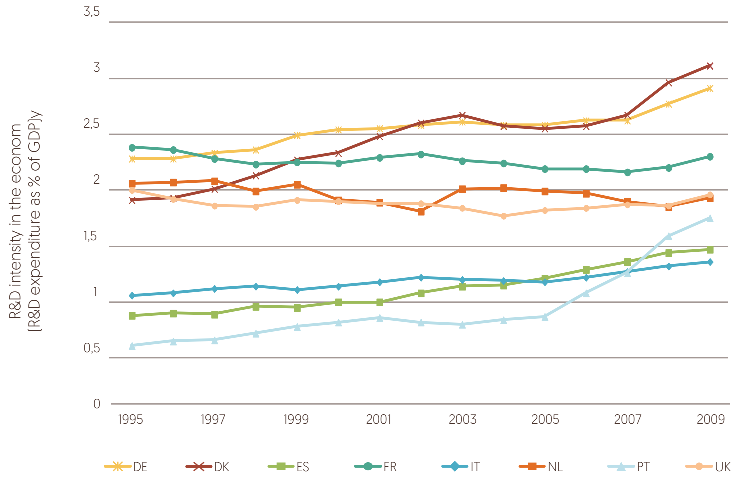
3.1. Innovation in energy

The analysis of innovation (or R&D expenditure as a proxy for innovation) in energy must take into consideration a broader perspective on innovation and R&D. This is due to the fact that several technological innovations in other areas of research affect positively the energy industry state of the art. Some examples of this situation rely on the computational sciences or telecommunications' developments, which have impact in dynamic, complex and real-time management of electricity market, or in the developments of new materials that enhance the efficiency standards of energy components. Thus, although its extent is hardly measurable, energy industry innovation is positively affected by this spill over effect of the global innovative efforts.

Therefore, energy specific innovation should be considered in perspective within the global innovation effort in the economy. In general terms, R&D expenditure in European countries have been increasing in the past two decades: in the EU-27 member states, R&D expenditure evolved from an average of 1,8% of GDP in 1995 to 2% in 2009. Figure 1 shows the evolution of R&D efforts in some of the EU countries, with Portugal, Spain and Denmark experiencing important growth in the R&D intensity of the economy, although starting from a lower intensity compared to the EU-27 average. For France, the Netherlands and the United Kingdom the economy intensity in R&D is either decreasing or stagnant in the period. German and Italian R&D intensities, although increasing less than in the Iberian countries and Denmark, experienced continuous growth, with Germany reaching 2.8% of GDP in R&D expenditure in 2009.

Given this figures and evolution it is fairly acceptable to conclude for an intensification of innovation efforts in the EU as a whole and in some of its member states in particular. In the specific case of Portugal, global R&D intensity more than tripled between 1995 and 2009.

Figure 1 - R&D intensity in European countries

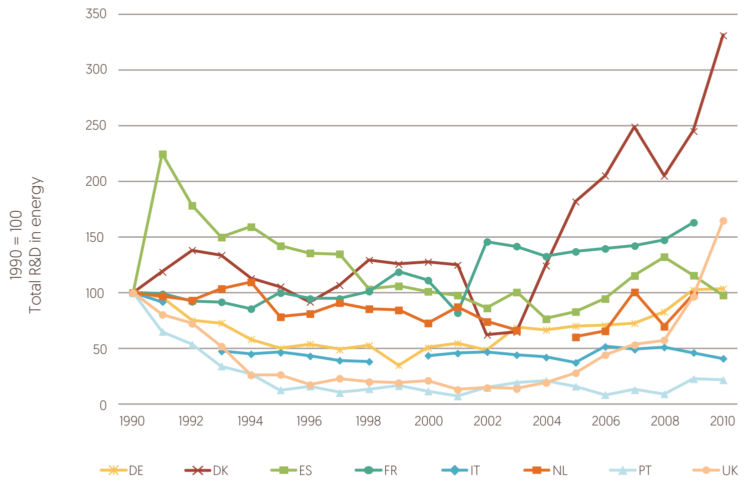


Source: EU DG Research; EUROSTAT

We have seen that the R&D effort has grown since the mid 1990's for the economy as a whole. Due the mentioned spill over effects of global R&D expenditure, energy industry is expected to benefit from that, but it is important to evaluate how the specific energy R&D effort has evolved in the last two decades. To do that, we will use the International Energy Agency (IEA) database on annual energy R&D budgets for OECD countries, which allows us to analyze energy specific R&D.

The R&D budgets for energy comprise several research areas, not all directly attributable to electricity market. In this database we may find expenditure in energy efficiency in buildings or fossil fuels' related developments. Since it is difficult to exclude or consider a particular area only, we will take the global value of R&D in energy in our analysis. Considering the data for the countries mentioned above, we have estimated annual index values for each in order to avoid scale effects in the comparison. Figure 2 presents the evolution of R&D expenditure for the eight countries, with1990 as the reference year and using the values of IEA database (expressed in 2010 prices and exchange rates when applicable) and shows a declining tendency for the R&D effort in energy, at least for the majority of cases. In fact, apart from the outstanding case of Denmark (and the United Kingdom in the latest 2 to 3 years), all of the remaining countries present a R&D budget in 2010 which is lower than the 1990' value. Therefore, from this first set of data, we might conclude that the R&D effort in energy has evolved differently from the rest of the economy: a decline or, in the best scenario, a stagnation of specific energy R&D budgets, comparing with growth in the R&D intensity of the economy.

Figure 2 - Total R&D expenditure in the energy industry

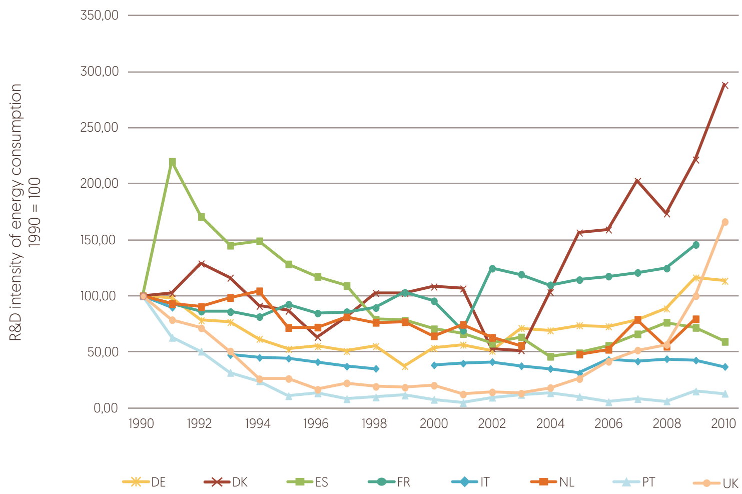


Source: IEA, Energy Technology R&D Statistics

In 2009, the value of energy specific R&D budgets for the eight countries is barely the same as in 1990. Countries like Portugal or Italy experienced dramatic cuts in their R&D budgets and Germany only by the end of the period recovered to the values of 1990. As the global primary energy consumption for these countries experienced an average 0,5% annual growth between 1990 and 2010, the R&D intensity of energy consumption[5] declined in this period, e.g., less R&D investment per unit of energy consumed. The Portuguese experience is even more dramatic, with the value of R&D expenditure in energy being in 2010 around 13% of the corresponding value in 1990.

[5] Ratio between the total amount of R&D expenditure and the primary energy consumed in the same year.

Figure 3 - R&D intensity of energy consumption



Source: IEA, Energy Technology RD&D Statistics; Authors calculations

The study by Jamasb and Pollitt (2008) had already revealed a cut in the R&D expenditure of the energy industry. Following the empirical evidence from other authors, Jamasb and Pollitt considered the liberalization processes in the energy industry as a plausible cause for the cuts in R&D budgets. This assumption relied on the chronological coincidence of the two facts and did not consider any impacts from the spillover effects deriving from other industries. This situation was observable in the case of the UK, for which the liberalization process was simultaneous with a dramatic fall in the R&D intensity of energy consumption.

In any case, and even considering that energy investment in innovation may generate lower returns than in other industries – which could explain the simultaneous growth in the economy R&D intensity and the decline in specific energy expenditure -, one should consider whether the R&D budget is the best variable to describe the innovation effort in the energy industry and, specifically, in the electricity market.

Given the emphasis on the support for new and renewable energy sources (RES) in the electricity market, it is plausible to consider the deployment of these technologies as another proxy for the innovation effort in the industry. The joint analysis of the Danish policy for RES promotion, in particular wind generation, and the evolution of R&D expenditure in this country support the idea of using RES deployment as another descriptive innovation variable in electricity, if we consider Denmark as an example for coordinated and consistent policy for development of an innovative energy cluster, as suggested by Buen (2005) in his comparison of Danish and Norwegian cases in the wind industry.

The coexistence of different electricity generation technologies implies some extent of economic benchmark between those more mature with the ones in the early stages of development. This is, by definition, a barrier to innovation that specific policies should address in order to encourage the use of new and less competitive energy sources and, thus, overcome youth problems. Sagar and Zwaan (2005) stressed the positive impact of experience obtained with broader use of energy RES technologies in its economic outcome and investment profitability.

The support given to RES follows more or less the same rationale worldwide: RES are not fully economically competitive with other traditional energy sources, due to scale effects and technology maturity. For this reason, RES policy follows most commonly an approach of providing these technologies with a feed-in tariff and priority dispatch. The value of the feed-in tariff is theoretically set in a level suitable to remove price competition disadvantages to other energy sources. Table 1 shows the values of RES support in some of the EU-27 countries, as well as the value of the support per unit of consumption.

Combining the global values of RES support schemes in Table 1 with the R&D budgets for energy one may find that RES support budgets are clearly above the R&D expenditure in the energy sector as a whole. In the case of Portugal or Spain, the R&D budgets in 2009 are a quite negligible part of RES support schemes values (respectively, 0.7% and 1.3%).

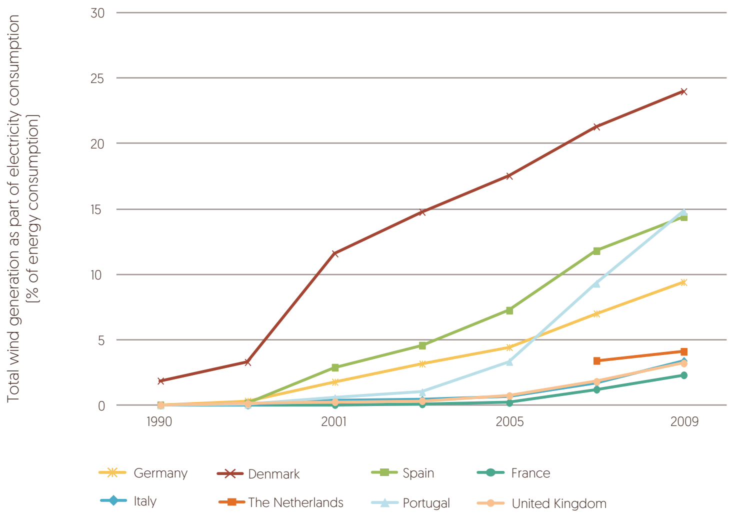
Table 1 - Total expenditure of RES support policies

Member State	RES-electricity support expenditure [million euro]	Gross electricity consumption [Eurostat][GWh]	RES - electricity suppot per unit of gross electricity consumed [€/MWh]
Austria	307	69 584	4,42
Belgium	489	88 949	5,5
Czech Republic	150	68 595	2,19
Denmark	294	36 541	8,05
France	556	516 455	1,08
Germany	5 618	520 968	10,78
Great Britain	1 250	378 523	3,3
Hungary	83	41 515	2,00
Italy	2 638	334 363	7,89
Lithuania	25	11 318	2,25
Luxembourg	16	7 259	2,27
Portugal	528	42 809	12,33
Spain	6 035	268 297	22,49
Sweeden	478	141 884	3,37
The Netherlands	639	117 119	5,46

Source: Council of European Energy Regulators, CEER Report on Renewable Energy Support in Europe

As a result of RES promotion policies, the wind generation deployment grew significantly in the past decade. Figure 4 shows a significant growth in wind generation contribution to gross consumption in Denmark, Spain, Portugal and Germany. Apart from the Danish case, the countries in which the wind generation has grown more significantly are roughly the same for which we have observed an overall tendency of declining energy R&D expenditure.

Figure 4 - Wind generation contribution to electricity consumption



Source: EWEA

The Danish example, for which we find simultaneous growth in R&D effort and RES penetration, is fairly explained by the country's option to promote an energy industrial cluster around the wind generation industry, extensively described by Buen [2005]. In the case of Spain, Germany and, more noticeably, Portugal, RES promotion policies seem to be a substitute for R&D expenditure, given the chronological coincidence of declining R&D budgets and RES deployment.

3.2. Competition in energy

A significant part of energy markets' deregulation relies on successful market opening, meaning by this the ability of consumption to freely express its economic preferences. Legal framework for energy internal market has set the goal to have all consumers able to freely choose their energy supplier. Table 2 shows the level of market opening in the previously mentioned countries.

Table 2 - Degree of retail marketing opening (as % of total retail market)

		2001	2004	2006	2007	2008	2009
Germany	DE	100	100	100	100	100	100
Denmark	DK	100	100	100	100	100	100
Spain	ES	100	100	100	100	100	100
France	FR	37	69	70	100	100	100
Italy	IT	70	79	73	100	100	100
The Netherlands	NL	63	100	100	100	100	100
Portugal	PT	45	100	100	100	100	100
United Kingdom	UK	100	100	100	100	100	100

Source: EC Reports on progress in creating the internal gas and electricity market

Legal full market opening achievements does not necessarily mean that market structure has evolved at the same pace. In fact, the degree of market concentration has not changed substantially even in those countries with more than 10 years of liberalization in retail markets.

Actually, as the EC recognizes in the 2009-2010 report, "at retail level, the integration of the European electricity and gas markets has not developed sufficiently yet. European gas and electricity retail markets are still characterized by substantial disparities in the different Member States as far as price levels and switching rates are concerned". Table 3 presents the combined market shares of the 3 largest retailers, which reveal, for those countries with available data, a tendency for the same degree of retail market concentration throughout the last decade. That is the case of Portugal, where slight changes have occurred in what concerns retail market structure: the 3 largest retailers comprise more than 95% of the market from 2001 to 2009, clearly expressing negligible developments in market structure.

Market dimension seems to be an important aspect for market concentration: large countries (and markets) like Germany or Italy present lower concentration than smaller markets such as Portugal. This brings support to the market integration component of the European energy market policy and explains why most commonly the new entrants in national retail markets are often incumbents in other national markets.

Table 3 - Market share of 3 largest retailers (as % of total retail market)

		2001	2006	2007	2008	2009
Germany	DE	50,0	46,1	40,0	52,0	47,9
Denmark	DK	38,0	NA	NA	NA	NA
Spain	ES	94,0	67,5	83,9	84,8	82,7
France	FR	90,0	94,0	NA	97,0	96,0
Italy	IT	72,0	60,0	33,1	59,0	59,0
The Netherlands	NL	48,0	NA	NA	NA	81,1
Portugal	PT	99,0	98,5	99,6	99,6	95,2
United Kingdom	UK	42,0	NA	NA	NA	NA

Source: EC Reports on progress in creating the internal gas and electricity market

On the other hand, one of the main characteristics of electricity markets in Europe is the significant vertical operation of market participants: companies in the retail market are commonly those present in the wholesale market. This feature constitutes an important obstruction to competitive markets, since barriers to entry the retail market are obtainable by incumbents through electricity sourcing rigidity.

The evolution of wholesale electricity markets throughout the last 10 to 15 years does not present a significant reduction in market concentration on a national basis, as it is illustrated in Table 4. For that reason, significant effort has been placed in regional market integration as a way to achieve a wider integration at a European level.

Table 4 - Market share of 3 largest generators (as % of total electricity generation)

		2001	2004	2006	2007	2008	2009
Germany	DE	64,0	72,0	68,5	85,4	84,7	79,3
Denmark	DK	78,0	40,0	75,0	75,0	75,0	75,0
Spain	ES	83,0	74,0	60,3	76,0	72,9	79,4
France	FR	92,0	96,0	93,0	93,0	93,0	99,0
Italy	IT	69,0	65,0	66,3	61,2	57,6	55,6
The Netherlands	NL	59,0	69,0	62,0	61,0	69,9	64,0
Portugal	PT	82,0	76,0	75,0	72,5	72,2	72,6
United Kingdom	UK	36,0	39,0	37,5	41,0	42,0	46,0

Source: EC Reports on progress in creating the internal gas and electricity market

In this context, although German market is less concentrated than the French one, it is also true that the deregulation path is different in each situation: from several regional monopolies to a national market in Germany and already a single market prior to the liberalization process in France. Path dependencies are also present in the case of Spain and Portugal. In the Portuguese case, since the interconnection capacity is more or less a quarter of total electricity market dimension, deregulation has brought important competition developments also through the "imported competition" effect.

Empirical evidence from the innovation and competition policies in the selected European countries has provided some basic ideas that can be summarized as follows:

1. Despite a continuous growth for the economy, energy R&D has been declining for more than a decade;

2. Beneficiary spillover effects are present in the energy industry in what regards innovation in other industries;

3. RES support schemes, highly motivated by technologies' youth, involves important amounts of investment and in some cases such as Portugal or Spain are more than 100 times the total budget for R&D, leading to the idea of a substitution effect between R&D expenditure and RES support investments;

4. Combining the values for RES support schemes and explicit R&D budgets, the innovation effort in the electricity industry not only did not decline throughout the last two decades but has even experienced a major increase;

5. Competitive pressure in selected European countries' electricity markets has evolved in a quite diffuse way, with significant improvements in terms of legal and formal liberalization but incipient degrees of retail competition;

6. Competition in wholesale electricity markets has experienced some improvements, but these are far more attributable to regional market integration than to effective entrance of new players.

In countries such as Spain or, more interestingly for this paper, Portugal, positive results in terms of competition developments were accomplished simultaneously with a decisive option for RES promotion. Namely in the case of Portugal, higher competitive pressure arising from an increased market integration did not prevent a significant improvement in the deployment of RES and more explicitly wind generation. This relationship between the two policy axes seems to be attributable more to objectives' alignment rather to explicit policy coordination. In fact, deployment of new RES not only is contributing to technology diversification but is also promoting lower primary energy dependency (and, by this, security of supply) along with licensing new market participants.

As an important background to both the energy sector specific policy and the innovation policy, the emergence of environmentally sustainable energy market is a feature against which most of the policy results are confronted. In fact, environmental and climate changes concerns are present both in the explicit R&D effort (investment in energy efficiency and green technologies) and sector-specific policies such as energy source diversification and security of supply (given the finite characteristic of fossil fuels).

Conclusion

This paper focused on the role played by public policies' coordination in shaping a new industry model, namely the electricity market, which calls for a low carbon economy along with an innovative and competitive energy industry. Both policies were analyzed using proxies: less representative budgets in R&D in energy induced the use of renewable primary energy sources and its relative weight in the fuel mix is a proxy for sector specific innovation policy; and competition policy was assessed through ex-ante structural changes brought by the liberalization process rather than those in the traditional scope of competition regulation (ex-post or behavioral approach).

A first concluding remark relies on the fact that explicit coordination of both energy sector policy and innovation policy is positive for economic and environmental sustainability.

Taking separately competition and innovation policies in energy, some tendencies were clearly identified, either for Portugal or for EU as a whole. In terms of industrial organization, liberalization attained a significant success in terms of vertical unbundling of generation and retailing activities, at least in terms of formal separation of activities. However, horizontal market concentration remains high and there is strong evidence that vertical strategies have hindered better results through competition, along with the fact that new entrants are often incumbents in other domestic markets.

In what concerns innovation policy, evidence shows decreasing R&D budgets in the industry, with few exceptions across Europe (Denmark). Decreasing R&D budgets are also a feature of companies' activity, partially compensated by research institutions. Nevertheless, once the investment in renewables was considered as a proxy of innovation indicators, there is an impressive progress in terms of market penetration of those energy sources.

National results suggest the existence of three main clusters: (i) long term policy coordination in the case of Denmark; (ii) diffuse evidence of detrimental developments in innovation due to liberalization in the case of UK; and (iii) implicit goal alignment for innovation and competition policies in the case of Spain and Portugal.

As for the case of Denmark, public policies were designed to promote a wind energy economic cluster in the country, giving priority to this objective and implementing the deregulation process as a consequence of the EU single market objective. Accordingly, the competitiveness of the economy is reinforced by a value-added industrial cluster which contributes to lower energy dependency and structural energy policy is part of broader policy options.

In the case of the UK, Jamaasb and Pollitt (2008) have already highlighted the chronological coincidence of declining R&D in energy and the liberalization process. Nevertheless, the competitive available indicators don't clearly demonstrate significant improvements and, therefore, main results from both policies do not confirm nor refute the idea of negative impacts of liberalization processes on the innovation effort. One should not exclude a possible negative impact on R&D effort of market participant's perception of the liberalization challenges and market contextual conditions.

Finally, the case of Portugal seems to indicate a slower pace of liberalization in the beginning of the process, but increased competitive pressure (even in the case of competition derived from regional market integration) did not avert a significant effort in new technologies deployment, although both policy axes weren´t explicitly coordinated.

In the case of Portugal it is also important to observe that RES promotion policy have actively contributed to decreasing market concentration in electricity generation, showing some positive impact of innovation on competition. In any case, this single evidence alone does not confirm the inverted U-shape relationship between innovation effort and competitive pressure, but gives compelling signals that policy coordination, at least in terms of global objectives, may contribute to explore the positive relationship of those two policy axes and, thus, implement a new energy model.

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Econometric Study of the Spanish Electricity Spot Market and Primary Energy Markets using VAR/VECM methodology [cointegration and nonstationary time series]

Ricardo Francisco Firmino Mendes Pacheco

Article based on the Dissertation submitted in partial fulfilment of the requirements for the degree of Master in Finance

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Abstract

The aim of this article is to study the dynamic relationship between prices of wholesale electricity market in Spain and prices of the main fuel references to generate electricity [coal, crude oil, gasoil and natural gas]. The dynamic relationship between the various interconnected electrical systems [Spain and Portugal, Spain and France], using as reference prices for wholesale electricity markets formed in each electrical system, is also relevant for analysis purposes due to impacts on prices of wholesale electricity market in Spain.

The results suggest: cointegration between prices of wholesale electricity market in Spain and the variables under analysis (fuel and wholesale electricity market prices). A number of implications will be addressed.

Keywords

Energy - Market Integration - Electricity Pricing and Cointegration.

1. Introduction

This study examines the long-run relations and short-run dynamics between electricity prices and other factors that may impact the Spanish wholesale electricity spot prices. The factors under analysis are mainly three fossil fuels (coal, natural gas and crude oil), one refined oil product (gasoil) and also the wholesale electricity spot prices formed in Portugal and France. Providing information on the dynamics of electricity and fuel source prices allows for a better understanding of price information flow among the markets.

First, coal and natural gas serve as important sources of fuel supply in electricity generation process, being basically the marginal technologies that define the wholesale electricity spot price formation. According to 2008 data published by the Spanish transmission system operator REE[1], about 49% of the electricity in Spain was generated using coal, natural gas and fuel oil, with natural gas accounting for more than one third of the electricity generation and coal for around 16%. Thus, changes in coal and natural gas prices can directly affect the cost of generating electricity and contribute to its price at the retail level. Second, crude oil prices may also contribute to form electricity prices directly by raising electricity generation costs and indirectly through changes in market sentiments. The major long-term natural gas contracts that use crude oil as a price reference can be another relevant issue to discuss.

In the context of MIBEL[2], Portugal and Spain use OMEL[3] power exchange[4] platform as electricity wholesale market operator. Wholesale electricity spot price formation in OMEL

[1] Red Eléctrica de España.

[2] An acronym for Mercado Ibérico de Electricidade, the joint Spanish-Portuguese electricity market that came into effect in July 2007 and allows participants to buy and sell power on either side of the Spain / Portugal border to create a pan-Iberian market with more than 28 million business customers.

[3] Compañia Operadora del Mercado de Electricidad.

[4] Power exchange is an entity set up to provide an efficient, competitive trading arena, open on a non-discriminatory basis to all electricity suppliers, which meets the load of all exchange customers at efficient prices.

uses "market splitting" procedure to solve cross-border congestion management (one single Iberian price area if there is no congestion in the interconnection between Spain and Portugal and with distinct price areas if there is congestion in the interconnection between both countries). France is also another country connected with Spain that uses the interconnection between them for exporting and importing electric energy. In France the wholesale electricity spot price is determined by the Powernext power exchange which nowadays belongs to the European Power Exchange Spot (EPEX Spot, a former cooperation between EEX[5] and Powernext). Interconnection capacity makes it possible to trade electricity between countries. So, the wholesale electricity market price evolution in each country as an impact on the cross-border electricity flows between the two systems and dictates the transit of the energy flow from one system to another (if the electricity price in Spain is greater than the electricity price in France, a transit of energy flow between France and Spain should occur; if the electricity price in Spain is lower than the electricity price in France, a transit of energy between Spain and France should occur). Studying the relations and dynamics between interconnected systems using as an input the electricity spot price formed in each electrical system is also relevant because it might also have an impact on the evolution of the Spanish wholesale electricity spot prices.

This article aims to present a synthesis of econometric models that allow an explanation for the relationship between electricity prices and fuel prices.

2. Theorical Overview

Mjelde and Bessler (2009:4) refer that "there are strong prior beliefs that economic data are nonstationary", meaning that any particular price measured over time will not be tied to its historical mean. Further, as discussed earlier, electricity and fuel prices are expected to be linked. That is, similar economic forces are expected to influence each market; although price or price movements are not expected to be identical across the different markets.

As Engle and Granger (1987) have pointed out, individual economic variables may be nonstationary and wonder through time, but a linear combination of them may, over time, converge to a stationary process. Such a process, if present, may reflect the long-run equilibrium relationship, and is referred to as the cointegrating equation. To summarize, it is expected that the different prices will be tied together, so that prices from one market will not wander off independently of the behaviour of prices in the other markets.

[5] European Energy Exchange: Germany's energy exchange, is the leading energy exchange in Central Europe.

The presence of a cointegrating relation among energy prices forms the basis for the specification of the vector-error-correction model (VECM). This study uses the error-correction model (ECM) for electricity prices in order to capture their dynamic relations with fuel prices and other wholesale electricity spot price data from which it would be possible to analyse the price dynamics between those prices and the Spanish wholesale electricity spot prices. The ECM represents the change in electricity prices as a linear function of its past changes, past changes in fuel prices and also the other electricity prices under analysis, and an error-correction term. For a cointegrated system, the error-correction term represents the deviation from the equilibrium relationship. Thus, an ECM provides two alternative channels of the interaction among electricity prices and fuel prices: short-run causality through past changes in energy prices, and long-run causality through adjustments in the equilibrium error.

Moreover, it is also imperative to validate issues concerning some properties of such equilibrium relationship by studying exogeneity, proportionality and asymmetry of each cointegrated relationship.

3. Empirical Findings

Considering cointegration as a global characteristic of the series while threshold behaviour as local characteristic (Balke and Fomby, 1997), the analysis is conducted as follows:

1. First the degree of integration of the variables was tested by using the augmented test of Dickey and Fuller (Said and Dickey, 1984) known as ADF test, the Phillips–Perron test (PP) and also the Kwiatkowski–Phillips–Schmidt–Shin test (KPSS);

2. Second, bivariate cointegration analysis was made by using the Johansen Cointegration test. Both trace statistic and maximum eigenvalue statistic were used to confirm the presence of one cointegrating long-run relationship between POOL_ES and each variable in study. With the cointegration condition valid, a VEC model estimation for each cointegration relationship was made;

3. Finally, the properties of exogeneity, proportionality and asymmetry of each cointegrating relationship were analysed.

All the empirical analysis followed the principle of parsimony proposed by Granger[6] in 1990.

6 If two models appear to fit the data equally well, choose the simpler model (that is the one involving the fewest parameters).

3.1. Unit Root Tests and Nonstationarity

Table 1 shows the results of the ADF, PP and KPSS tests, where the Δ in front of every variable name indicates the differentiated series.

Table 1 - Unit Root and stationarity tests in levels and in first differences

Variables	ADFa,b,e		PPc,f		KPSSd,g	
API4	-1,556821		-0,047841		0,929356	**
API2	-1,780020		-0,340710		1,548652	**
BRENT	-1,464773		-0,182589		1,343613	**
FORTIES	-1,512793		-0,190653		1,320776	**
URALS	-1,526983		-0,121613		1,233448	**
GO_ARA	-1,526558		-0,213790		1,537871	**
TTF	-2,881464		-0,186579		1,674533	**
ZEE	-3,099051		-0,133243		1,802888	**
NBP	-2,931282		-0,186595		1,716500	**
PNX	-2,627483		-0,121424		0,641809	*
POOL_PT	-1,526576		-0,194723		1,395568	**
POOL_ES	-1,715359		0,036374		0,978581	**
ΔAPI4	-28,619410	**	-28,687250	**	0,455187	
ΔAPI2	-22,468920	**	-28,653440	**	0,400462	
ΔBRENT	-30,018950	**	-30,052960	**	0,161225	
ΔFORTIES	-30,413970	**	-30,446620	**	0,150894	
ΔURALS	-30,467520	**	-30,501980	**	0,156881	
ΔGO_ARA	-32,025530	**	-31,984280	**	0,206697	
ΔTTF	-28,779070	**	-28,794860	**	0,417435	
ΔZEE	-24,423090	**	-39,261880	**	0,391727	
ΔNBP	-24,991140	**	-39,805190	**	0,338879	
ΔPNX	-9,082943	**	-84,796160	**	0,086777	
ΔPOOL_PT	-9,346984	**	-50,180180	**	0,261421	
ΔPOOL_ES	-9,437233	**	-48,964720	**	0,337606	

(**) and (*) indicate the reject of the null at 0,01 and 0,05 significance levels

Notes: a) exogenous terms in levels: constant and linear trend (MacKinnon critical values: -3.96 ~ 1% and -3.41 ~ 5%); b) exogenous terms in 1st differences: constant (MacKinnon critical values: -3.43 ~ 1% and -2.86 ~ 5%); c) exogenous terms in levels and 1st differences: none (MacKinnon critical values: -2.56 ~ 1% and -1.94 ~ 5%); d) exogenous terms in levels and 1st differences: constant (KPSS critical values: 0,73 ~ 1% and 0,46 ~ 5%); e) automatic lag length based on SIC[7]; f) automatic lag length based on Newey-West using Bartlett kernel; g) 25 lag length fixed based on Bartlett kernel.

[7] Optimum lag lengths are based on Schwarz Information Criterion (SIC).

It emerges that all the differentiated price series are *I*(1). However, the KPSS test shows that the rejection of null hypothesis of nonstationarity in levels H_0:Y_t~*I*(0) is only significant at 5% for PNX. Apart from this, the results are, therefore, consistent in both cases and lead to the conclusion that the logarithm of price series[8] under analysis are, in fact, integrated of first order *I*(1).

Thus, it is possible to conclude that all energy prices are first-difference stationary, and proceed with tests of cointegration.

3.2. Cointegration and Estimated VEC Model

3.2.1. Cointegration

Since the price series are all nonstationary and integrated of the same order, cointegration analysis is the appropriate tool for investigating the relationships between POOL_ES and the other considered prices series under analysis.

The proposed methodology for doing this is investigating the bivariate relationships between the POOL_ES and each other considered price series, considering many VAR systems as the relevant price combinations, and tested for the presence of cointegration and the optimum lag length following the well-known Johansen procedure (Johansen, 1988, 1992; Johansen and Juselius, 1990), which involves a system based on a likelihood ratio test that contemplates two steps. Firstly, the lag number of VAR representation is determined using information matrices based on Akaike (1973), Hannan and Quinn (1979) and Schwarz (1978) information criteria (IC). Secondly, given the optimal lag length, the cointegration rank is obtained through the Trace test and the Maximum Eigenvalue test (both test statistics have non-standard distributions and their critical values have been tabulated by Johansen in 1988).

The two tests are used to determine the rank of the coefficient matrix ∏, i.e., the Trace and the Maximum Eigenvalue test, are reported in Table 2.

The column Rank $r = p$ identifies the null hypothesis of each cointegration test performed. Here, $p = 0$ corresponds to the null hypothesis that there are no cointegrating vectors, that is, the cointegrating rank is zero, and $p \leq 1$ corresponds to the null hypothesis that there

[8] In what follows, when prices are referred it means logarithm of prices.

is at most one cointegrating vector, that is, the cointegrating rank is less than or equal to one. The next column reports the eigenvalues for each hypothesis. The last two columns present the results of the Trace and Maximum Eigenvalue test statistics.

Table 2 - Bivariate Johansen test for cointegration

Variables	Rank	Eigenvalue	Trace Statistic		Max. Eigenvalue Statistic	
POOL_ES-API4	r = 0	0,020323	17,431750	**	17,431650	**
	r ≤ 1	0,000000	0,000105		0,000105	
POOL_ES-API2	r = 0	0,031431	28,362450	**	27,113000	**
	r ≤ 1	0,001471	1,249451		1,249451	
POOL_ES-BRENT	r = 0	0,015429	13,286240	*	13,201600	*
	r ≤ 1	0,000001	0,084643		0,084643	
POOL_ES-FORTIES	r = 0	0,014966	12,888630	*	12,802450	*
	r ≤ 1	0,000102	0,086185		0,086185	
POOL_ES-URALS	r = 0	0,015037	12,913010	*	12,863390	*
	r ≤ 1	0,000058	0,049619		0,049619	
POOL_ES-GO_ARA	r = 0	0,017674	15,204460	*	15,139490	**
	r ≤ 1	0,000077	0,064968		0,064968	
POOL_ES-TTF	r = 0	0,026505	26,350430	**	22,806530	**
	r ≤ 1	0,004166	3,543900		3,543900	
POOL_ES-ZEE	r = 0	0,028223	28,092310	**	24,306100	**
	r ≤ 1	0,004450	3,786207		3,786207	
POOL_ES-NBP	r = 0	0,028129	27,942180	**	24,223540	**
	r ≤ 1	0,004370	3,718645		3,718645	
POOL_ES-PNX	r = 0	0,056151	49,074460	**	49,063260	**
	r ≤ 1	0,000013	0,011192		0,011192	
POOL_ES-POOL_PT	r = 0	0,024675	21,315280	**	21,211670	**
	r ≤ 1	0,000122	0,103604		0,103604	

Lags Interval: 1 to 4 for all series (selected by AIC, SC and HQ criteria)

(**) and (*) indicate the reject of the null at 0,01 and 0,05 significance levels

Using the 5% significance level, both Trace and Maximum Eigenvalue statistics fail to reject the null of no-cointegration in each bivariate relationship.

However, at 1% significance level, both Trace statistic and Maximum Eigenvalue statistic tend to reject the null hypothesis in the considered crude oil prices series (BRENT, FORTIES and URALS). Moreover, the Trace statistic at 1% significance level applied to the cointegration analysis between POOL_ES and GO_ARA fails to reject the null hypothesis, suggesting the possibility of unique long-run relationships between POOL_ES and the considered coal prices, POOL_ES and the considered natural gas prices, POOL_ES and the considered wholesale electricity spot prices (PNX and POOL_PT).

Hence, at 5% significance level, it is possible to conclude that the results from the cointegration analysis indicate that there are long-run relationships between POOL_ES and each of the other considered price series, implying that each of the other considered price series is integrated with POOL_ES. This study will consider cointegration at 5% significance level to undertake the empirical analysis.

3.2.2. Estimated Bivariate VEC Model

The estimated vector error correction model for each bivariate cointegrated relationship between POOL_ES and other considered price series was defined according to the deterministic trend specification[9] applied to each bivariate cointegration relationship. In addition to this, the number of lags to include in each bivariate vector error correction model was determined by the Wald Lag length Criteria[10].

Table 3 reports the coefficient estimates included in the vectors **α** and ß for each bivariate vector error correction model between POOL_ES and each considered price reference.

The results in column **ß** refer to the first lag of the respective variable. Moreover, the results of column coefficients **α** represent the residuals of the long-term equation expressed in relation to the first difference of corresponding variable.

[9] The determinist trend specification is also selected by AIC, SC and HQ criteria in the Johansen cointegration test.
[10] The Wald Lag length Criteria carries out lag exclusion tests for each lag in the VAR. For each lag, the χ^2 (Wald) statistic for the joint significance of all endogenous variables at that lag is reported for each equation separately and jointly.

Table 3 - Bivariate VEC Model

Indepent Variable	ß	Test statistic$_{ß}$ ~ t		α	Test statistic$_{α}$ ~ t	
API4	-0,948218	-118,5870	**	-0,056292	-3,2859	**
API2	-0,770165	-9,1189	**	-0,057831	-4,1687	**
BRENT	-0,974806	-53,2769	**	-0,025529	-3,7009	**
FORTIES	-0,976917	-51,5636	**	-0,025033	-3,7039	**
URALS	-0,982637	-51,9056	**	-0,025021	-3,6871	**
GO_ARA	-0,628294	-65,3028	**	-0,026108	-2,7505	**
TTF	-0,895236	-9,2667	**	-0,033000	-2,3659	*
ZEE	-0,921927	-7,9522	**	-0,022689	-1,7782	
NBP	-0,871451	-7,6251	**	-0,019970	-1,5469	
PNX	-0,985181	-93,4229	**	-0,013617	-1,6433	
POOL_PT	-0,979847	-224,0200	**	-0,075691	-3,0838	**

(**) and (*) indicate the reject of the null at 0,01 and 0,05 significance levels
Notes: *t* statistic critical values: -2.58 ~ 1% and -1.96 ~ 5%.

All coefficients ß of the long-term relationship equation are significantly different from zero at 1%. The equation is normalized to the POOL_ES. Concerning the adjustment coefficients, α, only those for ΔZEE, ΔNBP and ΔPNX appear to be non-significant at 5%, indicating that in each one of these bivariate equations there is not a long-term relationship between one of these variables and POOL_ES. The results also mean that the variables in question should be exogenous, the remainder being endogenous, as will be confirmed in the next section.

3.3. Exogeneity

A test for weak exogeneity will provide information as to whether any of the considered price series are price leaders, finding which price actually adjusts to maintaining the long-run equilibrium (Asche *et al.*, 1999). Following Johansen (1992, 1995), a weak exogeneity test has been applied to each series, testing every element of the adjustment matrix coefficient against zero. The likelihood ratio test is χ^2 distributed with degrees of freedom equal to the number of cointegrating vectors.

The weak exogeneity results are reported in Table 4.

Table 4 - Weak exogeneity tests

Independent Variable	Test statistic ~ χ^2		P-value	Result
API4	10,947750	**	0,000937	Reject
API2	16,313060	**	0,000054	Reject
BRENT	13,699310	**	0,000215	Reject
FORTIES	13,719620	**	0,000212	Reject
URALS	13,635230	**	0,000222	Reject
GO_ARA	7,625843	**	0,005754	Reject
TTF	4,927169	*	0,026438	Reject
ZEE	2,619982		0,105526	Fail to reject
NBP	1,955906		0,161952	Fail to reject
PNX	2,757824		0,096780	Fail to reject
POOL_PT	9,538064	**	0,002013	Reject

(**) and (*) indicate the reject of the null at 0,01 and 0,05 significance levels

The null hypotheses of weak exogeneity can be rejected in all cointegrating relations at the 5% significance level or better, except for the natural gas prices NBP and ZEE and also for the French wholesale electricity spot price (PNX).

The impact of this weak exogeneity refers to the absence of significant adjustment coefficient in the long-term relationship of the corresponding VEC Model (see column α of Table 3). Nevertheless, for each one of these weak exogenous variables remains only a short-term relationship between one of these weak exogenous variable and POOL_ES.

Weak exogeneity of NBP, ZEE and PNX also implies that these same prices cannot be used to forecast POOL_ES in the long-run. For this to be also the case in the short-run, these prices must be strongly exogenous and hence not affected by the short-run movements in POOL_ES.[11] Moreover, this weak exogeneity test shows that TTF is endogenous to POOL_ES, probably because some long-term oil indexed contracts still dominate in this market, setting up the TTF spot price.

However, some remarks12 made by the International Energy Agency (IEA) refer that the majority of natural gas in UK is sold at the NBP prices (around 60%), while the remainder is

[11] See Hendry (1996) for a discussion of different exogeneity concepts and their implications.
[12] See Cronshaw *et al.* (2008).

sold by long-term oil indexed contracts. Research by Neumann *et al.* (2005) has provided evidence that there is a strong evidence of market integration between NPB and ZEE, so it seems reasonable to conclude that NBP and ZEE are weakly exogenous in relation to POOL_ES because in Spain the majority of CCGT[13] power plants have long-term oil indexed contracts for natural gas supply.

Observing the Granger causality tests (Table 5), for the considered price series in levels, to check if there were any signs of strong exogeneity for the weak exogenous variables, a causal relationship was found for the pair PNX-POOL_ES. It is possible to say that the French wholesale electricity spot price (PNX), where evidence of strong exogeneity was found, doesn't have a long-term and a short-term relationship with POOL_ES.

Table 5 - Granger Causality test

Pairwise Granger Causality	Test statistic ~ F	
API4 - POOL_ES	24,29990	**
API2 - POOL_ES	15,34570	**
BRENT - POOL_ES	3,82309	*
FORTIES - POOL_ES	3,81237	*
URALS - POOL_ES	3,75001	*
GO_ARA - POOL_ES	6,01908	**
TTF - POOL_ES	11,91660	**
ZEE - POOL_ES	9,17206	**
NBP - POOL_ES	8,96279	**
PNX - POOL_ES	0,66767	
POOL_PT - POOL_ES	7,41976	**

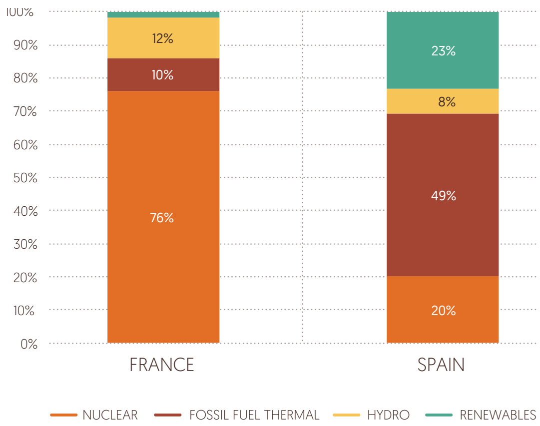
(**) and (*) indicate the reject of the null at 0,01 and 0,05 significance levels
Notes: H_0: X_{jt} is not Granger Cause of Y_t (Y_t~$POOL\_ES_t$)

A possible justification for this strong exogeneity of PNX could be the fact that PNX is a price formed in the day-ahead spot market Powernext, separated from the Iberian market by interconnections with limited capacity (interconnections capacity restrictions between countries is also an issue that can create some obstacles to a greater market integration among adjacent markets).

[13] Combined-Cycle Gas Turbine (CCGT): an energy efficient gas turbine system, where the first turbine generates electricity from the gas produced during fuel combustion. The hot gases pass through a boiler and then into the atmosphere. The steam from the boiler drives the second electricity-generating turbine.

Moreover, the share structure of the French wholesale electricity market is quite different from the Spanish one (in terms of levels of demand and technologies supported) with different fuel price references associated to French generation assets in the wholesale market. Correlation levels between PNX and POOL_ES and the PNX price volatility (measured by coefficient of variation) when compared with POOL_ES could demonstrate this fact. Looking at the 2008 generation statistics published by the French transmission system operator RTE14 and by the Spanish transmission system operator REE, it is possible to see the structural differences between the generation share of each technology on each country (Figure 1).

Figure 1 - France and Spain generation share per technology (2008)



3.4. Proportionality

Finally, this section will address the issue whether POOL_ES and each considered price series, for which a long-run relationship was found, are proportional, i.e., whether the spreads and relative prices are constant.

To obtain more information about these relationships, a test for price proportionality in bivariate relationships between POOL_ES and each considered price series was carried out. The results are reported in Table 6.

[14] Réseau de Transport d'Electricité.

Table 6 - Price proportionality tests

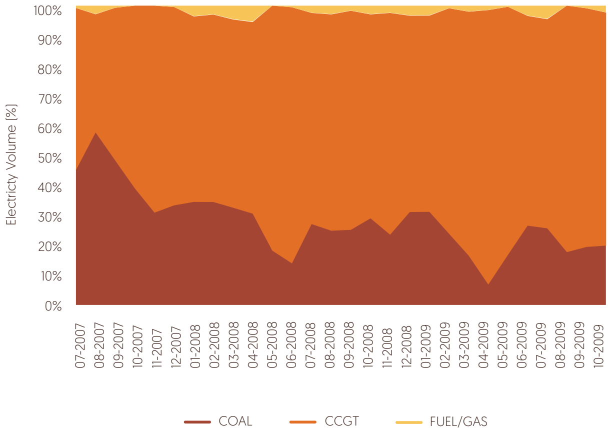
Indepedent Variable	Test statistic ~ χ^2		P-value	Result
API4	8,978173	**	0,002732	Reject
API2	4,463002	*	0,034637	Reject
BRENT	1,654986		0,198282	Fail to reject
FORTIES	1,323658		0,249937	Fail to reject
URALS	0,787408		0,374885	Fail to reject
GO_ARA	11,368120	**	0,000747	Reject
TTF	0,708763		0,399855	Fail to reject
ZEE	0,254005		0,614269	Fail to reject
NBP	0,632427		0,426467	Fail to reject
PNX	1,865580		0,171982	Fail to reject
POOL_PT	9,063862	**	0,002607	Reject

(**) and (*) indicate the reject of the null at 0,01 and 0,05 significance levels

The hypothesis of price proportionality is rejected, at 5% (significance level), between POOL_ES and coal prices (API4 and API2), gasoil prices (GO_ARA) and POOL_PT prices. The other considered prices are proportional with POOL_ES. These results indicate that changes in crude oil prices, natural gas prices and also in the French wholesale electricity spot prices are fully reflected in the prices of the Spanish wholesale electricity spot prices, but only partly in coal, gasoil and in the electricity spot prices formed in Portugal. However, it is important to remember that the following price series are weak exogenous: the natural gas prices NBP and ZEE and also PNX. So, it is not correct to affirm that changes in these variables are fully reflected in POOL_ES because these variables in question do not have long-run relationships with POOL_ES. So, the only variables that fail to reject the possibility of being proportional with POOL_ES are crude oil prices and the TTF natural gas.

In Figure 2 it is possible to see the evolution of the electricity volume by thermal technologies matched over 95% of marginal price POOL_ES. One method to check what kind of thermal technologies are setting the wholesale marginal spot price is looking at their bidding structure in terms of price, reflecting fuel costs and volume.

Figure 2 - Electricity volume by thermal technologies matched over 95% of marginal price

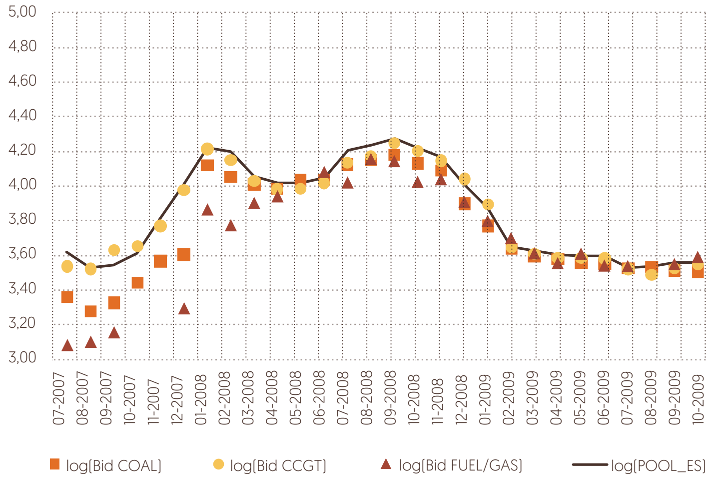


In period under analysis, 8692 GWh of thermal technologies matched over 95% of marginal price POOL_ES. From this total volume, CCGT power plants have a share of 69%, Coal power plants have a share of 28% and Fuel/Gas power plants with the residual share of 3%.

Figure 3 shows the evolution of the price bid by thermal technologies matched over 95% of marginal price and also the evolution of POOL_ES, BRENT and TTF.

Observing Figure 2 and Figure 3 it is easy to conclude that CCGT is the most used technology that basically formed the marginal price of OMEL wholesale market. So, analysing the impact of its fuel costs into their bidding structure is an important issue to discuss.

Figure 3 - Electricity average price bid by thermal technologies matched over 95% of marginal price



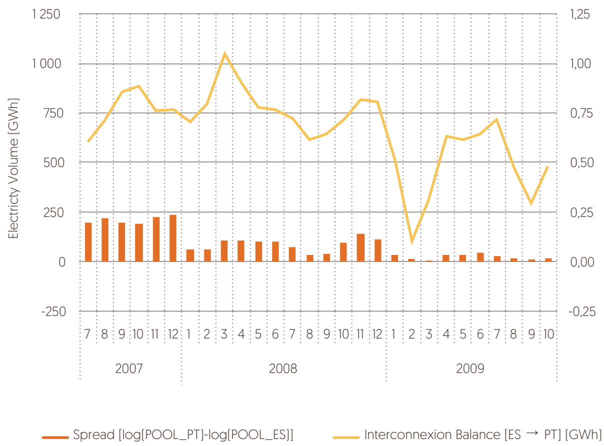
The proportionality test offered conclusive results that there is a full price reflection between BRENT[15] and POOL_ES prices. TTF is also proportional with POOL_ES. Since CCGT is the major marginal technology which determines the power pool prices and CCGT fuel is natural gas, full reflection of the crude oil prices and TTF in the natural gas formula of the long-term natural gas supply should certainly occur.

Coal prices and gasoil prices are partly reflected in POOL_ES because the remaining thermal power plants have a minor influence in the determination of the marginal price of the Spanish wholesale market (coal technology with 28% and fuel/gas technology with 3%). Gasoil price can be also a fuel reference for the Fuel/Gas thermal power plants.

Changes in POOL_PT are partly reflect in POOL_ES because during the analysis period, Portugal has been more an importer of electric energy than exporter (with electricity spot prices higher than the Spanish area) due to different structural market conditions in which Spain has more considerably efficient power generation assets than Portugal. These conditions can be found in Figure 4.

[15] To simplify this analysis, since there is a strong correlation and practically the same volatility among the considered crude oil prices, only BRENT shall be considered the benchmark crude oil reference.

Figure 4 - Spreads evolution of the Portuguese and the Spanish OMEL spot prices



The positive spread values indicate that the Portuguese electricity spot price is higher than the Spanish electricity spot price. The use of the cross-border interconnection between Portugal and Spain also reflects the direction of the energy flow from the cheaper area to the more expensive one (in this case the majority of electric energy flows from Spain to Portugal). Cross-border available interconnection capacity is the main restriction that does not facilitate price transmission between both systems. If there were more capacity available due to new interconnections investments between Portugal and Spain, probably the convergence to a unique MIBEL spot price would occur, with full price transmission between POOL_PT and POOL_ES.

3.5. Asymmetry

To conclude the empirical analysis presented here, this section shows the results of asymmetry tests conducted on the residuals of each long-term equation, with the aim of confirming the symmetrical adjustment of the estimated models.

Using the threshold methodology (TAR and MTAR approach) in order to verify whether price adjustment of each considered price series in analysis is asymmetric to POOL_ES. Eleven OLS equations were estimated in the same sequence as shown in Table 7.

POOL_ES is the dependent variable, object of this study, and the above mentioned independent variables are the explanatory variables. The OLS residuals obtained from each simple regression model were then used to estimate the thresholds. Table 7 summarizes the results for the relevant tests of the null hypotheses that:

1. $\rho_1=0$ and $\rho_2=0$;
2. $\rho_1=\rho_2=0$;
3. $\rho_1=\rho_2$.

Notice that the third test only makes sense when the two previous tests conclude the rejection of the null hypothesis. That is, if the ρ coefficients estimated for the threshold are significantly different from zero, then the regression is non-trivial and testing for symmetry makes all the sense.

Table 7 - Asymmetry Tests using TAR/MTAR (1 lag length)

Independent Variable	Model	ρ_1	ρ_2	$\rho = 0$ t-Max	t-Max 99%	t-Max 95%	$\rho_1=\rho_2=0$ Φ	Φ 99%	Φ 95%	Cointegration	F	$\rho1 = \rho2$ p-value	Asymmetry
API4	TAR	-0,111494	-0,184364	-4,560049 **	-2,51	-2,10	28,389640 **	7,81	5,79	Yes 1%	3,731510	0,0537	No
	MTAR	-0,107977	-0,170901	-3,961973 **	-2,42	-1,99	27,926360 **	8,40	6,28	Yes 1%	2,859226	0,0912	No
API2	TAR	-0,068917	-0,085993	-3,477077 **	-2,51	-2,10	14,330550 **	7,81	5,79	Yes 1%	0,362799	0,5471	No
	MTAR	-0,063760	-0,088891	-3,055948 **	-2,42	-1,99	14,548600 **	8,40	6,28	Yes 1%	0,784827	0,3759	No
BRENT	TAR	-0,023853	-0,032231	-2,015796	-2,51	-2,10	5,068771	7,81	5,79	-	-	-	-
	MTAR	-0,023035	-0,031515	-1,778511	-2,42	-1,99	5,071714	8,40	6,28	-	-	-	-
FORTIES	TAR	-0,023250	-0,032289	-1,975827	-2,51	-2,10	5,031679	7,81	5,79	-	-	-	-
	MTAR	-0,024080	-0,030052	-1,864559	-2,42	-1,99	4,954846	8,40	6,28	-	-	-	-
URALS	TAR	-0,023519	-0,031528	-1,996520	-2,51	-2,10	4,949055	7,81	5,79	-	-	-	-
	MTAR	-0,023148	-0,030467	-1,789638	-2,42	-1,99	4,931198	8,40	6,28	-	-	-	-
GO_ARA	TAR	-0,032595	-0,044910	-2,386111 *	-2,51	-2,10	7,044946 *	7,81	5,79	Yes 5%	0,363027	0,5470	No
	MTAR	-0,041581	-0,034942	-2,503005 **	-2,42	-1,99	6,914495 *	8,40	6,28	Yes 5%	0,106275	0,7445	No
TTF	TAR	-0,083745	-0,080831	-3,761516 **	-2,51	-2,10	15,119140 **	7,81	5,79	Yes 1%	0,009859	0,9209	No
	MTAR	-0,093950	-0,071902	-3,568560 **	-2,42	-1,99	15,408500 **	8,40	6,28	Yes 1%	0,568688	0,4510	No
ZEE	TAR	-0,079749	-0,083116	-3,597526 **	-2,51	-2,10	15,001990 **	7,81	5,79	Yes 1%	0,013214	0,9085	No
	MTAR	-0,092426	-0,072499	-3,618507 **	-2,42	-1,99	15,236080 **	8,40	6,28	Yes 1%	0,465421	0,4953	No
NBP	TAR	-0,083592	-0,093549	-3,733394 **	-2,51	-2,10	16,628120 **	7,81	5,79	Yes 1%	0,108897	0,7415	No
	MTAR	-0,109961	-0,071387	-3,454529 **	-2,42	-1,99	17,419340 **	8,40	6,28	Yes 1%	1,631895	0,2018	No
PNX	TAR	-0,128050	-0,148873	-4,721764 **	-2,51	-2,10	25,182990 **	7,81	5,79	Yes 1%	0,308654	0,5787	No
	MTAR	-0,165017	-0,107710	-3,833963 **	-2,42	-1,99	26,250920 **	8,40	6,28	Yes 1%	2,325642	0,1276	No
POOL_PT	TAR	-0,137617	-0,182205	-3,712179 **	-2,51	-2,10	32,314740 **	7,81	5,79	Yes 1%	1,037058	0,3088	No
	MTAR	-0,216735	-0,133180	-4,803637 **	-2,42	-1,99	33,847480 **	8,40	6,28	Yes 1%	3,889176	0,0489	Yes 5%

(**) and (*) indicate the reject of the null at 0,01 and 0,05 significance levels

The presence of autocorrelation in the residuals of each TAR and MTAR equation was tested by Durbin–Watson (DW) statistic16. Results from the DW statistic shows that there is not autocorrelation in the residuals of each TAR and MTAR equation defined for each relationship between POOL_ES and each of the other considered independent variables.

The negative sign of the coefficients ρ1 and ρ2 guarantees the stationarity of the variables.

The calculated Φμ and Φ*μ are above their critical values at 5% (significance level) except for the crude oil prices in which it wasn't possible to determine the asymmetric cointegration level using the TAR/MTAR methodology (the only way to check cointegration between symmetric variables is applying the Johansen cointegration test). The results of Enders and Siklos (2001) show that standard tests of cointegration exhibit low power in the presence of asymmetric cointegration and consequently failure to detect cointegration using standard tests may be due to presence of asymmetric behaviour.

POOL_PT is the only independent variable that is asymmetric with POOL_ES in "steep" movements (at 5% significance level there is rejection of the null hypothesis of symmetry test applied to the MTAR equation). Moreover, POOL_PT doesn't exhibit different degrees of autoregressive decay depending on the behaviour of the lagged residual and its first-difference respectively because the asymmetry test applied to TAR equation doesn't reject the null hypothesis of symmetry). The other independent variables, except the crude oil prices (due to inconclusive asymmetric cointegration test results it was not possible to perform the asymmetry test for each crude oil), are symmetric with POOL_ES.

Summary and Conclusions

Price discovery among wholesale electricity spot prices in Spain and prices of major electricity generating fuels such as crude oil, coal, gasoil and natural gas, is analysed. By including both fuel (inputs) and electricity (output) prices, this study shows that there are dynamic relationships between input and output prices which confirm that electricity prices are directly impacted by fuel prices. It is also relevant to analyse the dynamic relationship between interconnected systems (Spain and Portugal, Spain and France), using as an input the electric spot price formed in each electrical system, because it might also have an impact on the evolution of the Spanish wholesale electricity spot prices.

[16] The Durbin–Watson statistic is a statistic test used to detect the presence of autocorrelation in the residuals from a regression analysis.

The first finding in this study is that Spanish wholesale electricity spots prices, the fuel prices and wholesale electricity spot prices formed in Portugal and France are cointegrated (nonstationarity of each price data was confirmed). Therefore, there is a long-term equilibrium relationship between the Spanish wholesale electricity spot prices and coal prices, crude oil prices, gasoil prices, Portuguese wholesale electricity spot prices and TTF natural gas prices. Short-term relationships have been detected between Spanish wholesale electricity spot prices and natural gas prices from NBP and Zeebrugge natural gas hubs.

Long-term relationships between the Spanish wholesale electricity spot prices and crude oil prices, gasoil prices and TTF natural gas prices show that crude oil prices directly or indirectly (setting the price of refined oil products and natural gas) also have an impact on electricity prices, even though crude oil plays a minor role as a primary energy source for electricity generation. This increasing dependence on these inputs, coupled with the fact that CCGTs are often the price-setting technology in OMEL, implies that the link between the gas and electricity markets is crucial to an understanding of the dynamics of both markets. In addition, the long-term relationship between the wholesale electricity spot prices formed in Portugal and Spain is justified by the integration of Portugal and Spain in the same wholesale market, MIBEL, which confirms why the Portuguese wholesale electricity spot price evolution is strongly linked to the Spanish wholesale electricity spot price evolution.

The second finding determined that the French wholesale electricity spot prices were strongly exogenous to the Spanish wholesale electricity spot prices. Comparing the two electrical systems, the generation structure share of the French wholesale electricity market is quite different from the Spanish one (in terms of levels of demand and technologies supported) with different fuel price references associated to French generation assets in the wholesale market. The difference between the market liquidity in each market is also an issue that could create greater price volatility in the French market when compared to the more liquid Spanish market. Less liquidity in France is due to a higher percentage of bilateral power contracts entered into by power producers and retailers. Furthermore, another issue that can contribute for the presence of exogeneity in the French wholesale electricity spot prices is the price transmission in two interconnected systems with limited capacity, because it is a physical restriction that could create some obstacles to greater market integration among adjacent markets.

Third, no proportionality was found between coal prices, gasoil prices and the Portuguese wholesale electricity spot prices and the Spanish wholesale electricity spot prices. Coal prices and gasoil prices are partly reflected in the Spanish wholesale electricity spot price because the remaining thermal coal and Fuel/Gas power plants have a minor influence on setting up the marginal price of the Spanish wholesale electricity market. Moreover, changes in the Portuguese wholesale electricity spot prices are partly reflected in the Spanish wholesale electricity spot prices because throughout the analysis period, Portugal has imported more electric energy than exported it (with higher electricity spot prices than the ones in Spain because of the "market splitting" mechanism) due to different structural market conditions in which Spain has considerably more efficient power generation assets than Portugal.

However, there is a full price reflection between the crude oil prices, TTF natural gas and the Spanish wholesale electricity spot prices. Given the fact that CCGT is the major marginal technology that sets up the power pool prices and CCGT fuel is natural gas, full reflection of the crude oil prices and TTF in the natural gas formula of the long-term natural gas supply should certainly occur.

Fourth and finally, the Portuguese wholesale electricity spot prices are asymmetric in relation to the Spanish wholesale electricity spot prices in "steep" movements. The difference between both prices (spreads) over time may give a perspective of this movement. Basically, during the second half of 2007, following the official start of MIBEL, major spreads were found when compared with the remaining period. This fact may indicate that some structural changes occurred over time in the distribution of the generation share by technologies in Portugal.

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Electricity disclosure in Portugal[1]

Patrícia Lages, Pedro Costa, Jaime Vogado e Pedro Roldão

Abstract

Factors other than price can contribute to a more dynamic retail market for electricity. Environmental issues are having ever growing importance in terms of public opinion, and it is expected that consumers will take these into consideration when choosing their electricity supplier. Available information is essential to the promotion of new consumption patterns, following environmental criteria, and the resulting commercial offers. This article discusses the contents and the means used to disseminate electricity disclosure information to consumers on the Portuguese market. The need to reconcile the provision of information with the means of dissemination and the depth of the content is presented. Real examples from various suppliers illustrate these issues.

Keywords

Disclosure- Labelling- Electricity - Regulation - ERSE - Consumers.

Introduction

Price has been a decisive factor to electricity customers for making consumption choices. However, other factors can contribute to a more dynamic retail market for electricity, with more offers and better adherence to the different needs and expectations of consumers. Environmental issues are having ever growing importance in terms of public opinion. Among those are the energy sources of electricity and the environmental impact of the sector. Environmental awareness is increasing and it is expected that consumers will take these issues into consideration when choosing their electricity supplier.

[1] Adaptação do caso de estudo português a publicar no relatório "Study to Evaluate Guarantee Of Origin In Mediterranean Countries" pelo MedReg (*Mediterranean Energy Regulators*).

Available information is essential to the promotion of new consumption patterns and the resulting commercial offers. Also, the complexity of the contents and the means used to disseminate information to consumers have to be born in mind when providing electricity disclosure information.

The next sections present the Portuguese electricity market situation on disclosure. Firstly, it discusses what disclosure is and how suppliers should inform their customers about the origins of the electricity they consume. Then, the role that energy regulators can have in disclosure follows. These issues are illustrated with actual examples.

1. Background

The first discussions on best practices occurred in 2007 at ERSE's initiative. At the time, only a few suppliers had started disclosure – as required by the Directive 2003/54/EC[2], and the Commercial Relations Code[3]. A need to guarantee a minimum level of quality and harmonization was also identified. The following year, ERSE published its Recommendation on principles and best practices on disclosure for electricity[4]. In 2011, a revision ensued and Recommendation no. 2/2011 is in force since then[5].

1.1. What is disclosure and what is it for?

Disclosure can be defined as the information given to consumers on the sources and environmental impacts of the electricity they consumed.

This can be derived from Directive 2003/54/EC, in its article 3 (6):

"Member States shall ensure that electricity suppliers specify in or with the bills and in promotional materials made available to final customers:

(a) the contribution of each energy source to the overall fuel mix of the supplier over the preceding year;

[2] Directive 2003/54/EC, 26th June.
[3] Regulamento das Relações Comerciais, published by ERSE.
[4] Recommendation no. 1/2008 (version 2, January 2009), in Portuguese.
[5] Recommendation no. 2/2011 (December 2011), in Portuguese.

(b) at least the reference to existing reference sources, such as web-pages, where information on the environmental impact, in terms of at least emissions of CO_2 and the radioactive waste resulting from the electricity produced by the overall fuel mix of the supplier over the preceding year is publicly available.

With respect to electricity obtained via an electricity exchange or imported from an undertaking situated outside the Community, aggregate figures provided by the exchange or the undertaking in question over the preceding year may be used.

Member States shall take the necessary steps to ensure that the information provided by suppliers to their customers pursuant to this Article is reliable."

Also, disclosure should be addressed in the perspective of the consumer:

» Supplier/product differentiation
  - Disclosure as an additional criterion of choice (apart from price)
  - Greater competition in retail (e.g. new products based on disclosure).
» Consumers empowerment
  - More informed consumption choices (knowledge of environmental impacts)
  - Commitment of consumers regarding their consumption choices.

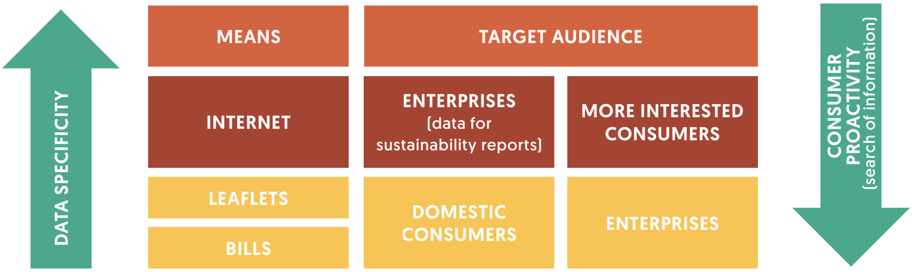
1.2. What information should be provided by suppliers to consumers and in what means?

As stated above, disclosure information includes the contribution of energy sources to the electricity consumed and information on environmental impacts. In Portugal, this translates to:

» Energy mix (percentage of each energy source)
» Specific carbon dioxide emissions and radioactive waste production
» Total carbon dioxide emissions associated to the consumption of each bill
» Other information on environmental impacts.

When providing information to consumers a balance between needed information and excess information must be evaluated. In Portugal, the weighting of these trade-offs resulted in different levels and detail of information and the means by which the information is provided according to the specific audience (see Figure 1).

Figure 1 - Means of disclosure and target audience



Internet is seen as the favoured means for providing easily accessible and detailed information to an interested audience [see Figure 2 and Figure 3].

Figure 2 - Example of internet page with disclosure data (monthly values)

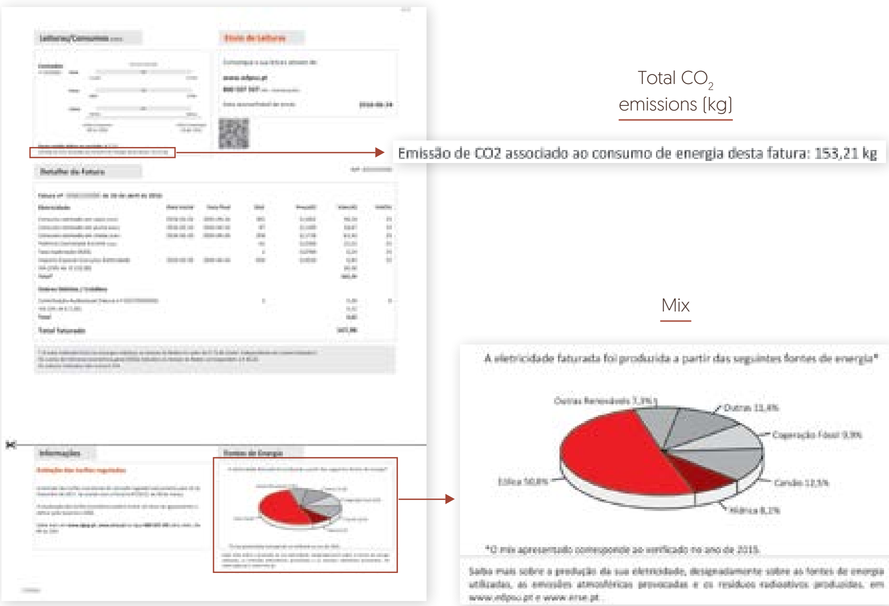
Figure 3 - Example of internet page with disclosure data (description of environmental impacts)

Leaflets serve as an intermediate means, being of mass dissemination, and are available from suppliers (sent yearly to consumers and delivered with pre-contractual information) (see Figure 4).

Figure 4 - Example of leaflet on disclosure

As for bills, while it is a privileged means for providing disclosure information for each and every consumer, one also has to bear in mind the need for bills that are simple to understand (see Figure 5).

Figure 5 - Example of bill with disclosure data (energy mix and total CO_2 emissions)



What can the regulator do regarding disclosure?

ERSE publishes information on disclosure that is reported by suppliers. This information is useful namely for comparison purposes:

» Disclosure simulator

Consumers can access ERSE's website and simulate their energy bills in what regards the energy mix and emissions for a given supplier (see Figure 6). The resulting emissions are compared with those from travelling by car and airplane to allow for a better understanding of the magnitude of the values.

Figure 6 - Electricity disclosure simulator provided by ERSE (http://simuladores.erse.pt/rotulagem)

» Disclosure comparison tool

Consumers can access ERSE's website and compare the disclosure information of different suppliers regarding the energy mix and emissions (see Figure 7).

Figure 7 - Electricity disclosure comparison tool provided by ERSE (http://www.erse.pt/pt/desempenhoambiental/rotulagemenergetica/comparacaoentrecomercializadores/)

» State of disclosure report

A yearly report on the state of disclosure provision by suppliers is published by ERSE in its website [see Figure 8].

Figure 8 - Report on the state of disclosure
published by ERSE [http://www.erse.pt/pt/desempenhoambiental/rotulagemenergetica]

Conclusion

Portuguese disclosure obligations consider the high level of market integration in the Iberian electricity market, being a European integrated market driven model. Since 2008, ERSE has worked in these issues trying to better cope with the need for a rigorous conceptual framework and data, on the one hand, and consumers' ability to understand that information, on the other hand. This trade-off is an open issue and disclosure should be understood as a work in progress.

CAPÍTULO 3

REGULAÇÃO DAS INFRAESTRUTURAS ENERGÉTICAS

CAPÍTULO 3

REGULAÇÃO DAS INFRAESTRUTURAS ENERGÉTICAS

Time-of-use electricity tariffs with smart meters

Paulo Oliveira[1] and Margarida Pato[2]

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Abstract

Smart meters for electricity residential consumers must be used for enabling demand response. This paper proposes a method for scheduling tariff time periods for electricity consumers. A heuristic method for tariff time period scheduling and pricing is proposed which considers different consumer groups with parameters studied a priori, taking advantage of demand response potential for each group and the fairness of electricity pricing for all consumers. The tool was applied to the case of Portugal, considering the actual network and generation costs, specific consumption profiles and overall electricity low voltage demand diagram. The proposed method achieves valid results. Its use will provide justification for the setting of tariff time periods by energy regulators, network operators and suppliers.

Keywords

Dynamic Electricity Tariffs - Demand Responde - Non Linear Optimization - Heuristics.

[1] ERSE (Portuguese Energy Services Regulatory Authority), Av. D. Cristóvão da Gama, 1, 1400 - 113 Lisboa, poliveira@erse.pt
[2] ISEG and CMAFCIO, Universidade de Lisboa, Rua do Quelhas, 6, 1200-781 Lisboa, mpato@iseg.ulisboa.pt

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Introduction

The present paper is based on the work done in the framework of a MSc project [Oliveira, 2013].

The internal energy market implements the three strategic vectors of the European energy policy [European Commission, 2010]: the continuous availability of energy products and services at reasonable costs (through a competitive market and innovation in energy services); the promotion of security of supply on a European scale (through diversification of energy routes in supplying Europe and promotion of endogenous resources); and the promotion of social and environmental sustainability. Moving towards 2030, the energy policy objectives build on the previous ones and go deeper into realizing the full potential of renewable generation and energy efficiency [European Commission, 2014].

The 3rd Energy Package of European Directives includes the participation of demand in the electricity market and the adoption of smart meters. Directive 2009/72/CE [European Parliament and Council, 2009] establishes that Member-States must evaluate the rollout of smart energy measurement systems. These smart meters offer a technological leap in the relationship between consumers, networks and the electricity market, allowing for detailed (timely discriminated) and updated (in real time) knowledge concerning consumption. This data can be used by the consumer to manage his/her consumption; by grid operators to improve grid management and to involve consumers in the supply of network services; and by suppliers to develop cost adherent prices that promote rational options by consumers [Vasconcelos, 2008]. European policy regards the smart meter as a tool to promote energy demand response which, in turn, will contribute to a competitive and efficient market, to the reduction of CO_2 emissions and to economic growth [European Commission, 2011].

In the Portuguese electricity market, smart meters are already being deployed by network operators in certain pilot projects. The trend is for them to become a standard solution for metering in the future. Network tariffs are approved by the energy regulator while energy generation costs derive from the Iberian wholesale market.

Electricity tariffs

Electricity tariffs paid by end-users reflect costs through the supply chain, some originated from regulated activities (transmission and distribution networks, costs related to energy policy decisions) and others from competitive market activities (generation costs and retail supply costs).

Apolinário et al. (2006) presented the Portuguese additive tariff model. Tariffs for using the networks (also called third-party access tariffs) result from adding sub-tariffs of each activity included in the service. In this additive model, end-user tariff results from adding the network tariff to generation and retail costs.

Houthakker (1951) and Boiteux (1960) presented two fundamental papers about applying marginal cost pricing to electricity. According to the authors, tariffs based on marginal costs produce a better distribution of resources (economic efficiency) and induce demand reduction at peak periods, with subsequent benefits in overall costs of the electricity sector. These costs include either variable generation costs, generation capacity costs or network infrastructure costs.

For consumers, marginal pricing may mean a reduction in the bill, if they can adapt their consumption to prices (Bartusch, Wallin, Odlare, Vassileva and Wester, 2011) and adopt efficient technologies (Kim and Shcherbakova, 2011).

For grid operators, system management costs are reduced (services supplied by generators in standby mode), network losses and maintenance costs are brought down, enabling them to postpone new investments and reduce risks of supply interruptions.

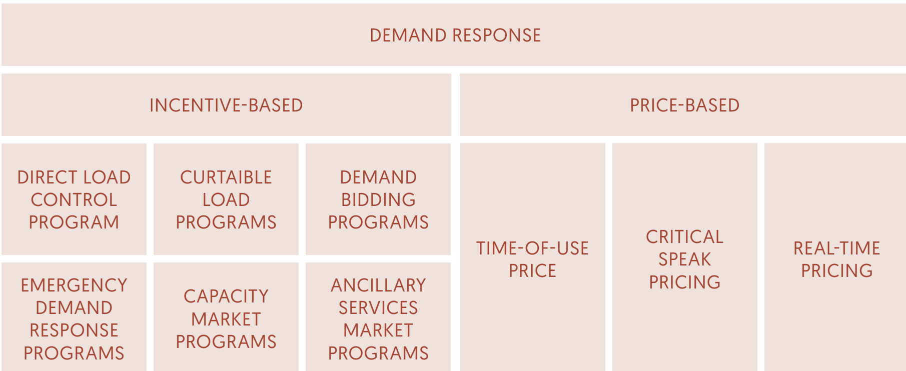
For suppliers, these tariffs set a more competitive market environment, with more information. Bartusch et al. (2011) also mention the reduction of financial risks of the supply activity since the supplier signs a contract with the customer for a given period, with fixed prices.

For society in general, marginal cost pricing can increase electricity market efficiency, thus reducing the potential for market power abuses, and reduce environmental impacts related to electricity generation and transmission (Bartusch et al., 2011).

There are several examples of prices depending on the time the service is used. Faruqui (2010) mentions prices for car parking, tolls for bridges with traffic congestions, flights and hotels, or prices for cultural events and sports or even pricing in the telecommunications business.

Dynamic demand involvement has been promoted with the goal of offering services to the power system or reducing overall sector costs. Dupont, Jonghe, Kessels and Belmans (2011) present a classification of different types of demand response programs (Figure 1).

Figure 1 - Types of demand response programs



Source: (Dupont et al., 2011)

Time-of-use (TOU) tariff is a demand response mechanism common in the residential customer segment. TOU tariffs have prices variable with time, fixed within time blocks known in advance. Although TOU tariffs are usually available, they still are not generally applied (Wang and Li, 2011).

This work on TOU electricity tariffs with smart meters aims to contribute to the process of changing the Portuguese electricity market, by looking at new technologies in energy measurement.

1. Time-of-use tariffs considering demand response

Thanks to smart meters, retail offers can be differentiated in terms of price and service, as today, but also in terms of price differentiation through time. Faruqui (2010) maintains that each consumer should be able to choose his own pricing structure, to which he can best adapt, among alternative price offers.

This work considers consumer groups with specific demand profiles and parameters for price elasticity of demand, as target groups to the definition of alternative TOU tariffs. A tool is proposed to determine the time location of prices and their respective values, with the purpose of achieving the demand response potential of each consumer group and maintaining fair pricing among all consumers. This tool was applied to the case of Portugal, considering the actual network and generation costs, specific consumption profiles and overall electricity low voltage demand diagram.

Modelling demand response dynamics

Electric Power Research Institute (2008) states that most consumers show price responsiveness and that the response level differs from one individual or group to another.

Price elasticity of demand is related to the utility function of electricity consumption. In the assumption of a rational use of energy, the consumer will only use energy while its cost is below the marginal utility derived from this energy use. Schweppe, Tabors, Caraminis and Bohn (1988) refer to this assumption in the following way: the rational consumer chooses the demand level that maximizes his net gain (utility minus cost).

Demand response to price variations includes readjusting the consumption level, changing overall consumption or transferring it between time periods with different prices. TOU tariffs aim mainly to transfer consumption, while structural modification of demand is promoted through other means, such as incorporating environmental externalities (like the European carbon emission trading scheme) in supply costs or promoting consumer information about energy efficiency[3].

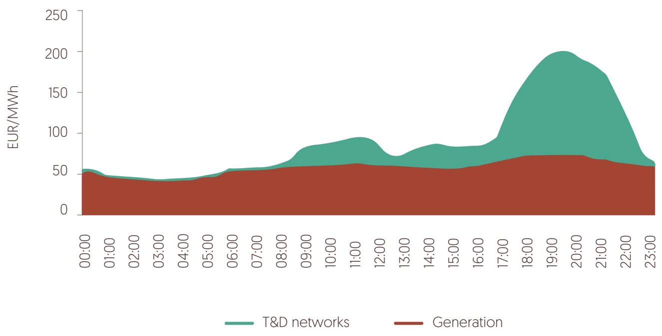
In the short term, consumers use technology and behaviour modifications at their disposal, in order to adapt demand to price changes. This short-term response is limited. When price changes persist, consumers adjust demand through additional tools, like investing in more efficient energy using devices (new production technologies, appliances or insulation measures in buildings), searching for information and training or changing the energy sources used in processes. As a result, price elasticity of demand is higher in the long term than in the short term (Electric Power Research Institute, 2008).

[3] This is the case of energy labels for appliances and buildings or information campaigns targeted to end-users.

Setting TOU tariffs

A method is proposed and used to identify peak time and off-peak time periods and its prices, using the hourly marginal costs of electricity supply, load profiles of demand of significant consumer groups and parameters for price elasticity of their demand. The half-hourly profile of marginal cost of supply (Figure 2) is estimated from marginal generation cost at wholesale market and incremental costs of using the transmission and distribution networks. Brandstatt and Friedrichsen (2012) have also referred the importance of using not only generation cost data but also network costs in the optimization process.

Figure 2 - Hourly profile of marginal cost of supply (example for a typical winter day)



For generation costs this work considered data on hourly wholesale market day-ahead prices (publicly available data at the website of the Iberian Electricity Market Operator, OMIE), without technical restrictions or ancillary services costs, in the Portuguese price area, during 2011. Prices at market referential were adjusted to low voltage consumer level through the application of power loss factors published by ERSE for 2011.

For transmission and distribution incremental costs there is no market reference to be used. Instead the authors developed a method to estimate half-hourly incremental costs based on the regulator's approved average incremental costs of each tariff period (peak, half peak, off-peak and super off-peak) in 2012 and on the characterization of the probability of each half hour period belonging to a given tariff period. Demand used to calculate the mentioned probability was from a 2005 internal study by the regulator on the demand profile at each voltage level. The method here described is detailed by Oliveira (2013).

Three load profiles are used to represent residential consumers and small companies in Portugal (A, B, C). The regulatory consumer segments defined for load profiling by the regulator and determined by ERSE (2011) were used. Group A corresponds to contracted power above 13.8 kVA (medium tertiary companies), Group B to contracted power up to 13.8 kVA and annual consumption above 7140 kWh (large residential consumers) and Group C to other consumers with contracted power up to 13.8 kVA (general small residential consumers). Group A accounts for 27% of consumption by consumers with contracted power under 41.4 kVA, Group B accounts for 3% and Group C makes the other 70%, according to the regulator's 2012 data. These consumers to which demand profiles apply represent 40% of total electricity demand.

Assumptions made by the authors on price elasticity of demand were based on price-demand elasticity parameters from a review of several papers presenting empirical studies. Fan and Hyndman (2011) indicate values between -0.4 and -0.2 for own elasticity, while Electric Power Research Institute (2008) mentions -0.6 to -0.2 (and 0.04 to 0.11 for crossed elasticity). In a study on Spanish consumers, Labandeira, Labeaga and López-Otero (2012) pointed to -0.25 to own elasticity and 0.05 for crossed elasticity.

2. Method for determining TOU tariff periods

The purpose of the method developed is to set tariff time periods, e.g. the classification of each hour in the day into tariff price levels, and the determination of the price levels which optimize a given objective function.

The method for determining TOU tariff periods uses a non-linear optimization model with real and binary variables (optimization model). A heuristic is used to determine valid (feasible) solutions to the optimization problem. The heuristic has two components that act sequentially: a greedy selection algorithm (which sets values for the binary variables) and a procedure to solve a system of non-linear equations. Other authors presented alternative methods for determining time-of-use tariffs such as Li, Wang, Le Blond and Li (2014) that used clustering of time periods without considering the dynamics of demand response. Holtschneider and Erlich (2013) used neural networks and an optimization heuristic for TOU determination close to real time. For regulators and other public bodies, the transparency of the optimization model proposed in the current study and its constraints can be considered as an advantage because it enables stakeholder consultations and involvement.

As a result from the application of this methodology, TOU tariffs are set for each consumer group.

Non-linear optimization model

A new integer non-linear programming model was developed, for two tariff price levels: peak (p_1) and off-peak (p_2). Considering that the time horizon *H* (1 day) is divided in sub periods *h* (30 minute periods), the model's variables are the price levels p_1 and p_2, the vector [y_h] which associates to each period h a price level p_1 or p_2 and the demand in each period h represented by q_h.

$$\min f_1 (p_1, p_2, [y_h]) = \sum_h q_h \cdot c_h - C_{ref} \quad \text{(a)}$$

s.a

$$\sum_h (1 - y_h)(q_h \cdot c_h - q_h \cdot p_1) = 0 \quad \text{(b)}$$

$$\sum_h y_h (q_h \cdot c_h - q_h \cdot p_2) = 0 \quad \text{(c)}$$

$$q_h = q_h^0 + \sum_j q_j^0 \cdot \left\{ \epsilon_{hj} \frac{[(1 - y_j) \cdot p_1 + y_j \cdot p_2] - p^0}{p^0} \right\}, \textit{ with } h \in H \quad \text{(d)}$$

$$p_1 \in [p_0, p_{max}] \quad \text{(e)}$$

$$p_2 \in [p_{min}, p^0] \quad \text{(f)}$$

$$y_h \in \{0,1\}, \textit{ with } h \in H \quad \text{(g)}$$

$$q_h \geq 0, \textit{ with } h \in H \quad \text{(h)}$$

Being (variables),

y_h decision variable on the applicable price for period *h* (0 for p_1 or 1 for p_2)

p_1, p_2 price variables (two time period tariff)

q_h demand during time period h

Given (constants),

p^0 single starting price

q_h^0 demand during time period *h* with starting price

c_h unit cost of supply during time period *h*

C_{ref} reference cost for starting conditions of demand and price (starting bill)

ϵ_{hh}, ϵ_{hj} own price-demand elasticity in period h (ϵ_{hh}) and crossed between *h* and *j* (ϵ_{hj})

Constraints for price adequacy to cost

Model constraints (*b*) and (*c*) ensure that prices, p_1 and p_2, are set such as resulting revenue is equal to the cost of supply. In the present case, the constraint was used so that the social optimum is pursued. However, it can be formulated as an inequality condition, namely ensuring that the tariff revenue is at least equal to cost, which could be the goal of a single market competitor when setting its prices.

These constraints impose the non-linearity to the model. Revenue is a square function of price, once demand depends linearly on price.

Demand response to price functionality constraint

Constraint (d) relates demand in each 30 minute time period with the starting demand, as a function of own and crossed price-demand elasticities. Own elasticities are negative hence demand in period *h* decreases when price in the same period increases. Crossed elasticities are positive hence demand in period *h* increases when prices in time periods next to *h* increase, since consumers transfer consumption from one period to the next. For the parameters ϵ_{hj} in the elasticity matrix the following values were used:

- Own elasticity: central value ϵ_{hh} = -0.2, with a sensitivity analysis in the interval [-0.4, -0.1].
- Crossed elasticity: central value ϵ_{hj} = 0.05, with a sensitivity analysis in the interval [0, 0.1]. It was considered in the central scenario that demand in a given period is only influenced by price in the previous and next 2 hours. The parameter value set for crossed elasticity correspond to the sum of all contributions from time periods close to *h*.

The sensitivity analysis for elasticity values was used to investigate the response of the model to different consumer segments with specific consumption patterns. Special tariffs can be designed for each consumer group. Another scenario was also used to simulate a more complex consumption type, with price-demand elasticity varying throughout the day, representing the greater or lesser will to modulate consumption according to prices in different times of the day. This scenario was called “optimized elasticity”.

Price structure constraints

Constraints (e) and (f) define the price structure, namely that p_1 is higher or equal to starting price p^0 (uniform price during the day) and that p_2 is lower or equal to p^0. It also confines prices within the max and min interval corresponding to the limits of the marginal cost function. Limits are also used in order to avoid extreme results coming from the linear demand function (Faria and Vale, 2011).

Time period classification constraint

(g) constraint defines each time period has belonging either to price tariff p_1 or p_2.

Demand variable constraint

Demand constraint (h) limits demand to a non-negative real number.

Objective function

The objective function (a) minimizes cost for the supplier and for the customer. If market prices reflect marginal costs then the reduction of costs to the end user means also reduction of total system costs, as well as environmental impacts.

A sensitivity analysis was performed on the marginal cost function using two alternative sets of marginal costs.

Using a heuristic method to solve the problem

An optimization solver was applied to the model described - Risk Solver Platform v11.5, from Frontline Systems, Inc. (Frontline Systems, 2011), running with Microsoft Excel 2010. However, due to the model's structure and dimension of the instances tested the solver did not determine optimal solutions. In fact, it was possible to manually find better solutions than the ones found by the solver, hence a heuristic was designed and applied to the model. The constructive heuristic uses a greedy algorithm to fix the integer variables and has two major steps:

- Procedure to solve the non-linear equation system, constraints (b)-(c), through a numeric approximation method to determine p_1 and p_2 and the value of the objective function.
- Greedy algorithm to search for a vector $[y_h]$ that improves the objective function, by changing one component of the vector in each iteration, constraint (g).

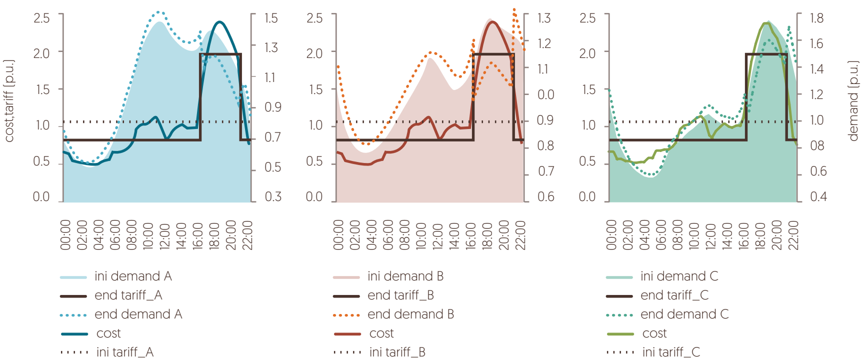
The use of a heuristic method to solve the non-linear optimization problem makes very easy to further impose other constraints on the solution. These constraints can be useful, for instance, if one wants to interfere in the time duration of each price block, the number of discontinuous price blocks throughout the day or other type of requirements. In fact, including these constraints in the model could be quite challenging and complex. Hence, the proposed heuristic approach gives much flexibility to the user of the optimization model.

3. Results obtained for TOU electricity pricing in Portugal

Demand profile changes with TOU tariff

Applying TOU tariffs with two prices (peak and off-peak) results in changes of the hourly profile of demand, due to the price elasticity of demand (Figure 3). The transfer of consumption is notorious when the peak price is considerably superior to off-peak price. In the cases studied, total daily demand was practically invariant.

Figure 3 - Impact of TOU tariffs in load profile of demand for load profiles A, B and C



Note: ini demand – initial demand profile; end demand – demand profile when TOU tariff is applied; "p.u." – per unit

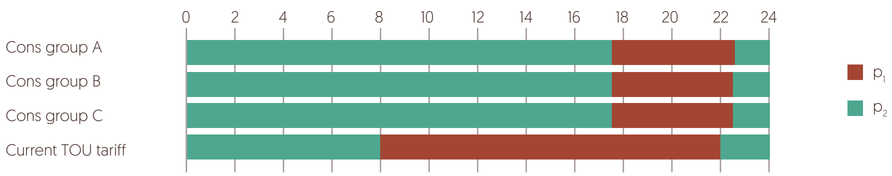
Analysis of results expected with TOU tariffs application

Simulations were performed for different consumer groups, corresponding to the groups used in the Portuguese regulatory regime concerning load profiles for tariff setting (ERSE, 2011). The results all suggested the same time period location for prices at peak (p_1) and off-peak (p_2) (Table I).

The current 2 TOU tariff has a peak time period between 8h and 22h, every day of the year. The time periods that resulted from the application of the methodology proposed in this work differ from those currently in place in Portugal. The proposed peak price time period is shorter and ends half an hour later [Table I].

Table I - TOU tariff time periods for load profiles A, B and C

Load profile [cons. group]	**Bill variation** [€/year]	**p1/p2**	**Peak TOU**
Profile A	-16,54	2,35	17:30 - 22:30
Profile B	-18,69	2,47	17:30 - 22:30
Profile C	-20,01	2,45	17:30 - 22:30
Current 2 TOU tariff			8:00 - 22:00

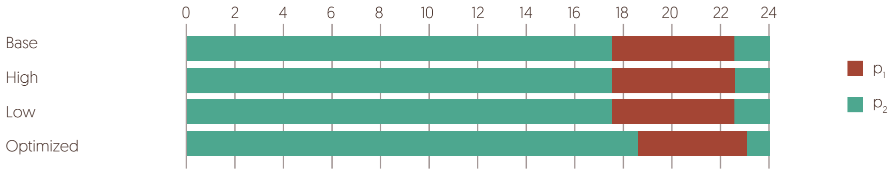


Notes: p1/p2 - ratio between prices

A sensitivity analysis was performed for different values for price elasticity of demand. Values for own and crossed demand-price elasticity were simulated higher and lower than the base case, as well as an optimized elasticity scenario where elasticity values vary along the hours of the day. Results showed that price period time location is quite insensitive to different scenarios of elasticity [in Table II the sensitivity results are presented for the profile C, the most significant consumer group].

Table II - Sensitivity analysis to price elasticity in TOU tariff for load profiles C

Load profile [cons. group]	**Elasticity**	**Bill variation** [€/year]	ϵ_{ii}	ϵ_{ij}	**p1/p2**	**Peak TOU**
Profile C	Base	-20,01	-0,2	0,05	2,45	17:30 - 22:30
Profile C	High	-45,25	-0,4	0,10	2,44	17:30 - 22:30
Profile C	Low	-12,07	-0,1	0,00	2,45	17:30 - 22:30
Profile C	Optimized	-24,08	*	**	2,34	18:30 - 23:00



Legend: p1/p2 - TOU price ratio
* -0,4 (6-9h and 21-24h); -0,1 (0-6h and 9-21h) ** 0,1 (6-9h and 21-24h); 0,025 (0-6h and 9-21h)

The consequences of the application of the TOU tariffs derived from the methodology presented can be estimated in terms of variation of consumer bills and maximum demand values (the latter is reflected on investment costs in the networks). Three demand price elasticity scenarios were simulated (high, average, low). Table III presents the main results respecting each consumer group.

Table III - Results expected from applying TOU tariffs

Load profile	Demand elasticity to price				Annual bill variation		Max demand
Consumer group	**Elasticity**	ϵ_{ii}	ϵ_{ij}	**p1/p2**	**[EUR/year]**	**[%]**	**18-23h variation [%]**
Group A	Average	-0,2	0,05	2,35	-16,54	-3,1%	-12,5%
	High	-0,4	0,10	2,35	-36,73	-7,0%	-18,7%
	Low	-0,1	0,00	2,35	-10,06	-1,9%	-7,5%
Group B	Average	-0,2	0,05	2,47	-18,69	-3,5%	1,6%
	High	-0,4	0,10	2,46	-41,32	-7,8%	8,0%
	Low	-0,1	0,00	2,47	-11,43	-2,2%	-2,2%
Group C	Average	-0,2	0,05	2,45	-20,01	-3,5%	-5,2%
	High	-0,4	0,10	2,44	-45,25	-8,0%	1,1%
	Low	-0,1	0,00	2,45	-12,07	-2,1%	-6,8%

The table shows own (ϵ_{ii}) and crossed (ϵ_{ij}) elasticity values used in each scenario and indicators on anticipated results: the ratio between peak (p_1) and off-peak (p_2) prices; annual bill variation; and the variation of the maximum demand value between 18h and 23h. This critical period contains the maximum aggregated demand in low voltage networks with 92% of probability.

The proposed method was applied to setting a 2 TOU tariff for all the days in the winter period, as an example. The winter period generally includes the yearly peak demand and, because of that, the greater marginal price differentiation. With the data used and the options taken, described in this paper, the time location of price periods was very stable across different scenarios. The period from 17h30 to 22h30 was chosen as the peak price time period.

A price ratio p_1/p_2 of around 2.5 was obtained from the simulations. This compares with a lower ratio in current 2 TOU tariff in Portugal for the year 2012 (ratio of 1.9). A higher price ratio corresponds to a greater price differentiation between peak time period and off-peak time period. Hence, the time periods for TOU tariff proposed in this paper are more effective in carrying price signals to consumers. Li et al. (2014) proposed a technique for TOU tariff determination using clustering algorithms which looks for reducing within-group dissimilarity in each time block with the same price, correspondingly a greater price differentiation between price blocks.

Demand response to different prices during the day results in annual bill reductions for consumers. Results expected (Table III) account for 1.9% to 8.0% reductions in the annual bill (assumed bill includes only the marginal costs of supply used in this paper, excluding taxes and fixed tariff prices). The major differences come from the responsiveness of the consumer (between high and low elasticity scenarios). The effects on the bill simulated for the three different consumer groups are quite invariant: from -1.9% (Group A) to -2.2% (Group B) with low elasticity and from -7.0% (Group A) to -8.0% (Group C) with high elasticity.

In order to measure changes to the hourly load profile of demand resulting from TOU tariffs, the expected variation in the maximum value of demand inside the 18-23h time window was estimated. In the simulated cases, the reduction of maximum demand in the critical period reached 18.7% (Table III). In this analysis, the results for the three consumer groups are quite distinct. For example, while Group A can reduce maximum demand in the time window 18-23h for 18.7% (with high elasticity), Group B increases the demand in the same period about 8% (and Group C demand increases 1.1%).

Considering the average scenario of elasticity values, the proposed TOU tariff results in an estimated variation in peak demand between +1.6% and -12.5%. Other studies like Faruqui and Sergici (2010) mention an average 4% decrease in peak demand by consumers in several TOU tariff pilot projects.

Conclusions

This work proposes a method to set electricity TOU tariff time periods for small size low voltage consumers (residential and companies). The adoption of smart meters, thus enabling consumption registration and consumer interaction far beyond current standards, will permit the promotion of demand response through electricity pricing.

Electricity supply costs vary in time and are bound by aggregated demand. Tariffs set by regulators or by market suppliers should reflect these costs, allocating them to the consumers that cause them, and should convey price signals that promote a correct response from demand.

The method proposed is based on the knowledge of the hourly marginal cost of supply, of the load profile of demand of certain consumer groups and their respective parameters for demand price elasticity.

With the scenarios used, the application of TOU tariffs with two prices resulted in a reduction in the annual bill of consumers of between 2% and 8% (mostly due to different price-demand elasticities), besides a reduction in the maximum demand in the critical period of up to 19%. These figures show that both consumers and network operators stand to gain with added efficiency brought about by this type of tariff. It also points to the relevance of enabling demand responsiveness. Different forms of promoting consumer responsiveness levels can coexist and can be delivered in the energy services market. Together with a cost reflective TOU differentiated electricity tariff this can deliver value to consumers and to the power sector. All consumer groups simulated showed a similar potential for reducing bills when applying such a TOU tariff. In other dimensions, such as changing the maximum demand in the 18-23h time window, the three consumer groups presented very different results (from an 18.7% decrease in maximum demand in Group A to an 8% increase in Group B). This can mean that for certain objectives to be achieved, network operators or public bodies should target specific consumer groups for applying TOU tariffs. This is also true for the geographical dimension of the problem.

TOU pricing should be accompanied by complimentary measures facilitating demand response. Electronic devices such as in-house displays are examples of tools for marketing price and consumption information to consumers. TOU tariffs can play an important role in the electricity system in order to cope with electric vehicles charging, which can follow TOU tariff price incentives to minimize network reinforcement costs (Brandstatt and Friedrichsen, 2012).

The method and the results obtained in this study could support the setting of time location of TOU prices by market players (regulators, suppliers, network operators). The method is also useful to assess the estimated benefits obtained by consumers and by the electricity sector as a whole, as a result of different pricing options, since the dynamics of price responsiveness of demand are considered.

Disclaimer

The analysis, opinions and conclusions in this paper reflect only the authors' views.

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Biographical note

Paulo Oliveira graduated in Power Engineering at Lisbon Technical University (UTL) in 1999. He did post-graduate studies in Information Systems and Technologies in 2001 and concluded a Masters in the field of Applied Mathematics and Economics in 2013, at UTL. He began his career at the Portuguese TSO (REN), working with decision support systems and regulatory reporting. In 2001, joined the Portuguese Energy Services Regulatory Authority (ERSE) where he worked mainly with electricity and gas tariffs and codes. He also worked in the field of energy efficiency programs and European regulatory cooperation. He is currently advisor of ERSE's Board of Administration.

Margarida Pato received the BSc in Mathematics and the PhD in Statistics and Computation from the University of Lisbon, in 1977 and 1989, respectively. Later she received the qualification in Mathematics from the Technical University of Lisbon in 1997. She is currently full professor of ISEG from the new Universidade de Lisboa (UL) and she is enrolled in teaching, students supervising, research and university management activities. Current management activities include the coordination of the MSc course on Quantitative Methods for Economic and Corporate Decision-making and the PhD course in Mathematics Applied to Economics and Management. She is researcher of CMAFCIO research centre of UL. Her research interests include production planning, school timetabling, personnel scheduling for bus transit companies and hospitals, and surgery scheduling.

Efficient pricing on distribution network tariffs

Isabel Apolinário, Cristina Correia de Barros, Hugo Coutinho, Liliana Ferreira, Bruno Madeira, Paulo Oliveira, Artur Trindade, Pedro Verdelho

ERSE (Energy Services Regulatory Authority) - Portugal

Abstract

This paper presents and discusses a methodology for the calculation of efficient prices on distribution network tariffs. Tariffs should reflect costs and assure the absence of cross subsidies between clients. Tariffs based on marginal cost send to consumers the right price signals, promoting economic efficiency in electricity use and in the use of its associated resources. The methodology presented is adopted in the Portuguese Tariff Code for electricity by the Portuguese Energy Services Regulatory Authority (ERSE). The work presented in this article reflects the experience acquired by ERSE during the preparation, discussion and implementation of this efficient pricing system.

Introduction

Electricity tariffs structure should be as simple as possible to assure that price signals transmitted to consumers are well understood. Price signals should be stable and coherent, promoting the correct medium and short term decisions (investments, load shifting, etc.) by electricity consumers and an efficient use of electricity and of the resources involved in the value chain of the power system. In order to achieve these objectives electricity tariff price structure should be based on marginal/incremental costs. Cost reflective pricing also contributes to reducing cross subsidization between groups of consumers, thus promoting a better allocation of resources in the economy allowing for improvements in the economic efficiency of the power system and energy using activities. Not less important, cost reflective pricing assures the fairness of the tariff system, promoting a level playing field for all consumers and suppliers.

In a competitive market, marginal costs set the price at a point where they equal or exceed the average cost of supply. In this case, companies assure their economic profit, practicing fair prices in the consumer's perspective. Social best coincides with economic best where minimum costs and maximum welfare are assured, resulting in equality between average costs, marginal costs and prices. For the social best to be achieved it is necessary that marginal costs consider all social costs involved in the productive process.

1. Tariffs Reflecting Costs

Electricity tariffs are defined by a set of prices applicable to several measured price variables. The choice and definition of such variables, as well as the determination of how they are measured, should allow for the setting of cost reflective prices for each service associated with electricity distribution, induced by each consumer. The resulting price should reflect the costs of the network. Also the tariff structure should reflect the marginal or incremental cost structure, encouraging its use in times of lower demand periods, where the saturation of networks is smaller, and discouraging the use of networks in times of increased demand periods of the system, in which the probability of saturation of the networks is higher.

Price variables for the pricing of electricity distribution networks

The present paper discusses the rational for the choice of price variables on distribution networks, how are these variables measured and what costs should these variables reflect.

The costs of the network sections close to the delivering points should be recovered by contracted power, measure on short periods of time, as 15 minutes, once the dimensioning of the peripheral sections is conditioned by the behaviour of a small number of consumers, if not by only one consumer.

The costs of the more central network sections should be recovered by average power in the periods of higher demand. In fact, the most central network sections are used by a large number of clients and, due to reduced synchronization of the peak occurrences of 15 minutes of each consumer (annually or monthly), we may admit that the individual behaviour of a consumer only subjects the dimensioning of these more central sections of the network proportionally to its average peak power on a wider period of time, coincident with the network aggregated peak and not through its annual peak power, or even monthly. For these reasons, the power measured in a more widen period of time, coincident with the time periods where the network peak powers are observed, is a variable more adequate than the annual peak power of each consumer, to transmit to consumers the costs associated with the more central sections of the distribution network, as well as the costs of the upstream networks imputable to each voltage level.

In Figure 1, 20 different load profiles are represented, in values per unit, as well as the aggregate diagram (diagram of the central network sections). Figure 2 presents the same load profiles simulating the existence of technologies limiting contracted power, with the corresponding effect of smoothing the individual load profiles. The figure also shows the aggregate diagram on these conditions. The natural aggregation of the loads on the distribution network promotes the elimination of the 15 minutes power oscillations. There is a remarkable resemblance between the two aggregate profiles, which means that the maximum power on a reduced time period for each consumer is not an adequate variable to reflect in each consumer or incite cost reductions on the upstream networks. By the contrary, the average power on a wider period of time coincident with the aggregate peak of the network is a good measure of the maximum power on the main network sections. It presents also the property of being an additive variable, which means that the power on the central network sections is equal to the sum of each consumer's power, including network losses, what allows to represent on a reliable way the individual responsibility of each consumer for the system costs.

Figure 1 - Consumptions aggregation, without control of 15 minutes power

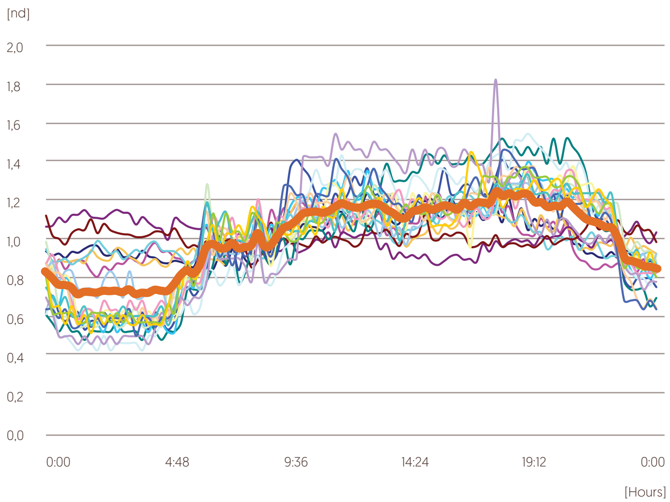
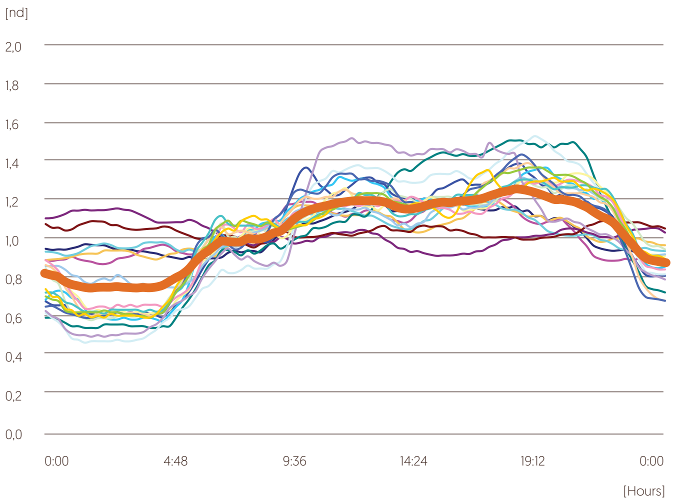


Figure 2 - Consumptions aggregation, with control of 15 minutes power



The reactive energy supplied (inductive demand) is a variable which should be used on the billing of the network use on peak and half-peak time periods, because its compensation allows the reduction of the electric system global costs, either on the minimization of energy losses on the peripheral network sections, or on its reinforcement. The costs associated with the local compensation of reactive energy, conditioned by the price of capacitors or other equipments based on power electronics which start to be available, are quite lower than those which result from the central compensation on substations. Thus, it is desirable that the compensation of reactive energy is done locally, and that it's billing, similarly to the contracted power, is applied to each supply voltage level. Although it should not be entirely disconnected from the corresponding costs, the price can also have a character of fine to incite the consumer to compensate the reactive energy locally.

Concerning reactive energy received (capacitive demand), its compensation may also be desirable in off-peak periods, because it may lead to overvoltage situations on the delivery points. Due to that, capacitive reactive energy in off-peak periods may also be priced.

The active energy delivery on each time period causes losses on distribution networks, different in size and cost for each time period. Technical losses depend on a set of factors, namely on the type of network, underground or aerial, and on power, once losses are proportional to the square of power. Being aware that losses, and its economic value, vary considerably with the time and seasonal period of consumption, the adequate billing variables to give consumers the adequate economic signal of the cost of losses are active energy, by time period and seasonal period.

Contracted power, peak average power, active energy, differentiated by time period and seasonal period, and reactive energy are the price variables, together allow to pass on to consumers the multiplicity of factors that affect the costs of distribution networks. The choice of these variables has to be made considering that they must be simple to bill, according to the size and complexity of the consumers, and that they must cover all the costs.

Long Run Average Incremental Costs

In an efficient tariff system, the tariff structure should reflect marginal or incremental costs of the electricity sector. By adopting prices that reflect marginal or incremental costs, the crossed subsidization amongst clients groups tends to be reduced, thus promoting optimal resources distribution and increasing the electric system economic efficiency while fostering the equality of treatment and opportunities.

The marginal or incremental costs of each of the physical variables determined correspond to the cost due to delivering one additional unit of that variable.

Contracted power and average power in peak hours should be calculated through the long run average incremental costs methodology, according to the following formula,

$$Inc\ C_j\ P_i = \frac{\dfrac{\sum_{t=-L}^{t=H-L} \Delta I_{j,i}}{(1+d)^t}}{\dfrac{\sum_{t=0}^{t=H} \Delta P_{j,i}}{(1+d)^t}}$$

where: $IncC_j\ P_i$ is the long run average incremental costs for power i and network j; ΔI is the network j annualized investments and variation in operational expenditures to meet the increases in power I; $\Delta P_{j,i}$ is the increase in power i for network j; d is the discount rate; H is the number of years; L is the time gap between investment and increase in demand; i is the contracted power or average power in peak hours; j is the high, medium or low voltage network.

Investments in more central network sections depend essentially on the increases in power in peak hours, whereas investments in peripheral sections depend essentially on increases in contracted power.

To apply the present methodology a lot of network cost high quality information is needed. Namely, it is necessary that this information is disaggregated by network component (overhead lines, underground cables, transformers and switching substations, transformers, switchgears, peripheral cables, among others), in order to determine the central network section costs and the peripheral ones.

Whenever prices resulting from applying the incremental costs methodology don´t allow for the full recovery of the allowed revenues (associated to establishment, exploitation, development and maintenance of the networks in order to distribute electricity from its reception points to the end users), additive or multiplicative factors should be applied, for each price, in order to assure costs recovery and also to simultaneously reflect the incremental costs structure.

It must be borne in mind that these factors must not distort consumption decisions, i.e, more price inelastic demand components should endure a higher factor (Ramsey-Boiteux Rule). When opting between additive or multiplicative factors, the latter is preferable because (i) the price ratio is equal to incremental costs ratio, (ii) the equilibrium dynamics is maintained and (iii) the consumers get responsible for the costs they bring on the system thus promoting a more efficient demand.

2. Portuguese Distribution Network Tariffs

In Portugal there are three distribution network tariffs for high voltage (HV), medium voltage (MV) and low voltage (LV).

The HV distribution network tariff applies to HV, MV and LV consumers, while the MV tariff applies to MV and LV consumers.

The tariff variables used in the Portuguese distribution network tariffs are:

1. Contracted Power. For HV, MV and SpLV (Special Low Voltage with power higher than 41,4 kW) corresponds to the maximum average active power in kW, in any uninterrupted period of 15 minutes. For StLV (Standard Low Voltage with power lower than 41,4 kVA) corresponds to the apparent power in kVA. Each consumer only pays for maximum 15 minutes peak power to the network he is connected to, and according to the voltage level.

2. The Average Peak Power that is the ratio between peak hour active energy and the number of peak hours.
3. The Peak Hours Active Energy that is the energy consumed in the peak hours time period.
4. The Half-Peak Hours Active Energy that is the energy consumed in the half-peak hours time period.
5. The Off-Peak Hours Active Energy that is the energy consumed in the normal off-peak hours time period.
6. The Super Off-Peak Hours Active Energy that is the energy consumed in the super off-peak hours time period.
7. The Reactive Energy Supplied that is the reactive energy supplied which exceeds 40% of the active energy, in peak and half-peak hours.
8. The Reactive Energy Received that is the reactive energy received in off-peak hours.

Reactive energy is only billed to the consumer regarding the network and voltage level of connection.

When a price is calculated for a variable in a superior voltage level it must be converted to the lower voltage levels applying the correspondent loss factors. Additionally another type of conversion is necessary. It's the conversion from complex tariffs with several variables to simpler tariffs with just some few tariff variables for application to smaller clients. These conversions are made using load profiles for each tariff category and the conversion occurs in a way that the amount of revenue recovered by variable is not affected.

Table 1 illustrates the conversion of the MV distribution network tariff to the LV tariff options of four, three, two or one time periods.

The prices of the MV distribution network tariff are referred to the distribution network exit in MV, being converted to LV using loss factors in the LV network. The reactive energy is only billed to MV consumers. For the SpLV consumers, the converted tariff has only a peak power price, resulting from the sum of the contracted power price multiplied by an increase factor and the peak power price. For the StLV consumers, the peak power prices are converted into prices of peak hours energy if the tariffs have 3 time periods, into prices of (broad) peak hours if the tariffs have 2 time periods or into prices of energy if the tariffs have 1 time period.

As it can be seen the energy prices increase from MV to SpLV. This increase is also higher for peak time periods than for off-peak time periods due to the values of loss factors.

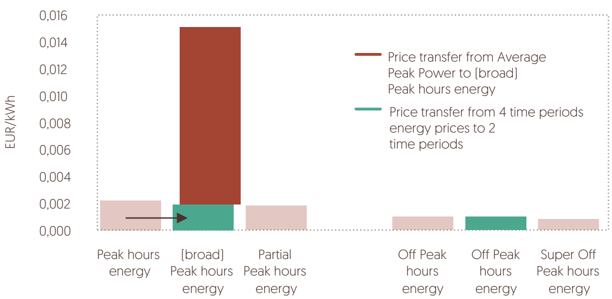
Table 1 - MV network distribution tariff conversion to LV

PRICES OF MEDIUM VOLTAGE DISTRIBUTION NETWORK TARIFF

		Power (EUR/kW.month)		Active Energy (EUR/kWh)								Reactive Energy (EUR/kvarh)	
				Season I e IV				Season II e III					
Voltage level and tariff option	**Number of time periods**	**Peak hours**	**Contracted**	**Peak hours**	**Half-peak hours**	**Off-peak hours**	**Super off-peak hours**	**Peak hours**	**Half-peak hours**	**Off-peak hours**	**Super off-peak hours**	**Supplied**	**Received**
MV	4	3,798	0,668	0,0020	0,0017	0,0009	0,0008	0,0021	0,0017	0,0010	0,0008	0,0178	0,0134
SpLV	4	4,967	-	0,0022	0,0018	0,0010	0,0008	0,0022	0,0018	0,0010	0,0008	-	-
StLV 3 time periods	3	-	-	0,0615	0,0018	0,0009		0,0615	0,0018	0,0009	0,0000	-	-
StLV 2 time periods	2	-	-	0,0151		0,0009		0,0151		0,0009		-	-
StLV 1 time period	1	-	-	0,0096				0,0096				-	-

Figure 3 illustrates the conversion of the energy and average peak power prices of the MV distribution tariff to a simplified two time period LV tariff applicable to small LV consumers. This two time period LV tariff presents only two prices of energy (on broad peak hours and off-peak hours) and a price of contracted power. Thus the energy prices on peak hours and half-peak hours and the average peak power price are all converted to a broad peak hours energy price. Also the energy prices on off-peak and super off-peak hours are both converted to a larger off-peak hours energy price.

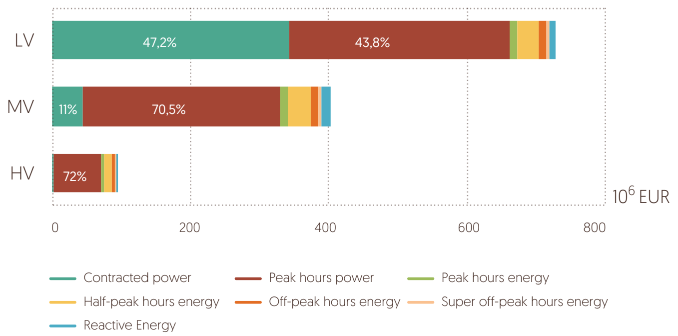
Figure 3 - MV Distribution network tariff conversion to a 2 time period LV tariff



The use of load profiles to obtain simplified tariffs might create some distortions between consumers in the same tariff. Nevertheless it is believed that such small inefficiency is accepted when compared with the costs of implementing more sophisticated metering to smaller consumers, which maybe hardly economically justifiable. The converted tariffs to the different levels of application are published by ERSE in a justified way. Therefore every consumer might know in advance what is included in every price variable he pays.

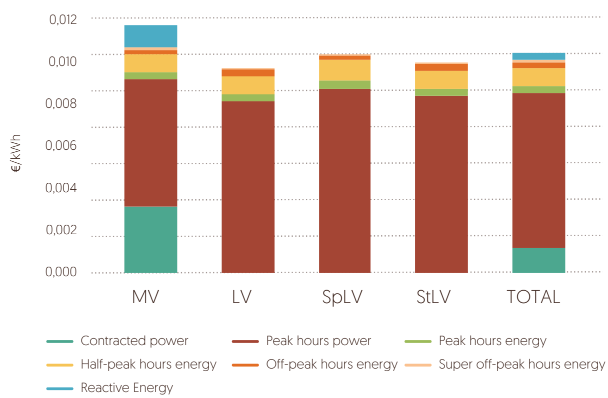
The methodology of the long run average incremental costs used for the calculation of the prices of contracted power and average peak power has resulted on the price structure for the distribution network tariff illustrated in Figure 4. It can be seen that the variable that recovers the costs of investment in the central sections of the network, peak hours power price, represents 70% of the total revenues in the HV and MV distribution network tariffs. In LV distribution network tariff, because of the higher weight of investments in the peripheral sections of the network, contracted power has the higher weight in the total revenues.

Figure 4 - HV, MV and LV Distribution network tariff price structure



In Figure 5, it is depicted the price structure of MV electricity distribution network in MV and LV. Contracted power and reactive energy are variables billed only to MV consumers.

Figure 5 - MV Distribution network tariff price structure



Conclusions

In the present paper it is presented the distribution network tariff calculation methodology established in the Portuguese Tariff Code for electricity, which is of ERSE's responsibility. The choice of the billing variables has been made by the Portuguese energy regulatory authority considering that they must be simple to bill, according to the size and complexity of the consumers, and that they must cover all the costs. Contracted power, peak average power, active energy and reactive energy are the price variables considered, which together allow to pass on to consumers the multiplicity of factors that affect the costs of distribution networks. Tariff price structure should reflect marginal/incremental cost structure and cost reflective pricing should be applied, contributing to reduce cross subsidization between groups of consumers, thus promoting a better allocation of resources in the economy allowing for improvements in the economic efficiency of the power system and energy using activities.

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Introduction of a decoupled entry-exit tariff system in the Portuguese natural gas sector

Isabel Apolinário, Liliana Ferreira, Pedro Verdelho

Portuguese Energy Regulator (ERSE), Lisboa, Portugal

Abstract

A major element of the 3rd EU energy package is the mandatory entry-exit tariff systems that shall be adopted to the transmission network access. There is a huge consensus around decoupled entry-exit tariff systems, because they can be more cost reflective, avoid cross subsidies between network users, facilitate gas trade and can provide signals for the location of gas injections or off-takes.

The importance of transmission tariffs for the completion of the EU internal energy market is such that EC Regulation 715/2009 foresees a network code on rules regarding harmonised transmission tariff structures.

This paper presents the methodology applied by the Portuguese Energy Regulator (ERSE) to implement a decoupled entry-exit tariff system for the Portuguese natural gas transmission network. Different entry-exit prices independent of the contractual paths are obtained leading to an efficient use of the transmission network, facilitating gas trade and thus contributing to market development.

For the calculation of transmission gas tariffs in Portugal a matrix approach is applied based on the unit capacity costs of every possible path. As entry-exit tariffs should be independent from the contractual path, unit capacity costs in each entry point and exit zone, independent of the contractual path, are obtained through an optimization problem.

Keywords

Gas Transmission Network Tariffs - Entry Exit Tariff Systems - Natural Gas System Acess Tariffs.

Introduction

The 3rd EU energy package, which entered into force in 2009, defines a number of structural elements for achieving a single European market for gas. A major element is the mandatory entry-exit organization of transmission network access, in the belief that the creation of entry-exit zones is a precondition for the creation of functioning markets in the EU.

To enhance competition through liquid wholesale markets for gas, it is vital that gas can be traded independently of its location in the system, giving network users the freedom to book entry and exit capacity independently, thereby creating gas transport through zones instead of contractual paths. Article 13 of the EC Regulation 715/2009 establishes that "tariffs for network users shall be non-discriminatory and set separately for every entry point into or exit point out of the transmission system" [1]. There is a huge consensus around decoupled entry-exit tariff systems, because they can be more cost reflective, avoid cross subsidies between network users, facilitate gas trade and can provide efficient economic signals for the location of gas injections or off-takes. Decoupled entry-exit tariffs are an important tool to ensure non-discrimination between national and cross border gas flows.

In 2010, the Portuguese Energy Regulator (ERSE) changed the methodology for the calculation of natural gas transmission network tariffs, from a postage stamp to a fully decoupled entry-exit tariff system.

The purpose of this paper is to present the methodology applied to implement a decoupled entry-exit tariff system in the Portuguese natural gas sector that ensures a correct cost allocation of the gas transmission network.

The transmission tariff has a small weight in the final prices, ranging from 2% to 5% depending on the pressure level, but it is very important to define an adequate structure because it has a strong impact on infrastructure investments and on market development.

1. Entry-exit tariffs

1.1. Rational for an entry-exit tariff system

Until 2010 the methodology applied in Portugal to calculate gas transmission network tariffs was the postage stamp methodology, because when transmission tariffs were introduced in Portugal, the transmission system was characterized by dominant flows, almost all gas was hauled in the same direction and so a postage stamp was most likely to be cost reflective. However, with liberalization and the goal of a higher integration of Iberia, where flows may be less predictable, a postage stamp by which a uniform tariff is applied to all points irrespective of their location in the system, will not be cost reflective and may lead to cross subsidies.

When third party access to transmission networks was introduced the preferred tariff methodology adopted by transmission system operators (TSOs) was point-to-point (also known as distance related tariff), by which prices are fixed according to contractual paths, varying with the distance between entries and exits.

In 2010, ERSE changed the methodology for the calculation of natural gas transmission network tariffs, from a postage stamp to a fully decoupled entry-exit tariff system.

The advantages of an entry-exit tariff methodology are fourfold: i) it offers flexibility to shippers and promotes competition because there is not a contractual path defined, i.e, shippers may buy entry into the system without committing to an exit; ii) it is cost reflective, avoids cross subsidies between network users, facilitates gas trade and can provide signals for the location of gas injections, unlike a postage stamp methodology that involve cross subsidies; iii) it is transparent and simple especially if the entry and exit points are grouped into zones so that a limited number of prices are applied; and iv) is a more general methodology which includes both postage stamp and point-to-point as particular cases.

Decoupled entry-exit tariffs are an important tool to ensure non-discrimination between national and cross-border gas flows.

1.2. EC Directives and Regulations

The importance of transmission tariffs for the completion of the EU internal energy market is such that EC Regulation 715/2009 foresees a network code on rules regarding harmonized transmission tariff structures. The EU Agency for the Cooperation of Energy Regulators (ACER) is working on the framework guidelines on harmonized transmission tariff structure, setting out clear and objective principles for the development of this network code.

EC Regulation 715/2009 of 13 July 2009 states that "To enhance competition through liquid wholesale markets for gas, it is vital that gas can be traded independently of its location in the system. The only way to do this is to give network users the freedom to book entry and exit capacity independently, thereby creating gas transport through zones instead of along contractual paths." Additionally, article 13 states that "Tariffs for network users shall be non-discriminatory and set separately for every entry point into or exit point out of the transmission system. Cost-allocation mechanisms and rate setting methodology regarding entry points and exit points shall be approved by the national regulatory authorities. By 3 September 2011, the Member States shall ensure that, after a transitional period, network charges shall not be calculated on the basis of contract paths." Also, "In order to ensure transparent, objective and non-discriminatory tariffs and facilitate efficient utilization of the gas network, transmission system operators or relevant national authorities shall publish reasonably and sufficiently detailed information on tariff derivation, methodology and structure."

Postage stamps and point-to-point tariffs are not in line with the principles of the single market and therefore are not supported by the EC. Entry-exit tariffs are the chosen model.

As the calculation of entry-exit tariffs always entails some regulatory decision about cost allocation, transparency of tariff setting criteria is crucial, because reduced transparency may consist of a problem, with a certain risk that tariff systems may overweight on transit flows with respect to domestic destinations, or the reverse.

1.3. Entry-exit tariff methodology

The calculation of transmission charges according to an entry-exit tariff methodology can be briefly described as follows (Ascari, 2009):

(i) a snapshot of the gas transmission network is required, where the network is split into entry points, exit points and main pipelines that connect each entry and exit points, together with technical information (distance, diameter, pressure, flow direction);

(ii) a cost index is associated to each pipeline segment, which is calculated as a point to point tariff (it depends mostly on its length and diameter). A decision has to be made on the concept of cost to be used, either average cost or marginal/incremental long run cost;

(iii) paths must be defined linking each entry point with each exit point and cost index paths are calculated by summing up all cost indexes of pipeline segments included in the path, considering whether they are used in the direction of gas flows or backhaul. A matrix is generated where costs of reaching each exit from each entry point are calculated. Path costs then form a matrix with as many rows as entry points and as many columns as exit points (or exit zones including several delivery points);

(iv) once costs of all paths have been determined, entry-exit charges are calculated, which are only related to entry points irrespectively of exit, and to exit points irrespectively of entry. This is achieved by minimizing the sum of the squares of the difference between the sum of entry and exit capacity charges (ETI_e and XTI_x) for each path and the corresponding actual path cost index (*PCI*). Negative solutions are not allowed. Formally:

$$\min \sum_{e,x} (ETI_e + XTI_x - PCI_{e,x})^2$$

Subject to: ETI_e , $XTI_x \geq 0$ for each *e*, *x*.

Where: ETI_e is the charge for the entry point *e*; XTI_x is the charge for the exit point *x*; and $PCI_{e,x}$ is the cost of the relevant network asset used to flow gas from entry *e* to exit *x*.

(v) Finally, the entry and exit capacity tariffs determined by the previous optimization problem are proportionately increased or reduced so that the allowed revenue is achieved by selling all available entry and exit capacities.

1.4. Transmission tariff structure in Portugal

The tariff setting process comprises two fundamental steps, the calculation of the allowed revenues for the operators and the definition of the tariff structure that allows for the revenues to be recovered while ensuring that the correct price signals are being transmitted to the network users in order to foster network efficiency. ERSE is in charge of setting the allowed revenues and tariffs, on the basis of TSO operational charges and investments and demand forecasts, according to the rules and methodologies established on the Tariff Code approved by ERSE after a public consultation. Tariffs final approval is preceded by a tariff proposal subject to the non-binding opinion of the tariff council, which is made of representatives of all stakeholders from the natural gas sector.

Gas tariffs structure should be as simple as possible to assure that price signals transmitted to consumers are well understood. Price signals should be stable and coherent, promoting the correct long and short term decisions (investments, load shifting, etc.) by investors and network users and an efficient use of gas. In order to achieve these objectives gas tariff price structure should be based on marginal/incremental costs. Cost reflective pricing also contributes to reducing cross subsidization between network users, thus promoting a better allocation of resources in the economy allowing for improvements in the economic efficiency of the gas system and energy using activities.

For the tariff structure is fundamental to choose the most adequate price variables, according to cost drivers. The price variables applicable to natural gas transmission network are used capacity at entry points, used capacity at exit points, peak time energy at exit points and off-peak time energy at exit points.

The following table discusses the rational for the choice of price variables on transmission networks, how are these variables measured and what costs should these variables reflect.

Figure 1 - Transmission price variables

Price variables	Description	Rational and costs reflected
Used capacity at entry points	Maximum daily flow in the last 12 months, in the transmission network entry point, in kWh/day. The maximum daily value is paid in the twelve following months.	The maximum daily flow determines investments in central and upstream sections of the gas pipeline. Its dimensions is determined by the injection capacity by the users/suppliers.
Used capacity at exit points	Maximum daily flow in the last 12 months, measured in the network delivery point, in kWh/day. The maximum daily value is paid in the twelve following months.	The maximum daily flow determines investments in peripheral sections of the gas pipeline, that include connections to end users and GRMS, shared by a small number of clients. Its dimension is influenced by the maximum capacity required by the clients.
Peak time Energy at exit points	Volume of gas, measured in the network delivery point, in kWh, during peak day.	The flow in peak day periods partially determines investments in central sections of the gas pipeline, shared by a large number of clients. Its dimension is indirectly influenced by the average capacity required in peak days. The capacity expansion of the network is partially justified by the energy that flows in peak days, thus avoiding congestions in those periods.
Off-Peak time Energy at exit points	Volume of gas, measured in the network delivery point, in kWh, during off-peak day.	This variable should reflect the costs that depend on the volume of gas carried in the gas pipeline and processed in the GRMS.

It is worth noting that the tariff structure should be capacity based, because capacity, and not the amount of energy, defines the costs of the pipelines. In Portugal capacity recovers 90% of the total allowed revenues.

With the goal of achieving more tariff flexibility, and enabling the access to the gas system of market players with time concentrated uses, the transmission tariff includes two extra tariff options: (i) short duration tariff (on entry and on interconnection exit points) and (ii) low-load-factor tariff (applied on exit points to customers whose consumption has a very low load factor).

In the short duration transmission tariff option, the used capacity price is totally converted to an energy price, applied to the flows in the transmission network, resulting in energy prices (commodity prices) higher than the annual reference energy prices.

In the Low-load-factor tariff option, the used capacity price is partially converted to an energy price in peak days periods, applied to the flows in the transmission network.

2. Entry-exit tariff methodology applied to the Portuguese horizontal transmission network

The methodology used in Portugal for the calculation of transmission network access tariffs, namely for the price variable used capacity at entry points is a matrix approach based on the capacity unit costs of every possible path.

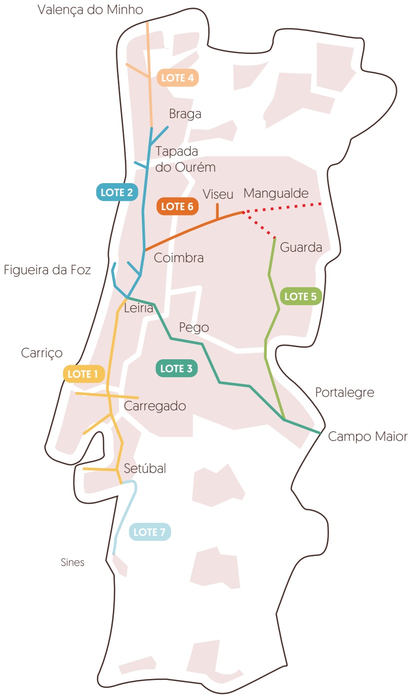
To calculate the unit costs of capacity at entry points a methodology for optimal allocation of costs is applied (Hunt, 2008).

3. First step: Simplified model of the horizontal transmission network

The first step in applying the entry-exit methodology is to design a simplified model of the horizontal transmission network (indentifying entry points, exit points and pipeline segments' length). The horizontal transmission network does not include peripheral sections of the gas pipeline, namely connections to consumers and Gas Regulation and Measurement Stations (GRMS) used by a limited number of consumers.

In Portugal there is one balancing zone and the transmission network concerns high pressure gas network, above 20 Bar. Figure 2 presents the Portuguese transmission network.

Figure 2 - Portuguese gas transmission network



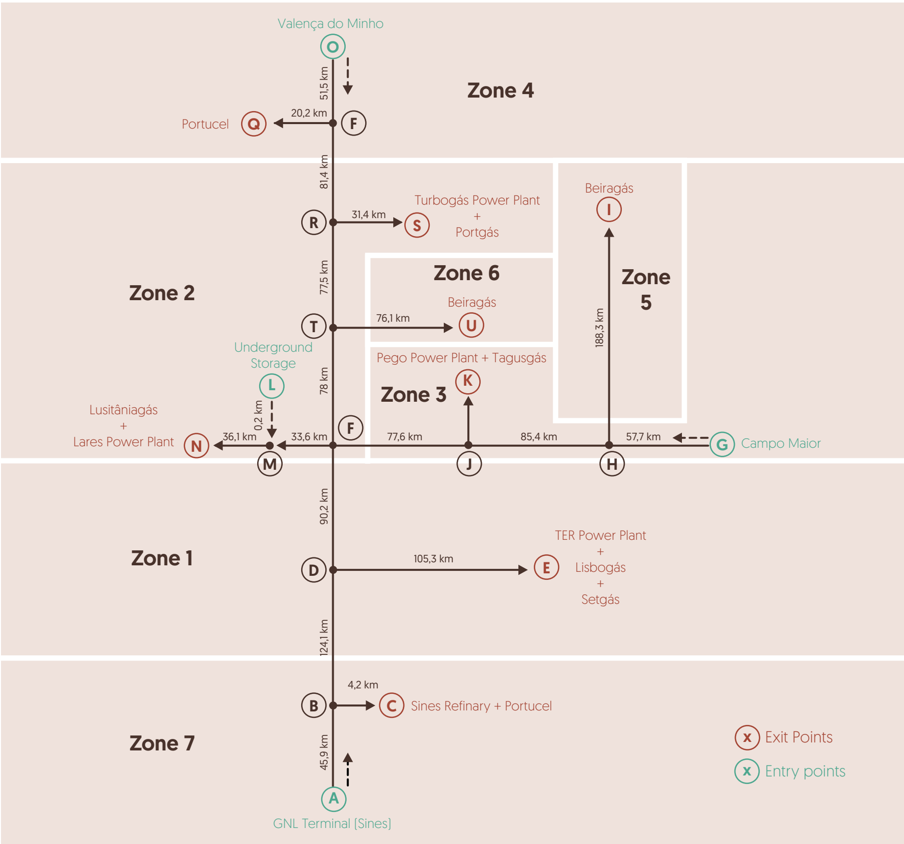
The Portuguese natural gas transmission network has approximately 1200km, with four entry points. The entry points are two international interconnection points (O-Valença do Minho and G-Campo Maior), one LNG Terminal (A-Sines) and one underground storage facility (L). The exit points are the high pressure clients (which include electricity power plants), the LNG terminal and the distribution networks.

The LNG Terminal is also used for balancing, it gives greater flexibility for balancing purposes to shippers. Additionally, it gives more flexibility to small suppliers of LNG to small isolated industrial customers.

The underground storage facility is considered an entry point to the system and not an exit point because physically the exit flows from the grid is always small, investments depend on the exit from the underground facility to the grid.

For the simplified model of the network the exit points are clustered into eight exit zones [Q, S, U, K, I, N, E, C].

Figure 3 - Simplified model of the network



3.1. Second step: Used capacity at entry points and exit zones

The second step is the characterization of the maximum capacities in the medium term (3 years) in each entry point and exit zone of the simplified model, according to the company's investment and business plan (figure 4).

Figure 4 - Maximum capacity in the medium term

Entry points		Capacity MWh/day
A	Sines	192 780
G	Campo Maior	122 000
L	Carriço	6 762
O	Valença do Minho	23 000
	TOTAL	**344 542**

Exit zones		Capacity MWh/day
C	Refinaria+Cogeração GALP em Sines+Portucel [...]	26 785
E	TER+Carregado+Lisboagas+Setgas+Cog Barreiro	99 424
I	Beiragas (Guarda)	2 178
K	Pego+Tagusgas	41 522
N	Lares+Lusitaniagas+Soporgen+Carriço(ind)+Leirosa	89 891
Q	Portucel	2 390
S	Turbogas+Portgas+Refinaria Petrogal+Air Liquide	80 174
U	Beiragas (Mangualde)	2 178
	TOTAL	**344 542**

These maximum capacities are divided by the several sections, resulting in the following matrix (figure 5). The matrix has thus the capacity used in each branch of the network and the contribution associated with each entry point.

Figure 5 - Maximum capacity in the medium term per section, Mega Watt hour per day

Zone	Sections	Capacity (MWh/day)				Flow per section (MWh/day)
		Flow from A	Flow from G	Flow from L	Flow from O	
7	AB	192 780	-	-	-	192 780
7	BC	26 785	-	-	-	26 785
7+1	BD	165 995	-	-	-	165 995
1	DE	99 424	-	-	-	99 424
1	DF	66 571	-	-	-	66 571
3	GH	-	122 000	-	-	122 000
5	HI	-	2 178	-	-	2 178
3	HJ	-	119 822	-	-	119 822
3	JK	-	41 522	-	-	41 522
3	JF	-	78 300	-	-	78 300
2	FM	38 199	44 930	-	-	83 129
2	LM	-	-	6 762	-	6 762
2	MN	38 199	44 930	6 762	-	89 891
2	FT	28 372	33 370	-	-	61 742
6	TU	1 001	1 177	-	-	2 178
2	TR	27 371	32 193	-	-	59 564
4	OP	-	-	-	23 000	23 000
4	PQ	-	-	-	2 390	2 390
2+4	PR	-	-	-	20 610	20 610
2	RS	27 371	32 193	-	20 610	80 174

3.2. Third step: Investments

Then, the investments required to meet maximum capacity are identified, annuities are calculated and allocated to each branch of the network, proportionally to its length.

The investments considered are related just to gas pipelines.

The following figure shows the investments made in the past and planed for the future, for a 16 year series. The longer the series the better, the less biased are the results.

Figure 6 - Investments per zone, thousands of euros at current prices

Capex €th	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7
1997	205 123	214 607	116 767	22 491	0	931	
1998	7 251	5 592	4 326	21 086	0	574	
1999	322	592	247	5 639	3 210		
2000	386	6 975	38	291		10	226
2001	157	345	44	337	2 019	103	
2002	2 101	468	24	131	282	1 385	
2003	246	691		202	2 548	27 487	47 515
2004	351	873	82	5 362	87	130	818
2005	286	514	730	1 693	81	107	442
2006	212	386	217	295	98	357	207
2007	95						
2008	25	1 935			24	29	1 203
2009	3 475	21 890	1 052	71	16	122	4 433
2010	8 909	7 385	1 652	190	117	103	463
2011	12 465	3 544			29	286	1 698
2012	5 245				0		
Total	**246 647**	**265 798**	**125 178**	**57 787**	**8 511**	**31 624**	**57 005**

This is the level of investment needed to meet the capacity.

It is worth noting that investments in GRMS are not to be considered in the assets of the horizontal transmission network as they are related to exit points to supply domestic clients in the downstream market.

Considering the useful lifetime of these assets of 43 years[1], the companies discount rate of 8% (rate of remuneration fixed by ERSE) and corresponding operational costs of 2,3%[2], we are able to calculate the annuities per zone in figure 7 [4].

[1] The lifetime of assets is defined on the Portuguese fiscal accounting legislation.

[2] The percentage for the operational costs is based on the actual ratio between operating costs and gross fixed assets (year 2008).

Figure 7 - Annuities per zone, thousands of Euros at current prices

	Annuity €th
Zone 1	18 975
Zone 2	20 892
Zone 3	9 838
Zone 4	4 542
Zone 5	669
Zone 6	2 485
Zone 7	4 480
TOTAL	61 882

3.3. Fourth step: Unit cost calculations

Finally the calculation of unit costs is performed and so the unit cost for each possible path (every possible combination of entry point – exit zone) is obtained.

Figure 8 presents the annuity for each gas pipeline section, the maximum daily capacity used and the corresponding annual unit cost obtained. For example, section [BE] total unit cost is given by the sum of the unit cost of the section [BD] and [DE].

The "Total" line represents prices related to contractual paths and they do not favour market freedom. It's a point-to-point tariff that is adherent to cost, but doesn´t give flexibility to shippers because the path is defined.

The unit cost associated with each exit point or zone depend on the entry point and vice versa, ie, the unit cost associated with each entry point depend on the exit point or zone.

In this situation the cost depends on the contractual path.

Figure 9 presents the final results of unit costs for each contractual path in a matrix format.

Figure 8 - Annuities per section, euros per kilowatt hour per day at current prices

					Unit costs €/(kWh/day)												
Zone	**Section**	**Annuity** €th (1)	**Capacity per section** MWh/day (2)	**Unit costs** €/(KWh/day) (3=1/2)	**BC**	**BE**	**BN**	**BU**	**BS**	**HI**	**HK**	**HN**	**HU**	**HS**	**MN**	**PQ**	**PS**
7	AB	2 250	192 780	0,0117													
7	BC	204	26 785	0,0076	0,0076												
7+1	BD	7 665	165 995	0,0462		0,0462	0,0462	0,0462	0,0462								
1	DE	7 181	99 424	0,0722		0,0722											
1	DF	6 156	66 571	0,0925			0,0925	0,0925	0,0925								
3	GH	2 519	122 000	0,0206													
5	HI	669	2 178	0,3072						0,3072							
3	HJ	3 725	119 822	0,0311							0,0311	0,0311	0,0311	0,0311			
3	JK	209	41 522	0,0050							0,0050						
3	JF	3 384	78 300	0,0432								0,0432	0,0432	0,0432			
2	FM	2 206	83 129	0,0265			0,0265					0,0265					
2	LM	13	6 762	0,0019													
2	MN	2 372	89 891	0,0264			0,0264					0,0264			0,0264		
2	FT	5 128	61 742	0,0830				0,0830	0,0830				0,0830	0,0830			
6	TU	2 485	2 178	1,1413				1,1413					1,1413				
2	TR	5 094	59 564	0,0855					0,0855					0,0855			
4	OP	2 468	23 000	0,1073													
4	PQ	971	2 390	0,4061												0,4061	
2+4	PR	4 942	20 610	0,2398													0,2398
2	RS	2 241	80 174	0,0280					0,0280					0,0280			0,0280
				TOTAL	**0,0076**	**0,1184**	**0,1916**	**1,3630**	**0,3352**	**0,3072**	**0,0361**	**0,1272**	**1,2987**	**0,2708**	**0,0264**	**0,4061**	**0,2678**

Figure 9 - Annuities per section, euros per kilowatt hour per day

	[AB]	[GH]	[LM]	[OP]
System entries	0,0117	0,0206	0,0019	0,1073

Exit zones		SECONDARY SYSTEM ENTRIES B	H	M	P
0,0020	C	0,0076			
0,0303	E	0,1184			
0,0787	I		0,3072		
0,0093	K		0,0361		
0,0884	N	0,1916	0,1272	0,0264	
0,6820	U	1,3630	1,2987		
0,1041	Q				0,4061
0,2239	S	0,3352	0,2708		0,2678

As entry-exit tariffs should be independent from the contractual path, unit capacity costs in each entry point and exit zone, independent of the contractual path, are obtainable through an optimization algorithm. The algorithm adopted minimizes the differences between network charges paid by users under the decoupled entry-exit tariff system and the costs computed for the different entry-exit paths that may be defined.

The optimization problem guarantees that the sum of the decoupled entry-exit unit capacity costs are as close as possible to the unit costs for each possible path.

Figure 10 presents the solution to the optimization problem, consisting in the minimization of the square of the sum of the differences mentioned. The prices matrix result from adding the average of each line in figure 9 and multiplying by α (78%), which results from the optimization problem, and the average of each column in figure 9 multiplying by 1 - α.

Figure 10 - Unit capacity costs by entry point and exit zone, euros per kilowatt hour per day, non adjusted

	[AB]	[GH]	[LM]	[OP]
System entries	0,0117	0,0206	0,0019	0,1073

SECONDARY SYSTEM ENTRIES

Exit zones unit costs \ Entry points unit cost		**0,0550**	**0,0557**	**0,0007**	**0,0184**
		A	**G**	**L**	**O**
0,0015	**C**	0,0565	0,0572	0,0022	0,0199
0,0231	**E**	0,0782	0,0788	0,0239	0,0415
0,0600	**I**	0,1150	0,1157	0,0607	0,0784
0,0071	**K**	0,0621	0,0627	0,0078	0,0255
0,0675	**N**	0,1225	0,1231	0,0682	0,0858
0,5201	**U**	0,5751	0,5758	0,5208	0,5385
0,0794	**Q**	0,1344	0,1350	0,0801	0,0977
0,1707	**S**	0,2258	0,2264	0,1715	0,1891

Exit zones

In figure 10 the column marked in bold (exit zones unit cost) is the result of the product of the average of each line in figure 9 by the above mentioned α. The line marked in bold (entry points unit cost) is the result of the product of the average of each column by 1 - α.

Because the unit cost do not allow for the adequate level of revenues given by the unit costs in figure 9, a multiplying factor must be applied, resulting in the prices matrix of figure 11.

Figure 11 - Unit capacity costs by entry point and exit zone, euros per kilowatt hour per day, adjusted

System entries	[AB]	[GH]	[LM]	[OP]
	0,0117	0,0206	0,0019	0,1073

SECONDARY SYSTEM ENTRIES

	Entry points unit cost / Exit zones unit costs		0,072138271	0,07300766	0,00094414	0,024115228
			B	**H**	**M**	**P**
Exit zones	**0,0020**	**C**	0,0741	0,0750	0,0029	0,0261
	0,0303	**E**	0,1025	0,1033	0,0313	0,0545
	0,0787	**I**	0,1508	0,1517	0,0797	0,1028
	0,0093	**K**	0,0814	0,0823	0,0102	0,0334
	0,0884	**N**	0,1606	0,1614	0,0894	0,1126
	0,6820	**U**	0,7541	0,7550	0,6829	0,7061
	0,1041	**Q**	0,1762	0,1771	0,1050	0,1282
	0,2239	**S**	0,2960	0,2969	0,2248	0,2480

In figure 12 the final capacity entry prices calculated by the summation of the system primary and secondary entry unit costs are shown in the first row of the table, highlighted in bold. The capacity exit prices are shown in the first column highlighted also in bold. The resulted added entry and exit prices are shown in the cells inside the table.

Figure 12 - Unit capacity costs by entry point and exit zones, euros per kilowatt hour per day

		SECONDARY SYSTEM ENTRIES			
Entry points unit cost		0,0838	0,0937	0,0029	0,1314
Exit zones unit costs		A	G	L	O
0,0020	C	0,0858	0,0956	0,0048	0,1334
0,0303	E	0,1141	0,1240	0,0332	0,1618
0,0787	I	0,1625	0,1724	0,0816	0,2101
0,0093	K	0,0931	0,1029	0,0121	0,1407
0,0884	N	0,1722	0,1821	0,0913	0,2199
0,6820	U	0,7658	0,7756	0,6849	0,8134
0,1041	Q	0,1879	0,1977	0,1069	0,2355
0,2239	S	0,3077	0,3175	0,2268	0,3553

Exit zones

This methodology reflects the costs and provides the adequate economic price signals for an efficient use of the horizontal transmission network avoiding discrimination between domestic gas flows and cross border trade.

3.4. Adopted prices for entry points

As capacity entry prices in points A, G and O were quite similar, ERSE adopted the same price for simplicity reasons. The transmission network entry price from the underground storage is smaller than the previous ones because it is situated in the middle of the transmission network where fewer pipelines are being used.

The prices for the entry points of the Portuguese transmission network presently adopted are depicted in figure 13. They are obtained dividing the entry prices of figure 12 by 12 months.

Figure 13 - Entry prices of the Portuguese transmission network

Used capacity entry points	Capacity prices €/[(kWh/day)/month]
(A)	0,008580
(G)	0,008580
(O)	0,008580
(L)	0,000241

4. Long run average incremental cost of used capacity at exit points to supply domestic clients in the downstream market

The capacity exit prices of the horizontal transmission network were defined in figure 12. Although the presented methodology gives different capacity exit prices for 8 regional zones a common average value was adopted because the Portuguese law states that access end-user prices have to be uniform throughout the country. An average annual value of 0,090721 €/(kWh/day) is obtained corresponding to a monthly value of 0,007560 €/[(kWh/day)/month].

Moreover, to calculate the exit prices applicable to deliveries (i) to clients connected directly to the transmission network and also (ii) to distribution networks one must add to the previous computed capacity exit prices the capacity prices related to the cost of connections to end users and GRMS necessary to supply the downstream market. The investment in connections to end users and GRMS represent 26% of the total transmission network investment.

Prices should be as close as possible to the long run marginal costs, which provide the right scarcity signal as they show the cost for the system of expanding the service.

Long run average incremental cost is a more correct designation, since we are not calculating the derivative of a function. The long run average incremental cost of used capacity at exit points corresponds to the additional investment required to meet the increased demand given by the following equation.

$$IncC\ Cap = \frac{\sum_{t=-L}^{t=H-L} \frac{\Delta I}{(1+d)^t}}{\sum_{t=0}^{t=H} \frac{\Delta Cap}{(1+d)^t}}$$

Where I*ncC Cap* is the long run average incremental costs for Capacity; *I* is the annuity of investment (including the correspondent additional operational costs) required to meet the increase in capacity; *Cap* is the increase in Capacity; d is the discount rate; *H* is the number of years; *L* is the time gap between investment and increase in demand.

Investments include peripheral sections of the gas pipeline, which consist of connections to end users and GRMS, shared by a small number of clients.

The top half of the table in figure 14 presents the annuity level of past and future investments for GRMS and connection to end users considering that the investments are remunerated at 8% and generate operation expenses of 2,3%. On the bottom half of the table is shown the necessary increases in exit capacity in order to meet the demand that generates the investments in the top half. The peripheral network capacity incremental cost is given by the ratio of the present value of the investments annuity and the used capacity.

This incremental capacity cost is only applicable to deliveries to clients directly connected to the transmission network and to distribution networks. Thus to calculate the exit capacity prices applied for domestic flows one must add the previously exit capacity prices of the horizontal network, presented in figure 12, with the peripheral network incremental capacity cost, presented in figure 14. An average value of 0,015431 €/((kWh/day)/month) is obtained.

The access exit tariffs besides having capacity prices calculated in line with the methodology shown present energy prices applied to the energy transported. The methodology adopted on the calculation of these energy prices is shown in [4]. This energy prices are obtained dividing the present value of the operational costs associated to the total investments on the horizontal and peripheral network done in a series of years by the present value of the total annual energy to be transported in the same time period. The operational costs are computed as a percentage (2,3%) of the investments annuity over this period. A value of 0,01329 €/MWh is obtained.

Figure 14 - Used capacity incremental cost at current prices

Capex th€		GRMS	Connection to end users	1997	1998	1999	2000	2001	(...)	2009	2010	2011	2012	2013
	1997	44 974	69 616	10 026	10 026	10 026	10 026	10 026		10 026	10 026	10 026	10 026	10 026
	1998	5 513	2 746		723	723	723	723		723	723	723	723	723
	1999	1 730	439			190	190	190		190	190	190	190	190
	2000	4 406	6 865				986	986		986	986	986	986	986
	2001	1 352	302					145		145	145	145	145	145
	2002	3 423	1 030							390	390	390	390	390
	2003	4 171	2 370							572	572	572	572	572
	2004	3 862	5 635							831	831	831	831	831
	2005	2 545	1 604							363	363	363	363	363
	2006	971	470							126	126	126	126	126
	2007	1 125	0							98	98	98	98	98
	2008	12 104	3 113							1 332	1 332	1 332	1 332	1 332
	2009	4 031	29 283							2 915	2 915	2 915	2 915	2 915
	2010	10 515	6 751								1 511	1 511	1 511	1 511
	2011	2 111	1 747									338	338	338
	2012	0	1 966										172	172
	2013	72	0											6
CAPEX				10 026	10 749	10 939	11 925	12 070		18 697	20 208	20 545	20 717	20 724
OPEX	**2,30%**			231	248	252	275	278		431	465	473	477	477
Total annuity				10 257	10 997	11 191	12 200	12 348		19 127	20 673	21 018	21 194	21 201
Total annuity (present value)				27 896	27 692	26 093	24 683	24 683		20 658	20 673	19 462	18 171	16 830
Used capacity (m3/day)				436 083	3 000 571	9 809 121	9 958 147	11 144 286	(...)	17 038 366	20 534 528	21 505 172	23 144 483	24 373 966
Annual increase in capacity	**1997**			436 083	436 083	436 083	436 083	436 083		436 083	436 083	436 083	436 083	436 083
	1998				2 564 488	2 564 488	2 564 488	2 564 488		2 564 488	2 564 488	2 564 488	2 564 488	2 564 488
	1999					6 808 551	6 808 551	6 808 551		6 808 551	6 808 551	6 808 551	6 808 551	6 808 551
	2000						149 026	149 026		149 026	149 026	149 026	149 026	149 026
	2001							1 186 139		1 186 139	1 186 139	1 186 139	1 186 139	1 186 139
	2002									1 428 873	1 428 873	1 428 873	1 428 873	1 428 873
	2003									1 905 044	1 905 044	1 905 044	1 905 044	1 905 044
	2004									1 842 939	1 842 939	1 842 939	1 842 939	1 842 939
	2005									2 352 522	2 352 522	2 352 522	2 352 522	2 352 522
	2006									-3204278	-3204278	-3204278	-3204278	-3204278
	2007									485 529	485 529	485 529	485 529	485 529
	2008									110 774	110 774	110 774	110 774	110 774
	2009									972 676	972 676	972 676	972 676	972 676
	2010										3 496 161	3 496 161	3 496 161	3 496 161
	2011											970 645	970 645	970 645
	2012												1 639 311	1 639 311
	2013													1 229 483
	Used capacity (present value)			1 185 983	7 555 948	22 871 330	21 498 893	22 277 479		18 401 436	20 534 528	19 912 196	19 842 664	19 348 840
Used capacity inc. costs (peripheral sections) (€/(Kwh/day)/month)				0,007871										

The energy price applied to peak days is obtained scaling the previously presented energy price so that at least 10% of total payments are recovered through energy prices and the rest 90% through capacity prices. The peak days energy exit price obtained is 0,19989 €/MWh. With this approach a more variable tariff structure is obtained leading to more flexibility in infrastructure use by customers. The off peak days energy exit price is thus equal to the previously presented value of 0,01329 €/MWh.

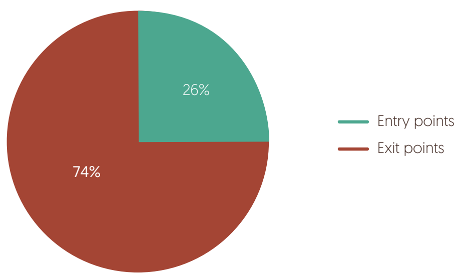
Whenever prices resulting from applying the present cost methodology don´t allow for the full recovery of the allowed revenues, multiplicative factors should be applied, for each price, in order to assure costs recovery and also to simultaneously reflect the incremental costs structure.

5. Results

Applying the Entry-Exit tariff system of the horizontal transmission network and the Long Run Average Incremental Cost Methodology related to investments necessary to supply the domestic downstream market we obtain a tariff structure which we believe will promote a more efficient use of the infrastructures, an efficient allocation of costs, the rational use of the capacity and a harmonized integration with the Spanish market.

The application of a decoupled entry-exit tariff system in Portugal resulted in a tariff structure where prices at the entry points equal matrix unit costs, recovering 26% of the TSO allowed revenues. The remaining 74% are recovered on exit points to supply the downstream market, with prices based on long run average incremental costs, as shown in figure 15.

Figure 15 - Tariff structure payments between entry and exit points



The methodology presented in this paper is part of the global methodology applied by ERSE on the calculation of the Portuguese transmission network entry-exit access tariff system.

Conclusion

Directive 2009/72/EC and Regulation (EC) n.715/2009 state that transmission tariff systems shall be based on entry-exit tariff systems in order to foster market development. In line with these provisions the Portuguese Energy Regulator (ERSE) approved new entry-exit transmission tariffs.

To evaluate this entry-exit prices a matrix methodology for optimal allocation of costs related to the horizontal transmission network to entry points and exit zones is adopted.

This tariff system ensures non discrimination between domestic flows and cross border flows as stated by European regulation. Final access prices to end-user consumers are obtained adding the costs of network equipment necessary to supply the downstream market. For this purpose a long run average incremental cost methodology is adopted.

With the presented tariff methodology appropriate transmission network entry-exit tariffs are computed promoting an efficient use of the infrastructure and contributing to market enhancement and integration.

Acknowledgment

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Biographies

Isabel Apolinário was born in Lisbon, Portugal, on October 29, 1973. She graduated in Economics, in 1996, and received her MSc Degree in Energy and Environment Economics in 2005, both from the Technical University of Lisbon - Instituto Superior de Economia e Gestão. She is with ERSE since 1998 and her professional background includes the Portuguese Electricity Operator (EDP) and the Portuguese National Institute of Statistics, producing the Quarterly National Accounts. Her current interests are electricity and gas tariffs, economic regulation, efficiency and productivity, energy efficiency and market liberalization.

Liliana Ferreira was born in Lisbon, Portugal, on July 2, 1978. She graduated in Management in 2001 from the Universidade Nova de Lisboa. She is with ERSE since 2007 and her professional background includes the Portuguese Electricity Operator (EDP). Her current interests are electricity and gas tariffs, economic regulation and energy efficiency.

Pedro Verdelho was born in Porto, Portugal, on December 26, 1963. He received the Dipl. Ing., the M.S. and Ph.D. degrees from the Technical University of Lisbon-Instituto Superior Técnico, Lisbon, Portugal in 1987, 1990 and 1995, respectively, all in electrical engineering. In 1985 he joined Instituto Superior Técnico doing research at Centro de Automática. From 1995 till 2002 he was an Assistant Professor at the same university. In 1999 he joined ERSE, being responsible for the Tariff and Prices Division. His main interests include electricity and gas tariffs and prices, energy efficiency, economic regulation, power quality, power electronics, active power filters, reactive power compensation systems, variable speed drive and generator systems. He received the Meritorious Paper Award in 1996 from the IEEE Industrial Electronics Society.

Incentive Mechanism to Reduce Power Losses in the Portuguese Distribution Networks

José Capelo, Jorge Esteves, Hélder Milheiras

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Abstract

It is well known that losses at power networks constitute an undesired reality, since they increase, among others, energy inefficiency, global cost of the system and levels of CO_2 emissions. In 2006, figures showed a total energy emission to networks of 49 177 GWh and aggregated losses in the Portuguese transmission and distribution networks of 3 730 GWh (8,48% referred to network energy consumption).

By default, concern about losses reduction is taken into account in the planning stage of network development by using network losses as a criterion for selection between different technical solutions.

The National Plan for Climatic Changes (PNAC), approved by the Portuguese Government, states that until 2010, total network losses (Transmission and Distribution) should be lower than 8,60%.

The Tariff Code includes an incentive mechanism to reduce losses in distribution networks and allowing the DSO to be rewarded (or charged) in case of achieving global distribution losses below (or above) than a reference value set by ERSE, for each year.

At the beginning of the present regulation period (2006 – 2008), ERSE set the reference values for the distribution network losses. In each year, if real losses relies under (or above) the reference value, the DSO is entitled to a financial reward (or penalty) proportional to the differential between those values, being this differential capped to a maximum value also set by ERSE.

This article presents the evolution of losses reference values for the successive regulation periods since 1999 and the evolution of real losses in distribution networks, allowing a better cost benefit analysis of financial consequences of the incentive mechanism for power losses reduction application.

Keywords

Power Losses - Incentive Mechanism - Distribution Networks - Regulation.

1. Introduction

This article aims at describing the incentive mechanism to reduce power losses in Portuguese distribution networks and at showing the results of its application since its very beginning in 1999.

It is well known that losses constitute an undesired reality, since they increase, among others, energy inefficiency, global cost of the system and levels of CO_2 emissions. In 2006, figures show in Portugal a total energy emission to networks of 49 177 GWh and aggregated losses in transmission and distribution networks of 3 730 GWh (8,48% referred to total energy consumption).

Power losses in networks is a very delicate and diversified subject, so this article is structured in a way that it deals with a number of related issues such as:

- What is understood by network power losses;
- How are losses calculated and metered;
- What is the Portuguese model to deal and compensate for power losses;
- How are losses reflected in tariff system and in regulation;
- What are the national goals and incentives to reduce network losses set by law and regulation;
- How the present incentive mechanism works.

The following sections describe the present situation and answer to these questions in Portugal.

2. Power Losses

As a first step, it should be clarified what is understood by network power losses. Only physical losses in transmission and distribution networks, or includes items such as "hidden" non-technical losses (i.e., in-house consumption), thefts (should not be mixed with losses), non-metered public lighting or any other items.

In the Portuguese case, losses, being derived from the global energy balance of the system, include physical losses, unavoidable thefts and metering errors. Regarding frauds, once detected, these are subject to criminal procedure, without prejudice of operators who shall be compensated based on an estimated value.

In-house consumptions are measured and charged through regular tariffs like every other normal consumption.

Regarding public lighting, it exists a specific Public Lighting Tariff. It is not considered as a loss.

3. Evaluation

This issue refers to how losses are calculated and metered, high voltage/medium-voltage metering and accuracy of measurement equipment.

In Portugal, losses are calculated by network type (Transmission and Distribution) and voltage level (VHV, HV, MV, LV) and result from the global energy balance of the system and for each network type, both based on the difference between network injection and withdraw. These procedures are carried out in the following year (Y+1).

For the current year, losses are quantified by means of hourly losses profiles, approved by ERSE upon proposal by network operators.

Every connection point between different networks and voltage levels is subject to metering.

The accuracy classes of the measurement equipment are established in the Metering and Data Availability Guide [2] (a code established by ERSE) as presented at Table 1.

Table I - Accuracy classes of the measurement equipment

Voltage level	Requested power (MVA)	Accuracy class: Metering transformers	Accuracy class: Active energy meter	Accuracy class: Reactive energy meter
VHV	-	0,2	0,2	0,5
HV & MV	S ≥ 50	0,2	0,2	0,5
	10 ≤ S < 50	0,2	0,2	1
	0,630 < S < 10	0,5	0,5	1
	S ≤ 0,630	1	1	2
LV	S > 0,0414	1	1	2
	S ≤ 0,0414	---	2	---

Source: ERSE

Table 2 lists the network losses values for 2006, both in GWh and relative value (%), with the % values calculated having as reference the total energy emission to networks and the total energy consumption supplied by the networks.

Table 2 - Total emission to networks and values of losses by network type

Year 2006	Losses (GWh)	Losses (%): Ref. to emission	Losses (%): ref. to consumption
Transmission network	562	1,14	1,28
Distribution networks	3 168	6,44	7,2
Total emission to networks = 49 177 GWh			

Source: ERSE

4. Procurement

There are several possible solutions to deal with power losses procurement and compensation, such as specific tariffs, dedicated balancing groups, physical injections or through power exchange pools.

In Portugal, power losses are physically injected by suppliers. Suppliers are supposed to buy their consumption needs in the most efficient way. So, being losses already included in these purchases, it is considered that the power losses procurement will be optimized.

Each supplier must, in each hourly period, inject in the network the energy that their costumers will consume adding the energy for compensation of power losses related to its clients' consumption in that period, resulting from the application of hourly losses profiles approved by ERSE.

Regarding the global system energy balance, there is no specific treatment for power losses or dedicated generation groups. Power losses are treated as any other induced or occurred imbalance.

5. Tariffs and Regulation

Since power losses are physically injected, there is no specific tariff for power losses.

Concerning energy, for each programming hour, each supplier must inject its own energy, including that one for power losses compensation related to its clients consumption in that period, i.e. injecting its clients' energy consumption quantities affected by hourly losses profiles. These hourly losses profiles (8760 values), are differentiated by network type and voltage level and are approved by ERSE, upon a proposal from the network operators.

For a LV client with an E_C estimated energy consumption for an hour h, the supplier must provide the injection of the energy E_P as follows:

Hour (h): $E_P = E_C \times (1 + \rho_{HV/RT}) \times (1 + \rho_{HV}) \times (1 + \rho_{MV}) \times (1 + \rho_{LV})$

where:

$\rho_{HV/RT}$ – VHV transmission network losses profile, including VHV/HV transformers.

ρ_{HV}, ρ_{MV} and ρ_{LV} – HV, MV and LV distribution network losses profiles.

Regarding the application of the network use tariffs, the prices of the components of each related tariff (network use and global use of the system) are also affected by losses adjustment factors, which convert the consumption quantities measured at the client referential (metering point for tariff application) to the energy injection referential (assumed to be VHV plant bus bars).

These losses adjustment factors, differentiated by network type, by voltage level and by day time period (peak, partial peak, valley, and super-valley) are approved and published by ERSE every year, upon a proposal from network operators. For the current year (2008) these values, in percentage, are shown at Table 3.

Table 3 - Loss Adjustment Factors For 2008

		Hourly period			
		Peak	Partial peak	Valley	Super valley
Transm.	γ_{VHV}	1,14	1,09	1,22	1,38
	$\gamma_{HV/RT}$	1,44	1,39	1,52	1,68
Distrib.	γ_{HV}	1,52	1,37	1,08	0,99
	γ_{MV}	4,66	4,16	3,27	2,92
	γ_{LV}	7,24	6,53	5,91	4,7

Source: ERSE

6. Regulatory Incentives

Reduction of power losses aims at achieving better energy efficiency and to reduce the system global costs.

The concern about losses reduction is taken into account, by both TSO and DSO, in the planning phase of network development, as a main criterion for selection between different technical solutions.

The National Plan for Climatic Changes (PNAC) [3], approved by the Portuguese Government, states that until 2010 aggregated power networks losses (Transmission and Distribution) should be lower than 8,60%.

The Portuguese energy regulatory authority (ERSE), based on the price-cap based economic regulation model of the Distribution System Operator (DSO), established an incentive mechanism for reducing losses in the distribution networks that aims at inducing investment decisions, by DSO, regarding projects that contribute to extended losses reductions.

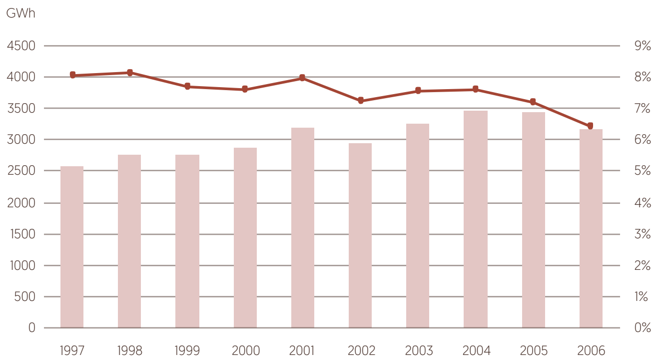
According to this, the incentive mechanism allows the DSO to be rewarded (or charged) in case of achieving global distribution losses below (or above) than a reference value set by ERSE, on a yearly basis.

Figures 1 and 2 present, respectively, the evolution of transmission and distribution network losses, referred to total energy emission to the network.

Figure 1 - Evolution of losses in the transmission network

Source: ERSE

Figure 2 - Evolution of losses in distribution networks



Source: ERSE

For both transmission and distribution networks, there is a clear positive evolution in the percentage of losses, with a gradual reduction over the recent years.

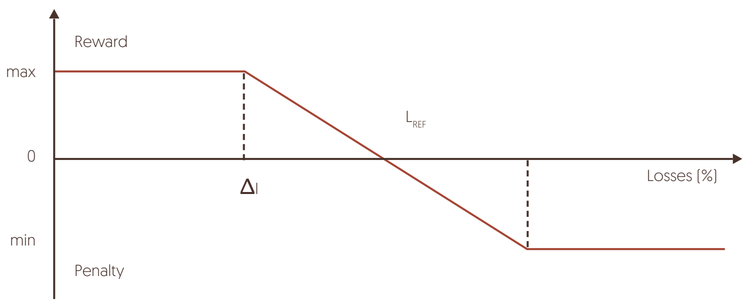
Moreover, the 8,60% PNAC goal for network losses in 2010 was already achieved in 2006 with real total losses of 8,47%. However, evolution of the networks during next years and the great effort taken in place for a large penetration wind energy plants in the Portuguese electric system oblige to maintain attention to this component.

7. Incentive Mechanism

Based on the regulation type specificity and on current value for power losses in each network type, the present incentive mechanism for power losses reduction applies only to distribution networks, where higher losses (in percentage) have been observed.

At the beginning of the present regulation period (2006 – 2008), ERSE set reference values for the distribution networks losses for each of these years. According to this, if losses rely under (or above) the reference value, the DSO is entitled to a financial reward (or penalty) proportional to the difference between those values, being this difference capped to a maximum value also set by ERSE, as shown below.

Figure 3 - Incentive mechanism in the distribution networks



Source: ERSE

By legal understanding, for the effects of application of the incentive mechanism, the reference values for distribution losses shall be referred to the total energy consumption supplied by distribution networks.

Table 4 presents the reference values for network losses set by ERSE for the previous and current regulation period, and the cap value set for difference between real and reference losses.

Table 4 - Reference loss values of the incentive mechanism

	1999-2001	2002-2005
L_{REF}	8,80%	8,60%
Δl	1,00%	1,00%

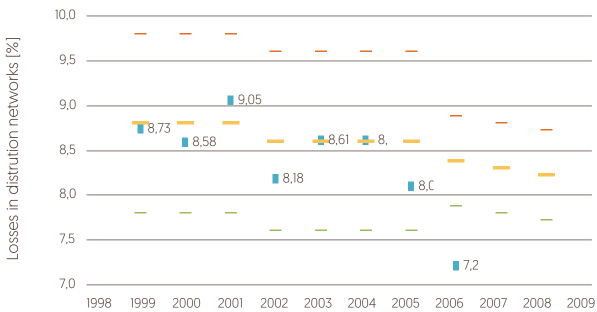
	2006	2007	2008
L_{REF}	8,38%	8,30%	8,22%
Δl	0,50%	0,50%	0,50%

Source: ERSE

In a "per unit values" basis, for the period between 1999 and 2005, losses reduction were economically evaluated (slope of the incentive mechanism) on an energy cost basis close to 50 €/MWh. In 2006, this value was set close to 60 €/MWh.

Losses reference values for previous and current regulation periods, as well as the evolution of real losses in distribution networks [4], referred to total energy consumption, are shown at Figure 4.

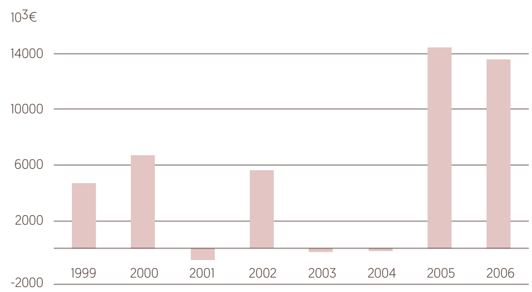
Figure 4 - Reference values and evolution of losses in the distribution networks



Source: ERSE

The financial results of the incentive mechanism, in terms of reward or penalty amounts to the distribution company, are shown at Figure 5, with relevance for the performance of the last two years.

Figure 5 - Financial results of the incentive mechanism to the distribution company



Source: ERSE

As shown in Figure 4, for the first time since the beginning of the application of the incentive mechanism, back in 1999, the reward entitled to the distribution system operator in 2006 was capped to its maximum value. For financial reward purposes of the incentive mechanism, a maximum allowed losses reduction of 0,50% was evaluated on a 60 €/ MWh energy basis.

A short cost-benefit analysis can be derived from this figures: In 2006, assuming that the expected value should be the reference value (LREF), 8,38% and knowing that the real value of losses decreased to 7,20%, a benefit of 1,18% has been achieved. On the other hand, the cost to the system of the incentive mechanism application, rewarding the operator, corresponded to 0,50% resulting on a net benefit of 0,68% (299 GWh), which turned out to be $17{,}94 \times 10^6$ €, when evaluated on the referred basis.

Being necessary a more precise and complete analysis, currently, with an approximated value of 50 000 GWh of total energy emission to networks, if the incentive mechanism could led to a losses reduction of 1%, evaluated on a basis of 60 €/MWh, it would result on a reduction on energy cost of 30×10^6 €, to be shared between the network operator and the system.

Depending on future results, further studies and improvements on the design of the mechanism itself and fine tuning of the parameters values and their definitions, should be carried out.

Conclusions

In Portugal, losses are calculated by network type (Transmission and Distribution) and voltage level (VHV, HV, MV, LV) and result from the global energy balance of the system and for each network type, both based on the difference between network injection and withdraw. These procedures are carried out in the following year (Y+1). For the current year, losses are quantified by means of hourly losses profiles, approved by ERSE upon proposal by network operators.

Network power losses are physically injected by suppliers. Each supplier must, in each hourly period, inject in the network the energy that their costumers will consume adding the energy for compensation of power losses related to its clients' consumption in that period, resulting from the application of hourly losses profiles approved by ERSE.

Beside the natural concern of TSO and DSO to reduce network power losses, in Portugal there are legal goals (in PNAC) and regulatory incentives (in Tariff Code) to reduce networks power losses. According to this, the Portuguese incentive mechanism allows the DSO to be rewarded (or charged) in case of achieving global distribution losses below (or above) than a reference value set by ERSE, on a yearly basis.

The evolution of the power losses (in absolute and relative values) in the distribution networks shows a positive reduction trend during last years. The maintenance, and even reduction of these values, has entitled the distribution system operator to be financially rewarded for its network management performance.

In general, real losses have been below or very close to the reference value set by ERSE. In 2005 and 2006, the percentage values were significantly lower than the goal set by the mechanism. In 2006, the reward was capped to its maximum value.

Depending on future results, further studies and improvements on the design of the mechanism itself and fine tuning of the parameters values and their definitions, should be carried out.

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Biographies

José Capelo (b. 1956) received his degree in electrical engineering from Instituto Superior Técnico, Technical University of Lisbon, Portugal in 1980.

From 1980 to 2000, he taught at Instituto Superior Técnico, as Assistant of the Department of Electrical and Computers Engineering.

In 1999, he joined ERSE, the Portuguese energy regulatory authority, in the Dispatch and Network Division.

Jorge Esteves (b. 1958) received his degree, M.Sc. and Ph.D. in electrical engineering from Instituto Superior Técnico, Technical University of Lisbon, Portugal in 1983, 1986 and 1992, respectively.

From 1983 to 2004, he reached the position of Assistant Professor with Instituto Superior Técnico, Technical University of Lisbon.

From 1983, he has been a research member of the Centro de Automática of the Technical University of Lisbon.

In 2004, he joined Instituto Superior de Engenharia de Lisboa as Coordinator Professor. Also in 2004, he joined ERSE, the Portuguese energy regulatory authority, as director of the Dispatch and Network Division.

Hélder Milheiras (b. 1973) received his degree in electrical engineering from Instituto Superior Técnico, Technical University of Lisbon, Portugal in 1997, and concluded his MBA lecture part in 2005.

After graduation, in 1997, he joined ERSE, the Portuguese energy regulatory authority in the Dispatch and Network Division.

Exceptional Events and Force Majeure Events and their use in the Electricity Sector

Amanda Falcão[1], Math Bollen[2]

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Abstract

This paper contains some reflections about "exceptional events" and "force majeure events" as used within quality of supply regulation. The terms are widely used, but without commonly-used definitions. A survey among 20 European countries has been used as the basic for the paper. It is concluded that "exceptional events" are more appropriate for regulation but that they should cover events that are both sufficiently rare and with a effective cause beyond control of the network operator.

Keywords

Exceptional Events - Force Majeure Events - Continuity of Supply - Electricity.

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[1] ERSE - Portugal, afalcao@erse.pt
[2] STRI AB - Sweden

Introduction

The designation "exceptional event" is widely used in the electricity sector to remove supply interruptions from the continuity of supply statistics. There is however no agreement about the concept of exceptional event: what it really refers to and how to identify it.

In legal and regulatory documents the term "force majeure" is used in a general way in responsibility discussions and it is normally linked to the cause of the events. The terms "force majeure" and "exceptional event" are often used as synonyms in discussions, represent two significantly different concepts.

It is important to realise how exceptional events are taken into account in the interruption statistics in order to understand the meaning of the various countries' interruption indicators and how these events affect the interruption level experienced by customers.

1. The Basic Concept

The concepts of exceptional event and force majeure event are widely used. These terms are generally associated with specific and special events. There is no exact understanding of their meaning but both terms are associated to situations that in some way are out of network operator's responsibility or that are very rare and with a strong impacted in the network. Some reflection should be made to stabilize the meaning of these concepts with the aim to understand the situations that are considered.

This paper summarizes the experience collected from the Europeans countries that participated in the survey conducted as part of the work towards the fourth Benchmarking Report on Quality of Electricity Supply [1].

More details about the survey and about other parts of the report are summarized in [2].

2. The CEER Countries Classification

According to the responses received from 20 countries, only 2 countries do not consider the concept of exceptional events or other similar concepts related to situations having a specific treatment in their national quality of supply regulations. For the other 18 countries, the existing concepts are referred to as:

- » Exceptional events/ Extraordinary situations;
- » Force majeure;
- » Emergency situations;
- » Multiple incident situations;
- » Security situations;
- » Highly critical power situations.

These situations can be classified based on their causes or based on their impact on network performance.

It was noted that the situations related to the effective cause of the interruptions, as natural disaster, strikes with external causes or more severe conditions than the ones considered at the network design requirements, are generally classified as force majeure.

However, the definition of exceptional events is often related to the impact on the network performance, like number of customers interrupted and duration of interruption.

There are some countries where the classification of an exceptional event considers both the cause and the impact on the network performance. For example, in Italy, exceptional events are identified when the number of faults on MV networks or LV networks over the course of 6-hours exceeds a function of the historical average number of faults in a 6-hour time period as observed in the prior 3 year.

In the United Kingdom, two different categories of exceptional events are considered:

- » Severe weather exceptional events - events resulting in a fault of more than 8 times the daily average fault rate on higher voltages.
- » Non-weather exceptional events - events outside the DSO's control that results in more than 25,000 customers interrupted and/or 2 million customer-minutes lost.

In Norway, two different terms exist - highly critical power situations and extraordinary situations. Highly critical power situations are normally related to tight energy balance situations. Extraordinary situations are defined in each individual case, i.e., a unique definition does not exist.

From the experiences collected it is possible to conclude that the concepts of exceptional events and force majeure events reflect the characteristics of each country's unique electricity sector and the impact of severe weather conditions in each country.

3. Main Characteristics

Following is summarised the main characteristics considered in a force majeure event and an exceptional event definition and are made some reflections about it.

3.1. Force majeure

Most of the analysed countries use the classification of force majeure. In many cases, the definition of force majeure is established in the civil law that is applied in a general way for many activities; it is not restricted to the electricity sector and continuity of supply regulation. In this context, the definition of force majeure is normally related to the system operator's responsibilities. While this is a factor that must be taken into account, it does not mean that a force majeure event should be always excluded from the quality of supply regulation. Moreover, the force majeure event classification is usually related to the primary causes of the incidents. Nevertheless, when an incident is classified as a force majeure event, the lack of quality (namely number and duration of interruptions) due to that incident is dependent on actions taken by the system operators. It is important that this aspect of the event is not overlooked. The classification of a situation as a force majeure event should only be accepted when the incident is well justified and the relation between the causes and the effects of the continuity of supply performance has been proven. The required procedures for clarifying these situations are generally burdensome for the system operators and for the National Regulator Authority.

3.2. Exceptional events

The exceptional event concept is used in most countries related to an unlikely occurrence, based on statistical methods. Statistical methods can be based on the level of exceptional impact of the weather conditions or it can be based on criteria such as the number of customers interrupted or the duration of the interruption. Some countries have adopted a list of situations that are considered exceptional events. In these cases, the definition should be sufficiently clear, so as there are no ambiguities when the classification is applied; borderline situations should be minimised. In some countries, regulators take decisions on a case by case basis, using general guidelines.

4. Visibility in Interruption Statistics

Continuity of supply indicators give information on number and duration of the interruptions that affected the customers; i.e. the reliability as experienced by the customers. If all interruptions are considered in the indicators calculation, they will provide information on the continuity of supply as seen by the customers. However once exceptional/force majeure events are excluded from the statistics, there will be a discrepancy between the "experienced reliability" and "reported reliability".

It is important to realise how exceptional events are taken into account in the interruption statistics in order to interprete the various countries' interruption indicators and how these events affect the reliability experienced by customers. As an example, it is analysed the contributions of exceptional/force majeure events in the continuity of supply data from 2 countries. Austria considers exceptional events in the interruption statistics and Portugal considers force majeure in the interruption statistics. In Austria, an incident is considered an exceptional event when a natural disaster takes place: when a crisis situation is declared by a local authority and/or when the federal or provincial government takes measures aimed at providing financial support (e.g. catastrophe funds). In these cases it is necessary to give detailed descriptions of the natural disaster for the failure and disturbances statistics of electricity networks.

In Portugal, force major events are incidents that are simultaneously, unpredictable, unavoidable and external related to the operator as for example:

- Natural disasters, including fire, flood, drought, earthquake, hurricane, hoar frost;
- The acts of state, including martial law, emergency state, embargos, blockades etc;
- Acts of war, the acts of sabotage, the acts of terrorism,
- General strikes or other social unrests, including public demonstrations, lock-outs.

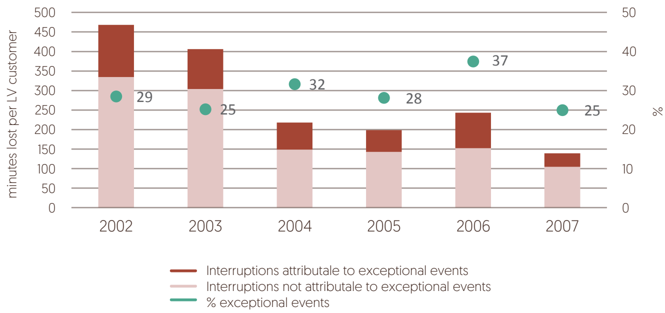
The interruption data analysed for this purpose is shown in Figure 1 through Figure 4.

Figure 1 – Number of interruptions per customer in Austria due to unplanned interruptions.

Figure 2 – Minutes lost per customer in Austria due to unplanned interruptions.

Figure 3 – Number of interruptions per LV customer in Portugal due to unplanned interruptions.

Figure 4 – Minutes lost per LV customer in Portugal due to unplanned interruptions.



In Austria, exceptional event classification has not been applied during half of the analysed years. In the years that the concept has been applied, it refers to one specific incident. During the analysed years, the causes that justified the classification of exceptional events where:

» 2002 - August, flood [Danube]

» 2005 - August, flood [Salzburg, Tirol]

» 2006 - 4th of November [UCTE interruption]

» 2007 - 19th January, storm [Kyrill]

These exceptional events represent 17% to 55% of the total ASIDI value and 2% to 23% of the ASIFI value. On the other hand, in Portugal, events that are classified as force majeure occur every year, several times per year. The annual contribution of force majeure events is 25% to 37% of the SAIDI value and 19% to 29% of the SAIFI value, both evaluated on LV customers.

This example shows the impact of the incidents classified as exceptional/force majeure events on the level of the continuity of supply in the analysed countries. It also shows the differences for the values of the continuity of supply indicators that are reported when the exceptional/force majeure events are excluded. This example brings out the importance of an accurate classification of the events for the quality of supply analysis.

5. Quality of Supply Regulation

At this point it is necessary to make some reflections about exceptional events and force majeure events; especially concerning the way they should be applied in supply or service regulation. These reflections are for a large extent the authors' personal opinions, but strongly influenced from the study of the way in which exceptional events and force majeure are used within the quality of supply regulation in different countries.

The following observation should be the basic condition:

» The electricity system's objective is to supply the customers with the required quality necessary to use the electricity in their daily life.

» The system operator is the entity responsible for the network. It means that the system operator is responsible not only for the management and all the procedures to be taken in order to prevent the interruptions occurrence but also to minimise the effects of events, even those for which the effective cause isoutside of its control.

For any interruption, the following questions should be asked by the network operator:

» Could the incident have been avoided? If yes: how?

» Could the impact of the incident have been reduced? If yes: how?

» Is it likely that a similar effective cause and chain of events result in a similar interruption?

To obtain an indicator of the quality of supply as experienced by the customers, all interruptions should always be considered in the continuity of supply indicators. First because this is the way to measure the interruption's impact on the customers. Secondly all interruptions should be taking in consideration by the system operator to manage the network.

All interruptions should be accurately recorded, with information about its effective cause, equipments affected and its characteristics (not only physical characteristics but also design criteria and operation mode) and customers affected.

Based on the information collected, the operator should question if the procedures in force, related to the network planning, design criteria, maintenance actions and emergency plan should be improved.

All interruptions should be taking in consideration to analyse the system operator behaviour. However, in some cases separate statistics may be reported to better visualize trends or to obtain a better input to for example economic regulation. This is where force majeure or exceptional events are needed.

The force majeure concept is a legal concept, associated with the operator responsibilities and linked to damages. This concept is not an appropriate tool for removing statistics so as to better visualize trends in the statistics. However, the legal concept may be used as base to decide which events should be removed from economic regulation. In that case it should however be clarified very clearly what the responsibilities of the network operator are.

The exceptional event concept is more appropriated to quality of supply regulation. This holds especially for visualizing trends, but even for economic regulation the concept is very suitable. The definition of exceptional event should be considered statistically and it should be applied case by case. To have events classified as exceptional year after year, is against the basic idea behind exceptional events. Exceptional events should by nature be rare. Exceptional events should be easily identified and characterised, there should be no doubt about whether an event is an exceptional or not. Any event where the effective cause is within the responsibility of the network operator should not be classified as an exceptional event. Any event that the network operator could avoid should not be considered as exceptional. Besides that, even if the occurrence is exceptional, the regulation must assure that the operator acts in an efficient way to minimize the impact of the event.

Conclusions

The concepts of exceptional events and force majeure are commonly used in quality of supply statistics and regulation, but the concepts are applied with different designations and meanings.

Understanding the meaning of the situations considered as exceptional events or as force majeure events in each country and their influence on interruption statistics is of significant importance to understand and analyse quality of supply statistics and network performance. Ideally, it would be desirable to have a harmonised definition. However, it is recognised that there are some environmental conditions, structural network characteristics and national regulation specificities that make this impossible. For example, within Europe, the climate conditions are very different between regions, making it difficult to set out a European definition of exceptional events using criteria based on weather conditions. Criteria based on statistical approaches could be more easily standardised all across Europe.

Besides, the definition of force majeure is established in the civil law that is applied in a general way for many activities; it is not restricted to the electricity sector and continuity of supply regulation.

Some countries include exceptional events in their interruption statistics, while others do not. Some countries include interruption statistics, with and without exceptional events. These aspects are of paramount importance to evaluate the quality level in each country and for an acerbated benchmarking. It is recommended that any publication of continuity of supply data should include information about which interruptions are included and which are excluded. Moreover, the concepts applied in the publications should always be in accordance with the ones established in the national regulations.

The system operator is responsible for the network management and for all the procedures to be taken not only to avoid the occurrence of a supply interruption but also to minimise the impact of an event on the network. The system operator is responsible too for the improving of design, planning and operation taking into consideration the recent occurrences.

All interruptions should be taking in consideration to know the quality of supply experienced by the consumers and to analyse the system behaviour. To obtain trends in performance statistics and in terms of quality of supply regulation, if may be decided to treat some interruptions in a different way. The concept of exceptional events is more appropriate for that than the concept of force majeure. Thereby exceptional events should be rare and their effective cause should not be with the network operator.

Acknowledgements

This paper is a summary of parts of the CEER fourth benchmarking report on quality of electricity supply. The authors of this paper have been involved in preparing this report, but the contributions from many others, especially the members of the CEER Electricity Quality of Supply Task Force, is gratefully acknowledged. This paper represents the personal interpretation by the authors of the material presented in the benchmarking report. The opinions and recommendations represented in this paper do not necessarily correspond with the opinions of CEER.

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Voltage quality monitoring, dips classification and responsibility sharing

Math H.J. Bollen, Jorge Esteves, Karstein Brekke, Kevin Niall and Maurizio Delfanti[1]

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Abstract

The CEER and EURELECTRIC cooperation in the field of quality of electricity supply, involving joint meetings and the participation at the relevant CENELEC Technical Committee, contributed to the results attained in the recent publication of the EN 50160:2010 edition that includes a new voltage dips classification table allowing harmonisation at European level on voltage dips data collection. The generalization of voltage quality monitoring data publication all over Europe will allow the definition of responsibility sharing between the different involved stakeholders and the evolution of voltage quality regulation applied at national level. Examples from Sweden and Italy are briefly presented in this paper.

[1] The text of this paper is based on CEER and Eurelectric documents. Where the text of this paper deviates from the text of those documents, it is the authors' personal opinion and not necessarily the opinion of CEER or Eurelectric, neither of the authors' employers.

M.H.J. Bollen is with Energy Markets Inspectorate (EI), Eskilstuna, Sweden (m.bollen@ieee.org); J. Esteves is with Energy Services Regulatory Authority (ERSE), Lisboa, Portugal (jesteves@erse.pt); K. Brekke is with Norwegian Water Resources and Energy Directorate (NVE), Oslo, Norway (kab@nve.no); K. Niall is with ESB Networks, Dublin, Ireland, (kevin.niall@esb.ie); M. Delfanti is with Department of Energy, Politecnico di Milano, Milano, Italy (maurizio.delfanti@polimi.it).

Keywords

Power Quality - Voltage Quality - Voltage Dips - Voltage Quality Monitoring - Standards.

1. Introduction

A high level of voltage quality is fundamental for some European industries' competiveness and assuring standardisation and harmonisation at national level is essential for the European internal market development.

The Council of European Energy Regulators (CEER) and the Union of the European Electricity Industry (EURELECTRIC) have been cooperating for several years in the field of quality of electricity supply, involving joint meetings and the participation of the European Energy Regulators in the relevant CENELEC Technical Committee.

A workshop on voltage quality monitoring was organized jointly by CEER and EURELECTRIC during November 2009, in Brussels, involving more than 80 participants and achieving significant conclusions about the importance of this topic. Detailed information is available at the "Events/2005 2009" folder of the CEER webpage http://www.energyregulators.eu.

In parallel, one of the improvements agreed at CENELEC level for the EN 50160 standard revision is a comprehensive and effective treatment of voltage dips classification, including reference to standards (e.g. EN 61000-4-11 and EN 61000-4-34) for testing of equipment against voltage disturbances and to the electromagnetic environment classes defined by the EN 61000-2-4. This reference can be seen as an important pre-condition to responsibility sharing between the stakeholders, as follows:

» The voltage quality at the customer's bus, as defined in standards and regulations, is the network operator's responsibility.
» It is the responsibility of the customers that the impact of the voltage disturbances that can be expected on their process, installation and equipment is limited.
» The quality for current withdrawals at the point of connection is the customer's responsibility.
» Developing and supplying equipment with adequate tolerance to voltage quality and cost-effective power conditioning devices with appropriate technology is a continuing challenge for manufacturers.

» Ensuring an efficient balance between the views of different stakeholders – in order to reach the best optimum possible from the viewpoint of the society – is the role of the National Regulatory Authorities.

This paper intends to summarise the major conclusions on these topics attained at a Joint Round Table organised by CEER and EURELECTRIC at the CIRED 2011 held during June 2011, and representing the most recent cooperation activity developed by the two organisations, [1] - [4].

2. CEER overview of voltage quality monitoring

The Council of European Energy Regulators (CEER) has published several documents where the importance of quality of electricity supply and, in particular, voltage quality for the

European Energy Regulators is revealed. Some examples available at www.energy-regulators.eu are:

» Third CEER Benchmarking Report on Quality of Electricity Supply [5].

» Towards Voltage Quality Regulation: An ERGEG Public Consultation paper [6] [7][8].

» Fourth CEER Benchmarking Report on Quality of Electricity Supply [9].

» Energy Regulators' pledge to ensuring good quality of electricity supply [10].

» Guidelines of Good Practices on Estimation of Costs due to Electricity Interruptions and Voltage Disturbances [11].

Another reference, [12], represents the European Energy Regulators' vision about quality of service regulation, developed by a joint effort from CEER and the Florence School of Regulation.

The fifth benchmarking report [13] is in the final production stage when this paper is being written. A summary of the main results on voltage quality is presented in a companion paper [14].

The impact of voltage disturbances in national economies justified several surveys on costs that were carried out bydifferent entities during last years in Norway, Sweden and Italy, and also the development of the Pan-European LPQI Power Quality Survey at European level. Table I summarises some of the conclusions from these survey.

In their collective positions, the European Energy Regulators assume the need of harmonised voltage quality regulation all over Europe.

CEER verified that at least in 18 European countries the distribution network operators are compelled to provide voltage quality measurements when requested by the customer or after complaints. However, there are some countries where this rule is not yet applied and CEER recommends its adoption by all the European countries, even in the absence of a former complaint by the requesting customer and in the absence of power quality contracts as well.

Table I - Results from surveys on voltage disturbances costs

	Inhabitants	Conclusions on estimated annual costs
Norway (2002)	ca 5 million	Estimated annual costs due to dips for end-users to be between 120 and 440 million NOK
Sweden (2003)	ca 9.5 million	Estimated annual costs for industrial customers due to dips and interruptions at about 157 M€
Italy (2006)	ca 60.6 million	Estimated annual costs due to dips and interruptions (< 1 s) for the whole production system to be between 465 and 780 M€
PAN European LPQI Power Quality Survey (2005-2007)		Costs of PQ wastage EU-25 exceeds 150 billion € annually

Real voltage quality data is an important prerequisite for understanding voltage quality (VQ) and for regulation. According to the "5th CEER Benchmarking Report on Quality of Electricity Supply", at least 15 European countries have VQ monitoring systems in operation. Some details of these monitoring schemes are presented in [14]. In this context CEER recommends countries to encourage network operators to continuously monitor voltage quality in their transmission and distribution networks. Monitoring should take place at such locations that a good estimation can be made of the voltage quality as experienced by the customers.

The fifth Benchmarking Report further finds that the measured voltage quality parameters vary strongly from country to country. Voltage dips are consistently monitored in almost all countries; this confirms that voltage dips are seen as an important issue. Supply voltage variations, flicker, voltage swells, voltage unbalance and harmonic voltage are continuously monitored in most countries. Transient overvoltages, single rapid voltage changes and mains signalling voltage are monitored in a small number of countries. A trend towards harmonisation of voltage-dip reporting has been observed, trigged by the latest edition of EN 50160 (see Section IV). There remains however a lack of standardised measurement methods for rapid voltage changes, transient overvoltages, and mains signalling voltages.

The possibility of using smart meters for voltage-quality monitoring should, according to the fifth Benchmarking Report, be exploited. It is however also emphasised that voltage quality monitoring through smart meters should not result in an excessive increase in price of the meters or tariffs for the network users. The European Energy Regulations also do not deem necessary monitoring all voltage quality phenomena through smart meters for all low-voltage users.

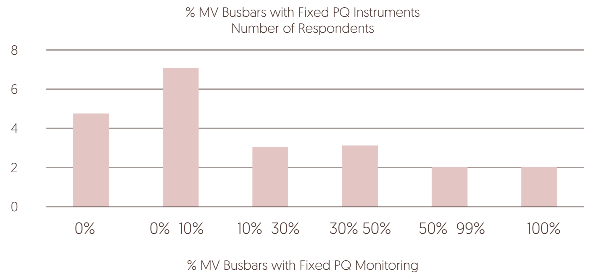
Similar conclusions were drawn in the 2010 guidelines of good practice on regulatory aspects of smart metering [15].

3. EURELECTRIC view on power quality monitoring and voltage dips

During 2008, EURELECTRIC carried out a survey on Power Quality (PQ) monitoring with the participation of 23 distribution system operators (DSO) serving 120 million customers and representing 16 European countries. Two national electric industry associations were also involved. The survey showed that 82% of the DSOs surveyed have PQ monitoring at some HV/MV substations. The majority of DSOs surveyed that have PQ monitoring at some HV/MV substations, are monitoring less than 30% of MV busbars (see Figure 1). It is EURELECTRIC's view that it is not necessary to monitor all HV/MV substations to realise the benefits of PQ monitoring.

Costs on communication, storage, software, presentation and external access are the main VQ challenges in the EURELECTRIC perspective.

Figure 1 - EURELECTRIC survey results about the number of PQ instruments on MV Busbars in HV/MV Substations



EURELECTRIC point to new challenges and possibilities related to PQ monitoring:

» Recent developments affecting low voltage systems like new loads (electric vehicles and heat pumps) and distributed generation.

» Smart Metering implementation that could allow for recording of voltage magnitude, voltage dips and swells.

In EURELECTRIC view there are shared responsibilities related to voltage quality with the overall objective being that the performance of customers' equipment meets their need:

» Standardisation bodies are responsible for defining a coherent set of EMC compatibility levels, along with emission and immunity limits.

» DSOs are responsible for planning the system for adequate VQ, and for defining emission limits applicable to customers' installations.

» Equipment providers being important for assuring acceptable levels of immunity and emission from their equipment.

» Customers assuring the protection of their sensitive equipment and processes against expected voltage disturbances and also for ensuring that the emission from their installation is within the allowed limits.

Focusing on voltage dips, EURELECTRIC's view is that it is not possible to eliminate such events, with networks containing overhead lines being especially prone to faults due to external factors. Undergrounding of electricity networks and faster protection are possible solutions to reduce frequency and severity of voltage dips. However, these solutions impose substantial investments that can face difficulties on customers' willingness to pay and timescales of many years to be implemented.

EURELECTRIC recognise that some of the customers most sensitive to voltage dips are also economically important customers. However, the most economic solution is often for the customers to make their installation and processes more robust. The report entitled "Voltage Dip Immunity of Equipment and Installations" [16], from the CIGRE, CIRED and UIE joint working group JWG C4.110, is a very good reference to be consulted.

DSOs view VQ monitoring as useful to ensure adequate voltage quality for their customers and most DSOs have some VQ monitoring in place already. EURELECTRIC emphasizes that standardisation continues to make a key contribution and several challenges will be faced.

4. EN 50160 voltage dips and swells classification as an instrument for responsibility sharing

The European Standard EN 50160, entitled "Voltage characteristics of electricity supplied by public electricity networks" defines, describes and specifies the main characteristics of the voltage at a network user's supply terminals in public low, medium and high voltage electricity networks under normal operating conditions.

This standard describes the limits or values within which the voltage characteristics can be expected to remain at any supply terminal in public European electricity networks; the standard does not describe a typical situation experienced by an individual network user.

The EN 50160 first edition has been published during November 1994 and two other editions were approved during 1999 and 2007. The most recent edition, the EN 50160:2010, was ratified as of 1 March 2010, and has therefore only recently been published. In this new edition some important improvements have been achieved.

In particular, a distinction is made between:

» Continuous phenomena, i.e. small deviations from the nominal value that occur continuously over time - such phenomena are mainly due to load patterns, changes of load or nonlinear loads.

» Voltage events, i.e. sudden and significant deviations from normal or desired wave shape like interruptions of the supply voltage, supply voltage dips and swells and transient overvoltages between live conductors and earth.

Limits are specified by the EN 50160: 2010 standard for some continuous phenomena; on the other hand, for voltage events, some indicative values are provided in an informative annex to the standard (Annex B).

Voltage events are typically due to unpredictable causes (e.g., equipment failure) or to external causes (e.g., weather, third party actions). The standard states that more research is needed before setting European joint limits for voltage events.

Apart from interruptions, voltage dips are the events most affecting industrial customers. Defined as a temporary reduction of the voltage, a voltage dip is typically associated with the occurrence and termination of a short circuit or other extreme current increase in the system. According to the conventional view of the standard, a voltage dip is a two dimensional electromagnetic disturbance, the level of which is determined by both voltage [residual voltage] and time [duration].

In the perspective of the harmonisation on data collecting all over Europe, a major advance introduced by the new edition of EN 50160 is a new voltage dips classification table presented in Table II, allowing a common method for presentation of voltage dips data.

Table II - The voltage dips classification table in EN 50160:2010

	Duration [ms]				
Residual voltage u [%]	**10-200**	**200-500**	**500-1000**	**1000-5000**	**5000-60000**
90 > u ≥ 80	CELL A1	CELL A2	CELL A3	CELL A4	CELL A5
80 > u ≥ 70	CELL B1	CELL B2	CELL B3	CELL B4	CELL B5
70 > u ≥ 40	CELL C1	CELL C2	CELL C3	CELL C4	CELL C5
40 > u ≥ 5	CELL D1	CELL D2	CELL D3	CELL D4	CELL D5
5 > u	CELL X1	CELL X2	CELL X3	CELL X4	CELL X5

Being useful to describe the possible behaviour of the network with the same parameters used for testing appliances [Product Standards], EN 50160 made reference to test levels given in EN 61000-4-11 [different test levels for different equipment classes: 1, 2, 3, X] using such levels as a base for the new classification table.

When compared with the original one published in the EN 50160:2010, Table II has been modified for this paper introducing grey shading for certain cells. For a given equipment class [e.g. class 3], the cells with grey colour [A1, B1, C1, A2, B2, A3 and A4] represent the immunity area to voltage dips [duration and residual voltage] that must be assured by these appliances. Classes are referred to different electromagnetic environment, as defined in EN 61000-2-4.

For the cells below the referred immunity curve, aregulation can eventually be enforced at a national level imposing voltage quality requirements to be fulfilled by the TSO or DSO.

5. Responsibility of stakeholders for voltage dips

The voltage dips classification table introduced in EN 50160:2010 (Table II) allows for a more harmonized way of presenting these voltage quality events. Furthermore, it also gives the opportunity to apply the concept of "responsibility sharing" between customers, equipment manufacturers and network operators, as introduced in [6,7,8] and shown in Figure 2.

Some standards and national regulations (France, South Africa) already foresee setting up a boundary between the voltage dips for which appliances or installations have to be immune and the events that can be limited by the DSO/TSO and to be subject to voltage quality regulation. Other possible sharing curves would be based on the equipment immunity requirements in documents like SEMI F47 and ITIC.

More recently, the Swedish national regulatory authority (Energy Markets Inspectorate) has introduced voltage-quality regulation [17,18]. This regulation includes an evolution of the concept by introducing a second curve as shown in Figure 3.

In complement to the Area A (in terms of residual voltage and duration of the voltage dips) already defined where installations should be immune, the remaining area where the voltage quality regulation is applied has been divided in two.

Figure 2 - The "responsibility sharing curve"

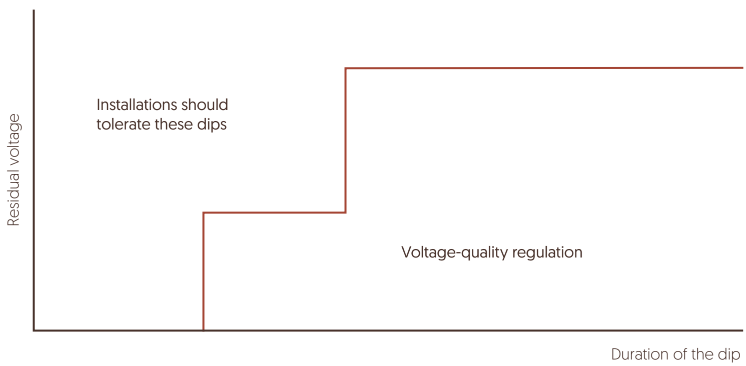
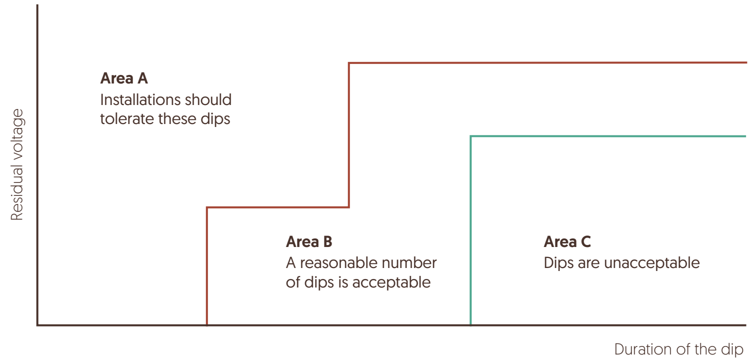


Figure 3 - The evolution of the "responsibility sharing curve" according to the Swedish regulation.



Voltage dips with duration longer than certain values and overpassing a specified voltage reduction (Area C) are considered unacceptable and when such a voltage dip occurs the quality of supply is considered to be insufficient. Finally, a third intermediary area (Area B) has been introduced where a reasonable number of voltage dips is considered acceptable.

Figure 4 and Figure 5 present the limits for Area A, Area B and Area C according to the Swedish regulation for networks above 45 kV and for networks with nominal voltage of 45 kV or less.

With this approach, the network operator must prevent dips in Area C and limit the number of voltage dips in Area B. On their side, customers should assure that their processes and equipment are immune to voltage dips in Area A and assure that the impact of dips in Area B is limited. Equipment manufacturers must assure that their equipment is immune to dips in Area A and must assure that different classes of equipment immunity are able to cover Area B.

Figure 4 - Limits according to the Swedish regulation for networks above 45 kV

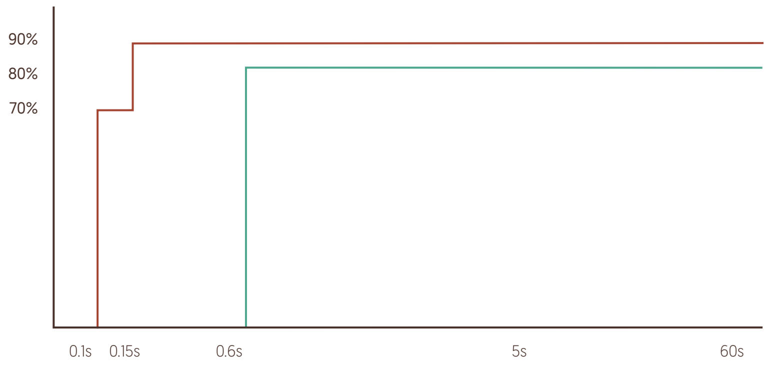
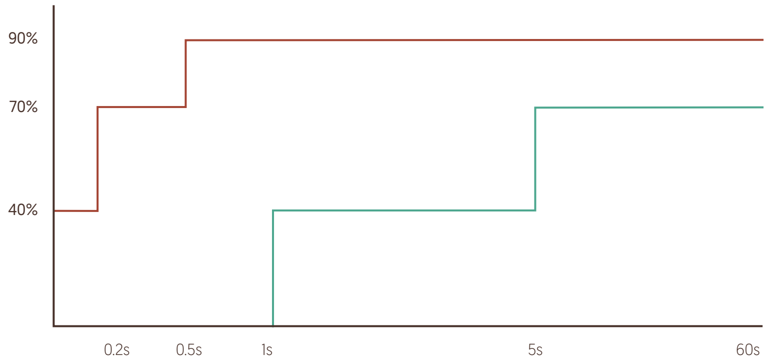


Figure 5 - Limits according to the Swedish regulation for networks 45 kV or less.



This new approach opens a new challenge in the form of the question "What is a reasonable number of events to be specified in Area B?"

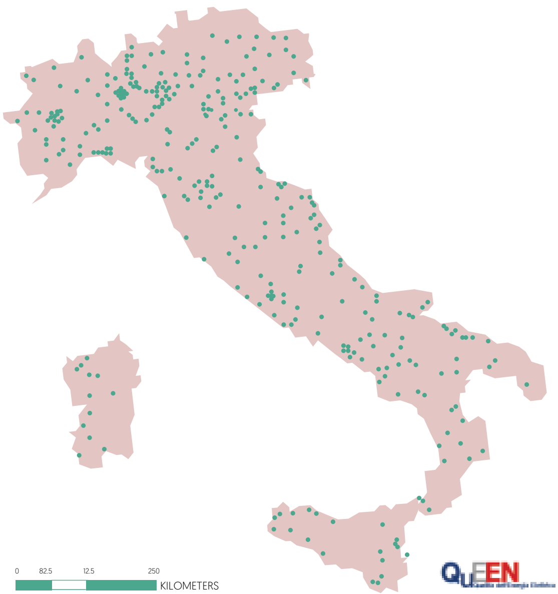
Different approaches can be adopted, like the one used in South Africa (related to the number monitored in a predefined percentage of locations, i.e. 95% of the sites) or the one used in France (resulting from the comparison with the last several years) or the one mentioned in the text of the Swedish regulation (for example, historical data, other similar networks under similar conditions, technical possibilities, and costs associated with taking measures). A further approach could also consist in evaluating (for each individual case) the costs for end-users due to the number of voltage dips in area B, and comparing them with the costs associated with the measures to reduce the number and duration of the specific dips.

6. A national example: towards VQ regulation in Italy

Installing a reliable VQ monitoring system in each country is important in order to be able to inform customers about the voltage quality to be expected in each location.

In Italy a VQ monitoring system, QuEEN (Quality of Electric ENergy), is spread over the country involving 400 monitoring units installed on medium voltage (MV) busbars of high voltage/medium voltage (HV/MV) substations, Figure 6.

Figure 6 - Location of the 400 VQ monitoring units installed in Italy by QuEEN



The 400 VQ monitoring units installed monitor about 10% of such main busbars of the MV distribution network, being considered that this sample is representative of the network characteristics in terms of:

» Number of HV/MV substations in each region.

» Length of the MV lines.

» Type of MV lines: cable, overhead, mixed.

» Neutral compensation or isolated neutral.

» Number of MV customers.

» Density of low voltage customers.

Tables III, IV and V present the QuEEN report on voltage dips collected annually during 2008, 2009, and 2010, respectively. QUEEn reports all the poly-phase events (given that neutral is isolated/compensated, no dip originates from single-phase to ground faults), regardless of any time aggregation (i.e., if two dips occur even in a few seconds, they are both reported). The same applies to adverse weather condition: no exclusion is foreseen, all events are duly reported, and contribute to the figures of the tables. For more details on the methods used to calculate the values in the table see reference [19].

Table III - QuEEN Report on voltage dips: year 2008

Range of res. Voltage Ur [in % of Un or Ud]	Duration t [ms]		
	10 < t ≤ 200	200 < t ≤ 500	500 < t ≤ 5000
90 > u ≥ 80	29,2	5,6	2,0
80 > u ≥ 70	18,6	4,3	0,6
70 > u ≥ 40	40	6,8	0,7
40 > u ≥ 5	15,4	2,6	0,3

Table IV - QuEEN Report on voltage dips: year 2009

Range of res. Voltage Ur [in % of Un or Ud]	Duration t [ms]		
	10 < t ≤ 200	200 < t ≤ 500	500 < t ≤ 5000
90 > u ≥ 80	34,9	7,5	2,6
80 > u ≥ 70	17,1	5,3	0,8
70 > u ≥ 40	28,2	5,3	0,7
40 > u ≥ 5	9,9	1,7	0,2

Table V - QuEEN Report on voltage dips: year 2010

Range of res. Voltage Ur [in % of Un or Ud]	Duration t [ms]		
	10 < t ≤ 200	200 < t ≤ 500	500 < t ≤ 5000
90 > u ≥ 80	31.5	6,4	2
80 > u ≥ 70	15,5	4,4	0,6
70 > u ≥ 40	22,6	4,8	0,5
40 > u ≥ 5	8,5	1,3	0,2

Data collected on 10% of MV main busbars show:

» An average number of dips per bus reducing from 126.1 in 2008 till 98.3 in 2010.

» An evolution from 99.7 voltage dips that would be overcome by class 3 equipment in 2008 till 82.4 in 2010.

» An evolution from 26.4 voltage dips that might impair the operation of class 3 equipment in 2008 till 15.9 in 2010.

Based on the EN 50160:2010, on the data collected by QuEEN and on an economic analysis of the impact of transient interruptions and voltage dips on the Italian economy, AEEG, the Italian Energy Regulatory Authority, published two Consultation Papers [DCO 42/10; DCO 15/11] to be considered for the Italian regulatory period from 2012 till 2015 [20].

Some proposals regard:

» Extension of VQ monitoring to all MV busbars of HV/MV stations [about 4000 VQ meters needed].

» Publication of expected/registered values of transient interruptions and voltage dips by the DSO for each MV main busbar [publication of long and short interruptions is already in force].

The availability of such data will allow a sensitive user to evaluate on a sound technical base if further immunisation or mitigation is needed for a specific industrial process.

Comparisons between VQ levels provided by different DSOs, or by different technical solutions put in place along the entire national MV systems, will also be possible.

Conclusions

Cooperation between CEER and EURELECTRIC in the field of quality of electricity supply involved joint meetings and the participation of the European Energy Regulators in the relevant CENELEC Technical Committee contributing to EN 50160:2010. This new edition of the standard includes a new voltage dips classification table allowing harmonisation at European level on voltage dips data collection in line with immunity testing standards like EN 61000-4-11 [and EN 61000-4-34].

This European standardised approach gives the opportunity to apply the concept of “responsibility sharing” between customers [end-users], equipment manufacturers and network operators. This concept defines a boundary between the voltage-dip events for which appliances or installations have to be immune and the events that can be limited by the DSO/TSO and be subject to voltage quality regulation.

More recently, the voltage-quality regulation in force in Sweden introduced an evolution in the concept defining an intermediate area where a reasonable number of voltage dips is considered acceptable.

All this requires the installation of reliable VQ monitoring systems. The majority of DSOs have already developed efforts in VQ monitoring through which the importance of harmonisation and standardisation has been identified.

It is also important that European countries disseminate their own national experience in order to consolidate the European view on VQ monitoring. The Italian example has been presented with their last 3 years results obtained from a voltage dips monitoring system covering a significant share of MV main busbars (≈10%) that is compliant to the data collection rules specified by EN 50160:2010.

The systematic monitoring all over Europe and the implementation at national level of this standardized classification will result in an improved knowledge on the voltage dip phenomenon. It will also contribute to the benchmarking of their impacts for networks and customers, and to supporting voltage quality regulation, definition of equipment and processes immunity, and emission limits for voltage dips. All these efforts will contribute to mitigate the costs related to VQ events in Europe, in the general perspective of increasing the European productivity.

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A status review of regulatory approaches to smart electricity networks across Europe

Riccardo Vailati, Math Bollen, Jorge Esteves, Gareth Evans, Werner Friedl [1]

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Abstract

As a result of three years work in the field of smart electricity grids and their regulation, the priorities and recommendations of European Energy Regulators include (i) encouraging co-operation amongst stakeholders and identifying possible barriers to smart grid deployment; (ii) ensuring dissemination of the results and lessons learned from demonstration projects financed by network tariffs to all interested parties; (iii) evaluating the breakdown of costs and benefits of possible demonstration projects for each network stakeholder and to take decisions or give advice to decision-makers based on societal cost-benefit assessment

[1] Riccardo Vailati, Italy
Math Bollen, Luleå University of Technology (LTU), Sweden,
Jorge Esteves, Energy Services Regulatory Authority (ERSE), Portugal,
Gareth Evans, Office of Gas and Electricity Markets (Ofgem), United Kingdom,
Werner Friedl, Energie-Control Austria (E-Control), Austria

which takes into account costs and benefits for each stakeholder and for the society as a whole; (iv) pursuing regulation of outputs as a mechanism to ensure value for money for network users and investigating metrics for the quantification of the most important output effects and benefits at national level.

In line with such recommendations, the Council of European Energy Regulators (CEER) prepared in 2011 a "Status review of regulatory approaches to smart electricity grids", which reviewed (i) regulatory challenges related to smart grids; (ii) innovation and demonstration projects; (iii) cost benefit analyses for the demonstration and deployment of smart grids; (iv) potential performance indicators and incentive schemes for regulating network outputs.

According to the answers to the preparatory survey for the 2011 Status Review, the challenge of dealing with incentives to improve cost-effectiveness was identified (and/or commented on) by most of the countries. The following three challenges also generated a significant reaction from the National Regulatory Authorities (NRAs):

» how to encourage network operators to choose innovative solutions;

» the inadequacy of existing standards or lack of standards on smart-grid technology; and

» the need to enhance the definition of national objectives and policies at political level.

According to the answers to the survey, a significant number of countries indicated that they use some of the 34 potential performance indicators (output effects) for transmission and distribution networks which were identified in the 2010 Conclusions Paper on Smart Grids. This can be either for monitoring purposes, as a minimum requirement, or as a revenue driver. In particular, the indicators for continuity of supply (quality of supply) and the indicators related to losses (efficiency) are used as revenue drivers in more than half of the countries.

Keywords

Regulation - Networks - Benefits - Performance Indicators - Demonstration Projects - Smart Grids.

1. Introduction

The European Energy Regulators started addressing the issue of smart transmission and distribution networks by launching - through the European Energy Regulators' Group for Electricity and Gas (ERGEG) - a public consultation, "Position Paper on Smart Grids", on 17 December 2009 [1].

A "Conclusions Paper on Smart Grids" [2], including an evaluation of comments received, was published on 10 June 2010. The European Energy Regulators continued their activities on smart electricity grids in 2011 by preparing, through CEER, the "Status review of regulatory approaches to smart electricity grids" [3]. The Status Review, based on a survey among NRAs in the EU-27 Member States and Norway, examined the scope and definition of smart grids; regulatory challenges affecting smart grids, national roadmaps for their implementation; and recommendations regarding demonstration projects, cost benefit analyses and potential performance indicators and incentive schemes.

This paper mainly focuses on the results of the Status Review in the European countries regarding:

» Regulatory challenges related to smart grids (section 2);

» Innovation and demonstration projects (section 3);

» Cost benefit analyses for the demonstration and deployment of smart grids (section 4);

» Potential performance indicators and incentive schemes for regulating network outputs (section 5).

Furthermore, elements from the 5th Benchmarking Report on Quality of Electricity Supply [4] discussing performance indicators in the fields of continuity of supply are also presented in section 5.

2. Regulatory challenges related to smart grids

As the benefits of smart grids are becoming increasingly relevant in European countries, regulators are considering possible challenges to their implementation. The analysis of these challenges, which is important for regulators in order to take appropriate national actions, has already occurred in many countries. Using an internal questionnaire, CEER analysed a range of possible challenges. Taken overall, the feedback of NRAs suggests differences in the importance attached to possible challenges at national level. Some challenges have been recognised more than others.

The question of dealing with incentives to improve cost-effectiveness was identified [and/or commented on] by most of the countries. The following three challenges also generated a significant reaction from the NRAs:

- how to encourage network operators to choose innovative solutions;
- the inadequacy of existing standards or lack of standards on smart-grid technology; and
- the need to enhance the definition of national objectives and policies at political level.

3. Innovation and smart grid demonstration projects

The 2010 ERGEG Position Paper on Smart Grids [2] includes recommendations that relate to smart grid demonstration projects. CEER recommends encouraging the deployment of smart grid solutions where they are a cost-efficient alternative to existing solutions, and as a first step in this direction, finding ways of incentivising network companies to pursue innovative solutions where this can be considered beneficial from the viewpoint of society as a whole. Based on the responses of NRAs to the internal questionnaire, CEER sees various approaches to encouraging innovation through different regulatory regimes and the varying status of smart grids development in different countries. Different incentive mechanisms to encourage network companies to pursue innovation/demonstration projects are already in place or planned. Further, some countries rely on current approaches which do not necessarily encourage innovative solutions, especially when focused parameters are implemented, but have separate funding schemes using public money for demonstration projects.

CEER also recommends ensuring dissemination of the results and lessons learned from the demonstration projects. Seven countries said there are guarantees in place regarding such dissemination, but nine said there are not. In the former ones, there are generally clear rules that ensure dissemination. Still, it is noteworthy that the majority of responses indicated that no requirements are in place to ensure the dissemination of results and lessons learned. CEER considers that there are very significant benefits to the efficient communication of the results of demonstration projects to all interested stakeholders.

4. Cost benefit analyses for the demonstration and deployment of smart grids

European Energy Regulators recommend evaluating the breakdown of the costs and benefits of possible demonstration projects for each network stakeholder and taking decisions or giving advice to decision-makers based on a societal cost benefit assessment. The survey found that, as of March 2011, three countries (the Danish transmission system operator and energy association, the GB Electricity Networks Strategy Group and a Polish distribution system operator) had undertaken a cost benefit analysis (CBA) of a full smart grid or specific value streams. However, six countries indicated that a CBA was either on-going or planned.

These initial activities have recently been complemented by one EU-wide initiative regarding CBA of smart grid projects. In 2012, the European Commission set up an expert group in its Smart Grids Task Force for assessing projects of common interest in the field of smart grids. The group identified a multi-criteria assessment framework for smart grids projects and a subsequent cost-benefit analysis framework [5]. 20 out of 21 adopted key performance indicators appear in the list of potential performance indicators of the 2010 ERGEG Position Paper on Smart Grids (see next section).

5. Potential performance indicators and incentive schemes for regulating network outputs

In the 2010 ERGEG Position Paper on Smart Grids, European Energy Regulators identified 34 potential performance indicators related to 8 groups of benefits: (1) increased sustainability, (2) adequate capacity of transmission and distribution grids for "collecting" and bringing electricity to consumers, (3) adequate grid connection and access for all kinds of grid users, (4) satisfactory levels of security and quality of supply, (5) enhanced efficiency and better service in electricity supply and grid operation, (6) effective support of trans-national electricity markets, (7) coordinated grid development through common European, regional and local grid planning to optimise transmission grid infrastructure, (8) enhanced consumer awareness and participation in the market by new players.

The list of 34 potential performance indicators is available in [2], whereas [6] - [7] provide further insights. According to the survey answers in the CEER 2011 Status Review, a significant number of countries indicated that they use some of the indicators proposed in [2]. This can be either for monitoring purposes, as a minimum requirement, or as a revenue driver. In particular, the indicators for continuity of supply (one quality element) and the indicators related to losses (one efficiency element) are used as revenue drivers in more than half of the countries.

9 indicators out of the list of 34 were selected for more detailed analysis proposed in the smart grid conclusions paper:

1. Hosting capacity for distributed energy resources (DER) in distribution grids;

2. Allowable maximum injection of power without congestion risks in transmission networks;

3. Energy not withdrawn from renewable sources due to congestion and/or security risks;

4. Measured satisfaction of grid users for the "grid" services they receive;

5. Level of losses in transmission and distribution networks;

6. Actual availability of network capacity (e.g. DER hosting capacity) with respect to its standard value;

7. Ratio between interconnection capacity of one country/region and its electricity demand;

8. Exploitation of interconnection capacity (ratio between mono-directional energy transfers and net transfer capacity); and

9. Time for licensing/authorisation of a new electricity transmission infrastructure.

The short discussion in this paper focuses on indicators (1-3) of adequate grid capacity and on indicators (4-6) of enhanced efficiency and better service.

Hosting capacity for distributed energy resources in distribution grids is used in one country (Italy) as a revenue driver and is under consideration in four countries (Austria, Czech Republic, Latvia and Lithuania) for monitoring and in three countries (Austria, Ireland and Poland) as a revenue driver. Two countries (Great Britain and Norway) have minimum requirements in place for this indicator. Allowable maximum injection of power without congestion risks in transmission networks is used in one country (Italy) as a revenue driver and is under consideration in three countries (Austria, Czech Republic and Lithuania) for monitoring and in two countries (Austria and Poland) as a revenue driver. Two countries

(Great Britain and Norway) have minimum requirements in place for this indicator. When using these first two indicators as a revenue driver, care should be taken as with the hosting capacity as well as with the net transfer capacity. A possible incentive mechanism should not result in excessive unnecessary investments and the method for calculating the index should not favour one technology above another.

Energy not withdrawn from renewable sources is used in two countries (Germany and Ireland) for monitoring and is under consideration in three countries (Czech Republic, Lithuania and Spain) for monitoring and in two countries (Great Britain and Poland) as a revenue driver. One country (Latvia) has minimum requirements in place for this indicator

Measured satisfaction of grid users for the grid services they receive is used in two countries (Czech Republic and Great Britain) as a revenue driver and in three countries (France, Italy and Portugal) for monitoring. It is under consideration in three countries (Austria, Lithuania and Poland) for monitoring.

Level of losses in transmission and distribution networks is used in twelve countries (Austria, Czech Republic, France, Great Britain, Ireland, Italy, Norway, Poland, Portugal, Slovenia, Spain and The Netherlands) as a revenue driver, in six countries (Czech Republic, Germany, Finland, Ireland, Norway and Sweden) for monitoring and is under consideration in one country (Luxembourg) for monitoring and in two countries (Luxembourg and Lithuania) as a revenue driver. As a result, there is a significant amount of experience in the use of this indicator. However, the indicator is likely to be calculated in different ways in different countries. It is not clear to what extent this will have an impact on the results and the ability to compare.

Actual availability of network capacity with respect to its standard value is used for monitoring in five countries (Austria, Czech Republic, Great Britain, Italy and Norway) and is under consideration in two countries (Lithuania and Poland) for monitoring and in one country (Great Britain) as a revenue driver. One country (Norway) has minimum requirements in place for this indicator. Furthermore, the survey revealed two possible understandings of this type of indicator:

- » the availability of network capacity compared to a reference value at national or local level; or
- » the actual availability of network capacity in selected lines or network cross-sections compared to their normal capacity (e.g. winter peak net transfer capacity), due to unavailability of some network components or actual operational conditions.

The CEER 2011 Status Review showed differences concerning the calculation of performance indicators and the way they are (or can be) used as a revenue driver. It remarked that the indicators, and any associated revenue mechanism, are defined in such a way that they do not favour one technology above another. Other key features, such as the determination of a quantifiable benefit to grid users and society as a whole, the accountability of the indicators in a sufficiently accurate and objective way and the clear possibility to influence the value of the indicators by the network operator(s) or the system operator, had already been identified by European Energy Regulators.

A few months after the publication of the CEER 2011 Status Review, the European Energy Regulators completed the analysis of the performance indicators in place in Europe by focusing on the fields of continuity of supply, voltage quality and commercial quality. This analysis is captured in the fifth edition of the CEER Benchmarking Report on Quality of Electricity Supply [4]. In addition to NRAs from CEER member countries, the 9 NRAs from the Energy Community and the National Regulatory Authority of Switzerland joined for the 2011 Benchmarking Report.

In this paper, the discussion focuses on fields of continuity of supply (CoS) indicators. All 36 countries who participated in the CoS survey stated that continuity is monitored within their electricity networks country-wide. This monitoring is done in different ways in different countries. Differences vary from the kind of interruptions monitored and the level of detail being reported to the interpretation and highlighting of various indicators.

System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) are the most commonly used indices with weightings in most countries based on the number of network users. Energy Not Supplied (ENS) is mostly used for transmission networks. 12 CEER countries (Czech Republic, Finland, France, Great Britain, Hungary, Italy, Lithuania, Norway, Poland, Portugal, Slovenia and Sweden) reported that they collect separate data on short and sometimes even transient interruptions. Two formulations are used for short interruptions, depending on aggregation rules for interruption events: Momentary Average Interruption Frequency Index (MAIFI) and Momentary average interruption event frequency index (MAIFIE).

Reward and/or penalty schemes or incentives to optimise continuity of supply levels have been introduced in 15 of the 26 CEER countries that provided feedback to the survey: Bulgaria, Denmark, Finland, France, Great Britain, Hungary, Ireland, Italy, Lithuania, Norway, Portugal, Slovenia, Spain, Sweden and the Netherlands. Most of the countries which have not yet implemented a continuity of supply incentive scheme have plans or the intention to introduce such a regime (i.e. Austria, the Czech Republic, Germany, Greece, Luxembourg and Romania). Table 1 provides additional insights on the indicators used in the countries to implement performance-based incentive regulation of continuity.

Table 1 - Continuity of supply regulation at system-level (source: [4])

	Rewards	Penalties	Combination	Continuity indicators used
Distribution	-	DK, HU, IT	BG, FI, FR, GB, IE, IT, LT, NL, NO, PT, SI, SE, ES	BG (SAIFI, SAIDI); FI (outage costs on basis of planned and unplanned long and short term interruptions); FR (SAIDI); GB (customer interruptions and customer minutes lost); HU (SAIDI, SAIFI, outage rate); IE (customer minutes lost, customer interruptions); IT (for the main scheme: SAIDI and SAIFI+MAIFI); NO (interrupted power – planned, unplanned, reference time, duration, time of occurrence); PT (END); SI (SAIFI, SAIDI); SE (SAIFI and SAIDI for DSOs and ENS and interrupted power for regional networks); ES (TIEPI, NIEPI); NL (CAIDI, SAIFI)
Transmission	ES	DK, HU, IT	FI, FR, GB, IE, IT, LT, NO, PT	FI (outage costs on basis of planned and unplanned long term interruptions); FR (AIT); GB (ENS for England & Wales / number interruptions for Scotland); HU (AIT); IE (System Minutes lost); IT (for the main scheme: ENS from 2012; ENS and SAIFI+MAIFI and number affected users till 2011); NO (interrupted power – planned, unplanned, reference time, duration, time of occurrence); PT (TCD – combined average availability rate, in %); SE (ENS and interrupted power)
No existing CoS scheme	AT, CY, CZ, EE, DE, GR, LV, LU, PL, RO, SK			
Intention/ plans for implementation	AT (details under consideration), CZ (incentive regime on the basis of reward and penalty schemes with SAIFI and SAIDI indicators), DE (reward and penalty scheme implemented in 2012), GR (penalty and reward scheme on basis of SAIFI and SAIDI indicators), LU (quality incentives under consideration), RO (implementation under consideration)			

Note: AIT "Average Interruption Time", CAIDI "Customer Average Interruption Duration Index", END "Energy Not Distributed", NIEPI "Equivalent number of interruptions related to the installed capacity", TCD "combined average availability rate", TIEPI "Equivalent interruption time related to the installed capacity".

Conclusions

This paper, based on the "Status review of regulatory approaches to smart electricity grids", provides a review of the regulatory challenges related to smart grids innovation and demonstration projects and cost benefit analyses for the demonstration and deployment of smart grids in European countries.

Furthermore, the paper discusses potential performance indicators and incentive schemes for regulating network outputs, with particular focus on indicators of adequate grid capacity and of enhanced efficiency and better service. A significant number of countries indicated that they use some of the indicators proposed in the 2010 ERGEG Position Paper on Smart Grids. This can be either for monitoring, as a minimum requirement, or as a revenue driver. In particular, the indicators for continuity of supply and the indicators related to losses are used as revenue drivers in more than half of the countries (15 out of 26 countries for continuity, 12 out of 24 countries for losses). The experience showed differences concerning the calculation of performance indicators and the way they are (or can be) used as a revenue driver.

Disclaimer

The authors of this paper prepared publications of CEER and ERGEG, together with other members of the CEER/ERGEG Electricity Quality of Supply and Smart Grids Task Force. Still, the paper represents the personal interpretation by the authors of the material presented. The opinions and recommendations represented in this paper do not necessarily correspond with the opinions of CEER/ERGEG or of any of the organisations the authors currently work for.

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Guidelines for Good Practice on Voltage Quality Monitoring

Math Bollen, Philippe Baumann, Yvonne Beyer, Romain Castel, Jorge Esteves, Sérgio Faias, Werner Friedl, Samuele Larzeni, Jasmina Trhulj, Ferrucio Villa, Lars Ström[1]

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Abstract

Guidelines are given for setting up and running a voltage quality monitoring programme. These guidelines are published jointly by CEER and ECRB and contain among others recommendations on the number and location of monitors, on disturbances to be monitored and indices to be calculated, on reporting of the results and on financing of the programme. It is concluded that voltage quality monitoring programs are important tools for voltage quality regulation and that all other possible applications should be kept in mind when setting up such a programme. It is also concluded that such programmes

[1] Math Bollen, Luleå University of Technology (LTU), Sweden
Philippe Baumann, Federal Electricity Commission (Elcom), Switzerland
Yvonne Beyer, Authority for Consumers and Markets (NMA), The Netherlands
Romain Castel, Commission de Régulation de l'Energie (CRE), France
Jorge Esteves, Energy Services Regulatory Authority (ERSE), Portugal
Sérgio Faias, Energy Services Regulatory Authority (ERSE), Portugal
Werner Friedl, Energie-Control Austria (E-Control), Austria
Samuele Larzeni, Autorita per l'energia elettrica ed il gas (AEEG), Italy
Jasmina Trhulj, Energy Agency (AERS), Serbia
Ferrucio Villa, Autorita per l'energia elettrica ed il gas (AEEG), Italy
Lars Ström, Energy Markets Inspectorate (EI), Swedent

should be funded through the network tariffs, that the results should be made available regularly and the diversification of indices and methods is to be avoided.

Keywords

Voltage Quality Monitoring-Service Quality Regulation-Electricity.

Nomenclature

NRA: national regulatory authority

CEER: Council of European Energy Regulators

ECRB: Energy Community Regulatory Board

VQ: voltage quality

VQM: voltage quality monitoring

LV: low voltage

MV: medium voltage

HV: high voltage

EHV: extra high voltage

Introduction

The 5th CEER Benchmarking report on Quality of Electricity Supply, published in 2011 [1], is a joint deliverable of the Council of European Energy Regulators (CEER) and the Energy Community Regulatory Board (ECRB). In this document, 18 countries reported to have an operational voltage quality monitoring (VQM) system. Next to that the majority of network operators in most countries perform VQM on a continuous basis at one or more locations. The number of voltage quality (VQ) monitors in operation in the public distribution and transmission networks has seen a significant growth in recent years, largely due to a number of technical developments. The cost of monitoring equipment has dropped significantly, making it no more an unsurpassable barrier to install a larger number of instruments. Also, the costs of ancillary technologies, like communication, data storage, data processing and visualisation of results have significantly decreased , whereas at the same time their performance has improved a lot. The appearance of smart meters with VQM functionality is the most visible proof of such development.

Recent and on-going developments within the power grid and equipment connected to it have further resulted in an increased interest in VQ, e.g.: photo-voltaic installations; wind power; energy-efficient lighting; HVDC; and voltage quality regulation. These developments were the driving forces behind a joined report by CEER and ECRB containing guidelines on VQM supported by both organisations [2]. This paper summarizes those guidelines; the reader is referred to the full report for more details.

1. Applications of VQM

A number of possible applications of the results obtained from VQM programmes have been identified in the report:

» Compliance monitoring

» System performance monitoring

» Specific site monitoring (complaints, pre-connections and contracts)

» Benchmarking

» Network development and investment approval

» Reporting and publishing of VQM results

» Further development of VQ regulation

» Remedial and mitigation measures

» Network operators and end-users awareness

» Verification of compliance by network users

» Transition to smart grids

» Research and education

2. VQM Programmes

According to the possible applications listed above, it is advisable to start a VQM programme as a tool for:

- continuous monitoring aimed at verification of compliance and introduction or further development of VQ regulation;
- further understanding of relations between network properties, disturbances and equipment behaviour with the aim of improving compatibility between equipment and the grid;
- benchmarking analysis of VQ both at national and international level.
- collecting data in order to set or improve technical standardisation;
- research and education, aimed at gaining knowledge from data collected, leading further to continuous VQM programmes implementation;

When a VQM programme is in place, other applications are possible in parallel, such as obtaining information on local VQ to existing users, following complaints, providing information to future users, prior to connection to the network (especially industrial users who are generally the most sensitive to VQ) or in the case of VQ contracts.

It is especially recommended that the results from VQM programmes are used for identifying and dealing with new challenges in the system, such as impact of distributed generation and new types of customers or in facilitating the transition to smarter grids.

When starting the process of setting up a VQM programme, all possibly needed applications should be considered. An initially well-designed VQM programme will allow other applications immediately or following minor inexpensive adjustments. In order to have a wider insight into required applications of VQM programmes, close cooperation between interested parties, especially NRAs, network operators and network users, but also equipment manufacturers and researchers, is recommended in the early phases of establishing a VQM programme.

3. Number and Location of Monitors

The report also gives guidelines for the number of monitors, which locations in the network they should be placed and the length of the measurement period.

In EHV and HV networks, it is considered good practice to monitor the VQ at all EHV/HV, EHV/MV and HV/MV substations and at the connection points of all EHV and HV customers, producers (power stations) as well as consumers (industrial customers). Given that the number of monitoring points will be relatively small, the costs of continuous VQM at these points in the network are expected to be limited.

In MV networks, it is recommended to monitor the VQ at the MV busses of all EHV/MV and HV/MV transformers and at a selection of MV/LV substations and connection points of MV customers. The exact number of measurement locations is expected to vary between countries due to differences in network structure.

In LV networks, it is considered good practice to monitor the VQ at a random selection of connection points of LV customers throughout the country for a statistically relevant sample. For VQM in the LV networks, it is possible to use both fixed and portable instruments. Portable monitors are considered acceptable as long as they are combined with a number of locations with fixed monitors. Fixed instruments will give a better overall view of the VQ at each monitoring location, but monitoring with portable instruments tends to be cheaper in capital costs and allows the monitoring of more locations. Furthermore, smart meters might become part of VQM in the future. However, smart meters are currently only able to measure a limited set of VQ disturbances.

4. Disturbances and Indices

When setting up a VQM programme it is considered good practice to monitor all disturbances as listed in the European voltage-characteristic standard EN 50160. The lack of standardised measurement methods for some disturbances makes benchmarking between network operators, between regions within a country, and between countries impossible, but it does not prevent feedback to network operators, network users and NRAs on the performance of the network. Therefore it is recommended to follow the standards whenever possible and use a broad set of characteristics and indices, beyond what is used for reporting or benchmarking. There is no need to be limited to standard methods, but standard methods should be included. For benchmarking purposes, commonly-agreed indices should be used.

For the evaluation of the VQ, it is considered good practice that the following voltages are used:

- For measurements in solidly-grounded LV networks (which covers the majority of LV networks in Europe) the phase-to-neutral voltage should be used for the evaluation of the VQ;
- In all other cases, the phase-to-phase voltages should be used.

The following is considered to be good practice where it concerns the processing of flagged values:

- Flagged 10-minute values (or 1-minute values in case these are used) should be removed from the statistics for flicker, voltage unbalance, harmonic voltage and interharmonic voltage.
- The same holds for 10-minute or 1-minute values during which a transient or a single rapid voltage change occurs.
- For supply voltage variations only flagged values due to interruptions should be removed. All other values should be included in the calculation of the indices.

It is also recommended to keep track of the time stamps of those flagged values that have been removed from the data. When a large number of values is removed the resulting indices (e.g. over one week) will have limited value and it may be decided to not report those.

Recommendations are given in the report for the calculation of indices for benchmarking. These indices include annual indices per monitor location for each of the three phase-to-phase or phase-to-neutral voltages and annual indices for a number of monitors at similar location. The following disturbances are covered by these indices:

- Supply voltage variations;
- Flicker;
- Voltage unbalance;
- Harmonic voltage;
- Interharmonic voltage;
- Voltage dips;
- Voltage swells.

5. Reporting of the Results

Different parties are interested in the network performance concerning VQ: NRAs, network operators, individual users, research organizations. Reporting and publishing of the results from a VQM programme is thus important and it is recommended that the publishing is done in a uniform manner. Guaranteeing comparison of VQM results will push improvements in networks and will give suitable and preliminary information to network-users. This will raise the awareness of network-users about voltage quality levels, as well as giving them suitable information for designing their installations.

NRAs should publish main results from VQM programmes, including compliance with VQ regulation and observed trends, in a report at least once a year. This report might also be used to provide information about VQ fundamentals and practical consequences of insufficient VQ. A centralised approach should be used in designing data collection and reporting system.

Data should be made available to all interested parties, when necessary according to security mechanisms aiming at protecting the interests of network operators and of individual network users. Initiatives should be taken in order to inform network users about their responsibilities.

The use of the internet is strongly encouraged for the publication of VQ data. Comparative publications are recommended for pushing improvements in networks and giving suitable and preliminary information to end-users.

The use of proprietary software should be avoided in order to facilitate interoperability and promote standardised common data formats.

6. Financing of VQM

It has become clear from the applications of VQM presented above that there are several benefits for different stakeholders of implementing a national VQM programme. However due to the costs of VQM programmes financing frameworks must be considered in order to ensure its effective implementation. The VQM financing framework should include two main steps: the costs assessment and the financing plan. VQM programme costs assessment should be performed throughout an inventory of the whole costs associated to the programme implementation (capital expenses) and maintenance (operational expenses). The most appropriate way of funding such a programme is through the grid tariffs, mostly with the contribution of all connected customers (socialised costs).

According to the questionnaire results, for most NRAs with national VQM programmes underway, the expenses of their programmes are not completely available. In this regard, it is recommended that the NRA follows the national VQM programmes in order to keep inventory of the expenses.

According to the current practice in most European countries with national VQM programmes underway, it is a reasonable approach to allocate the costs of a national VQM programme to all connected customers through the use of grid tariffs, provided that those costs do not exceed 0.2% of the capital and operational expenses of the grid and most customers benefit from the implementation of such programmes.

However, in order to better balance the costs and benefits of the different type of customers and avoid some sense of unfairness of the connected customers that do not expect direct advantages from a national VQM programme implementation, special attention should be given to grid tariffs design

The experiences reported in this GGP demonstrated that in most European countries the NRA is responsible for approving the annual budget for the national VQM programmes. However, the figures of such investments should be more detailed and transparent.

It is further recommended that network operators, where needed in cooperation with research institutes and universities, develop methods to apply VQM data towards a more cost-effective planning and operation of the electricity network. The results from this development should be disseminated at least at a European level.

Conclusions

Voltage quality monitoring programmes are important tools for voltage quality regulation

Voltage quality (VQ) is an important aspect of the service network operators provide to the network users. As such, network operators should be transparent about the level of quality they deliver. Voltage quality monitoring (VQM) programmes can facilitate the delivery of such transparency. There are sufficient applications of the data obtained from VQM and advantages to network users, to justify a VQM programme. The costs of such a programme, along the proposed lines, are a small part of the total costs of operating the electricity networks. A VQM programme can be fully run by network operators, or be installed by the NRA and operated by the network operator with NRA access to the data. Which option is most appropriate depends on national circumstances.

All possible applications should be kept in mind

When setting up a VQM programme it is important to consider all possible applications. Even if the purpose of a programme is initially limited, small changes in the set-up of a programme or of parameters recorded or calculated, can allow future applications at no or very small extra cost. The setting up of such a programme should be done in close cooperation between the NRA and the other stakeholders, especially the network operators.

Voltage quality monitoring programmes should be funded through the network tariffs

It is deemed that the benefits, with regards to the wide range of possible applications, outweigh the costs ofVQM programmes. The most appropriate way of funding such a programme is through network tariffs. However this can vary between countries based on the local tariff structure and regulation.

Results should be made available regularly

Publication of the results and making data available in other ways are important parts of a VQM programme. It is recommended that the NRA publishes the main results from the programme, including compliance with voltage quality regulation and important trends, in a report at least once a year. Such a report can be published by an NRA, network operators or transmission system operators and combined with a similar report on continuity of supply and/or commercial quality.

In addition, data should be made available to other stakeholders, including the general public. Where no objections from individual network users or other important objections exist, all data should be made available for free or at a reasonable cost, for research and education purposes.

Diversification of indices and methods is to be avoided

A number of VQM programmes have already been launched in some European countries. There are large differences between these programmes making it difficult to compare the results. Such a diversification also makes it more difficult to exchange knowledge and experience.

It is strongly recommended that VQM programmes are harmonised according to the guidelines proposed in the report. The need for harmonization applies to, among others, the choice of monitoring locations, types of disturbances monitored, characteristics recorded and indices calculated. Beyond the list of indices for benchmarking, which is recommended as a harmonised set of indices to be obtained from every programme where possible, each European country is recommended to obtain additional indices that specifically reflect the local circumstances.

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Continuity of Supply in the Portuguese Distribution Network and Comparison with other European Countries

Sérgio Faias, Jorge Esteves[1]

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Abstract

In the present paper, the evolution of the continuity of supply in the Portuguese distribution network is analyzed considering different performance indices, such as the number and duration of planned and unplanned interruptions. For the unplanned interruptions, special attention is given to the contribution of exceptional events. The continuity of supply performance of the Portuguese distribution network is then compared with the European average performance. In addition, the different countries are clustered according to technical characteristics of their networks and the continuity of supply indicators of each cluster are compared. The main conclusions of the paper are (i) that the Portuguese distribution network has significantly improved its performance during the last 10 years and still has potential for improvement; and (ii) that technical characteristics, namely the degree of undergrounding, are an important determinant of technical quality measured by existing indices.

[1] Sérgio Faias, Energy Services Regulatory Authority (ERSE)

Jorge Esteves, Energy Services Regulatory Authority (ERSE), Portugal

Keywords

Benchmarking - Continuity of supply - Electricity distribution - Regulation.

Introduction

The liberalization of the electricity sector establishes the separation of basic functions of electricity generation, transmission, distribution and supply (or retailing). However, while in the generation and supply functions a potential for competition exists, in the transmission and distribution networks, their natural monopoly nature requires regulation to induce optimal price and quality of service [1]-[3].

The quality of service regulation, with its three dimensions, continuity of supply (network reliability and availability), voltage quality (characteristics of the supply voltage) and commercial quality (timeliness in dealing with customers' requests) provides a balance between customers' willingness to pay network tariffs and their expectations on minimum levels of quality of service. This topic became more relevant with the evolution from a rate-of-return economic regulation, in which total utility costs were fully recouped by the tariff, to a price-cap regulation, wherein, with the objective of improving the utilities' economic efficiency, their allowed revenues are capped in a level that does not necessarily reflect the actual costs, leading firms to avoid investments and consequently to decrease the quality of service provided to customers [2], [4], [5].

This regulation, namely in what concerns continuity of supply dimension, can be exercised with recourse to a set of direct and indirect instruments such as the definition of minimum standards for the continuity of supply indicators and respective individual monetary compensations, financial incentive schemes, regular reporting of continuity of supply indicators and national and international benchmarking [2], [3], [6].

In order to simulate a competitive environment and contribute to the continuity of supply performance improvement of regulated companies, the different standards, monetary compensations and financial incentive parameters should be periodically adjusted in accordance with the evolution of the continuity of supply performance.

In this regard, integrated in the preparatory work carried out for the revision of the Portuguese quality of service code, scheduled for the first semester of 2013, this paper presents an analysis of the Portuguese distribution network performance evolution in what concerns continuity of supply and compares this evolution with the performance of other

European countries. Thus, in the paper, the main instruments applied to the continuity of supply regulation in Portugal are initially described. Following, the evolution of some of the Portuguese continuity of supply indicators are analyzed for the period 2001-2011 and compared to the average performance of some European countries represented in the Council of European Energy Regulators (CEER). Finally, the different countries are clustered according to technical characteristics of their networks and the continuity of supply indicators of each cluster are compared.

1. Continuity of Supply Regulation in Portugal

In Portugal, the first steps of the electricity sector liberalization started in 1995. As result, with the objective of defining the minimum quality of service standards that utilities should provide to customers and the practices used to monitor the compliance with those standards, the government published the first Portuguese code on the quality of electricity supply in the year 2000. This code, comprising the continuity of supply, voltage quality and commercial quality dimensions was revised in the years 2003 and 2006 [7].

Until 2012, the role of Portuguese national regulatory authority for energy services (ERSE) on the quality of electricity supply subject was limited to the supervision of compliance with the quality of electricity supply code and to the definition of regulatory incentives for improvements in continuity of supply. However, new legislation, published in September and October 2012, transferred to ERSE the power to prepare and approve the national regulatory framework on the quality of electricity supply. In this regard, ERSE is promoting a revision of the quality of supply code, scheduled for 2013.

1.1. Indicators for the Continuity of Supply Characterization

The regular operation of distribution networks can be disrupted by several internal (malfunctions of network equipment) or external sources (as for instance extreme atmospheric phenomena) that usually result in interruptions of the customers electricity supply.

The measurement of actual continuity of supply levels through indicators and standards constitutes one of the basic instruments for regulating continuity of supply [2]. In the Portuguese quality of electricity supply code, a set of indicators to measure the number and duration of long term interruptions (over 3 minutes) are defined. Those main indicators are:

- TIEPI MV – Average duration of interruptions in medium voltage per installed capacity, per year;
- END – Energy not distributed due to interruptions, per year;
- SAIDI MV – Average duration of interruptions in medium voltage per customer, per year;
- SAIFI MV – Average number of interruptions in medium voltage per customer, per year;
- SAIDI LV – Average duration of interruptions in low voltage per customer, per year;
- SAIFI LV – Average number of interruptions in low voltage per customer, per year.

SAIDI and SAIFI indicators, mainly focused in the domestic customer perspective (weighted by the number of customers), are those used in most European countries to characterize the continuity of supply. In addition, in Portugal and Spain, TIEPI MV is used to characterize the continuity of supply of industrial customers, since it is weighted by the installed capacity, and used for distribution network planning purposes by the operators [8].

1.2. Standards and Individual Monetary Compensations

Standards for continuity of supply indicators and individual monetary compensations resulting from noncompliance with the standards are considered in the quality of electricity supply code. Those standards, expressed in the form of limits to the number and duration of interruptions experienced by each customer per year, represent a commitment of the company with their customers to maintain a certain level of quality of supply. Whenever individual limits are exceeded, customers must be informed and monetary compensations must be paid. Since individual monetary compensations paid to customers should act as a stimulus to the company to improve its continuity of supply, the total amount of monetary compensations annually paid to customers is subtracted to its allowed revenues.

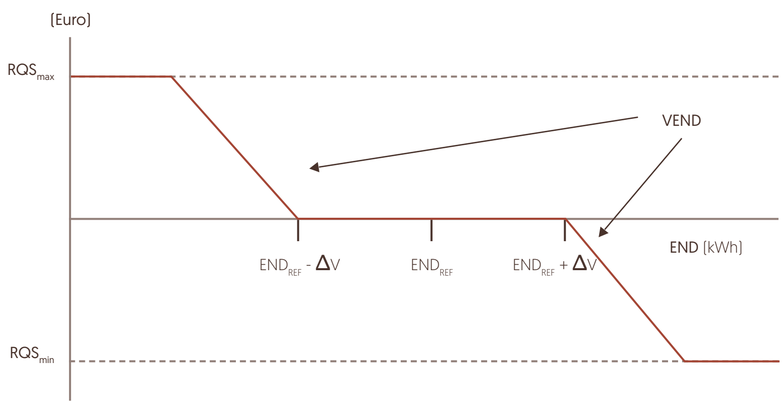
Considering that the demography, as well as technical characteristics of the distribution network, is not homogeneous along the country, different standards are defined according to three kinds of areas, urban, sub-urban and rural. In urban areas it is assumed that the distribution network mainly comprises underground cables in LV and MV and, as such, more demanding standards are prescribed. On the other hand, standards for rural areas are less demanding, since the respective MV and LV networks are characterized by long overhead lines often exposed to the elements. Sub-urban areas represent a transition zone between rural and urban areas. In this sense, standards for continuity of supply indicators are in between those defined for urban and rural areas.

1.3. Incentive for the Continuity of Supply in the Distribution Network

In the quality of electricity supply code, in complement to standards and individual monetary compensations, incentive schemes comprising revenue increases (rewards) and decreases (penalties) can be developed. Portugal is considered one of the pioneers in Europe regarding the implementation of an incentive for the continuity of supply in the distribution network [6], [9].

ERSE implemented this incentive scheme in 2003 in order to stimulate a performance increase in the medium voltage (MV) distribution network. The incentive scheme is based on historical values of the energy not distributed (ENDref) indicator. As presented in Figure 1, a dead band (ENDref ± ΔV) is used to avoid the incentive activation when small performance improvement or deterioration is experienced. On the other hand, in order to avoid overstating the impact of the incentive on the company economic results, maximum amount of reward (RQSmax) and penalty (RQSmin) are defined. Reward and penalty limits are symmetric and, at moment, its value is fixed at 5 million euro. When the performance improvement or deterioration is placed between the dead band boundaries and the reward and penalty limits, the amount of the incentive is computed based on the valorization of the energy not distributed (VEND), 1.5 euro/kWh.

Figure 1 - Incentive scheme for the continuity of supply in MV network.



1.4. Reporting and Benchmarking Quality of Electricity Supply

One of the indirect instruments of the quality of electricity supply regulation is the systematic publication of information about networks performance and benchmarking those results between different companies [3].

In this regard, the present Portuguese quality of electricity supply code requires network operators to publish an annual report including information about their performance, expressed by different indicators defined for continuity of supply, voltage quality and commercial quality, and including information about number and amount of monetary compensations to customers that result from noncompliance with minimal quality standards. Also a description of the events that led to the main interruptions occurred over the year must be included in the report. The report on the quality of electricity supply of each company must be available on its website.

In addition, an annual report comprising the evaluation of the utilities' performance is published by the national regulatory authority. This report is made available on its website and disseminated by different stakeholders, namely customer associations.

In what concerns benchmarking the continuity of supply performance, only international benchmarking is possible since the Portuguese mainland distribution network is operated by one large utility that supplies almost all customers. In this regard, ERSE participates in the elaboration of the European benchmarking reports published by CEER.

2. Portuguese Distribution Network Performance

2.1. Network Characterization

The Portuguese distribution network, comprising HV, MV and LV, is operated by one large company supplying approximately 6.1 million customers (99.5% of overall). The remaining 0.5% customers are supplied by 10 other small companies operating exclusively in LV.

The main characteristics of the distribution network at 2011 are presented in Table I and Table II. In HV, the grid is operated at 60, 130 and 150 kV voltage levels and presents a high level of automation and self-restoration. In what concerns the MV grid, the voltage levels in operation are 6, 10, 15 and 30 kV, with a lower level of automation than in HV.

Table I - Overall Lines Length (km)

Lines	Voltage Level		
	HV	MV	LV
Overhead	8592	58 133	106 744
Underground	522	16 009	32 627

Table II - Substations and Transformers

Voltage Level		Number	Capacity (MVA)
HV/MV and MV/MV	Substations	411	16 809
	Transformers	721	
MV/LV	Transformers	64 458	19 417

The percentage of underground cables in the MV grid is 22%, mainly corresponding to the supply of MV/LV transformers placed in urban and sub-urban areas. In the LV grid, the percentage of underground cables is similar to MV, 23%, also corresponding to the supply in urban and sub-urban areas.

Regarding the annual investment in the Portuguese distribution network, at 2011, capital expenses (CAPEX) and operational expenses (OPEX) corresponded to about 83 euro/customer and 70 euro/customer, respectively.

2.2. Evolution of Planned and Unplanned Interruptions

The evolution of the continuity of supply performance of the Portuguese distribution network is analyzed next, based on empirical data reported by the distribution network operator to ERSE. In this context, planned interruptions are those usually resulting from predictive maintenance and imply customers to be informed in advance in order to mitigate their potential impacts. All the other interruptions are considered as unplanned interruptions.

The duration and the number of planned and unplanned interruptions experienced by LV customers between 2001 and 2011 are presented in Figure 2 and Figure 3, respectively.

In general, during this period, there is a decreasing trend on the number and duration of the all kind of interruptions experienced by LV customers.

Figure 2 – Duration of planned and unplanned interruptions experienced by LV customers.

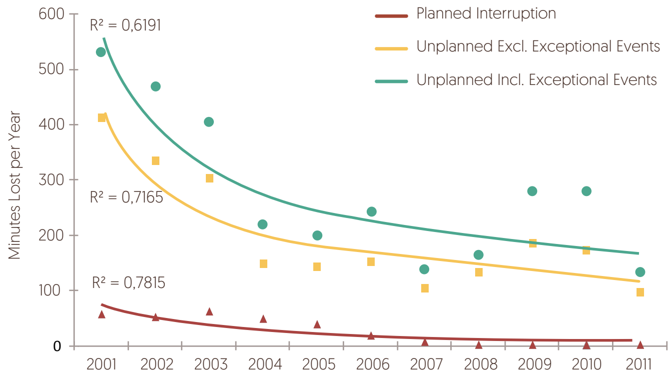
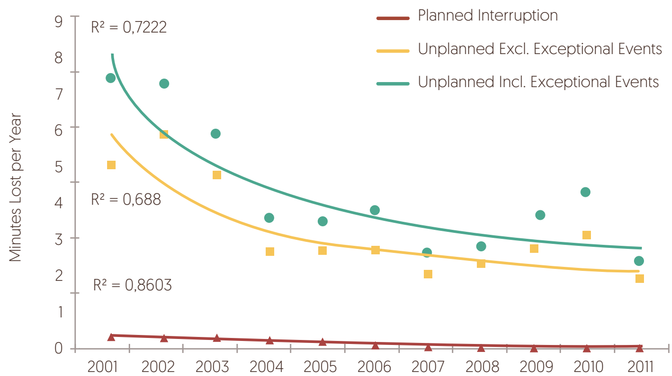


Figure 3 – Number of planned and unplanned interruptions experienced by LV customers.



In what concerns planned interruptions, since 2007 the average number of interruptions experienced by customers is lower than 0.1 interruptions/year while in the case of planned interruptions duration, average values do not exceed 2 minutes/year since 2008. The involved network operator explains that such small number of planned interruptions is not the result of a reduction on predictive maintenance investment, clarifying that this good performance is due to the systematic recourse to live working and the use of portable generators to supply customers that otherwise would be interrupted.

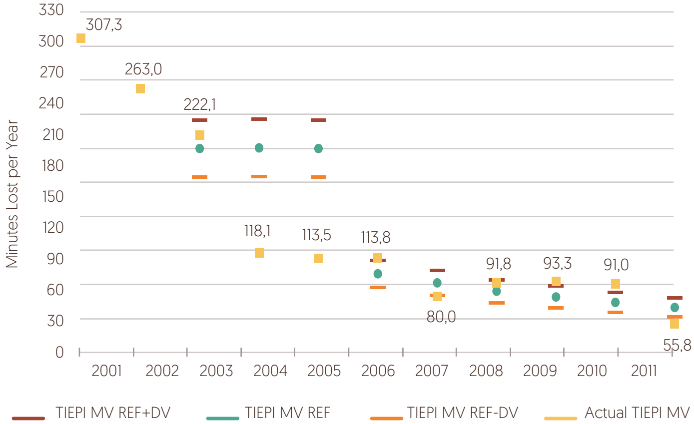
The correct balance between benefits from the better performance due to these practices and the increase of the related operational expenses must be assured.

Regarding the unplanned interruptions, an improvement has been experienced in the last 10 years, namely between 2001 and 2007, period in which a 60% reduction in the number of interruptions and 75% reduction in their respective duration is observed. However, the trend line presents some stagnation after 2008, as a consequence of the depreciation of the continuity of supply performance observed in the period 2008 to 2010. In the year 2011, mainly due to unusual very favorable weather conditions, the continuity of supply indicators improved and the lowest number and duration of unplanned interruptions is reached since the continuity of supply indicators reporting began.

An analysis of the unplanned interruptions evolution also highlights the recurrent impact of exceptional events on the number and duration of interruptions experienced by LV customers, contributing for 20 to 40% of the unplanned interruptions duration every year. This fact becomes relevant because the concept of exceptional events should refer to incidents external to the grid with a considerably small probability to occur.

The application of the incentive mechanism on continuity of supply is presented in Figure 4. In this case, for a most comprehensive analysis and due to the direct relation with the END, the performance of the continuity of supply is expressed by the TIEPI MV indicator.

Figure 4 – Application of the incentive mechanism on the continuity of supply.



In general, the results show that the implementation of the incentive mechanism combined with the effort of the distribution company has contributed for the continuity of supply performance improvement of the Portuguese network.

Since 2003, when the incentive mechanism was implemented, the company has received a reward in 4 different years, 2004, 2005, 2007 and 2011. On the other hand, in 2006, 2009 and 2010, a continuity of supply performance that deviated from the incentive mechanism targets resulted in penalties payment. In the remaining years, the performance was within the dead band and, as such, no reward or penalty payments have occurred.

3. Comparison with other European Countries

Benchmarking the continuity of supply performance is one of the instruments available for the quality of electricity supply regulation. However, as referred previously, for the Portuguese distribution network only international benchmarking is reasonable. In this regard, the evolution of the continuity of supply indicators from the Portuguese network is compared with the performance of the other CEER members published in the 5th CEER Benchmarking Report on the Quality of Electricity Supply (2011).

CEER Benchmarking Reports on the Quality of Electricity Supply are the result of periodical surveys and analyses performed by national regulatory authorities that are CEER members. The first report was issued in 2001, followed by the second, third and fourth editions in 2003, 2005 and 2008 respectively. The 5th CEER Benchmarking Report on the Quality of Electricity Supply comprises data from 1999 to 2010 and, as presented in Figure 5, the countries involved were Austria, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain and Sweden. Also Swiss national regulatory authority provided information on continuity of supply and voltage quality aspects for this 5th edition of the report. In addition, an annex was added with quality of service performance from the Energy Community Regulatory Board (ECRB), comprising Albania, Bosnia and Herzegovina, Croatia, Former Yugoslav Republic of Macedonia, Moldova, Montenegro, Serbia, Ukraine and United Nations Interim Administration Mission in Kosovo.

Figure 5 – European countries involved in the 5th CEER Benchmarking Report on the Quality of Electricity Supply [8].

Considering that for benchmarking purposes, long time-series are preferable, the Portuguese continuity of supply performance is only compared with the 16 countries involved in the fourth edition of the CEER Benchmarking Report, namely Austria, Denmark, Estonia, Finland, France, Germany, Great Britain, Hungary, Ireland, Italy, Lithuania, Netherlands, Norway, Poland, Spain and Sweden [10]. In order to evaluate how far the Portuguese performance compares with these European countries, for each indicator, besides the 16 countries average, also a band containing 1 standard deviation (SD) away from the average is considered. Assuming that the data dispersion follows a normal distribution, 68% of countries with indicators closer to the average are within this standard deviation band.

For a most comprehensive approach, the comparison between the Portuguese and European performance on the continuity of supply comprises the indicators analysis of the overall interruptions experienced by customers and the respective desegregation in planned interruptions, unplanned interruptions excluding exceptional events and unplanned interruptions with origin in exceptional events.

3.1. Overall Interruptions

The duration and the number of all interruptions (planned and unplanned) experienced by Portuguese and European LV customers are compared in Figure 6 and Figure 7.

Figure 6 - Duration of overall (planned and unplanned) interruptions experienced by Portuguese and European LV customers.

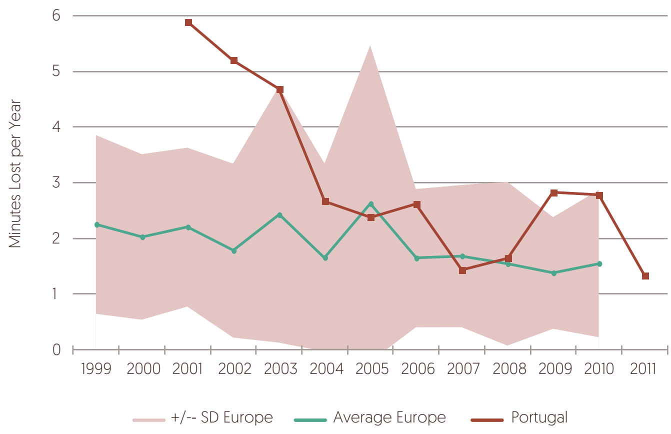
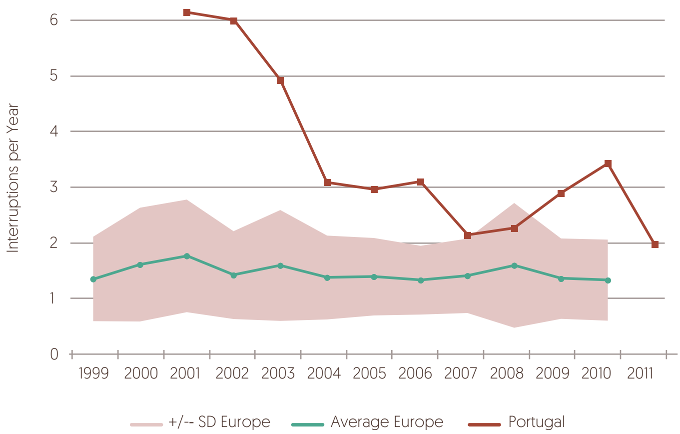


Figure 7 - Number of overall (planned and unplanned) interruptions experienced by Portuguese and European LV customers.



In what concerns the interruptions duration, the European average presents a slight trend of reduction between 1999 and 2010. This trend is not clearly followed by the number of interruptions, in which the average value keeps almost constant for the period analyzed.

Regarding the Portuguese distribution network performance is observed a considerable convergence towards European average in the period 2001-2004, in which the minutes lost per year have been reduced to a half. Between 2004 and 2008 the performance of the Portuguese distribution network was worse than in the most European countries.

However, in 2011, according to data available, the convergence with the European average is resumed. For the overall number of interruptions, in spite of the convergence observed in the last 10 years, a gap between the Portuguese and the European average performances still exists.

3.2. Planned Interruptions

According to available data, the number and duration of planned interruptions in Portugal, as presented in Figure 8 and Figure 9, is very small when compared with the European average. This unusual performance, as referred previously, can be justified by the resource to live working and the use of portable generators. However, it is not clear why utilities from the other European countries are not following these practices. In this sense, further possible reasons for such disparity on the number and duration of planned interruptions should be considered, as for instance the use of non-harmonized criteria for the interruptions classification or different approaches in what predictive maintenance is concerned. A more comprehensive approach on this topic is only possible with more data available for the different European countries, namely the respective regulation model and the composition of the utilities OPEX and CAPEX values.

Figure 8 - Duration of planned interruptions experienced by Portuguese and European LV customers.

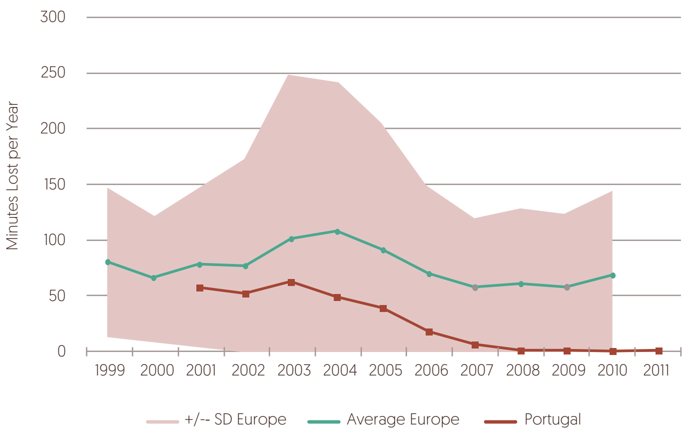
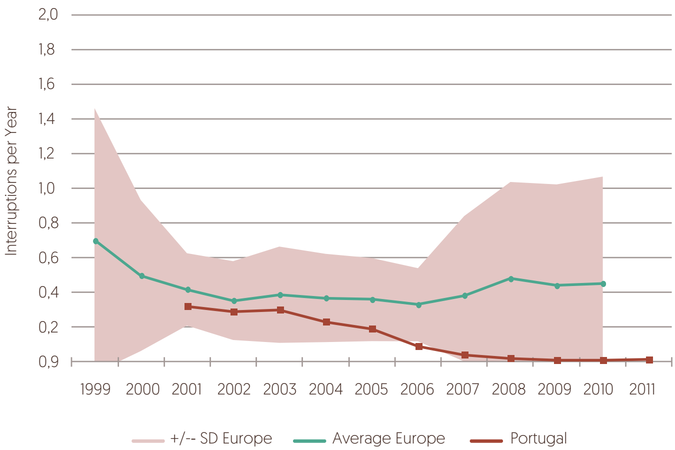


Figure 9 - Number of planned interruptions experienced by Portuguese and European LV customers.



3.3. Unplanned Interruptions

The duration and the number of unplanned interruptions excluding exceptional events experienced by Portuguese and European LV customers are presented in Figure 10 and Figure 11.

Figure 10 - Duration of unplanned interruptions excluding exceptional events experienced by Portuguese and European LV customers.

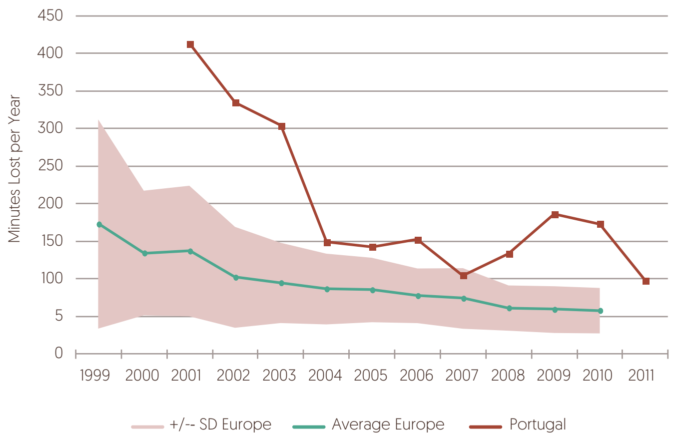
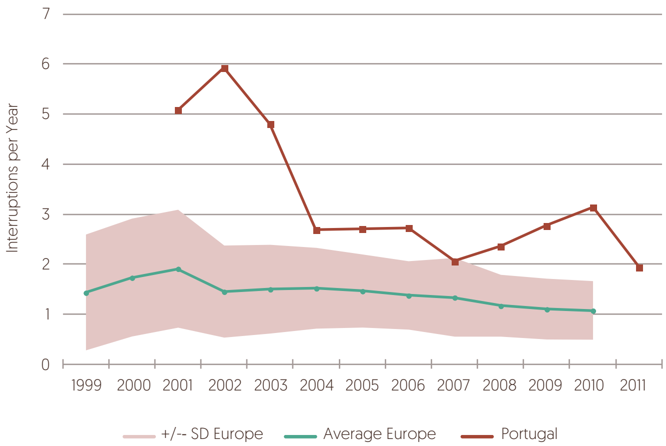


Figure 11 - Number of unplanned interruptions excluding exceptional events experienced by Portuguese and European LV customers.



In both indicators, duration and number of interruptions, a decreasing trend in the European average is observed for the period 1999-2010. Also the standard deviation band presents a tendency to become narrower in this period, which means that more countries present values closer to the average.

In what concerns the Portuguese distribution network is concerned, in spite of the convergence towards European average observed, the number and duration of unplanned interruptions excluding exceptional events remain outside the standard deviation band.

3.4. Exceptional Events

The analysis of the Portuguese distribution network performance has shown a considerable contribution of exceptional events for the continuity of supply indicators. Therefore, in order to compare the Portuguese and European realities, their respective duration and number of unplanned interruptions with origin in exceptional events are presented in Figure 12 and Figure 13.

Figure 12 - Duration of unplanned interruptions with origin in exceptional events experienced by Portuguese and European LV customers.

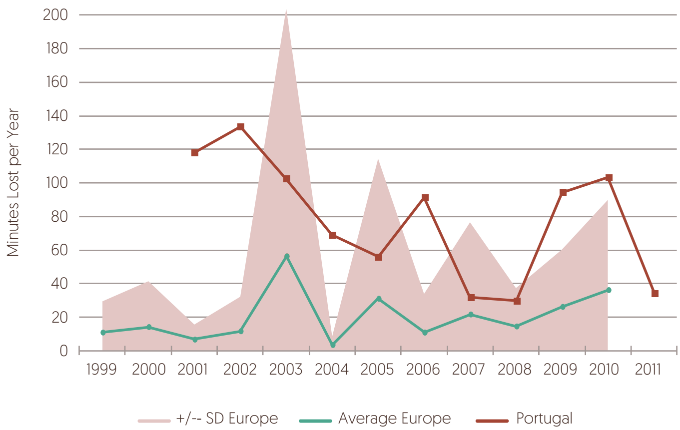
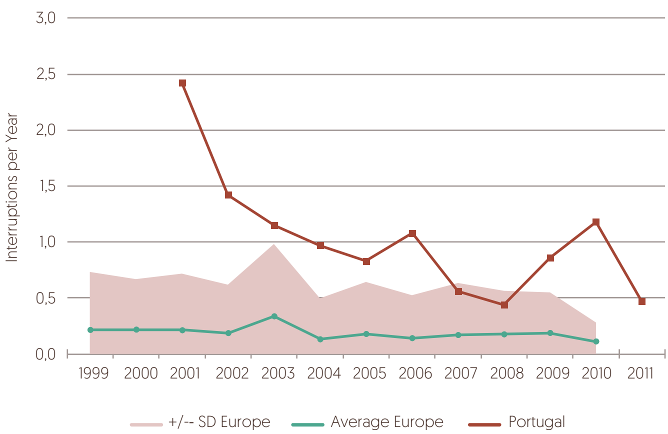


Figure 13 - Number of unplanned interruptions with origin in exceptional events experienced by Portuguese and European LV customers.



The number and duration of interruptions with origin in exceptional events in European countries are in line with the expectations for such continuity of supply indicators. Thus, a reduced number of interruptions are observed that, due to their uncontrollable and severe nature, result in very long interruptions. It is also observed that different countries are responsible for the occurrence of exceptional events experienced each year. This is the case of Italy at 2003, Lithuania at 2005 and 2007 and, Spain and Lithuania at 2010. Regarding the comparison between Portuguese and European performances, for the duration of unplanned interruptions with origin in exceptional events a convergence trend is observed. However, for the number of interruptions, a considerable gap still exists between Portugal and European average that can be justified by different definitions of exceptional events adopted in each European country, as discussed in [10] and [11].

3.5. Interruptions with origin in Distribution Networks

Planned and unplanned interruptions with origin in distribution networks, excluding exceptional events, are the responsibility of the network operators. In this sense, a different utilities comparison on continuity of supply performance, as presented in Figure 14 and Figure 15, should include interruptions with the origin in their networks.

Figure 14 - Duration of planned and unplanned interruptions excluding exceptional events experienced by Portuguese and European LV customers.

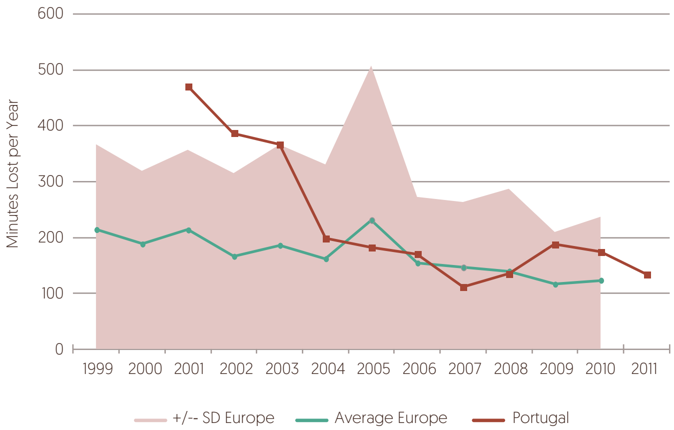
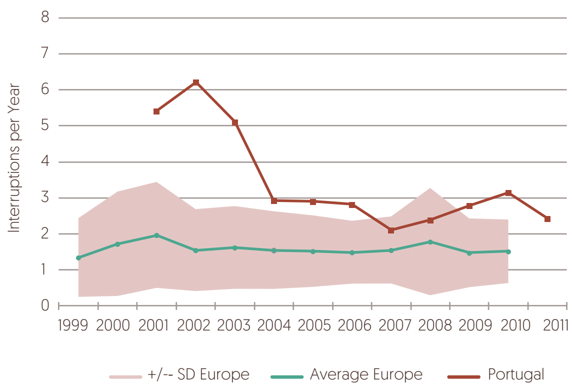


Figure 15 - Number of planned and unplanned interruptions excluding exceptional events experienced by Portuguese and European LV customers.



The results show a trend of decreasing the duration of interruptions in the European average. This is not the case in the number of interruptions, which presents some stability.

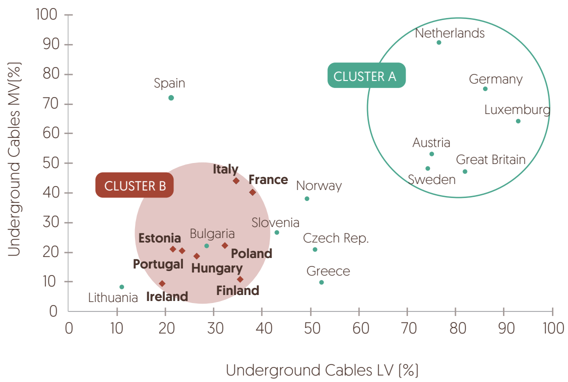
Regarding the Portuguese distribution network performance, a considerable convergence toward European average duration of interruptions is observed since 2004. In 2009 and 2010, in spite of performance deterioration, the duration of interruptions is still within the standard deviation band. However, in what concerns the number of interruptions, in spite of the convergence observed in the last 10 years, a potential for improvements is identified.

4. Clustering European Countries according to the Network Technical Characteristics

Technical characteristics of distribution networks have considerable influence in their continuity of supply performance. In this sense, benchmarking continuity of supply performance of distribution utilities in a national or international level should also take into account some of those technical characteristics, as for instance the percentage of underground cables existing in the network. Since underground cables avoid exposing network to the elements, the higher the percentage of underground cables the better the continuity of supply performance expected.

Therefore, according to the percentage of underground cables existing in LV and MV distribution networks, available in [8], the different European countries are clustered. As presented in Figure 16, two different clusters, A and B, are assumed; cluster A refers to countries with percentage of underground cables over 50% and 70% in MV and LV respectively, while cluster B comprises, from the remaining countries, those with similarities to Portugal, such as a percentage of underground cables between 10% and 40% in MV network and between 20% and 40% in the LV network. Furthermore, in cluster B only countries involved in the fourth edition of the CEER Benchmarking Report are included.

Figure 16 - Clustering European countries according to the percentage of underground cables existing in LV and MV distribution networks.



The average duration and number of overall interruptions experienced by LV customers from some of the clusters defined are presented in Figure 17 and Figure 18.

Figure 17 - Duration of overall (planned and unplanned) interruptions experienced by LV customers from the different clusters.

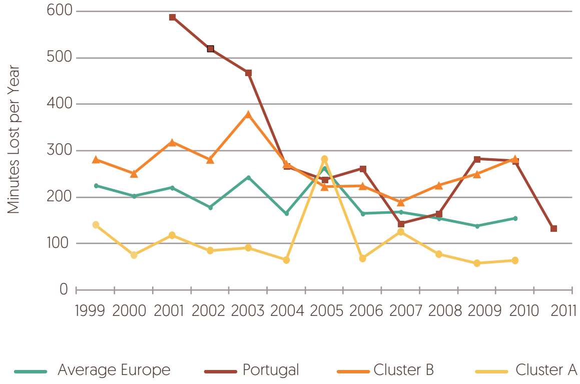
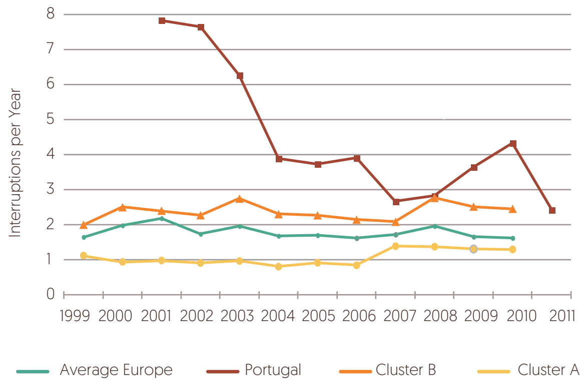


Figure 18 - Number of overall (planned and unplanned) interruptions experienced by LV customers from the different clusters.



It is observed that countries with higher percentage of underground cables (cluster A) typically present number and duration of interruptions lower than the European average. The gap between performances is even more pronounced when comparing average values of cluster A with cluster B.

In what concerns the Portuguese distribution network performance, it is observed that the duration of interruptions is in line with countries with similar technical characteristics (cluster B) since 2004. However, in what concerns the number of interruptions, the Portuguese distribution network usually presents worse performance than cluster B.

Conclusions

In this paper, integrated in the preparatory work carried out for the revision of the Portuguese quality of electricity supply code, scheduled for 2013, the evolution of the continuity of supply in the Portuguese distribution network was analyzed and compared with the performance of other European countries represented in CEER.

From the paper results, it may be concluded that the Portuguese distribution network has improved its performance during the last 10 years. When compared to the average of the CEER countries, in what concerns planned interruptions, the Portuguese network presents one of the best European performances. On the other hand, for the unplanned interruptions a considerable potential for improvements in the Portuguese network was identified.

A particular attention was also given to the unplanned interruptions with origin on exceptional events. It was observed that in Portugal these events frequently account for more than 20% of the number and duration of unplanned interruptions. These results suggest that a greater harmonization between Portugal and the other European countries should be carried out.

Finally, it was also concluded that a comprehensive benchmarking should take into account the different technical characteristics of the networks and clustering countries according to the percentage of underground cables in MV and LV could be a good approach to achieve that.

Disclaimer

The text in this paper represents the personal opinion of the authors and not necessarily the opinion of the Portuguese regulatory authority for energy services (ERSE).

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An Overview on the Portuguese Quality of Electricity Supply Code Revision 2013: The Continuity of Supply and Power Quality Perspective

Sérgio Faias, Rui Castro, Jorge Esteves[1]

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Abstract

New legislation, published in September and October 2012, transferred to the Portuguese national regulatory authority for energy services (ERSE) the authority to prepare and approve the national regulatory code on the quality of electricity supply. As a consequence, ERSE promoted a revision of the quality of supply code, which came in force in January 2014.

[1] Sérgio Faias, Energy Services Regulatory Authority (ERSE), Lisbon Engineering Superior Institute (ISEL), INESC ID, Portugal
Rui Castro, INESC ID, Instituto Superior Técnico, Portugal
Jorge Esteves, Energy Services Regulatory Authority (ERSE), Portugal

This paper presents an overview on the Portuguese quality of electricity supply code revision, highlighting the main topics addressed during this revision, in what concerns continuity of supply and voltage quality aspects. The quality of electricity supply code revision created an opportunity to adjust the quality of supply requirements to the current networks performances, to promote a change on the continuity of supply performance analysis, from a network operators perspective to a customers perspective, and to increase the share of responsibilities between network operators and users.

Keywords

Electricity Sector Regulation - Quality of Service - Continuity of Supply - Power Quality.

Introduction

The liberalization of the electricity sector establishes the separation of basic functions of electricity generation, transmission, distribution and supply (or retailing). However, while in the generation and supply functions a potential for competition exists, in the transmission and distribution networks, their natural monopoly nature requires regulation to induce optimal price and quality of service [1]-[3].

The quality of service regulation, also referred to as quality of electricity supply regulation, with its three dimensions, continuity of supply (network reliability and availability), power or voltage quality (characteristics of the supply voltage) and commercial quality (timeliness in dealing with customers' requests) provides a balance between customers' willingness to pay network tariffs and their expectations on minimum levels of quality of service. This topic became more relevant with the evolution from a rate-of-return economic regulation, in which total utility costs were fully recouped by the tariff, to a price-cap regulation, wherein, with the objective of improving the utilities' economic efficiency, their allowed revenues are capped in a level that does not necessarily reflect the actual costs, leading firms to avoid investments and consequently to decrease the quality of service provided to customers [2], [4], [5].

This quality of electricity supply regulation can be exercised with recourse to a set of direct and indirect instruments such as the definition of minimum standards for the continuity of supply indicators and respective individual monetary compensations, financial incentive schemes, implementation of national voltage quality monitoring programmes, regular reporting and dissemination of the network performance and national and international benchmarking [2], [3], [6], [7].

In order to simulate a competitive environment and contribute to the quality of electricity supply performance improvement of regulated companies, the different direct and indirect instruments should be periodically adjusted in accordance with the evolution of the networks performance. In this regard, the Portuguese regulatory authority for energy services (ERSE) promoted a revision of the quality of electricity supply code during 2013.

The objective of this paper is to present an overview on the Portuguese quality of electricity supply code revision, in what concerns the continuity of supply and power quality aspects. In this sense, the paper describes the direct and indirect instruments used on the regulation of the quality of electricity supply in Portugal and the main changes introduced by the 2013 code revision, as well as the substantiation for those changes. A description of the steps taken and initiatives promoted by ERSE during this code revision is also included in the paper.

1. Quality of Electricity Supply Regulation in Portugal

In Portugal, the first steps towards the electricity sector liberalization started in 1995. As a result, with the objective of defining the minimum quality of service standards that utilities should provide to customers and the practices used to monitor the compliance with those standards, the government published the first Portuguese code on the quality of electricity supply in the year 2000. This code, comprising the continuity of supply, voltage quality and commercial quality aspects, was revised in the years 2003 and 2006 [8].

Until 2012, the role of the Portuguese regulatory authority on the quality of electricity supply topic was limited to the supervision of compliance with the quality of electricity supply code and to the definition of regulatory incentives.

The main direct and indirect instruments used in Portugal for the quality of electricity supply regulation are described next.

1.1. Continuity of Supply

1.1.1. Indicators for the Continuity of Supply Characterization

The regular operation of distribution networks can be disrupted by several internal (malfunctions of network equipment) or external sources (as for instance extreme atmospheric phenomena) that usually result in interruptions of the customers electricity supply.

The measurement of actual continuity of supply levels through indicators and standards constitutes one of the basic instruments for regulating continuity of supply [2]. In the Portuguese quality of electricity supply code, a set of indicators to measure the number and duration of long term interruptions (over 3 minutes) are defined for low voltage (LV), medium voltage (MV), high voltage (HV) and extra high voltage (EHV). Those main indicators are:

Transmission network:

- TIE – Equivalent duration of interruptions, per year;
- ENS – Energy not supplied due to interruptions, per year;
- SAIFI EHV – Average number of interruptions per delivery point, per year;
- SAIDI EHV – Average duration of interruptions per delivery point, per year;
- SARI – Average time to restore the supply after an interruption;

Distribution networks:

- TIEPI MV – Average duration of interruptions in medium voltage per installed capacity, per year;
- END – Energy not distributed due to interruptions, per year;
- SAIDI MV – Average duration of interruptions in medium voltage per customer, per year;
- SAIFI MV – Average number of interruptions in medium voltage per customer, per year;
- SAIDI LV – Average duration of interruptions in low voltage per customer, per year;
- SAIFI LV – Average number of interruptions in low voltage per customer, per year.

The SAIDI and SAIFI indicators are used in most European countries to characterize the continuity of supply. They are mainly focused in the domestic customer perspective, as they are weighted by the number of customers. In addition, in Portugal and Spain, TIEPI MV is used to characterize the continuity of supply of industrial customers, since it is weighted by the installed capacity, and used for distribution network planning purposes by the operators [9].

1.1.2. Standards and Individual Monetary Compensations

Standards for continuity of supply indicators and respective individual monetary compensations resulting from noncompliance with the standards are considered in the quality of electricity supply code. Those standards, expressed in the form of limits to the number and duration of interruptions experienced by each customer per year, represent a commitment of the company with their customers to maintain a certain level of quality of supply. Whenever individual limits are exceeded, customers must be informed and monetary compensations must be automatically paid. The total amount of monetary compensations annually paid to customers is not supported by tariffs. This may act as an incentive to operator to improve the continuity of supply performance along the years.

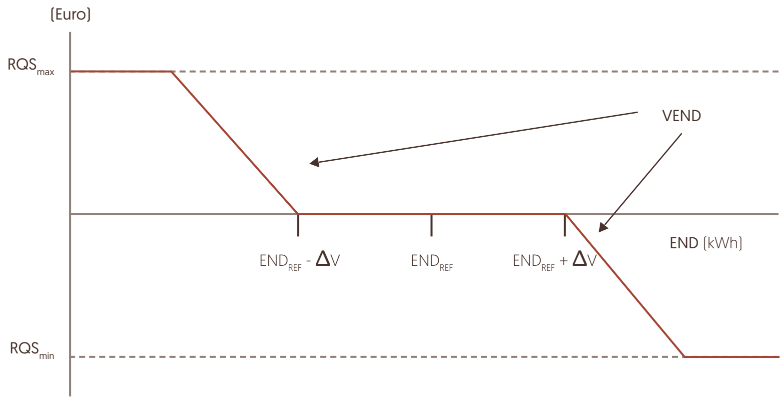
Considering that the demography, as well as technical characteristics of the distribution network, is not homogeneous along the country, different standards are defined according to three kinds of areas, urban, sub-urban and rural. In urban areas it is assumed that the distribution network mainly comprises underground cables in LV and MV and, as such, more demanding standards are prescribed. On the other hand, standards for rural areas are less demanding, since the respective MV and LV networks are characterized by long overhead lines exposed to natural elements. Sub-urban areas represent a transition zone between rural and urban areas. In this sense, standards for continuity of supply indicators are in between those defined for urban and rural areas.

1.1.3. Incentive for the Continuity of Supply in the Distribution Network

In complement to standards and individual monetary compensations, incentive schemes comprising revenue increases (rewards) and decreases (penalties) can be developed. Portugal is considered one of the pioneers in Europe regarding the implementation of an incentive for the continuity of supply in the distribution network [6], [10].

ERSE implemented this incentive scheme in 2003 in order to stimulate a performance increase in the MV distribution network. The incentive scheme is based on historical values of the energy not distributed (ENDREF) indicator. As presented in Figure 1, a dead band ($END_{REF} \pm \Delta V$) is used to avoid the incentive activation when small performance improvement or deterioration is experienced. On the other hand, in order to avoid overstating the impact of the incentive on the company economic results, maximum amount of reward (RQSmax) and penalty (RQSmin) are defined. Reward and penalty limits are symmetric and, at moment, its value is fixed at 5 million euro. When the performance improvement or deterioration is placed between the dead band boundaries and the reward and penalty limits, the amount of the incentive is computed based on the valorization of the energy not distributed (VEND), 1.5 euro/kWh.

Figure 1 - Incentive scheme for the continuity of supply in MV network.



1.2. Voltage Quality

The quality of electricity supply code establishes that network operators must monitor the following voltage characteristics and voltage events in their networks:

- Frequency;
- Supply voltage variations;
- Dips;
- Unbalances;
- Flicker;
- Harmonics.

Under regular conditions of operation, network operators must maintain supply voltage characteristics in compliance with the limits defined in the international standard EN 50160. However, because until the 2010 edition, the scope of this standard was restricted to MV and LV levels, the Portuguese quality of electricity supply code has an annex with the definition of the voltage characteristics limits for the EHV and HV networks.

Regarding voltage quality monitoring, the quality of electricity supply code also establishes the obligation of the network operators to develop voltage quality monitoring programs. Those programs should include the monitoring of 100% of the EHV network delivery points, in every 2 years, 100% of the HV/MV substations, in every 4 years, and two different MV/LV transformers by municipality, in every 4 years. The duration of each monitoring campaign can vary from one week to one year.

In practice, network operators have adopted more demanding targets for voltage quality monitoring than those required by the quality of electricity supply code [11], [12]. For instance, transmission and distribution network operators, on a voluntary basis, have adopted the strategy of installing permanent voltage quality monitoring devices in all new or refurbished EHV/HV and HV/MV substations.

Besides the voltage quality monitoring program, network operators must perform a measurement of the voltage characteristics whenever a customer complains.

1.3. Reporting and Benchmarking Quality of Electricity Supply

One of the indirect instruments of the quality of electricity supply regulation is the systematic publication of information about networks performance and benchmarking those results between different companies [3].

In this regard, the present Portuguese quality of electricity supply code requires network operators to publish an annual report including information about their performance, expressed by different indicators defined for continuity of supply, voltage quality and commercial quality, and including information about number and amount of monetary compensations paid to customers that result from noncompliance with minimal quality standards. Also a description of the events that led to the main interruptions occurred over the year must be included in the report. The report on the quality of electricity supply of each company must be available on its website.

In addition, an annual report comprising the evaluation of the utilities' performance is published by the national regulatory authority. This report is made available on its website and disseminated by different stakeholders, namely customer associations.

In what concerns benchmarking the continuity of supply performance, only international benchmarking is possible since the Portuguese mainland distribution network is operated by one large utility that supplies almost all customers. In this regard, ERSE participates in the elaboration of the European benchmarking reports published by the Council of European Energy Regulators (CEER).

1.4. Audits to the Quality of Electricity Supply Information Systems

The national regulatory authority promote biannual audits to the quality of electricity supply information systems of the network operators in order to assess the integrity and traceability of their procedures in what concerns interruptions registration, computation of indicators and individual monetary compensations, as well as the voltage quality data management. Also the compliance with the quality of electricity supply code, concerning systematic publication of networks performance information is audited.

These audits are performed by independent consultants, according to guidelines defined by the national regulatory authority. ERSE is also responsible to follow the progress of the audits and to provide inputs for the final report of the audit. When deemed appropriate, ERSE can recommend consultants to perform additional queries to the audited system.

The costs of the audits to the quality of electricity supply information systems are supported by the network tariffs.

2. Main Changes in the 2013 Revision of the Quality of Electricity Supply Code

As already referred to, in spite of the first Portuguese code on the quality of electricity supply was published back in the year 2000, until 2012 the role of Portuguese regulatory authority on this topic was limited to the supervision of compliance with the quality of electricity supply code and to the definition of regulatory incentives. However, new legislation, published in September and October 2012, transferred to ERSE the authority to prepare and approve the national regulatory framework on the quality of electricity supply. In this regard, during 2013, ERSE promoted a revision of the quality of electricity supply code, identifying the next three main drivers for this code revision:

» Adjust the electricity quality of supply requirements to the current networks performance;

» Increase the share of responsibilities between network operators and users;

» Adapt the regulation to the supply services liberalization.

During the quality of electricity supply code revision, initiated in January 2013, ERSE identified the different stakeholders (customers, network operators, suppliers, academics and other specialists) and promoted a set of meetings with the objective of collecting their proposals.

In addition, in April 2013, ERSE organized a workshop dedicated to continuity of supply and power quality subjects with the participation of some international specialists. In June, ERSE published a first proposal for the new quality of electricity supply code, promoted a public consultation and started the collection of comments to improve that first code proposal. The final version of the code was published in November 2013 and came into force in January 2014.

It should be referred that in this code revision process, beyond the proposals received from the different stakeholders, several valuable inputs gathered from the different technical reports produced by CEER were also included, as for instance the different editions of the Benchmarking Report on the Electricity Quality of Supply and some of the Guidelines of Good Practices, as well as other technical reports and international standards published by CENELEC and IEC.

During quality of electricity supply code revision, the different stakeholders identified the need to maintain the participation and interactivity level promoted by ERSE, in what concerns the quality of supply topic. In this sense, a working group to follow the application of the new quality of electricity supply code and to gather inputs for future code revision processes was created.

2.1. Continuity of Supply

From the three aspects of the quality of electricity supply, the continuity of supply is the one for which customers are more sensitive. In this sense, one of the objectives identified for this code revision was to promote a change on the continuity of supply performance analysis, from a network operators perspective to a customers perspective [13]. This change of perspective was implemented, for instance, through the obligation of the distribution operators to report all the interruptions that affected their network users, independently from the origin of those interruptions, or by the introduction of new continuity of supply indicators, such as the momentary average interruption frequency index (MAIFI), in order to measure the number of short interruptions (less than 3 minutes) experienced by customers [14].

Another example of this change from the network operators perspective to the customers perspective is the fact that, from now on, in Azores and Madeira islands groups, the continuity of supply performance indicators and system standards must also include the interruptions with origin in generation failures.

The process of the exceptional events classification was also subjected to some changes in this quality of electricity supply code revision. With the new code, all the exceptional events (those whose responsibility is not from the network operators [15]) must be approved by the regulatory authority, based on evidence gathered by the network operators to prove that the origin of the interruption was outward the network, was non-predictable and that it was non-economically efficient to avoid its occurrence.

Following the need to adjust the electricity quality of supply requirements to the current networks performance, identified as one of the three main drivers for the quality of electricity supply code revision, the system and individual standards on the continuity of supply were updated (last update was in 2006). The update was more ambitious for the rural area standards (usually with less demanding requirements) in order to define standards closer to those established for the urban area.

In the new quality of electricity supply code a second component of the existing incentive scheme for the increase of the continuity of supply for MV distribution network was also introduced. This new component aims at reducing the gap between average continuity of supply performance of the Portuguese system and the continuity of supply experienced by the customers with worst service supply.

Still regarding continuity of supply, it was also introduced a new limit to the annual monetary compensation paid by network operators to customers when individual standards are exceeded. This new limit corresponds to 100% of the customer annual network tariff (value of the previous year) and it was defined as result of a benchmarking with other European countries [9].

2.2. Power Quality

Voltage quality is an important aspect of the quality of electricity supply that network operators provide to their connected customers. When voltage quality is poor, problems such as reduced life-time, loss of efficiency, flickering lights and even explosion or fire can arise in the use of electrical appliances and equipment.

Larger or industrial customers are those to whom these issues are most noticeable. However, the characteristics of their loads, namely the respective electric current waveform, can also be a source of perturbations that affect the quality of the voltage supplied. In this sense, in order to increase the share of responsibilities between network operators and users, the new quality of electricity supply code evolved from a voltage quality perspective, only focused on the consequences, to a power quality perspective, also committed with the identification and mitigation of the sources.

Since the Portuguese quality of electricity supply code adopted the standard EN 50160 to define the characteristics and limits for the supplied voltage, some of the changes introduced to this standard by CENELEC in the 2010 edition were considered as inputs for the code revision. This was the case of widening the standard scope to the HV network and an adaption of the table used for registration and classification of voltage dips.

Another change introduced in the new code refers to a need for harmonization with the international practice of calculating the equivalent voltage dip when poly-phase events occur. In this case, the method proposed in IEC 61000-4-30 standard was adopted for the Portuguese quality of electricity supply code.

In the previous Portuguese quality of electricity supply code, monitoring voltage swells was not mandatory. As such, due to the potential impact of this issue on the electrical devices life-time, the obligation to record and classify voltage swells was also introduced.

In addition, in what concerns power quality, recognizing the need to increase the knowledge about the network performance, it was introduced the obligation of the network operators to submit a bi-annual plan for the power quality monitoring to be approved by the regulatory authority. Furthermore, the results of the power quality monitoring plans must be published in the network operators web page, disaggregated by monitored network point. Beyond these obligations, some new targets for the number of network points covered by power quality monitoring plans were defined. This is the case of the EHV network, wherein 100% of the delivery points must be covered by permanent monitoring devices until the end of the year 2016, and also the case of HV and MV networks, in which, at least 20% of the HV/MV substations must be covered by permanent monitoring or annual monitoring campaigns until the end of 2014.

Conclusions

In this paper, an overview on the Portuguese quality of electricity supply code revision promoted by ERSE during 2013 was presented.

The quality of electricity supply code revision created an opportunity to adjust the quality of supply requirements to the current networks performance, to promote a change on the continuity of supply performance analysis, from a network operators perspective to a customers perspective, and to increase the share of responsibilities between network operators and users.

This code revision process was also an excel opportunity to involve most stakeholders in an enlarged compromise and to bring their different perspectives to a comprehensive and participated debate. This approach to the revision code process was prized by the stakeholders and the need to maintain this interactivity beyond the 2013 code revision was identified. In this sense, a working group to follow the application of a new quality of electricity supply code and to gather inputs for future code revision processes was created.

Finally, it is worth to mention the valuable inputs gathered from the different technical reports produced by CEER, as well as some technical reports and international standards published by CENELEC and IEC that most enriched the final version of the quality of electricity supply code, in force since January 2014.

Disclaimer

The text in this paper represents the personal opinion of the authors and not necessarily the opinion of the Portuguese regulatory authority for energy services (ERSE).

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Smart Grids in the EU with smart regulation: Experiences from the UK, Italy and Portugal

João Crispim, José Braz, Rui Castro, Jorge Esteves [1]

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Abstract

The paper describes the integration between what used to be a passive element of the energy value chain - the grid - and both upstream and downstream elements. The evolution of communications among the elements has permitted a more robust and adaptable structure that already is being implemented: the Smart Grid. The paper relates the evolution of EU policy concerning both the development and the rolling-out of solutions to exploit the potential of the Smart Grid concept and describes what has been

[1] João Crispim - Lisbon MBA Católica/Nova, Lisbon, Portugal
José Braz and Jorge Esteves - ERSE - Portuguese Energy Regulatory Authority, Lisbon, Portugal
Rui Castro - INESC-ID & Instituto Superior Técnico, University of Lisbon, Av. Rovisco Pais, 1049-001 Lisboa, Portugal
João Crispim currently with GE e General Electric, Bristol, UK.
José Braz currently with AdC - Portuguese Competition Authority, Lisbon, Portugal.

done by the regulators of three countries that share the same goal but seek to attain it via distinct paths.

The article starts with a justification of the need for more integrated networks and a definition of the Smart Grid. A second part covers the risks and difficulties of implementation within an established network, introducing the role of the regulator. The third part describes EU policy response and three different approaches by regulators in the UK, Italy and Portugal, showing how in each case policy is influenced by characteristics of their respective national electricity markets in terms of competition dynamics.

Keywords

Smart Grids - Regulation - Competition - UK - Italy - Portugal.

1. . Introduction

Evolution in the electricity system was long considered to be a slow process. In recent decades, however, the pace has been accelerating, mainly due to climate change concerns, as sustainability policies have deep repercussions on the consumption of natural resources in everyday life (Agrell et al., 2013). This global trend is increasingly visible in the number of national or regional commitments to greenhouse gas reduction, efficient energy use, lower energy intensity, and other programs focused on limiting humanity's carbon footprint.

The European Union (EU) has been a leader in sponsoring such programs, with perhaps the best known being the 20/20/20 agenda for the year 2020. This agenda reflects the goals of increasing renewable energy supply up to 20% of total demand, reducing energy consumption by 20% compared to 2020 forecasts, and reducing greenhouse gas (GHG) emissions by 20% relative to 1990 levels.

As a major user of primary energy and source of GHG emissions, the electricity sector will play a major role in achieving the set targets, involving all its stakeholders in a sector-wide change. From the shift toward the integration of low predictability renewable energy generators of all sizes, to the ability to deliver information that may help consumers make more efficient choices, the whole value chain can contribute to meeting the sustainability goals embodied in the 2020 agenda and subsequent targets through 2050. This process will include the incremental roll out of new technologies that improve coordination between different market players, allowing the power grid to become a platform for new energy services (ERGEG, 2010) and providing stakeholders with access to added-value solutions.

As key players in this sector, regulatory authorities have the crucial task of creating incentives for the development of cost effective innovative solutions that benefit society. In the business of operating transmission and distribution grids (natural monopolies where remuneration normally is coupled with the volume of power flow or the amount of investment in transport capacity), the challenge is to create appropriate incentives for economically effective grid development, while assuring the consumer that the cost increases are not met by higher rent-taking from firms and operators in the supply chain (Agrell et al., 2013).

Within this overall context, this paper aims to provide a succinct yet holistic account of what has been done in the EU to support the evolution of the grid into what is now called a "Smart Grid," a first step toward the creation of the future electricity system (Gangale et al., 2013). The account is organized into five main sections:

1. a justification of the need for more integrated networks and the definition of the Smart Grid concept;

2. a summary of the main risks and difficulties of implementation within an established network, introducing the role of the regulator in providing for an appropriate return for investments in innovation, satisfying needs of both operators and consumers;

3. a brief description of the principal EU programs that promote the development of Smart Grids;

4. three different approaches by regulators in the UK, Italy and Portugal; and

5. conclusions and policy implications, emphasising how different stages of market development, namely the degree of competition, serve to determine the choice of regulatory practices in each country.

2. The need for an alternative solution

2.1. The evolution of the network

Traditionally, the energy sector has been seen as a cascade of elements, with energy flowing from generation to transport, to distribution, and finally reaching the consumer. The consumer, on the other hand, has grown accustomed to taking energy availability for granted, with power always available at the flick of a switch [Healy and MacGill in Sioshansi, 2011]. Both of these concepts are now evolving into a more complex reality, with some elements of bi-directionality being introduced in the network, with new constraints in dispatch and predictability, with the consumer now having the opportunity to take a more active role in the management of consumption and, in many cases, even producing energy, giving rise to the “prosumer” (producer þ consumer) concept. The grid hence stands to shift from a demand-following principle to a potential supply-driven one [Verbong et al., 2013].

This new dynamic of electricity services has been made possible predominantly by the evolution in communication technologies. As once happened with the use of computers to enhance the grid with increased automation and real time responsiveness to faults, so does the communications boom stand to alter the management and capability of the grid.

Though there are almost as many definitions for the term Smart Grid as there are experts [Sioshansi, 2011], these may be aggregated into two types:

1. the technology-based approach, focussing on the use of technology to enhance the intelligence of the grid through communication and electronic equipment installed on the premises of the network user [IEC, 2010]; and

2. the output-based approach, focussing on the problems to be solved. Such is the approach of European regulators and will be the one used throughout the current paper. In this view [ERGEG, 2010], the Smart Grid is an electricity network that can cost efficiently integrate the behaviour and actions of all users connected to it e generators, consumers and those that do both e in order to ensure economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety.

The Smart Grid concept is often bundled with the Smart Metering concept, and many times mistaken as a synonym. Although the Smart Meter is an important part of the wider Smart

Grid concept, it does not, of itself, constitute a Smart Grid. Acknowledging the broadness of this definition of the Smart Grid, it is pertinent to explore some of the many possibilities it opens and focus on the main drivers that support the transformation it implies.

2.2. Drivers

The commitments of the EU concerning the sustainability of the energy sector call for a more dynamic concept of grid. Three main drivers stand out as important benefits that require the implementation of Smart Grids:

1. integration of Renewable Energy Sources (RES) and Distributed Generation (DG);

2. promotion of Demand Response (DR); and

3. optimisation of new end-uses of electricity.

2.2.1. Integration of distributed generation and RES

Given the negative environmental externalities of carbon intensive processes and fuels, several measures have been taken to promote the lowering of greenhouse gas emissions through the use of RES. However, factors such as exhaustion of good locations, "Not-In-My-Back-Yard" (NIMBY) resistance and lesser relevance of scale economies in production, have led to the conclusion that the initial concentrated (large-scale) RES formats may give way to more decentralized generation, connected to the distribution network (Agrell et al., 2013). This implies a potential shift from the centralized solutions to local cooperatives, with groups of houses sharing micro-generation production or even the "prosumer" concept referenced above (Geelen et al., 2013).

The fact that RES generation cannot be dispatched with the predictability of a conventional plant presents several grid management challenges, such as the risk of grid overload due to excessive production, increased voltage levels due to the injection of active power in periods of low consumption (Hanser in Sioshansi, 2011), and decreased reliability due to fault protection triggers and islanding risks.

Although the first two situations may be dealt with by expanding the grid (more lines and transformers to provide further interconnectedness and power flow), this is a slow and capital intensive approach that puts additional burden on the consumer and fails to drive incentives toward a rational allocation of resources.

2.2.2. Promotion of demand response

At the centre of the changes toward a more efficient use of energy, consumers are expected to evolve from a passive to an active role. The demand-response concept refers to changes in electricity consumption by end-users in response to supply conditions (Geelen et al., 2013). To achieve this, the consumer will have to be engaged and provided with information, additional services, and incentives in order to benefit from potential selective reductions in load. These reductions will come mainly from commercial and industrial users but also from households, coordinated and combined by aggregators and other energy services companies (ESCOs). Smart Grids are a tool to enable consumers to better manage their energy consumption for their own benefit and for that of the whole electricity system. Implementation will need to build on trust, as consumers shed resistance to new technical, regulatory, and market solutions (Gangale et al., 2013).

To provide a first element of information to the consumer and act as a platform for further energy services, Smart Meters have been developed and deployed in several EU countries (current EU legislation calls for the roll out of Smart Meters to at least 80% of consumers until 2020 in all member-states, except where a comprehensive Cost Benefit analysis yields a negative outcome (European Commission, 2014)). It should be noted however that the Smart Meter alone does not provide for user interaction and hence has little effect on user behaviour (Geelen et al., 2013).

The ability to collect and treat data should enable home automation solutions that focus on load management and overall energy efficiency as well as convenience and security (Slaboszewicz in Sioshansi, 2011). With household energy consumption related to a combination of technology and end-user behaviour, there is concern over the lack of product and service design to support consumers in their new roles (Geelen et al., 2013). Smarter grids and meters facilitate tariff innovation to improve end-use efficiency that results in direct savings to customers. Tariff solutions can also be designed for specific concerns, such as reliability and affordability.

For the wider system, the ability to reflect system conditions through price signals may lead to greater awareness and behavioural adjustments (Sanders in Sioshansi, 2011), resulting in reductions of peak demand and therefore deferred grid investments (Hindsberger in Sioshansi, 2011) (Pudjianto et al., 2013). The underlying assumption is that consumer decisions are affected by the economics of consumption and, though inelastic in terms of total demand, the consumer is at least flexible enough to shift the hours of consumption (Geelen et al., 2013) (Agrell et al., 2013).

However, the hardware is only a platform from which to build an informed consumer-driven response and ensure demand driven changes in the use of energy. An automated system to trigger the time for electrical appliance use would still require user intervention for adjustments that better suit consumer needs (Geelen et al., 2013), as well as the shift of choice toward "smarter" appliances (Verbong et al., 2013), making engagement crucial. The type of service contract expected by the consumer will vary, as users will require different incentives and solutions to adopt Demand Response schemes (He et al., 2013). To maximize potential adoption, the roll out must be accompanied by policy interventions that induce technology change in a purposeful direction (Jennings, 2013). Success also requires market design and regulations that promote dynamic-pricing tariffs as well as information campaigns to increase consumer awareness (Torriti et al., 2010).

2.2.3. New energy stakeholders

The main focus of Smart Grid discussions has been on the integration of new energy sources. However, increasing attention is turning to the impact of new forms of energy consumption, such as electrical vehicles (EV) and heat pumps (Verbong et al., 2013). Whereas the heat pump has the characteristics of conventional load, the storage capability of the EV offers possibilities for enhanced grid management and associated services. Additionally, with the transport sector being responsible for more than 25% of overall greenhouse emissions, with two thirds of these coming from road transport (EUROPA, 2011), this is one sector that sustainability policy cannot afford to ignore. Indeed, EVs are seen as key instruments to enable a redirection of the transport demand from fossil fuels to the electricity sector that relies increasingly on renewable and low-carbon electricity generation (Pudjianto et al., 2013); in fact, EVs are expected to almost double the average electricity demand per household (Verbong et al., 2013). The EU has understood the need to eradicate the barriers to the development of this cleaner technology through direct policy measures.

There are several key aspects to be dealt with before a significant adoption of the electric vehicle can be achieved, namely battery cost, autonomy, standardization, etc. Moreover, aspects related with dynamic management of the grid, namely the charging mechanism, are of utmost importance. On this issue, the EV presents new challenges, including power availability and legal constraints to having multiple meters in shared parking/charging spaces. On the other hand, the possibility of using the storage capacity of the electric vehicles to optimize energy supply over a specified time period is an interesting one due to its potential synergies with non-dispatchable RES (Zubaryeva and Thiel, 2013).

Equally important on the demand side is the activity of new intermediaries, such as aggregators and other electricity services providers. Technological innovation is reducing the cost of distributed generation and self-generation while new players are providing platforms for more efficient home energy management and for transacting energy savings from automated demand response, namely for short-term operating reserve power. This evolution of new stakeholders provides a challenge to regulators in terms of ensuring that market design and tariff structures provide incentives for new forms of energy efficiency and investments that permit energy bi-directionality.

3. Common challenges

3.1. The unbundled network

Competitive markets are generally accepted as being the most efficient mechanism for the allocation of goods and services, thereby achieving maximum total welfare. However, whereas generation and supply are potentially competitive activities, transmission and distribution functions are considered natural monopolies. In the absence of regulation, vertically integrated utilities that operate the grids may have opportunities to restrict competition in the upstream markets of electricity generation, and generally to constrain price competition through cross-subsidization. Full ownership unbundling is legislatively required to ensure competition in these markets (European Parliament and Council, 2009) and in some national policies (Braz and Esteves, 2008). Smart Grid investments bring benefits to several players along the value chain, rendering obsolete the previous investment models for assigning unique tasks to specific agents. This dispersion of costs and benefits of the value chain among various traditional stakeholders and new stakeholders (e.g., the communications sector and aggregators), justifies a more active role for the regulator in defining the roles, boundaries and responsibilities of the system operators (Ruester et al., 2014).

3.2. The regulator

In contrast with other jurisdictions, such as the USA, where energy policy is largely the responsibility of individual state authorities and varies greatly across states, energy policy in EU member states is largely determined by Community legislation. Successive "Energy Packages" (the latest is the 3rd Package, dating from 2009; European Parliament and Council, 2009) have established common rules for energy market organization and institutions.

Focussing on the areas of transport and regulation, the objective was to "complete" the Internal Energy Market by 2014. Other legislation, including the Infrastructure Package [EUROPA, 2011], the Regulation on Energy Market Integrity and Transparency [European Parliament and Council, 2011] and the Energy Efficiency Directive [European Parliament and Council, 2012], sets common EU-wide guidelines and obligations in areas such as cross-border interconnectivity, wholesale market transactions reporting, security of supply, and the promotion of energy efficiency.

Within the context of the corresponding EU legislation, energy policy is the responsibility of each EU state's national government, which normally defines the structure of the electricity system and the rights and duties of different players, grants licences or concessions, and decides the choice of production technologies and subsidy structures [if any]. The regulator, on the other hand, is the entity responsible for creating a framework that enables the integration of new services in the electricity network while apportioning any extra costs in a fair way among the stakeholders who benefit from the solutions. This goal is to be achieved while navigating through the government-defined policy and social objectives [Zinaman et al., 2014]. In addition to dealing with the traditional problems of information asymmetry, the regulator must now also devise incentives to promote energy savings, and possibly including the challenging task of decoupling operator returns from the volume of energy supplied or distributed, in line with government policy determinations and commitments.

Considering new investments for the implementation of Smart Grids, the regulators' challenge stems from the challenge that the current [traditional] regulatory models may fail to elicit the intended response. Under traditional regulation, the operator would only be interested in grid innovations to the extent that they provide an investment opportunity, help in fraud prevention, or reduce grid maintenance costs. To address these limitations, the regulatory authority is tasked with complementing existing regulations with effective incentives for energy efficiency and decarbonisation, taking into consideration the specific structure of the energy markets in its jurisdiction.

3.3. Data protection

The amount of sensitive customer information transmitted by the grid to all relevant actors, the number of control devices implemented and very low physical security, the prospective use over the internet of energy-related apps and services, along with a potentially significant increase in the number of intervening players, are all factors that make data protection a major concern, especially for consumers. Even though users have been largely left out of other grid innovations, their acceptance of the changes needed to their homes and daily routines will be pivotal to the success of Smart Grid implementation (Verbong et al., 2013).

In addition, cyber security is increasingly acknowledged as an area of concern, given the enormous potential harm that can be inflicted on operators and consumers by malicious hacking into the systems that control grid operation. This calls for a careful separation of data systems between customer data provision (including billing data and smart-meter functioning) and systems operation data flows.

To better target the data protection concerns, the Joint Research Centre (JRC) identifies the need for a privacy-by-design approach, as integrated in Mandate M490 for European Smart Grid's Standards, issued in 2011. The mandate is intended to ensure that privacy concerns are at the very core of the development of Smart Grid solutions.

4. Smart Grid initiatives at EU level

Following the 2020 agenda, the Strategic Energy Technology Plan (SET-Plan) was created by the EU both to develop the technologies needed to meet the targets and to ensure that European companies benefit from this new approach to providing energy (European Union, 2010). However, the implementation of Smart Grids at a European level has not been as swift as was initially expected. Across member states, development has occurred at different speeds and based on different premises, which hinders the potential of a fully integrated network.

The philosophy under which the EU operates stems from approaching Smart Grids innovation in several incremental steps:

1. basic research and development;

2. development of equipment;

3. pilot programs and additional data gathering;

4. implementation of solutions.

In order to ensure a coordinated effort to drive the study and implementation of Smart Grids throughout the EU, several programs have been developed and a special task force was created to facilitate the sharing of information, best practices, and lessons learnt across experiences

4.1. EU 7th Framework Programme (FP7)

The FP7 joins the EU research-related initiatives under the same umbrella and groups them into four categories: Cooperation, Ideas, People and Capacities. Each objective is attributed to a programme corresponding to the main areas of EU research policy, facilitating collaboration and promoting the creation of European poles (or centres) of scientific excellence. The Smart Grid projects are within the Cooperation category, under the broader Energy programme, representing the efforts of member states to join forces for the cooperative development of Smart Grid solutions.

4.2. Horizon 2020

Merging the principles of the 7th Framework Programme, Competitiveness and Innovation Framework Programme (CIP) and the European Institute of Innovation and Technology (EIT), Horizon 2020 is EU's 80 billion euros Research and Innovation Programme. Running from 2014 to 2020, the programme aims at simplifying the rules of participation and closing the gap between innovation and market through 3 main pillars: Excellent Science, Industrial Leadership and Societal Changes (EUROPA, 2014a). The Smart Grid projects are addressed in the latter pillar, under the key challenge named "Secure, clean and efficient energy" with a budget of approximately 5.9B euro (EUROPA, 2014b).

4.3. EEGI

The European Electricity Grid Initiative (EEGI) is one of the European Industrial Initiatives under the SET-Plan. This initiative proposes a nine-year EU-wide research, development and demonstration programme to push forward the development of the Union's future electricity networks, ensuring the 2020 agenda objectives are met. The first EEGI roadmap 2010e2018, with costs estimated to reach around EUR 2 billion, not including the costs of deploying the final solutions, was approved by the European Commission in 2010 (EEGI, 2010). It has since been updated and upgraded by the GRID+ project in response to recent EU energy policy evolutions (Brunner et al., 2012).

4.4. Smart Grid Task Force

Created in 2009 and with an updated mandate in 2011, the Smart Grid Task Force (SGTF) is invested with the specific objective of assisting the Commission on policy and regulatory frameworks for the implementation of Smart Grids under the Third Energy Package. This task force brings together diverse stakeholders and is comprised of a Steering Committee and, currently, four Expert Groups focussing on Standardization, Data Protection, Regulatory Issues and Infrastructures, reporting periodically to the Commission and making the information available through the publishing of findings through the Commission website. (EUROPA, 2013a,b,c).

4.5. EU energy infrastructure legislative package

In October 2011, the European Commission (EC) proposed a legislative package called "The Connecting Europe Facility" (CEF) aimed at improving the links between the three infrastructure sectors (Energy, Transport and Communications), ensuring coordination of funding and reducing administrative overlaps. This strategy aims to attract financial resources from both the public and private sectors by increasing the credibility of infrastructure projects and lowering their risk profiles (European Commission, 2011).

The proposal for a "Regulation on guidelines for trans-European energy infrastructure" sought to put in place the necessary tools for the 2020 objectives. With it, the Commission stressed that an interconnected, reliable and modernized infrastructure is necessary for EU energy and climate policy goals as well as economic strategy. The Commission proposed that energy infrastructure projects of common interest (PCI), which are eligible for EU funding, should be approved by a single authority within the concerned Member State, responsible for coordinating the permit granting process of the projects, namely the ones that concern the evolution toward a "smarter" grid. In 2013, the European Parliament approved the regulation on Guidelines of the EU energy infrastructure package with a funding of 5.1 billion euros intended to leverage more funding from other private and public investors.

5. Three countries' experience

While sharing the EU's guiding principles as a background for implementation, countries preserved their independence regarding the choice of the most appropriate ways to pursue the common objective, also taking into account local conditions and market dynamics. As a consequence, the options taken to implement smarter grids were distinct, permitting a cross study of policy decisions and outcomes. The three markets chosen, UK, Italy and Portugal, present substantial diversity in terms of historical evolution, market size, and competition characteristics, having in common the fact that national energy policy and regulatory practice have explicitly promoted innovation, namely in the "smartening", of electricity grids.

5.1. UK[2]

5.1.1. Overview of the electricity sector in the UK

The UK electricity grid was constructed in the 1950s and 1960s to accommodate concentrated generation technologies heavily reliant on coal mining. With electricity generation representing approximately 30% of the UK's CO_2 emissions (Hammond and Pearson, 2013) and the Government having signed the EU Renewable Energy Directive, including a UK target of 15 per cent of energy from renewable energy by 2020 (a seven-fold increase from 2008 levels), the path is set for an ambitious increase of RES. The government has further mandated that every house be fitted with smart meters and internal home displays before 2020 (Jennings, 2013). The UK energy market has long been considered one of the most competitive in the EU, with a large number of producers, system operators, and suppliers.

5.1.2. Regulation

5.1.2.1 The traditional role.

After the late 1980s privatization of the energy sector, the UK sought to provide for ownership unbundling of generation and transmission systems, while ensuring that network

[2] The global policy guidelines refer to the UK. However, it should be noted that the scope of the energy regulator (and the regulatory measures mentioned in the text) are limited to Great Britain; regulation in Northern Ireland is autonomous.

companies were regulated under the RPI-X framework (a price-cap mechanism where revenues are adjusted by inflation less an efficiency factor (X) each year), with periodic updates. The entity responsible for the regulation of the sector is the Office of Gas and Electricity Markets (OFGEM). As an independent regulator, its attributions include the issuing, modification, and enforcement of existing licenses as well as the setting of price controls for the Transmission System Operators (TSOs) and Distribution System Operators (DSOs). The current price control for the Distribution Network Operators (DPCR5) was published on the 1st of April 2010, and will remain in place up to 2015.

5.1.2.2 Evolution of the regulatory role.

Prompted by the commitments the UK made toward sustainability, the regulator has been an active party in the search for solutions. The fourth carbon budget requires greenhouse gas (GHG) emissions to fall by 50% by 2025 relative to 1990 levels and by 32% relative to 2009 levels. The Renewable Energy Directive also sets a target for 15% of consumed energy to be provided by renewable energy sources by 2020. To meet these goals, OFGEM started working in March 2008 on a complete review of the RPI-X regime used to regulate gas and electricity transmission, and distribution companies, having presented on October 2010 the RPI-X@20 document that laid the foundations for the RIIO model (standing for Revenue using Incentives to deliver Innovation and Outputs). The new model is considered an evolution of the RPI-X framework, adding elements to ensure that operators work toward ensuring a sustainable energy sector, with long-term value for money and added encouragement for innovation. These elements include: (i) an upfront (*ex ante*) specification of the outputs that network companies are required to deliver and the revenue they are able to earn for delivering these outputs efficiently; and (ii) a time-limited innovation stimulus for network companies and non-network parties. In March 2013, OFGEM published what is to be the new regulatory framework for DNOs, running from 2015 to 2023, and known as the RIIO-ED1.

5.1.2.3 Supporting the sustainability project.

The Department of Energy and Climate Change (DECC) is one of the entities committed to driving the action on RES penetration on the grid (Agrell et al., 2013) while assuring energy affordability for consumers. In the period of 2012-2013, this entity assumed the priority to set in place a framework backed by the Energy Bill to enable the estimated £110 billion needed for energy infrastructure. In April 2011, OFGEM and DECC established the Smart Grids Forum (SGF) to provide further leadership to the industry on smart-grid issues. The SGF is a combination of key opinion leaders, experts and stakeholders in the development of smart grids and aims at providing strategic input to help shape OFGEM's and DECC's role in this area. The Electricity Networks Strategy Group (ENSG) is another forum that brings together key stakeholders in electricity networks, supporting the government in meeting the long-term challenges of providing sustainable energy solutions. The ENSG is jointly chaired by DECC and OFGEM and its broad aim is to identify and coordinate work to help address key strategic issues that affect the electricity networks in the transition to a low-carbon future. The ENSG aims to deliver a range of well-targeted pilot projects between 2010 and 2015 in the expectation that many of them will prove to be technically and economically successful and therefore available for UK-wide application from 2015 onwards. Work undertaken by the ENSG has included the publishing of a smart grid Vision and Routemap outlining a potential path to test the feasibility, costs, and benefits of smart grid technology and the means by which the UK could realize the smart grid Vision. In 2013 the Central Delivery Body was also set up, realising the need for consumer engagement for a successful roll-out activity. This organization will be responsible for creating confidence and awareness of users as to how to take advantage of the smart meters (SGF, 2014).

5.1.2.4 Special funding for innovation and specific programs.

In December 2009, OFGEM announced a funding mechanism of £500m over the period 2010 to 2015 to support competitive tenders for "large-scale trials of advanced technology including smart grids", as part of DPCR5, and only applicable to electricity distribution companies. The aim of the Low Carbon Network Fund (LCNF) is to provide assistance to projects that help release the spare capacity built into the distribution network via a more intelligent management of supply and demand with the Transform Model, created by the SGF, estimating savings of 25e30% of reinforcement costs to 2050. The objective is to permit the validation of technology that can realistically be deployed across the network at the end of the project.

Later, in 2012, the DECC notified the EU of the development of a first version of the technical specification for smart meters (SMETS 1), currently under revision (SMETS 2). Privacy and data-access arrangements for suppliers and DNOs were also established in 2012. To promote the roll out of smart meters, the supplier license was amended, placing a duty on suppliers to have meters replaced by 2019. Under the LCNF several pilots have been launched, including a £53.6 million project lasting from 2010 to 2013, to create incentives for higher demand response through smart meters and ancillary services.

5.1.3. Final remarks on the UK

With a pragmatic approach in a competitive market that has a large number of operators, the UK is currently making use of its flexible regulation mechanisms to create the necessary incentives for Smart Grid solutions. It is also now ranked by the Joint Research Centre as the leading country in levels of investment in Smart Grid research and demonstration projects. Through programmes and councils, the UK is attaining thought leadership on the subject that can, with the correct strategy alignment, shape the European standards and boost the supply chain and therefore the economy [SGF, 2014].

The SGF clearly states that, given uncertainties in supply and demand, it is not possible, nor is it the regulator's intention, to map out the evolution of the network. The LCNF is thus promoting DSO competition for funding. Information from the pilot programs will help tailor the roll-out solution and provide both industry and regulators with tools to devise incentives for this alternative to expensive and time-constrained grid expansion.

5.2. Italy

5.2.1. Overview of the electricity sector in Italy

According to the Italian regulator "Autorità per l'Energia Elettrica e il Gas" [AEEG], about 30% of the nation's 2011 electricity production was accounted for by RES, with a majority contribution [56%] from hydro resources. None the less, the impressive 2010 to 2011 increment of 466% from photovoltaic technologies, or even the 14% and 8% increments from biomass and wind, respectively, are proof of a continued drive toward RES.

Further characterizing the RES operators, it is important to note that most of the wind farms are above the 10MW threshold, have a high geographic concentration in the south of Italy, and are connected to the transmission grids. The photovoltaic surge is also a direct response to the stimulus provided by a favourable feed-in tariff, with these resources located mainly in the centre and south of Italy and connected directly to the distribution grids.

These characteristics make Italy one of the EU member states that has been most impacted by the increase of intermittent generation, with RES serving over two-thirds of overall demand for some summer days [Lo Schiavo et al., 2013].

5.2.2. Regulation

5.2.2.1 The traditional role.

Italy's energy regulator was given the task of "protecting the interests of consumers and to promote competition, efficiency and deployment of services with adequate levels of quality, through the activity of regulation and control" (AEEG, 2011). AEEG has prompted TSOs and DSOs to trim down OPEX costs by a factor X year-on-year, while the invested capital is remunerated at a rate that is fixed in periods of four years. Regulatory measures also address service quality, congestion management and losses, to which the regulator has granted additional remuneration for the cost of capital for a pre-specified time period (e.g., for specific investments addressing network losses, the DSO is granted a 2% premium over the cost of capital for eight years).

5.2.2.2 Evolution of the regulatory role.

The European objectives for renewable energy production and overall system efficiency have had an impact on the role of the Italian regulator. The need to consider the integration of distributed generation (DG) and large scale renewable energy providers, stimulate efficiency measures on the demand side (Demand Response), and allow for innovative uses of energy, such as the case of electrical mobility, has brought a new dynamic to AEEG's activity.

5.2.2.2.1 Integration of DG.

Acknowledging the lack of experience in the development of innovative solutions and respective technological uncertainties, the Italian regulator focused on a three step approach e Research, Pilot Programs and Roll Out - that would allow for the acquisition of knowledge prior to defining the output based incentive scheme for a full deployment scenario. Under the first step, research by Italian universities was commissioned with the objective of understanding the medium-voltage (MV) grid capacity for connection of DG without recourse to grid expansion. Collateral information provided by these studies was used to create a network performance indicator: the Reverse Powerflow Time (RPT), or the amount of time the power flows from the distribution network to the transport grid when DG injection exceeds actual local demand in a specific time frame.

Using the knowledge from the initial study phase, specific geographies were targeted for pilot programs and specifications were drawn up to ensure the positive impact on the RPT indicator, while assuring that the technology used abided by standard and nonproprietary protocols. These specifications were key to ensure that a roll-out phase would not be constrained by a specific technology that would ultimately drive up prices. To generate interest on the promoters' side (DSOs), these pilot programs allowed for a 2% premium over the cost of capital for a limited time period (12 years). The selection of the programs was conducted by the regulator and projects were evaluated based on technical and economic parameters. A new indicator, *Psmart*, accounts for the amount of DG energy that could further be injected into the network without its expansion, thereby rendering unnecessary grid expansions and creating conditions for efficient network usage.

These programs aimed at providing a comprehensive test of the indicators and assumptions drawn from the initial research to support the roll-out phase. The major regulatory concerns outlined were as follows (AEEG, 2011):

1. An incentive-type system was to direct investment toward critical geographies through the use of indicators such as the RPT and other critical parameters, including the amount of DG connected in a specific area;

2. Admissible energy was to be maximised after a nonstructural grid upgrade, using one simple indicator (*Psmart*), based on the added value of the Smart Grid upgrade when making investment decisions;

3. Minimum levels of innovation were set for interventions, such as voltage control at DG plants through reactive power control or real-time adaptive measures to ensure anti-islanding protection.

These concerns envision an output-based incentive scheme for the future roll-out phase that includes an incentive that is proportional to *Psmart*, an RPT threshold, or a minimum level of DG for MV networks, and the application of a regulator-defined set of minimum requirements.

5.2.2.2.2 Demand response (DR).

To promote a more interactive role by consumers, AEEG rolled out programs to push the deployment of smart meters, allowing operators to recover investment costs through tariffs. These programs were a success, with smart meters currently covering more than 95% of the Italian low-voltage (LV) consumer base. More sophisticated internet-linked meters that can engage consumers and make them a dynamic part of the system to enable benefit sharing throughout the value chain, are also being developed. Such new demonstration projects should promote innovation and adoption, and lead to active management of the grid.

As of 2010, AEEG introduced a Time-of-Use (ToU) tariff for residential and small commercial consumers within the Universal Supply Regime that became fully operational in 2012. These tariffs are gradually creating consumer awareness of the differences in the price of energy throughout the day and leading to shifts in consumption habits.

5.2.3. Final remarks on Italy

In its approach to Smart Grids, Italy has devised a structured effort that draws knowledge from its institutions and creates incentives for the development of what is centrally acknowledged as the sustainable solutions. The use of an additional remuneration for investments related to Smart Grids is consistent with the models already in use for upgrades related to service quality and efficiency. Furthermore, the feedback loop created for the analysis of data related to the pilot programs provides the necessary tools for building a fully tested approach to full deployment.

5.3. Portugal

5.3.1. Overview of the electricity sector in Portugal

The energy sector in Portugal in the 1970's was nationalized as a vertically integrated monopoly; the unbundling process started in 1995, with a legislative package that re-organized the electricity sector, preceding the EU directive 96/92/EC that instructed member states to do so. The package provided for the legal separation of production, transport, distribution and supply, as well as establishing the rules for access to the transmission and distribution grids. Unlike the UK and Italy, the main distribution grid is entrusted to a single company (EDP Distribuição, 2011).

Regarding the energy mix, Portugal now has a 21% level of renewable energy penetration in primary energy consumption, with large hydro and wind responsible for most of this share (Pordata, 2014). This value corresponds to 44% when measured as the renewable mix in the production of electricity. Through generous feed-in tariff incentives, Portugal has witnessed a rapid rise in renewable energy production. Efficiency has also been promoted, namely through incentive programs for solar thermal collectors. It is estimated that, in 2011, the thermal contribution was twice that of photovoltaic (Pordata, 2014). The expansion of the electricity grid has accompanied the need for connecting renewable generation. However, the economic downturn in Portugal increased interest by the DSO and the regulator in a more efficient strategy to foster the development of "prosumers."

5.3.2. Regulation

5.3.2.1 The traditional role.

Portugal's regulator "Entidade Reguladora dos Serviços Energéticos" (ERSE) was established in 1997 with the mission to protect consumers through appropriate pricing and quality of service, while assuring an adequate economic return to the regulated companies and promoting the internal energy market. Since 1999, Portugal has chosen to use the price-cap model of regulation, applying it based on efficiency measures and the definition of returns calculated for both CAPEX and OPEX. In the allowed returns, CAPEX is fully considered and only the OPEX figure is affected by the efficiency measures (ERSE, 2011).

If performance is better than agreed on, the company reaps all of the extra benefits, thus ensuring an incentive toward efficiency. If, however, the company fails to meet established targets and goes over-budget, the consumer is safeguarded and the DSO will assume the loss. Historically this strategy achieved declining OPEX unit costs, though to a lesser extent than forecast and revealing possible limitations of this model.

5.3.2.2 Evolution of the regulatory role.

Understanding the potential savings for consumers that can result from efficiency enhancements provided by Smart Grids, and the savings these can ensure by avoiding grid expansion, ERSE has established incentives for the development of these solutions. The incentive scheme differentiates the common grid expansion solutions from the ones that might be considered "smart." As the latter are acknowledged as riskier investments, they can earn a premium over the cost of capital, implying a sharing of the innovation's risk by consumers. However, just as the risk is shared, so are the achieved benefits. This is conveyed by an extra efficiency target for overall OPEX, added to the target of 3.5% that is currently used for standard solutions. This target is calculated considering the investment costs and forecast efficiency gains so as to compensate for the premium in the cost of capital. For the current regulatory period and considering the period's allowed investment on "smart" solutions, this extra efficiency target amounts to 0.1%. The attribution of the "smart" designation to a project depends on the DSO's research into the potential benefits of a proposed solution. As no specific guidelines or requirements are set for the technologies or equipment used, the DSO is free to procure the solutions that best fit the need. The detailed study must be reviewed by the regulator to test the validity of assumptions and validate the cost-benefit analysis. If the project is expected to provide for an overall efficiency gain (with OPEX savings over time compensating for initial extra CAPEX), the regulator allows the DSO the 1.5% premium return on the "smart" investments.

5.3.2.3 Specific programs and timings.

Starting in 2007, the DSO partnered with entities that include an academic institute, technology and innovation firms, and a metering equipment supplier to create the InovGrid project, which aimed to promote innovation in the interaction between energy companies and their customers. InovGrid's first investment was in May 2009, with the implementation of a Distribution Transformer Controller (DTC) that. managed communications with intelligent grid terminals (Energy Boxes or "EB") that incorporate electricity meters and allow customers to interact with electrical appliances as well as monitor consumption. This unit was installed in the DSO's premises and resulted in the active control of public lighting and measurement taking. The concept test was rolled out to other locations and further developed to provide consumption data to consumers, innovative methods of tracking grid faults to enhance the fault correction, remote control over home appliances, and the integration of micro-generation.

With the experience gathered from the InovGrid project, InovCity was developed as a larger scale concept to further evaluate technologies and functionalities, test the interoperability, better understand the mechanisms related to cost-benefits analysis (CBA) and acquire valuable know-how and deployment experience. Choosing Évora (a medium-sized Portuguese city), Portugal's DSO implemented a pilot project that installed 31,000 smart meters and 340 DTC. This project was selected as a pilot on the validation of the Electric Power Research Institute's (EPRI) Cost-Benefit Analysis by the JRC. Currently, EDP is rolling out a new project that aims at the consolidation of results and validation of data through the installing of 100,000 EB in six different locations throughout Portugal. The target for a plug-and-play solution is one of the major aspects important to the full roll-out phase.

The Mobi.e project took its first steps in 2008, tasked with developing all the necessary equipment for electric vehicle utilization. With 1300 standard and 50 quick points of charge for electric vehicles, the Mobi.e programme has a network that covers 25 cities (Mobi.e, 2010). The programme joins the DSO, Portuguese software and hardware solution companies, as well as international partners, and is considered a "Smart" solution as it integrates all charging and electric mobility systems into a single open platform. As it is open to all operators, the dynamics of a competitive energy retailer market is at the core of the solution and enables the tracking of all financial and energy flows and establishing the communication between energy providers and customers. Aimed at potential international expansion, the equipment was designed to support all types of grid connections.

5.3.3. Final remarks on Portugal

The Portuguese approach to Smart Grid innovation is one based exclusively on the potential benefits of the solution. Technology is seen as means to an end, and is not, therefore, the subject of the regulator's specific attention.

The lack of competition in distribution (a single DSO covers all of continental Portugal) has required a more intrusive role for the regulator in terms of defining criteria, allocating incentives and measuring compliance.

The expansion of the Portuguese grid in recent decades and the boost in renewable energy sources, coupled with the slowing of energy needs due to a slowdown in the economy, make for a current state of affairs that is compatible with a slow adoption of the smart grid concept. However, the DSO's initiative pushed for the roll-out of several pilot programmes and the development of equipment in partnership with local hardware and software suppliers.

The testing phase has produced important data that supports the solutions found and is now being used to improve the equipment and the potential complementary services for the scaling-up phase.

Conclusions

This paper aims at transmitting an overview of the current smart-grid policies and key regulatory trends that are being carried forward in the European Union (EU).

To address the issues, the paper introduced the need for an alternative to the conventional grid system. The measures now being considered concentrate on three vectors:

1. Focussing on the need to lower the impact of the energy conversion systems on greenhouse gases, the EU has adopted concrete measures that imply the generalized

use of renewable energy sources. However, as high concentration locations become exhausted, the need arises to focus on the possibility of dispersion in production. This, too, poses significant challenges to the grid, as the management of the grid no longer deals only with unidirectional power flow. The need to create systems that can cope with the integration of variable, unpredictable, and distributed generation is, thus, the first vector.

2. As communications permeate the energy grid, the amount of information being supplied to the consumer increases greatly, and with it the possibility to offer new services. These new grid attributes may help consumer habits to diversify, thus allowing the management of the grid to create incentives that better suit efficiency improvement. This implies abandoning the tradition of providing enough supply to meet expected demand, replacing it with a system that adjusts to meet the moment's conditions for supply by means of demand response.

3. The emergence of new energy consumers that may not behave in the classical way is the third vector. Elements like the electric vehicle have the potential to change the way that consumers are looked at, having the potential to constitute, in aggregate, a storage battery for use by the grid. Naturally, to manage the system in a way to take advantage of these possibilities depends on the bi-directionality of power flows, as well as creating new charging infrastructure and tariff schemes to optimise the usage of such equipment.

Although the vectors remain the same throughout Europe, different member states have approached the challenge in different ways, both in terms of energy policy choice and in terms of regulatory practice. In this paper three different models are referred and are synthesized in Table 1.

Table 1 - Cross country comparison of incentives

	Portugal	Italy	Uk
Classic regulation	PC	RoR	PC
Regulation of "Smart" elements	PC and Efficiency increase	RoR increase	RIIO
Definition of "Smart" elements	Case by case; CBA [DSO + Reg]	CBA + requirements [DSO + Reg]	Case by case [DSO + Reg]
Current phase	Pilot programs	Pilot programs and SM roll-out	Pilot programs

PC – Price Cap; RoR – Rate of return; RIIO – UK's incentive regulation; CBA – Cost benefit analysis; DSO – Distribution System Operator; Reg – Regulator; SM - Smart Meter.

Despite the different choices of member states in pursuing objective of collecting data to guide the implementation of the Smart Grid concept, the various pilot programmes implemented have provided useful insights to both industry and regulatory authorities. In Portugal, for example, the Inovgrid pilot helped to gauge the strengths and limitations of different data transmission technologies and their appropriateness to different urban and rural population densities. As in various other pilots, Inovgrid also tested the proclivity of customers to respond to different types of energy-efficiency incentives, helping to better profile the population in terms of alternative tariff incentives. In all three countries analysed, the process has actively involved the regulators in a constructive dialogue with stakeholders, and led to proposals to alter the regulatory framework as necessary to provide incentives for "smart" investments and permit the involvement of new market players (such as aggregators) that were not foreseen in existing regulations. In Italy, the pilots helped the regulator develop specific metrics, such as RPT and P-Smart, to assess the "smartness" of proposed new investments while in the UK, the SGF, and LCNF are good examples of beneficial multi-stakeholder involvement, with operators competing for available assistance.

It also is clear that different regulatory approaches are, to a very significant degree, determined by the respective market structures in terms of the degree of competition among market players. In situations with a large number of operators and a tradition of competitive markets, such as the UK, incentives can be allocated on the basis of competition between operators, with a fair expectation that this will call forth efficient solutions. In smaller markets with a single incumbent DSO, as in Portugal, the regulator's role is of necessity more direct in terms of negotiating incentives and monitoring outcomes. Between these two extremes, the Italian regulator has developed regulatory guidelines and metrics that are more susceptible of cross-operator application than those in Portugal but less market-dependent in their formulation than the UK variety.

As the implementation phase advances in different markets, further research will help to understand the impact of the eventual withdrawal of incentives and the balance between initial investment costs and longer-term efficiency benefits to the consumer. The rapid pace at which several countries are advancing with regard to the introduction of Smart Grid innovations promises to provide ample opportunities for interested parties to seek answers to these and other relevant questions.

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The cost of electricity interruptions in Portugal: The Value of Lost Load by the production function approach

Rui Castro, Sérgio Faias, Jorge Esteves [1]

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Abstract

Despite the fact that the current level of security of supply in Europe is far satisfactory, new challenges show a potential risk of jeopardising the current state of affairs. Among others, this new challenges are related to the strengthening of the market framework, in the context of deregulation and unbundling as imposed by EU directives, and to the increasing penetration of renewable energy sources in the generation mix, with its inherent higher degree of volatility. Under these circumstances, the assessment of the value of lost load (VoLL) is useful to support energy politics decisions, benefit-cost analysis and the design of adequate regulatory frameworks. The paper develops the VoLL's estimation using a macroeconomic methodology, the production function approach. In this sense, the VoLL determines the foregone value added due to the electricity outage. The production

[1] Rui Castro, INESC ID, Instituto Superior Técnico, Portugal
Sérgio Faias, Energy Services Regulatory Authority (ERSE), Lisbon Engineering Superior Institute (ISEL), INESC ID, Portugal
Jorge Esteves, Energy Services Regulatory Authority (ERSE), Portugal

function method is applied to the Portuguese case and an average value of 5.12 €/kWh is found. The paper also presents the VoLL results obtained for the different economic activity sectors, plus the households. Moreover, the temporal evolution of the VoLL along typical weekdays and weekend, in winter and in summer, for the most relevant sectors – manufacturing, services and households –, is shown and discussed.

Keywords

Security of Supply - Power Interruptions - Value of Lost Load - Portugal.

Introduction

It is commonly accepted that the quality of service regulation, also referred to as quality of electricity supply regulation, has three components:

1. continuity of supply, that deals with network reliability and availability;

2. power or voltage quality, concerned with the characteristics of the supply voltage; and

3. commercial quality, related to timeliness in dealing with customers' requests.

The main goal of quality of electricity supply regulation concept is to provide a balance between customers' willingness to pay network tariffs and their expectations on minimum levels of quality of service. Recently, this topic became more relevant in Portugal. As a matter of fact, a rate-of-return economic regulation, in which total utility costs were fully recovered by the tariff, has evolved to a price-cap regulation, in which the utilities' allowed revenues are capped in a level that does not necessarily reflect the actual costs. This change was implemented bearing in mind the objective of improving the utilities' economic efficiency. However, there is a risk that firms postpone investments and, consequently, decrease the quality of service provided to customers [Ajodhia and Hakvoort, 2005; Ajodhia, Lo Schiavo and Malaman, 2006; Fumagalli, Garrone and Grilli, 2007]. As so, more effective quality of electricity supply regulation is required to counteract the above mentioned risk.

The continuity of supply features and evaluates the situations in which the occurrence of incidents in the electrical grid originates power supply interruptions to the customers. Accordingly to the regulatory code, continuity of supply deals only with interruptions that last for more than three minutes, the so-called long interruptions.

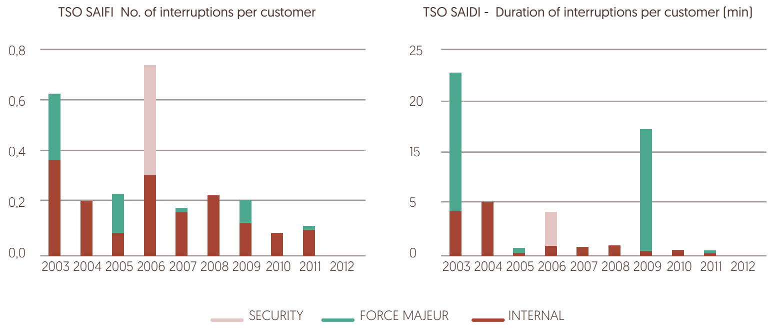
There are some commonly used indexes to assess the continuity of supply both at the Transmission System Operator (TSO) and Distribution System Operator (DSO) levels. Two of these indexes are:

» System Average Interruption Frequency Index (SAIFI) – This index computes the average frequency of power supply interruptions in the system, being expressed in number of interruptions per customer, per year.

» System Average Interruption Duration Index (SAIDI) – This index measures the average cumulative duration of power supply interruptions in the system, being expressed in minutes per customer, per year.

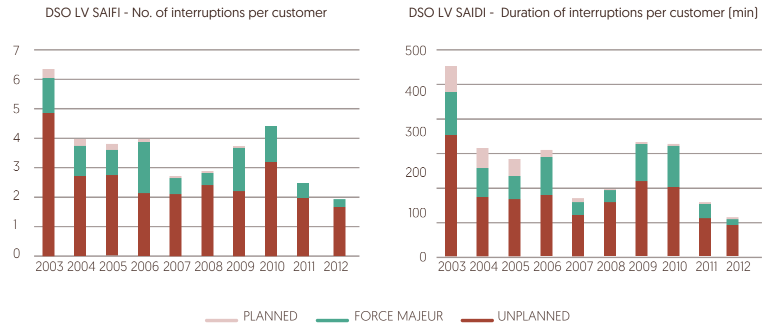
Figure 1 and Figure 2 report the past ten years evolution of the SAIFI and SAIDI for the TSO grid and for the Low Voltage (LV) grid of the DSO, respectively.

Figure 1 - Ten year evolution of the annual SAIFI (left) and SAIDI (right), TSO grid, Portugal.



Source: ERSE – Portuguese Energy Regulatory Authority.

Figure 2 - Ten year evolution of the annual SAIFI and SAIDI, DSO LV grid, Portugal.



Source: ERSE – Portuguese Energy Regulatory Authority.

As far as the TSO performance is concerned (Figure 1), one can see that it is occasionally spoiled by some Force Majeure (FM) events or by security reasons, but in general the TSO performance is much satisfactory. At this respect, it should be mentioned that the Portuguese TSO has achieved zero long interruptions in year 2012.

The performance of the DSO (Figure 2) is also satisfactory and shows a remarkable progress since 2003. It should be noted that small absolute figures are not to be expected, due to the particular characteristics of the MV and LV grids, namely its radial structure, as well as its extension and larger number of electrical devices. Moreover, there are interruptions in the distribution network caused by faults in the transmission network. These figures include all long power supply interruptions felt by the customers, namely the FM events, which represent 25%, in average, of the electricity outages. In general, FM events are caused by bad weather conditions.

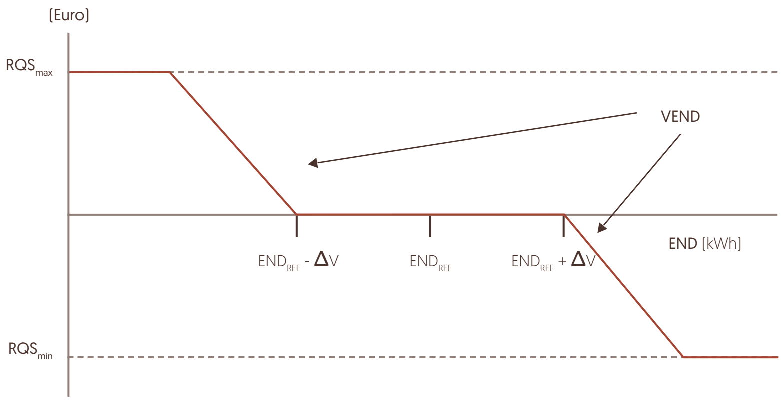
This quality of electricity supply regulation can be exercised by means of a set of direct and indirect instruments. Examples of direct regulation tools used in Portugal are: (i) the definition of minimum standards for the continuity of supply indicators, alongside with monetary compensations to the customers, in case of noncompliance; and (ii) financial incentive schemes to the system operators to improve the quality of power supply. As far as indirect tools are concerned, the implementation of: (i) national voltage quality monitoring programmes, (ii) the regular reporting and dissemination of the electrical network performance, and (iii) national and international benchmarking are examples of instruments used in Portugal (Ajodhia and Hakvoort, 2005; Giannakis, Jamasb and Pollitt, 2005; Fumagalli, Lo Schiavo and Delestre, 2007; CEER, 2012). Monetary compensations to the customers and financial incentive schemes to the system operators are undoubtedly two of the most important tools used in quality of electricity supply regulation, because they have a direct and measurable impact in the revenues of the regulated companies.

Guaranteed standards for continuity of supply indicators are included in the Portuguese quality of electricity supply code. These standards take the form of maximum limits to the number and duration of interruptions experienced by each customer per year and may be viewed as a commitment of the company with their customers to maintain a certain level of quality of supply. Whenever individual limits are exceeded, customers are informed and monetary compensations are automatically paid. It should be noted that the total amount of monetary compensations annually paid to customers is not supported by network tariffs. In this way, it is assured that the network operator is compelled to improve the continuity of supply performance along the years.

In complement to guaranteed standards and monetary compensations by nonfulfillment, incentive schemes comprising revenue increases (rewards) and decreases (penalties) are also considered in the Portuguese quality of electricity supply code. As a matter of fact, Portugal is considered one of the pioneers in Europe in implementing such rewards/ penalties incentive schemes (Fumagalli, Lo Schiavo and Delestre, 2007; Growitsch, Jamasb, Müller and Wissner, 2010).

As an example of these incentives schemes, the Portuguese Energy Regulatory Authority (ERSE) put in practise, since 2003, an incentive to improve the continuity of supply in the Medium Voltage (MV) distribution network. The basis of the incentive scheme is shown in Figure 3.

Figure 3 - Incentive scheme for the continuity of supply in MV network. Portugal.

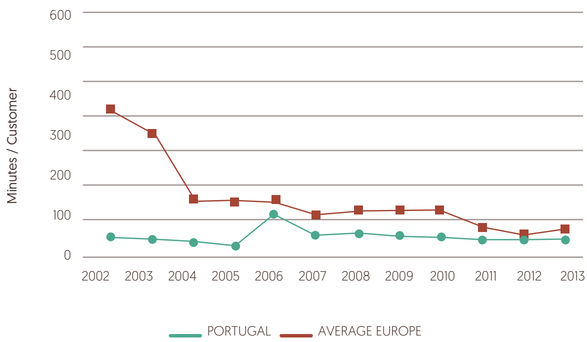


Source: ERSE – Portuguese Energy Regulatory Authority.

It is grounded on historical values of the energy not distributed (ENDREF) indicator, a dead band (ENDREF ± ΔV) being used to avoid the incentive activation when small performance improvement or deterioration is experienced. On the other hand, in order to avoid overstating the impact of the incentive on the company economic results, maximum amount of reward (RQSmáx) and penalty (RQSmin) are defined. When the performance improvement or deterioration is placed between the dead band boundaries and the reward and penalty limits, the amount of the incentive is computed based on the value of the energy not distributed (VEND).

The incentive scheme to improve the continuity of supply in the MV distribution network has been an important tool to induce a noticeable enhancement of the continuity of supply in Portugal. Figure 4 shows the duration of unplanned interruptions experienced by Portuguese and European MV customers in the period 2002-2013.

Figure 4 - Duration of unplanned interruptions experienced by Portuguese and European MV customers.



Source: CEER Benchmarking Report 5.2 on the Continuity of Electricity Supply - Data update 2013.

It can be seen that there was a considerable mismatch between the Portuguese continuity of supply indexes and the European ones, in the past years, but more recent results show that a noticeable convergence is being reached. We believe that this positive evolution is a consequence of the application of the incentive scheme. Considering that: (i) the incentive scheme proved its effectiveness over the past years; (ii) the Portuguese continuity of supply indexes are in line with the European ones (Faias and Esteves, 2013) and (iii) the Regulatory Authority does not intend to provide regulatory signals that would result in overinvestments in the networks by the DSO and ultimately in tariffs increase, the incentive scheme parameters have remained unchanged over the past years. On the other side, as the current incentive scheme is based on an average continuity of supply index, it follows that there are some customers whose continuity of supply indexes are much higher than the average. In an attempt to reduce this asymmetry, a second component of the incentive scheme is being currently introduced with the aim of specifically improving the continuity of supply of those poorly served customers.

It is now becoming clearer that a proper estimate of the economic value of the electricity not delivered to the customers is a key issue, as far as quality of power supply regulation is concerned, namely to calibrate the monetary compensations and the incentive schemes. Moreover, in Portugal, the economic value of the electricity interruptions is based on very old and rough estimates, which reinforces the need for more accurate estimates based on recent available data. On the other hand, many investment decisions made by the network operators are justified by arguments regarding demand for security of supply. As so, the value of the electricity not delivered is crucial for the regulator's decision on the acceptance of the related costs.

This paper intends to provide a contribution to the important subject of estimating the value of the electricity interruptions in the Portuguese electrical system, commonly known as Value of Lost Load (VoLL). The literature reports the results of such estimations for other European countries – The Netherlands (de Nooij, Koopmans and Bijvoet, 2007), Republic of Ireland (Leahy and Tol, 2011), Spain (Linares and Rey, 2013), Cyprus (Zachariadis and Poullikkas, 2012), Germany (Growitsch, Malischek, Nick and Wetzel, 2013), Austria (Reichl, Schmidthaler and Schneider, 2013), Great Britain (London Economics, 2013), etc. To the best knowledge of the authors, scientific based VoLL estimates for the electricity sector do not exist, as far as Portugal is concerned.

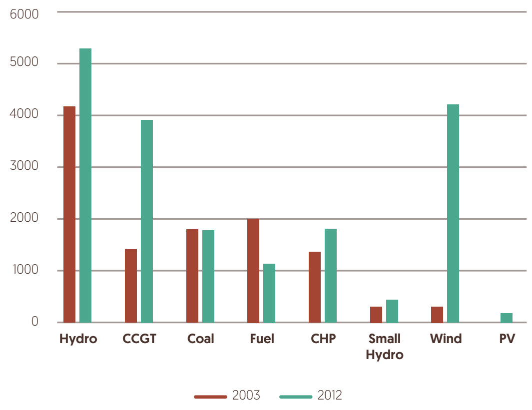
The literature reports several existing methodologies to calculate the VoLL. Taking into account the available data, we decided to use a macroeconomic technique known as production function approach, in which electricity is treated as an input necessary to produce a valuable output; when the input fails, the output good is not produced, therefore enabling a cost of electricity outage to be derived. Thus, the consequences of a power interruption are estimated through the computation of lost production, for firms, or lost time, for households.

The paper is organised as follows. In Section 2 a brief overview of the Portuguese electrical system is given. The next Section is devoted to the presentation of the available methods to estimate the VoLL, highlighting the main advantages and drawbacks of each one. Moreover, an abridged survey of past research in this topic is offered, with the main findings achieved so far in what relates to the value of lost load in several EU countries. The selected methodology, the production function approach, is presented in Section 4, including the details of the application to the Portuguese system, namely as far as the valuation of the household leisure time is concerned. The main achievements of our research are focused in Section 5, where the total average VoLL, alongside with the different sectorial VoLLs, are estimated and commented. Also, a comparison with the results related to other EU countries is performed in this Section, with a view to somehow validate our estimations. Still in this Section, the evolution of the VoLL along typical weekdays and weekend, in winter and summer, is depicted and analysed. Finally, the last Section contains a summary f the main findings achieved with the current work.

1. The Portuguese Electrical System

The structure of the Portuguese electrical system experienced a major change in the last decade, as can be seen in Figure 5. No new coal power plants have been installed since then, and some fuel power plants have been decommissioned. A clear option on cleaner technologies was pursued with the deployment of new combined cycle gas turbine (CCGT) power plants, and, mainly, with a strong investment in renewable energy sources (RES), namely, in wind energy conversion systems. In 2012, the total installed capacity was 18.5 GW, being 54% in RES, mainly hydro (28%) and wind (23%), and 46% in thermal power plants, mainly CCGT (21%), CHP (combined heat and power, 10%) and coal (9%). It is worth to mention that no nuclear power do exist in Portugal.

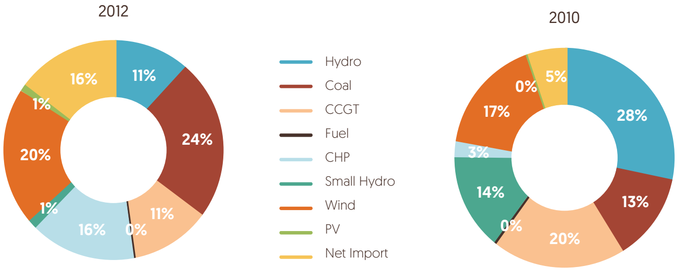
Figure 5 - Installed capacity by source (MW), Portugal, 2003 and 2012.



Source: REN – Transmission System Operator.

In what concerns the electrical energy production, Figure 6 depicts the typical situation for two typical years: a dry year (2012) and a wet year (2010). There is a strong dependency on the meteorological conditions, which directly affects hydro power. For instance, 2010 was a rainy year, as so, hydro power contributed with 28% of the demand supply; in contrast, 2012 was a dry year and the hydro contribution dropped to 11%. This volatility is reflected mainly on the electricity imports from Spain, which jumped from 5% in 2010 to 16% in 2012. Nevertheless, it should be kept in mind that electricity imports from Spain are also dependent on market conditions. The thermal contribution is around 35%, and the distribution between coal and natural gas depends on market price conditions. Wind contribution is more or less steady in about 20% of the demand supply.

Figure 6 - Electrical energy production by source, Portugal, 2012 (left) and 2010 (right).



Source: REN – Transmission System Operator.

2. Background and Materials

The consequences of electricity supply interruptions can be classified into three main categories (Manson and Targosz, 2008):

1. Direct economic impacts
    - Loss of production
    - Costs to resume production
    - Damages in the equipment
    - Deterioration of raw material

2. Indirect economic impacts
    - Delayed receipt of rents
    - Financial cost of losing market share

3. Social impacts
    - Uncomfortable temperatures at work or at home
    - Loss of leisure time
    - Risks to health and safety

As a matter of fact, a deep analysis on VoLL estimation should be able to capture all these aspects. However, the lack of adequate data and information makes this task extremely difficult.

2.1. Available methodologies

Four main methodologies can be identified to incorporate, to a greater or lesser extent, the impacts listed, so that an estimate of the value of the electricity interrupted can be produced (van der Welle and van der Zwaan, 2007): case-studies, revealed preferences, stated preferences and proxy methods.

Case studies (past blackouts): This method involves the analysis of past real events to quantify the cost of power supply outages (Corwin and Miles, 1978). Data gathered from real life experience, namely an assessment of the damages, serve as a basis to determine the costs involved. With these data, the costs of both production and network interruptions can be quantified, directly or indirectly. An important drawback of this technique is it implies that past and future are equally probable, which is much arguable, especially in countries facing rapid economic and structural changes. Moreover, by definition, a single case study can never be fully representative for all interruptions and their consequences. It follows that it is almost impossible to generalise the findings.

Revealed preferences (market behaviour): A revealed preference method is based on the investment made by a firm in order to prevent power supply interruptions, for instance, backup power or uninterruptible contracts. The method considers this investment as an indication of the expected costs of these interruptions. The main advantage of this method is that it provides information based on the actual customers' behaviour. However, some drawbacks do apply also. Backup units and uninterruptible contracts are used to provide absolutely essential services in high sensible customers (hospitals, certain industries). Given the high reliability of supply, namely in EU and USA, backup facilities are bound to present a very low utilisation; therefore, the price of backup power is an underestimation of the true value of security of supply. On the other hand, this method cannot provide results for small firms or households, because they do not use to install backup power, nor uninterruptible contracts.

Stated preferences (consumers' surveys): The stated preferences method uses the results of dedicated inquiries to gather information about industrial, commercial and domestic consumers (see, for instance, Balducci, Roop, Schienbein, Desteese and Weimar, 2002; Bertazzi, Fumagalli and Lo Schiavo, 2005; Kjølle, Samdal, Singh and Kvitastein, 2008; Sullivan, Mercurio, Schellenberg, Freeman and Sullivan & Co., 2009; Bliem, 2009). Consumers showing good knowledge about the economic consequences of the interruption of electricity supply, for instance, large industrial consumers, are able to identify impacts and assess the cost of interruptions. As far as domestic consumers are concerned, they are less comfortable in assessing the impact of interruptions, because these are less tangible. As so, indirect methods are used, based on the "Willingness To Pay" (WTP) to avoid interruptions, or "Willingness to Accept" (WTA) compensations for having a larger number of interruptions. This may prove problematic, because people are asked to answer about trade-offs they have never made at all and show difficulties to monetize the value of a secure supply, in a context where power interruptions are rare. In addition, customers are often aware that their answers are to be used by policy makers and tend to respond in a strategic way. As a result, WTP figures are often equal to zero or much smaller than WTA values, which distort the results.

Proxy methods (production function approach): Proxy methods estimate interruption costs in an indirect way, by calculating variables that are closely related to the direct cost of power supply outages. The most known proxy method is the so-called production function method, which relates the use of electricity to the value generated by it. The interruption costs by economic activity sector are calculated through the ratio between an economic measure and a measure of electricity consumption. The economic measure commonly used is the Gross Value Added (GVA), which is the difference between the value of goods produced and the cost of raw materials and services used to produce them. GVA is evaluated at base prices, i.e., adds taxes and subtract subsidies. The goal is to find the value of each unit of energy interrupted, the so-called Value of Lost Load (VoLL), i.e., the value created per unit of electricity. For example, if a sector GVA is 10 million using one million kWh of electrical energy, then the cost of each unit of interrupted energy is 10 €/kWh. However, the quantification of costs is not trivial for households, because they do not produce market goods. Still, it is possible to relate power interruptions to lost leisure time. Interruptions mean less free time, and the loss of leisure can be expressed in terms of the wage rate. This method assumes that electricity is essential for any productive activity, which is not always true. Thus, it can overestimate the cost of electricity interruption. It is worth to mention that the VoLL is no more than the inverse of the electricity intensity quantity, which measures the amount of electricity required to produce a unit of economic value. Therefore, electricity intensive sectors display, by definition, a low VoLL. The production function method will be used throughout this paper and, as so, will be discussed further along the paper.

2.2. Advantages and disadvantages of the most used methods

The most used methods to assess VoLL estimations are, by far, the two last mentioned methods – consumers' surveys and production function. In general, they differ in two key aspects.

On one hand, the cost of interruptions in the supply of domestic electricity is relatively high using the production function approach; on the opposite, the consumer surveys approach usually finds this cost to be low. The reason for this is that the production function approach uses the loss of leisure time as a cost indicator. As a result, it does not capture the fact that leisure activities can be shifted in time, and, as so, it tends to overestimate this cost. When the consumers' surveys approach is used, this issue is not especially valued, because the supply cutbacks are extremely rare, and, therefore, people are not willing to pay more for fewer interruptions.

On the other hand, the survey results show that the outages costs affecting the industrial sector and the services sector are very close, while the production function points, in general, to interruption costs in the service sector much higher (by about four times) than in the industrial sector. This difference is justified by the fact that the indirect economic impacts are higher in the industrial sector; however, these impacts are not captured by the methodology of the production function.

In general terms, we can say that the production function approach is objective, does not depend upon historical background data, that may not be general, nor on the customers' opinion, which is much subjective. Moreover, the required data is publically available, which facilitates the development of this technique. Its main drawbacks are that it disregards instantaneous damages, only recovering the output loss. It supposes that electricity is essential for an economic activity to be developed, neglecting the adjustments that can come forward when there is no electricity. In short, the assumption that all economic activity is lost when a power outage occurs is not necessarily always true. As a consequence, this kind of approach is more appropriate to capture the effects of short-term and not frequent power interruptions.

Despite the differences in results, both approaches provide very useful information. The method of the production function is suited to account for the loss of production that cannot be avoided by time shifting the production or when electricity is critical for the productive activity. The surveys should be used to supplement this information, namely in what relates: (i) to capture the indirect economic impacts in the industrial sector; (ii) to adequately weigh the social impacts in the domestic sector.

2.3. Brief survey on recent past research

The topic of estimating the VoLL in EU countries has been very active in recent years. Hereafter, we summarize the main findings of those studies.

de Nooij, Koopmans and Bijvoet, 2007, assessed the VoLL for The Netherlands. Using the production function approach, they came to the conclusion that the average VoLL for the Dutch system is 8.56 €/kWh (2001 prices). Disregarding the household sector the VoLL is 5.97 €/kWh, the specific household value being 16.38 €/kWh.

Leahy and Tol, 2011, approached the Irish VoLL with the production function and accounted for an average value of 12.9 €/kWh (2008 value), with the following disaggregation: industrial – 4 €/kWh, services – 14 €/kWh, residential – 24.6 €/kWh.

Linares and Rey, 2013, studied the Spanish system, the tool at hand being the production function technique. Their main findings were (2008 reference): average VoLL – 5.98 €/kWh; VoLL without households – 5.13 €/kWh; households VoLL – 8.11 €/kWh.

The VoLL of Cyprus was included in the study by Zachariadis and Poullikkas, 2012. They achieved an average VoLL of 6.5 €/kWh, the residential specific value being 9.07 €/kWh (2009 values). The production function method was used.

In Growitsch, Malischek, Nick and Wetzel, 2013, the German system is analysed through the production function approach. The authors of the study came across an average VoLL of 7.41 €/kWh (5.74 €/kWh if the households are disregarded). The household contribution is 11.92 €/kWh and the services account for 11.04 €/kWh. The manufacturing sector has the lowest VoLL (2.19 €/kWh) and the construction and public works show the greatest (102.93 €/kWh). Another recent study (Röpke, 2013) pointed to slightly different conclusions: 12.51 €/kWh for the average VoLL and 15.05 €/kWh for the household sector, but these figures refer to the 2008–2010 period average, whereas the former refer to 2007.

A hybrid approach, combining a value-added production approach, complemented by survey inputs, (for non-households), with consumers' surveys to determine WTP (for households), is available in Reichl, Schmidthaler and Schneider, 2013, targeting the Austrian system. The economic assessment of a 12-hour summer power outage in Austria, 2011, produced the following results: average VoLL, excluding household – 5.7 €/kWh; household VoLL – 1.2 €/kWh.

Finally, the findings for the British system are reported in London Economics, 2013, referring to year 2012. Also, a hybrid methodology is used: a stated preference choice experiment to estimate the VoLL in terms of WTA payment for an outage for domestic and small and medium sized business electricity users, whereas for industrial and commercial customers, they used a value-at-risk approach and econometric techniques. Depending on the season, on the specific day and on the hour of the day, the values range from 8.35 to 14.18 €/kWh, for domestic consumers, and from 40.03 to 47.06 €/kWh, for small and medium sized business consumers. For the industrial and commercial customers they found a VoLL of 1.98 €/kWh.

3. Methods

To the best knowledge of the authors, no significant consumers' surveys, related to the VoLL's estimation, have been carried out in Portugal. Moreover, a scientific based assessment of the Portuguese VoLL has not been performed, so far, current estimates relying on past engineering practices and rules of thumb. Under these circumstances, it was decided to apply the production function methodology to the Portuguese case.

We are aware of several disadvantages that are often pointed out against this method and that are extensively explained in (van der Welle and van der Zwaan, 2007). We pick up here the most significant ones:

1. The valuation of interruption costs for households through the wage differential method is frequently criticized, because the wage rate constitutes only a rough estimate of the value of free time.

2. Customers do not always use their leisure time when faced with a power outage, since other work-related activities can often be carried out during the interruption time instead. Likewise, not all production in the industrial and service sector is necessarily completely lost when supply disruptions occur.

3. The value of free time is not constant; it may change according to the time of the day and the season of the year.

4. In general, interruption costs diminish over time in relative terms, which is not captured by the method.

5. Restart costs and damages encountered to the equipment are not taken into account.

In short, the main assumptions of the production function method are that the time of occurrence of the power interruption is not important, and the same applies for the duration of the outage (Leahy and Tol, 2011). Nevertheless, this method is used elsewhere, like in Spain, Ireland, The Netherlands, Germany, Austria, Cyprus, Great Britain, because one of its main operational advantages is that it uses only readily available information to estimate the cost of power supply interruptions, disaggregated by economic activity sector. In those countries, the application of the method proved well, which is an additional argument in favour of our choice to apply the production function method to the Portuguese case.

The technique for calculating the VoLL is slightly different for the sectors of economic activity in general (industry, corporate and government services) and the domestic sector (households).

3.1. Economic activity sectors

As far as the industry, business and public services are concerned, it is assumed that electricity is essential to the activity, i.e., if there is no electricity, the activity is stopped. Obviously, this assumption is not always true, at least for some segments; in these sectors, the application of this methodology leads to overestimations of the VoLL. This is a known drawback of this methodology, as already stated before. Again, it should be noted that this method only accounts for the direct economic impacts related to the loss of production, meaning that it is assumed that the production cannot be time-shifted. Other impacts – equipment damage, or raw material deterioration, are not captured. This may somehow compensate the full dependency on electricity consumption (Growitsch, Malischek, Nick and Wetzel, 2013).

Production losses are quantified by the GVA not generated during the interruption. The VoLL (€/kWh) is obtained by dividing the GVA (€) by the amount of electricity used (kWh). The relevant data was obtained from the Portuguese governmental offices – Institute of Statistics (www.ine.pt) and Directorate-General for Energy and Geology (www.dgeg.pt) and, except otherwise stated, it refers to year 2010.

3.2. Domestic sector

Following Becker, 1965, households gain utility from the consumption of goods and from leisure activities. As so, to calculate the GVA of the domestic segment, it is considered that electricity is essential for some leisure activity, as so, in the absence of electricity, leisure time is lost. It is assumed that private-life time is a normal good. In an ideal labour market, it can be verified that when the income generated by the last worked hour equals the value of one hour of private-life time, it follows that the optimal amount of working time has been reached. Then, the marginal hour work has approximately the same value (utility) as the marginal hour of leisure time (Röpke, 2013). This method to value leisure time turned out to be controversial, especially to non-economists. In economics, this idea is commonly accepted and is used regularly (de Nooij, Koopmans and Bijvoet, 2007).

The Spanish Institute of Statistics (www.ine.es) provides data on the percentage of people that performs an activity during a day and the respective duration of that activity. To the best knowledge of the authors, the Portuguese Institute of Statistics does not provide this type of data. As so, and due to the lack of adequate Portuguese data, it was decided to follow the Spanish data (INE, accessed April, 2014) to represent the Portuguese case. It is expected that this replacement does not introduce a significant error, because Portugal and Spain are the two Iberian countries that share most of the habits.

Based on the time spent on each activity and on the percentage of people who executes it, Table I was built.

Table I - Timely distribution of the daily activities of the average citizen, on an average day: Portugal, 2009–2010 (based on data from Spain, 2009–2010)

Activities	h
Personal care (sleep, eat, drink, ...)	11.50
Paid work	2.47
Study	0.65
Household and family care	3.03
Volunteer work and meetings	0.22
Social life and recreation	1.05
Open air sports and activities	0.73
Hobbies and computers	0.57
Media (tv, video, radio, read, ...)	2.62
Travel and unspecified time	1.17
TOTAL	**24.00**

Following the reasoning given above, it was considered that the monetary value of an hour of leisure time is equal to the hourly average wage. This assumption holds for the active people, however it may not be valid for non-employed people (unemployed or inactive), who have more leisure time available. Therefore, the different opportunity cost of leisure time for non-employed people is incorporated by assuming that one hour of leisure time for non-employed people is worth half one hour of leisure time for employed people. This approach is in line with other similar studies, namely in de Nooij, Koopmans and Bijvoet, 2007, Linares and Rey, 2013 and in Growitsch, Malischek, Nick and Wetzel, 2013.

According to Pordata (www.pordata.pt), a Portuguese distinguished database, the monthly average gross wage in Portugal in 2009 (data concerning 2010 was not available at the access date) was 1034.2 €. An average tax income of 20% was considered, which results in a monthly average net wage of 827.36 €. Furthermore, considering 22 working days, 7.5 work hours per day, points to an hourly average net wage of 5.01 €. According to the Portuguese Institute of Statistics, in year 2010, the active and inactive population totals 5,582,700 and 5,055,600 people, respectively.

This information allows us to calculate the GVA of the domestic sector. As previously mentioned, the cost of power supply interruptions can be overestimated if, during the interruption, people can use their leisure time in activities that do not require electricity. However, other costs, such as spoiled food and personal losses are not being accounted for.

4. Results

4.1. Average VoLL

Table II shows the results achieved using the described methodology based on the production function approach. It depicts the electricity consumption, the GVA and the VoLL, by economic sector and households, in absolute value and in percentage.

From Table II, it can be seen that, including all activity sectors, Portugal generates 5.12 € from 1 kWh of electricity. However, some differences between sectors are prone to be pointed out, paying special attention to what happens in Spain (Linares and Rey, 2013):

- The industry manufacturing sector is the most electricity intensive sector, closely followed by the services and domestic. Altogether, they account for more than 90% of the total electric energy consumption in Portugal. A similar figure is found in Spain (85%).
- Demonstrating that the electricity use is not proportional to the GVA, the manufacturing sector only contributes with 8 % of the GVA, while the services sector accounts for 40%. The correspondent figures in Spain are 8% and 31%, respectively. This explains the lowest VoLL of the manufacturing sector, 1.28 €/kWh (in Spain is 1.38 €/kWh).

» When the household GVA is included, it becomes the sector with the highest GVA, 42%. The same situation occurs in Spain, the correspondent GVA being 39%.

» The construction and public works sector has the highest VoLL, 15.52 €/kWh, which is common in other EU countries. In Spain it is even about the double than in Portugal.

» The VoLL for the services and household sectors is very similar, between 6.67 and 7.43 €/kWh. The same behaviour is observed in Spain, 8.47 and 8.11 €/kWh are the correspondent figures.

Table II - Value of lost load by activity sector, Portugal, 2010.

	Electricity GWh		Total GVA M€		VoLL €/kWh
Agriculture and fisheries	1,025	2.03%	3,467	1.34%	3.38
Extractive industries	557	1.10%	695	0.27%	1.25
Manufacturing	15,821	31.26%	20,221	7.80%	1.28
Electricity, gas and water	1,206	2.38%	5,833	2.25%	4.84
Construction and public works	610	1.20%	9,465	3.65%	15.52
Transportation	1,224	2.42%	7,378	2.85%	6.03
Services	15,649	30.92%	104,354	40.25%	6.67
Total without household	36,091	71.31%	151,413	58.40%	4.20
Household	14,522	28.69%	107,866	41.60%	7.43
TOTAL	**50,613**	**100.00%**	**259,280**	**100.00%**	**5.12**

The explanation for the cost of electricity outages being so much bigger in the construction sector than in industry is that electricity is essential in the industrial sector (it is an intensive electricity sector), while the construction may be run in its absence (low electricity intensity). Furthermore, it is worth to mention that the costs of production recovery or equipment damage in the industrial sector are not captured by the production function methodology.

A comparison with the results obtained using the same production function method in other European countries, Spain (Linares and Rey, 2013), Germany (Growitsch, Malischek, Nick, and Wetzel, 2013, for year 2007 and Röpke, 2013, for the period 2008-2010), Cyprus (Zachariadis and Poullikkas, 2012), Republic of Ireland (ROI) (Leahy and Tol, 2011) and The Netherlands (de Nooij, Koopmans and Bijvoet, 2007) is worth to show (see Table III).

Table III - VoLL; comparison with other European countries; production function approach.

Country	Portugal	Spain	Germany	Germany	Cyprus	ROI	Neth.
Year	2010	2008	2007	2008-10	2009	2008	2001
Agriculture and fisheries	3.38	4.40	2.49	2.20	2.30	NA	3.90
Manufacturing	1.28	1.38	2.19	2.81	1.91	4.00	1.87
Const. and public works	15.52	33.37	102.93	NA	118.06	NA	33.05
Transportation	6.03	8.53	NA	7.61	NA	NA	12.42
Services	6.67	8.47	11.04	15.37	6.12	14.00	7.49
Total whithout household	4.20	5.13	5.74	NA	NA	NA	5.97
Household	7.43	8.11	11.92	15.05	9.07	24.60	16.38
TOTAL	**5.12**	**5.98**	**7.41**	**12.51**	**6.50**	**12.90**	**8.56**

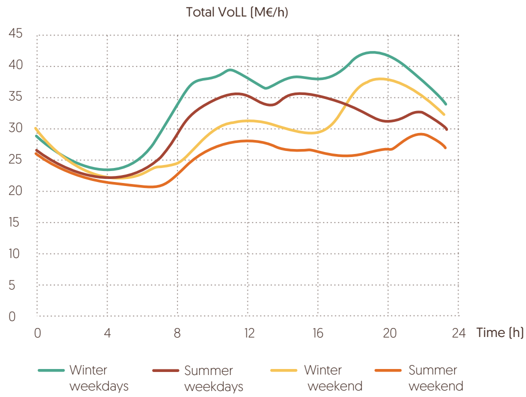
The results showed in Table III allow the conclusion that the Portuguese VoLL is consistent with the other EU countries, namely with the other Iberian country, Spain. The slightly variations encountered lie in structural differences, namely in terms of net wages and electrical energy intensities, among the countries analysed.

A key finding is the low VoLL of the domestic sector in Portugal, especially when compared with The Netherlands and Ireland. Since household consumption per capita is similar (Portugal – 1358, The Netherlands – 1487, Ireland – 1902, all figures in 2010 kWh/person; source: Eurostat), the explanation lays in the low average wage levels in Portugal, which lead to a lower valuation of leisure time.

4.2. Typical day variation

As seen in Table 2, the average VoLL for Portugal is 5.12 €/kWh. It is worth to give a further insight on its variation along a typical weekday or weekend, in winter and in summer. Since we do not know the value added by the economic sectors per day and hour, we cannot derive the temporal evolution of the VoLL per hour of the day. However, we can estimate the total hourly value by multiplying the average value of 1 kWh of electricity by the amount of electricity used. For this purpose, the average total VoLL (€/kWh) is multiplied by the electrical system average load curve (MW) (source: ERSE – Portuguese Energy Regulatory Authority) for each hour of each one of the above mentioned typical days. The obtained result is the value of lost load in each hour of the typical day and is showed in Figure 7.

Figure 7 - Hourly evolution of the total VoLL in a typical day; weekday / weekend; winter / summer.



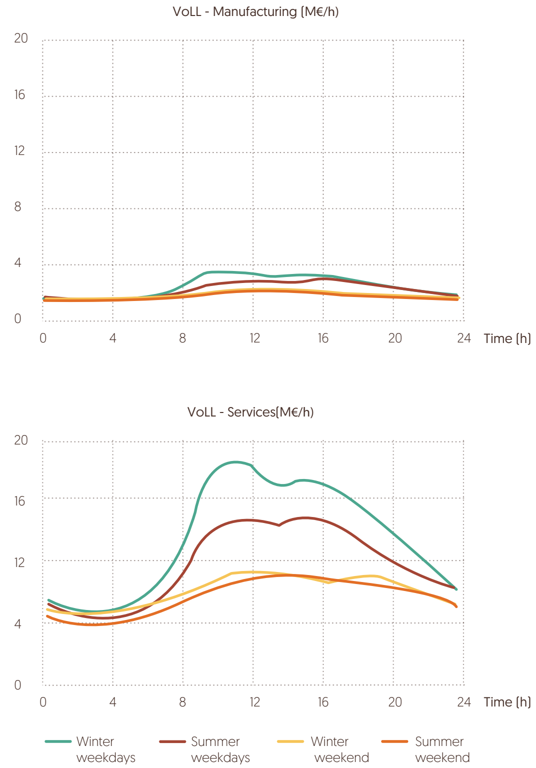
It can be observed that the maximum value of the lost load (more than 40 M€, at that particular hour) is reached in the weekdays by the dinner time at about 7–8 p.m., in the winter. This behaviour is partly explained by the operation of electrical heating systems. On the opposite, in the summer, the maximum VoLL (about 35 M€, by that hour) is in the afternoon of a weekday, due to the air conditioning systems.

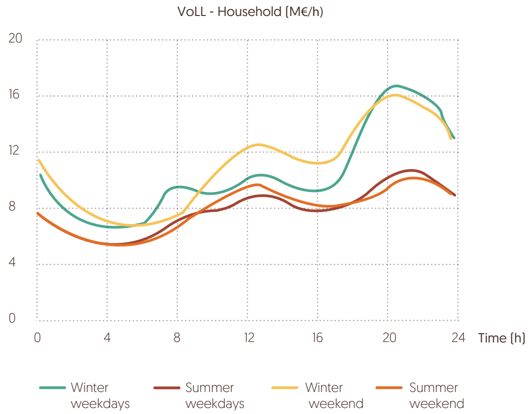
The three sectors that are more electricity intensive are: manufacturing (31.26%), services (30.92%) and household (28.69%). As so, it is justified to take a closer look at them, namely by inspecting the temporal variation of the specific sector VoLL, along one typical weekday and weekend, both in the winter and in the summer. The starting point is the typical daily load diagram (weekday / weekend; winter / summer) for each one of the three sectors, which were built based on the information provided by the Energy Regulator to assist the traders in buying electricity in the market. Then, the load value for each hour is multiplied by the specific sector VoLL shown in Table II, in order to obtain the total monetary quantity that is lost when the electricity is curtailed in that particular hour. The results are displayed in Figure 8 for the manufacturing, services and households. All three graphics are plotted in the same y-scale, so that the comparisons can be easier performed.

As it can be seen, the highest VoLL is reached in the household sector in a typical winter weekday, by 8 p.m. At this time, one hour without electricity is evaluated in near 16 M€. Both in the winter and in the summer, the services VoLL is higher than the household VoLL in the morning and in the afternoon, but not in the night time, as it could be anticipated. Moreover, for these two sectors, the VoLL in the winter is much higher than in the summer, due to the electricity consumption for heating purposes.

In what concerns the manufacturing sector VoLL, it is very much lower than the other two, because the value of the lost kWh is very low in the manufacturing sector (about 1.3 €/kWh against about 6–7 €/kWh in the other two). Due to the intrinsic characteristics of the manufacturing sector, its VoLL is fairly constant along the day and from winter to summer, but always below 4 M€/h.

Figure 8 - Hourly evolution of the sectorial VoLL in a typical day; weekday / weekend; winter / summer; top – manufacturing; middle – services; down – households.





Conclusions

Everyone thinks power supply security is of utmost importance, but there is no consensus about the value society gives on it. On one hand, the cost of the kWh not delivered cannot be approximated by the user price of electricity, because it does not include the marginal damages of supply interruptions. On the other hand, this value could be derived from the market, but the thing is that no market exists where power interruptions are traded. Therefore, the value of lost load (VoLL) must be determined using indirect methods. The knowledge of the VoLL is useful for investment decisions on the topic of network reliability, in a context of cost-benefit analysis. Planning decisions are made with a view to improve security of supply, but without knowing its real value, decisions are often based on past engineering practices and rules of thumb, as it is the case of Portugal.

Consumers' surveys asking them to monetise their willingness to accept electricity curtailments or their willingness to pay for not having those cut-offs are a methodology often used to derive the VoLL. Besides the known limitations of this method, related to its subjectivity, the thing is that these surveys have not so far been carried out in Portugal. As so, it was decided to use an alternative method, based on macroeconomic considerations, the so-called production function approach. So far, this methodology has been successfully applied in other EU countries to derive the VoLL. To the best knowledge of the authors, it is the first time that a scientific methodology is being applied to the Portuguese electrical system.

This approach gives the gross added-value per kWh of consumed electricity, which is roughly equal to the lost value in case of a power interruption. The damages are quantified in terms of lost production, for firms, and lost leisure time, for households. We assume that all activity stops when power fails, which is a generous assumption, but it is a known limitation of the method.

Using the production function approach, we found an average VoLL of 5.12 €/kWh. This average value hides some differences between economic activity sectors. For instance, the construction and public works VoLL is 15.52 €/kWh, whereas the manufacturing industries VoLL is 1.25 €/kWh. It is worth to be mentioned that the services and households VoLL is similar, the former being 6.67 €/kWh and the latest 7.43 €/kWh. All of these figures are in line with previous research on this topic, applied to other EU countries.

Also, an attempt to monetise the damages caused by a power failure along a typical weekday and weekend, in winter and summer, was made. For the overall electrical system, we found that the damage can be estimated in more than 40 M€, for a power interruption at about 7 to 8 p.m. in a winter weekday. Looking deeper in each of the most relevant economic activity sectors, the obtained results show that the worse damage occurs always on winter weekdays, but in different time frames. In the residential sector it happens at about 8 p.m. and the damage, at that particular hour, can be estimated in more than 16 M€. As far as the services sector is concerned, the worse situation occurs in the morning, at about 10 a.m. and the harm was found to be less than 16 M€, for that hour. For the manufacturing sector the damage is much smaller, due to the high electricity intensive nature of this sector.

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Disclaimer

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The "Smart Paradox": Stimulate the deployment of smart grids with effective regulatory instruments

Vitor Marques[1*], Nuno Bento[2], Paulo Moisés Costa[3]

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Abstract

The concept of SG (Smart Grids) encompasses a set of technologies that raise the intelligence of the electrical networks, such as smart meters or instruments of communication, sensing and auto-correction of networks. Nevertheless, the cost is still an important obstacle for

[1] Entidade Reguladora dos Serviços Energéticos - ERSE, Rua Dom Cristovão da Gama, Edifício Restelo, n.º1 – 3º andar, 1400-113 Lisboa, Portugal.
[*] Corresponding author. Tel.: (351) 21 30 33 224; Fax: (351) 21 30 33 201; Email: vmarques@erse.pt (Vítor Marques)
[2] DINÂMIA'CET, ISCTE - Instituto Universitário de Lisboa, Av. das Forças Armadas, Edifício ISCTE, Sala 2N19, 1649-026 Lisboa, Portugal
[3] Instituto Politécnico de Viseu, Escola Superior de Tecnologia e Gestão, Campus Politécnico de Repeses, 3500 Viseu, Portugal and "INESC TEC – INESC Technology and Science (formerly INESC Porto), Rua Dr. Roberto Frias, Porto, Portugal

the transformation of the current electricity system into a smarter one. Regulation can have an important role in setting up a favorable framework that fosters investments. However, the novelty with SG is the disembodied character of the technology, which may change the incentives of the regulated network companies to invest, affecting the effectiveness of the regulatory instruments ("cost plus" or "price cap"). This paper demonstrates that the solution to this "Smart" paradox requires strong incentive regulation mechanisms able to stimulate the adoption of SG technologies. Moreover, the regulation should not jeopardize conventional investments that are unable to be substituted by SG. Thus, a combination of performance regulation and efficiency obligations may be necessary.

Keywords

Technological Change - Economics of Regulation - Price-cap - Cost-plus - Smart Grids.

Introduction

The power system faces many challenges concerning growing demand, environmental constraints, efficiency requirements, connection of more decentralized generation, and security of supply [1]. SG (Smart grids) are particularly well-suited to address those challenges, promoting both decarbonization and competition in the electricity market. This new concept encompasses a set of technologies that raise the intelligence of the networks, such as smart meters at consumer level or instruments for the capture, transmission and storage of data, as well as control devices at the level of electrical networks [2]. However, costs are still an important barrier for the transformation of the current electricity system into a smarter system, despite the expected decline on such costs as a result of the technology deployment [3,4].

Regulation can have an important role to set up a favorable framework that fosters investments in SG. The regulator can apply different regulatory instruments (e.g., "cost plus" or "price-cap") to the investment costs and include them in the network access tariffs [5]. Theoretically a "cost plus" regulation would spur the deployment of innovations in the network by reducing uncertainties on its adoption [6]. However, the novelty of the investment on SG, comparing with the network investments of the past, is the more disembodied character of the technology, that provides a large spectrum of services with great scope for efficiency gains by relying heavily in software and other information and communication technologies [7]. This results in a lower regulatory asset base, changing the incentives of a regulated firm to invest as well as the effectiveness of each regulation instrument.

This paper assesses the impact resulting from the nature of the SG technologies on the regulation of investments in the networks. Conventional "cost plus" regulation has well-documented effects of overinvestment in physical investments (see Refs. [8 and 10]), but the same may not hold with more disembodied type of investments. firstly, the innovative features of SG are presented as well as the main factors that are likely to place constraints to the rhythm and direction of their diffusion. Secondly, it is presented the theoretical features of a simple regulatory model which deals with the problems of moral hazard and asymmetric information of the investment in innovations in the network. Thirdly, the practical issues with the implementation of this regulation are discussed and assessed through the approach that has been applied in a real context, in Portugal.

1. Why do we need to support smart grids?

The diffusion of SG has potential to address most of the economic and environmental challenges currently faced by the electricity sector, by performing a series of services across different levels of the power system. The aim of this section is to investigate the effect that the characteristics and benefits of SG have on the investments and on the speed of diffusion of such technology. A literature review on innovation and technological change is presented, followed by the investigation about the effect of the economic attributes and complexity of SG on their diffusion.

The literature identifies a set of key variables that constrain the speed of diffusion. Technological and innovation studies have revealed at least five important determinants of diffusion rate [11 and 13]: relative advantage; market scope; complexity; observability; and trialability. firstly, the perceived "relative advantage" depends particularly on the economic attributes of the innovation, namely concerning its performance (e.g., service quality), efficiency and costs. This anticipatory variable is related to the rate of diffusion in the sense that a good "perception" accelerates the penetration. Secondly, the market scope has an effect on the amount of resources needed (e.g., time, people, financial) to start diffusion. In fact, the progression should be slower (low diffusion rate) with those innovations that require a comparatively higher investment level. Thirdly, technology complexity is related to the interdependence with other technologies (e.g., hardware needing software in informatics) and the perception of the difficulty of use in a macrolevel, this would deal with institutional needs for technological change. The more the technology is complex the slower is its adoption. Fourthly, observability is a determinant of the speed of diffusion in the sense that a more visible technology has many opportunities to spread the information and to create positive externalities. finally, the possibility of experimenting and testing the technology (trialability) may increase adoption because consumers are more familiar with the innovation and know how to use it in a more efficient way [14]. All these factors are not static but rather co- evolve with the development of the innovation in the market [15].

Economic attributes are crucial for SG diffusion, the rate of which depends greatly on the relative advantage of the innovation against other competitive technologies [16]. The adoption would be faster with a larger relative advantage in terms of costs, efficiency and performance [11,13]. SG have multiple functionalities that explain their attractiveness, particularly concerning the reduction of the operational costs, the raise of the efficiency of generation and use of electricity, the support to renewable generation penetration, and the improvement of the quality of service [7]. Table 1 shows a detailed description of the potential benefits of SG.

Table 1 - Potential benefits of smart grids implementation [14,15]

Main area	Description
Economic	Optimized generator operation
	Deferred generation capacity investments
	Reduced ancillary service cost
	Reduced congestion cost
	Deferred network (transmission and distribution)
	Capacity investments
	Reduced equipment failures
	Reduced distribution equipment maintenance and
	operation cost
	Reduced meter reading cost
	Reduced electricity theft
	Reduced electricity losses
	Detection of anomalies relating to contracted power
	Reduced electricity cost
Reliability	Reduced major, sustained and momentary outages
	Reduced restoration cost
	Reduced sags and swells
	Reduced wide-scale blackouts
Environmental	Reduced CO_2 emissions
	Reduced SO_x, NO_x, and PM-10 emissions
	Reduced fossil fuels usage

The implementation of SG has benefits for different actors intervening in the power system. Moreover, the distribution of those benefits will influence the capacity of each actor to invest and assume a part of the costs [1,19]. Thus:

a. consumers benefit from an improved quality of supply and potential lower electricity bills due to the development of dynamic tariffs and demand response procedures [8]. As well, they may benefit from a better integration of microgeneration units, electric vehicles and storage devices;

b. network operators (namely DSO (distribution system operator)) may take advantages from a higher level of monitoring and automation of the networks, increasing the control over the system. This may allow a lower level of network losses and a better quality/reliability of supply (namely by the automation of network reconfiguration actions). Depending on the regulation in force, this may bring financial benefits to the network operators. Moreover, the information about consumer's behavior is a valuable resource in the process of setting investments. Note that the SG may postpone or even avoid some investment needs (by, for instance, developing demand response procedures, which tend to promote peak load transfer). Furthermore, the use of smart meters will reduce the costs related to meter reading;

c. the system operator may benefit from a more easy and less costly balance service;

d. electricity retailers could use the enhanced information about consumers' behavior as well as the demand response procedures to improve electricity purchase procedures and to avoid penalties related to imbalances;

e. generators may benefit from the ability to create virtual power plants consisting of a greater number of smaller units being able to act as a single entity with a more "discretized" generation capacity. This may contribute to improve the economic performance of the generating entities and to reduce the risks inherent to the investment on large capacity power plants;

f. regulator takes advantage from a better knowledge of demand to anticipate the need of investments in the infrastructure, as well as from the development of a stronger competition due to a more intense exchange of information between consumers and potential providers;

g. society benefits from a high quality service in terms of less frequent and shorter interruptions, as well as from the integration of a major quantity of endogenous and renewable energy sources in order to reduce the emission of pollutants and to decrease the energy dependence from the exterior.

Market surveys showed that distribution system operators (DSOs) have been playing a leading role in early projects [3]. They are expected to have a great importance in the roll-out together with consumers [20]. Both actors have important benefits with the deployment of SG, and their participation is needed because of the systemic nature of the innovation, i.e., the benefits with its implementation only come into play once the entire system is in place and actors participate actively in the new grid [18]. For instance, the investment in the grid is a prerequisite for demand behavioral change, namely concerning the adoption of a more active role in the management of energy or even becoming "prosumers", i.e., households that produce and commercialize energy [20].

Infrastructure needs are another important factor which constrains the rhythm of development of a new technological system. This point was very well documented in previous transitions in transport [21] or energy technologies [22]. SG concern the deployment of devices in millions of houses and the upgrade of an extensive electrical network. Therefore, the transformation of the entire system will take several years, if not decades. For instance there are already 40 million smart meters installed in Europe and estimates forecast 240 million more by 2020 [23 and 25]. Even though the challenge is not the same as the construction of the first electrical networks in the past, the need for a minimum of infrastructures is of a paramount importance for the development of services such as telemetering or demand response. Two situations must be separated here. On the one hand, the infrastructure part, concerning to the update of already installed equipment with new sensors, controllers or communication devices. In this case the implementation may be more rapid because it is a matter of upgrading (not even substitute in most cases) the existing technology with new "smart" components. On the other hand, the implementation of "smart grids" will need to create an information system that collects, stores and processes (securely) all the new data generated by the system. In this case, new software and other technologies are necessary which in some cases have not been developed yet. Therefore, there are still some technical and market uncertainties surrounding those innovations, what can slow the rhythm of diffusion.

In short, the speed of adoption of SG is likely to be affected by the size of the technological change, the complexity of the innovation, and the infrastructure needs. Thus, the economic benefits should be high enough to accelerate the implementation, bearing in mind that the costs are currently high and the technology will only mature with deployment. However, the implementation of SG is crucial to make possible the increase of intermittent and distributed generation and the connection of millions of electric vehicles with very variable loads. There are clearly externalities and public benefits with the investment in SG that may not be possible to grasp without some kind of external support, which compensate for positive spillovers for the electricity system and not only for a particular stakeholder [26].

2. Effective support to smart grids without creating economical rents

The following analysis assumes that the regulator is not in charge of public policy and so it can only support SG on the basis of the expected efficiency gains in the future. Furthermore, it is implicit that the regulator ensures that its decisions provoke minimal distortions in the economy, particularly by minimizing the creation of rents.

2.1. The "adverse selection" and the "moral hazard problem": a review of regulatory approaches and instruments

In order to understand how the regulation of the networks may influence SG investment one has to realize the main features of the regulatory issue. Natural monopolies, like electricity distribution and transmission activities, are characterized by decreasing long run marginal costs, justifying their need to be regulated. However, the regulation of natural monopolies is a challenging issue for regulatory authorities due to the asymmetric information problem.

In the principal-agent theoretical framework, this challenge can be divided into two main concerns: the "adverse selection" and the "hazard problem". If we focused on the cost issue, the first concern would be related to the lack of information by regulators about the firm cost function and to the economical rent, whereas the second concern would be related to the manager effort to decrease firms' cost level [27]. To overtake the "adverse selection" situation, the regulator applies a "cost plus" regulation, based on the regular ex- post firms' costs analyses and on their profits limitation. However, this can limit the effort of firms' manager for controlling costs, leading to economical inefficiencies. This is a moral hazard problem, which can be overtaken by the regulators through an incentive based regulation approach [5,28,29]. Under "pure" incentive regulation, the price level is fixed by the regulator and it is not reviewed [30]. The firm has an incentive to reduce its costs, but it keeps all the welfare gains due to cost reductions. As the regulator is unaware of the true cost level of the firm, a higher price level may be defined. This is the main drawback of this regulatory methodology, since it can produce monopolistic rents [31]. Thus, pure incentive regulation and cost plus regulation are partial approaches that cannot by themselves solve the lack of information issue. Therefore hybrid methodologies have been adopted trying to consider both the adverse selection and the hazard problem concerns [27,29]. For example, variants of the pure incentive regulation methodology with temporary price review and productivity targets have been applied since 1984 [32], namely for regulating the electricity distribution network [see Refs. [33,34]].

Since the eighties, variants of pure incentive regulation have been widespread in parallel with the liberalization of utilities in most western countries. Most of the time, those methodologies are labeled as price cap or revenue cap methodologies. Actually, the main differences between price cap and cost plus regulation schemes are related to the maximum lag between the price review and the minimum set of cost elements that determines the price review (see Refs. [6,35]). The impact of this price review on the choice of suboptimal strategies by the regulated firm has been broadly analyzed (see Ref. [36] about the ratchet effect in general terms, or [37,38] for regulatory context). Once those conditions are relaxed, it is quite difficult to define the boundaries between these two types of regulatory methodologies (see Refs. [39,40]). As will be argued in the next section, these factors play a major role in the investment strategies that are followed by regulated firms.

Eq. (1) illustrates how the different regulated methodologies are related.

$$P_{t+i} = E_t\left(\frac{\hat{R}_{t+i}}{\hat{Q}_{t+i}}\right) = \frac{C_t^{A_{t+i}*r + \hat{D}_{t+i} + \hat{O}_{t+i}} - X + \left[(C_{t+i} - C_{t-i}^{t})(1 + r_A)^{2i}\right]}{C_t^{(\hat{Q}_{t+i})}} = \frac{E_t^{Capex + Opex} - X + Ad_{t+i}}{E_t^{(\hat{Q}_{t+i})}} \quad (1)$$

where:

E_t is the expected value for period t.

i is the number of years between each regulatory review for price setting[4]

R_{t+i} is the expected regulatory revenue in period t + i.

A_{t+i} is the expected RAB (regulatory asset base) in period t + i, which includes the actual net asset value plus the expected investments in period t + i of the regulated activities. The actual net asset value can be based on historical costs (account value) or on substitution costs (market value).

D_{t+i} is the expected firm capital depreciation in period t + i.

O_{t+i} is the expected operating cost in period t + i

[4] Most of the time i is equal to 1.

r is the rate of return of the regulatory asset base, which has to be equal to the cost of capital of the regulated activity, since this is the minimum rate of return necessary to attract capital for investments in the sector [37].

P_{t+i} is the price level settled for period t + i.

$\hat{Q}_{t+i}$ are the expected quantities sold in period t + i.

X is the incentive factor[5].

C_{t-i} are the amount of costs allowed to be recovered that occurred in t - i.

C^{t}_{t-1} are the costs recovered through the regulated incomes in t - i.

r_A is the interest rate considered by the regulator to adjust the allowed revenues[6].

Ad_{t-i} is the adjustment to the t - i regulatory revenue, i.e., the difference between the amount of costs occurred in period t - i that are allowed to be recovered and the revenues obtained in period t - i.

Prices are settled in period *t* for period *t + i* based on the expected regulated revenue and quantities to be sold in period *t + i*. Beyond the expected Opex and Capex, the regulated revenue includes an incentive factor and an adjustment factor. The latter corresponds to the difference between the firm costs that occurred in period *t - i* allowed to be recovered and the costs that have been recovered through the regulated incomes of the period *t - i*. The factors *X* and Ad_{t-i} explain the difference between the incentive regulation and the cost plus regulation.

The magnitude of the difference between the pure incentive regulation and the pure cost regulation can be defined by the variable **β**, as follows:

$$\boldsymbol{\beta} = \frac{Ad_{t-i}}{C_{t-i} - E_{t-2i}^{\hat{R}_{t+i}} * (1 + r)^{2i}} \quad \text{and } \boldsymbol{\beta} = \in [0;1] \qquad (2)$$

[5] Which can be related to technical efficiency targets as for a typical price cap regulation or to include other targets namely related to quality of supply [41] what is close to the performance base regulation [5,42].

[6] Theoretically this interest rate should be equal to the firm's cost of capital. However, when most of costs are adjusted, this adjustment is similar to a pay-off with no systematic risk associated.

where:

C_{t-i} is the firm's costs occurred in the t - i period.

$E_{t-2i}^{\hat{R}_{t-i}}$ is the expected firm's regulated revenues foreseen in the t - 2i period for the t - i period, without any adjustment for costs recovery related to the period before t - i.

r is the firm's cost of capital.

There is a continuous relation between the pure incentive regulation and the cost plus regulation. If β equals to 1 all cost variation are transferred to the consumers through the regulated prices. That is a typical cost plus regulation. If β equals 0, costs variation are not transferred to the consumers through prices. The gain and the lost due to the cost evolution are borne by firms. Therefore, the regulatory methodology is not risk neutral for the regulated firms. Consequently the firms' investment choice will be influenced by the regulatory framework.

2.2. The impact of the regulatory approach on investment decisions

The regulatory framework can influence investment decisions in completely different directions in what concerns the type and the level of investment. Since the paper published by Harvey Averch and Leland Johnson in 1962 [10], it is known that the typical cost plus regulation leads regulated firm to overinvest, in the sense that the firm's investment decision is not motivated by its long run marginal cost, but rather by the allowed return on investment. Moreover, it has also been demonstrated that pure incentive regulation promotes investments leading to cost reduction [6,43]. The SG investment can be framed in this category of investments.

In Ref. [6], Guthrie analyzed the impact of regulatory schemes on the firm's decision to make irreversible investments that can decrease OPEX. The choice between pure cost plus and pure incentive regulation is explained by the proportion γ of the investment expenditure that is accrued on the firm's RAB after the next price review, T, and to the proportion α of the cost savings that is transferred to consumers after T. Guthrie also related those variables and the type of regulatory scheme. Thus, when γ = α = 0 the regulatory scheme is a pure incentive regulation approach and when γ = α = 1 the regulatory scheme is a pure cost of service regulation. This kind of investment is quite similar to an SG investment type. The author concluded that a firm will not invest in a "socially optimal cost reducing project” if $\alpha > \gamma$. In the present case, a regulatory scheme that mixed an incentive type regulation on the OPEX and a cost plus type regulation on the CAPEX would promote this type of investment.

This analytical framework can be used to define a regulatory scheme that raises the interest of regulated companies in developing SG, taking into account the impact on OPEX and CAPEX.

The present value of an investment of this kind, when the first price review has occurred in period *T* is:

$$- I_{SG} + \sum_{t=1}^{T} \frac{\Delta C}{(1+r)^t} + \sum_{t=1}^{T} \frac{\Delta I_C}{(1+r)^t} ++ \sum_{t=T+1}^{\infty} \frac{r\gamma(I_{SG} - \Delta I_C) + (1 - \alpha)\Delta C}{(1+r)^t}$$

$$= - I_{SG} + \frac{\Delta C}{r} + \left(1 - \frac{\alpha}{(1+r)^T}\right) + \frac{\Delta I_C}{r} + \left(1 - \frac{1}{(1+r)^T}\right) + \frac{\gamma}{(1+r)^T} + (I_{SG} - \Delta I_c) \quad (3)$$

where:

T is the next time review period.

α is the is the proportion of the cost savings that is transferred to consumers after T .

γ is the proportion of the investment expenditure that is accrued on the firm’s RAB after T.

ΔC is the cost decrease.

I is the cost expenditure.

r is the firm’s cost of capital.

I_{SG} is the amount invested in SG technology

ΔI_c is the reduction of conventional investment due to the SG investment.

In the present case, a firm will invest when:

$$\Delta C + \Delta I_C + \left(\frac{r\gamma(I_{SG} - \Delta I_C) + (1 - \alpha)\Delta C}{(1+r)^t} \right) \geq rI_{SG} \qquad (4)$$

The firm's motivation to invest is directly proportional to i) the reduction of operating costs, ΔC, and since $[r\gamma(I_{SG} - \Delta I_C) + (1 - \alpha)\Delta C]/(1 + r)^t]$ is probably minus than 0[7]; to ii), the period until the next price review, T. On the contrary, the firm's motivation to invest is inversely proportional to: i) the share of costs saving that are transferred to consumers, α; ii) the cost of capital, *r*. For *r*, this conclusion is due to the fact that the proportion of investment transferred to the RAB, *r*, is lesser or equal than 1 and *T* is greater or equal than 1.

The impact of ΔI_C on the investment decision is not straightforward, rather depends on whether the reduction on conventional investments is greater or smaller than the SG investment.

Considering $\Delta I_c \leq I_{SG}$, the firm motivation to invest increases with γ. Conversely, if $\Delta I_c > I_{SG}$ the firm's willingness to invest decreases with γ. In practice, the latter situation is likely to happen since the investment avoided in "copper and iron" may be larger than the expenditure in getting the electric networks more "intelligent". This leads to our proposition:

Proposition. A pure incentive regulation applied in CAPEX and OPEX, where $\alpha = \gamma = 0$, is the best regulatory scheme to promote SG investments, whenever they avoid expensive conventional investments.

In addition, eq. (4) can be transformed into three different formulas according to the types of regulatory schemes: i) cost plus; ii) price cap; and iii) hybrid regulation.

Situation 1: Under a pure cost plus regulation, it is assumed an extreme instantaneous review process (T = 0) that increases the RAB of the regulated firm in the amount corresponding to all investments made as well as transfers all operational gains to consumers: $\alpha = \gamma = 1$. In this case, eq. (4) can be re-written as following:

$$\Delta I_c \leq 0 \qquad (5)$$

Therefore the firm will invest in SG if, and only if, that decision is unlikely to lead to a

[7] Whether $(I_{SG} \leq \Delta I_c) + (\Delta C + \Delta I_c)/ r\gamma$

diminution in the conventional investments. That is understandable because the company doesn't want to reduce its RAB.

Situation 2: Under a pure price cap regulation, the assumptions are: $T = +\infty$; $\alpha = \gamma = 0$. Therefore,

$$\frac{\Delta C + \Delta I_C}{r} - I_{SG} \geq 0 \qquad [6]$$

The firm would only invest in SG if the perpetual rent of the avoided costs (first part of eq. (6)) is larger than the initial investment. That is similar to the expected behavior of any company in a deregulated market.

Situation 3: Hybrid regulation in which the regulator applies a price cap on OPEX to keep the operational gains within the firm ($\alpha = 0$) and a cost plus on CAPEX to promote the investment in new technologies ($\gamma = 1$). In addition, it is assumed an instantaneous price review (T = 0). Then,

$$r\Delta I_c \leq \Delta C \qquad [7]$$

The firm has an incentive to invest in SG if the reductions in OPEX are larger than the decrease in CAPEX. In this case the SG will be implemented whether that brings great productivity gains or the cost of capital is low.

Situation 3': finally, the hybrid regulation with no review ($T = +\infty$) has an equivalent solution to situation 2 of a pure price cap regulation.

2.3. The "smart grid incentive paradox"

It is generally agreed that cost plus regulation promotes investments in the network, so as the investor is sure to recover its money and gains are directly proportional to the amount invested. However, the nature of investments may be such that it breaks the relation between gains and scale, namely by avoiding the need to overinvest, as it is the case of SG. The implementation of sensors and controls in the electric networks may solve most of the foreseen problems in the grid with relatively low physical investments in the near future. However, the system operator may prefer to invest in conventional network assets, which can raise its regulated revenues in the future.

The effect of the nature of investments on decisions has to be considered whenever the regulatory scheme is designed. Eq. (4) shows that the impact of regulatory instruments on investments depends on technology characteristics. Therefore, the regulatory scheme has to be adapted taking into consideration the SG effects on firm's CAPEX and OPEX, i.e., less need of capital investment and improved operational efficiency. The more SG decrease costs, the more incentive regulation is effective on promoting "smart" technologies, and the less cost plus regulation is effective. In this situation, we are in front of what can be called the "smart grid incentive paradox".

3. The new regulatory model in practice

In this section we discuss about practical issues that may be raised with the implementation of an incentive regulation to promote SG. Then, the theoretical model is compared to the regulatory model that was applied in a real case, in Portugal.

3.1. Dealing with the paradox: uncertainties on technology and on investor response may lead regulators to prefer a mixture of approaches

As suggested above, the type of investments on SG requires a regulatory scheme different from the conventional approaches (see Refs.: [6]8, [44,45]]). The promotion of SG only based on a strong incentive regulation leads to two main problems. firstly, the "adverse selection" issue becomes crucial as the firm may retain most of the rent. Secondly, this regulatory option can jeopardize conventional investment that is unable to be substituted by SG [5]. Therefore, the regulators may have to take additional measures to ensure that: i) investments are made in a timely and efficient manner; ii) the quality of service is not affected by the incentive regulation[9].

In a context marked by several uncertainties on technology and on investor response, the regulator may prefer a hybrid approach composed of a mixture of instruments, instead of a simple incentive regulation which is more unpredictable. In particular, three possible

[8] In that case for CAPEX

[9] It was shown above that an incentive regulation can raise the efficiency of the regulated firm, but it can also push the company to further cut costs and investments which undermine the quality of the service. In a study for utilities in the US in the 1990s, it was shown that a move towards price-cap regulation resulted in a significantly longer duration of service outages [54].

measures are suggested that can help the regulator to implement a more favorable framework for the deployment of SG:

- by enhancing quality standards of electricity supplies - performance-based regulation [see Refs.: [29,55]] - through greater incentives and penalties, in a process of gradual increase of the quality targets in order to create a more challenging benchmark for network operators[10];
- by taking advantage of declared SG efficiency gains to revise the price cap and limit the perception of rents by the regulated firm later on; and
- by differentiating the remuneration applied to SG and to conventional assets, or the implementation of a cost plus regulation differentiated by type of technologies. In this case, the SG investment may receive a risk premium to mitigate unwished effects of this regulation in the investment in cost saving technologies, as well as accounting for technological uncertainties.

The last two measures are practical alternatives to the incentive regulation in case it reveals problems to deal with the formation of rents or to induce timely investments on the physical parts of the network. The first measure can complement all types of regulatory instruments.

In particular, the premium/penalty mechanism should be appropriately set, namely concerning the targets to be achieved, in order to be effective in promoting the innovation diffusion. This is essential to preserve the quality of the service in a context of increasing demand and connection of more intermittent and decentralized generation. In the past, the investments have been mainly concentrated in increasing the amount of “copper and iron”. However, the design of more “intelligent” networks is an interesting approach to be followed by system operators to improve reliability, while minimizing capital and operational costs in comparison with a more physical “copper and iron” type of investments [17]. Therefore the incentives for the implementation of new “smart” technologies in the network will depend greatly on the performance criteria adopted by the regulation.

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[10] The reliability of electric networks has become crucial due to the increase of systems and devices that are strongly dependent on electricity, raising customer’s requirements for quality of the service. Several studies have evaluated the costs of customer outages, mainly based on customer surveys and simulation procedures [46,48]. Typical values of the cost of energy not delivered in some countries can be found in Refs [49,50] where the following range of values are presented: Residential - 0,98-16,4 €/kWh; Agricultural - 1.83-15 €/kWh; Commercial – 2 - 124 €/kWh; Industrial - 0.3-56 €/kWh; Public - 1.59-80 €/kWh. Despite the significant variation in the costs, they are significantly higher than the lost revenue faced by network operators with the non-delivered energy. Therefore, the regulation of electrical systems often measures the performance of the regulated firms and includes incentive mechanisms intended to improve the quality of service, namely concerning the continuity of supply, seeking a reduction of the costs for consumers that result from outage situations [5,42,51]

3.2. The incentive scheme adopted in Portugal

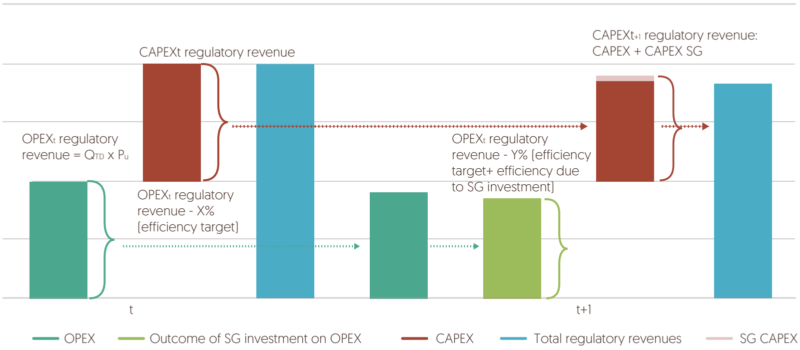
The regulatory framework presented in the previous sections is now assessed by comparing with the approach adopted in Portugal to stimulate the deployment of SG, which has been applied since2012.

The Portuguese regulation brings together two main features [52,53]: i) a cost plus regulation applied on CAPEX, with investments on SG benefiting of higher remuneration than conventional investments; and ii) an incentive regulation applied on OPEX, where the efficiency target rises with the penetration of SG. The "premium" of 1.5% was estimated in order to improve efficiency in the allocation of resources while avoiding any distributional distortions. In particular, it considers the efficiency gains in terms of physical investment avoided by the implementation of SG (figure 1).

The expected benefits resulting from the implementation of these innovations in the networks are compared to the greater risk that the investor has to hold with the adoption of an immature technology, which is in the early years of diffusion. In that sense, the additional risk is compensated by differentiating the capital expenditure in such investments relatively to the capital costs in conventional investments in the distribution network. However, this discrimination is likely to be limited in time in order to stimulate early deployments of the "smart" technologies.

The initial increase in the value of CAPEX, as a result of the implementation of SG, is coupled with an expected decrease in the value of OPEX, which raises the fear of rationed investments in the physical network that may lead to a lower quality of the service in the future. Hence, on the one hand, the return on assets associated with innovative investments is higher compared to other investments, but, on the other hand, the target efficiency required to OPEX in SG is also more important. In this way the regulator searches to ensure that conventional investments, which are unable to be substituted by SG, are made without being affected by the promotion of those innovations.

Figure 1 - The incentive scheme for smart grids investment in Portugal



Considering the uncertainties and benefits that are still characterizing the implementation of SG, the regulatory approach followed in Portugal features has the advantage of sharing the risk between different actors (for instance, the distribution system operator and final consumers). However, the efficacy of this approach remains uncertain. firstly, SG innovations and concepts are still immature. Even though progresses have been made in the diffusion of smart meters in several countries, the level of implementation in the distribution network (a key component for SG) remains far from the initially predicted [18,23]. Secondly, the adverse conjuncture context, which started as a budget deficit crisis that became an important economic crisis, has led to the reduction of investments in the economy. Hence the more difficult financing conditions may explain the slow progress in SG penetration, though it is not discarded that in a context of less restrained capital availability SG would still be unattractive in relation to other more profitable investments. Thirdly, the disembodied nature of the SG technologies may not be suitable for a cost plus type of regulation because of strategic behavior of the regulated firm, who may prefer to invest in conventional assets in order to ensure a higher level of regulated revenues for the future ("smart grids paradox", see Section 2.3.). If that is the case, there is an interesting challenge to the regulation community in the coming years to improve the regulatory instruments in order make them more effective in the promotion of (capital) cost saving innovations such as SG.

Conclusions

The cost-plus regulation is generally used to stimulate investments in networks and technologies because it transfers a part of the risk from the investor to the society. In the past such regulation showed very effective in the early phase of electrification. The implementation of SG promises to offer new services to the users of the system; however in the medium term it will substitute the need for heavier, though lower risk, investments in the network, which would otherwise increase the revenues of the regulated firm. This explains why a cost plus framework may not spur investment in a technology that is less capital intensive and able to save operational costs, such as SG. Conversely, an incentive regulation allowing the investor to keep a part of the gains with cost reductions may prove more effective to prompt the investment in SG. Nonetheless, this approach has generally two main drawbacks: economic rents and a deterioration of the service. On the one hand, the level of efficiency requirements imposed to the regulated firm can reinforce the regulator willingness to support SG, with the minimization of any redistribution distortion. On the other hand, the quality of the service can be ensured by a better redefinition of the performance standards in order to lead the regulated firm to take investment decisions without deteriorating the service. These two elements (efficiency obligations and performance regulation) may be the key for the creation of a favorable regulatory context for the deployment of SG, and their role in the adoption of innovations in networks should be more studied in future researches.

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What Drives Efficiency on the Portuguese Gas Distribution?

Vitor Marques[1], Paula Almeida[2], Mónica Cunha[3], Marco Paço[4], Marta Rocha[5], Artur Trindade[6]

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Abstract

With a history of less than two decades, the Portuguese natural gas sector is still growing. Consequently, the impact of regulatory reform is evidently recent. The aim of this paper is to assess the performance of the Portuguese gas distributors in order to define the efficiency targets for the regulatory period, 2010-2013. It also conducted further analysis in order to determine the best level of attainable operating costs by determining the major costs drivers. Therefore, the focus was on the deterministic frontier method, Data Envelopment Analysis (DEA) accounting for variable returns to scale (VRS). This technique allowed the computation of X-factors for each firm. The study suffered from data problems since the sector is very recent and the set of comparable companies is small. In order to avoid misspecifications or misinterpretations, firms were divided into three main groups with different scale factors and exogenous factors were also considered. The cross-section analysis was crossed with a dynamic one using panel data methodology.

[1] ERSE, email vmarques@erse.pt
[2] REN, email: paula.almeida@ren.pt
[3] ERSE, email: mcunha@erse.pt
[4] ERSE, email: mpaco@erse.pt
[5] Nova School of Business and Economics in Portugal, email: martaproenca@gmail.com
[6] ERSE, email: atrindade@erse.pt

Keywords

Econometrics - Industrial Economics - Gas Industry - Cost Function - Optimization Method.

1. Introduction

An efficient allocation of resources is associated with the theoretical concept of perfect competition. However, resources are often allocated in combinations that are socially suboptimal, that coupled with highly concentrated markets result considerable inefficiencies in production. The measurement of efficiency is not only important to the economic theorist but also for the economic policy maker [1]. Consequently, efficiency analysis has played a relevant role in regulating network industries, particularly electricity and natural gas [2]. Natural gas sector is a network industry where particular segments, such as distribution and transport, are considered to be natural monopolies, meaning that the cost function of the firm is subadditive over the relevant output range [3]. The presence of asymmetric information boosts further potential inefficiencies. The answer of this problem has been regulation through prices, network access and service quality [4].

As liberalisation and competition are introduced in the gas market, specifically in the segments of generation and supply, incentive based schemes have been increasing in the number of countries for regulation of the subadditive segments. The incentive regulation proposed by [5] has been giving higher evidences of inducing efficiency than the traditional rate-of- return regulation [6]. The incentive regulation attempts to provide enough incentives to firms in minimizing costs and improving efficiency. There are several categories of incentive based schemes which are generally based on benchmarking. This technique compares a certain measure of actual company's efficiency level against a reference performance in order to identify the most efficient production frontier [7]. From a regulatory point of view, "benchmarking is used to infer the level of attainable costs and in setting the X-factors for periodic price reviews" [8]. However, the youth and peculiarities of the Portuguese gas sector make difficult the application of any benchmark.

The Portuguese natural gas sector is growing, with a history of less than two decades. Consequently, the impact of regulatory reform is evidently recent. Only by the end of the first regulatory period, in 2009, it was possible to analyze the sector by distinguishing the potential efficiency gains of the gas distributors and ultimately implement an incentive based regulation.

The aim of this paper is to assess the performance of the Portuguese gas distributors in order to define the efficiency targets for the regulatory period, 2010-2013. We focus on the deterministic frontier method, Data Envelopment Analysis (DEA). This is mainly due to Portuguese particularities, namely the low number of observations and the existence of highly differences among companies. Indeed, the data available refers to a very short period, 2008 and 2009, because distribution and supply were still bundled in 2007. Additionally, it is difficult to compare Portuguese gas distributors for several reasons one being the different maturities of each firm. Some companies began their activity before 1997 whereas others began only in 2007. This paper also addresses an analysis of the main inputs, outputs, cost drivers of the gas distributors and exogenous factors. Notice that the present study is the first efficiency analysis of the Portuguese gas distributors to date. The computation of a benchmarking analysis has been undertaken to set the X- factors needed in price-cap regulation as an incentive mechanism that rewards or punishes companies [9]. Such an analysis when implemented to the companies has major consequences to the various economic agents. Therefore, the results should not be carried out in a mechanical way but rather as a fundamental instrument and general sector knowledge for the regulator decision-making [10]. In the present case, this recommendation has special relevance since the sector is recent and the set of comparable companies is small, resulting in a small sample. Additionally, the sector is so recent that hardly is comparable with other countries. These aspects lead to data problems and so a direct application of the DEA results could lead to misspecifications and misinterpretations. Therefore, the X-factors given by DEA have not been applied directly to firms but rather by groups of firms. Dimension, population density of the area and maturity of each firm have also been considered. Since firms are different from each other especially in terms of fixed and variable costs, it has been undertaken a dynamic analysis in order to infer the percentage of fixed and variable costs applicable in each case. The rest of the paper proceeds as follows: Section 2 provides information on the regulatory regime for Portuguese gas distributors and the main characteristics of the various companies in the distribution of gas. *Section 3* presents a brief literature review. Section 4 describes the main frontier method applied in order to measure the performance of the gas distributors. Section 5 presents the data used and the estimation results. Section 6 provides some regulatory implications. The main conclusions are summarized on Section 7.

2. Regulation of Gas Distribution

Over the last years, incentive regulation and benchmarking analysis have become widely used in regulation of public utilities. Since the discovery of the Averch-Johnson effect [11], rate-of-return regulation has been commonly criticized hence the increased use of incentive based regulation.

The major types of incentive regulation have been price caps (or revenues caps), profit sharing, yardstick regulation, banded rate-of-return regulation and menus. However, price caps have become the incentive regulation mechanism mostly adopted by regulators. The price cap mechanism operates for a pre-established time period [4]. This period corresponds to three years in Portugal electricity and natural gas regulation. At the end of this date, a new starting price and a new X-factor are defined after another cost analysis and firms' performance review. This mechanism allows the combination of two characteristics: incentives for cost reductions as well freedom and incentives for price rebalancing [12].

Natural gas reforms focus on the introduction of competition in generation and supply whereas distribution and transport have been less affected due to their natural monopoly nature. Several regimes have been applied to gas distribution but the main one due to its potential benefits has been incentive regulation.

Portuguese natural gas distribution was initiated on 1997 with 5 companies mainly on coastline region. Until 2006, the gas sector was organized as a vertical integrated monopoly, without switching possibilities. The Decree Law nº140/2006, on July, 26th, modified the industry structure by establishing unbundling on the gas market. By the end of 2006, the ownership unbundling occurred with the separation of the transport segment from the vertically integrated firm. The same Decree Law established a few points related to the market opening. Since January 2010, the market opening embraced all clients.

Legal unbundling between the distribution and supply activities occurred on the beginning of 2008. Furthermore, in 2008, few distributors were still on their introduction life cycle phase or in their growth phase while others firms were already expanding maturity. This reality led to several problems related to data: the sample is relatively small and firms are not readily comparable with each other. These facts allied with the liberalisation process, had conditioned the X-factors setting.

A. Main features of the Portuguese gas distribution

In 2008, the Portuguese gas distribution was provided by 6 concession companies (Beiragás, Lisboagás, Lusitaniagás, Portgás, Setgás and Tagusgás) and 5 "licensed"[7] companies (Dianagás, Duriensegás, Medigás, Paxgás and Sonorgás). The concession ones generally have a higher maturity than the licensed ones. The four biggest distributors (Lisboagás, Lusitaniagás, Portgás and Setgás) held, in 2008, a market share of 90.8% regarding the number of customers[8] and 92.8% related to delivered gas. From the 11 distributors, 8 of them belong to the GALP Group (Beiragás, Setgás, Dianagás, Lusitaniagás, Medigás, Duriensegás and Paxgás); 1 belongs to the EDP Group (Portgás); 1 to the Lena Group (Tagusgás) and 1 to the Dourogás Group (Sonorgás).

Portuguese gas distribution is especially recent. However, it was on the first six years (1997-2002) that the main investments were made. From this date on, the investments are essentially directed to the secondary network. The gas distribution network in Portugal increased from 2 759 km in 1997 to 15 597 km in 2007.

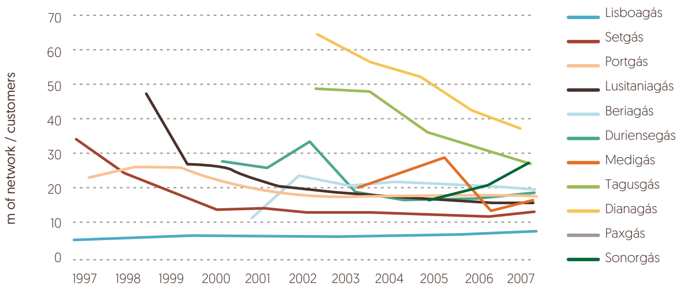
Distribution of natural gas is already present in 93% of the continental Portuguese population and 65% of national territory. Nevertheless, there is only 1 million (roundly) gas consumers in Portugal where almost half has its gas distributed by Lisboagás. Between 1997 and 2007, the average annual growth rate of the volume of gas sales was around 24%. In 2007, the total gas sales by the licensed distributors represented less than 5%. When considering Portgás, Lisboagás and Lusitaniagás, these three companies represented 80% of the total sales in 2007. Regarding the number of clients, the number exceeded 1 million in 2007. Between 1997 and 2007, the average annual growth rate was roundly 15%. Though, this tendency has been suffering a reversal in the last few years.

Since 2001, the number of employees in Portuguese gas distributors is quite stable, approximately 600 employees. Most companies, instead of recruiting have been responding to their needs through outsourcing. This management option set problems when choosing the variables in a benchmarking analysis. When firms outsourced, they do not have to use their physical resources, being the costs registered on the External Supplies and Services accounting line. Thus in the present case, physical measures of cost should not be used when evaluating potential efficiency gains.

[7] License is a legal term for a concession of a smaller area and for a shorter period of time.
[8] Notice that until 2007 this number regards to the customers, after this date it regards to supply points.

Figure 2 shows the relation between the length of the network built versus the number of customers, i.e., the network saturation. We may conclude that the network has been built accordingly to supply foreseen new customers.

Figure 2 - Network Saturation, 1997-2007



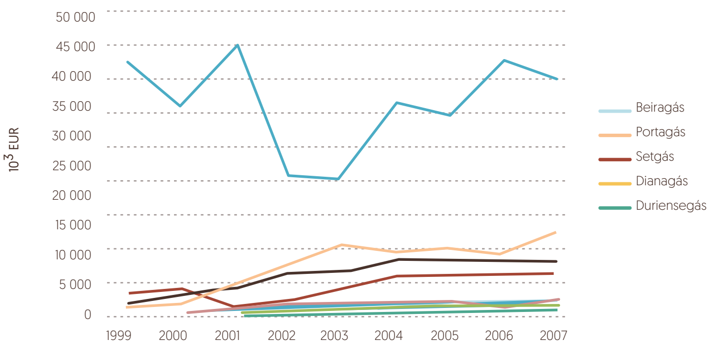
The next figure shows the net operating expenses evolution (excluding amortizations). These are computed as follows:

» (+) Operating expenses: External supplies and services, Employee costs, Interest, Provisions, Adjustments and Other operating expenses.

» (-) Operating income: Sales, services rendered and other operating income.

As referred above, distribution and supply were bundled until 2007. Therefore, the data related to OPEX costs over the period 1999-2007 concerns both activities.

Figure 3 - Net operating expenses, 1999-2007



B. Measuring Efficiency

Reference [1] demonstrated empirically that economic efficiency can be decomposed into allocative efficiency and technical efficiency. The former refers to the ability of combining inputs and outputs in optimal proportions given its prices. While technical efficiency refers to the ability of producing a given output with the least amount of inputs [13]. Economic efficiency occurs when both allocative and technical efficiency are achieved. According to [1] (p. 253), it is crucial to "know how far a given industry can be expected to increase its output by simple increasing its efficiency, without absorbing further resources".

There are several benchmarking methods that provide an efficiency analysis. The most accessible and easy application is the partial productivity measure. However, this method involves some drawbacks and limitations. Unlike partial ratios methodology, most of the remaining methodologies seek to measure the distance, in terms of efficiency, between the analyzed companies performances and the efficient production (or cost) functions. Therefore, the choice for empirical techniques that measure the efficient frontier, such as DEA, Stochastic Frontier Analysis (SFA), OLS, Corrected OLS (COLS) or Modified OLS (MOLS), is more appealing. According to [10], the employment of several measures of efficiency reduces the risk of misinterpretations due to omitted variables or/and other potential issues. Consequently, in this section, partial ratios and a correlation analysis will be undertaken, whereas the empirical techniques will be left for the following sections.

Partial productivity measures correlate outputs and inputs. This method allows measuring efficiency in a broader way since it does not require any cost function determination or any specific relationship between inputs and outputs. The next table shows an application of these measures to the Portuguese gas distributors regarding the performance of each distributor. The performance indicators relate the operating costs (OPEX) with several outputs present in the distribution activity, as network length, volume of gas delivered and number of customers. The partial ratios reported in Table I provide some insights on the relative performance. Lusitaniagás, Portgás and Setgás present the most efficient results when compared to the rest of the distributors. However, for the others distributors, conclusions are harder to make. Therefore, partial ratios can be highly informative on the extremes but less accurate on the average.

Notice that there is a significant distinction between the licensed and the concession companies on the operating costs. This potential difference might be explained by relative economies of scale.

Table I - Performance Indicators, 2008

	Net operating Costs	Operating Costs per unit delivered	Operating Costs per km of network	Operating costs per customer
	EUR	€\1000 m3	€\km	€\no
Beiragás	2 865 957	61	4 477	80
Dianagás	584 557	107	4 912	161
Duriensegás	2 075 970	151	4 978	112
Portgás	8 999 511	18	2 975	47
Lisboagás	27 544 808	54	6 912	58
Lusitaniagás	8 095 169	12	2 842	48
Medigás	512 420	85	2 847	46
Paxgás	273 893	2 513	10 956	408
Setgás	5 641 447	38	3 414	42
Sonorgás	1 777 272	333	8 886	257
Tagusgás	3 385 245	52	4 942	159
Total	**61 756 249**			

Source: Natural gas distributors

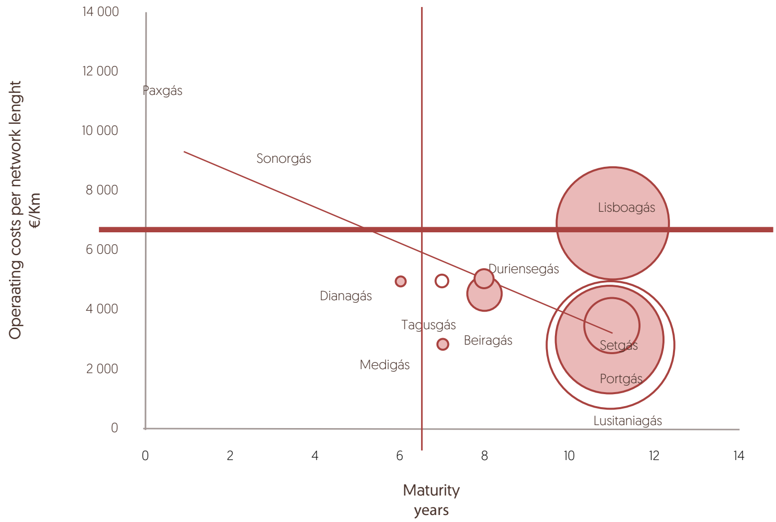
Exogenous factors such as population density, maturity and industry gross added value (GVA) per capita highly influences the performance of each gas distributor. When implementing an incentive regulation is essential consider such factors in order to evaluate possible deviations from the efficiency frontier of a given firm. In demographic terms, there are clearly three main groups: a first one that contains Portgás, Lisboagás and Setgás; the second group includes Lusitaniagás, Medigás and Duriensegás and the third regards the lowest population density areas supplied by Beiragás, Dianagás, Paxgás, Sonorgás and Tagusgás.

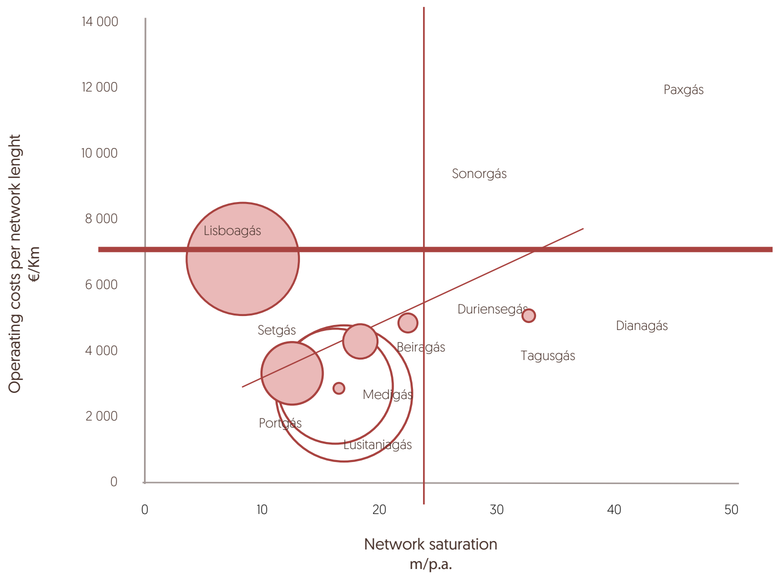
Besides partial ratios, correlation analysis might enlarge the knowledge of the main variables that influence the gas distribution as well as the identification of possible relationships or trade-offs.

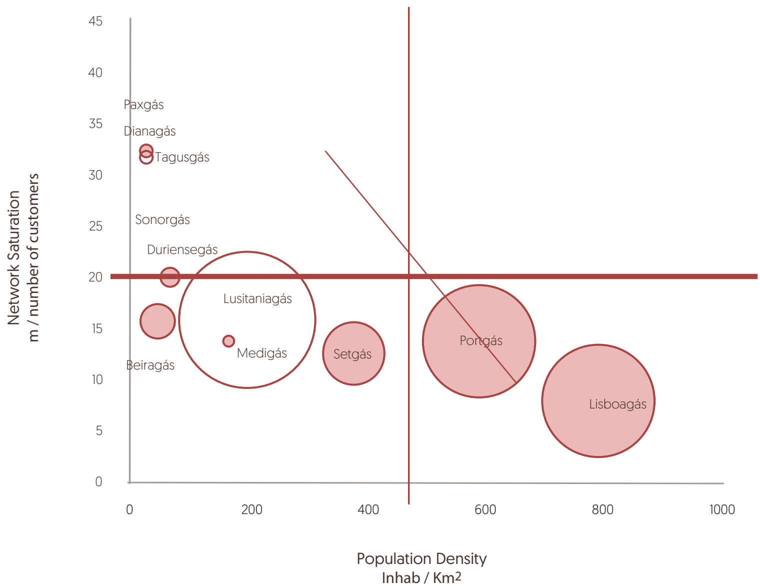
As it may be observed on the graphs below, there is a highly negative correlation between density population and network saturation. Maturity is positively correlated with company's performance[9] whereas network saturation is negatively correlated with performance.

[9] Company's performance relates to operating costs per gas delivered, operating costs per number of customers and operating costs per network length.

Figure 4 - Correlation analysis, 2008







Note: The circle size is related to size of the company's turnover.

The present analysis is fundamental since it shows the impacts that exogenous factors such as maturity and population density may have on the performance of each gas distributor. Thus, company's performance reflects, to some extent, the conditions under which these firms perform their activities.

3. Empirical Literature Review

Regarding empirical literature, technical approaches like COLS, DEA and reference methods are frequently used in the natural gas sector whereas SFA is less applied.

Reference [10] applied SFA, COLS and DEA methodologies in order to derive measures of efficiency for Australian gas distributors relative to U.S. counterparts. However, the results present in the study are only concerning DEA methodology. The authors presented as results, an average technical efficiency between 73% (considering constant returns to scale) and 82% (considering variable returns to scale) and a scale efficiency of 89.9%. Reference [14] justified the non-application of the SFA method due to the limited sample size. Reference [15] also applied a DEA approach to the natural gas industry with the support of bootstraping technique. A major difficulty in these studies has been associated with the sample size. Therefore, several authors had proceeded to a mixture of countries and companies in order to surpass this issue. If this approach might well surpassed this issue it might create others since observations must be comparable with each other. The choice of countries with different realities might well lead to a skewness problem.

Reference [16] analysed 46 gas distributors. The results indicate a medium level of technical efficiency between 63 and 66% whereas the scale efficiency is higher and appears between 80 and 83%. The authors also stated that the inclusion of firms with a higher consumer's density underestimates the technical efficiency and overestimates the scale efficiency. The study concluded that the optimum scale is hit with 65 000 clients and 150 million m3 of gas sold. The study by [14] concluded that the average efficiency of Slovenian companies is between 52% (considering variable returns to scale) and 67.4% (constant returns to scale).

Reference [17] provides an international survey about the benchmarking techniques used by several energy regulators from 40 different countries. From the total survey respondents', eight used benchmarking techniques in the natural gas sector while twenty used on the electrical sector. This large difference between both sectors might be explained by the distinction on the growth phase since the gas sector is less developed than the electrical one. Furthermore, electricity is usually seen as an essential good which increases its relative importance. In terms of methodologies, methods such as COLS, DEA and reference methods are the most used whereas SFA is less applied in the gas sector.

4. Methodology

At as was already been noted, Portuguese gas distribution is very recent with a small set of comparable firms. Unbundling of distribution and supply gas activities has been a reality only since 2008. Therefore, the frontier method applied is the Data Envelopment Analysis (DEA). This methodology was developed by [18] considering constant returns to scale, being extended for variable returns to scale by [19].

DEA is a non-parametric method based on linear programming to construct a linear efficiency frontier. This methodology can be input or output oriented. The latter models seek to maximize the output vector for a set of inputs quantities; whereas the former minimize the inputs over a given quantity of outputs. The aim of such approach is to define a frontier envelopment surface for all observations. The surface is determined by the units that lie on it, the efficient decision making units (DMU). The ones that do not lie on the surface are inefficient [20]. Therefore, we begin by assuming that there exists a production frontier and an ideal production point that companies attempt to achieve. Different distances from the surface will be observed since there is heterogeneity across companies.

In non-parametric methods, such as DEA, there is no need to specify a function for the cost frontier contrary to the parametric approaches. It also requires less stringent knowledge and less number of observations. Parametric approaches like SFA, allow separating the inefficiency effect from the statistical noise however it demands high datasets. SFA approaches incorporate the idea that certain deviations from the frontier might be explained by exogenous factors that the given firm might not control. Any misspecification of the model would be translated as an increased inefficiency which is clearly a disadvantage [21].

The DEA model developed in 1978 imposed three restrictions: constant returns to scale (CRS), convexity of a set of feasible input-output combinations and strong disposability of inputs and outputs. This model is next formalized.

Given a set of *N* firms (or DMUs) characterized by an input-output vector with *M* outputs and *K* inputs, a matrix *K* x *N* inputs and a matrix *M* x *N* outputs are built. For each firm *i* (or unit), outputs and inputs are respectively y_i and x_i. The efficiency scores of the *i*-th firm can be determined by the following mathematical programming formulation,

$$\min_{\theta, \lambda} \theta$$

$$\text{s.t} \begin{cases} -y + Y\lambda \geq 0 \\ \theta xi - X\lambda \geq 0 \\ \lambda \geq 0 \end{cases} \quad (1)$$

where θ is the efficiency score ($\theta \leq 1$) with a value of 1indicating a point on the surface or frontier; λ is a N x 1 vector of constants that represents the weight of each firm within the sample. The aim is to compute the linear combination of referents that for each firm minimizes the value of θ. The constant returns to scale restriction assumes that all firms are producing at an optimal scale which in the real world might not be true. The DEA extension of 1984 allowed a further assumption of variable returns to scale (VRS) by adding the convexity constraint $\sum_i^n \lambda i = 1$ to the model formulated above. This constraint guarantees that each firm is only benchmarked against firms with similar size.

5. Model Specification and Application

A. Variables

The DEA approach is sensitive to the specification of both inputs and outputs and so variables' definition will influence the results. Inputs can be represented by physical or monetary measures. The former measure is mainly used in studies that focus on the technical efficiency of organizations [10]. In the present case, physical inputs respect to the labour force and the equipment set needed for the activity like connections to end-users, regulating stations, meters and satellite plants. Monetary measures may better reflect the capital used in the activity. In the present case, this is not that straightforward since a few activities of the responsibility of the distributors are outsourced. When firms outsourced, they do not have to use their physical resources, being the costs registered on the External Supplies and Services accounting line. Thus in the present case, physical measures should not be used when evaluating potential efficiency gains. In order to account for this reality, the analysis will focus on accountability data where inputs will correspond to the operating costs net of investment costs (OPEX).

Natural gas distribution may be associated with three main outputs: number of customers, volume of gas distributed and network length. These outputs are also the main choice from other studies. Reference [10] chose for the capacity to deliver gas (in Joules), residential customers and other customers whereas [14] chose as outputs the gas supplied (in m3), peak demand (m3/day), number of customers and network length (in km). Reference [16] study used distributed gas and number of customers as outputs. However, each output influences differently costs dynamics where the outputs that mostly influence costs are often designated by cost driver. In the present case, the number of customers and the volume of gas distributed may be considered as cost drivers. Following a study from [22], "volumetric returns to scale exist such that as the diameter of the pipe doubles, its volume increases by a factor of 4, while its surface area only increases by a factor of 2". The volume of gas distributed is highly correlated with the investments costs in the distribution of gas but while output is proportional to volume, the cost is proportional to surface area. On the other hand, an increase on the number of customers leads to higher operating and maintenance costs. In the Portuguese case, distribution networks are different across companies. Network distribution of Lisboagás[10] is relatively old which requires higher maintenance efforts.

[10] In 1997 the network was converted from manufactured gas.

Hence, the number of customers is an important cost driver. However, gas delivered and network length are also relevant cost drivers and thus the decision to include it as outputs as well. In fact, accepted revenue of gas distribution activity varies with gas delivered. If accepted revenues do not reflect evolution of quantities then the risk associated with fluctuating quantities is fully transmitted to consumers.

In order to better understand the several relationships between variables and consequently ensure that the cost driver's choice is the most accurate one, a dynamic analysis has been undertaken. The independent variables are represented by the total number of customers, gas delivered and network length The dependent variable corresponds to the OPEX costs (at constant prices). The analysis includes six concession companies (Beiragás, Portgás, Tagusgás, Lusitaniagás, Lisboagás and Setgás) and four from the five licensed companies (Duriensegás, Sonorgás, Dianagás and Medigás)[11]. Due to the high correlation between those variables models, we discard models' results with more than 1 independent variable. Table II reports the estimations results of three different panel data models: the first one with 10 companies (without Paxgás), the second includes the licensed companies data and the third regards only to the four biggest firms (Lisboagás, Lusitaniagás, Setgás and Portgás). In order to avoid multicollinearity, it was decided to consider only the number of customers as independent variable. Overall, an increase in the number of customers leads to an increase less than proportional of OPEX costs, which it might be translated into economies of scale. However, these results differ in the third model regarding the four biggest firms. In fact, an increase in the number of customers leads to an increase more than proportional of OPEX costs, which could be translated as diseconomies of scale. This analysis ensures that the number of customers is a cost driver in the Portuguese natural gas distribution.

Further analyses were made in order to investigate the gas delivered and network length as outputs. In fact, it was not conclusive that the number of customers is the only cost driver, not rejecting the hypothesis of natural gas quantities delivered and network length being also relevant cost drivers.

[11] The decision not to include Paxgás was mainly because it only presents operational activity since 2008.

Table II - Panel data results

Companies	Period	No. Obs	Effects	Independent Variable	Coeficient independent variable [t- stat.]
All	2005 a 2007	30	Fixed	constant	5,772 [13,30]
				log customer	0,869 [20,93]
	2005 a 2007	30	Random	constant	5,75 [13,32]
				log customer	0,810 [21,1]
Licensed	2005 a 2007	12	Fixed	constant	8,87 [5,37]
				log customer	0,50 [2,62]
	2005 a 2007	12	Random	constant	7,75 [5,09]
				log customer	0,63 [3,60]
Lisboagás, EDP Gás, Lusitâniagás, Setgás	2003 a 2007	20	Fixed	constant	1,89 [2,38]
				log customer	1,188 [18,08]
	2003 a 2007	20	Random	constant	1,99 [2,69]
				log customer	1,180 [19,27]

Exogenous factors can also influence the gas distribution activity like population density, climate, macroeconomic shocks and others. Once set the efficient attainable costs for a given level of outputs, it is crucial to verify if the distance from the frontier is exclusively due to the conduct firm or it may also be explained by other factors outside from the control of the firm.

B. Estimation Results

The DEA method is applied in order to determine the X- factors needed in the price-cap regulation. DEA models for each dataset were constructed, four for the year 2008 and three for the gas year 2008-2009[12]. The models differ according to the outputs considered:

» Model 1: number of customers, delivered gas and network length

» Model 2: number of customers and delivered gas

» Model 3: number of customers

» Model 4: delivered gas

It was applied both a CRS-DEA model and a VRS-DEA model. However, in the case of natural gas distribution there are strong evidences of scale effects and thus it will only be provided

[12] The tariffs are settled for a one year period beginning in July and ending in June of the next year.

the estimation results for the VRS-DEA models. In fact, the clearly sizeable differences among firms enhance the relevance of the VRS-DEA models against the CRS-DEA. Table III reports the scale effects for each firm. Each firm scale effects can be: (I) increasing returns to scale, arise when a firms is below the minimum efficient scale or the optimal point; (II) decreasing returns to scale, above the minimum efficient scale and (III) constant returns to scale, at the optimal point. Almost all firms are producing below their minimum efficient scale, except Portgás and Lisboagás (in the first three models) and Lusitaniagás, in the third model.

Table III - Scale effect analysis, 2008

	Model 1	Model 2	Model 3	Model 4
Beiragás	Increasing	Increasing	Increasing	Increasing
Dianagás	Increasing	Increasing	Increasing	Increasing
Duriensegás	Increasing	Increasing	Increasing	Increasing
Portgás	Decreasing	Decreasing	Decreasing	Increasing
Lisboagás	Decreasing	Decreasing	Decreasing	Increasing
Lusitaniagás	Constant	Constant	Decreasing	Constant
Medigás	Constant	Increasing	Increasing	Increasing
Paxgás	Increasing	Increasing	Increasing	Increasing
Setgás	Constant	Constant	Constant	Increasing
Sonorgás	Increasing	Increasing	Increasing	Increasing
Tagusgás	Increasing	Increasing	Increasing	Increasing

Table IV shows the efficiency scores for the Portuguese gas distributors, except for Paxgás, for the year 2008. Firms that present efficiency scores equal to 1, it means that it is on the efficient frontier or that it lays on the surface. Different distances from the frontier will be proportional according to the difference between the unit and the computed score by the DEA.

Firms could be separated by the following groups:

» Group 1: Portgás, Lusitaniagás and Medigás

» Group 2: Dianagás, Lisboagás and Setgás

» Group 3: Beiragás, Duriensegás and Tagusgás

» Group 4: Sonorgás

Table IV - VRS-DEA, 2008 (without Paxgás)

	Model 1	Model 2	Model 3	Model 4
Beiragás	0,64	0,55	0,54	0,34
Dianagás	0,88	0,88	0,88	0,88
Duriensegás	0,57	0,40	0,40	0,29
Portgás	1,00	1,00	1,00	0,70
Lisboagás	1,00	1,00	1,00	0,23
Lusitaniagás	1,00	1,00	0,95	1,00
Medigás	1,00	1,00	1,00	1,00
Setgás	1,00	1,00	1,00	0,38
Sonorgás	0,32	0,29	0,29	0,29
Tagusgás	0,58	0,35	0,28	0,35

The following analysis addresses the relationship between the efficiency scores obtained from the VRS-DEA and the exogenous variables. As has already been noted, exogenous factors such as maturity and population density may have strong impacts on the performance of each gas distributor. Therefore, it is crucial to cross the scores obtained with the exogenous factors in order to investigate whether the results have well been given by each firm or whether they can be explained by other factors outside of the firms' control. From table V, population density and maturity are related with three of the four estimated models at a 10% significance level.

Table V - Exogenous Factors vs. DEA results, 2008 (without Paxgás)

		Population Density	Maturity
Model 1	Number of customers Network length	2,26	3,36
Model 2	Number of costumers Delivered gas	2,30	2,69
Model 3	Number of costumers	2,37	2,53
Model 4	Delivered gas	-0,37	0,28

Notice that Portgás presents the highest population density, fact that might helps explaining the good performance given by the DEA scores. Therefore, it was decided to rectify the conclusions made before:

» Group 1: Lusitaniagás and Medigás

» Group 2: Dianagás, Lisboagás, Portgás and Setgás

» Group 3: Beiragás, Duriensegás and Tagusgás

» Group 4: Sonorgás

When considering the period 2008-2009 (gas year), the first model was not able to be estimated due to missing data related to the network length. From the results, firms are redistributed by the next order of efficiency:

» Group 1: Lusitaniagás, Medigás and Portgás

» Group 2: Dianagás, Lisboagás, and Setgás

» Group 3: Duriensegás, Sonorgás and Tagusgás

» Group 4: Beiragás

Table VI - VRS-DEA, 2008-2009 (without Paxgás)

	Model 2	Model 3	Model 4
Beiragás	0,60	0,57	0,46
Dianagás	0,88	0,88	0,88
Duriensegás	0,68	0,67	0,58
Portgás	1,00	0,95	0,74
Lisboagás	1,00	1,00	0,24
Lusitaniagás	1,00	0,83	1,00
Medigás	1,00	1,00	1,00
Setgás	1,00	1,00	0,51
Sonorgás	0,65	0,65	0,65
Tagusgás	0,75	0,40	0,75

VRS-DEA technical efficiency scores are regressed against population density and maturity to assess their impact on efficiency.

Table VII - Exogenous Factors vs. DEA results, 2008-2009 (without Paxgás)

		Population Density	Maturity
Model 2	Number of costumers Delivered gas	2,52	2,47
Model 3	Number of costumers	2,52	1,63
Model 4	Delivered gas	-1,48	-0,63

The t-statistics (Table VII) showed that population density is highly significance for model 2 and 3 (10% significance level), whereas maturity variable is only 10% significance for the second model. Based on these results, the groups are once again redistributed, as follows:

» Group 1: Lusitaniagás, Medigás and Portgás

» Group 2: Dianagás, Lisboagás, and Setgás

» Group 3: Beiragás, Duriensegás, Sonorgás and Tagusgás

C. Implications on X-Factors

Despite the high differences among the results of each dataset, results by group appear to be similar. The first group that defines the efficient frontier includes Medigás, Lusitaniagás and Portgás. The second group incorporates Dianagás, Lisboagás and Setgás. And the last group includes the remaining companies (Beiragás, Duriensegás, Sonorgás and Tagusgás). For any model, the third group presents average differential efficiency targets around 30%, whereas the second group has an average differential efficiency roughly 15%. Table VIII reports the annual I-factors decision where the minimum value, 0.5%, represents potential efficiency improvements resulting from technological progress.

Table VIII - Annual *X*-Factors

	Efficiency Factor %
Beiragás	3,0
Dianagás	0,5
Duriensegás	1,5
Portgás	1,5
Lisboagás	3,0
Lusitâniagás	0,5
Medigás	1,5
Setgás	0,5
Sonorgás	3,0
Tagugás	3,0

The decision to not include Paxgás was mainly due to its incipient dimension and its maturity.

Conclusions

The Portuguese gas distribution has several specifications which did not allow the application of an incentive regulation in the first regulatory period. Efforts have been made in order to apply such regulation in the second regulatory period, 2010-2013, since the benefits appeared to be higher when compared to a rate-of-return regulation. Several issues related to data, such as small sample and missing data have been mitigated by applying the DEA. However, DEA is a partial and non-parametric approach which does not allow to isolate the effects of external factors from the effects of internal factors on the results. In that context, one couldn't directly apply the results obtained as efficiency targets. The main reasons are the uncertainty due to the data limitations, the regulatory framework and the weight of external factors. Besides the data limitation, this research suggests that the ability of Portuguese gas distributors to achieve efficiency differs strongly from firm to firm (as expected) mainly due to the referred external factors, than can be gathered. Thus, Erse chose not to apply directly the results obtained as efficiency targets and on the other hand ERSE applied efficiency target by group of firms, with similar environmental characteristics, instead of by individual firms. For further developments, it is necessary to continue analysing the performance of each firm in order to insure that efficiency is attainable. Further efforts should be made in order to collect more reliable information about the Portuguese gas distributors. This improvement could actually influence results and strength the robustness of a future benchmarking analysis.

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Smart Grids Regulation as a Corporate Governance Paradox

Vitor Marques[1]*, Nuno Bento[2], Paulo Moisés Costa[3], Mónica Cunha[4]

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Abstract

Is the investment in emergent innovations, such as Smart Grids which can reduce the need of further investments, better supported with a riskless regulation? In a competitive environment, companies have natural incentives to improve their processes and decrease costs. In a monopoly context, this rule may not occur. In the case of a regulated monopoly the incentive to reduce costs depends on the type of regulation applied. For the regulator, the effectiveness of the regulatory scheme in decreasing costs depends on the way it

[1] Entidade Reguladora dos Serviços Energéticos - ERSE, Rua Dom Cristovão da Gama, Edifício Restelo, n.º1 – 3º andar, 1400-113 Lisboa, Portugal.
* Corresponding author. Tel.: (351) 21 30 33 224; Fax: (351) 21 30 33 201; Email: vmarques@erse.pt (Vítor Marques)
[2] DINÂMIA'CET, ISCTE - Instituto Universitário de Lisboa, Av. das Forças Armadas, Edifício ISCTE, Sala 2N19, 1649-026 Lisboa, Portugal
[3] Instituto Politécnico de Viseu, Escola Superior de Tecnologia e Gestão, Campus Politécnico de Repeses, 3500 Viseu, Portugal and "INESC TEC – INESC Technology and Science (formerly INESC Porto), Rua Dr. Roberto Frias, Porto, Portugal
[4] Entidade Reguladora dos Serviços Energéticos - ERSE, Rua Dom Cristovão da Gama, Edifício Restelo, n.º1 – 3º andar, 1400-113 Lisboa, Portugal.

deals with asymmetric information. Whether the regulator applies a price cap or a cost plus regulation may lead to completely different results. The former is more likely to decrease costs, whereas the latter may be more effective to promote investments. Thus, it seems difficult for a regulator to promote new investments while setting up incentives to reduce costs. This can be seen as a paradox of the regulated firm governance. However, when it comes to cost saver investments, such as SG innovations, this paradox may be solved. It is shown that an incentive regulation re-creates a competition environment, encouraging the adoption of innovations which increase efficiency and ameliorate internal organization. In addition, the effectiveness of any regulation depends on the constant monitoring of the results, as well as on the flexibility of adapting the regulatory scheme. The Portuguese SG regulation (i.e. a short regulatory period, mixing both "cost plus" and "price cap", and a WACC premium on investments compensating for a higher efficiency target on OPEX) is presented as an example of the proposed solution.

Keywords

Economics of Regulation - Price-Cap - Cost-Plus, Corporate Governance - Smart Grids.

Introduction

In a competitive environment, companies have natural incentives to improve their processes to decrease costs. In a monopoly context, this rule may not occur. In the case of a regulated monopoly the incentive to reduce costs depends on the type of regulation applied. For the regulator, the effectiveness of the regulatory scheme in decreasing costs is directly related to the way it deals with the problem of asymmetric information. Assuming that the regulator of a natural monopoly acts as an important shareholder that aims that the company grows in a sustainable way, though not compromising the social welfare equilibrium, he considers long run strategies based on cost efficiency, quality of service and innovation. The regulator can apply different regulatory instruments (e.g. "cost plus" or "price-cap") to the investment costs and include them in the access tariff of the regulated activities (i.e., networks) (Joskow, 2008). Theoretically, a "cost plus" regulation would spur the deployment of innovations in the network by reducing uncertainties on its adoption (Guthrie, 2006). Whether the regulator applies a price cap type or a cost plus regulation may lead to completely different results, being the first type more likely to decrease costs. Conversely, it is well known that a cost plus regulation is more adequate to lead companies to invest at the expense of putting less pressure to reduce costs. Therefore, it seems to be difficult for a regulator to promote new investments while setting up incentives to costs reduction.

However, when it comes to Smart Grids (SG) investments, this is not the case. These innovations promise great reduction on operational costs with less need of investment in conventional "copper and iron" (European Commission, 2012a). This new concept encompasses a set of technologies that raise the intelligence of the networks such as smart meters at consumer level or instruments for the capture, transmission and storage of data, as well as control devices at the level of electrical networks (European Commission, 2011a). Those technologies would allow, among other things, to improve the quality of the service as well as the emergence of new business models namely related with demand management and dynamic tarification (Bergaentzle and Clastres, 2013). Even though the high potential benefits of SG for the society, the regulated firm may be more concerned with the reduction of allowed expenses in the future.

The novelty of the SG investment, in comparison with other investments in the network in the past, is the more disembodied character of the technology, which provides a large spectrum of services with great scope for efficiency gains by relying heavily in software and information and communication technologies. Therefore, it results in a lower regulatory asset base, changing the incentives of a regulated firm to invest, what may affect the efficacy of each regulation instrument.

Hence, it may be difficult for the regulator to stimulate the regulated firm to adopt new technologies which can reduce future allowed revenues. This paper addresses this issue in four steps. Firstly, different regulatory schemes are reviewed, namely concerning the way they deal with asymmetric information and moral hazard problems. Secondly, the innovative features of the SG are analyzed. Thirdly, a simple regulatory model is presented that is able to cope with moral hazard problems and asymmetric information related to the investment in innovations in the grid. Finally, we present the Portuguese regulatory model which addresses the corporate governance paradox by combining a mix of regulatory schemes with a close monitoring of the outcomes. It is argued that an effective regulation which promotes the adoption of new efficient technologies is a sign of good corporate governance that reduces capital costs while contributes to an economic efficiency of the energy sector.

1. Effectiveness of regulatory schemes under asymmetric information

Natural monopolies, like electricity distribution and transmission activities, are characterized by decreasing long run marginal costs, justifying their need to be regulated.

In the principal-agent theoretical framework, this challenge can be divided into two main concerns: the "adverse selection" and the "hazard problem". If we focused on the cost issue, the first concern would be related to the lack of information by regulators about the firm cost function and to the economical rent, whereas the second concern would be related to the manager effort to decrease firms' cost level [Joskow, 2007]. To overtake the "adverse selection" situation, the regulator applies a "cost plus" regulation based on the regular ex-post firms costs analyses and on their profits limitation. However, this can limit the effort of firms' manager for controlling costs, leading to economical inefficiencies. This is a moral hazard problem that can be overtaken by the regulators through an incentive based regulation approach [Laffont and Tirole (1993), Armstrong and Sappington (2006), Joskow (2008a)]. Under "pure" incentive regulation, the price level is fixed by the regulator and it is not reviewed [Baron and Myerson (1982)]. The firm has an incentive to reduce its costs, but all the welfare gains due to the cost reductions are kept by the firm. As the regulator doesn't know the true cost level of the firm, he may define a price level much higher than the true cost level. This is the main drawback of this regulatory methodology, since it can produce monopolistic rents [Schmalensee, 1989]. Thus, both pure incentive regulation and cost plus regulation are partial approaches that cannot by themselves solve the lack of information issue. Therefore hybrid methodologies have been adopted trying to consider both the adverse selection and the hazard problem concerns [Armstrong and Sappington (2006), Joskow (2007)]. For example, variants of the pure incentive regulation methodology with temporary price review and productivity targets have been applied since 1984 [Beesley and Littlechild (1983)], namely for regulating the electricity distribution network [see e.g. Jamasb and Pollit (2005), Farsi et al (2007)].

Since the eighties, variants of pure incentive regulation have become widespread in parallel with the liberalization of Utilities in most western countries. Most of the time, those methodologies are labeled as price cap or revenue cap methodologies. Actually, the main differences between a price cap regulatory scheme and a cost plus regulation scheme are related to the maximum lag between the price review and the minimum set of cost elements that determines the price review [see Joskow (2000) and Guthrie (2006)]. The impact of this price review on the choice of suboptimal strategies by the regulated firm has been broadly analyzed [see Weitzman (1980) about the ratchet effect in general terms or Vogelsang and Finsinger (1979) and Sappington and Sibley (1988) for price review in the regulatory context]. Once those conditions are relaxed, it's quite difficult to define the boundaries between these two types of regulatory methodologies [see Marques, 2003]. As will be argued, these factors play a main influence in the investment strategies that are followed by regulated firms.

2. The nature of Smart Grids investments

SG have multiple functionalities that explain its attractiveness in terms of reducing operational costs, raising efficiency of generation and use of electricity, and improving the quality of service. The implementation of SG has benefits for different actors intervening in the power system. Moreover, the distribution of those benefits will influence the capacity of each actor to invest and assume a part of the costs (Clastres, 2011; Meeus et al., 2010). Thus:

1. **consumers** benefit from an improved quality of supply and potential lower electricity bills due to the development of dynamic tariffs and demand response procedures. As well, they may benefit from a better integration of microgeneration units, electric vehicles and storage devices;

2. **network operators (namely DSO)** may take advantages from a higher level of monitoring and automation of the networks, increasing the control over the system. This may allow a lower level of network losses and a better quality/reliability of supply (namely by the automation of actions of network reconfigurations). Depending on the regulation in force, this may bring financial benefits to the network operators. Moreover, the information about consumer's behavior is a valuable resource in the process of setting investments. Note that the SG may even postpone or even avoid some investment needs (by developing the demand response, for instance, which tends to promote peak load transfer). Furthermore, the use of smart meters will reduce the costs related to meter reading;

3. **the system operator** may benefit from a more easy and less costly balance service;

4. **electricity retailers** could use the enhanced information about consumers' behavior as well as the demand response procedures to improve electricity purchase procedures and to avoid penalties related to imbalances;

5. **generators** may benefit from the ability of create virtual power plants consisting on a greater number of smaller units able to act as a single entity with a more discretized generation capacity, which tends to improve the economic performance of the generating entities and to reduce the risks inherent to the investment on a power plant of large capacity;

6. **regulator** profits from a better knowledge of demand to anticipate the need of investments in the infrastructure, as well as taking advantage of the development of

competition due to a more intense exchange of information between consumers and potential providers;

7. **society** benefits from a high quality service in terms of less frequent and shorter interruptions, as well as from the integration of a major quantity of endogenous and renewable energy sources able to reduce the emission of pollutants and to decrease the energy dependence from the exterior.

Market surveys showed that distribution system operators (DSOs) have been playing a leading role in early projects (European Commission, 2011b). They are expected to have a great importance in the roll-out together with consumers (Verbong, Beemsterboer and Sengers, 2013). Both actors have important benefits with the deployment of SG, and their participation is needed because of the systemic nature of the innovation, i.e., the benefits with its implementation only come into play once the entire system is in place and actors participate actively in the new grid (European Commission, 2012a). For instance, the investment in the grid is a prerequisite for demand to evolve and adopt a more active role in the management of energy through behavioral change or even becoming “prosumers”, i.e., households that produce and commercialize energy (Verbong, Beemsterboer and Sengers, 2013).

The investment in SG concerns the deployment of devices in millions of houses and the upgrade of an extensive electrical network, thus the transformation of the entire system will take several years, if not decades. For instance there are already 40 million smart meters installed in Europe and it is forecasted 240 million more by 2020 (European Commission, 2012b; Pike Research, 2011; Faruqui et al., 2010). Even though the challenge is not the same as the construction of the first electrical networks in the past, the need for a minimum of infrastructures is of a paramount importance for the development of services such as telemetering or demand response. Two situations must be separated here. On the one hand, the infrastructure part concerning the update of already installed equipment with new sensors, controllers or communication devices. In this case the implementation may be more rapid because it is a matter of upgrading (not even substitute in most cases) the existing technology with new “Smart” components. On the other hand, the implementation of “Smart grids” will need the creation of an information system that collects stores and treats (securely) all the new data generated by the system. In this case new software and other technologies are necessary, some of which have not been developed yet.

Therefore, these technologies are not mature and they are still surrounded by technical and market uncertainties that slow the rhythm of diffusion. However, the investment in SG clearly has externalities and public benefits for the electrical system which may not be possible to grasp without some kind of external support [BNetzA, 2011]. Thus, it is important to underline that the concept of “Smart” or, simply, the innovative character of the investment in the grids is not always straightforward. This may be the main challenge for the regulator in the practice.

3. The regulation of SG investments: a simple model

As previously mentioned, the regulatory framework can influence investment decisions in completely different directions: not only for the level of investment, but also for the type of investment. Harvey Averch and Leland Johnson [Averch and Johnson (1962)], shown that the typical cost plus regulation leads regulated firm to overinvest, in the sense that the firm’s investment decision is not motivated by its long run marginal cost, but rather by the allowed return on investment. However, it also has been demonstrated that pure incentive regulation promotes investments leading to cost reduction (Carrington et al 2002, Guthrie, 2006].

Guthrie (2006) analyzed the impact of regulatory schemes on the firm’s decision to make irreversible investments that can decrease operating expenditure (OPEX), where the investment on SG can be framed. Guthrie (2006) shown that the choice between pure cost plus and pure incentive regulations is explained by the proportion γ of the investment expenditure that is accrued on the firm’s Regulatory Asset Base (RAB) after the next price review, *T*, and to the proportion α of the cost savings that is transferred to consumers after *T*. Guthrie also related those variables and the type of regulatory scheme. Thus, when $\gamma = \alpha = 0$ the regulatory scheme is a pure incentive regulation approach and when $\gamma = \alpha = 1$ the regulatory scheme is a pure cost of service regulation. Moreover, Guthrie concluded that a firm will not invest in a “socially optimal cost reducing project” if $\alpha > \gamma$. In this approach a regulatory scheme that mixed an incentive type regulation on the OPEX and a cost plus type regulation on the capital expenditure (CAPEX) would promote this type of investment.

The knowledge provided by Guthrie (2006) can be used to define a regulatory scheme able to keep the interest of the regulated companies in developing SG, taking into account its impact on OPEX and CAPEX.

The present value of an investment of this kind, when the first price review has occurred in period *T* is:

$$- I_{SG} + \sum_{t=1}^{T} \frac{\Delta C}{(1+r)^t} + \sum_{t=1}^{T} \frac{\Delta I_C}{(1+r)^t} + \sum_{t=T+1}^{\infty} \frac{r\gamma(I_{SG} - \Delta I_C) + (1-\alpha)\Delta C}{(1+r)^t}$$

$$= - I_{SG} + \frac{\Delta C}{r}\left(1 - \frac{\alpha}{(1+r)^T}\right) + \frac{\Delta I_c}{r}\left(1 - \frac{1}{(1+r)^T}\right) + \frac{\gamma}{(1+r)^T}(I_{SG} - \Delta I_C) \quad (1)$$

Where:

T is the next time review period.

α is the proportion of the cost savings that is transferred to consumers after *T*.

γ is the proportion of the investment expenditure that is accrued on the firm's RAB after *T*.

ΔC is the cost decrease.

I is the cost expenditure.

r is the firm's cost of capital.

I_{SG} is the amount invested in SG technology.

ΔI_C is the reduction of conventional investment due to the SG investment.

In the present case, a firm will invest when:

$$\Delta C + \Delta I_c + \frac{r\gamma(I_{SG} - \Delta I_C) - (\alpha\Delta C + \Delta I_c)}{(1+r)^T} \geq rI_{SG} \quad (2)$$

The firm's motivation to invest is directly proportional to i) the period in-between until the next price review period, *T*; ii) the reduction of operating costs, ΔC. On the contrary, the firm's motivation to invest is inversely proportional to: i) the share of costs saving that are transferred to consumers, α; ii) the cost of capital, *r*. For *r*, this conclusion is due to the fact that case, γ, the proportion of investment transferred to the RAB, is lesser than 1.

The impact of ΔI_C on the investment decision is not straightforward, depending whether the reduction on investment cost is greater or not than the SG investment.

Considering $\Delta I_C \leq I_{SG}$, the firm motivation to invest increases with γ. On the contrary, if $\Delta I_C > I_{SG}$, the firm motivation to invest decreases with γ. In practice, the latter situation is likely to happen since the investment avoided in "copper and iron" may be larger than the expenditure in getting the grid more "intelligent". This leads to our proposition.

Proposition. A pure incentive regulation applied in CAPEX and OPEX, where $\alpha = \gamma = 0$, is the best regulatory scheme to promote SG investments, whenever they avoid expensive conventional investments.

In addition, eq. (2) can be transformed into three different formulas according to the types of regulatory schemes: i) cost plus; ii) price cap; and iii) hybrid regulation.

Situation 1. Under a pure cost plus regulation, it is assumed an extreme instantaneous review process ($T = 0$) that increases the RAB of the regulated firm for all investments made and transfers all operational gains to consumers: $\alpha = \gamma = 1$. In this case, eq. (2) can be re-written as following:

$$\Delta I\_C \leq 0 \qquad (3)$$

The firm will only invest in SG if it does NOT lead to a diminution in the conventional investments. That is understandable because the company doesn't want to reduce its RAB.

Situation 2. Under a pure price cap regulation, the three assumptions are: $T = +\infty$; $\alpha = \gamma = 0$. Therefore,

$$\frac{\Delta C + \Delta I_c}{r} - I_{SG} \geq 0 \qquad (4)$$

The firm would only invest in SG if the perpetual rent of the avoided costs (first part of Eq.(4)) is larger than the initial investment. That is similar to the expected behavior of any company in a deregulated context.

Situation 3. Hybrid regulation in which the regulator applies a price cap on OPEX to transfer the operational gains to consumers (α=0) and a cost plus on CAPEX to promote the investment in new technologies (γ=1). In addition, it is assumed an instantaneous price review (T=0). Then,

$$r\Delta I_C \leq \Delta C \qquad (5)$$

The firm has an incentive to invest in SG if the reductions in OPEX are larger than the decrease in CAPEX. In this case the SG will be implemented if that bring great productivity gains or whether the cost of capital is low.

Situation 3'. Finally, the hybrid regulation with no review (T = +∞) has an equivalent solution to *situation 2* of a pure price cap regulation.

4. Incentive regulation and corporate governance

4.1. Smart grids promotion and corporate governance

This final point discusses the implementation issues that arise from the application of an incentive regulation to promote SG investments. The execution of a workable regulation should consider the reaction of the firm, namely the consequences on its internal organization and corporate governance. Therefore, the Corporate Governance framework (OECD, 2004; Shleifer and Vishny, 1997) is used to have a dynamic perspective.

There are several definitions on Corporate Governance. According to OECD (2004), Corporate Governance "involves a set of relationships between a company's management, its board, its shareholders and other stakeholders". In addition, it comprises a multiplicity of factors, among which the nature of ownership (Goldstein, 2000). The separation between management and financing, i.e., the gap between ownership and control, arises agency's problem in terms of adverse selection and moral hazard (Shleifer and Vishny, 1997). In this context, the regulator must ensure that activities which have great benefits for the company and the entire sector, such as innovation and the adoption of new technologies, receive attention by the management of the firm.

The adoption of innovations, which are likely to have strong positive repercussions for the future of the sector and of the firm, may be regarded as a sign of good Corporate Governance. Anderson and Orsagh (2004) sustain that some credit risk companies, such as Standard & Poor's and Moody's, look at corporate governance aspects when they issue their credit ratings. For these agencies, companies with a better corporate governance practice present a lower risk. This translates into a lower capital cost which allows the firm to undertake more projects with additional social value in the medium to long term. Thus, an adequate regulatory framework plays a role in setting the right incentives for the implementation of projects with high externalities for the sector. Note that the regulator of a natural monopoly cannot replace a Board of a company; it can only influence their decisions through the design of the regulated framework.

A more active promotion of efficient investments should not be confounded with an interference in the companies' management [La Porta et al., 2000], but a stronger governance position. To recover the metaphor of the regulator as a shareholder, it is well-known that a stronger shareholder right rises the value of the company while lowering the cost of capital [Gompers et al., 2003]. In the case of a regulated natural monopoly, the decrease in the capital cost will spread to the entire sector. Therefore, an effective regulation scheme which promotes innovation is also a contribution for the economic efficiency of the energy sector.

In a regulated environment, the regulator can be viewed as a stakeholder with special privileges since the framework under which the regulated firm operates is designed by him. This is particularly the case when he promotes the choice of efficient projects like SG. Nevertheless, distinct features arise in respect to the definition of the time horizon: normally, the regulator of a natural monopoly has a long run perspective of investments while a typical investor might have a short term perspective. And the fact that regulator's decisions affect directly (e.g., setting the tariffs, acceptance of investments) and indirectly (e.g., influencing changes in the internal organization) the corporate governance of the regulated firm.

The regulator has a large set of regulatory mechanisms at its disposal to stimulate the natural monopoly company, which by definition has no competitive pressure, to invest in new technologies. However, the regulator can't use these methodologies mechanically[5]. Heine sustains (2013) that the efficacy of any incentive mechanism deeply depends on the straightforwardness and comprehensibility of incentives .It can difficult for both regulator and firm to understand the challenges encountered with implementation of the new technology. Therefore, there is no optimal solution that can be applied to promote SG. The observation of the regulated firm's reaction to the policies is required.

The interaction between regulator and regulated companies is very important, but the application of an effective regulatory scheme may take time. This fact may not *per se* hamper the development of SG because these are new technologies in the formative phase and the time they need to be fully implemented allows to improve and to adapt the regulatory scheme. The way as regulatory incentives to promote SG were applied by the Portuguese regulator is a good illustration of this approach.

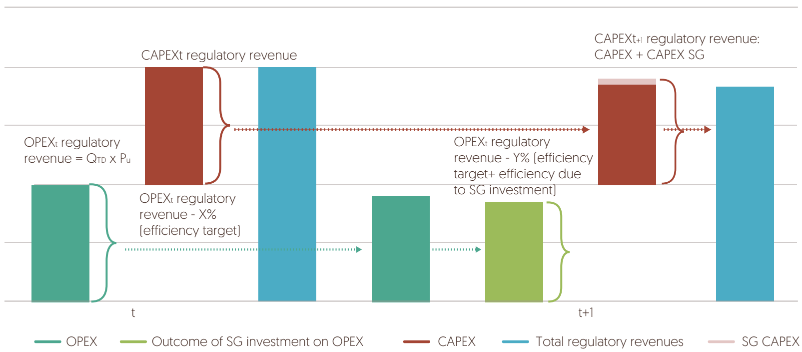
[5] Thus, it has to be highlighted that the conclusions shown in the precedent point, which are derived from mainstream economics tools, may suffer from the fact that these abstract models are built on some assumptions, based on the neoclassical analysis (for instance Heine, 2013), namely the assumption that firms are rational and always make rational choices (with access to full information).

4.2. The Portuguese approach to SG promotion

The Portuguese methodology was presented to the stakeholders in 2012 as part of a set of regulatory scheme to the next regulatory period. This regulation has three main features [ERSE, 2011a, 2011b]: i] a cost plus regulation applied on CAPEX, with investments on SG benefiting of higher remuneration than conventional investments; ii] an incentive regulation applied on OPEX, where the efficiency target rises with the penetration of SG and iii] a close monitoring of the process. The "premium" of 1.5% was estimated in order to improve efficiency in the allocation of resources while avoiding any distributional distortions. In particular, it considers the efficiency gains in terms of physical investment avoided by the implementation of SG [Figure 1].

The expected benefits resulting from the implementation of these innovations in the networks is compared to the greater risk that the investor has to hold with the adoption of an immature technology in the early years of diffusion. In that sense, the additional risk is compensated by separating the capital expenditure in SG from the capital costs of conventional investments in the grid. However, this discrimination is likely to be limited in time in order to stimulate early deployments of the "smart" technologies. This approach is neutral for consumers since the greater rate of return has a counterpart: a greater efficiency obligation applied to the OPEX that is equivalent to the greater return received by the firm in CAPEX. However, if the company goes beyond the efficiency target due to the investments in SG, it can keep all the extra returns to itself.

Figure 1 - The incentive scheme for Smart grids investment in Portugal [ERSE, 2011a]



During the regulatory period, the eligibility of the investments in Smart Grids for the regulatory asset base is subject to a case by case analysis in order to check whether or not they comply with the criteria previously established. This is an important issue because the SG concept is not always unanimous. Therefore, companies are more conscious of the regulatory goals and objectives, and the regulator adapts its scheme based on the observation of realistic results. This approach was combined with the reinforcement of quality standards and the reward/penalties scheme associated with the quality of service regulation in force in 2013. This is expected to turn more effective the incentive regulation applied to the SG investments.

In summary, the Portuguese model of short regulatory period (three years), mixing up both “cost plus” and “price cap” regulation, is expected to easily adapt the regulatory scheme in order to make it more effective on the promotion of SG investments.

Conclusions

This research has analyzed the difficulty to stimulate regulated firms to invest in new technologies which reduces future allowed revenues. It was investigated the efficacy of different regulatory schemes under asymmetric information. A simple regulatory model was presented that is able to deal with the principal agent problem related to investment in innovations in the grid. It was proposed a support scheme for SG that may solve the regulatory paradox (i.e., a stable rate of return gives low incentives to invest in cost saving technologies). It is argued that an incentive regulation promoting the adoption of new efficient technologies can improve the corporate governance of the regulated firm, which reduces capital costs, while contributing to dynamic efficiency of the energy sector. However, it is not always an easy task to define an innovative investment and separate what can be considered a SG investment from what can be considered a conventional one. Moreover, the regulator needs to guarantee that the gains due to SG investments are fairly distributed between all the stakeholders, namely consumers and companies. To achieve this target a flexible regulatory scheme is required. Therefore, the Portuguese case is for us a good example of such approach.

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CAPÍTULO 4

ESTUDOS PROSPETIVOS E ENQUADRAMENTO DA REGULAÇÃO NO CONTEXTO DA POLÍTICA ENERGÉTICA

CAPÍTULO 4

ESTUDOS PROSPETIVOS E ENQUADRAMENTO DA REGULAÇÃO NO CONTEXTO DA POLÍTICA ENERGÉTICA

Incentive for the profit maximization of binding generation in a market environment

Vitor Marques, Carlos Vaz, Pedro Verdelho

Entidade Reguladora dos Serviços Energéticos, Portugal

Abstract

The opening of the market in the generation side obliges to renegotiate Power Purchase Agreements (PPA), traditionally applied in some electricity sectors. The renegotiation of those PPA should be exercised with the producers' agreement. In the case that this doesn't happen, a proper framework should be established in order to enable the existence of this agreement without any market interference. In this new framework, the energy produced by those power stations shall be sold in the wholesale market. The difference between the costs of the energy produced and the gains of selling this energy in the market is transferred to the customers through the access tariffs. Thus, the net consumers profit can be increased by an efficient management of those PPA. In this paper an incentive to maximize those profits is proposed. The mechanism is based on the fact that the Iberian spot market prices present a constant pattern, which allows the dispatch of power plants in a deterministic way, i.e., defined ex-ante at a minimum risk.

Keywords

Regulatory Incentives - Share of Benefits - Market Price - Profit Maximization - Combined Cycle Gas Turbine - Binding Generation.

1. Introduction

The opening of the market in the generation side oblige to renegotiate Power Purchase Agreements (PPA), traditionally applied in some electricity sectors.

The PPA usually establish that, as a counterpart to the electricity purchased and to the availability of the power plants, the producers receive an amount which enable to remunerate fixed costs related to the investments, defined as the Capacity Charge plus the amount of variable costs, defined as the Energy Charge, which are almost integrally related to the fuel consumption costs. Those two agreements are based on financial investments. Therefore, the Capacity Charge reflects the conditions how the loans which sustain the investments were negotiated.

The renegotiation of those PPA should be exercised with the producers' agreement. In the case that this doesn't happen, a proper framework should be established in order to enable the existence of this agreement without any market interference. A solution is to oblige the remaining producers with PPA to trade all the energy in the market. The difference between the costs of the energy produced and the gains of reselling this energy in the market is transferred to the customers through the access tariffs. Therefore, the existence of sunk costs or benefits have a neutral effect on the market. This scheme should be complemented with an incentive mechanism which leads the power generators to behave taking into account market rules.

The price structure in the wholesale energy market varies during the day, expressing the marginal unit group variable costs, which define the market clearing price. In view of the daily prices variability, the natural gas combined cycle power plant is a half-peak load power plant, which is generally not dispatched at off-peak hours. More recently, one can observed that the load factor of the combined cycle power plants in the Iberian market has been decreased. This is due to the increase of its production costs and, therefore, to the decrease of its competitiveness. The increase of renewable generation is also contributing to this situation, because of the spare capacity needed to the generation system.

On the other hand, the natural gas supplied to NGCC power plants is framed by agreements, which oblige to consume annually a minimum quantity of natural gas (QAC). The agreements are called take-or-pay agreements. If the annual consumption is lower than the QAC, the difference between the QAC and the natural gas consumption occurred has to be paid.

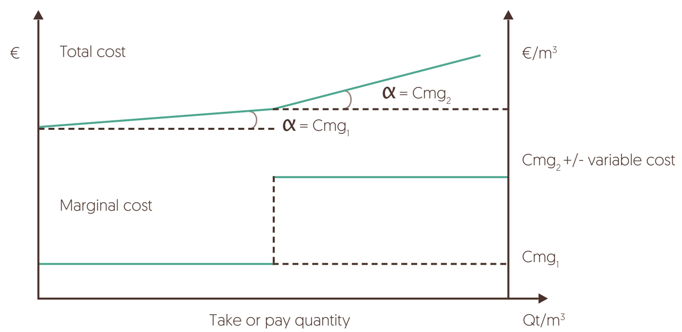
The existence of this kind of agreements has implications in the operation of the NGCC power plants. Therefore, up to the consumption of the QAC, the marginal cost of the

NGCC power plants is equal to the difference between the production cost and the cost which has to be paid for the non-consumed natural gas.

Figure 1 shows the evolution of the marginal cost of a power plant with a take-or-pay agreement. The rough equality between variable costs and marginal costs happens only when the quantity consumed is superior to the QAC. Up to the consumption of this quantity, it's economically rational to sell the energy bellow the variable cost.

Due to the recent evolution of the natural gas prices, hourly periods where the variable costs are lower than the market prices, are more limited. Therefore, the power plant has to be, more frequently, dispatched inclusively in periods where its marginal cost is higher than the market price, so as to consume the QAC. In this scenario, besides the guarantee that the QAC has to be consumed, the losses, proceeding from the fact that variable costs can be lower than the market price, have to be minimized.

Figure 1 - Marginal cost of a power plant with a *take or pay* agreement



2. Mechanism proposed

The optimized operation of NGCC power plants with PPA in a market environment can give important benefits to the customers. The optimized operation of the NGCC power plant, which materializes itself in benefits for the customers through the access Tariffs, is similar to a public good, as it shares with this kind of good two of its main characteristics, it's non-rival and non-excludable. Thus, the benefits obtained by the optimized operation of the NGCC power plant by one individual does not reduce the amount of those benefits available for others; and no one can be effectively excluded from benefiting from that good.

Therefore, the valuation of the optimized operation of the NGCC power plant is difficult, in practice. In Coase point of view, the solution for this issue would depend on the definition of the aggregated value that customers are willing to pay to create that public good. This solution is quite discretionary. In the present case the definition of this amount is left to the regulator. The mechanism for the optimized operation of the NGCC power plant should lead to operate this power plant in a way such it maximizes the benefits for the electricity customers. For this aim, the mechanism is based on the sharing of benefits between the operator of the NGCC power plant and the customers. The mechanism developed is framed by the following principles:

- Efficacy.
- Easy to implement and to monitor.
- Equilibrium in the incomes generated, such as they are enough to drive the operator of the NGCC power plant to optimize the operation of the power plant, without, however, being too high taking into account the costs borne by the operator to execute this task.

Thus, the mechanism main aim is to warrant that the NGCC power plant is operated long enough to enable the consumption of the QAC and, at the same time, this operation has to generate the highest possible income. The mechanism developed aims to lead the operator of the NGCC power plant to maximize the incomes obtained with the sale of the electricity in the wholesale market, allowing the operator to retain the incomes which exceed the value resulting from the product of α times the optimum income.

The mechanism developed to incentive the efficient operation of the NGCC power plant is presented in the following equation:

$$\begin{cases} I = R_{real} - \alpha \times (R_{opt}) \\ 0 \leq I \leq M_I \end{cases} \quad (1)$$

Where:

I, incentive for the correct bidding of the NGCC power plant in the wholesale market;

R_{real}, the total income obtained through the sale of the energy in the market;

α, Premium for the risk and the difficulty to achieve the optimum computed afterwards

R_{opt}, the optimum income i.e, the best income which would be obtained linked to the consumption of the natural gas;

M_I, the incentive maximum value.

The optimum income is computed *ex post*. That income is the income that would be obtained if the energy was sold at the higher price hours and, taking into account that the QAC had been consumed.

The application of this mechanism assumes that:

» The variable costs due to the consumption of the natural gas in the part which is larger than the QAC are lower or equal to the price of the energy sold.

» The costs due to the non-accomplishment of the take-or-pay agreement are not borne by the customers.

3. Justification

As it was mentioned before, the present mechanism aims to lead the operation of NGCC power plants with PPA in a market environment in a way such that the QAC is consumed and the energy is sold at the best hours, i.e., the highest price hours.

For the achievement of those aims, one looks for the measure of the inter-annual stability of the prices global structure. With this analysis, one intends to enquire if it's reasonable to apply, during several years, a mechanism based on the concepts of optimum and best hours.

Another analysis has to be done to define the degree of predictability of the hourly wholesale market price structure which faces the NGCC's power plant operator when it tries to bid the electricity in the wholesale market so as to maximize the income. The average level of uncertainty has to be considered in the definition of the mechanism's parameters.

Therefore, one seeks to know, firstly, if there is a stable relation between the possible incomes which can be obtained with the sale of the energy in the market, up to the consumption of the QAC. Figure 2 presents, for the period between 2004 and 2006, the hourly price decreasing annual curve, identifying the number of hours, which are necessary to consume the QAC for the NGCC power plant. Therefore, for each year, and per unit of power sold, the maximum annual incomes are compared to the maximum incomes which could be obtained up to the QAC consumption.

Figure 2 - Annual hourly prices curves

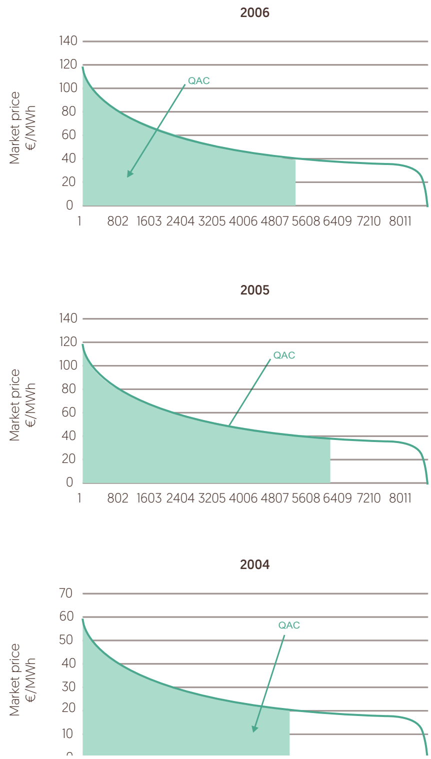


Table II presents the average value of the difference between the maximum income which could be obtained with the sale of 990 MW load in the wholesale market, OMEL, during the all year long, i.e, 8760 hours, and the maximum income which could be obtained with the sale of this load up to the QAC consumption (with and without a 15% deduction of that amount).

Between 2004 and 2006, this relation is about 35% or 21,3%, whether the reduction is considered or not. The standard deviations are 1,8% and 0,9%.

If the analysis is in quarterly terms, the relation between the maximum hourly income and the QAC's income is more volatile. Thus, for the same period the means value of the relation between the hourly maximum income and the QAC's income, without the deduction, are included between 20% and 24%; with the deductions those values are included between 34% and 39%. The standard-deviations are included between 1,3% and 2,8%, in what concerns the relation between the hourly maximum income without the deduction, and between 2,7% and 4,3%, when the QAC deduction is considered.

Table 2 - Difference between the maximum annual income and the income with the QAC consumption

	2004	2005	2006	Mean	Standard deviation
Difference betwen the maximum income and the income QAC	22,40%	20,8%	20,7%	21,3%	0,9%
Difference betwen the maximum income and the income QAC with a 15% reduction	36,9%	34,6%	33,4%	35,0%	1,8%

Therefore, a certain degree of stability is observed between the maximum income and the optimum income, being the standard-deviation of about 4%. This stability enables the application of a mechanism to maximize the incomes, which allows the operators of NGCC power plants with PPA to retain the incomes obtained beyond the optimum income, i.e., beyond the incomes which maximize the gains after the definition of the minimum consumption of natural gas for that year[1].

This mechanism has to be flexible enough in the definition of quantities, so as to consider technical restrictions, and changes to the effective value of the QAC.

4. Parameters to be adopted in 2008

The definition of parameters linked to that mechanism depends on the uncertainty which faces the operator of the NGCC power plants with PPA, when bidding the electricity so as to maximize incomes. This degree of uncertainty is analyzed afterwards. The monthly analysis of the hourly average prices permits to conclude that there's a similar pattern to the hourly price structure in monthly terms, Figure 3.

Figure 4 presents a ranking of these hours taking into account the market prices. This analysis is realized per trimester and also in an annual basis.

[1] QAC can be renegotiated each year.

Figure 3 - Hourly average market prices in 2006 per month

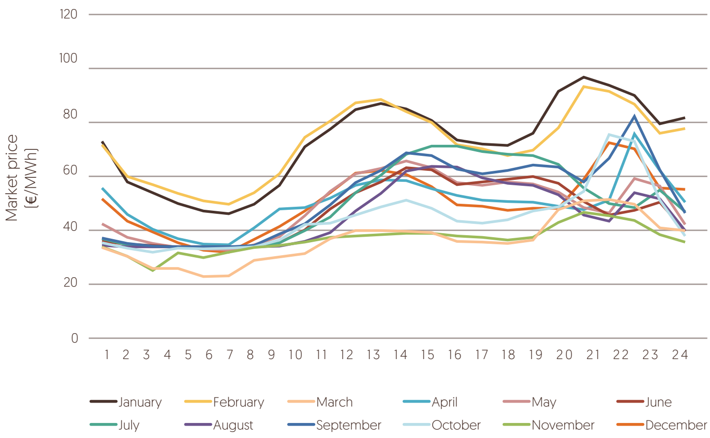
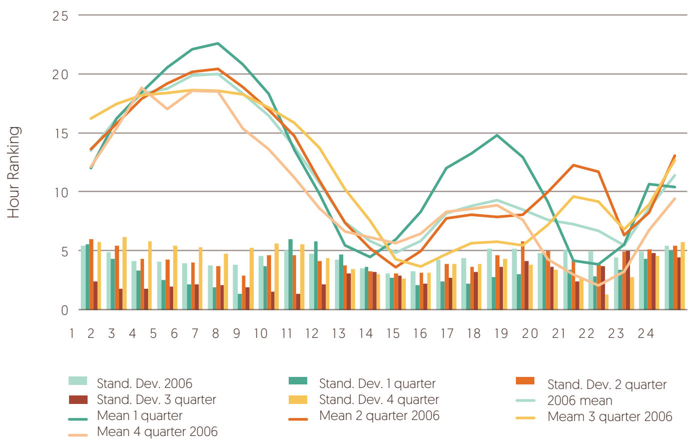


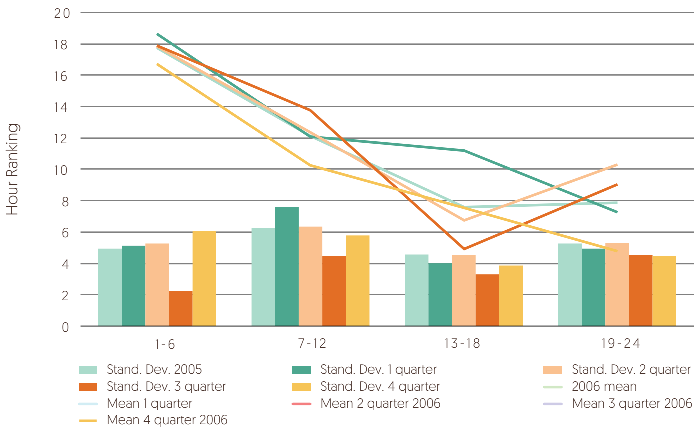
Figure 4 shows that in an annual or quarterly basis the hourly ranking, taking into account the market prices is quite volatile. Thus, at peak hours, which present the higher average prices, the standard-deviations are quite high in comparison to the rank of those hours. At off-peak hours (with lower prices), the standard-deviations are lower.

Figure 4 - Hourly rank taking into account the 2006 market prices



If the analysis of the hourly ranking takes into account a six hours period, the volatility observed previously is significantly lower as shown in Figure 5. Thus, for 2006 it can be observed that the period comprised between 1h and 6 h systematically presents lower prices.

Figure 5 - Hourly rank (6 hour period) taking into account the 2006 market prices



If the hourly average prices in yearly terms are considered, the volatility previously observed diminishes significantly.

Thus, Figure 6 shows that between 2004 and 2006, for example, the period included between 2h and 7h always presents the lower prices.

Figure 6 - Hourly ranking in an annual basis

The verification of this pattern all year long should allow the operators of those power stations to work out its dispatching plans safely, ordering each day the hours which maximize its incomes, taking into account the power plants technical restrictions.

Table III confirms what was mentioned. Thus, applying the average price structure, the incomes which could be obtained by a 1000 MW NGCC power plant are simulated, for the period between 2004 and 2006. In those simulations, the incomes are due to the sale of the NGCC power plant electricity up to the consumption of the QAC with a 15% deduction, i. e., for 5400 hours of operation, in the following situations:

- Operation during the 5400 "best" hours of the year, independently of the day (Maximum Income) (1);
- Operation during the 5400 "best" hours of the year, except for the week-ends and the holidays (2);
- Operation during the 5400 "best" hours of the year, fixed *ex-ante* for the week days in a deterministic way and taking into account the technical operating minimum load (3);
- Maximum income which could be obtained in 2006 with the real production (4).

Table III - Comparison between the annual maximum income for an operation of 5400 hours and the income obtained through a deterministic dispatch

Unit: euros

	Maximum income (1)	Income with operation only in weekdays (2)	Income after deterministic despach (only in weekdays and with techinal restrictions) (3)	((2)-(3))/(2) %	((1)-(3))/(1) %
2004	177 284 438	166 250 997	163 109 241	1,9%	8,0%
2005	345 833 878	323 084 233	317 389 592	1,8%	8,2%
2006	327 614 938	299 914 293	293 621 617	2,1%	10,4%

Note: The minimum technical load considered is 196 MW per unit.

The "deterministic" dispatch is based on the dispatching of the power plant at each hour of the week-day, at the maximum load, except for the hours which present the lower average prices. Between 2004 and 2006, the 6 hours with the lower prices were, always, by decreasing order of prices: 5h, 6h, 4h, 3h, 7h and 2h. It can be observed that the incomes obtained when the power plant is dispatched at the "best" hours, only known afterwards, are much closer to the income obtained when the power plant is dispatched in a deterministic way.

If the week-ends and holydays are not considered, the difference between the optimum income, known afterwards, and the income obtained with a deterministic dispatch, taking into account the technical minimum load, falls into a range between 1,5% and 2%. The difference increases up to values around 10%, if the set of the dispatched hours is enlarged and if week-ends are considered.

The consideration of the unavailability occurred leads to a significant diminution of both the maximum income and the real income.

Pondering the values presented in the Table III, the value adopted to the parameter α is 0,95. Therefore, it can be concluded that it's simple to achieve 90% of the optimum ex-post computed afterwards, which justify the consideration of the higher value of 95%.

Thus, the risk premium, has to be equal to 0,95. In what concerns the maximum value of the incentive, M_I, we proposed that it would be equal to 1 000 thousand Euros. This amount considers the operating costs of the operator of the NGCC power plant and the complexity assumed to the efficient operation of this power plant.

Table IV presents the income which could be obtained by a NGCC power plant with a PPA in 2006 whether the mechanism would have been already applied. It can be observed that in order for the operator to obtain the maximum value of income allowed by the mechanism, 1 million Euros, the application of this mechanism grants for the electricity system, revenues of about 10,4 million Euros. 10% of these revenues are shared with the operator of the NGCC power plant and the remaining 9,4 million euros are given to the customers through the access Tariffs.

Table IV - Estimated profit in 2006 whether the mechanism have been applied to a NGCC power plant with a PPA

Real income (energy sold at Omel)	Optimum income with avalaibility occurred and capacity restrictions	Income which triggers the mechanism	Minimum income to obtain the maximum value of the incentive		Operator's profit	Consumer profit
10^3 euros (1)	10^3 euros (2)	10^3 euros (3)=(2)*0,95	10^3 euros (4)=(3)+1000	(5)=((2)-(4))/(4)	10^3 euros (6)=(4)-(3)	10^3 euros (7)=(3)-(1)
240 078	262 634	249 502	250 502	4,6%	1 000	9 424

Conclusions

The mechanism developed aims to maximize the benefits for the customers due to an efficient management of the power plants with the remaining power purchase agreement (PPA). The basic principle is to lead the operators of NGCC power plants to follow market rules, maximizing its profit by selling the energy in the spot market. Thus, the mechanism allows these operators to share with the customers a part of this profit. As the management of this energy is similar to a Public Good, it has to be the regulator, as the customers' representative, who defines the remuneration due to the operators of the NGCC power plants for this service.

The incentive is defined ex-ante, based on the observation that the Iberian spot market prices presents a constant pattern, which allows the dispatch of power plants in a deterministic way, i.e., at a minimum risk.

Therefore, the mechanism allows that the economic principal of the profit maximization is used in the benefit of the customers and of the Portuguese electricity system.

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The opinions and interpretations presented in this paper do not necessarily reflect the official opinions of ERSE.

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Biographies

V. Marques (b. 1971) works for ERSE since 1997, the Portuguese Energy Regulator, as an economist at the DCP, the direction of the costs and profits.

His topics of work include cost of production issues, the definition of regulated profits and regulated parameters, namely costs of capital.

He published "Poder de Mercado e Regulação nas Indústrias de Rede" a book about the market power in network industries and the need for regulation in those industries. Vítor Marques is also a PhD student in the field of energy economics at the Faculty of Economy of the University of Coimbra.

C. Vaz (b. 1957) is graduated in Business Administration by the ISEG – Instituto Superior de Economia e Gestão of the Technical University of Lisbon, Portugal, in 1981. Since 1981 till 1987 worked as auditor at Ernst & Young Lisbon office. From 1987 to 1997 worked at EDP, becoming co-responsible for the implementation budget and control system of all group. In 1997 joined ERSE – Entidade Reguladora dos Serviços Energéticos, the Portuguese Energy Regulator, becoming since 2000 responsible for the Costs and Revenues Division. His main interests include all economic regulations subjects, namely the ones related with the definition and calculation of the regulated revenues and parameters.

P. Verdelho (b. 1963) received the Dipl. Ing., the M.S. and Ph.D. degrees from the Technical University of Lisbon-Instituto Superior Técnico, Lisboa, Portugal in 1987, 1990 and 1995, respectively, all in electrical engineering. He joined Instituto Superior Técnico in 1985. Since 1995 till 2002 he has been an Assistant Professor at the Universidade Técnica of Lisbon-Instituto Superior Técnico. Since 1985 he has been a research member of the Centro de Automática of the Technical University of Lisbon-Instituto Superior Técnico. In 1999 he joined the Portuguese energy regulatory authority, Entidade Reguladora dos Serviços Energéticos, being responsible for the Tariff and Prices Division. His main interests include electricity and gas tariffs and prices, energy efficiency, economic regulation, power quality, power electronics, active power filters, reactive power compensation systems, variable speed drive and generator systems. He published more than one hundred papers having received the 1996 IEEE Industrial Electronics Society Meritorious Paper Award.

Promoting demand-side management and energy efficiency in Portugal 2 years of experience

Isabel Apolinário, Cristina Correia de Barros, Hugo Coutinho, Liliana Ferreira, Bruno Madeira, Paulo Oliveira, Artur Trindade, Pedro Verdelho

Entidade Reguladora dos Serviços Energéticos
(Energy Services Regulatory Authority), Lisbon, Portugal

Abstract

ERSE has established a mechanism aimed at promoting efficiency in electricity consumption called PPEC, having a yearly (2007 and 2008) implementation budget of 10 million euros, representing 0,2% of final prices. PPEC consists of a tender mechanism, by which eligible promoters submit measures to improve electricity efficiency. These measures are selected through technical and economical evaluation criteria presented in this paper.

The benefits for the electricity sector and the environment from PPEC 2008 are much higher than the correspondent costs, with a ratio of 8:1 in the residential segment; 9:1 in the services segment and 7:1 in the industrial segment. From 2007 to 2008, the expected cumulative avoided consumption more than doubled from 390GWh / 144 455 tonCO_2 to 878GWh / 324 794 tonCO_2.

The costs per ton of CO_2 avoided (PPEC 2008: 9,2€/MWh; PPEC 2007: 21,2€/MWh) are much lower than the cost resulting from the implementation of equivalent measures in the supply side, such as the promotion of special regime generation (41,6€/MWh).

Keywords

Energy Efficiency - Demand Side Management - Economic Regulation.

1. Introduction

The purpose of this paper is to run a balance of the two years experience of implementing PPEC (Plano de Promoção da Eficiência no Consumo de Energia Eléctrica) demonstrating the importance of this sort of measures, that act on the demand side, in meeting international and national objectives for CO_2 emissions reduction.

2. Demand-Side Electricity Efficiency Plan (PPEC)

The most effective way to promote energy efficiency is through the definition of tariffs that allow the recovery of costs associated with each and every activity of the electricity sector and by tariff structures and prices that reflect marginal or incremental costs. This methodology is incorporated in the Portuguese electricity tariff code. Nonetheless, environmental externalities not reflected in prices and the existence of barriers to the adoption of efficient behaviours justify the implementation of initiatives to foster energy efficiency.

Therefore, ERSE has developed a mechanism for promoting efficiency in electricity consumption (PPEC). PPEC consists of a tender mechanism, by which eligible promoters (suppliers, network operators, consumers' rights associations, energy efficiency agencies, etc) submit initiatives to improve electricity efficiency in the industrial, services and household/residential sectors. The annual budget is 10 million euro and, as foreseen in the tariff code, that amount is supported through the Global Use of System Tariff, paid by all consumers.

PPEC comprises two types of measures:

» **Tangible** - installation of equipment with a level of efficiency superior to standard equipment on the market, therefore producing measurable consumption reductions. In Table I some examples of tangible measures are shown, as well as their technical characteristics.
» **Intangible** - disseminating information on energy efficient practices in order to promote a change in behaviours. An example of this kind of measures is energetic audits, information campaigns, seminars and conferences.

Table I - Technical characteristics of tangible measures (some examples)

Measure	Assumptions
Residential lighting (Fluorescent Compact Lighting 18 W)	- Aimed for the household segment - Useful lifetime: 6 years - Annual consumption reduction: 62 kWh (relative to 75W incandescent light bulb)
Electronic ballasts	- Aimed for the services segment - Useful lifetime: 16 years - Annual consumption reduction: 63 kWh (relative to a ferromagnetic ballast and considering T8 bulbs of 36W)
Electronic speed variator (<=70KW)	- Aimed for the industrial segment - Useful lifetime: 15 years - Annual reduction in consumption: 25%

3. Technical and economic criteria for evaluating energy efficiency measures

The measures are analysed and approved by means of a competitive process and ranked according to pre-established rules, based on a cost-benefit analysis.

3.1. Evaluation criteria for energy efficiency tangible measures

In evaluating the tangible measures, first of all, the Social NPV (Net Present Value from a social perspective) is calculated as in (1). Measures with a negative NPV are excluded.

$$NPV = \sum_{i=1}^{n} \frac{B_{St} - C_{St}}{(1+i)^{t}} \qquad (1)$$

where:

B_{St} Total benefits from the social point of view in year t

C_{St} Total costs from the social point of view in year t i Discount rate

n Useful lifetime

The net social benefit (NBS) of each measure for each year is given by the following expression (2)

$$NBS = B_{St} - C_{St} = \Delta MgC + B_{Env} - (CM_{part} + CM_{PPEC} + CM_{others}) \qquad (2)$$

where:

ΔMgC is the avoided cost of supplying electricity (includes generation, transmission and distribution)

B_{ENV} is the avoided CO_2 emissions

CM_{part}, CM_{PPEC}, CM_{others} are the costs borne by the participants, PPEC and other entities.

The tangible measures' ranking process is done individually for each segment: industry, services and households, thus allowing for the funds to be distributed by all segments.

Measures with a positive NPV are then ranked according to the following technical and economic criteria:

(a1) **benefit-cost proportional analysis** – 25 points (3);

$$P_P = 25 \times \frac{RBC_p}{RBC_{max}} \qquad (3)$$

where the weight of each measure (p) is proportional to its benefit-cost ratio (RBC), calculated in (5), up to 25 points, being 25 points given to the measure with the highest benefit-cost ratio.

(a2) **benefit-cost ordered analysis** – 25 points (4);

$$25 - (k - 1) \times \frac{25}{n} \qquad (4)$$

where:

n is the number of measures

k is the position of the measure in terms of RBC

The RBC is calculated accordingly to the following expression (5):

$$IS_c = \frac{\sum_{t=0}^{n} \frac{B_{St}}{(1+i)^t}}{\sum_{t=0}^{n} \frac{C_{PPECt}}{(1+i)^t}} \qquad (5)$$

where:

RBC Benefit-cost ratio

B_{St} Total benefits from the social point of view in year t

C_{PPECt} Total costs, from the PPEC point of view in year t

i Discount rate

n Useful lifetime

(b) equity (5 points) – evaluates the measure of equity considering the geographical scope and the way participants and suppliers are selected on the basis of a predefined set of questions;

(c) presentation quality (5 points) – evaluates the measure in terms of how clearly and objective it is presented and how well its assumptions are justified. It also evaluates the quality of its measuring and verification plan both on the basis of a predefined set of questions;

(d) scale risk (10 points) – evaluates the variation in average costs in each measure as a function of its execution rate (6);

$$IS_C = \left(\frac{CF + \sum_{i=1}^{m} C_{vi}}{CF + \sum_{i=1}^{n} C_{vi}} \right) - 1 \qquad (6)$$

where:

IS_C Scale index

CF Fixed PPEC cost, i.e, does not depend on the number of interventions

Cv_i Unit variable PPEC cost of intervention *i*

m Number of interventions

n Half the interventions

The best ranked measure receives 10 points and the following are ranked as shown in (7)

$$10 \times \frac{IS_C}{IS_{Cmax}} \qquad (7)$$

where:

IS_C Sensibility index

IS_{Cmax} Maximum sensibility index in all the measures of a given segment

(e) **ability to overcome market barriers and spillover effect** (5 points) – evaluates measures in terms of its effectiveness in overcoming market barriers to its implementation and its capability in spreading out its effects on the basis of a predefined set of questions;

(f) **innovation** (5 points) – evaluates the degree of uncommonness of a measure and compensates innovative measures for its higher costs relatively to conventional measures on the basis of a predefined set of questions;

(g) **weight of the investment in equipment in the total cost of the measure** (10 points) – awards measures that maximize the direct investment in equipment rather the administrative or support costs (8);

$$ID = \frac{K}{CT} \qquad (8)$$

where:

ID weight of the investment in equipment in the total cost of the measure

K PPEC amount spent on acquiring the equipment

CT total costs

The best ranked measure receives 10 points and the following are ranked as shown in (9)

$$10 \times \frac{ID}{ID_{max}} \qquad (9)$$

where:

ID weight of the investment in equipment in the total cost of the measure

ID_{max} Maximum weight of the investment in equipment in all the measures of a given segment

(h) **savings sustainability** (10 points) – awards measures that generate long lasting savings.

- Savings last up to 3 years: 3 points

- Savings last between 3 and 10 years: 1 point for each year - Savings last more than 10 years: 10 points

In order to maximize the program's score the measures are selected accordingly to the following expression (10). The marginal measure is subject to budgetary cuts in order to meet and fulfill PPEC's budget.

$$\max \sum_{i \in Us}^{m} f_i(A1, A2, B, C, D, E, F, G, H, Interv_i) \sum_{i \in Ap_S}^{m} Cost_i^t \leq Budget_s \qquad (10)$$

where:

$$Cost_i^t = C_{Fix\,i}^t + Interv_i \times C_{Var\,i}^t$$

Where f_i is the score of measure *i*, from the total measures in segment *s*, considering the number of interventions $Interv_i$ that ensures that the cost restriction is met (the total cost of measures approved in segment *s*, Ap_s, should be comprised in its segment budget). The cost of each measure *i* corresponds to the sum of the fixed cost (C_{Fix}) and the variable cost (c_{Var}).

3.2. Evaluation criteria for energy efficiency intangible measures

Intangible measures are ranked according to the following criteria:

(a) presentation quality – 20 points;

(b) equity – 20 points;

(c) ability to overcome market barriers and spillover effect – 20 points;

(d) innovation – 20 points;

(e) experience in similar programs – 20 points.

The number of interventions in intangible measures is not variable, however it is considered acceptable that the costs of the marginal measure be reduced up tp 20% to meet the budget frontier.

3.3. Classification matrix applied to the non-metric criteria

The benefit-cost ratio, weight of the investment in equipment in the total cost of the measure and, savings sustainability are metric criteria, while the remaining are of a non-metric nature. In order for the non-metric criteria to be objective, a classification matrix was created.

Table II - Presentation quality matrix

Question	Tangible	Intangible
Does the measure meet the information requirements in PPEC regulations (article 14)? For the *i* requirements, we have: 0xpts: if *i*≤9 (tangible); *i*≤7 (intangible) 1/3xpts: if *i*=10 (tangible); *i*=8 (intangible) 2/3xpts: if *i*=11/12 (tangible); *i*=9(intangible) 1xpts: if *i*≥13 (tangible); *i*≥10 (intangible)	1 point	5 points
What is the average presentation quality of the measure? Low (0xpts); Medium (1/3xpts); High (2/3xpts); Very High (1xpts)	0,5 points	4 points
Is all the information necessary to calculate the ranking criteria submitted?	1 point	5 points
Are the indicators necessary to the application of the ranking criteria presented in a correct, clear and coherent manner?	0,5 points	Not applicable
Are the assumptions relating the costs of equipment, avoided consumptions and reference scenarios well supported?	1 point	Not applicable
Does the measure contain a cost-benefit analysis?	Not applicable	2 points
Does the measure present an adequate timetable of its stages?	0,5 points	4 points
Is the verification plan in line with the measures' objectives?	0,5 points	Not applicable
Total	**5 points**	**20 points**

Table III - Equity matrix

Question	Tangible	Intangible
Is consumer eligibility based solely on characteristics related to the consumption of the potential beneficiary?	1,25 points	Not applicable
Does the measure ensure non discriminative behaviors concerning the geographic location?	1,25 points	6 points
Do the promotional events ensure that all potential participants are considered?	1,25 points	4 points
Is there a market consultation before choosing the supplier of the services /equipments?	1,25 points	Not applicable
What is the relation between the cost of the measure and its effectiveness to overcome market barriers?	Not applicable	10 points
Total	5 points	20 points

Table IV - Ability to overcome market barriers and spillover effect matrix

Question	Tangible	Intangible
Which of the following market failures does the measure help overcome? Higher cost; Lack of information; Difficult access to financing; Insufficient distribution network; Agency problems; Existence of negative externalities not included in the price What is the effectiveness of the measure in overcoming the above mentioned barriers? Low (0xpts); Medium (1/3xpts); High (2/3xpts); Very High (1xpts)	3 points	8 points
What is the probability of the measure producing tangible effects in the short / medium term? Low (0xpts); Medium (1/3xpts); High (2/3xpts); Very High (1xpts)	Not applicable	8 points
Are there durable information supports?	0,5 points	2 points
Does the measure make the beneficiaries accountable for results?	0,5 points	1 point
Does the measure help to create competences among participants?	Not applicable	1 point
Does the measure promote awareness among participants?	0,5 points	Not applicable
Does the measure have impact in consumers other than the participants?	0,5 points	Not applicable
Total	**5 points**	**20 points**

Table V - Innovation matrix

Question	Tangible	Intangible
How innovative is the measure in the context of energy efficiency promotion in Portugal? Low (0xpts); Medium (1/3xpts); High (2/3xpts); Very High (1xpts)	2,5 points	14 points
How innovative is the measure in what concerns consumers' involvement? Low (0xpts); Medium (1/3xpts); High (2/3xpts); Very High (1xpts)	0,5 points	6 points
Is the equipment's technology considered emergent?	0,5 points	Not applicable
Is there a concern to minimize environmental impacts?	1,5 points	Not applicable
Total	**5 points**	**20 points**

Table VI - Experience matrix

Question	Tangible	Intangible
Is the promoter's or his partners' experience relevant for the implementation of the measure? Low (0xpts); Medium (1/3xpts); High (2/3xpts); Very High (1xpts)	Not applicable	14 points
What is the relevance of the partnerships for the success of the measure and its implementation? Low (0xpts); Medium (1/3xpts); High (2/3xpts); Very High (1xpts)	Not applicable	6 points
Total	**0 points**	**20 points**

The PPEC regulations [5] defines some of the parameters used to evaluate the measures like, the discount rate applicable to the benefits and costs, the avoided unit costs, the value of the avoided CO_2 emissions, and the useful life of the equipments. Some parameters like the avoided consumption of the equipments were adjusted considering well justified proposals received from the promoters.

4. Impacts and benefits of the energy efficiency measures approved by PPEC

The first PPEC - PPEC 2007, comprise measures to be implemented in 2007, 2008 and 2009. The second PPEC – PPEC 2008, relates to measures to be implemented in 2008, 2009 and 2010.

Figure 1 depicts the array of measures candidate to PPEC 2008 and the measures approved by type of technology. It can be seen that the amount of candidate measures is much higher than the approved amount. So a very competitive contest was achieved.

Figure 1 - Measures candidate to PPEC 2008 and measures approved

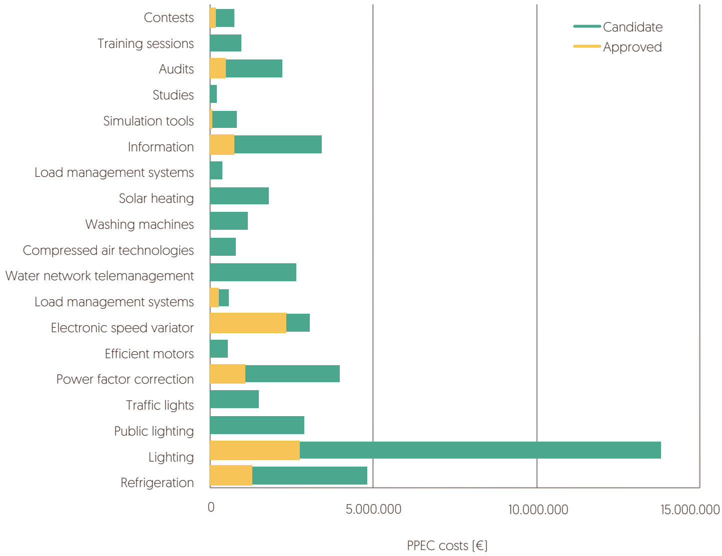


Figure 2, below, shows that PPEC 2008 was more competitive than PPEC 2007 in terms of candidate amounts, while Figure 3 compares PPEC 2007 with PPEC 2008 in terms of the number of candidate measures and total amounts. In 2008, 131 measures valued in 46,2 million euruos were submitted to the contest, while only the best measures valuing 9,3 million euros could be approved.

Figure 2 - Measures candidate to PPEC 2007 and PPEC 2008 and measures approved by contest

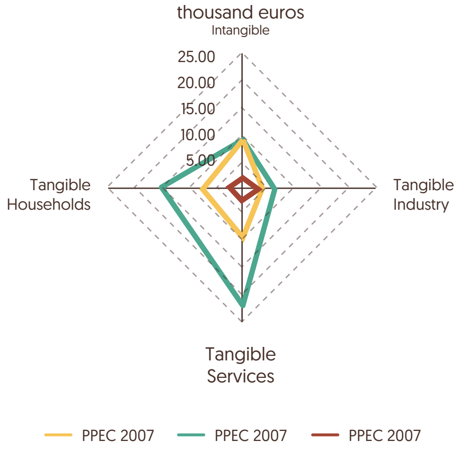


Figure 3 - Number and amount of measures candidate to PPEC 2007 and PPEC 2008

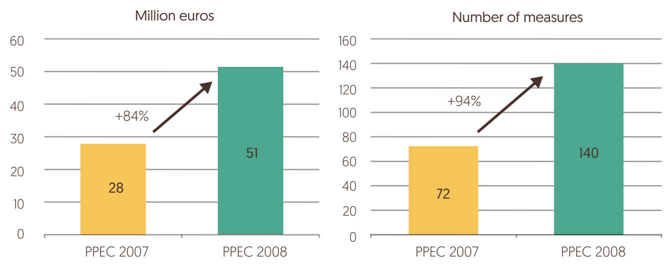
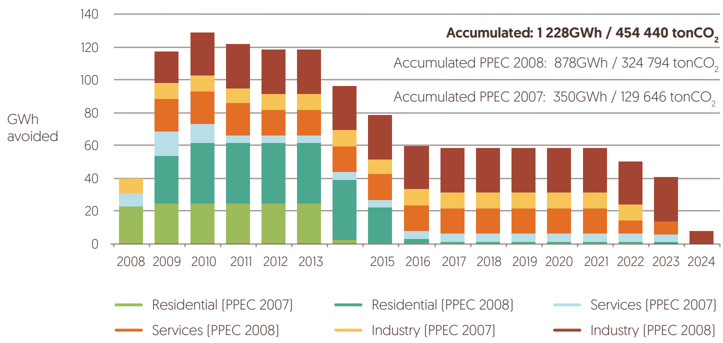


Figure 4 forecast expected measurable impacts for the implementation of PPEC 2007 and PPEC 2008. From 2007 to 2008, the expected cumulative avoided consumption from measures approved more than doubled (390 GWh / 144 455 ton CO_2 to 878 GWh / 324 794 ton CO_2). This is the result of the higher benefit/cost ratio of PPEC 2008 compared to PPEC 2007.

Figure 4 - Annual avoided consumption from PPEC 2007 and PPEC 2008 tangible measures



Measures approved in PPEC 2007 have a unit cost of 21,2€/MWh avoided, which compares to a lower value of 9,2€/MWh avoided in the measures approved by PPEC 2008 (Figure 5 and Figure 6).

The measures approved are subject to auditing in order to verify its degree of compliance in terms of costs, objectives and avoided consumption.

Figure 5 - Benefits and costs from PPEC 2007 tangible measures per unit of consumption avoided

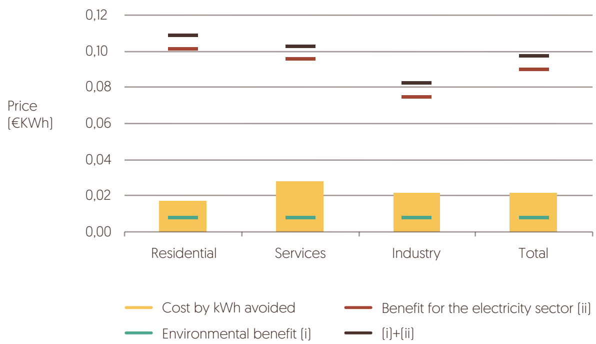
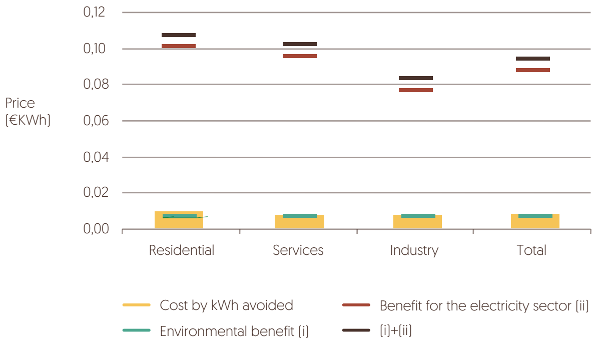


Figure 6 - Benefits and costs from PPEC 2008 tangible measures per unit of consumption avoided

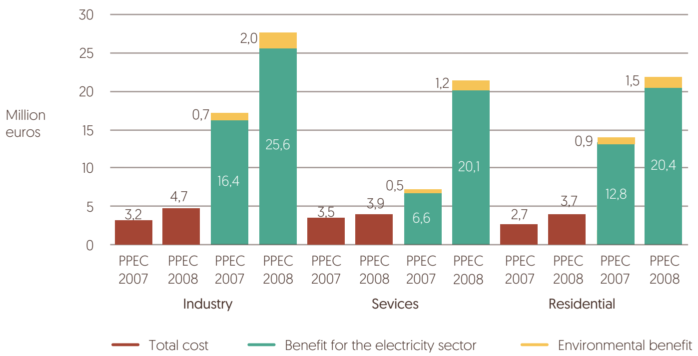


In any scenario the unit costs of consumption avoided are significantly lower than the cost resulting from the implementation of supply side equivalent measures, such as the premiums given to special regime generation (41,6 €/MWh).

The premium paid to special regime generation is justified by the goal of reducing CO_2 emissions and diversifying sources of supply. Demand side management tools, like PPEC, proves to be competitive and serve the same purposes as special regime generation. Although both solutions have other virtues, it is clear that their assessment should be made in parallel.

Figure 7 illustrates the cost and the social benefit per consumer estimated for PPEC 2007 and PPEC 2008. The analysis clearly shows that in only one year the efficiency of the measures approved increased. In fact, in any given segment or year, expected benefits clearly outweight expected costs, up to a factor of 9 in PPEC 2008 – services segment.

Figure 7 - Costs and social benefits per consumer from measures in PPEC 2007 and PPEC 2008



Conclusions

The paper presents 2 years' experience in promoting demand-side management and energy efficiency in the framework of the electricity regulation. The instrument conceived by ERSE to improve electricity efficiency in the demand side is called PPEC (Plano de Promoção da Eficiência no Consumo).

PPEC consists of a tender mechanism, by which eligible promoters submit measures to improve electricity efficiency. These measures are selected through an objective technical and economical evaluation criteria presented in the paper.

For PPEC 2008, 131 measures valued in 46,2 million euros were submitted to the contest, knowing that only the best measures worth 9,3 million euros would be approved. The expected cumulative avoided consumption is 878 GWh representing 324 794 tonCO_2. The expected measurable benefits to be recovered are 72 million euros leading to a global benefit/cost ratio of 7,7.

The analysis of the forecasted PPEC impacts encourages the adoption of competitive demand side management tools, such as PPEC, as a regulatory tool to foster energy efficiency in consumption and CO_2 emissions reduction.

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The opinions, interpretations and conclusions presented in this paper do not necessarily reflect the official position of ERSE.

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Biographies

I. Apolinário (b. 1973) graduated in Economics in 1996 and received her MSc Degree in Energy and Environment Economics in 2005, both from the Technical University of Lisbon – Instituto Superior de Economia e Gestão. She is with ERSE since 1998 and her professional background includes the Portuguese Electricity Operator (EDP) and the Portuguese National Institute of Statistics, producing the Quarterly National Accounts. Her current interests are electricity and gas tariffs, economic regulation, efficiency and productivity, energy efficiency and market liberalization.

C. Correia de Barros (b. 1974) graduated from the Technical University of Lisbon – Instituto Superior Técnico, Lisbon, in Electrical Engineering (1998). She is with ERSE since 1999 and her professional background includes the General Directorate for Energy end geology (DGEG). Her current interests are electricity and gas tariffs, energy efficiency and market liberalization.

H. Coutinho (b. 1978) graduated in mechanical engineering in 2003, and he got the M.Sc. degree in mechanical engineering, Energy profile, in 2006, both from the Technical University of Lisbon – Instituto Superior Técnico, Portugal. He is with ERSE since 2005 and his background includes Computational Fluid dynamics (CFD) and project analysis of micro Combined Heat and Power (CHP) plants. His current research interests include energy supply tariffs, energy efficiency, market liberalization and renewable energy systems.

L. Ferreira (b. 1978) graduated in Management in 2001 from the Universidade Nova de Lisboa. She is with ERSE since 2007 and her professional background includes the Portuguese Electricity Operator (EDP). Her current interests are electricity and gas tariffs, economic regulation, efficiency and productivity, energy efficiency and market liberalization.

B. Madeira (b.1978) graduated from the Technical University of Lisbon - Instituto Superior Técnico, Lisbon, in power engineering (2003). He is with ERSE since 2007 and his professional background includes the Portuguese Transmission System Operator, REN. His current interests are energy supply tariffs, energy efficiency, market liberalization and information systems.

P. Oliveira (b.1976) graduated from the Technical University of Lisbon - Instituto Superior Técnico, Lisbon, in power engineering (1999). He is with ERSE since 2001 and his professional background includes the Portuguese Transmission System Operator, REN. His current interests are energy supply tariffs, energy efficiency, market liberalization and information systems.

A. Trindade (b. 1971) graduated from the Catholic University of Lisbon, in Economics (1994). He Received the M.A in Development Economics from the University of Kent at Canterbury (1995). He is with ERSE since 2000 and his professional background includes the Portuguese Energy Agency (ADENE), the Portuguese Secretary of State for Industry and Energy and lecturing undergraduate economics. His current research interests include economic regulation, energy efficiency, renewable energy and energy markets reform.

P. Verdelho (b. 1963) received the Dipl. Ing., the M.S. and Ph.D. degrees from the Technical University of Lisbon-Instituto Superior Técnico, Lisboa, Portugal in 1987, 1990 and 1995, respectively, all in electrical engineering. He joined Instituto Superior Técnico in 1985. Since 1995 till 2002 he has been an Assistant Professor at the Universidade Técnica of Lisbon-Instituto Superior Técnico. Since 1985 till 2007 he was a research member of the Centro de Automática of the Technical University of Lisbon. Since 2007 he has been a research member of Centro para a Inovação em Engenharia Electrotécnica e Energia from Instituto Superior Técnico. In 1999 he joined the Portuguese energy regulatory authority, Entidade Reguladora dos Serviços Energéticos, being responsible for the Tariff and Prices Division. His main interests include electricity and gas tariffs and prices, energy efficiency, economic regulation, power quality, power electronics, active power filters, reactive power compensation systems, variable speed drive and generator systems. He published more than 100 papers having received the 1996 IEEE Industrial Electronics Society Meritorious Paper Award.

Behavioural factors' influence on energy savings

Isabel Apolinário, Cristina Correia de Barros, Hugo Coutinho, Liliana Ferreira,
Bruno Madeira, Paulo Oliveira, Alexandra Tavares, Artur Trindade, Pedro Verdelho

ERSE (Energy Services Regulatory Authority) – Portugal

Abstract

Energy consumption depends on various factors, such as equipment's energy efficiency, comfort level, consumer's behaviour and income. Equipment's efficiency and consumer's behaviour are crucial to achieve energy savings.

The present paper focuses on the relation between energy savings and consumer's behaviour.

For the majority of demand side management measures, energy savings obtained are affected by behavioural factors, introduced by the consumers.

The Portuguese Energy Services Regulatory Authority (ERSE) has developed a competitive mechanism for promoting efficiency in electricity consumption called PPEC (Demand-side Electricity Efficiency Plan). In this plan, energy efficiency measures, promoted by suppliers, network operators, consumers and energy agencies, etc, are evaluated and ranked by merit order. The merit of each measure is defined by a cost-benefit analysis.

A methodology to consider the behavioural factors in the merit analysis of energy efficiency measures is presented in the paper.

1. Introduction

The present paper presents a methodology to consider the behavioural factors in the usage conditions of certain electrical equipment in order to estimate electricity savings. This methodology is presented and applied to a set of measures designed to promote energy efficiency in the context of PPEC (Demand-side Electricity Efficiency Plan). It discusses several hypotheses for evaluating the behavioural factor (BF) on savings and the results in the ranking of energy efficiency measures.

Some conclusions about the influence of behavioural factors can be obtained.

2. PPEC - Demand-side Electricity Efficiency Plan

ERSE has developed a competitive mechanism for promoting efficiency in electricity consumption called PPEC by which eligible promoters (suppliers, network operators, consumer associations, energy agencies, etc.) submit initiatives to improve electricity efficiency in the industrial, commercial and residential sectors. The annual budget of the program is supported by the Global Use of System regulated tariff, paid by all consumers and included in third party access tariffs.

In this plan, energy efficiency measures are evaluated and ranked by merit order, based on a technical and economical analysis [1]. The evaluation process is based on a metrical criteria related with the amount of energy savings deemed achievable through a given measure. These energy savings depend on the efficiency measure tangibility. Thus, energy efficiency measures are classified in two categories: tangible and intangible measures [2].

A tangible measure is usually associated with the installation of physical equipment with a level of efficiency superior to standard equipment available on the market, therefore producing measurable consumption reductions.

An intangible measure is associated with disseminating information or technical skills on energy efficient practices in order to promote a change in behaviours. Some examples of this sort of measures are energy audits, information campaigns, seminars and conferences.

The ranking process for tangible measures is run separately for each consumer segment: industry, services and households, thus allowing for the funds to be distributed by all segments.

Intangible measures cannot be evaluated by metrical criteria. Consequently, non-metrical criteria have to be applied, e.g. the ability to address and suppress relevant market barriers, equity on the access of the general public to the measure's benefits, risk of scale or innovation level [4].

The results obtained with demand side management programs, like PPEC, have proven to be cost effective when compared to other measures intended to lower carbon emissions (as green generation for example). Evidently both approaches have different virtues but it is clear that their consideration in energy policy instruments should be made in parallel.

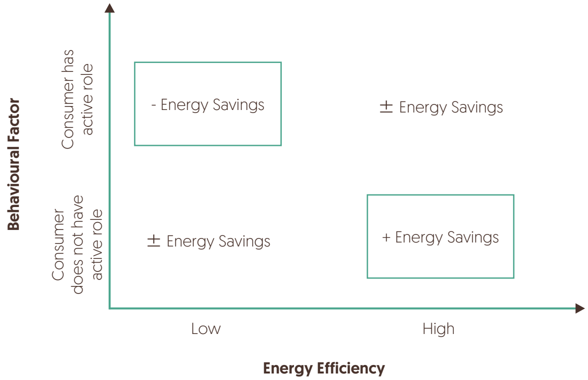
3. Behavioural Factors

The energy consumption level is influenced by equipment's energy efficiency, by consumer's behaviour, their comfort and income levels. The last two items are correlated. The efficiency level of equipment is mostly determined by technological issues. Energy consumption resulting from the use of certain equipment depends on this efficiency level but also on the intensity of use (for example, a heating device will consume more energy with the hours it is running or the necessary heating power). This intensity of use is related to the utility level required by the consumer. Finally, and without reducing this utility level (or intended output), consumer behaviour can affect the energy consumption resulting from using a given technology (e.g. leaving the room light on when there is nobody there).

The consumer behaviour is likely to affect energy savings in some cases more than others. When savings are more dependent on behavioural aspects they are less likely to materialize. Thus, the expected energy savings resulting from a given energy efficiency promotion measure should be riskier (therefore, lower), in the case of higher dependence on consumer participation (behaviour). A behavioural factor is used for each efficiency measure to characterize the likelihood of its energy savings (taking values from 0 to 1). If there is great dependence between energy savings and consumer behaviour, then the behavioural factor is high, penalizing the efficiency measure. On the other hand, the behavioural factor is low for measures whose results do not depend too much from consumer actions.

The next figure resumes these statements.

Figure 1 - Behavioural factor and energy efficiency contribution to energy savings



An example of great dependence between achieved energy savings and consumer deliberate action is a power strip with a switch. This equipment provides a simple way of reducing stand-by energy consumptions but in order for savings to happen the consumer must deliberately switch on and off the power strip. Otherwise, the power strip is just like a plug which does not avoid stand-by consumption by itself.

Behavioural factors application model

A model was designed to apply behavioural factors to energy savings estimation in the context of PPEC's evaluation and ranking process. It was also analysed the influence of these behavioural factors in the ranking results.

Behavioural factors were only applied to tangible efficiency measures, affecting the metrical evaluation criteria.

Some hypotheses were drawn to determine the behavioural factor for each efficiency measure. It was set that the behavioural factor would depend on the consumer's role in the installation and utilization of the equipment (Hypothesis 1), on the consumer's share of the overall cost of the new equipment (Hypothesis 2) and on the type of consumer (industrial, commercial or residential). For efficiency measures addressing the household segment, an additional hypothesis was considered, which is whether it targets or not consumer segments with special needs (Hypothesis 3). Each hypothesis is described in more detail in the next paragraphs.

Generally, energy savings can be determined by the expression:

$$W_{Savings} = W_{Potential\ savings} \times BF$$

Where:

$W_{Savings}$ are the expected energy savings after taking into account the behavioural factor BF;

$W_{Potential\ savings}$ are the total potential energy savings which can result from the efficiency measure when the consumer fully and correctly uses the efficient equipment.

Hypothesis 1

In this hypothesis, the behavioural factor is determined by the expression:

$$BF = BF_1 = BF_{1A} \times BF_{1B}$$

Where BF_{1A} and BF_{1B} are settled according to Table 1.

In one hand, if the consumer plays a big role in installing or in using certain equipment, the *BF* should be low, meaning that there is a higher risk that the measure is not correctly installed or used, thus not producing the expected results in respect to energy savings.

Additionally, the higher the energy consumption level of a given consumer, the more important can be expected to be for him the energy savings resulting from the efficiency measure. That importance can be translated into a more skilled and professional look into energy efficiency measures. Thus, the value of BF has been set higher for consumer segments with higher energy consumption.

Table 1 - Behavioural Factor for Hypothesis 1 (BF_{1A} and BF_{1B})

Question	Answer	BF_1 Household	BF_1 Services	BF_1 Industrial
BF_{1A} - Do energy savings depend of the consumer installing the equipment?	No	1	1	1
	Yes	0,9	0,95	0,975
	Yes and other alternatives with low saving performance exist.	0,2	0,6	0,8
BF_{1B} - Is the energy savings dependent on the consumer's equipment utilization?	No	1	1	1
	Yes	0,5	0,75	0,875

Hypothesis 2

This second hypothesis considers an additional question in determining the *BF*: what is the consumer's share in paying for the efficiency measure? The higher is this share the more probable is that energy savings are obtained, once the consumer is more personally committed to them. The share of consumer's participation in the costs of the efficiency measure is given by:

$$Cons_{share} = \frac{\text{Cost payed by the costumer}}{\text{Total cost of the measure}}$$

The BF_2 parameter was determined stepwise according to this share and intervals considered (0-10%, 10-30% and 30-100%) as shown in Table 2.

In this case, the BF to be applied to the energy savings is determined by:

$$BF = BF_1 \times BF_2$$

Table 2 - Behavioural Factor for Hypothesis 2 (BF_2)

Question	Answer	BF_2 Household	BF_2 Services	BF_2 Industrial
What is the share of consumer participation in the costs of the efficiency measure?	0-10%	0,9	0,9	0,95
	10-30%	0,95	0,95	0,95
	30-100%	1	1	1

Hypothesis 3

The last hypothesis in determining the BF takes into account whether the consumer targeted by the efficiency measure belongs to any consumer group economically fragile. For consumers with economic difficulties, there should be greater awareness of the energy costs, thus stronger commitment to obtain energy savings provided by an efficiency measure. The identification of such consumer groups can rely on the location where the measure is implemented (for instance in social districts or old neighbourhoods), or other means.

This hypothesis was only applied to measures implemented in the residential sector. The BF is determined using the BF_3 value, as described in Table 3, as well as the following expression:

$$BF = BF_1 \times BF_2 \times BF_3$$

Table 3 - Behavioural Factor for Hypothesis 3 (BF_3)

Question	Answer	BF_3 Household	BF_3 Services	BF_3 Industrial
Does the measure target economically fragile consumer groups?	Yes	1	-	-
	No	0,95	-	-

Results of BF application to energy efficiency measures

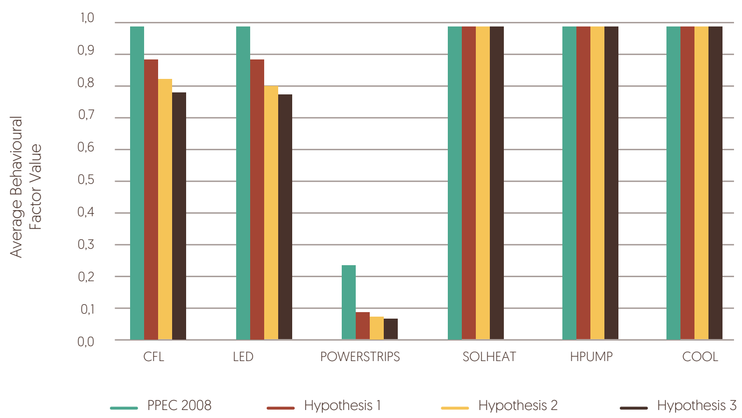
The behavioural factor model described was applied to a set of energy efficiency measures that were submitted for approval in the PPEC for 2008. Figure 2 shows the BF applied according to the hypothesis described.

The technologies included in the case study were: compact fluorescent lamps (CFL), LED lamps (LED), Power Strips (with a switcher), cooling (COOL), solar heating (SOLHEAT) and heating pump (HPUMP).

In PPEC 2008 analysis, only POWER STRIPS energy savings were affected by a risk factor of 0,25 because of its clear dependence on consumer's behaviour.

With the hypotheses presented in above, SOLHEAT, HPUMP and COOL measures were not affected by the behavioural factor since equipment installation is usually done by professionals and the efficiency performance of the equipment is not affected by the way consumers use the equipment. On the contrary, POWER STRIPS measures are the most influenced by the behavioural factor.

Figure 2 -Behavioural Factor application to energy efficiency measures

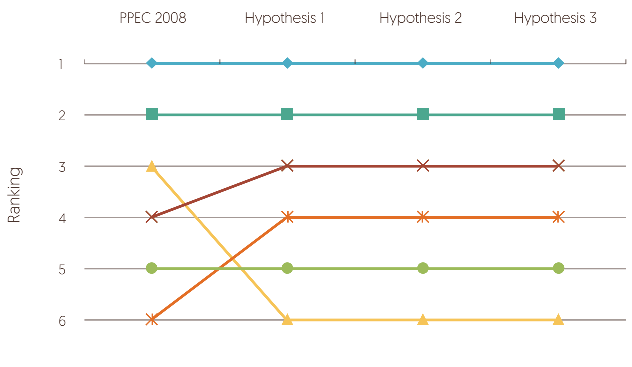


Some conclusions can be drawn from the application of the BF to energy savings evaluation.

The BF's influence on the evaluation of the efficiency measures is such that it can change the merit order resulting from the ranking process. Figure 3 shows an example of the way this ranking can be affected by the application of BF. It also shows that, for the particular set of measures analysed, the use of additional criteria for BF determination (Hypothesis 2 and Hypothesis 3) does not influence the relative ranking of different technologies.

Some types of measures change their ranking positions depending on the use of BF. SOLHEAT and HPUMP measures raised their ranking position, while POWER STRIPS measures decreased notably their rank. In a competitive mechanism like PPEC, which assigns financing resources to the best efficiency promotion measures, changing the merit order of a measure can make the difference between achieving the financing approval or not.

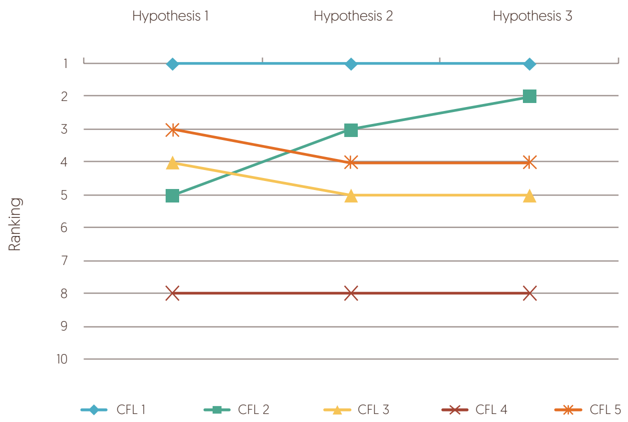
Figure 3 - Ranking of efficiency measures by technology considering the BF



In Figure 3, it was considered an average ranking position for each technology. It is also important to analyse the influence of BF in different measures of similar technologies. Figure 4 presents the influence of BF on the ranking results of CFL measures among the measures for the residential customers. The 5 CFL measures were submitted to PPEC by promoters and, although they address the same technology, they present several differences respecting the way they are delivered to the public, the consumer groups targeted and share of consumer participation in the cost of the lamps. This results in different ranking positions. Nevertheless, 4 out of 5 measures are in the top 5 efficiency measures for the residential sector, showing that CFL is a very cost-effective energy saving solution.

When comparing different measures that target the same efficient technology, the results of applying BF can be observed and can even be more visible because the global evaluation of the measures is similar. It shows that the ranking changes with every option taken in respect to the BF determination.

Figure 4 - Ranking of CFL measures considering the BF



Conclusions

In the context of a regulatory instrument for energy efficiency promotion, which attributes financing resources to measures upon a competitive mechanism, a methodology to take into consideration the relation between the energy savings and consumer behaviour is developed. Energy savings credited to efficiency measures that rely much on the consumer role can be discounted compared to other measures which presumably can produce results without having to account on the consumer good practices.

The use of such methodology is more important when a primary objective of the regulatory instrument is to maximize real energy savings as these behavioural factors affect the set of approved efficiency measures. This is the case of Demand-side Electricity Efficiency Plan (PPEC).

The methodology presented in this paper is currently being used in the evaluation of energy efficiency measures for the PPEC, thus impacting in the approval of these measures. In the paper several hypotheses for evaluating the behavioural factors on savings are presented and the corresponding results on the merit order of several typical energy efficiency measures are shown.

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Energias Renováveis, Regulação e Sustentabilidade

Bruno Madeira, Pedro Verdelho, Vítor Santos

Introdução

No âmbito da política energética europeia, orientada pelas dimensões da concorrência, sustentabilidade e segurança de abastecimento, o governo português tem promovido eficazmente a geração renovável e endógena designadamente a geração eólica. Este esforço tem sido determinante na satisfação da procura incremental representando a geração renovável e endógena em 2009, 36% da procura total apesar das condições hidrológicas desfavoráveis (cerca de 75% da produtibilidade hidroelétrica média).

Os instrumentos de incentivo ao desenvolvimento da geração renovável adotados pelo governo português são favoráveis à mitigação do risco dos produtores tendo sido numa primeira fase utilizado o modelo de tarifas de compra a preço garantido (*"feed-in tariff"*) e numa segunda fase o modelo de adjudicação da quota de produção e acesso à rede por concurso público competitivo. Estes incentivos são suportados pelos consumidores através das tarifas de acesso às redes e o seu impacte nos preços finais pagos é apresentado no artigo.

São apresentados e confrontados diversos modelos de promoção da geração renovável e distribuída compatíveis com o funcionamento e desenvolvimento do mercado interno da energia caracterizados por alocações distintas dos riscos de preço e de procura entre os produtores e os consumidores.

Por último, comparam-se os custos totais (custos operacionais e custos de capital) da produção de energia elétrica de 2006 a 2009 a partir da geração convencional a carvão e de ciclo combinado a gás natural, com os da geração eólica atribuída através dos dois mecanismos identificados anteriormente.

Considerando a maturidade observada pela tecnologia nas vertentes tecnológica, licenciamento ambiental, construção e operação das centrais, determina-se o custo total expectável para a nova geração eólica, que nas condições atuais se considera poder competir com os da produção convencional. Da comparação dos custos totais da geração eólica com os do ciclo combinado a gás natural dependentes do preço do petróleo em resultado da indexação dos contratos de gás natural do tipo *take or pay* aos preços do petróleo, determina-se o sobrecusto/benefício associado, para diferentes preços do *brent*. Efetua-se também uma análise prospetiva para 2020 e 2030 tendo em consideração cenários de previsão da *Energy Information Administration* mostrando-se o interesse presente e futuro da geração eólica, importando para benefício dos consumidores proceder à redução das condições de remuneração da nova geração eólica em linha com a maturidade alcançada por esta tecnologia.

1. A Política Energética Europeia e Nacional

1.1. A Política Energética Europeia

O exercício da atividade regulatória nas atuais circunstâncias não pode deixar de ter presente os seguintes constrangimentos com que se defronta o sistema energético:

» A dependência energética da UE tenderá a agravar-se nas próximas décadas;

» Os recursos fósseis tendem a ser cada vez mais escassos, a exibir custos marginais de exploração de longo prazo crescentes e a serem detidos (de forma expressiva) por um número reduzido de países que revelam claros indícios de instabilidade política e social;

» Num contexto em que os preços da energia são determinados por um choque do lado da procura, a taxa de variação dos preços da energia tende a ser superior à taxa de inflação;

» A forte dinâmica da procura e o fim do ciclo de vida de algumas infraestruturas exigirão um ritmo de investimento muito intenso;

» As condicionantes ambientais vão passar a marcar decisivamente a política e a regulação da energia.

Estas restrições conduziram a alterações substantivas na formulação da política energética, nomeadamente na definição de objetivos e na conceção de novas medidas (veja-se quadro 1).

Quadro 1 - Europa - Uma Nova Política Energética

Objectivos:
» **Sustentabilidade**: as atuais políticas energética e de transporte não são sustentáveis já que conduziriam a um aumento substancial das emissões de CO_2.   » **Segurança de abastecimento**: com um cenário "business as usual", a dependência energética na UE passaria dos atuais 50% do consumo total para 65% em 2030.   » **Competitividade**: a UE tem vindo a tornar-se progressivamente cada vez mais exposta à volatilidade e ao crescimento dos preços nos mercados internacionais da energia, ameaçando a competitividade da sua economia.
Políticas:
» Criação de um Mercado Interno para a Energia;   » De modo a assegurar o abastecimento energético europeu e a redução das emissões de gases de efeito de estufa, o pacote legislativo europeu para o clima e a energia definiu as seguintes políticas para 2020:   - Reduzir em pelo menos 20% as emissões de gases de efeito de estufa (30% caso outros países desenvolvidos se comprometam em cortes semelhantes);   - Aumentar em 20% a quota de geração renovável (eólica, solar, biomassa, etc) no consumo total de energia (atualmente em cerca de 8,5%);   - Reduzir cerca de 20% do consumo de energia expectável através da melhoria da eficiência no consumo.

O reforço e a consolidação do mercado interno para a energia em muito irá beneficiar da aprovação em 2009 do chamado 3º Pacote que visa concretizar os seguintes desenvolvimentos:

- Separação efetiva das atividades de transporte em relação às relativas à produção e comercialização;
- Harmonização dos poderes e grau de independência dos reguladores nacionais;
- Estabelecimento de uma instituição (ACER) que promove formalmente a coordenação entre os reguladores europeus;

- Criação de um mecanismo visando melhorar a coordenação das operações de rede, da segurança do abastecimento e das condições em que se processam as trocas transfronteiriças;
- Criar condições para que haja mais transparência no funcionamento dos mercados energéticos.

Na figura 1 identificam-se os três pilares que orientam a política energética europeia - Concorrência, Sustentabilidade e Segurança de Abastecimento – destacando-se algumas das medidas adotadas tendo em vista o reforço de cada uma dessas três dimensões.

Ao nível do desenvolvimento da concorrência cabe realçar o aprofundamento da regulação independente, a separação de atividades, a atribuição do direito de acesso às redes regulado a todos os consumidores viabilizando-se a escolha livre de comercializador, o desenvolvimento e aprofundamento de mercados grossistas e retalhistas, a maximização da transparência reduzindo-se assimetrias de informação e o reforço das interligações por forma a viabilizar-se a criação e integração de mercados regionais como um passo intermédio para a criação do Mercado Interno da Energia (MIE). Importa fazer uma referência especial às Iniciativas Regionais, que constituem um fórum de diálogo dinamizado pelos reguladores contando com a participação dos operadores das redes de transporte (ORTs) e dos agentes de mercado (comercializadores) e que numa perspetiva *bottom-up* identificam eventuais barreiras de mercado existentes e falhas de interoperabilidade e de harmonização regulatória numa perspetiva regional, propondo soluções que gradualmente vão sendo adotadas no quadro regulatório de cada país.

No que respeita à segurança de abastecimento assume particular relevância o aumento da coordenação entre ORTs e a definição de mecanismos de solidariedade entre os vários estados a adotar em situações de escassez e de emergência. Contribuem também para esta dimensão o grande esforço desenvolvido na promoção da geração endógena e renovável e a existência de infraestruturas de redes robustas em particular de gás natural utilizadas pelas centrais de ciclo combinado (CCGT) na produção de eletricidade, cada vez mais fundamentais nas situações de escassez dos recursos renováveis.

Ao nível da sustentabilidade, em particular ambiental, importa mencionar o forte desenvolvimento da geração de origem renovável, a internalização das externalidades ambientais através de mecanismos coaseanos como o sistema de transação de emissões de gases com efeito de estufa (ETS) e o controlo automático da rede de distribuição, à semelhança do atualmente praticado ao nível da rede de transporte.

Nesta dimensão e considerando o carácter essencial da energia elétrica assume particular relevância assegurar a sustentabilidade social do sector elétrico através da definição do conceito de consumidor vulnerável e da adoção de mecanismos de proteção ao nível das regras comerciais e da aplicação de tarifas sociais compatíveis com o desenvolvimento do mercado.

Por último um destaque especial para a promoção da eficiência no consumo considerada uma das medidas mais determinantes para assegurar os compromissos assumidos pelos vários estados europeus no que respeita à descarbonização da sociedade. A promoção da eficiência no consumo e da gestão da procura ativa e passiva, para a qual a existência de medição com transferência de informação bidirecional entre os consumidores e os prestadores de serviços designadamente os operadores de redes, comercializadores e empresas de serviços de energia muito contribuirá, é das poucas medidas que assegura simultaneamente o desenvolvimento dos três pilares identificados, razão que a par do potencial de poupança presentemente identificado justificam o forte empenho nesta matéria. Esta é uma opção incontornável num sistema elétrico cada vez mais dependente das energias renováveis com forte carácter variável havendo a necessidade, por razões de minimização dos custos para o consumidor, de promover a adaptação da procura à variabilidade da oferta através do aumento da sua elasticidade procura-preço.

Figura 1 - A Política Energética Europeia sustentada nos três pilares: Concorrência, Sustentabilidade e Segurança de Abastecimento

✓ Sustentabilidade ambiental
- Promoção gerção renovável
- Sistema de comercialização de gases de efeito de estufa (ETS)
- Internalização de externalidades
- Promoção da eficiência no consumo
- Medição inteligente
- Redes inteligentes

✓ Sustentabilidade social
- Consumidores Vulneráveis
- Tarifas sociais

- Regulação independente
- Separação de actividades
- Direito de acesso às redes regulado (rTPA)
- Mercados grossitas bem desenhados (diário, intra-diário, serviços de sistema e futuros)
- Mercados retalhistas bem desenhados
- Plataformas logísticas adequadas
- Transparência
- Iniciativas regionais (integração de mercados)
- Harmonização regulamentar e de tarifas de Acesso
- Redução congestionamentos
- Reforço de Interligações

- Redes eléctricas robustas
- Aumento de coordenação entre ORTs
- Mecanismos de solidariedade para segurança de abastecimento
- Promoção de geração endógena (renováveis)
- Diversificação energética / Diversificação do aprovisionamento de combustíveis fósseis
- Infra-estruturas de gás robustas e capacidade de regaseificação (CCGT)

1.2. A Política Energética Portuguesa

Desde a primeira hora, a ERSE tem sido um agente ativo de construção do mercado interno da energia. Para um pequeno país como Portugal, geograficamente periférico e apostado em retomar o seu processo de convergência real com os países mais desenvolvidos da União Europeia, é essencial que a regulação das indústrias de rede (eletricidade e gás natural) seja eficiente, de forma a criar condições propícias à convergência real em relação aos países mais desenvolvidos da União Europeia.

Também é imprescindível ter presente as fragilidades estruturais que caracterizam o nosso sector energético. As opções de política energética, o nível de desenvolvimento, a dotação de recursos endógenos, entre outros, conduziram a que Portugal exiba as seguintes características:

- Fraca diversificação energética;
- Forte dependência energética;
- Intenso ritmo de crescimento da procura, nomeadamente quando se toma como comparação os países mais desenvolvidos da União Europeia;
- Intensidade energética evoluindo segundo uma trajetória divergente da média da UE;
- Incumprimento dos objetivos comunitários definidos em relação aos gases com efeito de estufa (GEE).

1.2.1. Objetivos

As fragilidades estruturais do nosso sector energético constituem a principal justificação para que a atual política energética em Portugal esteja muito focada no desenvolvimento dos recursos endógenos de base renovável e a aposta clara na eficiência energética, visando aumentar a diversificação, reduzir a dependência, tornar o ritmo da procura sustentável e reduzir o nível da intensidade energética tornando a sua trajetória convergente com os níveis médios da UE.

No quadro seguinte identificam-se as necessidades de nova capacidade de geração renovável para se alcançarem os objetivos da política energética portuguesa estabelecidos para 2020. O esforço necessário face ao valor atual (mais que duplicação da capacidade instalada com o adicionamento de cerca de 1000 MW/ano) é assinalável.

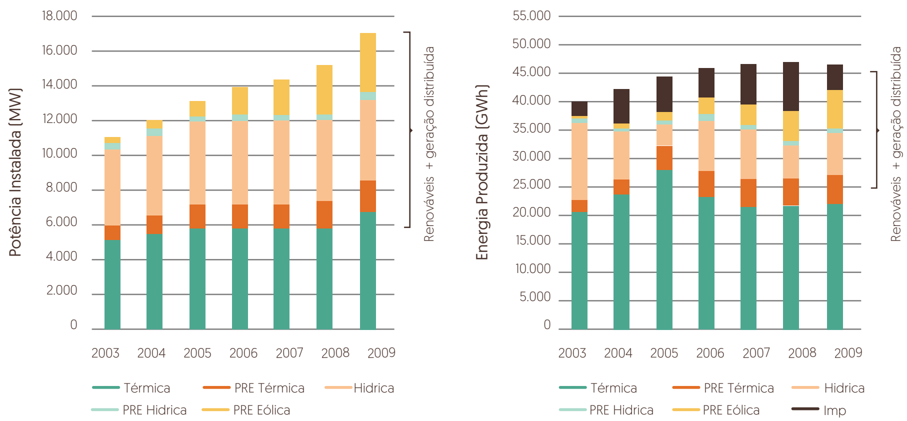
Quadro 2 - Energias renováveis: objetivos da Política Energética Portuguesa

Tecnologia	Capacidade Instalada 2009	Δ Capacidade 2020
Eólica	3 350 MW	5 150 MW
Hídrica	4 980 MW	3 620 MW
Solar	75 MW	1 425 MW
Ondas	2 MW	248 MW

Na figura 2 apresenta-se a estrutura da potência instalada e da energia produzida de 2003 a 2009 registando-se o grande aumento da potência instalada em tecnologia renovável (cerca de 500 MW/ano) em particular de carácter distribuído e de origem eólica. Este esforço tem sido determinante na satisfação da procura incremental representando a geração renovável e endógena em 2009, 36% da procura total apesar das condições hidrológicas desfavoráveis (cerca de 75% da produtibilidade hidroelétrica média).

A produção hidroelétrica varia significativamente consoante as condições hidrológicas, sendo que a potência instalada tem-se mantido constante ao longo dos últimos anos. A geração distribuída em regime especial (PRE) à base de energia eólica, térmica de biomassa e de cogeração e alguma pequena hídrica apresenta menor volatilidade anual.

Figura 2 - A geração renovável em Portugal



1.2.2. Remuneração e alocação dos custos da produção em regime especial

A promoção da produção de eletricidade baseada em recursos renováveis nos diferentes países tem subjacente a aplicação de diferentes mecanismos de entre os quais se destacam as seguintes modalidades:

» Instrumentos de internalização das externalidades produzidas pelas energias convencionais:
  - Taxas ambientais (mecanismos pigouvianos);
  - Mercados de direitos de emissão (mecanismos coasianos).

» Instrumentos de apoio direto:
  - Apoio ao investimento;
  - Apoio à I&D.

» Instrumentos de incentivo ao desenvolvimento apresentados por ordem decrescente de intervencionismo público:
  - Tarifas de compra a preço garantido (*"feed-in tariff"*);
  - Adjudicação da quota de produção e acesso à rede por concurso público competitivo;
  - Mercados de certificados verdes (mecanismo do tipo coasiano).

No caso português, o preço de venda ao comercializador de último recurso resulta da aplicação de duas modalidades:

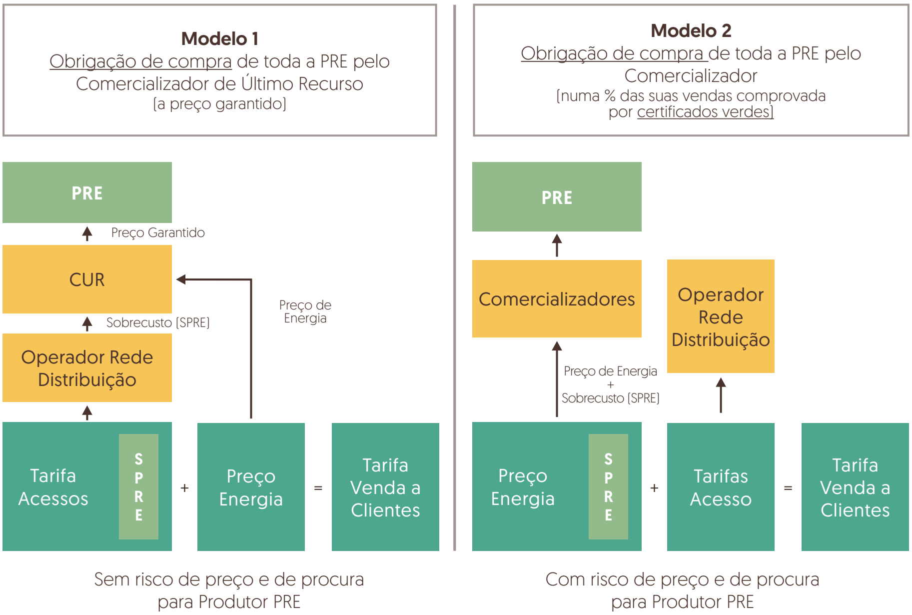
» Preço que resulta da aplicação do tarifário publicado pelo Governo e que, no momento presente, constitui o mecanismo com maior expressividade;

» Preço que resulta das propostas apresentadas aos concursos de atribuição de pontos de interligação para instalações de energia eólica e biomassa. Nestes concursos, o desconto sobre o preço de venda publicado pelo Governo é um dos fatores ponderados.

Os preços publicados pelo Governo atualmente em vigor têm por base uma lógica de custos evitados, procurando quantificar-se os custos evitados em termos de potência (investimento em novas instalações), energia (custo de combustível) e ambiente (valorizando-se as emissões de CO_2 evitadas).

Na figura 3 apresentam-se os sistemas de remuneração e os mecanismos de partilha de risco que estão subjacentes ao *feed-in tariff* (mecanismo mais intervencionista) e aos mercados de certificados verdes (mecanismo de mercado).

Figura 3 - Modelos de atuação da Produção em Regime Especial

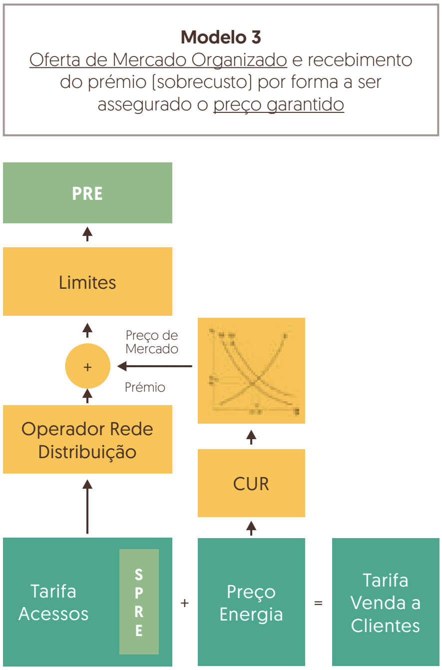


No modelo de *feed-in tariff* o comercializador de último recurso (CUR) é obrigado a comprar toda a energia dos produtores em regime especial pagando os preços garantidos pelo governo. É assim mitigado qualquer risco de preço e de procura aos produtores em regime especial, que é assumido inteiramente pelos consumidores. O CUR que se aprovisiona no mercado para satisfação dos consumos dos seus clientes tem que internalizar nas suas compras a produção em regime especial como um autoconsumo, sendo compensado em base anual do respetivo sobrecusto desta produção face aos preços praticados no mercado, determinados fundamentalmente pela produção em regime de mercado designada por produção ordinária. O sobrecusto da PRE é repercutido nos diversos consumidores através das tarifas de acesso às redes independentemente do seu modo de participação no mercado ou do seu comercializador, situação compatível com o desenvolvimento do mercado interno de energia.

No modelo 2 de mercado de certificados verdes são impostas aos diversos fornecedores obrigações de compra de energia em regime especial numa percentagem das suas vendas a comprovar por certificados verdes. O não cumprimento das obrigações por parte dos comercializadores está sujeita ao pagamento de penalidades. Esta situação obriga os vários comercializadores a fazer investimentos em produção renovável para satisfazer a quota imposta ou em alternativa a comprar certificados verdes a outras instalações de produção em regime especial. Este mecanismo do tipo coasiano aloca os riscos de preço e de procura do lado dos produtores em regime especial.

Modelos mistos são possíveis como o modelo 3 apresentado na figura 4, em que o produtor em regime especial é obrigado a vender a energia no mercado recebendo um prémio (sobrecusto) de forma a ser assegurado o preço garantido pela *feed-in tariff*. O prémio é repercutido nos consumidores através das tarifas de acesso às redes à semelhança do modelo 1. Parte do risco de preço e de procura designadamente o associado à previsão da produção é assumido pelo produtor em regime especial, dependendo da adoção de limitadores (*caps* e *floors*).

Figura 4 - Modelos de atuação da Produção em Regime Especial



Com risco parcial de preço e de procura
(PRE é chamada a fazer previsões de produção sendo responsabilizada pelos desvios de energia)

No quadro 3 apresentam-se os valores de energia e de remuneração da produção em regime especial expectáveis para 2010 evidenciando-se o sobrecusto pago por todos os consumidores. O custo de cada tipo de produção é apurado (legislação do Governo) e comparado com o "custo de referência" (preço transacionado no mercado organizado). O sobrecusto aplicado às quantidades produzidas resulta no montante do sobrecusto a recuperar através das tarifas de acesso às redes. O sobrecusto é sensivelmente metade da remuneração da PRE.

A alocação dos sobrecustos da produção em regime especial de origem eólica, mini-hídrica, biomassa, fotovoltaica, ondas e resíduos sólidos e urbanos (RSU) encontra-se estabelecida através de legislação específica (Decreto-Lei n.º 90/2006) sendo efetuada proporcionalmente ao número de clientes, situação que conduz a que o mesmo seja fundamentalmente pago pelos consumidores domésticos em baixa tensão (BT). Os fornecimentos em baixa tensão com potências contratadas inferiores ou iguais a 2,3 KVA são isentos. A mesma legislação determina que, para cada tipo de fornecimento – muito alta tensão (MAT), alta tensão (AT), média tensão (MT) e baixa tensão (BT) – o sobrecusto calculado de forma proporcional ao seu número de clientes seja repercutido em função da energia consumida. Relativamente à restante PRE (cogeração e microgeração) a alocação do sobrecusto é efetuada proporcionalmente à energia consumida por cada cliente.

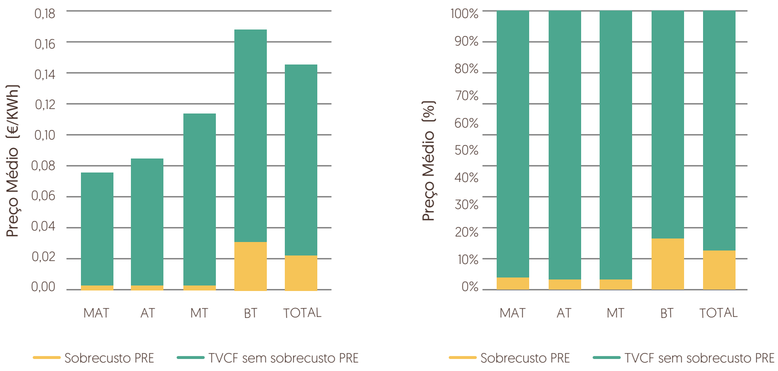
Quadro 3 - Produção em regime especial e sua remuneração expectável para 2010

	Tarifas 2010				
	GWh	Preço médio	Custo Total 10 EUR	Preço médio de referência €/MWh	Sobrecusto PRE 10 EUR
Produção em regime especial enquadrados nos termos do Decreto-Lei n.º 90/2006	11 443	92,55	1 058 991		486 852
Eólicas	7 794	91,07	709 816	50,00	320 107
Hídricas	885	88,70	78 500	50,00	34 250
Biogás	58	111,20	6 398	50,00	3 521
Biomassa	590	113,40	66 882	50,00	37 392
Fotovoltaica e energia das ondas	83	344,77	28 616	50,00	24 466
Térmica (exclui cogeração	1 588	83,60	132 782	50,00	53 367
RSU	445	80,90	35 999	50,00	13 750
Produção em regime especial não enquadrados nos termos do Decreto-Lei n.º 90/2006	3 456	85,89	296 823		124 040
Térmica - Cogeração	3 441	83,80	288 379	50,00	116 315
Microgeração	14	587,00	8 444	50,00	7 725
Total da produção em regime especial	**14 898**	**91,00**	**1 355 814**		**610 892**

Fonte: Documentação de aprovação das tarifas e preços da energia Elétrica para 2010

Na figura 5 apresenta-se o impacte tarifário do sobrecusto da PRE nas tarifas de Venda a Clientes Finais (TVCF) em 2010.

Figura 5 - Impacte Tarifário – sobrecusto da PRE nas Tarifas de Venda a Clientes Finais em 2010

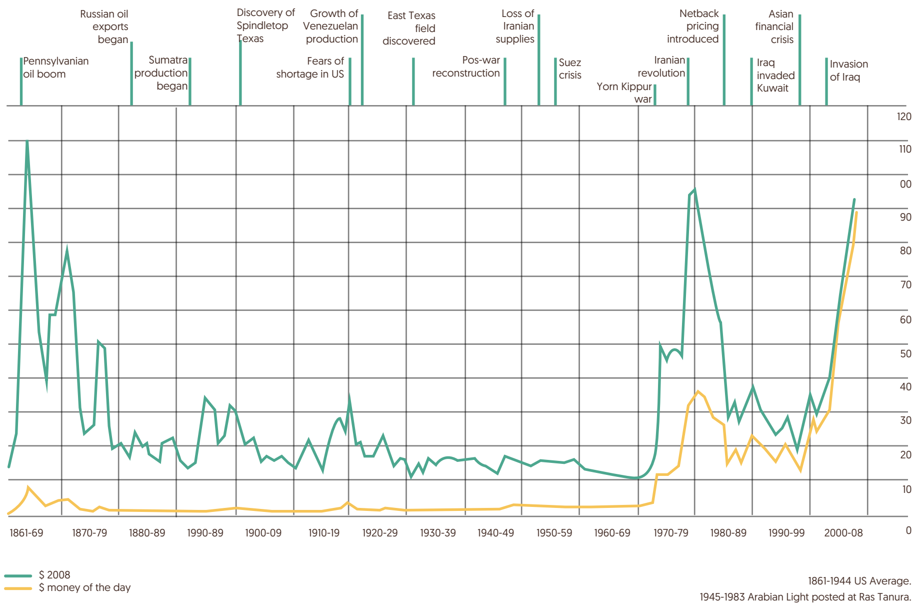


Nos fornecimentos em baixa tensão este impacte é significativo representando já cerca de 20% dos preços pagos. Globalmente o sobrecusto da PRE representa cerca de 15% dos preços finais pagos pelos consumidores.

2. O sobrecusto Presente/Benefício Futuro da Produção em Regime Especial

Na figura seguinte apresenta-se uma série longa de evolução do preço do petróleo desde o início da sua extração com objetivos comerciais até ao choque de energia primária registado em 2008 com o petróleo a atingir em Julho de 2010 os 140 US$/bbl.

Figura 6 - Evolução do preço do Brent



Fonte: Bristish Petroleum

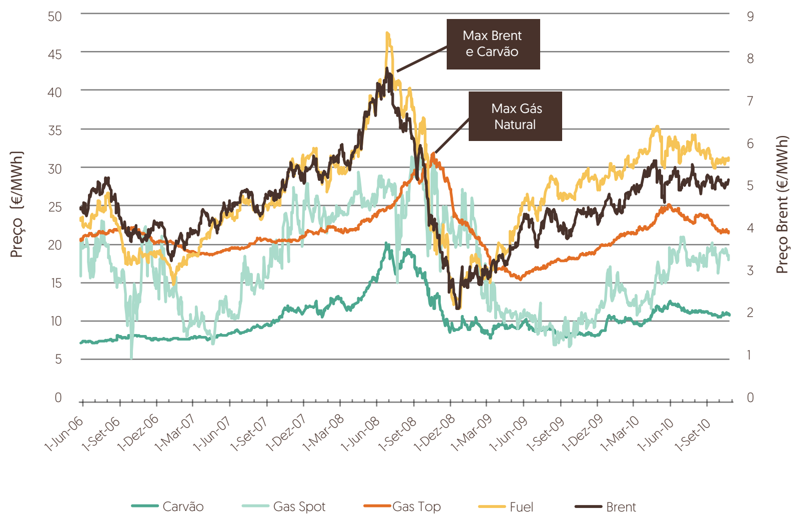
De salientar, por um lado, o baixo preço do petróleo em termos reais registado durante uma série longa de anos que muito contribuiu para o enorme desenvolvimento da sociedade moderna no último século e por outro lado, os sucessivos choques de preços influenciados por alterações da ordem geopolítica na região do médio-oriente, onde se encontram cerca de 57% das reservas provadas de petróleo, designadamente a guerra Yom Kippur de Outubro de 1973 entre Israel e vários estados Árabes liderados pelo Egipto e a Síria (1º choque de preços do petróleo), a revolução iraniana em 1979 (2º choque de preços do petróleo) que veio alterar o regime monárquico pró-ocidental do Irão por uma república islâmica liderada por aiatola Khomeini, a invasão do Kuwait pelo Iraque em Agosto de 1990 e mais recentemente, a 20 de Março de 2003, a invasão do Iraque com a destituição do regime de Saddam Hussein por tropas de coligação liderada pelos Estados Unidos da América e o Reino Unido e a consequente guerra civil entre sunitas e xiitas que se seguiu.

Este último choque de preços iniciado em 2003 até Julho de 2008, altura em que o brent atingiu 140 US$/bbl, a par com a perceção de uma cada vez maior escassez de reservas de petróleo no médio prazo e de uma maior sensibilidade da sociedade para os impactes ambientais associados com a queima de combustíveis fosseis e das consequências da sua pegada ecológica nas gerações futuras, impulsionaram decisivamente os legisladores comunitário e nacionais de cada estado europeu a promover ativamente a produção de energia elétrica a partir de recursos endógenos e renováveis, assumindo particular relevância a produção de eletricidade a partir de energia eólica pela sua maturidade tecnológica e expansão em termos de capacidade instalada e energia produzida.

Na análise seguinte comparam-se os custos totais de produção de energia elétrica a partir de fontes renováveis eólicas, com os custos totais de produção de tecnologias convencionais queimando combustíveis fósseis. Esta comparação é efetuada considerando os preços, observados desde 2006 até 2009 nos mercados internacionais, dos combustíveis fósseis (petróleo, carvão, fuelóleo e gás natural) e das emissões de CO_2. É igualmente efetuada uma comparação prospetiva utilizando cenários de longo prazo da EIA – *Energy Information Administration*.

Na figura seguinte apresentam-se os preços por unidade de energia (€/MWh) dos principais combustíveis fósseis utilizados na produção de energia elétrica, a saber: o gás natural que é o combustível da tecnologia marginal convencional na Península Ibérica (todas as novas centrais convencionais na Península Ibérica são ciclos combinados a gás natural), o carvão queimado em centrais construídas há cerca de duas décadas e por fim o fuelóleo queimado em centrais que estão presentemente em fase de descomissionamento.

Figura 7 - Evolução do preço dos combustíveis fósseis



Os preços apresentados para o carvão, petróleo e fuelóleo são os seguintes: API2 Amsterdam-Rotterdam-Antwerp, Brent Spot Crude FOB e Fuel Oil 1% Sulphur CIF MED

Cargo. Para o gás natural apresentam-se os preços do mercado spot de Zeebrugge e bem como os preços do gás natural tipicamente contratualizado pelos fornecedores do mercado ibérico de gás natural (MIBGAS) através de contratos do tipo *take or pay*, indexado ao preço do petróleo com um diferimento de 6 meses.

Na figura identifica-se o choque energético de 2008 em que os preços do petróleo, carvão e gás natural atingem máximos históricos, impactando de forma severa nos preços da energia elétrica. Assiste-se a partir de Agosto à descida abrupta do brent até atingir os 40 US$/bbl em Dezembro desse ano, situação que vem a refletir-se no preço do gás natural uns meses mais tarde, devido às fórmulas de indexação adotadas nos contratos. Em particular em 2009 observa-se que o preço do gás natural no mercado spot afasta-se dos preços dos contratos do tipo *take or pay*, em resultado das condições registadas no mercado internacional de gás natural que apresenta excesso de oferta justificadas, por um lado, pelo afundamento da procura inerente à crise económica que se seguiu e por outro lado, pelos desenvolvimentos verificados nos Estados Unidos da América em nova tecnologia de extração de gás natural (*shale gas*), a par com grandes investimentos em nova capacidade de liquefação anteriormente adjudicados e que vieram a entrar em exploração em 2009.

Os custos operacionais (OPEX) das centrais de produção de energia elétrica à base de combustíveis fósseis dependem dos preços dos combustíveis apresentados na figura anterior, dos rendimentos dos processos de conversão energética das centrais, das emissões específicas de CO_2 e do seu preço observado no mercado. Para além dos custos operacionais importa adicionar os custos de capital associados à amortização e remuneração do investimento. No quadro seguinte apresentam-se para as centrais de ciclo combinado e para as centrais a carvão valores típicos de investimento, sua duração, anuidade do capital por unidade de energia considerando uma taxa do custo de capital de 8% e uma utilização de 5000 horas, rendimento da conversão energética e emissões específicas de CO_2.

Quadro 4 - Valores típicos das centrais de ciclo combinado queimando gás natural (CCGT 400 MW) e a carvão (450 MW)

	Investimento (€/kW inst)	**Duração** (anos)	**CAPEX** €/MWh	**Rendimentos** (%)	**Emissões CO_2** ton/MWh
CCGT 400	371 000	25	7,0	55	0,368
Carvão 450	1 026 000	25	19,2	33	0,897

Os custos totais (TOTEX) são assim determinados por:

$$TOTEX = CAPEX + \frac{\text{Custo energia}}{\text{Rendimento}} + \text{Emissões x Custo emissão}$$

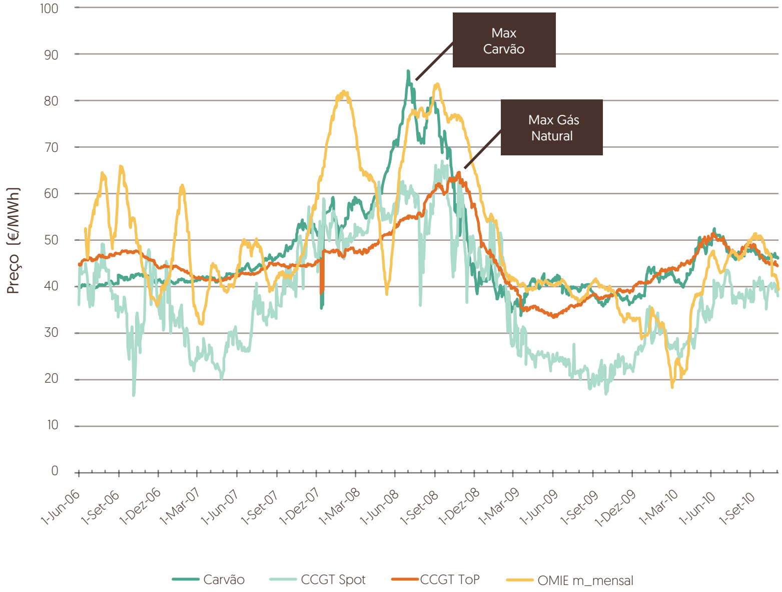
Os custos da geração eólica são fundamentalmente condicionados pelos custos de capital apresentando-se no quadro seguinte alguns valores típicos. Considerando uma utilização da potência instalada de 2000 horas, uma duração da tecnologia de 20 anos, custos de operação de 3% do custo de capital e uma taxa do custo de capital de 8%, obtém-se um custo unitário total (TOTEX) entre 47 €/MWh e 63 €/MWh para investimentos de 900 a 1100 milhões de euros por MW de potência instalada. Dada a maturidade já observada por esta tecnologia considerou-se uma taxa de desconto semelhante à da produção convencional, apesar de se considerar aceitável a utilização de valores inferiores na medida em que no regime de *feed-in tariff* regulado por legislação o risco de preço e de procura observado pelo promotor é mitigado sendo socializado pelos consumidores de energia elétrica.

Quadro 5 - Valores típicos das centrais de geração eólicas

	Investimento (€/kW inst)	**Utilização** (horas)	**Duração** (anos)	**Manutenção**	**Taxa** (%)	**TOTEX** €/MWh
Eólica	900	2 000	20	3% do custo capital	8	47
	1 200					63

Na figura seguinte apresentam-se os custos variáveis (custos de combustíveis e de CO_2) das centrais a carvão e de ciclo combinado a gás natural consoante o aprovisionamento é efetuado no mercado spot ou através de contratos *take or pay* indexados ao brent. Apresentam-se também os preços médios mensais do mercado ibérico de eletricidade (OMIE).

Figura 8 - Custos variáveis da produção de energia elétrica nas centrais de ciclo combinado e a carvão

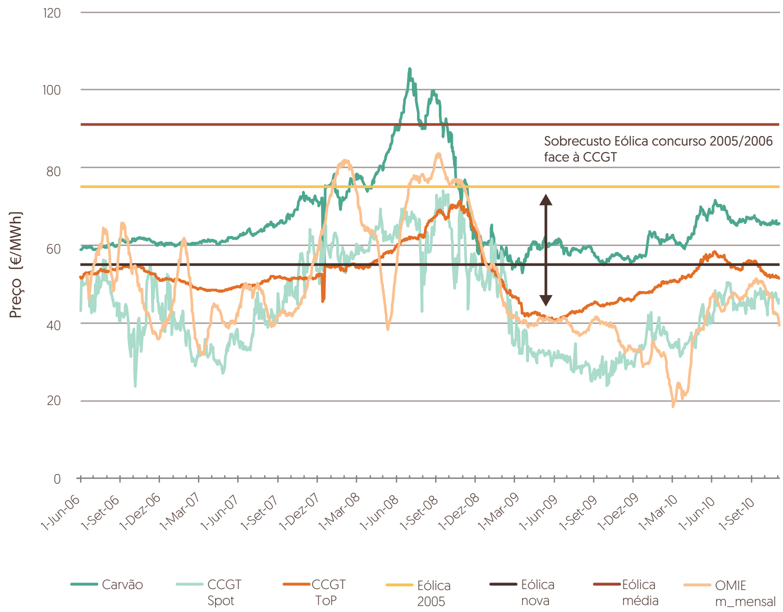


Durante o choque energético de 2008 assistiu-se a uma inversão clara da ordem de mérito entre o carvão e o gás natural contratado através de contratos do tipo *take or pay*, situação que comprometeu a recuperação dos custos de capital mais elevados das centrais a carvão.

Na figura seguinte comparam-se os custos totais [TOTEX] da geração convencional a carvão e a gás natural nos últimos 4 anos. Os resultados apresentados são determinados adicionando aos custos variáveis apresentados na figura anterior os custos de capital.

Nesta figura apresentam-se igualmente os preços médios mensais registados no mercado ibérico de eletricidade [OMIE] verificando-se que os mesmos se têm situado entre o TOTEX destas duas tecnologias determinantes no mix de produção de eletricidade da Península Ibérica. Verifica-se que as centrais a carvão têm apresentado dificuldade na recuperação dos seus custos de capital no mercado, situação que não se verifica nas centrais de ciclo combinado a gás natural. Para estas últimas verifica-se que os períodos em que o preço de mercado se situa abaixo do TOTEX e que não permitem a recuperação dos custos de capital, são compensados por outros períodos em que a situação é oposta. O preço da energia elétrica no OMIE é determinado por uma variedade de fatores, desde os custos variáveis das centrais convencionais, a sua disponibilidade, as condições hidrológicas e eólicas dada a elevada proporção destes vetores energéticos no mix de produção, a evolução da procura quer da eletricidade, quer do gás natural, esta última resultante das condições típicas do aprovisionamento de gás natural através de contratos do tipo *take or pay*, entre outros fatores.

Figura 9 - Comparação dos custos totais (TOTEX) da geração eólica com os da geração convencional de ciclo combinado e a carvão

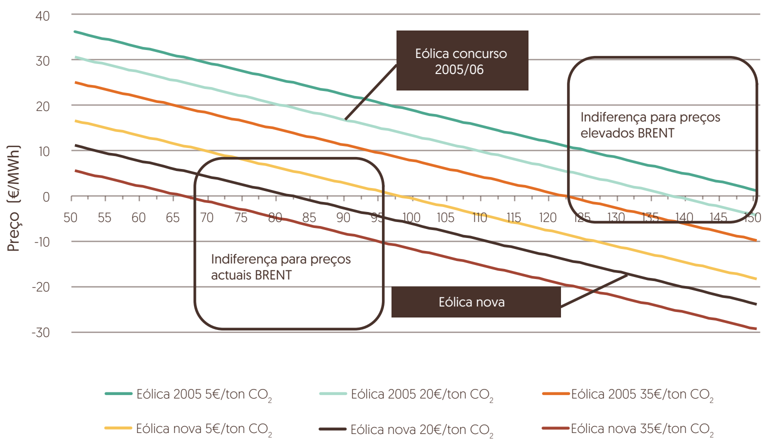


Na figura anterior apresenta-se igualmente o custo total da produção eólica resultante do concurso público de 1700 MW lançado em Julho de 2005 pelo governo português e adjudicado em 2006, do qual resultaram preços garantidos de cerca de 75 €/MWh. Apesar disso a existência de um conjunto elevado de instalações adjudicadas no passado a preços substancialmente mais elevados determina um custo médio desta produção de cerca de 90 €/MWh.

Por último, apresenta-se ainda o TOTEX por unidade de energia determinado no quadro 5 que se considera adequado à maturidade atualmente observada pela geração eólica nas suas diversas dimensões, tecnológica, licenciamento ambiental, construção e operação das centrais. Verifica-se que este valor, dependente dos pressupostos apresentados no quadro 5, é competitivo com os custos totais atuais da tecnologia convencional. Importava assim para benefício dos consumidores que suportam o sobrecusto deste tipo de produção que se procedesse à redução das condições de remuneração da nova produção eólica.

A tecnologia convencional marginal na Península Ibérica tem sido o ciclo combinado a gás natural (as novas centrais têm sido de ciclo combinado) em resultado, por um lado, dos custos de capital reduzidos que apresenta e por outro lado, da forte interligação do MIBGAS com a Argélia (país produtor) através de dois gasodutos e com o mercado internacional de GNL através de 7 terminais de receção, armazenamento e regaseificação de GNL. Nestas circunstâncias assume particular relevância comparar os custos de produção totais da geração eólica, com os do ciclo combinado a gás natural dependentes do preço do petróleo em função da indexação dos contratos de gás natural, determinando-se o sobrecusto/benefício associado, para diferentes preços do brent. Considera-se a indexação típica dos preços de gás natural aos preços do brent dos contratos *take or pay* comummente adotados no MIBGAS. Na figura seguinte apresenta-se este sobrecusto/benefício dependente dos preços do brent em US$/bbl (considerando uma taxa de câmbio de 1,39 US$/€) para diferentes cenários de valorização das emissões de CO_2 (5 €/tCO_2, 20 €/tCO_2 e 35 €/tCO_2).

Figura 10 - Sobrecusto/Benefício da geração eólica face à geração convencional de ciclo combinado em função do preço do petróleo

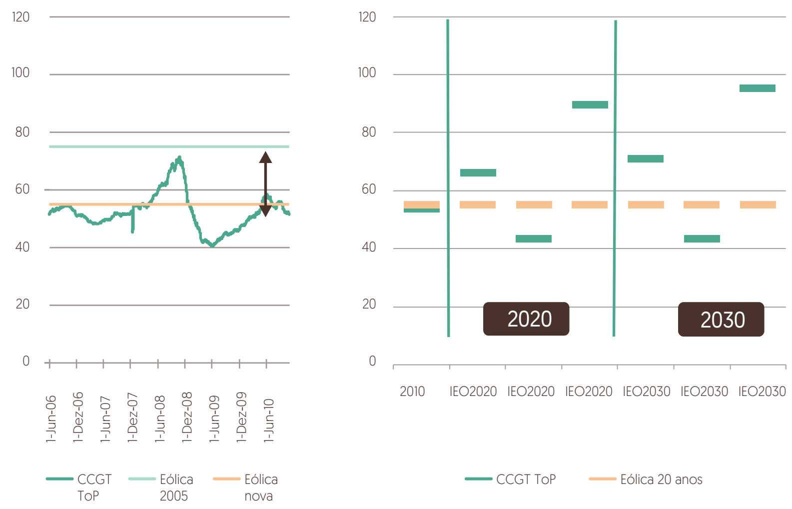


Para os preços da geração eólica adjudicada no concurso público de 2005/2006 a indiferença face aos custos de produção do ciclo combinado verifica-se para preços de brent entre 120 US$/bbl e 150 US$/bbl, dependendo de uma menor ou maior valorização das externalidades ambientais associadas às emissões de CO_2. Em 2008 observaram-se preços do brent próximos destes valores, embora na altura o euro estivesse bastante valorizado (1,47 US$/€) o que permitiu mitigar este efeito.

Considerando o TOTEX por unidade de energia considerado adequado à maturidade atual da geração eólica, apresentado no quadro 5, verifica-se que a situação de indiferença dá-se para preços do brent entre 65 US$/bbl e 100 US$/bbl dependendo da valorização do CO_2. Assumindo uma valorização da tonelada de CO_2 de 20 €, verifica-se que para preços do brent inferiores a 80 US$/bbl a geração eólica apresentaria um sobrecusto a pagar por todos os consumidores de energia elétrica através das tarifas de acesso às redes. Em contrapartida para preços de brent superiores resultaria um benefício a devolver aos consumidores também através das tarifas de acesso às redes. Esta situação permite desacoplar os preços da energia elétrica dos preços dos combustíveis fósseis tornando-os cada vez mais dependentes dos custos de capital da tecnologia.

Dum ponto de vista prospetivo assiste-se a uma grande incerteza sobre os preços dos combustíveis fósseis designadamente o petróleo. Esta situação é espelhada nos cenários de previsão das diversas agências internacionais de energia, em particular a EIA-*Energy Information Administration* que aponta para um cenário de referência em 2020 de 115 US$/bbl mas com possibilidade de desvios acentuados entre 50 US$/bbl e 185 US$/bbl. Para 2030 são previstos preços de brent superiores. Na figura seguinte compara-se o TOTEX da geração eólica com o TOTEX do ciclo combinado para os preços de brent prospetivos identificados, verificando-se custos de geração eólica inferiores aos do ciclo combinado. Na figura são igualmente comparados os custos de produção das duas tecnologias nos últimos quatro anos. Esta situação mostra o interesse presente e futuro da geração eólica, importando para benefício dos consumidores proceder à redução das condições de remuneração da nova geração eólica em linha com a maturidade alcançada por esta tecnologia nas suas vertentes tecnológica, de licenciamento ambiental e de construção e operação.

Figura 11 - Sobrecusto/Benefício presente e futuro da geração eólica face à geração convencional de ciclo combinado



IEO - International Energy Outlook 2009 da Energy Information Administration

Conclusões

Desde o primeiro choque de preços do petróleo em 1973, relacionado com o conflito de Yom Kippur, tem-se assistido a uma acentuada volatilidade dos preços do petróleo determinada por diversos fatores, designadamente os relacionados com conflitos que vêm alterar a ordem geopolítica da região do médio oriente, onde se encontram cerca de 57% das reservas provadas de petróleo. A escalada de preços do petróleo impacta diretamente nos preços do gás natural em resultado da sua forte indexação aos preços do *brent*, característica típica do aprovisionamento através de contratos do tipo *take or pay* comummente utilizados, designadamente na Península Ibérica.

A subida dos preços do petróleo e consequentemente do gás natural, tem pressionado a subida dos preços da energia elétrica nos mercados grossistas, em particular no mercado ibérico da eletricidade. Esta situação a par com a perceção de uma cada vez maior escassez de reservas de petróleo no médio prazo e de uma maior sensibilidade da sociedade para os impactes ambientais associados com a queima de combustíveis fosseis e das consequências da sua pegada ecológica nas gerações futuras, impulsionaram decisivamente os legisladores comunitário e nacionais de cada estado europeu a promover ativamente a produção de energia elétrica a partir de recursos endógenos e renováveis, assumindo particular relevância a produção de eletricidade a partir de energia eólica pela sua maturidade tecnológica e expansão em termos de capacidade instalada e energia produzida.

No artigo comparam-se os custos totais de produção de energia elétrica a partir de fontes renováveis eólicas, com os custos totais de produção de tecnologias convencionais queimando combustíveis fósseis. Os custos totais de produção das tecnologias convencionais são determinados considerando os preços, observados nos mercados internacionais desde 2006 até 2009, dos combustíveis fósseis (petróleo, carvão, fuelóleo e gás natural) e das emissões de CO_2, bem como valores típicos de investimento, de emissões específicas e de rendimentos de conversão energética. Esta análise comparativa é igualmente efetuada em termos prospetivos utilizando cenários de longo prazo da EIA – *Energy Information Administration*.

Os custos de geração eólica considerados correspondem aos praticados em Portugal determinados através de dois instrumentos de incentivo ao desenvolvimento da geração renovável adotados pelo governo português, a saber: modelo de tarifas de compra a preço garantido (*"feed-in tariff"*) adotado numa fase inicial e modelo de adjudicação da quota de produção e acesso à rede por concurso público competitivo adotado em 2005 na atribuição de 1700 MW de geração eólica.

Adicionalmente e considerando a maturidade observada pela tecnologia nas vertentes tecnológica, licenciamento ambiental, construção e operação das centrais, determina-se o custo total expectável para a nova geração eólica, que nas condições atuais considera-se comparável com os da produção convencional, conforme se apresenta no artigo. Nestas circunstâncias, será desejável proceder, no quadro do regime regulado de remuneração da produção eólica em que são mitigados para o produtor os riscos de preço e de procura, à redução das condições de remuneração da nova geração eólica em linha com a maturidade alcançada por esta tecnologia, tornando os seus preços comparáveis aos da produção convencional. Esta opção orientada pela necessidade de proteger os interesses económicos dos consumidores contribuirá decisivamente para desacoplar os preços da energia elétrica dos preços dos combustíveis fósseis, tornando-os cada vez mais dependentes dos custos de capital da tecnologia, sem prejudicar os objetivos estabelecidos na política energética, orientados pela necessidade de se proceder à descarbonização das sociedades modernas.

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Results from a competitive tender mechanism to promote energy efficiency in Portugal

Isabel Apolinário, Cristina Correia de Barros, Carolina Espirito Santo, Ana Ferreira, Liliana Ferreira, Bruno Madeira, Pedro Verdelho[1]

Abstract

The International Energy Agency believes that energy efficiency is the most cost-effective way to meet the environmental challenges.

ERSE, the Portuguese Energy Services Regulatory Authority, established in 2006 a competitive tender mechanism to promote efficiency in electricity consumption called PPEC. PPEC first edition (PPEC 2007) sponsored 26 measures, implemented during 2007, 2008 and 2009. The benefits were estimated to be 4,6 times higher than the costs. However, the ex-post measurement and verification plans revealed that the benefit cost ratio went well above the expectations, mounting to 7,4.

Clearly, competitive tender mechanisms are one of the means possible to ensure sufficient, affordable, reliable energy supply while meeting environmental goals. Regulators ensure the crucial balance between energy availability and energy affordability and thus have a central role in the transition to a low carbon energy sector.

[1] The authors are with the Portuguese Energy Services Regulatory Authority (ERSE), Lisbon, Portugal.

Keywords

Energy Efficiency - Demand Side Management.

1. Introduction

The growing awareness of the depletion of natural resources and the global warming has focused the attention of policy makers and energy regulators on energy efficiency. The International Energy Agency believes that energy efficiency is the quickest and least costly way of addressing energy security, environmental and economic challenges. Support mechanisms to promote energy efficiency can take many forms, with the major instruments being white certificates, tender mechanisms, time based pricing and energy audits.

The purpose of this paper is to provide an overview of a competitive tender mechanism to promote efficiency on electricity consumption developed by ERSE, the Portuguese Energy Services Regulatory Authority. This mechanism is known by the initials PPEC, the Portuguese acronym for electricity consumption efficiency promotion plan. This paper provides an overview of the main design features of PPEC and the results of its first edition (PPEC 2007), demonstrating the importance of this tool to achieve international and national objectives for CO_2 emissions reduction.

1.1. The European policy on energy efficiency

In order to secure Europe's energy supply and to reduce greenhouse gas emissions EU's climate and energy package set ambitious targets for 2020, including a cut on energy consumption by 20% of projected 2020 levels, by improving energy efficiency. This target is not binding and so far the EU is not on track to meet its 20% energy saving target by 2020.

To get on the track the EC has therefore developed in March 2011 a new Energy Efficiency Plan (EEP) setting out measures to achieve further savings in energy supply and use. In this plan the Commission clearly states that "energy efficiency is one of the most cost effective ways to enhance security of energy supply, and to reduce emissions of greenhouse gases" and that "in many ways, energy efficiency can be seen as Europe's biggest energy resource".

Many have claimed for a binding target on energy efficiency, but only in 2013 will the EC assess whether the national energy efficiency programmes will deliver the 20% objective. If it shows that the target is unlikely to be achieved, then the EC will propose legally binding national targets for 2020.

Following the EEP, in June a new directive on energy efficiency was proposed, which is currently being discussed and which is foreseen to enter into force by the end of 2012. This proposal transforms certain aspects of the EEP into binding measures.

Among the measures proposed on the new directive is the legal obligation to establish energy saving schemes in all Member States: "energy distributors or retail energy sales companies will be obliged to save every year 1,5 % of their energy sales". We believe that other mechanisms which have proven to give good results, like the tender mechanism we present on this paper represent a good tool to achieve the referred targets.

The new directive also clearly states a role for energy regulators on energy efficiency.

1.2. Several mechanisms to promote energy efficiency

The International Confederation of Energy Regulators (ICER) has produced a report on current regulatory practices for the promotion of energy efficiency grouping the measures into the following categories [13]:

i. Legal and regulatory obligations: governments can set legal requirements on power companies, industry and households with financial penalties for non-compliance. Examples include appliance, vehicle and building standards (on energy use or emissions).

ii. Financial instruments: Financial measures aim to encourage investment in energy-efficient equipment and processes operate either by reducing the costs associated with energy efficiency investments or by increasing the costs associated with energy use. Main examples of policies reducing costs are grants/subsidies for investments in energy efficiency, subsidized audits, low-interest loans, tax relief for the purchase of energy-efficient equipment.

iii. Voluntary agreements: commitments to improve energy efficiency or reduce usage undertaken by market players, power producers or industries, in consultation or negotiation with a public authority.

iv. Energy audits: exist both in a voluntary and in a mandatory form. Mandatory requirements for energy audits range from an obligation to carry out audits, if a threshold of energy consumption is passed, to mandatory reporting and implementation of certain types of measures and compliance with standards.

v. Consumer education and information provision (including billing regulation and smart metering): consumers' awareness and interest in energy saving is commonly recognised as a key factor in achieving greater energy efficiency and stimulating demand for related products and services.

vi. Provisions in the public sector: the public sector can contribute to promote and consolidate a market for energy efficient equipment and services by playing an exemplary role, leading to the development of policies in other sectors.

vii. Demand side management (DSM) programmes: which include mostly load interruption and time-of-use tariffs.

viii. Market-based incentives: such as tradable certificates and tenders.

Regarding the market-based incentives such as tradable certificates on energy utilities, they aim to achieve existing or newly formulated efficiency targets in a cost-effective way. They build upon experiences with similar types of schemes such as the EU ETS (Emissions Trading Scheme) and renewable certificate schemes. Tradable certificates have up to now been used in combination with an obligation scheme. Market actors (usually retail energy suppliers or distributors) are obliged to reach a certain amount of energy savings. The administrative costs related to the introduction of a white certificate market may be significant. Other problem this type of mechanism can have is the transposition of the energy market structure to the energy services market, therefore not boosting the number and type of agents. This problem can be magnified in countries with few suppliers.

An alternative market-based mechanism to promote energy efficiency consists of designing a tender mechanism for the selection of the most cost-effective measures. The main purpose is to promote competition in the implementation of energy efficiency measures, thus maximizing the benefit cost-ratio. Usually it is a voluntary mechanism. It has the advantage of bringing several entities for delivering energy efficiency (energy suppliers, consumers associations, municipalities, universities, ESCOs, institutions of social solidarity…) in order to maximize the number of agents involved, reducing the market failure to overcome, reaching more consumers and increasing the spill-over effect.

The tender mechanism should be designed to keep low administrative burden and minimise transaction costs. A tender mechanism minimizes these costs compared to mechanisms entailing a trading of certifications.

1.3. A role to regulators on energy efficiency

The competencies of Energy Regulators vary from country to country. Looking at ICER report [13] regulators in the most developed countries seem to have at least some competencies, especially with regard to end-use measures, roll-out of smart meters, setting DSM and administration of energy efficiency programmes, although policy usually rests with governments.

According to the proposal for a new directive on energy efficiency regulators must ensure that regulatory incentives are closely aligned with the objective of energy efficiency. Regulators can do this through the:

(i) definition of network tariffs and regulations that provide incentives for grid operators to offer system services to network users permitting them to implement energy efficiency improvement measures;

(ii) definition of access tariff structures which induce a rational use of electricity and support dynamic pricing for demand response measures by final costumers (time-of-use tariffs, real-time pricing, peak time pricing, peak time rebates);

(iii) Create the conditions for clear information in a consumer-friendly format on tariffs, on consumption and on the economic incentives to be gained from energy efficiency improvement.

(iv) Finally, because markets are not perfect, regulators can design specific mechanisms to promote energy efficiency to overcome the existence of market failures that hinder economic agents from taking efficient decisions.

Regulators ensure the crucial balance between energy availability and energy affordability and thus should have a central role in the transition to a low carbon energy sector.

2. Electricity consumption efficiency promotion plan (PPEC)

ERSE has responsibilities in energy efficiency promotion, stated in the energy end-use efficiency directive (2006/32/CE) transposition to the national order. Additionally in the Portuguese National Programme for Climate Change the government entitled ERSE of specific responsibilities in creating mechanisms to promote efficiency. Therefore, in 2006 ERSE established a mechanism for promoting efficiency in electricity consumption (PPEC).

PPEC is a voluntary competitive tender mechanism by which eligible promoters submit candidate measures to improve efficiency in electricity consumption. PPEC aims to promote a more efficient use of electricity, either by the installation of more efficient equipment on consumers of electricity or by acting on consumer's behaviour.

A tender mechanism is by nature a voluntary mechanism, i.e, it is not imposed upon energy companies. On the contrary, eligible promoters choose to join the programme because of the benefits it brings, namely on their public image on environmental friendliness and concerns about lowering the electricity bills consumers pay.

ERSE manages PPEC, receives the candidatures, evaluates and approves them. The candidate measures are analyzed and approved by means of a competitive process and ranked according to technical and economic criteria, based on cost-benefit analysis, publicly discussed and approved ex-ante. Once the measures are approved, energy savings obligations are imposed to each promoter accordingly to the submitted measure and ERSE is in charge of monitoring its progress. Once a project is in place the promoters have to submit to ERSE a measurement and verification plan, on the basis of which ERSE will verify the compliance of the obligations set.

The competitive nature of the mechanism ensures that only the best measures at the lowest costs are selected to be implemented.

2.1. Eligible promoters

Promoters are responsible for implementing the measures. Therefore, promoters should be all the agents that are closer to consumers and have the ability to influence their behaviour. The entities that have knowledge on energy efficiency may also give an important contribution on the promotion of energy efficiency.

The eligible promoters are electricity suppliers, electricity grid operators, business and consumer associations, energy agencies, municipal associations, universities and investigation centers. The partnerships with other entities are very important and are valued on the selection criteria.

PPEC is a voluntary mechanism but promoters adhere to it because of the benefits it brings, namely on their public image on environmental friendliness. It is in fact a win-win situation for all parties involved: i) the promoters improve their public image, ii) consumers see their electricity bill decrease; iii) the environment is spared the CO_2 emissions.

2.2. Type of measures

PPEC comprises two types of measures:

- Tangible – installation of equipment with a level of efficiency superior to standard equipment on the market, therefore producing measurable consumption reductions. Examples of measures being now implemented are the installation of LED lamps, fluorescent lamps, variable speed drives, high efficient motors and load management systems.
- Intangible – dissemination of information on energy efficient practices in order to promote a change in behaviours. Examples of this kind of measures are energy audits, educational programmes in schools, information campaigns, seminars and conferences.

3. Technical and economic criteria of evaluation

The measures should be selected through an objective technical and economical evaluation criteria. It is important that these rules are previously discussed with all the players involved.

3.1. Evaluation criteria for tangible measures

The tangible measures' ranking process is done individually for industry, services and households, as each segment has its own budget.

In evaluating tangible measures, first of all, the Net Present Value (NPV) is calculated as in (1). Measures with a negative NPV are excluded.

$$NPV = \Sigma_{t=0}^{n} \frac{B_{ST} - C_{ST}}{(1 + i)^t} \qquad [1]$$

where:

B_{ST} Total benefits in year t

C_{ST} Total costs in year t

i Discount rate

n Useful lifetime

Total benefits include the avoided cost of supplying electricity (generation, transmission and distribution cost) and the avoided cost of CO_2 emissions. Total costs comprise costs borne by the participants, PPEC and other entities.

Measures with a positive NPV are ranked according to the following technical and economic criteria:

(i) **proportional benefit-cost analysis** (40 points) – the benefit-cost ratio is used to compare investments which require different investment amounts and have different lifetimes, which is the case of the projects candidate to PPEC.

$$RBC = \frac{RBC_P}{RBC_{max}} \qquad [2]$$

where the weight of each measure (p) is proportional to its benefit-cost ratio (RBC), calculated in (4), up to 40 points, being 40 points given to the measure with the highest benefit-cost ratio.

(ii) **ordered benefit-cost analysis** (20 points)

$$20 - (k - 1) \times \frac{20}{n} \qquad [3]$$

where:

n is the number of measures

k is the position of the measure in terms of RBC

The RBC is calculated accordingly to expression (4):

$$P_P = 40 \times \frac{\sum_{t=0}^{n} \frac{B_{ST}}{(1+i)^t}}{\sum_{t=0}^{n} \frac{C_{PPECt}}{(1+i)^t}} \qquad (4)$$

where:

RBC Benefit-cost ratio

B_{St} Total benefits in year t

C_{PPECt} Costs supported by PPEC in year t

i Discount rate

n Useful lifetime

(iii) **Weight of the investment in equipment in the total cost of the measure** (10 points) – awards measures that maximize the direct investment in equipment rather than the administrative costs.

$$ID = \frac{K}{CT} \quad (5)$$

where:

ID weight of the investment in equipment in the total cost of the measure

K PPEC amount spent on acquiring the equipment

CT PPEC total costs

The best ranked measure receives 10 points and the following are ranked proportionally to the maximum score.

(iv) **Scale risk** (10 points) – evaluates the variation in average cost of each measure accordingly to the rate of execution of the measure.

$$IS_C = \left(\frac{CF + \sum_{i=1}^{m} Cv_i}{CF + \sum_{i=1}^{n} Cv_i} \right) - 1 \qquad (6)$$

where:

IS_C Scale index

CF Fixed PPEC cost

CV_i Unit variable PPEC cost of intervention *i*

m Number of interventions

n Half the interventions

The best ranked measure receives 10 points and the following are ranked proportionally to the maximum scale index.

(v) **Equity** (4 points) – evaluates the geographical scope and the way participants and suppliers are selected on the basis of a predefined set of questions.

(vi) **Presentation quality** (7 points) – evaluates the measure in terms of how clearly and objective it is presented and how well its assumptions are justified. It also evaluates the quality of its measurement and verification plan both on the basis of a predefined set of questions.

(vii) **Ability to overcome market barriers and spillover effect** (5 points) – evaluates measures in terms of its effectiveness in overcoming market barriers and ability in spreading out its effects on the basis of a predefined set of questions.

(viii) **Innovation** (5 points) – awards innovative measures relatively to conventional ones.

The benefit-cost ratio analysis, weight of the investment in equipment and scale risk are metric criteria, while the remaining are non-metric. In order for the non-metric criteria to be objective, a classification matrix made of a questionnaire was created [9][2].

PPEC approval process considers as much as possible standardized savings estimates. Additionally, PPEC rules define some of the parameters used to evaluate the measures like the discount rate applicable to the benefits and costs, the avoided unit costs, the value of the avoided CO_2 emissions and the useful lifetime of equipments.

Considering that the consumption level also depends on the behaviour and predisposition of the beneficiary, the evaluation methodology also includes a model that incorporates into expected savings the behavioural factors influence. If there is great dependence between energy savings and consumer behaviour, than the potential savings are reduced [11]. The same is done with relation to free ridership effects, reducing the savings of measures with potential of free ridership.

3.2. Evaluation criteria for intangible measures

Regarding intangible measures' ranking process depends exclusively on non-metric criteria [9][2]. They are ranked according to:

(i) Equity (20 points)

(ii) Presentation quality (25 points)

[2] Slight improvements were introduced to the classification matrix in 2009.

(iii) Ability to overcome market barriers and spillover effect (31 points)

(iv) Innovation (12 points)

(v) Experience in similar programmes (12 points)

4. The results of PPEC 2007

PPEC 2007 comprised measures to be implemented in 2007, 2008 and 2009, with a budget of 10 million euro. This amount was supported through the Global Use of System tariff, included in the access tariffs, paid by all consumers, and represents about 0,2% of the end-user tariff. 62 submissions were received which represent a total candidate cost of 27 million euros. Figure1 shows that PPEC 2007 was very competitive, with candidate cost measures outweighing the available budget in all the four segments.

The amount submitted in what concerns the tangible measures for industry and agriculture was 40% above the budget. Whereas, the amount submitted in what concerns the intangible as well as for tangible measures for services and residential sectors tenders was 3 times their respective budget.

Figure 1 - Measures submitted to PPEC 2007 and measures approved by segment

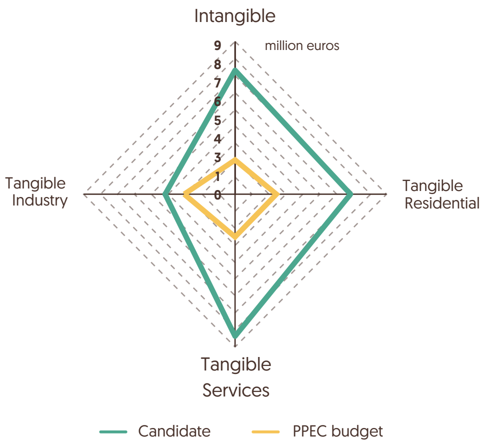
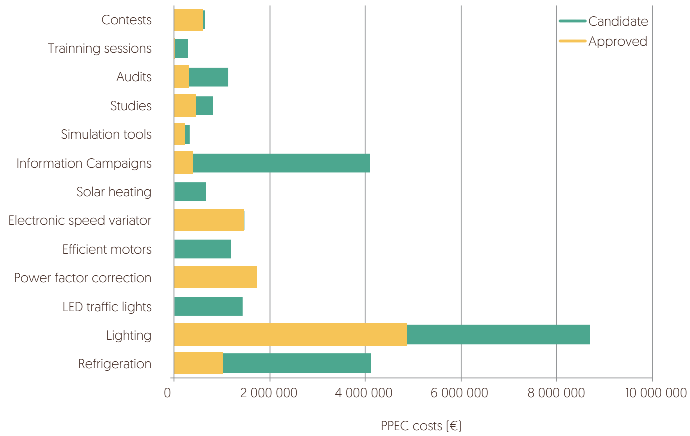


Figure 2 depicts the array of measures submitted to PPEC 2007 by type of technology. In what concerns tangible measures, it can be seen that the bulk of candidate measures were mainly in the lightning and refrigeration typologies. Regarding intangible measures, information campaigns related measures represented the higher submission amount.

Figure 2 - Measures submitted to PPEC 2007 by type of technology



26 measures from 7 promoters were approved representing a total of 10 million euros. The total amount of expected energy savings, calculated on the basis of an ex-ante evaluation, was 390 GWh.

4.1. Main results

An important aspect of PPEC is its ex-post verification exercise made in order to ensure that the savings assumptions included in the selection procedures turn out to be confirmed in practice. In this sense, the measures approved are subject to auditing in order to verify its degree of compliance in terms of costs, objectives and avoided consumption.

Moreover, each candidate measure must include a Measurement and Verification Plan (MVP) of energy savings, identifying the strategy to be used in measurement, to ascertain the impact of the measure. In the end of the project promoters have to submit to ERSE the final MVP, on the basis of which ERSE will evaluate the energy savings obtained and verify the compliance of the obligations set. The savings can be determined by comparing energy use before and after implementation of the measures. The MVP should address compliance with the candidate measure, equipment specifications (replaced and installed equipment), baseline scenario, the hours of usage of such equipment and the efficiency gains compared to standard technology. It is also important to discount possible rebound effect, free-riding effect and avoid double counting of savings via overlapping with other programmes.

The ex-post verification exercise revealed a greater-than-anticipated impact, as the costs assumed for some of the measures actually turned out to be lower than expected and forecasts for avoided consumption were largely overcome.

26 measures were implemented which saved Portugal 74 million euros, almost twice the projected amount, at an investment cost of 10 million euros. It helped to avoid the emissions of 285 thousand tons of CO_2 by cutting end user electricity consumption by 770 GWh.

Table 1 - PPEC 2007 results (approved and real)

Tipology	Electricity savings (GWh)			CO_2 avoided (ton CO_2)		
	Predicted	Real	%	Predicted	Real	%
Intangibles	n.d.	158	-	n.d.	58 613	-
Tangibles	390	611	57%	144 455	226 215	57%
Total	**390**	**770**	**97%**	**144 455**	**284 828**	**97%**

n.d. - not defined

Tipology	PPEC cost (million euros)			Total benefits (million euros)		
	Predicted	Real	%	Predicted	Real	%
Intangibles	2,6	2,3	-9%	n.d.	15,3	-
Tangibles	8,3	7,7	-7%	38,0	58,9	55%
Total	**10,8**	**10,1**	**-7%**	**38,0**	**74,2**	**95%**

n.d. - not defined

For this success was of the utmost importance the commitment of the promoters and their proximity to consumers in order to have the ability to influence their behaviour.

Moreover, PPEC 2007 leveraged the amount invested in energy efficiency. In particular, 15% of the funding needed for the implementation of PPEC 2007 came from the promotors and beneficiaries. The competitiveness of the programme is such that promotores in order to see their measures approved not only minimize the administrative or transaction costs, but also co-finance the measures.

Figure 3 shows that for PPEC 2007, the RBC of the submitted measures was lower than the one for the approved measures, showing that the adoption of an evaluation metric ensures the maximization of RBC. Moreover, a successful implementation and commitment by promoters as well as ERSE's monitoring, ensured a final RBC above the approved (7,4).

Figure 3 - Benefit-cost ratio (RBC) candidate, approved and real

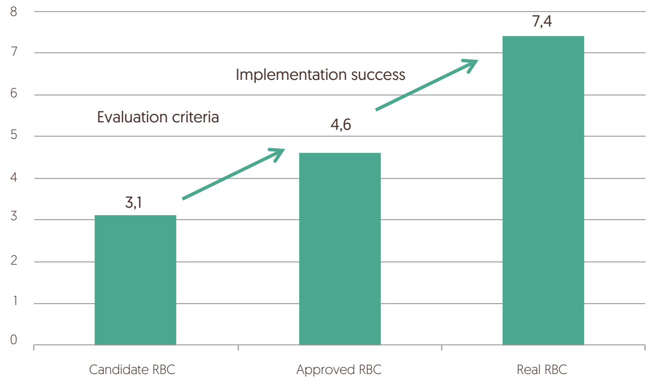
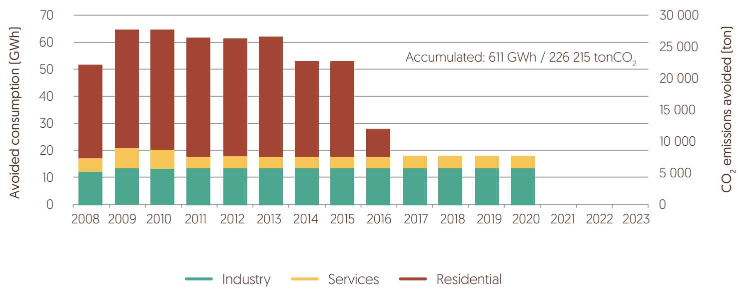


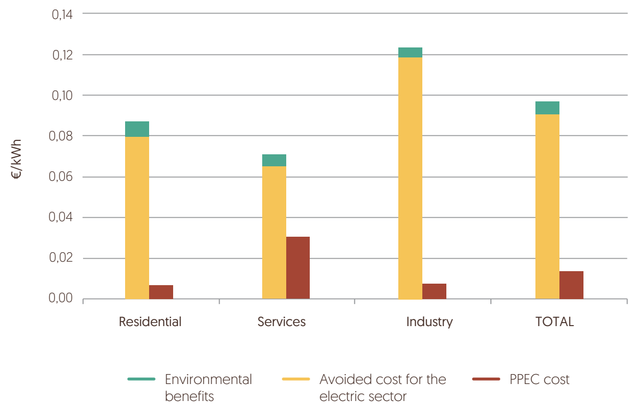
Figure 4 shows accumulated avoided consumption from PPEC the tangible measures. The measures were implemented during 2007, 2008 and 2009, though their results last until 2023 due to longer equipment useful lifetimes.

Figure 4 - Avoided consumption from PPEC 2007 tangible measures



The benefits for the electricity sector (measured by the avoided costs of supplying electricity) and the environment (measured by the avoided cost of CO_2 emissions) from PPEC 2007 are much higher than the correspondent costs, with a higher ratio for the industrial segment (13), followed by the residential segment (8) and by the services segment (2).

Figure 5 - Benefits and costs from PPEC 2007 tangible measures per unit of consumption avoided



The cost of each unit of consumption avoided (13 €/MWh) by PPEC 2007 is lower than the expected (21 €/MWh). It is important to highlight the net benefit which is 64 million €. Additionally, unit costs of consumption avoided are significantly lower than the cost resulting from the implementation of supply side equivalent measures, such as the *premia* given to special regime generation (29,4 €/MWh in 2007).

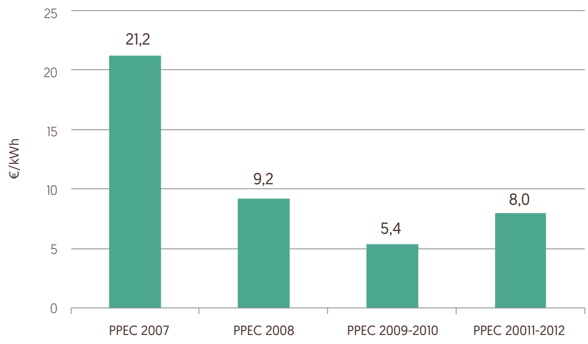
5. PPEC evolution

The competitiveness of PPEC is increasing. The tender for 2011-2012 received 150 submissions from 50 promoters. Only 50 measures were approved and now more than 20 promoters and 40 other partner entities (energy providers, consumers associations, business associations, municipal associations, universities, ESCO, environmental organizations, institutions of social solidarity, TV broadcasters...) are involved in the projects selected.

The growing interest in the mechanism has permitted an increase in the level of co-financing demanded from the promoters and beneficiaries, so as to ensure greater ownership and involvement. Currently, promoters have to support at least 20% of the total cost of the efficiency measure. In the last tender (PPEC 2011-2012), 38% of the funding needed for the implementation comes from the promoters and beneficiaries.

There is a progressive decrease in the unit cost of avoided consumption due to increased competition and action of ERSE in the establishment of rules including the mandatory minimum 20% co-financing from promoter and/or beneficiaries.

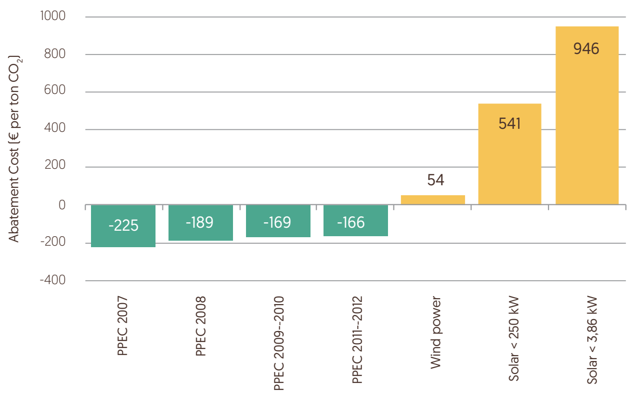
Figure 6 - Unit costs of the four editions of PPEC



ERSE estimates that the savings due to the four PPEC editions will represent in 2013 1,2% of the Portuguese consumption.

The following curve presents the global greenhouse gas (GHG) abatement cost curve made for Portugal, per ton CO_2. It is not a forecast of the maximum potential of all possible different abatement measures and technologies will play. The purpose is to illustrate based on the PPEC results that energy efficiency may not have costs but only net benefits. So, the net benefits of PPEC measures are compared with the net cost of some renewable generation, based on the *premia* paid to renewable generation in Portugal. The *premia* paid to renewables is calculated with the marginal feed in tariff and assuming a cost of 50 €/MWh for ordinary generation.

Figure 7 - Global GHG Abatement Cost Curve in Portugal



Conclusion

This paper runs a balance of the results of PPEC's first edition (PPEC 2007), proving that tender mechanisms are a cost-effective mechanism to achieve international and national objectives for CO_2 emissions reduction, having positive net benefits mainly associated to the energy costs avoided. Europe has in place a legal and regulatory framework to promote energy efficiency. PPEC has been giving an important contribution to achieve national energy policy goals. ERSE estimates that PPEC will contribute with 38% to achieve the goal set in National Plan for Climate Change (PNAC)[3] and with 19% to achieve the goal set in National Action Plan for Energy Efficiency (PNAEE)[4] for the period 2008-2015. It is important to note that these targets are achieved with a global net benefit as shown in the paper. These net benefits justified the adoption by ERSE of the tender mechanism PPEC in place, after a consultation process.

It is important to bring several entities for delivering energy efficiency (energy suppliers, consumers associations, municipalities, universities, ESCOs, institutions of social solidarity…) in order to maximize the number of agents involved, reducing market failures and barriers, reaching more consumers and increasing the spill-over effect. The obligation schemes applied to energy suppliers or distributors as foreseen in the EC proposal for a new directive on energy efficiency do not assure that involvement.

It is shown in the paper that tender mechanisms allowing to choose the best measures for the promotion of energy efficiency represent a good alternative to the above option. Tender mechanisms enable other participants besides suppliers and distributors to participate in the process for energy efficiency promotion leading to lower costs to meet the defined policy targets.

The Portuguese experience also confirms the importance of close cooperation between policy makers and regulators, to ensure that regulatory incentives are closely aligned with the objective of energy efficiency. The results so far clearly prove the maxim that "The best Megawatt is the Negawatt", that is that energy efficiency is far more cost-effective than other mechanisms to meet environmental targets, such as the promotion of renewable energy sources. In Portugal the cost per MWh saved through PPEC 2007 remained under 13 €/MWh, while renewables promotion can cost between about 80 and 500 Euros per MWh

[3] PNAC 2006/7 presented as a target for 2010 an energy saving of 1020 GWh.
[4] PNAEE established a wide range of measures in order for Portugal to meet the objectives set forth in the Directive 2006/32/EC. It establishes a 10% energy saving target by 2015.

produced, depending on the technology used. Considering the avoided costs associated with the energy saved, the 13 €/MWh cost of PPEC 2007 results in a net benefit of 225 €/MWh.

Clearly, energy efficiency is not the sole means to achieve the various related objectives of ensuring sufficient, affordable, reliable energy supply while meeting environmental goals but it is doubtlessly one of the main paths to be followed, with close participation of regulators.

Regulators ensure the crucial balance between energy availability and energy affordability and thus have a central role in the transition to a low carbon energy sector.

Acknowledgment

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The opinions, interpretations and conclusions presented in this paper do not necessarily reflect the official position of ERSE.

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Biographies

I. Apolinário (b. 1973) graduated in Economics in 1996 and received her MSc Degree in Energy and Environment Economics in 2005, both from the Technical University of Lisbon – Instituto Superior de Economia e Gestão. She is with ERSE since 1998 and her professional background includes the Portuguese Electricity Operator (EDP) and the Portuguese National Institute of Statistics, producing the Quarterly National Accounts.

C. Correia de Barros (b. 1974) graduated from the Technical University of Lisbon – Instituto Superior Técnico, Lisbon, in Electrical Engineering (1998). She is with ERSE since 1999 and her professional background includes the General Directorate for Energy end geology (DGEG).

C. Espírito Santo (b. 1978) graduated in Economics in 2001 from Universidade Católica Portuguesa (Lisboa) and received her MSc Degree in Finance in 2007 from ISCTE (Instituto Superior de Ciências do Trabalho e da Empresa). She is with ERSE since 2009 and her professional background includes the Portuguese Transmission System Operator (REN).

A. Ferreira (b. 1986) graduated in Economics in 2007 and received her MSc Degree in Economics and Public Policy in 2010, both from the Technical University of Lisbon – Instituto Superior de Economia e Gestão. She took an internship with ERSE between 2009 and 2011.

L. Ferreira (b. 1978) graduated in Management in 2001 from the Universidade Nova de Lisboa. She is with ERSE since 2007 and her professional background includes the Portuguese Electricity Operator (EDP). Her current interests are electricity and gas tariffs, economic regulation, efficiency and productivity, energy efficiency and market liberalization.

B. Madeira (b.1978) graduated from the Technical University of Lisbon - Instituto Superior Técnico, Lisbon, in power engineering (2003). He is with ERSE since 2007 and his professional background includes the Portuguese Transmission System Operator, REN.

P. Verdelho (b. 1963) received the Dipl. Ing., the M.S. and Ph.D. degrees from the Technical University of Lisbon-Instituto Superior Técnico, Lisboa, Portugal in 1987, 1990 and 1995, respectively, all in electrical engineering. He joined Instituto Superior Técnico in 1985. Since 1995 till 2002 he has been an Assistant Professor at the Universidade Técnica of Lisbon-Instituto Superior Técnico. Since 1985 till 2007 he was a research member of the Centro de Automática of the Technical University of Lisbon. Since 2007 he has been a research member of Centro para a Inovação em Engenharia Electrotécnica e Energia from Instituto Superior Técnico. In 1999 he joined the Portuguese energy regulatory authority, Entidade Reguladora dos Serviços Energéticos, being responsible for the Tariff and Prices Division. He published more than 100 papers having received the 1996 IEEE Industrial Electronics Society Meritorious Paper Award.

"Smart Grid": Uma Visão da Regulação[1]

Jorge Esteves, Hugo Pousinho, Paulo Oliveira, Pedro Roldão, Sérgio Faias, Vítor Marques, Alexandre Santos, Vítor Santos

Referências de Publicação

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Resumo

O presente artigo busca analisar o conceito da rede elétrica para o século XXI e alguns dos inúmeros desafios que a evolução mais recente do setor elétrico antecipa, focando-nos na redução do custo de instalação de sistemas de produção de energia elétrica a partir da tecnologia solar fotovoltaica e nas perspetivas de que idêntica evolução poderá acontecer com o armazenamento de energia elétrica em baterias eletroquímicas. As consequências dessa evolução nos diferentes tipos de relacionamento dos clientes com a rede elétrica é analisada. Identifica-se a importância da participação dos clientes em todos os segmentos do mercado elétrico, permitindo uma valorização adequada da flexibilidade por eles disponibilizada. Apresenta-se também a visão dos reguladores europeus da energia sobre a evolução do setor elétrico nos próximos dez anos e algumas das alterações na regulação dos ativos de rede que se antecipam no quadro do novo paradigma de redes "mais inteligentes", concluindo-se que a "inteligência" da rede elétrica do futuro ver se á, também, na sua capacidade em alinhar custos, benefícios e riscos.

Palavras-chave

Smart Grids - Regulação - Produção solar fotovoltaica - Armazenamento distribuído de energia elétrica - Flexibilidade disponibilizada pela procura.

[1] O presente artigo retoma a apresentação intitulada "Os projetos europeus de *Smart Grid* e a visão da regulação europeia", ocorrida em junho de 2015, no âmbito do Seminário Internacional "Análise das experiências europeias das políticas de incentivos às inovações tecnológicas de *Smart Grid*".

1. Introdução

O setor da energia atravessa um período de mudanças estruturais que apontam para uma visão de futuro bastante diferente do cenário atual, quer para os operadores e agentes do setor quer para os consumidores. Enquanto setor estratégico para a economia e para o desenvolvimento, a energia é objeto das políticas nacionais e da União Europeia. Além disso, observa-se que a política energética europeia tem como objetivos o combate às alterações climáticas, através da redução das emissões de CO_2, a promoção do aproveitamento dos recursos endógenos e renováveis e, finalmente, a promoção de medidas de eficiência energética. O desenvolvimento e a difusão de inovações tecnológicas será um elemento central nesta dinâmica.

No escopo do setor elétrico, ressalta-se que o desenvolvimento das redes elétricas foram vitais na ligação entre os produtores e os consumidores de energia elétrica. A sua arquitetura foi sendo centrada de modo a satisfazer as necessidades de ligar, predominantemente, grandes centrais electroprodutoras com tecnologias de produção com base em combustíveis fósseis de alto teor de carbono[2], localizadas remotamente, longe dos centros da procura.

Em contrapartida, unidades de produção baseadas em tecnologias com baixo teor de carbono, muitas vezes propriedade dos consumidores ou localizadas na sua proximidade, combinadas com muito maior eficiência e maior participação do lado da procura, obrigam a uma evolução das redes elétricas, com especial relevância nas redes de distribuição. Contudo, a evolução das tecnologias de informação e comunicação facilita o desenvolvimento dessa evolução quando a questão passa por permitir que os milhões de consumidores ligados à baixa tensão tenham oportunidade para uma participação ativa no sistema elétrico.

De todo modo, para o sucesso de todo o processo é fundamental o papel dos operadores de redes, que se irão debater com desafios tecnológicos e econômicos muito relevantes e se deverão assumir como principais facilitadores.

Sendo um tema muito vasto que pode ser abordado de muitos e variados pontos de vista, a reflexão que se segue centrou-se nas consequências que a evolução recente da tecnologia solar fotovoltaica e a eventual disseminação de sistemas de armazenamento distribuído de energia elétrica poderá ter no futuro do setor elétrico e da sua regulação. Algumas respostas que os reguladores europeus de energia anteciparam são também analisadas.

[2] Exceção da produção hidroelétrica ou à base de nuclear.

2. Alguns Desafios do Setor Elétrico

2.1. A rede elétrica do futuro

Os desafios que estão na base da transição que se está a viver no setor elétrico foram identificados há já algum tempo e têm vindo a ser consolidados passo a passo desde então.

Estes desafios implicam um setor elétrico que terá de lidar com uma maior volatilidade, introduzida pela produção de energia elétrica a partir dos recursos eólico e solar e por uma participação ativa dos clientes/consumidores, o que obriga a que a rede elétrica tradicional do Século XX, em que predominou o paradigma clássico de que "a produção segue a procura", evoluir para a rede elétrica do futuro, em que passará a reinar o novo paradigma de que "a procura contribui com a produção para o equilíbrio do sistema".

A rede elétrica tradicional do século XX carateriza-se, no essencial, por apresentar:

» Fluxo de energia unidirecional da muito alta tensão para a baixa tensão;

» Produção remota e centralizada;

» Comunicações limitadas;

» Automação limitada da rede;

» Rede passiva na entrega de energia elétrica aos consumidores domésticos.

Por sua vez, para a rede elétrica do futuro, o sistema elétrico caracterizar-se-á por apresentar:

» "*Mix* energético" da produção de energia elétrica (repartição da produção de energia elétrica por tecnologia e fonte de energia) com grandes centrais electroprodutoras e com produção distribuída ligada em alta, média e baixa tensão, baseada em fontes renováveis não despacháveis e com elevada variabilidade;

» Rede elétrica constituída pela rede tradicional que coexiste com novas topologias e novas filosofias de controle e operação;

» Clientes finais que irão participar mais ativamente em novos serviços de energia (incluindo os clientes domésticos) e com a procura a contribuir de modo ativo para o equilíbrio do sistema (DSM);

» Comunicações bidirecionais disponíveis em todos os níveis de tensão e por um despacho centralizado a coexistir com filosofias e sistemas de controlo descentralizado;

» Soluções de armazenamento de energia elétrica distribuído e veículos rodoviários elétricos.

São estas as bases que foram identificadas como correspondendo ao conceito de *Smart Grid*, a rede elétrica do século XXI.

Neste enquadramento, o Conselho Europeu de Reguladores Europeus (CEER) definiu que a *Smart Grid* é uma rede elétrica que integra, de modo eficiente quanto ao custo, o comportamento e as ações de todos os utilizadores a ela ligada – produtores, consumidores e aqueles com ambas as funções – com o objetivo de assegurar um sistema energético economicamente eficiente e sustentável, com baixas perdas e elevados níveis de qualidade de serviço, segurança de abastecimento e proteção [1].

Este conceito de *Smart Grid* assumido pelos Reguladores Europeus da Energia foi adaptado da definição publicitada pela *Smart Grids European Technology Platform* [2], onde foi introduzida a importância em assegurar a eficiência no custo das soluções tecnológicas que vierem a ser implementadas na rede elétrica do futuro.

Deste modo, as entidades reguladoras (que, entre outras atribuições, definem as tarifas de uso da rede e os proveitos dos operadores de redes elétricas) estabeleceram que as tecnologias "inteligentes" que permitam cumprir as metas estabelecidas de política energética terão que ser também eficientes na perspetiva do custo, assumindo uma posição de neutralidade em relação às opções tecnológicas a tomar.

A *Smart Grid* envolverá produtos e serviços inovadores em conjunto com soluções inteligentes de monitorização e controlo, no sentido de:

» Facilitar a ligação e operação de produtores de todas as tecnologias e dimensões;

» Permitir que os consumidores tenham um papel mais interativo na otimização da operação do sistema;

» Disponibilizar aos consumidores (que podem ser simultaneamente produtores) uma maior informação e escolha quanto ao fornecimento;

» Aumentar a flexibilidade estrutural da rede e assim contribuir para um mais rápido restabelecimento de funções em caso de incidentes com elevado impacto (tecnologias de auto-regeneração da rede);

» Reduzir significativamente o impacto ambiental do conjunto do sistema elétrico;

» Fornecer níveis avançados de fiabilidade e segurança de abastecimento.

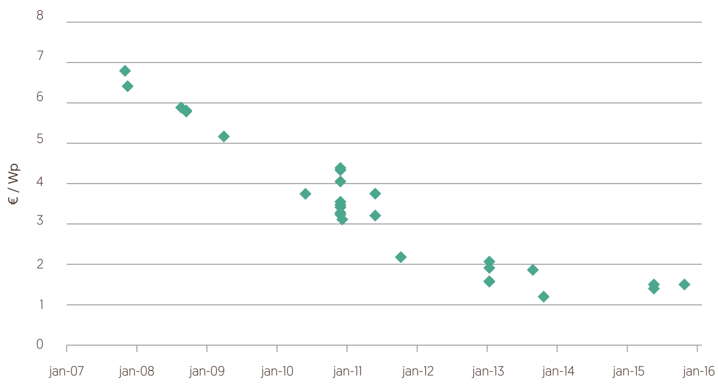
No sentido de fazer o acompanhamento da implementação deste novo paradigma das redes elétricas, o *Joint Research Centre* (JRC) da Comissão Europeia, no âmbito do *Institute for Energy and Transport* disponibiliza uma base de dados interativa sobre a evolução dos projetos *Smart Grid* europeus desde 2002 a 2014 [3], com diversas ferramentas disponíveis que permitem gerar mapas, gráficos e tabelas de forma personalizada. A JRC publicou o relatório "*Smart Grid Projects Outlook 2014*" [4], onde resume a base de dados "*JRC 2013-2014 Smart Grid*" e apresenta 459 projetos em fase de investigação e desenvolvimento ou em fase de demonstração e concretização comercial, em que os 28 países da União Europeia (UE) estão envolvidos. O JRC disponibiliza também na sua página da internet um inventário sobre laboratórios de I&D que se dedicam a aplicações de *Smart Grid* [5].

2.2. A evolução recente da produção solar fotovoltaica

Se a rede elétrica do futuro está já prevista há algum tempo, a redução de custo que ocorreu com a produção de energia elétrica a partir de tecnologia solar fotovoltaica, desde 2007, não era esperada de forma tão acentuada. A Figura 1 apresenta a evolução do custo por unidade de potência instalada, em euro por Watt-pico (€/Wp), de instalações de microprodução solar fotovoltaica que foram instaladas em Portugal e a cujos orçamentos de execução se teve acesso.

Tendo partido, em 2007, de valores da ordem dos 7 €/Wp atingiu valores ligeiramente superiores a 1,2 €/Wp no final de 2013, tendo estabilizado desde então.

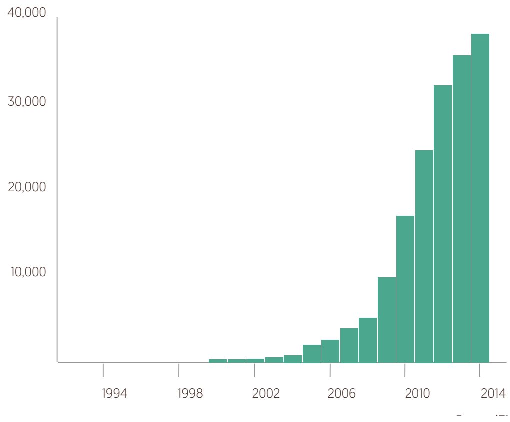
Figura 1 - Tecnologia fotovoltaica em Portugal: evolução do custo por unidade de potência em instalações de microprodução.



Na Europa, o caso mais significativo de sucesso de penetração do solar fotovoltaico ocorreu na Alemanha em que existiam 1,5 milhões de sistemas fotovoltaicos instalados em 2014, com uma potência de 38,5 GW e que produziram 34,9 TWh de energia elétrica, o que correspondeu a 6,8% da energia elétrica produzida nesse ano [6]. A Figura 2 apresenta a evolução da potência instalada de produção solar fotovoltaica nesse país europeu e a Figura 3 apresenta o "*mix* energético" da Alemanha em 2014.

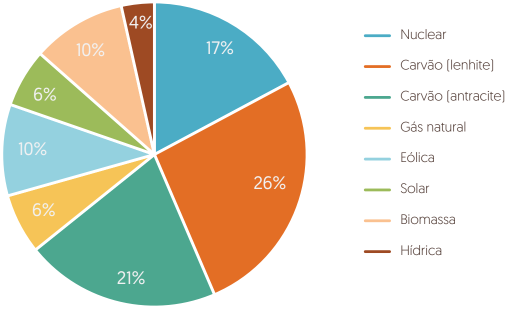
Por sua vez, a Figura 4 apresenta a evolução horária da produção de energia elétrica ocorrida nos dias 25 e 26 de maio de 2012, com a contribuição de cada uma das tecnologias disponíveis, visualizando-se o peso que a produção de energia elétrica de origem solar fotovoltaica teve durante esses dias. A Figura 5 apresenta o custo nivelado (*levelized cost*) de energia elétrica produzida por diferentes tecnologias de produção. Sabendo que na Alemanha, o preço da energia elétrica para o cliente doméstico (energia, redes e impostos) é superior a 0,20 € /kWh e que, em Portugal, o preço médio da energia no mercado diário ronda 0,05€/kWh, poder-se-á concluir que os custos do solar fotovoltaico não só já atingiram a "paridade com a rede" (*grid parity*) como, também, já se aproximam da "paridade com o mercado" (*market parity*).

Figura 2 - Potência solar fotovoltaica instalada na Alemanha, em MW.



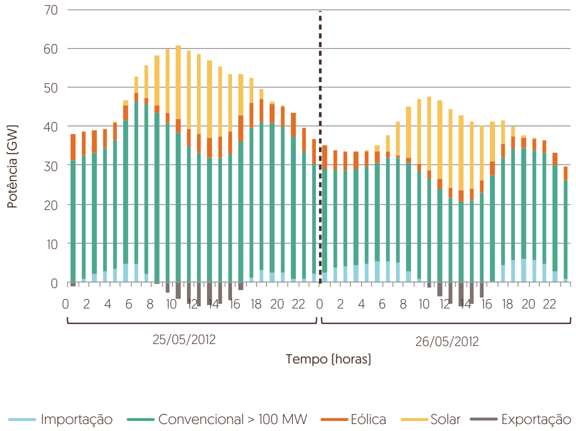
Fonte: [7]

Figura 3 - "*Mix* energético" da Alemanha durante 2014.



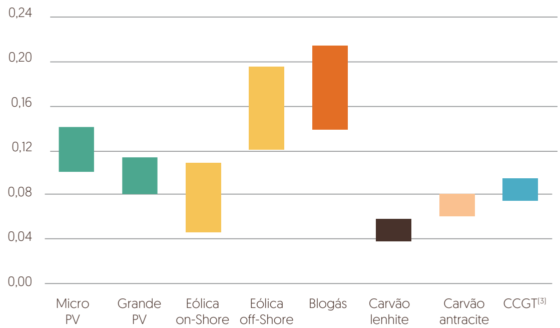
Fonte: adaptada de [8]

Figura 4 - Produção de energia elétrica na Alemanha nos dias 25 e 26 de maio de 2012.



Fonte: [9]

Figura 5 - Custo nivelado de energia elétrica produzida por diferentes tecnologias na Alemanha em novembro de 2013.



Fonte: adaptada de [10]

É reconhecido que o sucesso do solar fotovoltaico se deveu aos fortes subsídios de que beneficiou na última década. No entanto, atualmente esta tecnologia poderá já ter atingido a "maturidade", designadamente porque as instalações mais recentes são competitivas com a produção de energia elétrica convencional a partir de combustíveis fósseis, como é o caso por exemplo, de uma instalação cujo licenciamento esteve recentemente em consulta pública em Portugal, para a análise de impacto ambiental [11].

Perspetiva idêntica surge quando a revista Time noticia, em maio de 2015 [12], que os sistemas fotovoltaicos instalados em lares americanos evoluíram de pouco mais de 20 mil em 2012, para 156 mil em 2013 e 644 mil em 2014.

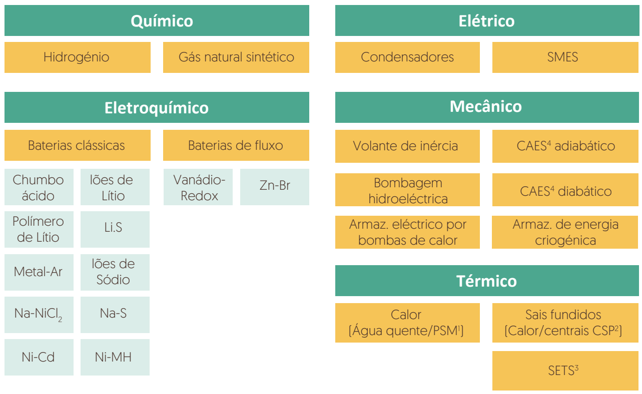
Com a evolução mais recente do seu custo, que a tornou competitiva quando comparada com as tecnologias tradicionais de produção de energia elétrica a partir de combustíveis fósseis, a produção solar fotovoltaica introduziu no mercado elétrico uma caraterística, que até agora é única, em que o fator de escala deixa de ser crucial para se ser competitivo. Anteriormente, a produção de energia elétrica tinha uma dimensão mínima para que as centrais pudessem ser economicamente competitivas em ambiente de mercado, o que, por exemplo, no ciclo combinado de gás natural se situava em valores próximos de 400 MW de potência por instalação.

Ao permitir custos unitários de instalação e operação (€/MW), que são de ordem de grandeza aproximada para diferentes dimensões de instalações (sejam centrais de grande dimensão ou sistemas com pouco mais de 250 W), a tecnologia solar fotovoltaica poderá permitir que a produção distribuída se possa verdadeiramente afirmar e contribuir para colocar os clientes (incluindo os clientes domésticos) no centro do sistema elétrico.

2.3. O contributo do armazenamento distribuído de energia elétrica

A evolução do armazenamento de energia elétrica é a próxima fronteira tecnológica que se espera "abrir" na direção da rede elétrica do futuro. A Figura 6 apresenta o leque alargado de diferentes soluções tecnológicas disponíveis para o armazenamento reversível de energia elétrica, que passa por fazer o armazenamento utilizando soluções de natureza mecânica, eletroquímica, química, elétrica ou térmica.

Figura 6 - Tecnologias de armazenamento de energia elétrica.



[1] PMC – Materiais de mudança de fase
[2] CPS – Centrais de concentração solar térmica
[3] SETS – Armazenamento termoelétrico "inteligente"
[4] CAES – Armazenamento de energia em arcomprimido

Fonte: adaptada de [13]

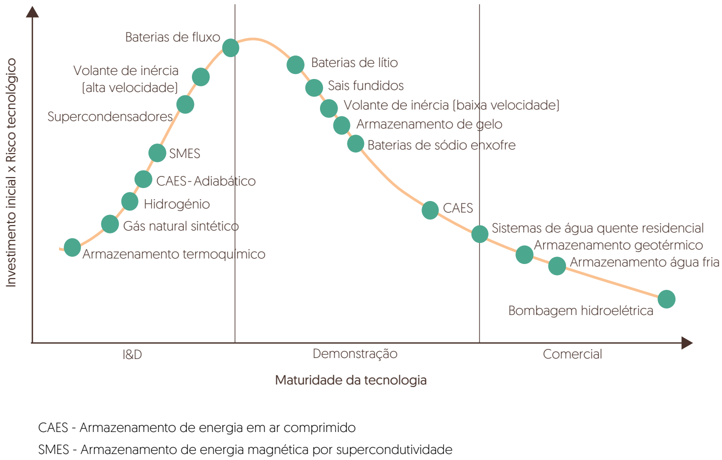
Verifica-se na Figura 7, no entanto, que muito poucas destas soluções são hoje consideradas como comercialmente competitivas. Regista-se, em especial, que a quase totalidade do armazenamento de energia elétrica reversível existente no mundo corresponde a barragens hidroelétricas com capacidade de bombagem[3] .

[3] Portugal é um caso ilustrativo [15]. Com a integração em larga escala da tecnologia eólica de produção de energia elétrica e o desafio da intermitência e volatilidade do recurso disponível que esta tecnologia coloca, foi considerado necessário apostar na construção de sistemas de armazenamento hidroelétrico com capacidade de bombagem que, ao serem reversíveis, disponibilizam a flexibilidade necessária para uma operação segura do sistema elétrico. Assim, foi possível apostar em concretizar rácios elevados de penetração de energia eólica no "*mix*" de produção nacional e, com um dimensionamento e uma exploração adequada do sistema elétrico, fazer uma otimização global de recursos, recorrendo ao armazenamento de energia elétrica quando a oferta de cariz renovável é excedentária face à procura e disponibilizando, essa energia armazenada, nas horas seguintes em que o preço de mercado é mais elevado. O fato da rede elétrica portuguesa estar fortemente interligada à rede elétrica espanhola também facilita a aposta concretizada.

O sucesso da tecnologia solar fotovoltaica volta a colocar um desafio idêntico já que a capacidade de produzir energia elétrica está diretamente ligada à incidência solar disponível, só sendo possível durante as horas do dia em que o sol está visível e com a energia que está a ser produzida instantaneamente por um determinado painel fotovoltaico a depender, mesmo com operação otimizada, de muitos outros fatores, tais como a localização geográfica, época do ano e nebulosidade ocorrida.

Mais uma vez, a bombagem hidroelétrica poderá ser uma solução complementar com interesse, armazenando o eventual excesso de produção face à procura durante o dia e aproveitando essa flexibilidade para disponibilizar a energia armazenada durante as horas em que não há sol ou em que se verifica maior procura.

Figura 7 - Maturidade das tecnologias disponíveis de armazenamento de energia elétrica.

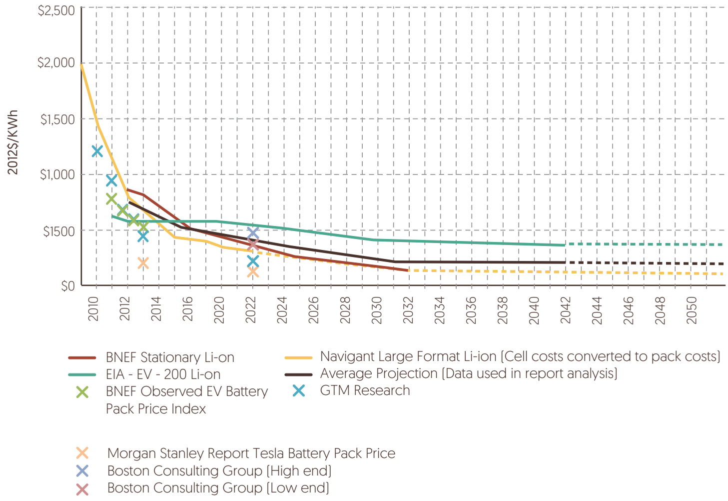


Fonte: adaptada de [14]

A confirmar-se a tendência de descida dos custos do armazenamento de energia em baterias, como se constata na Figura 8, o diferencial entre o custo do solar fotovoltaico e o preço da energia elétrica para o cliente doméstico (energia, redes e impostos) permitirá a aquisição de capacidade de armazenamento de energia elétrica por parte dos clientes.

Assim, um dos maiores desafios que se perspetiva para a rede elétrica do futuro é esta evolução para um sistema elétrico que, para além das soluções tradicionais centralizadas de produção e armazenamento, dispõe de recursos de produção e armazenamento distribuídos que são propriedade dos clientes, que tradicionalmente só participavam como consumidores no sistema.

Figura 8 - Preço ocorrido e previsto para as baterias de iões de lítio.



Fonte: [16]

2.4. Relações entre Clientes e a Rede Elétrica

Focando-nos apenas nos dois eixos[4] que este artigo procura aprofundar, no futuro, os clientes poderão optar por quatro modos de relacionamento com a rede elétrica, Figura 9.

Figura 9 - Diferentes tipos de relacionamento dos consumidores com a rede.

O seu maior nível de dependência ou independência de relacionamento com a rede elétrica terá em conta a opção que poderá ser feita entre ser:

[4] No futuro setor elétrico outras opções poderão ser tidas em conta, que poderão passar, por exemplo, por escolhas de outras tecnologias de produção distribuída ou pela gestão ativa da carga. No entanto, o seu desenvolvimento extravasa o âmbito deste artigo.

1. Cliente tradicional ligado à rede, que consome a energia elétrica que a rede lhe disponibiliza;

2. Cliente com produção solar para autoconsumo, que se mantem ligado à rede para o essencial do fornecimento dos seus consumos elétricos;

3. Cliente com produção solar para autoconsumo e armazenamento com baterias, que opta por se manter ligado à rede para, pelo menos, garantir a segurança de abastecimento;

4. Cliente com produção solar para autoconsumo e armazenamento com baterias autónomo, que opta por se desligar completamente da rede elétrica.

A evolução dos custos unitários da energia produzida localmente ou consumida da rede (que inclui o custo do uso de rede) será primordial na opção que cada cliente irá fazer.

Ao verificar-se que o fator de escala deixou de ser essencial para a competitividade das soluções de produção de energia elétrica, os clientes tradicionais do tipo 1, que tenham condições para tal, passarão a ser clientes do tipo 2, instalando sistemas e produzindo a energia de que necessitam para o seu autoconsumo durante as horas em que o sol esteja disponível. No entanto, para a generalidade dos clientes domésticos, a parcela de energia que irá ser produzida para autoconsumo será bastante reduzida, tendo em conta que uma parte substancial do consumo doméstico ocorre nas horas em que não há sol e estes clientes não têm consumos que apresentem flexibilidade para alterarem as horas em que estes podem ocorrer. Com grande probabilidade, esta transição de clientes do tipo 1 para clientes do tipo 2 não terá, assim, grandes consequências nas redes elétricas, já que a ponta de utilização, em Portugal e na generalidade dos países europeus, ocorre no início da noite.

É esta a situação que ocorre hoje em Portugal, em que a legislação publicada recentemente [17 - 18] incentiva a produção de energia elétrica distribuída para autoconsumo sem a necessidade de introduzir qualquer outro incentivo. A aprendizagem com outras experiências permitiu evitar a opção pelo "*net metering*"[5] que, tendo sido incentivador para

[5] "*Net metering*" corresponde a um quadro regulamentar ao abrigo do qual o excesso de eletricidade injetada na rede por um determinado consumidor pode ser usado, num momento posterior, para compensar o consumo durante períodos em que a respetiva produção renovável local não é suficiente para satisfazer o consumo desse mesmo consumidor. Noutras palavras, ao abrigo deste regime, os consumidores usam a rede como um sistema de armazenamento para a sua produção de energia em excesso (tradução a partir de [19]).

o rápido aparecimento de uma maior quota de solar fotovoltaico, está a criar problemas delicados de sustentabilidade em alguns outros países europeus.

Se for comercialmente atrativo, a generalização do armazenamento de energia elétrica distribuído poderá ter um impacto mais significativo na utilização da rede. Assim, se o diferencial entre o custo do solar fotovoltaico e o preço da energia elétrica para o cliente doméstico (energia, redes e impostos) permitir a aquisição de capacidade de armazenamento de energia elétrica por parte dos clientes, os clientes do tipo 2 poderão optar por ser clientes do tipo 3 e passarão a poder produzir energia elétrica para além da necessária para o seu autoconsumo durante as horas em que sol está disponível, aproveitando a flexibilidade que o armazenamento distribuído lhes disponibilizará para terem energia elétrica nas restantes horas. Nestas condições, surgirão diferenças significativas entre as quantidades da energia elétrica que os clientes efetivamente consomem e as quantidades fornecidas através da rede elétrica.

Os clientes do tipo 3 passarão a dispor de soluções alternativas à rede elétrica para o abastecimento parcial ou total de energia elétrica de que necessitam e, caso os custos de se estar ligado à rede seja excessivos, poderá ainda ocorrer uma migração deste tipo de clientes para clientes do tipo 4, que preferem estar desligados da rede elétrica.

O desafio para a regulação será conseguir criar condições para que essa migração se efetue sem pôr em causa a sustentabilidade do sistema, isto é, sem que os custos por unidade distribuída para os restantes clientes, que não podem migrar, sejam incomportáveis. Adicionalmente, a regulação deve garantir a adequação econômica dos sinais preço das tarifas de uso das redes, para que as escolhas dos utilizadores das redes sejam racionais numa perspetiva sistémica.

O primeiro passo passa por apresentar tarifas de uso da rede elétrica que sejam comparáveis com o valor económico que o uso da rede elétrica representa, para um cliente com um muito baixo fator de utilização da rede, no domínio da continuidade de serviço, da qualidade da energia elétrica e da segurança de abastecimento.

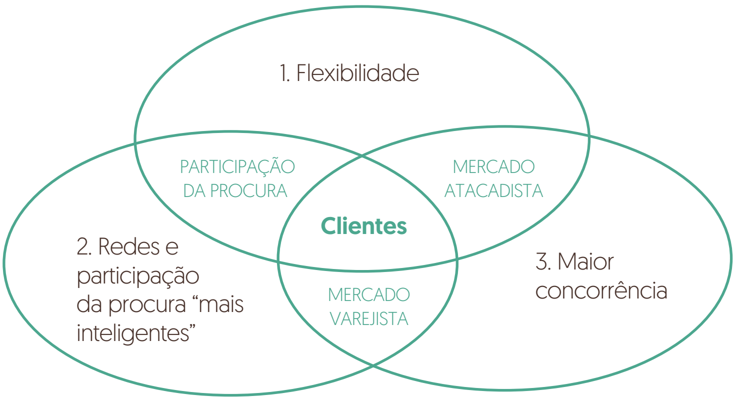
Além de um nível adequado de preços, estes devem ter uma estrutura que reflita adequadamente os custos incrementais do uso das redes, em termos da relação entre componentes fixas e variáveis, entre preços de potência e de energia, ou mesmo em termos da relação entre preços de energia pelo uso em diferentes momentos no tempo (ponta da rede).

Em complemento, o setor elétrico deverá ser capaz de valorizar a flexibilidade que os clientes do tipo 3 podem oferecer para a otimização do sistema.

Com os aspetos económicos a serem essenciais na tomada de decisão que os diferentes clientes irão fazer quanto ao modo como se pretendem relacionar com a rede elétrica, este será um novo desafio para o setor que implicará alterações, pelo menos, quanto às estruturas de tarifas e preços, aos modelos regulatórios e aos modelos de negócio aplicáveis aos diferentes intervenientes do setor elétrico.

Ao contrário de provocar a migração dos clientes do tipo 3 para clientes do tipo 4, que se desligam da rede elétrica, o setor elétrico deverá aproveitar esta disponibilidade dos clientes, de investirem para terem custos com a energia elétrica mais baixos, como mais um elemento de concorrência em ambiente de mercado competitivo, permitindo colocar o cliente no centro do sistema, Figura 10.

Figura 10 - Colocar o cliente no centro do sistema elétrico.



Fonte: adaptada de [20]

Por outro lado, sendo a rede elétrica composta por ativos que, em média, apresentam um tempo de vida de utilização superior a 30 anos, para evitar possíveis futuros custos “afundados”, é fundamental que todas as novas opções de investimento tenham em consideração como provável evoluções desta natureza. Deste modo, a eventual transição que se perspetiva irá sendo concretizada com tempo para uma adaptação do setor, sem disrupções “dramáticas” na regulação e na indústria do setor.

3. A Visão da Regulação Europeia

Os reguladores europeus da energia têm estado atentos à evolução do setor elétrico e têm publicado posições conjuntas, através das suas estruturas associativas europeias, nomeadamente o CEER - Conselho dos Reguladores Europeus da Energia e a ACER-Agência para a Cooperação dos Reguladores Europeus da Energia, sobre temas relativos à "*Smart Grid*" [1, 21 - 24], nomeadamente, no que se refere a medidores[6] inteligentes [25 - 27], armazenamento [28] e participação da demanda[7] [29 - 30].

3.1. Documento ACER "Energy Regulation: A Bridge to 2025"

Mais recentemente, em setembro de 2014 e após dois anos de reflexão conjunta sobre o tema, os reguladores europeus da energia publicaram o documento da ACER "*Energy Regulation: A Bridge to 2025*" [31] em que apresentaram a sua visão sobre a evolução do setor energético nos próximos dez anos. Deste modo, a visão dos reguladores europeus sobre como será o mercado elétrico, em 2025, passa por:

» Uma parte substancial da produção de energia elétrica ter origem em fontes diversificadas com um teor de carbono bastante baixo ou próximo de zero.

» Todas as formas de produção, de armazenamento e participação da demanda poderem competir em igualdade de condições e em todos os prazos de negociação, desde os horizontes temporais de longo prazo (relacionados com o investimento em infraestruturas) até ao associado à entrega em tempo real, em um mercado único de dimensão europeia, sem entraves justificados pela existência de fronteiras.

» A existência de um mercado atacadista[8] com liquidez e competitivo, onde será valorizada uma participação flexível de todos os intervenientes, com o objetivo de garantir elevados níveis de segurança do sistema.

» As redes de transporte aumentarem as suas interligações transfronteiriças, com a capacidade transfronteiriça a ser calculada de modo dinâmico e maximizando uma sua utilização eficiente.

» As intervenções políticas estarem circunscritas às situações onde falhas de mercado foram identificadas e tendo o objetivo único de minimizar as distorções de mercado.

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6 O termo "medidores inteligentes", utilizado no Brasil, é referido em Portugal, pelo setor elétrico, como "contadores inteligentes".

7 O termo "demanda", utilizado no Brasil, é usualmente referido em Portugal, pelo setor elétrico, como "procura".

8 O termo "atacadista", utilizado no Brasil, é referido em Portugal, pelo setor elétrico, como "grossista".

- O quadro regulatório assegurar o investimento econômico nas redes, sem discriminar entre projetos nacionais e transnacionais, em benefício dos consumidores.
- Todos os clientes, sejam eles grandes consumidores industriais ou clientes domésticos, poderem participar ativamente no mercado (quer diretamente ou através de prestadores de serviços que se comportam como agregadores).
- Os consumidores poderem possuir e operar equipamentos de produção de energia elétrica ligados às suas instalações (industriais, de terciário ou domésticas).
- Tecnologias inteligentes e novos serviços estarem disponíveis para gerir o consumo de clientes de menor dimensão (incluindo clientes domésticos), auxiliando na operação da rede elétrica e contribuindo para a redução do seu custo, o que permitirá reduzir as contas de energia elétrica dos consumidores envolvidos.
- Novas tecnologias, como o armazenamento de energia elétrica (incluindo a capacidade de armazenamento inerente aos veículos elétricos), irão desempenhar um papel cada vez mais importante no mercado e a flexibilidade necessária para a operação do sistema elétrico.

3.2. Flexibilidade Disponibilizada pela Demanda

Como já fora referido, no sistema elétrico do futuro, a estratégia de operação terá de deixar de ser a tradicional em que a "produção segue a procura", caraterizada por uma produção centralizada e previsível que, sendo totalmente controlada, disponibiliza em tempo real os valores necessários para abastecer o consumo.

Neste novo contexto, a incerteza já não se encontra somente do lado do consumo elétrico mas também em muita da produção disponível, de origem renovável, que também deixou de ser centralizada e se encontra distribuída por todos os níveis de tensão da rede. Em contrapartida, porque algum do consumo passa a ser controlável e se perspetiva a existência de capacidade de armazenamento distribuído, os clientes também poderão contribuir para a operação do sistema e beneficiar das receitas que essa participação irá gerar para reduzir os respetivos custos com energia elétrica[9].

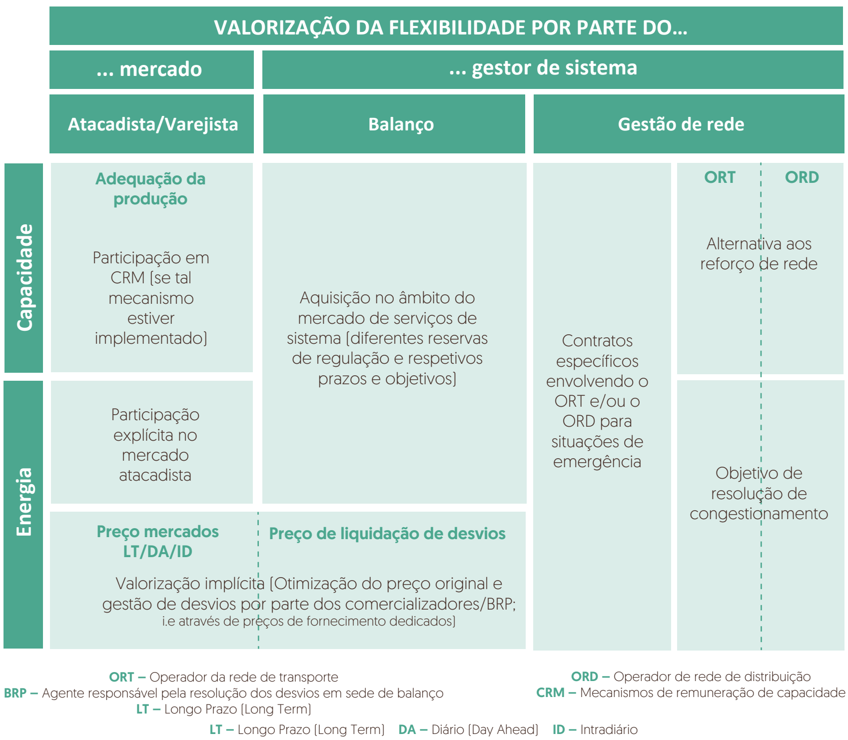
É assim que, a operação do sistema elétrico do futuro se terá que se basear num novo princípio em que a "demanda contribui com a produção e para o equilíbrio do sistema".

[9] A flexibilidade afeta os custos de energia, já que evita a entrada em funcionamento de tecnologias mais caras, e evita investimentos na rede, ao resolver potenciais congestionamentos.

Foi neste sentido a reflexão realizada pelos reguladores europeus que realçaram a importância em assegurar que todos os recursos de flexibilidade disponíveis deverão poder participar em igualdade de circunstâncias nos mecanismos de mercado que se encontram estabelecidos e que deverão ser derrubadas todas as barreiras que dificultam essa participação por parte da procura, do armazenamento e da produção distribuída. O primeiro passo será começar por abrir todos os segmentos de mercado (longo prazo, diário, intradiário, varejista[10] e de serviços de sistema) à participação da flexibilidade disponibilizada pelos clientes, Figura 11.

A gestão da rede, seja na perspetiva operacional de tempo real (resposta a emergências) ou na perspetiva do planejamento[11] de investimento de novas redes e equipamentos (como com alternativas a reforços de rede ou na resolução de congestionamento), também será uma oportunidade para soluções de flexibilidade e participação ativa da procura.

Figura 11 - Exemplos de segmentos de mercado que permitirão valorizar a flexibilidade disponibilizada.



Fonte: adaptada de [32]

[10] O termo "varejista", utilizado no Brasil, é referido em Portugal, pelo setor elétrico, como "retalhista".
[11] O termo "planejamento", utilizado no Brasil, é referido em Portugal como "planeamento".

A reflexão conjunta dos reguladores europeus também concluiu que, apesar da importância da harmonização das regras no interior do espaço europeu, não será possível uma solução única de âmbito europeu.

De todo modo, sistemas elétricos diferentes terão diferentes necessidades de flexibilidade. Serão utilizadas ferramentas variadas (por exemplo: valorização implícita ou valorização explícita, com base no preço ou com base em incentivo, unidade única ou unidades agregadas), com cada segmento de mercado (atacadista, serviço de sistema, gestão da rede, ...) a ter de responder a desafios específicos. Preços de energia e tarifas dinâmicas de uso de rede em tempo real poderão ser uma medida eficiente, mas não serão suficientes.

Existe um desafio acrescido quanto à gestão da entrada de novos atores no sistema, dos quais são exemplo os agregadores. Identificados como necessários para aumentar a concorrência no sistema elétrico, dever-se-á garantir que não enfrentam nem barreiras injustificadas nem desvantagens injustas. A solução a adotar poderá diferir em função das caraterísticas de cada mercado.

Os operadores das redes de distribuição irão ter funções acrescidas que ainda não se encontram totalmente identificadas [33]. Todavia, os reguladores europeus consideram que essas funções devem atender a alguns princípios básicos: i) os operadores devem ser diligentes e ir de encontro às expectativas razoáveis dos utilizadores das redes atuais e futuros; ii) os operadores devem atuar como facilitadores neutrais do mercado (incluindo o mercado dos serviços de energia); iii) os operadores devem atuar no interesse público, atendendo aos custos e benefícios das várias atividades; iv) os consumidores são os donos dos dados de consumo e os operadores devem assegurar a proteção desses dados.

A interação entre os operadores das redes de distribuição e o operador da rede de transporte será aumentada e o desenvolvimento da dimensão local do mercado de flexibilidade é mais um domínio onde é necessário a progredir e que coloca inúmeros desafios.

3.3. "Inteligência" na Regulação dos Ativos das Redes Elétricas

O novo paradigma de redes "mais inteligentes" vai introduzir algumas alterações na regulação dos ativos de rede.

Como contraponto às redes tradicionais que são compostas por subestações, linhas elétricas, transformadores, proteções, relés e disjuntores, "cobre" e ativos com vida útil maior, a *Smart Grid* será também focada em:

- Ativos[12] que incorporam mais tecnologias de informação e comunicação;
- *Software*;
- Ativos com vida útil menor;
- Operação recorrendo a mecanismos de mercado para mobilização de recursos de flexibilidade dispersos na rede (consumidores, pequenos produtores, agregadores, armazenamento, veículos elétricos);
- Produção distribuída;
- Armazenamento distribuído;
- Cibersegurança.

Os ativos (regulados) "inteligentes" têm tempos de vida útil da ordem dos 10 anos e não os 30 ou 40 anos que os ativos característicos das redes tradicionais. Isto significa maior taxa de substituição, importando ter em consideração quais serão os impactos tarifários que daí poderão decorrer.

Por outro lado, a tecnologia continua a evoluir e um ativo mais "inteligente" com 5 anos de idade pode tornar-se obsoleto. Nessas condições, importa clarificar quem deverá suportar os custos, ou seja, o CAPEX não depreciado.

A principal importância dos incentivos é promover decisões dos operadores que sejam eficientes, sustentáveis (visão de longo prazo) e alinhadas com os objetivos da política energética.

Os reguladores não têm toda a informação nem assumem cada decisão de investimento (faz parte da atividade dos operadores). Pelo contrário, devem incentivar/orientar essa tomada de decisão, a bem do sistema elétrico e dos consumidores do presente e do futuro.

O balanço adequado entre investimento em linhas e transformadores e em tecnologias da informação e comunicação, entre inovação e soluções tradicionais, entre investimento

[12] As subestações, no seu todo, já incorporam bastante automação. As redes tradicionais já incorporam "inteligência" e as proteções não atuam cegamente, tendo bastante seletividade e capacidade de isolar e resolver defeitos, sobretudo em nível da rede de transporte mas também nas redes de distribuição. Os relés e disjuntores vão continuar a ser necessários, e serão cada vez em maior número e mais caros, caso se queira aumentar a capacidade de reconfiguração das redes. Nas linhas e transformadores é que vai estar a redução da necessidade de investimento. A grande diferença estará na tecnologia de informação (infraestrutura e camada de dados em trânsito) e na mudança do tipo de atuadores que passarão a ter uma função bidirecional (sensores/atuadores).

e adiamento, deve ser promovido pela regulação, através dos mecanismos de incentivo regulatórios, e ir-se adaptando à evolução do próprio setor.

É por esta razão que é importante que os incentivos regulatórios e a partilha de riscos estejam corretamente equilibrados, para se conseguir ter os operadores de rede, a entidade reguladora, os consumidores e restantes utilizadores da rede alinhados e a concordarem que as redes “inteligentes” são o caminho para alcançar, com um custo menor, os objetivos sociais estabelecidos.

A “Inteligência” (“*Smartness*”) da rede elétrica do “futuro” ver-se-á também na sua capacidade em alinhar custos, benefícios e riscos.

Conclusões

No presente capítulo, analisam-se o conceito da rede elétrica para o século XXI e alguns dos desafios que a evolução mais recente do setor elétrico antecipa, nomeadamente decorrentes da redução do custo de instalação de produção de energia elétrica a partir da tecnologia solar fotovoltaica e as perspetivas de idêntica evolução poder vir a acontecer, no curto ou médio prazo, no que se refere ao armazenamento de energia elétrica em baterias eletroquímicas.

Ao fazer com que o fator de escala deixe de ser essencial para a competitividade das soluções de produção de energia elétrica e com a eventual generalização da utilização do armazenamento de energia elétrica distribuído, os clientes passarão a poder optar por diferentes tipos de relacionamento com a rede, já que terão disponíveis soluções alternativas para o abastecimento parcial ou total de energia elétrica de que necessitam, podendo passar pelo seu “desligar da rede”.

Neste enquadramento, o desafio para a regulação e para a indústria do setor elétrico será conseguir que os clientes valorizem adequadamente os benefícios de se manterem ligados à rede elétrica que, para além da sua utilização para o fornecimento de energia elétrica que necessitem adquirir, apresenta vantagens no domínio da continuidade de serviço, da qualidade da energia elétrica e da segurança de abastecimento.

Este será um novo desafio que implicará alterações, pelo menos, quanto às estruturas de tarifas e preços, aos modelos regulatórios e aos modelos de negócio aplicáveis aos diferentes intervenientes do setor elétrico. Tarifas de uso das redes adequadas, que não incentivem o abandonar da rede elétrico, são um dos passos mas, em complemento, o setor elétrico deverá ser capaz de valorizar a flexibilidade que os clientes podem oferecer para otimizar o sistema.

É, assim, importante assegurar que todos os recursos de flexibilidade disponíveis deverão poder participar, em igualdade de circunstâncias, em todos os segmentos de mercado (longo prazo, diário, intradiário, varejista e de serviços de sistema) que se encontram estabelecidos e que deverão ser derrubadas todas as barreiras que dificultam a participação da flexibilidade disponibilizada pelos clientes, seja ela na forma de procura, de armazenamento ou de produção distribuída.

Como contrapartida às redes tradicionais, a *Smart Grid* será constituída por ativos que incorporam mais tecnologias de informação e comunicação, mais *software* e mais ativos com vida útil menor. Este novo paradigma de redes "mais inteligentes" vai introduzir algumas alterações na regulação dos ativos de rede. Só com os operadores de rede, a entidade reguladora, os consumidores e restantes utilizadores da rede alinhados e concordantes quanto às redes "inteligentes" serem o caminho para alcançar, com um custo menor, os objetivos sociais estabelecidos, será possível concordar em incentivos regulatórios e numa partilha de riscos corretamente equilibrados. A "Inteligência" ("*Smartness*") da rede elétrica do "futuro" ver-se-á na capacidade de todos os intervenientes alinharem custos, benefícios e riscos.

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Incentive for an efficient management of CO_2 allowances in the Portuguese electricity sector

Vitor Marques, Pedro Costa, Amanda Falcão[1]

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Abstract

July 2007 was an important milestone for the liberalization of the Portuguese electricity sector. After this date, only two Power Purchase Agreements (PPA) are in force. REN Trading has to resale the energy generated by the two producers with a PPA in the market. The difference between the costs of the energy produced, which include costs resulting from the CO_2 allowances, and the gains of reselling this energy in the market is transferred to the consumers through the regulated tariffs. In the autonomous regions of Azores and of Madeira, generation costs are regulated, including CO_2 allowances costs. The Portuguese Energy Regulator (ERSE) created a regulatory mechanism which aims to

[1] Entidade Reguladora dos Serviços Energéticos, Portugal - Rua D. Cristóvão da Gama, n.º 1, 3.º - 1400 - 113 Lisboa, Portugal. Phone: +351 213033200 E-mail: vmarques@erse.pt; pcosta@erse.pt; afalcao@erse.pt

give to the regulated companies an incentive for administrate the CO_2 allowances in an efficient way. This mechanism is based on the profit and the losses sharing between the companies and the costumers resulting from the CO_2 allowances trading. After one year of application, in a context of great uncertainty for the carbon market, like other markets, the main results of the incentive mechanism are presented in this paper.

Keywords

CO_2 - European Emission Trading Scheme - Incentive - Regulation - Electricity Sector.

Introduction

After an initial period of 3 years, the European Union Emissions Trading System (ETS) started in 2008 the second market period which coincides with the Kyoto fulfillment period. The estimated demand of CO_2 allowances is greater than it was in the first period, due to the reductions from the National Allocation Plans (NAP) II. Therefore, during 2008 average prices were higher than in the previous market period, rounding 20 €/ton for most of the year.

The ETS frames CO_2 allowances allocated to several economic sectors in Europe, as the electricity sector. In what concerns the Portuguese electricity sector, July 2007 was an important milestone for the liberalization of this sector with the end of the majority of the Power Purchase Agreement (PPA). After this date, only two PPA are in force for Turbogás and Tejo Energia power plants. It was established a legal entity, named *Agente Comercial*, which purchases the energy from these producers in Portugal mainland. This function was attributed to REN Trading, a company from the same group of the transmission system operator. REN Trading also manages these producers' CO_2 allowances.

The difference between the costs of the energy produced, which include costs resulting from the CO_2 allowances, and the gains of reselling this energy in the market is transferred to the consumers through the regulated tariffs. In Azores and Madeira islands, the generation costs are also regulated by the energy regulator (ERSE) because there is not a wholesale market. So, EDA and EEM, the generation companies, must have a strategy to deal with carbon economy.

The Tariffs Code [1] previews the consideration of CO_2 costs for REN Trading, EDA and EEM in the tariffs' income. Tariffs Code also establishes that ERSE is responsible for design an incentive for an efficient CO_2 allowances management.

According to the NAP II, the estimated CO_2 allowances deficit represents approximately 30 million €/year cost for EDA, EEM and REN Trading power plants for a price around 20 €/ton. That is an important value when compared with the total estimated cost for the set of thermal power plants in Portugal (50 million €/year). It has to be pointed out that EDA and EEM have a surplus of CO_2 allowances and REN Trading is in the opposite situation.

The paper presents an incentive for an efficient CO_2 allowances management, resulting benefits that must be shared with the customers. The incentive developed by ERSE [2] was in force in 2008 for the first time.

1. Emission trading scheme – an introduction

1.1. The International and European context

The United Nations Framework Convention on Climate Change (UNFCCC), adopted in 1992, establishes that the climate change issues should be take into account in the other policies, like the energy, transport, industry, agriculture and waste policies. In 1997, it was adopted a Protocol to UNFCCC - Kyoto Protocol - where the signatories (only the industrial countries) accepted quantified reductions of greenhouse gases emissions (GHG). Kyoto Protocol is binding since 16th February 2005.

European Union accepted a common objective, postponing the burden sharing [2] among the member states. In the 2008-2012 period, Portugal can increase its GHG emissions up to 27% of 1990 level.

Aiming the cost reduction to fulfill the Kyoto objectives, EU decided to establish a cap-and-trade system for CO_2 allowances – the EU Emission Trade System (ETS). The first period of this scheme comprised 2005 - 2007 period. Next periods are 5 years long periods. For each period, a NAP is approved by European Commission (EC), after a member-state proposal, which share the burden within the sectors and the installations. EC shall ensure that NAP is consistent with the Member State's obligation to limit their emissions and doesn't have anti-competitive consequences.

1.2. The Portuguese case

Portuguese's NAP I, 2005-2007 period, was published on 13th September 2005 [3] and NAP II, 2008-2012 period, was published on 4th January 2008 [4].

In each CO_2 market period, the competent authority (Agência Portuguesa do Ambiente, in Portugal) shall issue the annual allowances for each installation, by 28th February of that year. Each installation will decide if it is cheaper to reduce CO_2 emissions with internal measures or to buy or sell allowances in the market. The installation operator is the agent well informed about its marginal cost reduction of CO_2 emissions. This is an advantage of a trade and cap scheme. By 30th April, the operator of each installation surrenders a number of allowances equal to the total emissions from that installation during the preceding calendar year.

Participants in the ETS could also receive credits from Kyoto mechanism (clean development or joint implementation). According to the Portuguese NAP II, each installation can surrender up to 10% of their emissions. Therefore, there are gains opportunities for the companies and the customers due to the price difference between the European Unit Allowance (EUA) and the Certified Emissions Reduction credits (CER) markets[2]. In addition to ETS, the Portuguese policy to fulfill Kyoto also includes, a national program against climate change (PNAC – Programa Nacional para as Alterações Climáticas) and a carbon fund, namely to invest in Kyoto mechanism credits.

1.3. Market results

In the first market period (2005-2007), prices reached values close to 30 €/ton in April 2006. Although, after the release of the 2005 results (verified emissions per each installation), prices suddenly drop to values from 10 to 15 €/ton. The decrease of the prices continued and the first market period finished with prices close to 0,02 €/ton. The market behavior showed a low demand against the supply because NAPs were generous.

For the second market period, NAPs II establish a reduction of CO_2 allowances when compared with NAPs I, which made prices rise significantly. However, it's not clear what is the rational for the CO_2 allowances price evolution. The correlation between oil prices and CO_2 allowances prices (Figure 1) evolution indicates that the demand for CO_2 allowances may be due to reasons beyond ETS obligations.

2 Credit from clean development mechanism.

Figure 1 - Oil prices and CO_2 allowances prices

The reduction of CO_2 allowances for the whole EU is close to 10%, comparing with NAP I [5]. For Portugal, the Electricity generation is one of the sectors with a greater reduction. It is expected that for the post-Kyoto period the initial allocation will follow an auction method in the European level.

2. Necessity of the incentive for an efficient management of CO_2 allowances

Taking into account another mechanism developed by ERSE applied to the regulated producers in Portugal mainland, REN Trading has an incentive for operate the power plants in such a way that it can sell the energy at the best price. The mechanism depends on the power plant. Therefore, it is a percentage of the mark-ups on prices, which cover variable costs (including CO_2), in Tejo Energia's case, and it's a percentage of the optimum incomes, in Turbogas's case.

The reduction of the production costs, in the Tejo Energia's case, can be considered as an incentive for reduce CO_2 allowances costs. However, the specificity of the CO_2 market, namely the possibility to buy and purchase CO_2 allowances independently of the production, leads to the creation of an independent mechanism for CO_2.

In what concerns Azores and Madeira islands, the purchase of electricity activity is regulated through a rate of return methodology. This methodology doesn't offer a great incentive for the efficiency achievement, when it's compared to other kind of regulatory schemes, namely price-cap schemes. That is another justification for the implementation of a specific mechanism for the CO_2 allowances.

3. Costs and revenues related to the CO_2 allowances

Taking into account what was mentioned previously, the annual costs and revenues transferred to the electricity costumers related to the CO_2 consider:

- The CO_2 allowances costs;
- An incentive for an efficient management of CO_2;
- Share of benefits obtained with SWAP operations

$$CO_2 = \sum_{i=1}^{n} Qpurchase_i \times Ppurchase_i - \sum_{j=1}^{m} Qsale_j \times Psale_j + ICO_2 - \frac{SWAP}{2} \qquad [1]$$

Where:

CO_2 - annual costs and revenues transferred to the electricity costumers related to the CO_2 allowances, €.

$Qpurchase_i$ - CO_2 allowances quantity purchase, at the moment i, ton.

$Ppurchase_i$ - CO_2 allowances price purchase, at the moment i, €/ton.

$Qsale_j$ - CO_2 allowances quantity sale, at the moment j, ton.

$Psale_j$ - CO_2 allowances price sale, at the moment j, €/ton.

ICO_2 - incentive for an efficient management of CO_2 allowances, €.

SWAP - benefits obtained with SWAP operations at the trade moment, €.

The SWAP operations are exchange of EUA and CER products. The consideration of the SWAP operations aimed to benefit consumers from the gains with those operations.

4. Incentive for the efficient management of CO_2 allowances

The incentive for the efficient management of CO_2 was setting up keeping in mind that it had to conciliate the aim of a regulated activity and the risk associated with the CO_2 allowances market. It was necessary to make a trade-off between the need to decrease the costumers risk and the required flexibility of the market participation. That flexibility allows the companies to follow a carbon strategy, which makes them considered the 5 years of the NAP period as one single period. They also have to consider the Kyoto mechanisms, mainly the clean development mechanism. This flexibility is important to decrease the CO_2 costs. However, the risks to participate on the CO_2 allowances market are related to the distance between the moment when the companies trade the CO_2 allowance in the markets and the moment when the deficit or surplus of CO_2 allowances was generated due to their activities.

This mechanism is based on profits and losses sharing between the companies and the costumers, which result from the CO_2 emission allowances trading. The average price market is the reference for the profits and the losses.

Considering the uncertainty related to the market behavior, namely because it is a new market, as a precaution, the incentive for the efficient management of CO_2 allowances includes a set of parameters to be yearly settled.

$$ICO_2 = \sum_{i=1}^{n} Qpurchase_i \times \alpha_i \left(Pmean_{month\ i} - Ppurchase_i \right) - \sum_{j=1}^{m} Qsale_j \times \alpha_j \left(Pmean_{month\ j} - Psale_j \right) \quad [2]$$

Where:

$Pmean_{month\ i}$ - monthly average price of CO_2 allowances purchase i, €/ton.

$Pmean_{month\ j}$ - monthly average price of CO_2 allowances sale j, €/ton.

α_i - profits and losses sharing factor at the purchase moment i.

α_j - profits and losses sharing factor at the sale moment j.

The parameters values in force in 2008 were the followings.

4.1. Reference price

For the definition of the average price, it has been considered that a monthly period is long and limited enough for enabling a flexible participation in the market, and allowing, respectively, to benefit from the best moments in the market, and to minimize the trading risks in the market.

The CO_2 allowances monthly average price corresponds to the arithmetic mean of the daily close price from a reference market in the period between the 15 days before and the 15 days after the transaction day. For 2008, the EUA 08-12 product in the Bluenext market is the reference.

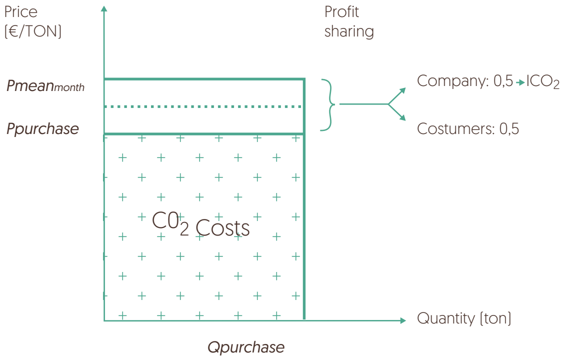
4.2. Profit and losses sharing factors - α_i and α_j

The α factors express the profits and losses sharing between the company that manages the CO_2 allowances and the costumers. A profit is achieved when the price of the CO_2 allowances purchased is lower than the reference price or when the price of the CO_2 sold is higher than the reference price. The inverse situations result in losses.

The α factors take into account the CO_2 allowances market risks and the need to give an effective incentive for the company to manage the CO_2 allowances in an efficient way, with benefits for the company and the customers. With this objective in mind, for 2008 it was established a symmetric profits and losses sharing between the costumers and the company: $\alpha_i=\alpha_j=0{,}5$.

Figure 2 gives an example of the incentive application to an efficient management of CO_2 considering the case of CO_2 allowances purchase with profits ($Ppurchase<Pmean_{month}$).

Figure 2 - Incentive for an efficient management of CO_2 allowances purchase with profits (Ppurchase < $Pmean_{month}$)



1. **CO_2 allowances costs paid by the company:**
   CO_2 allowances costs = Qpurchase×Ppurchase

2. **Profits with the CO_2 allowances purchase:**
   Profits= Qpurchase×($Pmean_{month}$-Ppurchase)>0

3. **Profit sharing:**
   Company profit = Qpurchase×0.5($Pmean_{month}$-Ppurchase) → ICO_2
   Costumers profit = Qpurchase×0.5($Pmean_{month}$-Ppurchase)

4. **Amount paid by the costumers to the company:**
   CO_2=Qpurchase×Ppurchase+Qpurchase×0.5($Pmean_{month}$ - Ppurchase)

The profits and losses sharing factors were established in such a way that the market risks are equally shared up to the limits defined in the next point.

4.3. Incentive limits

For Portugal mainland, it is important to remember that there are other mechanisms established in the Tariffs Code to the *Agente Comercial*, the entity that purchase the energy from the producers with PPA. It was established a maximum limit to all incentives, that includes the CO_2 incentive. Beyond that limit, all the benefits are transferred to the costumers. To settle up the minimum limit, it was taking into account the operation costs and the total allowed revenues obtained by this mechanism. For 2008, it was adopted the amount of -1,5 M€. Beyond that limit, all the losses are borne by the company.

For Azores and Madeira companies the limits were settle up considering the amount of CO_2 allowances gave to each company in proportion of the amount of CO_2 allowances gave to the power generators with a PPA in Portugal mainland. It was also taking into account the diseconomies of scale associated to the CO_2 allowances management by the islands companies.

For 2008, the incentive boundaries for Azores and Madeira companies were -300×10^3€ and 300×10^3€.

4.4. Limit to annual CO_2 allowances quantities

The incentive for an efficient management of CO_2 would not have any annual reference since it is dissociated from the CO_2 allowances consumed and the CO_2 allowances attributed annually. This is a normal situation in a market. However, considering that the incentive is applied to regulated activities, it is necessary to make an annual evaluation to prevent future risks for the costumers resulting from the accumulation of CO_2 allowances and the market fluctuations. Moreover, the electricity tariffs stability requires that costs and profits considered each year by ERSE for the tariffs definition should not be associated to a period longer than one year. Therefore, for 2008, it was defined that the amount of CO_2 allowances at the end of the year could not be higher than 30% of the amount of CO_2 emissions minus the amount of CO_2 allowances annually attributed by Agência Portuguesa do Ambiente.

5. Some results after one year

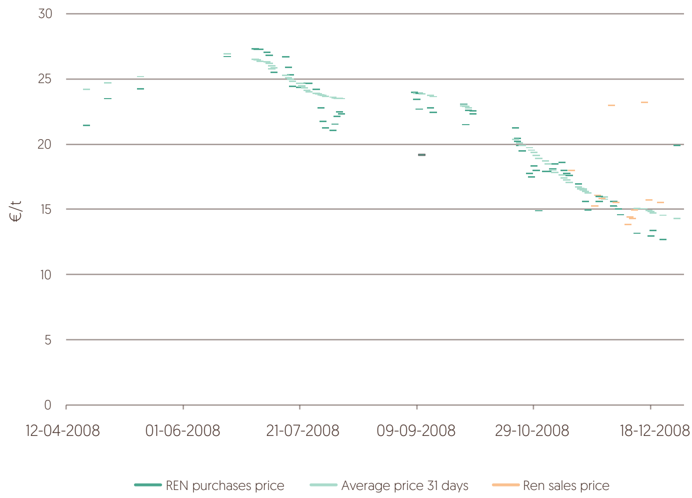
5.1. Spot and futures operations

To evaluate the REN Trading's behavior last year and try to understand the effect of the CO_2 incentive, it is important to analyze the following:

- Economic result of the incentive for the company and to the customers;
- Good and bad business made by REN Trading;
- Average price market versus average price of purchasing and selling.

Figure 3 represents the sales prices, purchases prices and the market reference price [31 days average]. Operations with future products are represented at the maturity date.

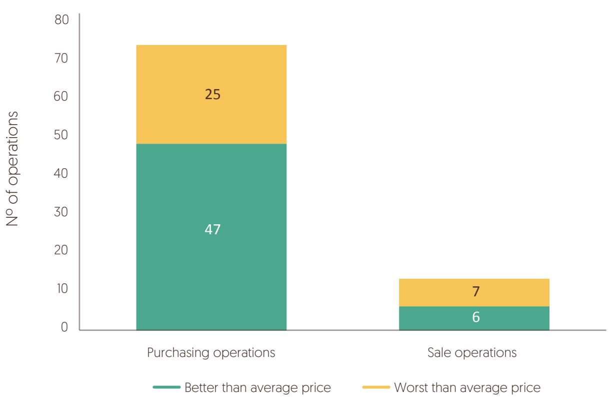
Figure 3 - Purchase, sale and reference price in 2008 for REN Trading operations



The greater differences between the reference prices and the operation prices result from future operations.

For purchases, REN Trading makes a good business when purchase price is below the reference price. There are 47 good businesses in a total of 72 purchase operations. For the selling situation, it is a good business when the sale price is over the reference price. There are 6 good businesses in a total of 13 sale operations. This information is summarized in the next picture.

Figure 4 - REN Trading operations – good and bad businesses



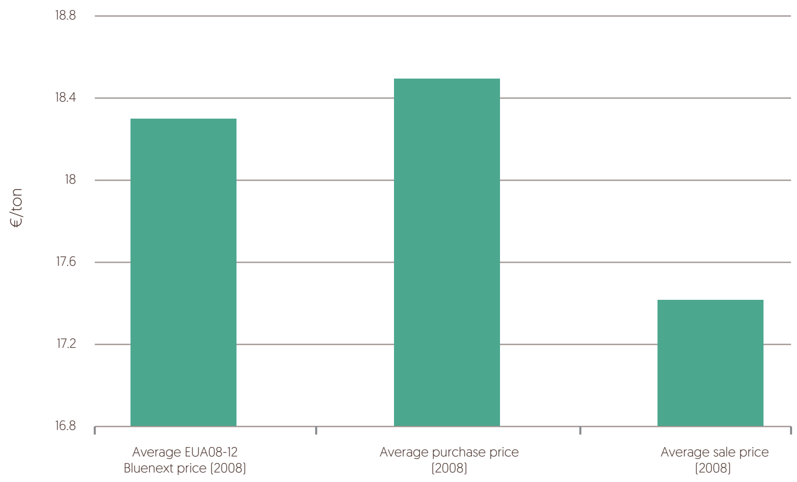
REN Trading made 62% of good purchase or sale operations. In the end of the year, the total value of the incentive (excluding SWAP gains) is 1,7 millions euros, shared 50/50 with the customers (Figure 5).

Figure 5 - Results from sales and purchases

Concluding, REN Trading had an efficient behavior in the short term.

In the next figure (Figure 6) it is compared the average purchase price, average sale price and average market price in 2008.

Figure 6 - Selling, purchasing and market prices



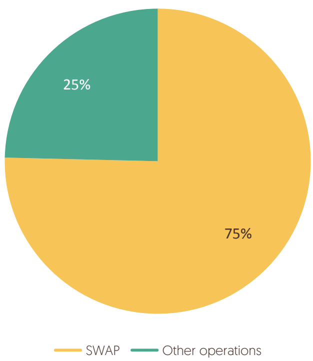
In an annual analysis we can observe that REN Trading presents worst results than the market. This reflects the fact that the decrease of the CO_2 allowances prices occurred along the year was not foreseen by REN Trading. It has to be analyzed the all 5 years NAP II period to know, exactly, if REN Trading strategies during 2008 were efficient.

As we can see, the mechanism awards the efficient short term behavior and limits the risks. However, the mechanism is not designed to eliminate risks at the medium and long term.

5.2. Spot and futures operations

REN Trading performed 25 swap operations in 2008. These operations are an exchange of EUA or future EUA for CER or future CER. The verified spreads in these operations are greater than 4,5 €/ton and lower than 9 €/ton. REN Trading had an income of 5,2 million euro that are shared (50/50) with the customers. The benefits from swaps to customers represent 75% of the total benefit that results from the incentive in 2008 (Figure 7).

Figure 7 - Benefits for the customers



Conclusion

The Portuguese Energy Regulator (ERSE) created a regulatory mechanism which aims to give to the regulated electricity producers an incentive for administrate the CO_2 allowances in an efficient way.

The incentive for the efficient management of CO_2 was setting up keeping in mind that it had to conciliate the aim of a regulated activity and the risk associated with the CO_2

allowances market. It was necessary to make a trade-off between the need to decrease the costumers risk and the required flexibility of the market participation. Considering the uncertainty related to the market behavior, namely because it is a new market, as a precaution, the incentive for the efficient management of CO_2 allowances includes a set of parameters to be yearly settled. Moreover, the electricity tariffs stability requires that costs and profits considered each year by ERSE for the tariffs definition should not be associated to a period longer than one year.

The incentive was in force in 2008 for the first time.

After one year in force, the results obtained show that in the short term the incentive drives companies to be proactive about the CO_2 allowances management and to act in an efficient way. Therefore, this scheme enables companies to obtain profits through the CO_2 allowances management, sharing it with the costumers. In an annual analysis, REN Trading presented worst results than the market. This reflects the fact that the decrease of the CO_2 allowances prices occurred along the year was not foreseen by REN Trading. However, it has to be analyzed the all 5 years NAP II period to know, exactly, if REN Trading strategies during 2008 were efficient.

Therefore, as the mechanism awards the efficient short term behavior, it can limit risks, but it can't eliminate risks, mainly in the medium or long term.

Knowing that it's dificult to predict the future, the option made was to link the strategies with the variables that are better known, which are the short term variables. Only at the end of the game, it will be possible to find out who the winners are.

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Europa: uma velha senhora a necessitar de "boas" energias

Jorge Esteves

Referências de publicação

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Resumo

Desafio de 400 palavras baseado em apresentação, intitulada "Os Terminais de GNL na Estratégia Europeia de Segurança de Abastecimento" realizada durante o Seminário "Portugal e a Segurança Energética Europeia, organizado, a 25 de Junho de 2014, pela Câmara de Comércio e Indústria Luso-Francesa em Lisboa.

Palavras-chave

Segurança de abastecimento - União Europeia - Mercado interno de energia.

Reza a lenda que a princesa Europa era, pela sua beleza, cobiçada por todos os deuses do Olimpo. Zeus conseguiu raptá-la e alcançar os seus intentos, depois de se aproximar transformado num belo, dócil e poderoso touro branco...

Figura 1 - "O rapto de Europa" de Gustave Moreau (c. 1869)

Serve esta história como ponto de partida para uma curta reflexão sobre a elevada dependência energética da União Europeia, as situações de crise que dela decorrem e sobre a necessidade de a União Europeia concretizar uma política energética comum que a torne menos dependente e utilize origens geográficas mais diversificadas para as fontes primárias de energia.

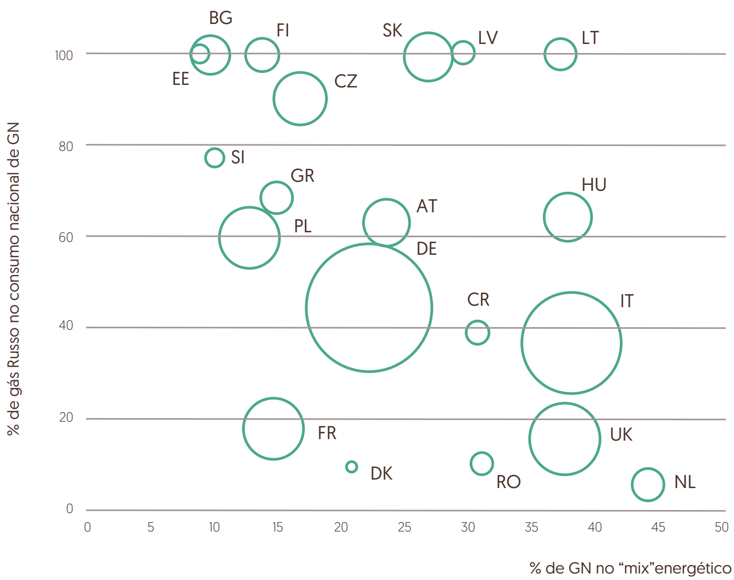
A tabela mostra o peso que os 3 maiores países fornecedores têm no volume de petróleo, gás natural, carvão e urânio consumidos na União Europeia.

Utilizando o gás natural como exemplo, a figura ilustra a dependência energética dos países do norte, leste e centro da União Europeia, relativamente à Rússia.

Tabela 1 - Peso dos 3 maiores fornecedores no volume de petróleo, gás natural, carvão e urânio consumidos na União Europeia

Petróleo	
Rússia	34%
Noruega	11%
Nigéria	8%
Gás Natural	
Rússia	39%
Noruega	34%
Argélia	13%
Carvão	
Rússia	26%
Colômbia	24%
Estados unidos da América	23%
Urânio	
Cazaquistão e outros ex-CIS	21%
Canadá	19%
Rússia	18%

Figura 2 - Dependência europeia do gás russo



Dimensão dos círculos: Volume de GN importado da Rússia

Estes dados ilustram o elevado nível de dependência energética da Rússia a que a União Europeia está sujeita e mostram que poucos são os países que a compõem que não estão fortemente dependentes desta origem geográfica para o fornecimento da energia de que necessitam.

Não existindo, no curto prazo, condições nem infraestruturas que viabilizem outras origens geográficas, as consequências desta situação de dependência são os cada vez mais frequentes incidentes com ameaça de corte do fornecimento (que já chegaram a vias de facto com cortes de fornecimento de gás natural em 2006 e 2009), as situações de crise, tal como aquela que hoje envolve a Ucrânia, e as preocupações que se vivem, em Bruxelas e nos países mais diretamente afetados, de como será o fornecimento de gás natural durante o próximo Inverno.

A linha de orientação adotada pela União Europeia para responder a este desafio começou a ser concebida há quase 20 anos. Passa pelo evoluir para uma economia de baixo teor de carbono e pelo completar do mercado interno da energia, o que implica hoje a concretização de mercados de eletricidade e gás natural que estejam verdadeiramente integrados em todo o espaço europeu e a implantação das infraestruturas que os tornem possíveis. O propósito será conseguir preços acessíveis para a energia, que sejam competitivos a nível global, e fazer com que as alternativas criadas pela solidariedade entre países europeus sirvam de contraponto à dependência energética externa que é vivida pelo conjunto da União Europeia.

São muitas as dificuldades e os desafios que terão de ser superados mas, para se ter sucesso, a solução só poderá passar por aprofundar mais e melhor a União Europeia. A inovação e o conhecimento serão fundamentais para alcançar o objetivo.

Convirá é que a "história" não se repita e que não se volte a cair no logro montado por qualquer um dos novos pretensos deuses que, por exemplo, poderão estar agora a surgir transformados num (mais ou menos cativante e possante) urso.

NOTA FINAL

Nota Final

Os artigos selecionados e apresentados na coletânea "A Regulação da Energia em Portugal 2007-2017" constituem apenas uma parte do universo da reflexão feita pelos colaboradores da ERSE em matéria de regulação setorial durante este período.

Para os interessados, disponibilizam-se as fichas técnicas dos artigos produzidos neste contexto e não incluídos nesta obra.

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