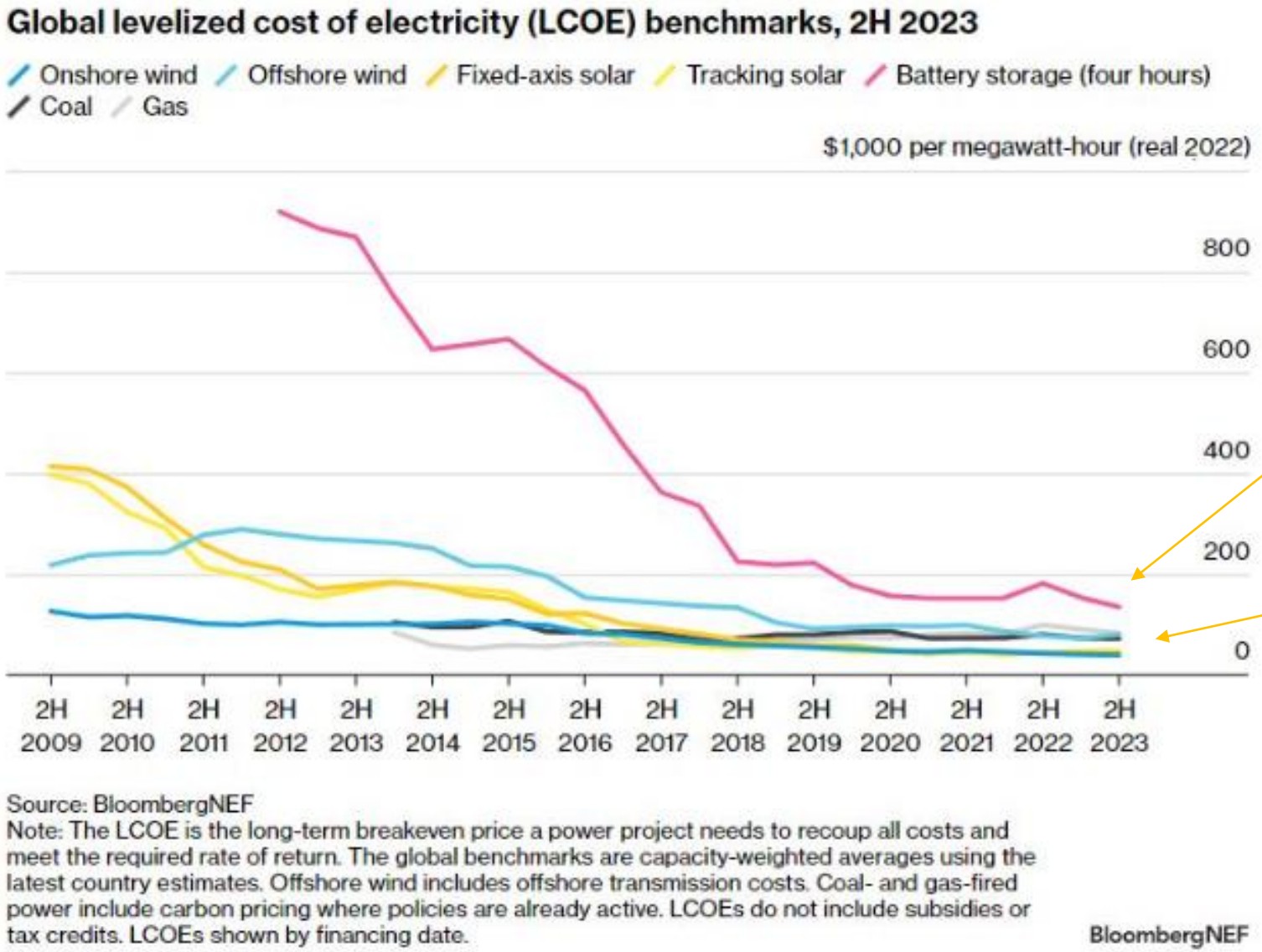
Flexible Energy Markets: pricing and strategies

ENTIDADE REGULADORA
DOS SERVIÇOS ENERGÉTICOS

8th Annual APEEN Conference

Pedro Verdelho
10 April 2025

Cost-Efficient Renewable Generation

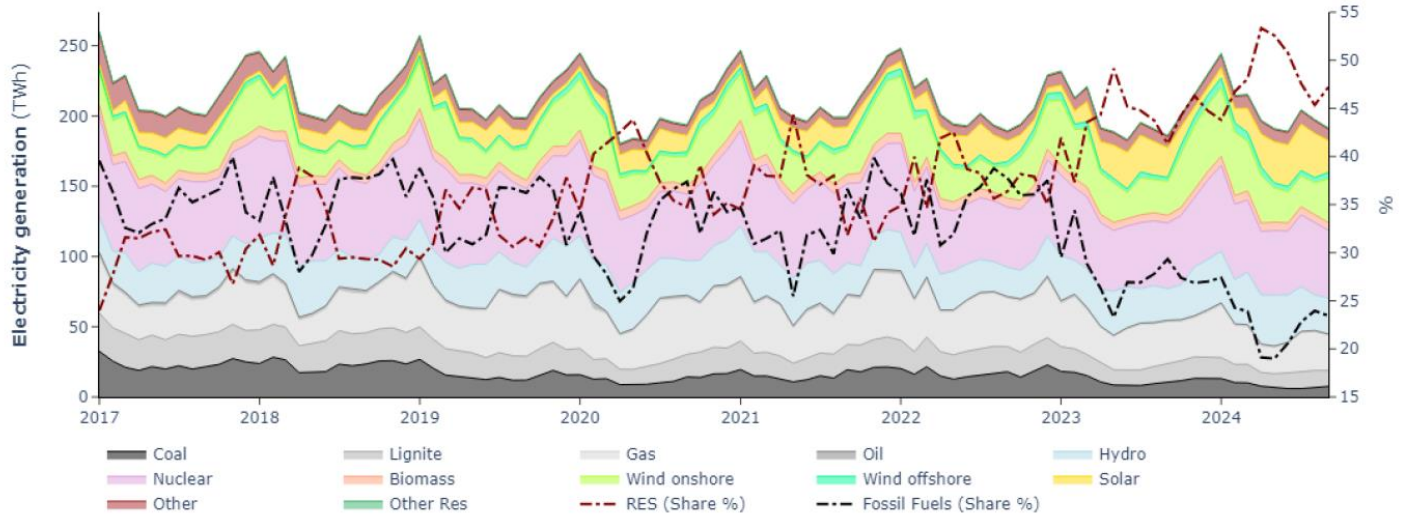


- *4 hour battery storage already at grid parity. It's expected that energy parity is close.*
- *On-shore renewable generation cheaper than fossil generation, which allows for fuel substitution with lower supply costs.*

Renewable integration as a fundamental piece of decarbonisation

Annual Electricity Generation in the EU

Figure 13 – Monthly electricity generation mix in the EU



Source: ENTSO-E. Fossil fuel share calculation covers power generation from coal, lignite, gas, oil and others.

1.4 **Electricity mix in the EU**

Oil	Coal	Gas	RES	Nuclear
3 TWh	20 TWh	80 TWh	277 TWh	151 TWh
▼−9%	▼−28%	▼−14%	▲12%	▲8%

Electricity generation in Q3 2024 compared to Q3 2023. Source: ENTSO-E

Wind Onshore	Wind Offshore	Solar	Hydro	Biomass
76 TWh	12 TWh	87 TWh	83 TWh	17 TWh
▲2%	▲21%	▲23%	▲13%	▲1%

***Electricity generation of RES** in Q3 2024 compared to Q3 2023*

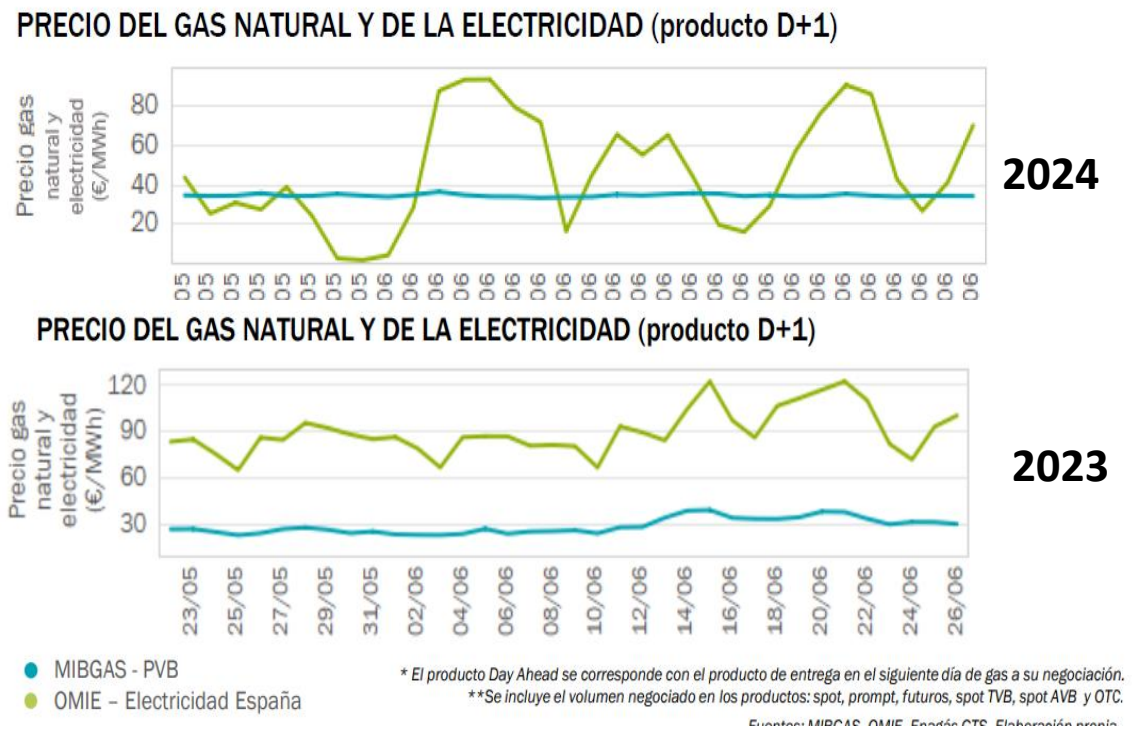
Progress in the transition to clean energies, with ’52% of annual electricity production generated by renewables, with fossil fuel production falling to 24%.’

Source: [EC Quarterly report On European electricity markets Q3 2024]

Impacts on Energy Prices

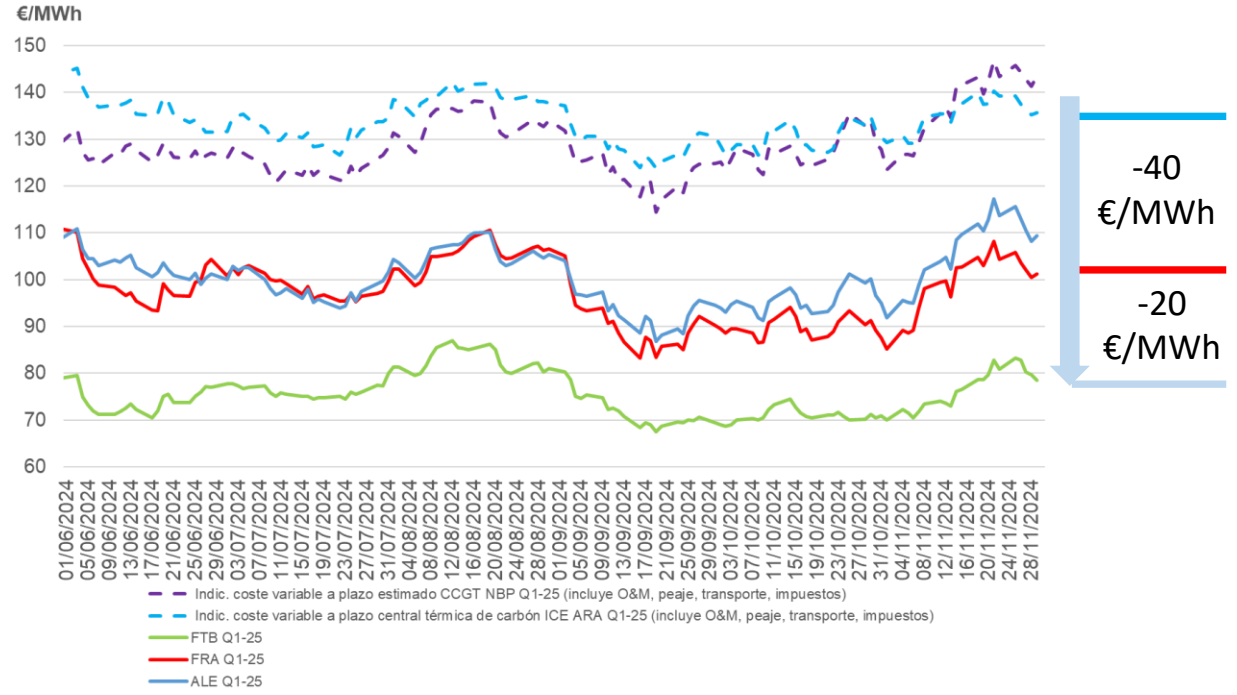
The increase in renewable generation promotes: (i) decoupling natural gas and electricity prices

MIBGAS daily gas market prices (EUR/MWh) Average hourly prices on the OMIE daily electricity market (EUR/MWh), June 2023 and 2024



Source: MIBGAS

Q1 2025 contract prices on the forward markets (EUR/MWh) (June to November 2024)

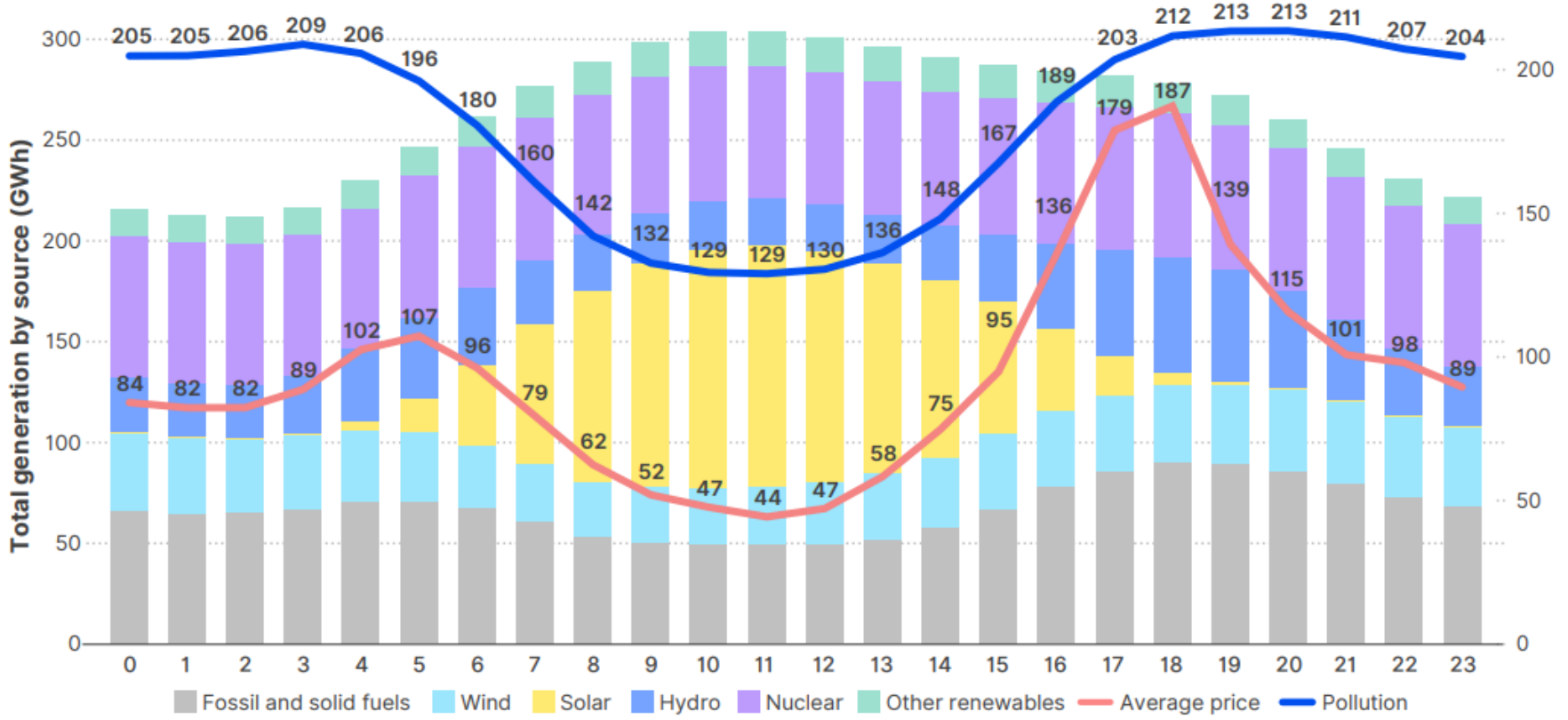


Source: MIBEL

Impacts on Energy Prices

The increase in renewable generation promotes: (ii) profound change in the structure and evolution over time of electricity prices

Average hourly generation by source (GWh), daily market prices (EUR/MWh) and CO2 emissions (kg/MWh) in the EU 27, August 2024

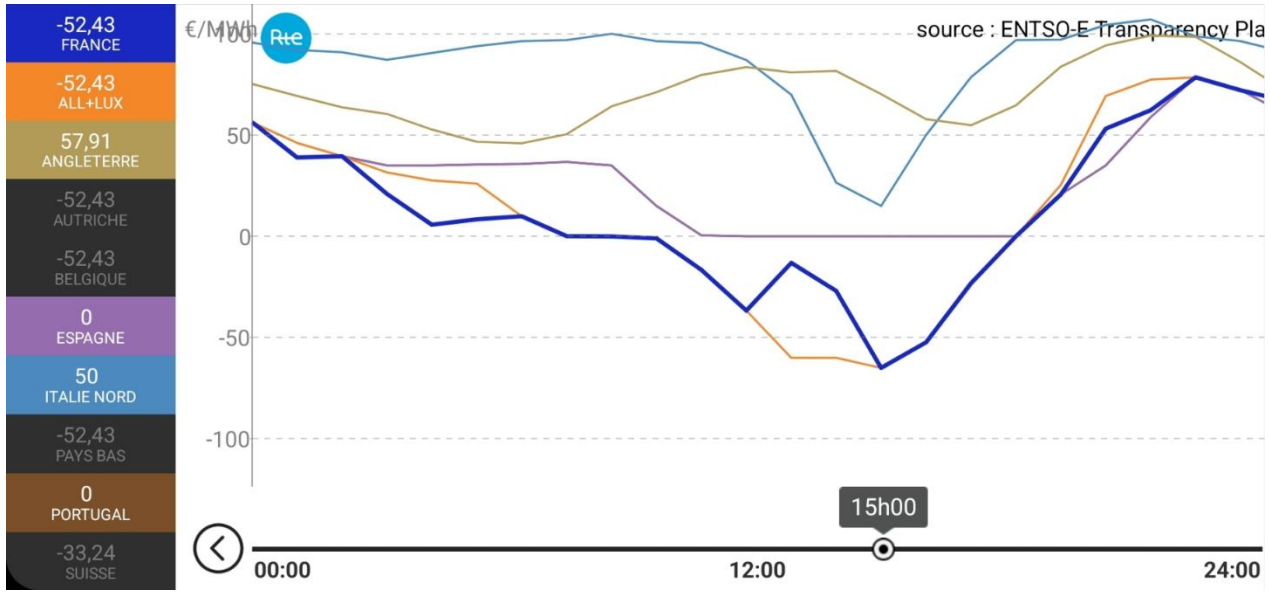


Source: ACER Retail MMR 2024

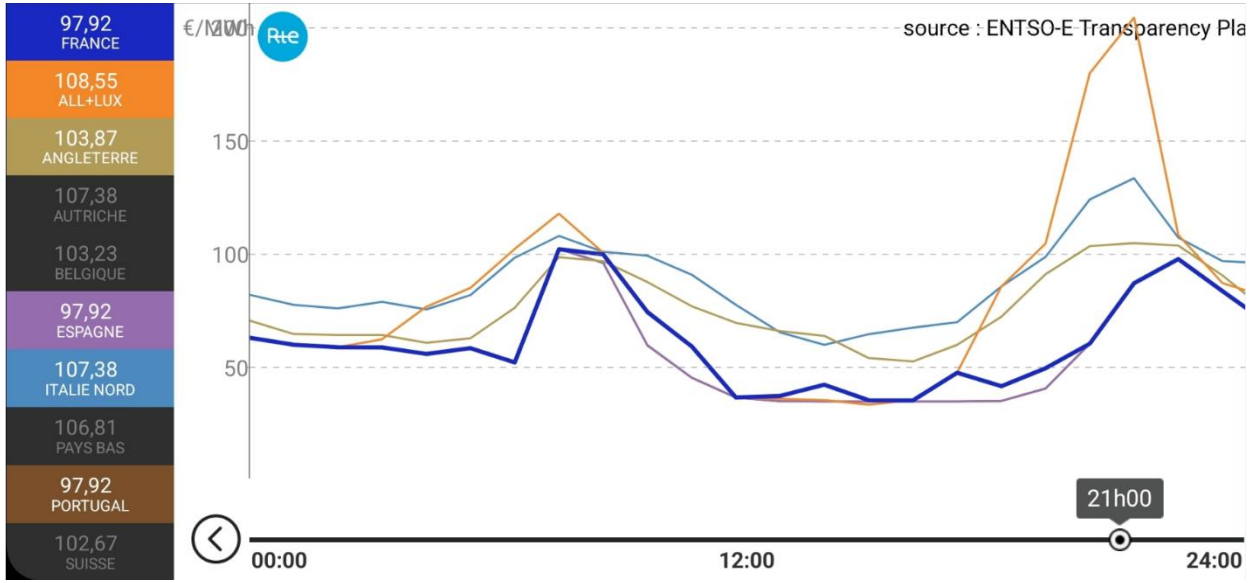
Impacts on Energy Prices

The increase in renewable generation promotes: (iii) increased volatility and the need for system flexibility services in the various dimensions: security, availability and sufficiency

Electricity price changes on 28/04/2024



Electricity price changes on 29/04/2024

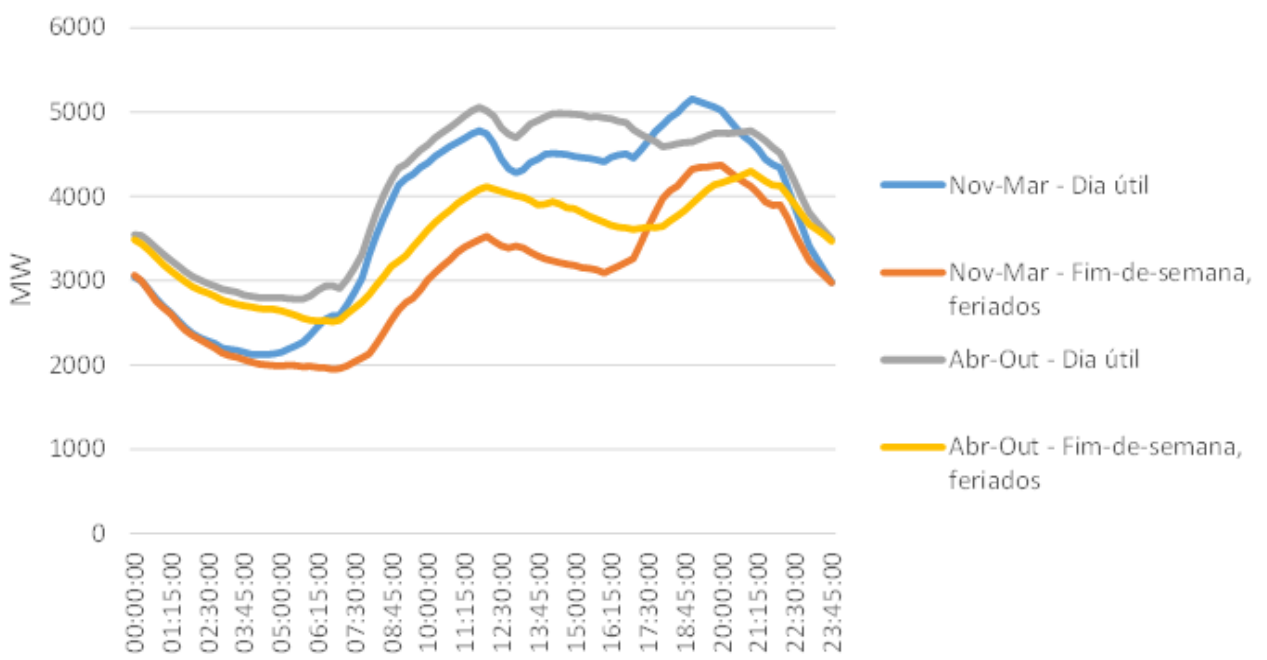


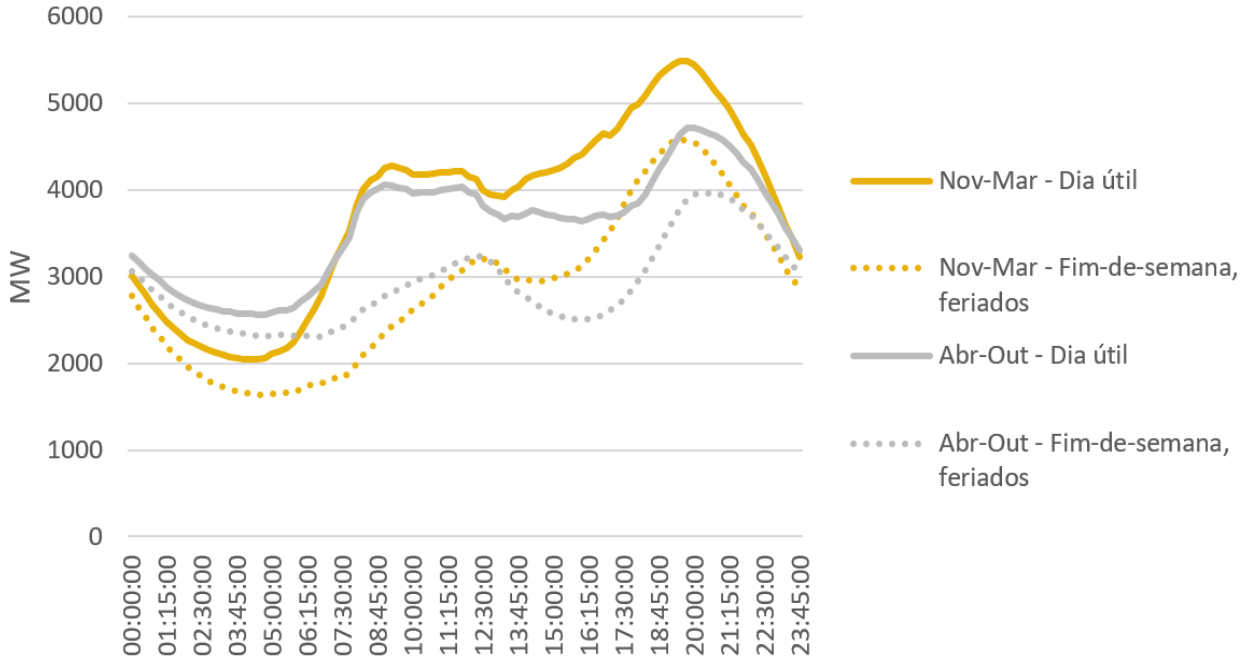
Source: RTE, https://www.rte-france.com/eco2mix/les-donnees-de-marche#

Impact on the price structure of ‘Time of Use’ tariffs

Impact of the Energy Transition on the price structure of **network access tariffs**

Load → Energy Network Transit





Impact on the price structure of ‘Time of Use’ tariffs

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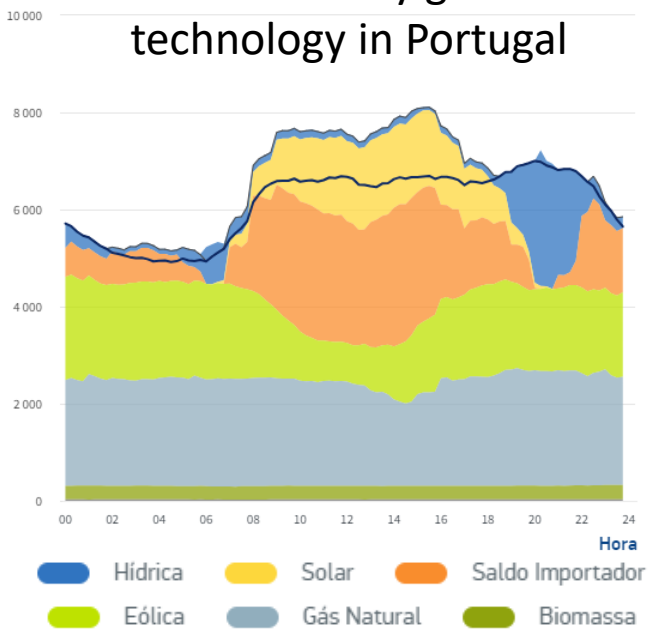
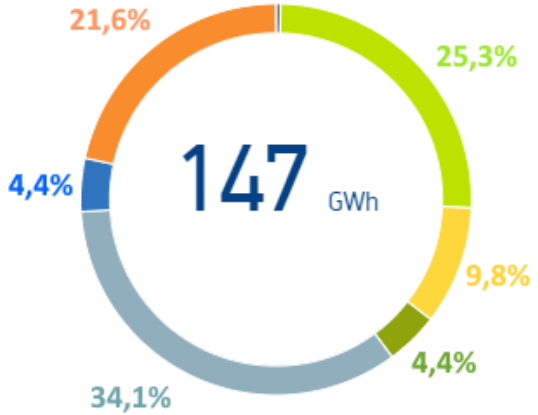
Impact of the Energy Transition on the price structure of the Energy component

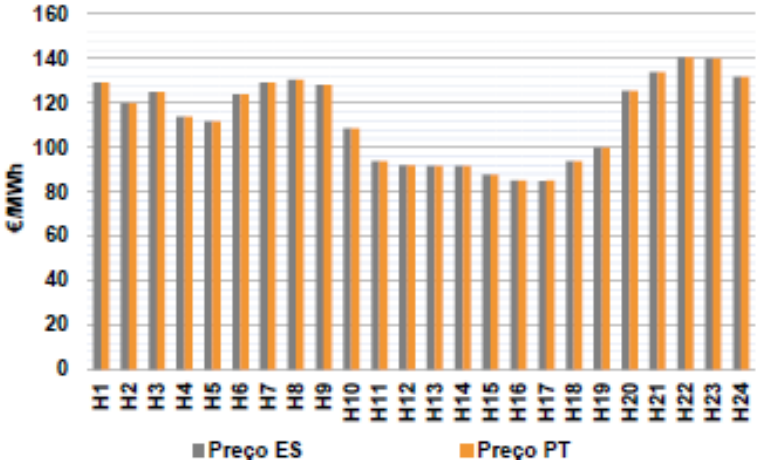
Power demand by generation technology in Portugal



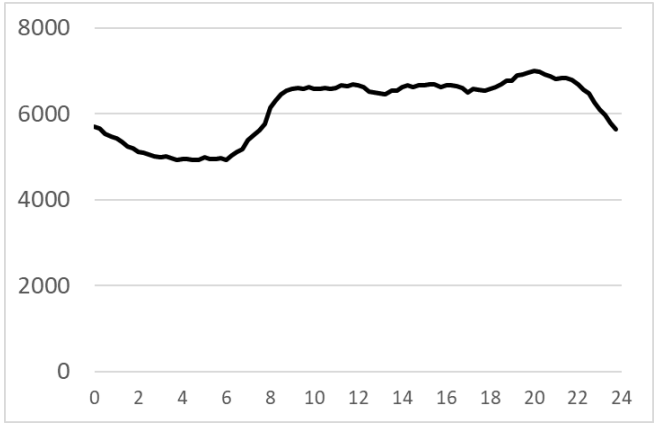
Daily consumption

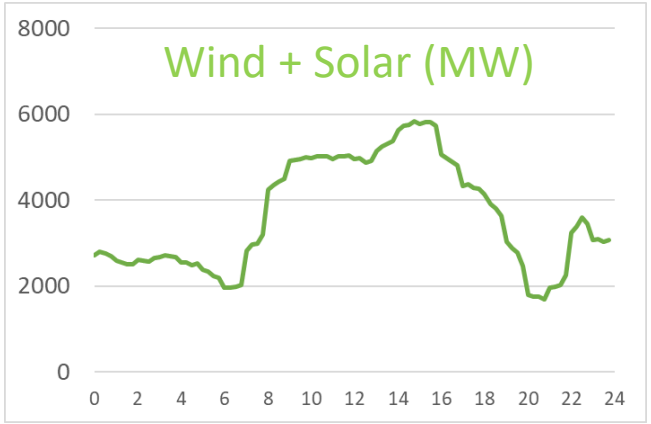


Day ahead market price (€/MWh)

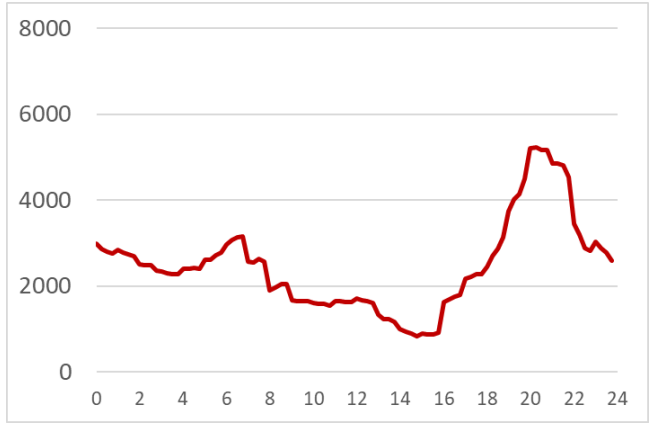


Power demand (MW)



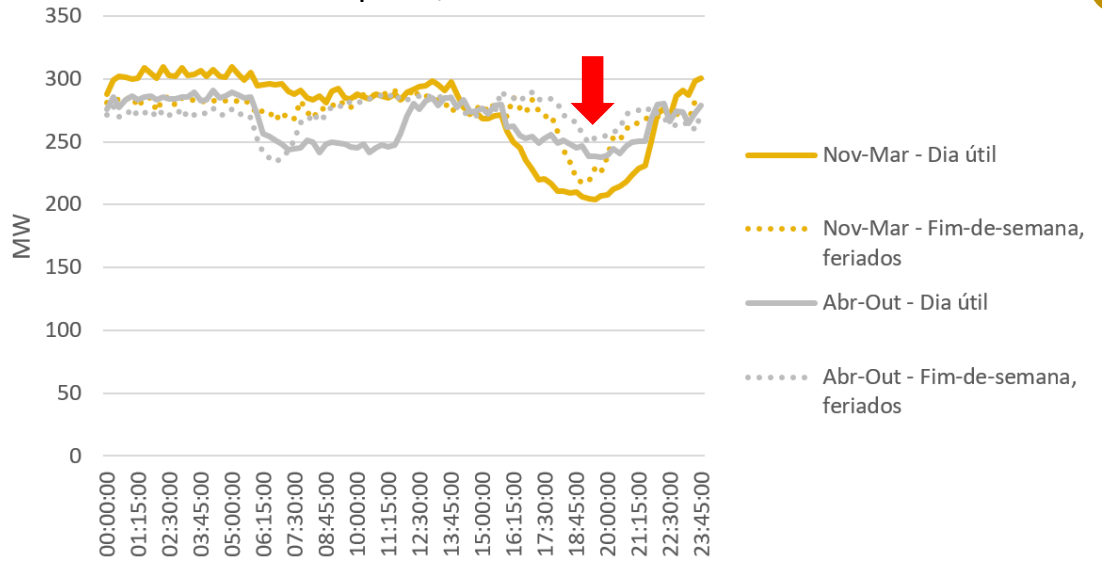


Residual Load (MW)

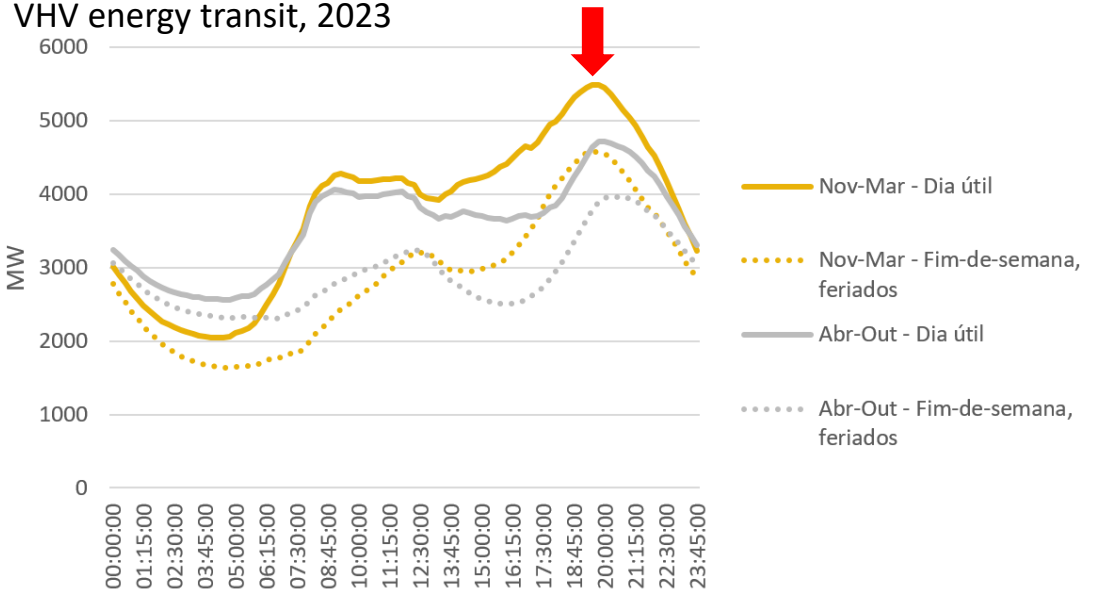


Impact on the price structure of 'Time of Use' tariffs - Seasonality

1 VHV customer consumption, 2023



VHV energy transit, 2023



2 New Network Access Tariffs in VHV, HV and MV

	Área de rede A	Área de rede B	Área de rede C
Janeiro	Alta	Alta	Média
Fevereiro	Alta	Alta	Média
Março	Média	Média	Baixa
Abril	Baixa	Baixa	Baixa
Maio	Baixa	Baixa	Baixa
Junho	Baixa	Baixa	Baixa
Julho	Baixa	Baixa	Alta
Agosto	Baixa	Baixa	Alta
Setembro	Baixa	Baixa	Alta
Outubro	Baixa	Baixa	Baixa
Novembro	Média	Média	Baixa
Dezembro	Alta	Alta	Baixa

Since 2024, we have applied a new tariff option for VHV, HV and MV customers in mainland Portugal.

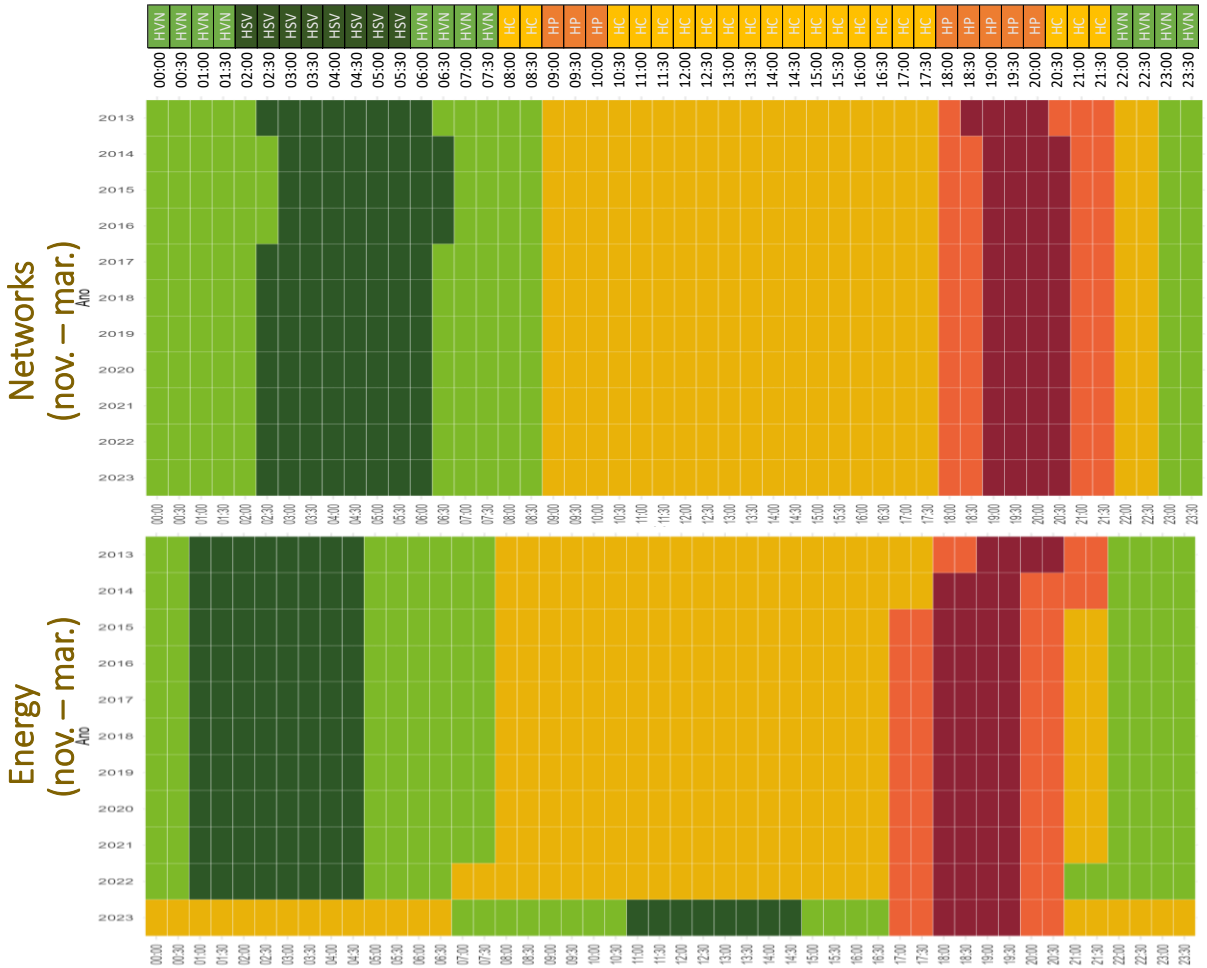
We have introduced locational differentiation, by network areas (North, Centre, South), and reinforced the price signal at peak times in three months of the year (High Season).

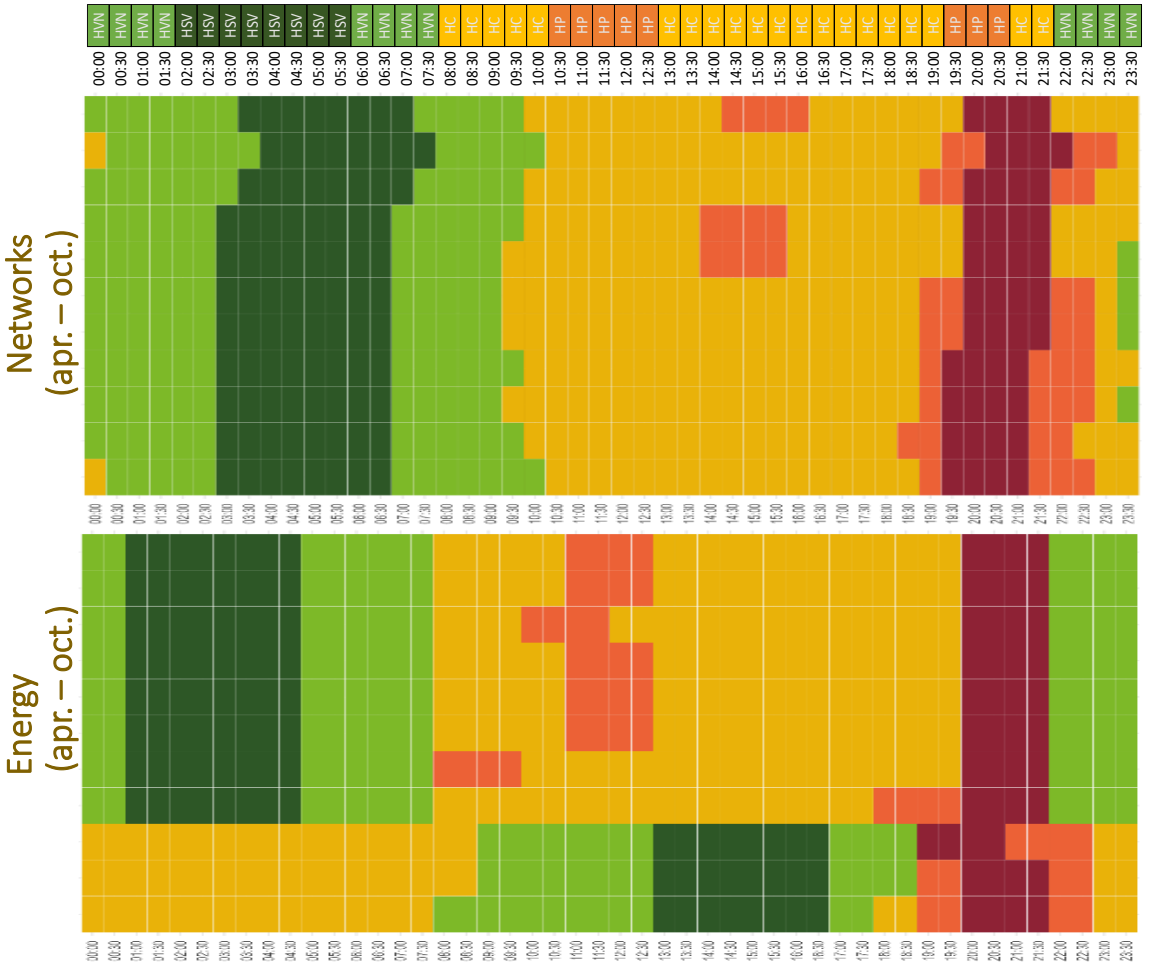
The aim is to define appropriate price signals for geographical and seasonal flexibility.

Before, network access tariffs were guided by demand load diagrams.

More recently, with the new tariff model, the time-of-use signal is directly influencing consumption hours.

Impact on the price structure of ‘Time of Use’ tariffs - daily cycle





ERSE is reassessing the time periods applicable to consumers in general.

The time-of-use signal for Network use, which takes into account energy transits at the various voltage levels (distributed generation, consumption), shows the greatest use of networks at the end of the day in the winter period.

The time-of-use signal for Energy, which takes into account energy prices on the spot market, shows more volatile behaviour, with the off-peak period occurring during the day in recent years.

Self-consumption and energy sharing

1

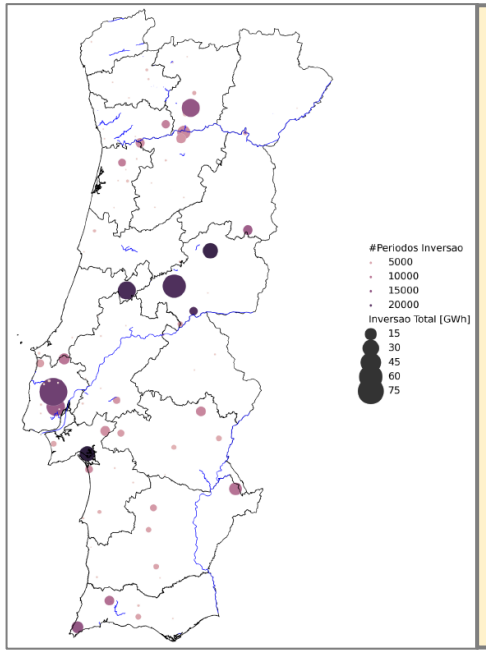
Tariff structures must be prepared for new uses of the electricity grid, such as sharing energy via the public network.

Allocating this energy over short periods (e.g. 15 minutes) avoids the need to resort to other solutions, such as net metering.

2

TARIFA DE ACESSO ÀS REDES DO AUTOCONSUMO ATRAVÉS DA RESP ISENÇÃO 100% DE CIEG							*Nota*
Instalação de consumo	Instalação de produção	Energia ativa EUR/kWh				Potência em horas de ponta EUR/kW/dia	*Potência em horas de ponta EUR/kWh*
		Ponta	Cheias	Vazio normal	Super vazio		
Baixa Tensão Especial	Baixa Tensão	0,0060	0,0054	0,0045	0,0036	0,2139	*0,0805*
	Média Tensão	0,0087	0,0078	0,0061	0,0049	0,3260	*0,1226*
	Alta Tensão	0,0097	0,0087	0,0067	0,0054	0,3476	*0,1308*
	Muito Alta Tensão	0,0107	0,0097	0,0076	0,0062	0,4872	*0,1833*

3



The National Distribution Network Operator must submit an annual report on the occurrence of flow reversals at substations and distribution transformer stations (frequency, energy).

Depending on the intensity of the flow reversals, the shared energy may bear part of the upstream network costs.

Network access tariffs for sharing energy through the public network therefore include only the network tariffs for the necessary voltage levels.

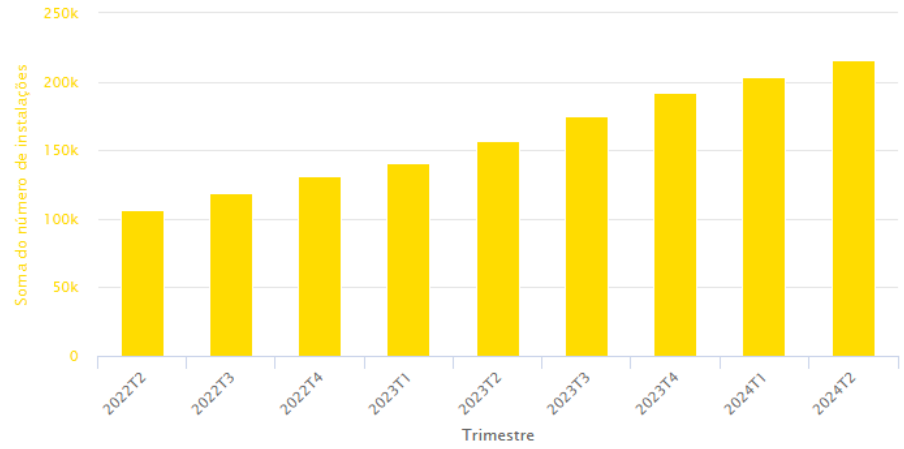
In addition, the legal regime also provides for the possibility of exemptions from costs of general economic interest (CGEI).

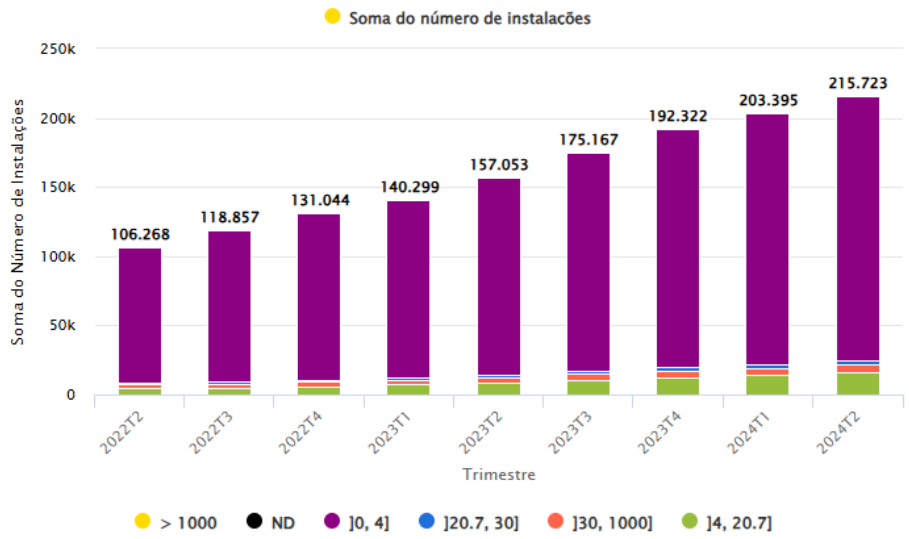
This design promotes flexibility by reflecting geographical proximity in the tariff structure, thus encouraging relationships between active consumers who also bring benefits to the system.

Self-consumption and energy sharing

Número de instalações para autoconsumo

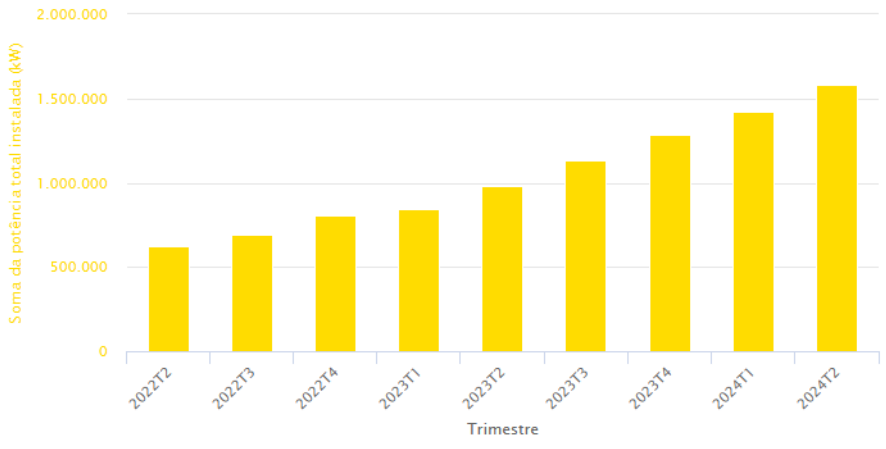
Número de instalações acumuladas por trimestre - Total nacional

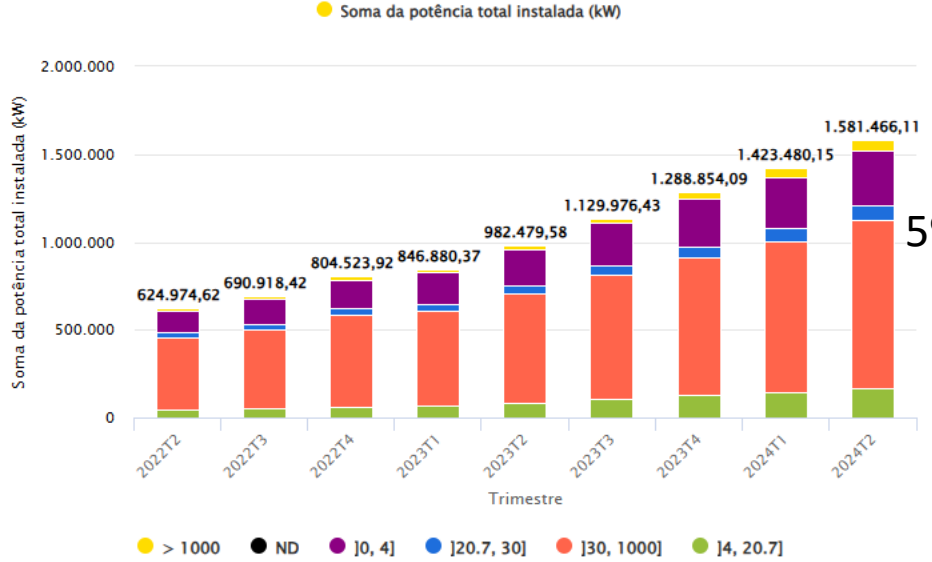




Potência total instalada para autoconsumo

Potência total instalada acumulada por trimestre - Total nacional





2,5 TWh

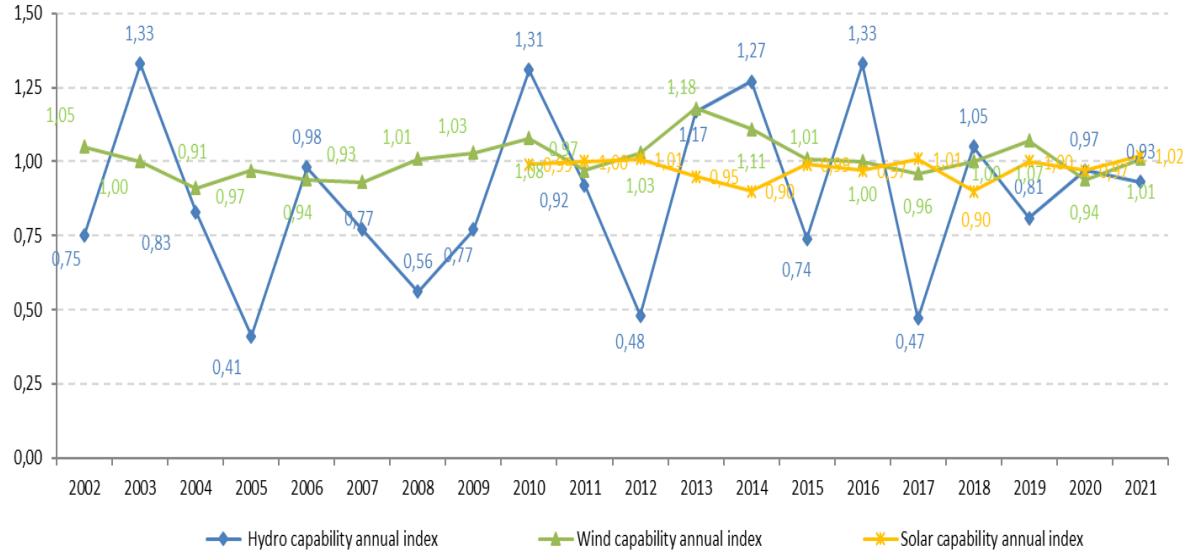
5% Consumption

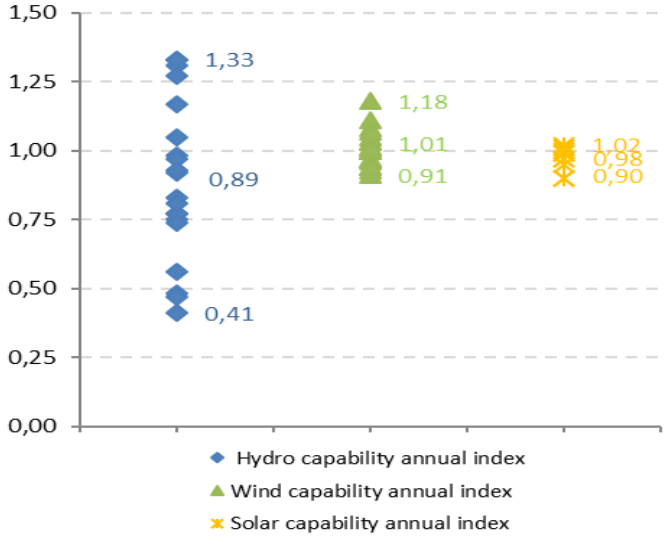
+1,7%/ano

Source: *E-Redes*

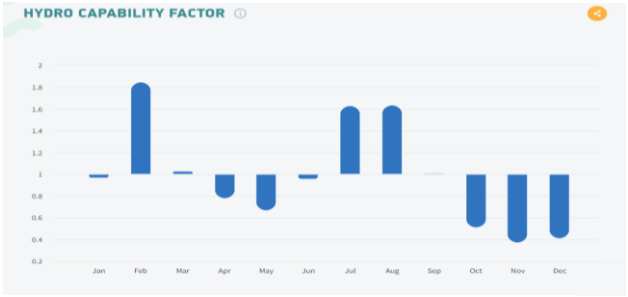
Regulatory Challenges for the Integration of Renewables

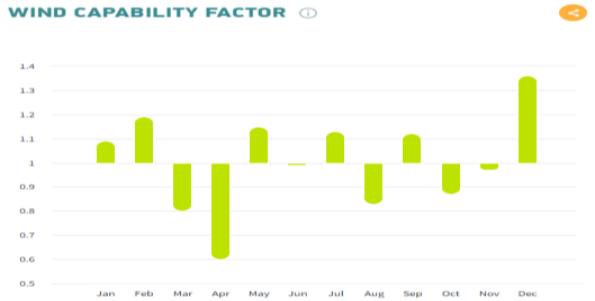
2002-2021

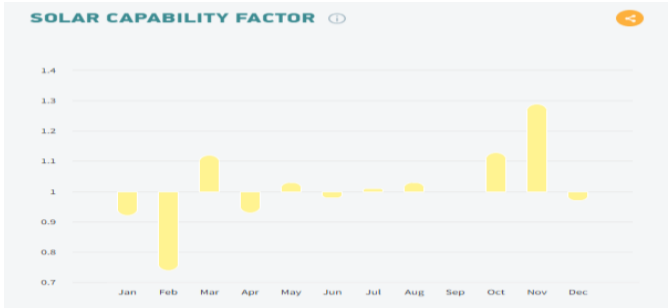




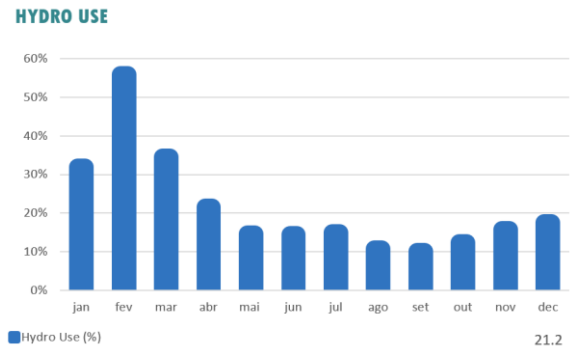
2021

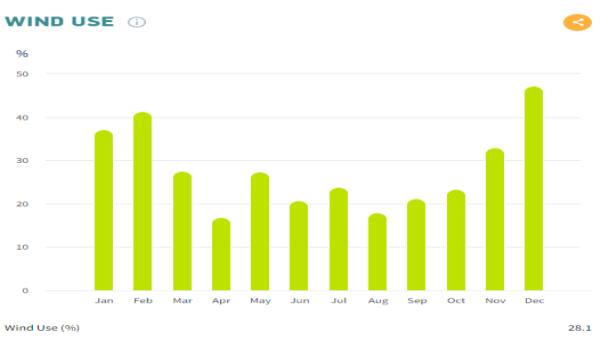


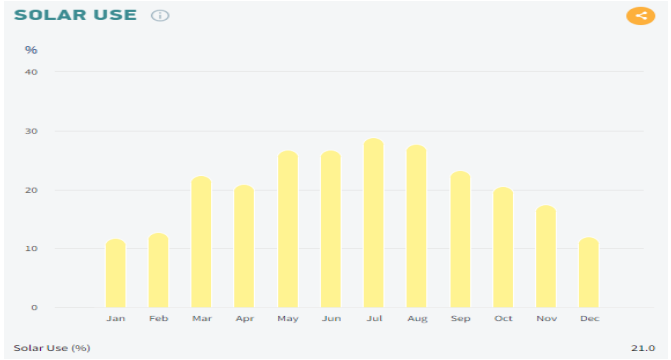




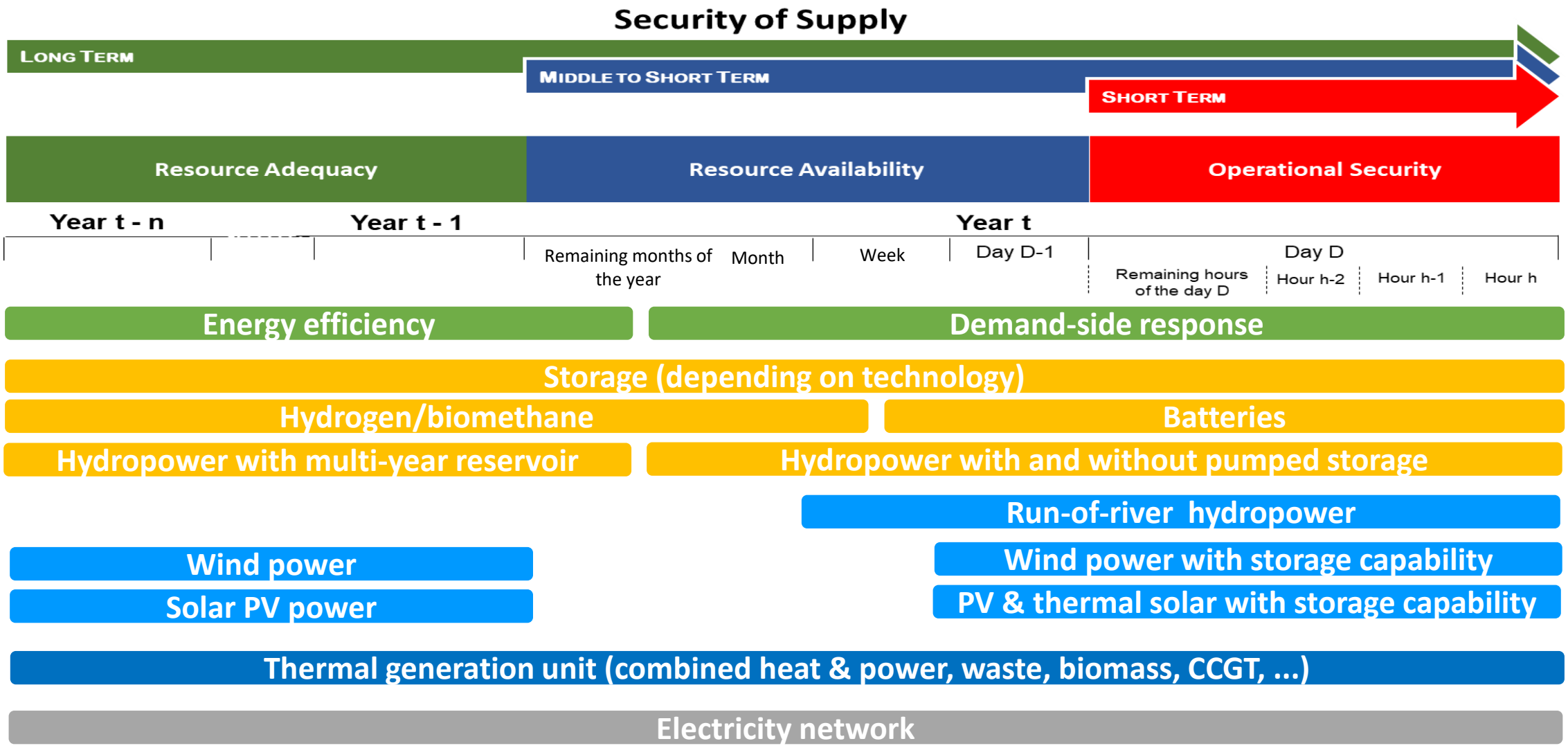
2021







Power generation resources and security of supply timeframes



Regulatory Challenges for the Integration of Renewables

Deep penetration of renewables

	Until 2030 (?) SRMCg > LRMCg	Beyond 2030 (?) SRMCg < LRMCg
Energy (decarbonised)	1)	3)
Capacity (firmness)	2)	4)

Regulatory intervention might be expected

SRMCg – Short Run Marginal Cost of generation technology

LRMCg – Long Run Marginal Cost of generation technology

CCGT – Cycle Combined Gas Turbine generation technology

DSM – Demand Side Management

VoLL – Value of Lost Load

1) With lower long run marginal costs, market delivers desired policy objectives toward decarbonisation with cost reduction for consumers.

2) How to monetise CCGT firm capacity in an environment where capacity usage is expected to decrease? Can volatility of market prices help?

3) With higher long run marginal costs, how can you monetise renewables to substitute the remaining fossil fuel generation to reach net zero (RES cannibalisation effect)? Can the carbon price provide a solution? Is further support for RES needed?

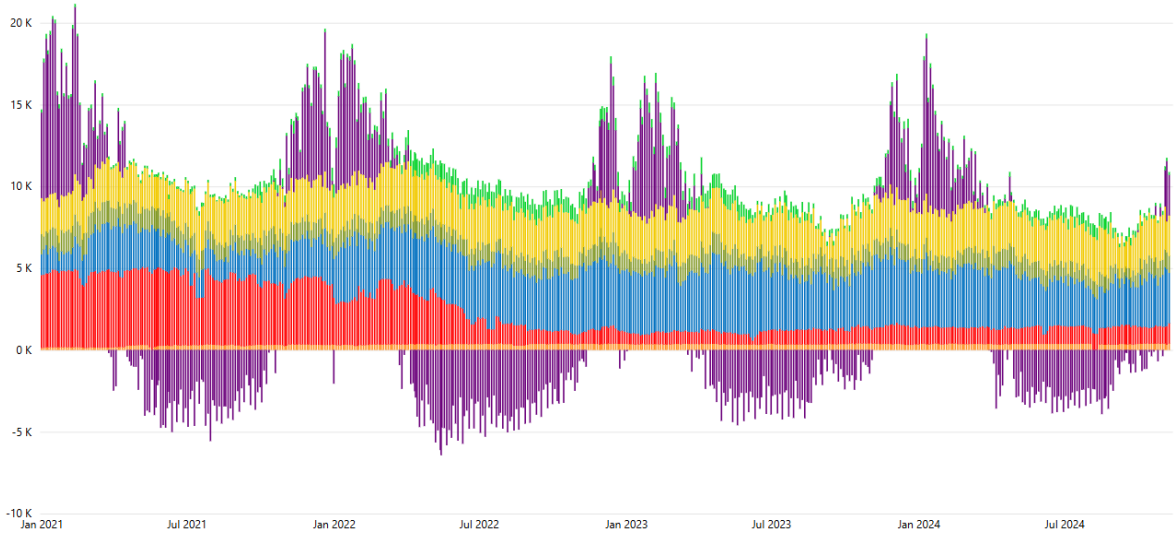
4) Use of controllable flexibility resources (short + medium term), can be monetised (reflecting the shadow price of DSM or of curtailment (VoLL)), but with such high price volatility how to address:
   - Consumer preferences for price stability?
   - Financing for technologies with fixed capacity costs?

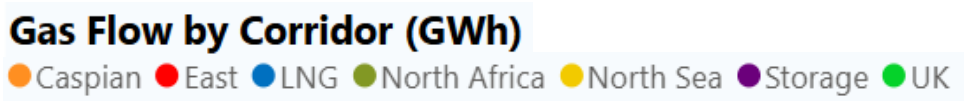
   Will short-term market prices in the future provide sufficient revenues to ensure that sufficient back-up capacity and flexibility resources stay in or enter the market? Can trends of Power-to-H_2 and H_2-to-Power help?

Natural Gas: The great provider of Flexibility

The gas sector, which naturally has more flexibility than the electricity sector, has undergone changes in Europe that have increased the physical and commercial flexibility of the system.

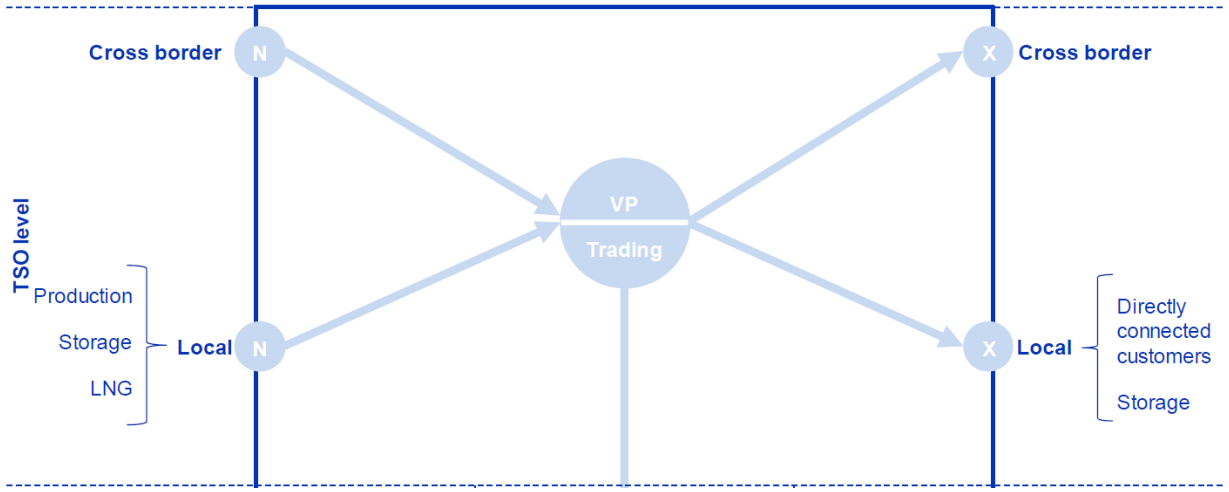
Physical flexibility





Source: ENTSOG's Gas Flow Dashboard

Comercial Flexibility

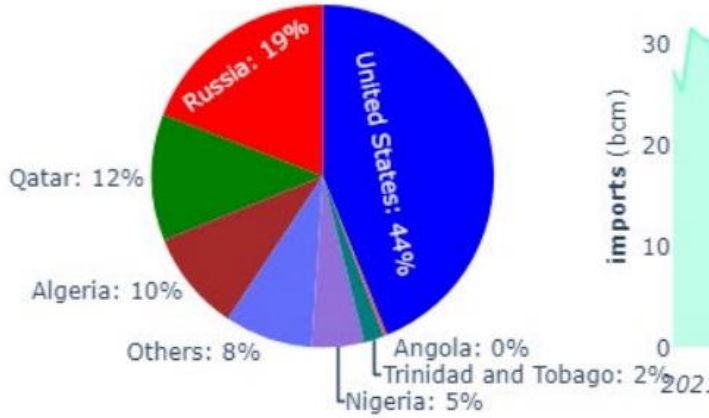


Source: Entry-Exit Regimes in Gas (KEMA, 2013)

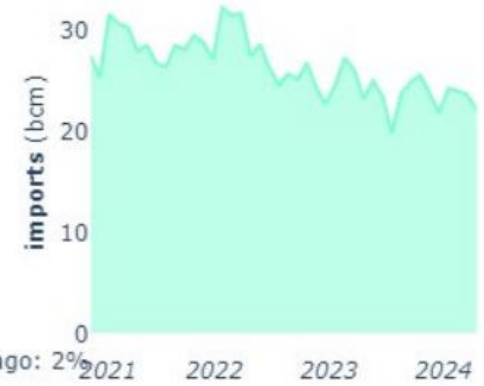
Innovative and Structural Regulatory Development that provided new Hardware and Software within the framework of the third legislative package of 2009, maximising the offer of Flexibility:Bi-directionality of flows

New network codes: TAR + CAM + BAL + CMP

Impacts on gas markets



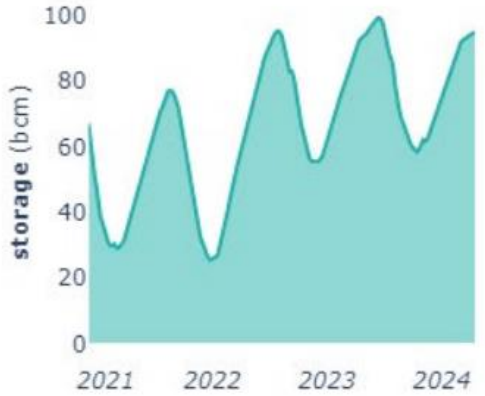
LNG: 25.4 bcm



Gas imports

70bcm

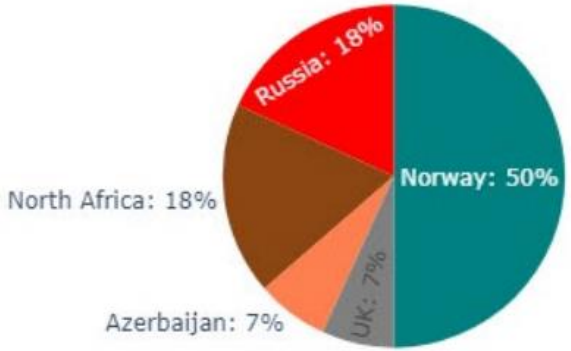
▼−6bcm



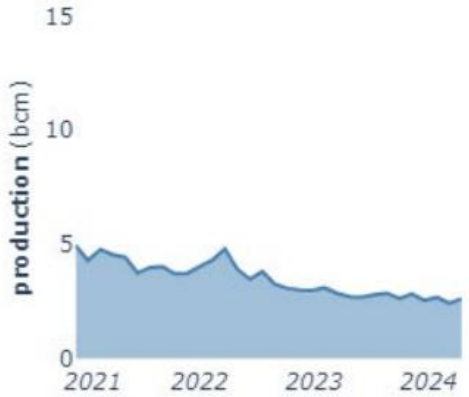
Gas storage

69bcm

▼−2bcm



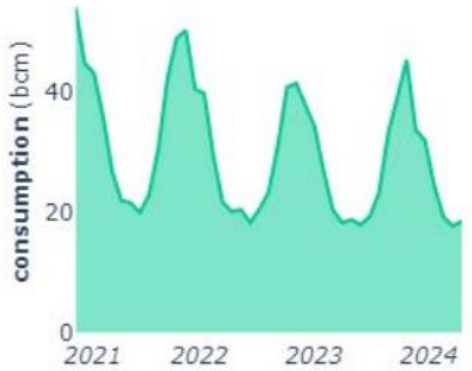
Pipelines: 44.2 bcm



Gas production

8bcm

▼−2bcm



Gas consumption

61bcm

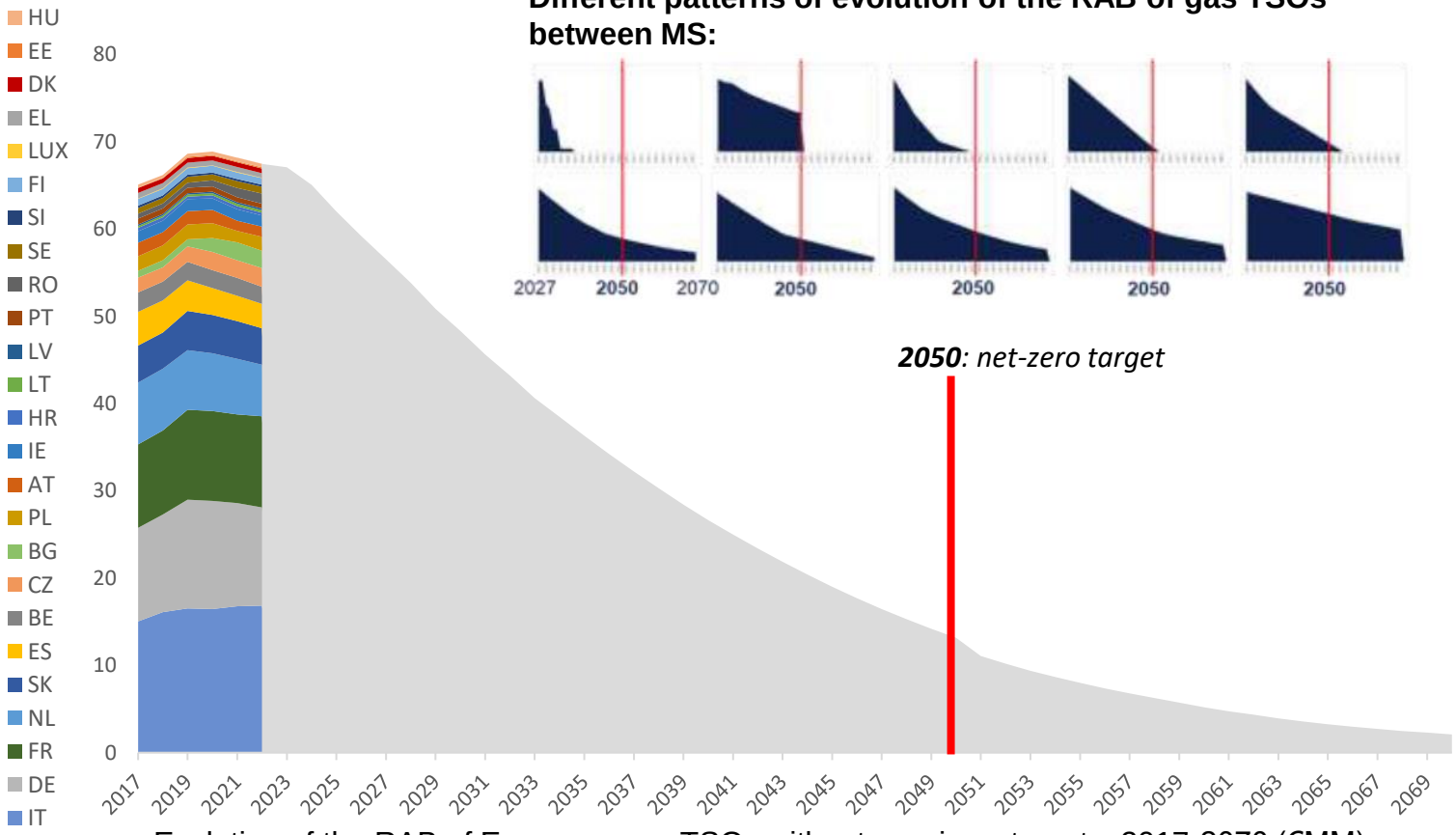
▼−4bcm

Source: European Commission, Quarterly Report on European Gas Markets Q2 2024

Electrification of Consumption and the Sustainability of the Gas Sector

Evolution of the RAB (base of assets to be remunerated) and Gas Consumption
The trend towards electrification of consumption and the risk of stranded assets and cost-spiralling
Sectors where molecules are easily substitutable represent a greater risk

Different patterns of evolution of the RAB of gas TSOs between MS:

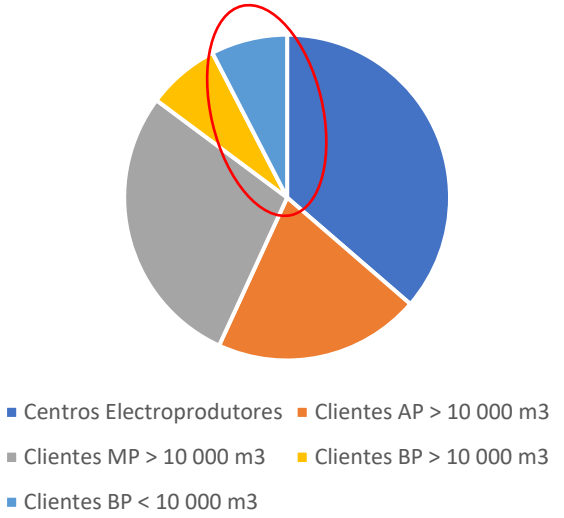


***2050**: net-zero target*

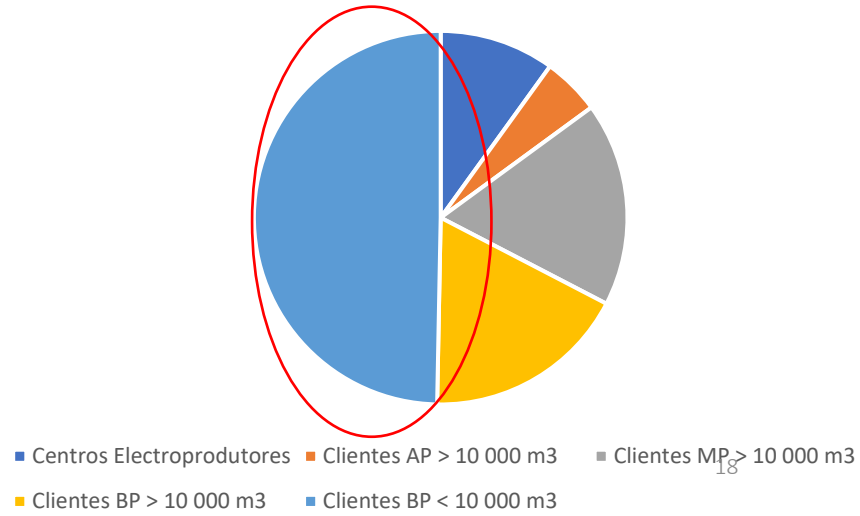
Evolution of the RAB of European gas TSOs without new investments, 2017-2070 (€MM)

Source: ACER

Natural Gas Consumption in Portugal for the 2023-2024 Gas Year (GWh)



Revenues: Network Access Tariffs in Portugal for the 2023-2024 Gas Year (million €)



Opportunity: Decarbonisation of Gas Markets and Hydrogen

These changes require

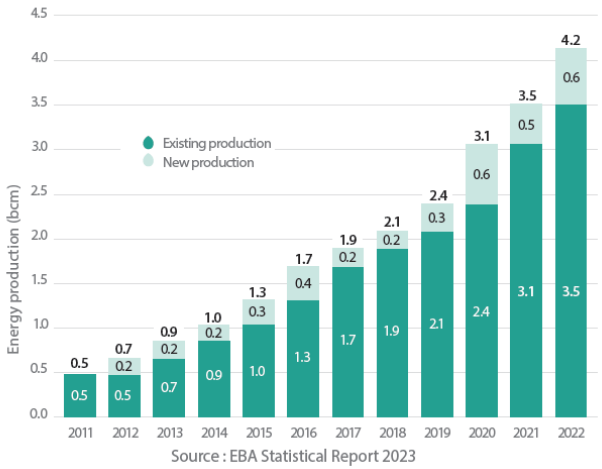
- Prudence in investments
- Cost-effective solutions for gas networks (decarbonised methane or repurposing to H2)
- Clear political, legislative and regulatory guidelines

The implementation of the Hydrogen and Decarbonisation of Gas Markets Package gives us the tools to plan for the future of the gas markets

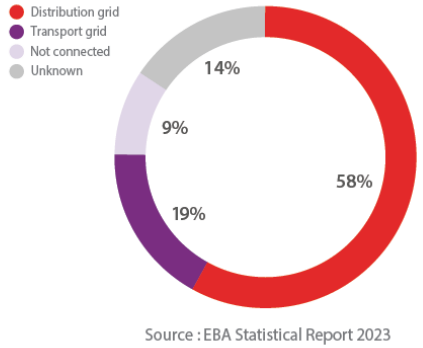
- Development of hydrogen markets
- Priority for biomethane and other decarbonised gases (tariff discounts and injection priority)
- Preparation for the natural gas phase-out (new rules on gas network planning and decommissioning plans)
- Possibility of financial transfers between regulatory bases
- Consumer protection
- Review and approval of new Network Codes

Decarbonisation of the gas sector - Biomethane

European biomethane production (bcm) in 2022



Percentage of biomethane plants connected to the distribution and transport grids in Europe in 2022



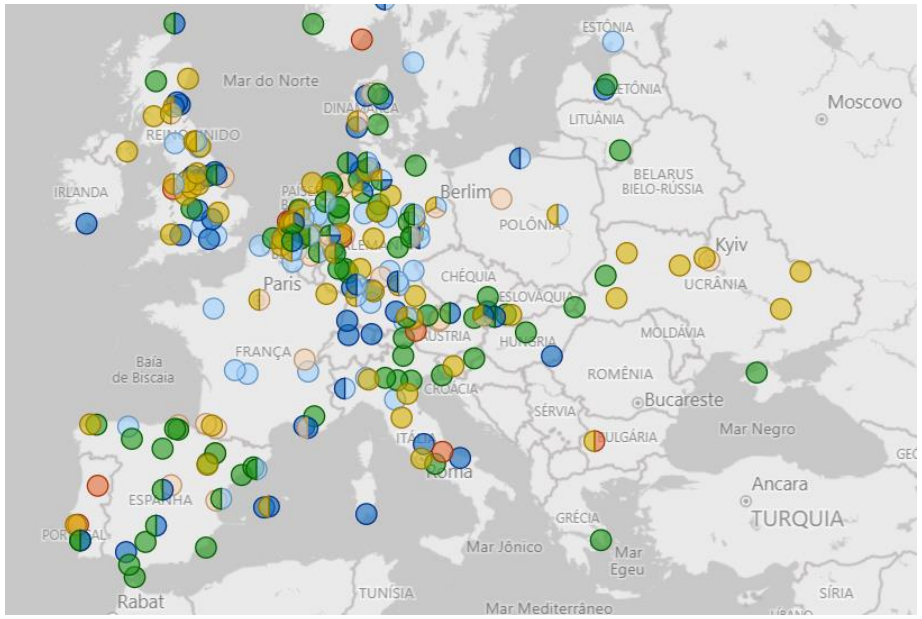
Compared to the rest of Europe, the Iberian Peninsula still has some way to go in developing biomethane and other renewable gases

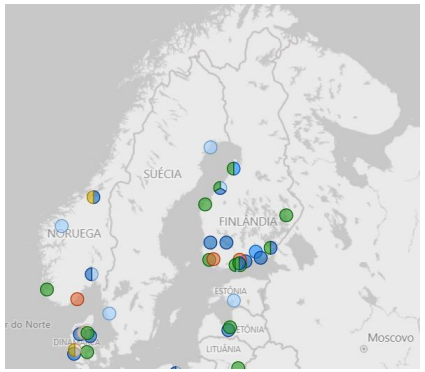
Biogas production in Europe in 2023

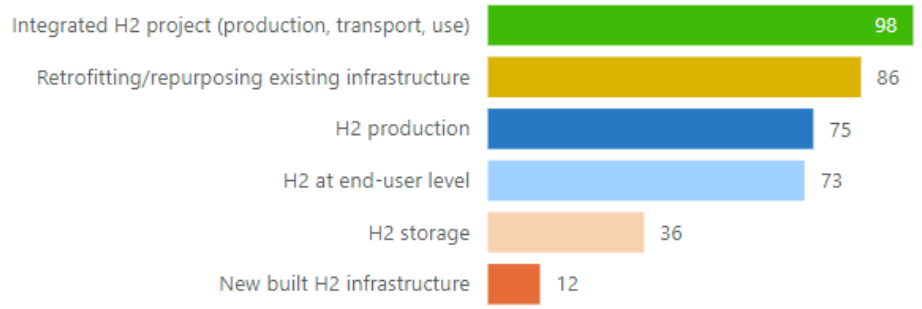
Source: European Biogas Association

The future role of hydrogen and long-term flexibility

Hydrogen as a source of integration and flexibility in the energy system, but it remains to be seen how the sector will develop:







Source: ENTSOG

A majority of H2 projects are "hydrogen valleys":

- Focus on local hydrogen projects
- Repurposing of existing infrastructure creates important regulatory challenges
- Projects have different stages of maturity and viability is still uncertain

The REPowerEU Action Plan foresees the development of "Hydrogen Corridors":

- Long distance cross-border projects

Source: REPowerEU Action Plan (EC), 2022.

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THANK YOU!

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