CONVERSE
Para uma melhor cultura da energia e da regulação em Portugal

Workshop - INOVAÇÃO NA ENERGIA
Auditório da ERSE - 11 de maio de 2018

EDP Innovation

Innovation strategy and priorities

António Vidigal

EDP GROUP OVERVIEW

RENEWABLES WORLD LEADER

EDP CONSOLIDATED 2017

Clients: ~12Mn
Market Cap: ~ € 10Bn
EBITDA: € 4Bn
Generation Cap: ~ 26.8GW (73% Renewables)

GENERATION & SUPPLY

IBERIA

17% of EBITDA
Generation Cap. – 13.6 GW in Portugal and Spain
(7.1GW is hydro)

EDP BRASIL

17% of EBITDA
Generation Cap. - 2.5 GW
(1.7 GW is hydro)

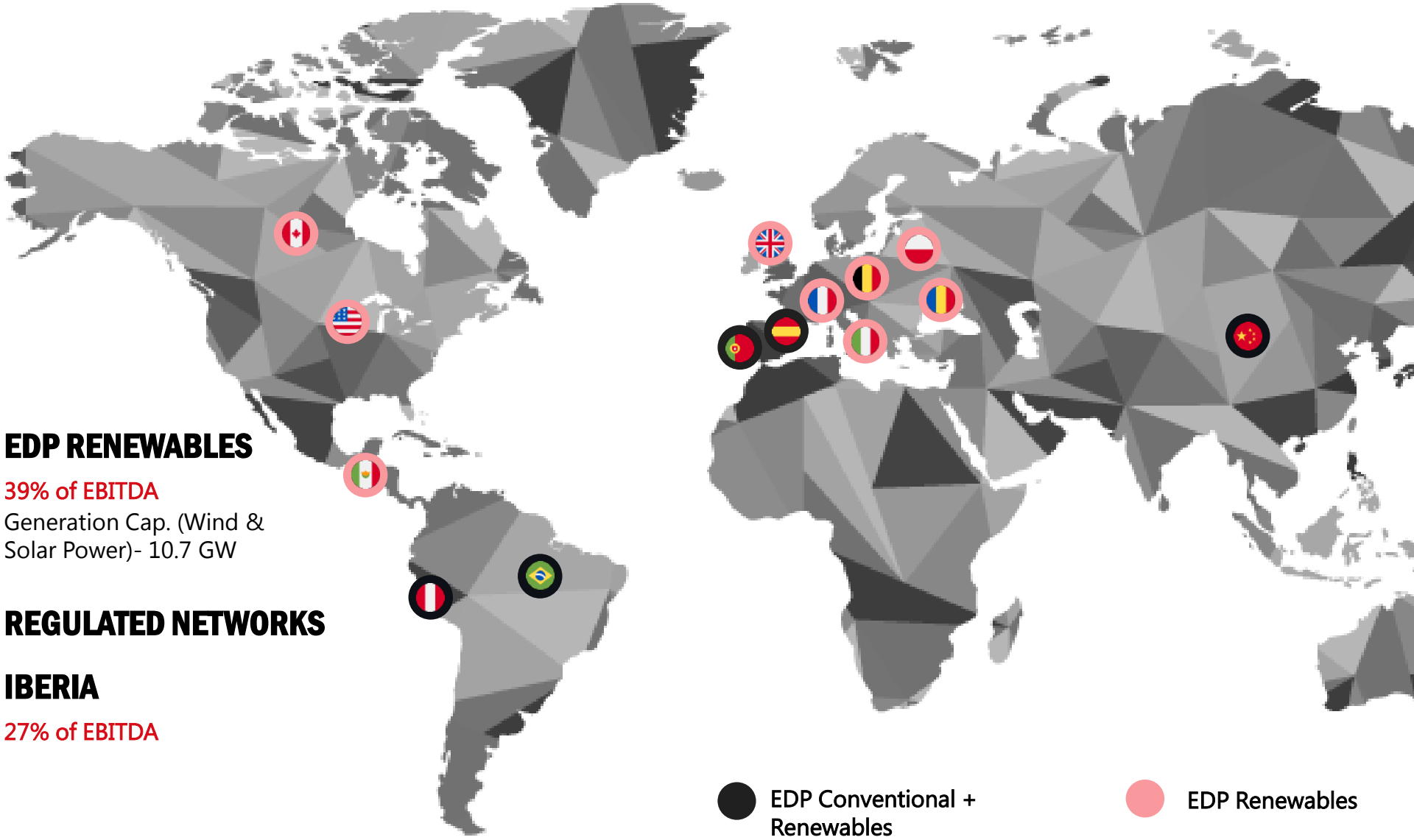
EDP RENEWABLES

39% of EBITDA
Generation Cap. (Wind & Solar Power)- 10.7 GW

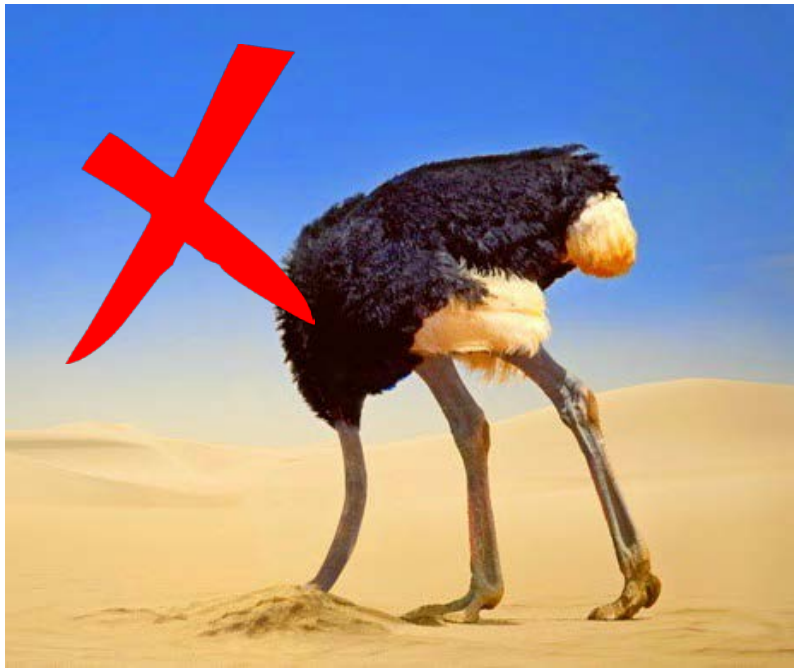
REGULATED NETWORKS

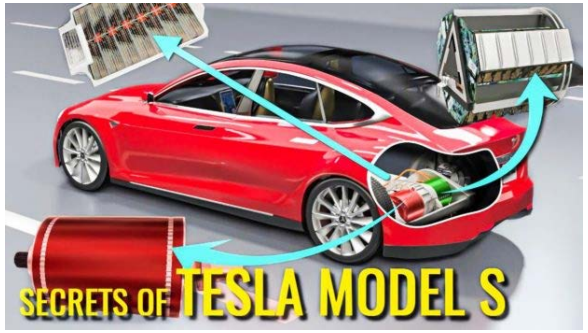
IBERIA

27% of EBITDA



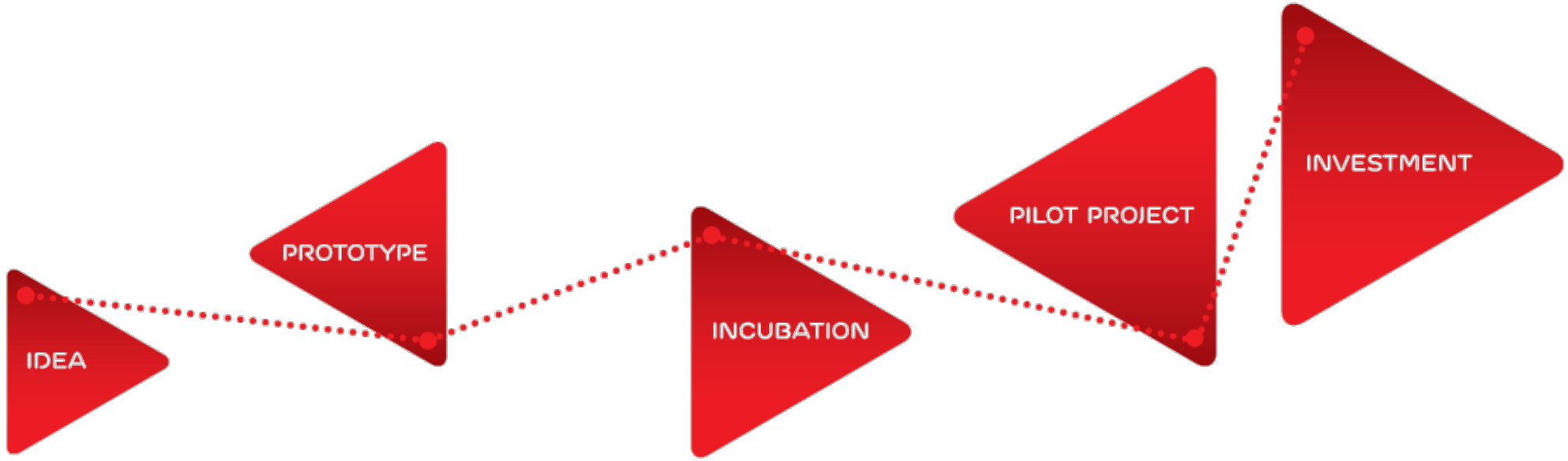
Power Systems are changing, and we want it to be an opportunity rather than a threat



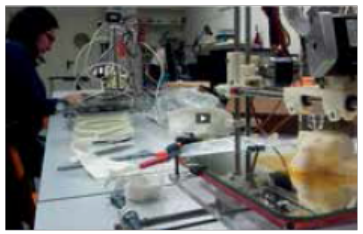


EDP INNOVATION | ECOSYSTEM DEVELOPMENT TIMELINE

EDP Innovation has several instruments to address disruptive ideas through out the development road map



innovation competitions, challenges and hackathons	edp fablab	incubator	technology development projects	venture investments



EDP INNOVATION STATISTICS

+2500
Applications

50
Focal Points

5
Work Groups

15
Interim Managers

32
People work in EDP Innovation

27
Pilot Projects

+550K€
Awards

34
Startups*

41M€
Yearly Revenues*

15
Export Countries*

+500
Jobs Created*

18
VC Investments (including 2 Funds)

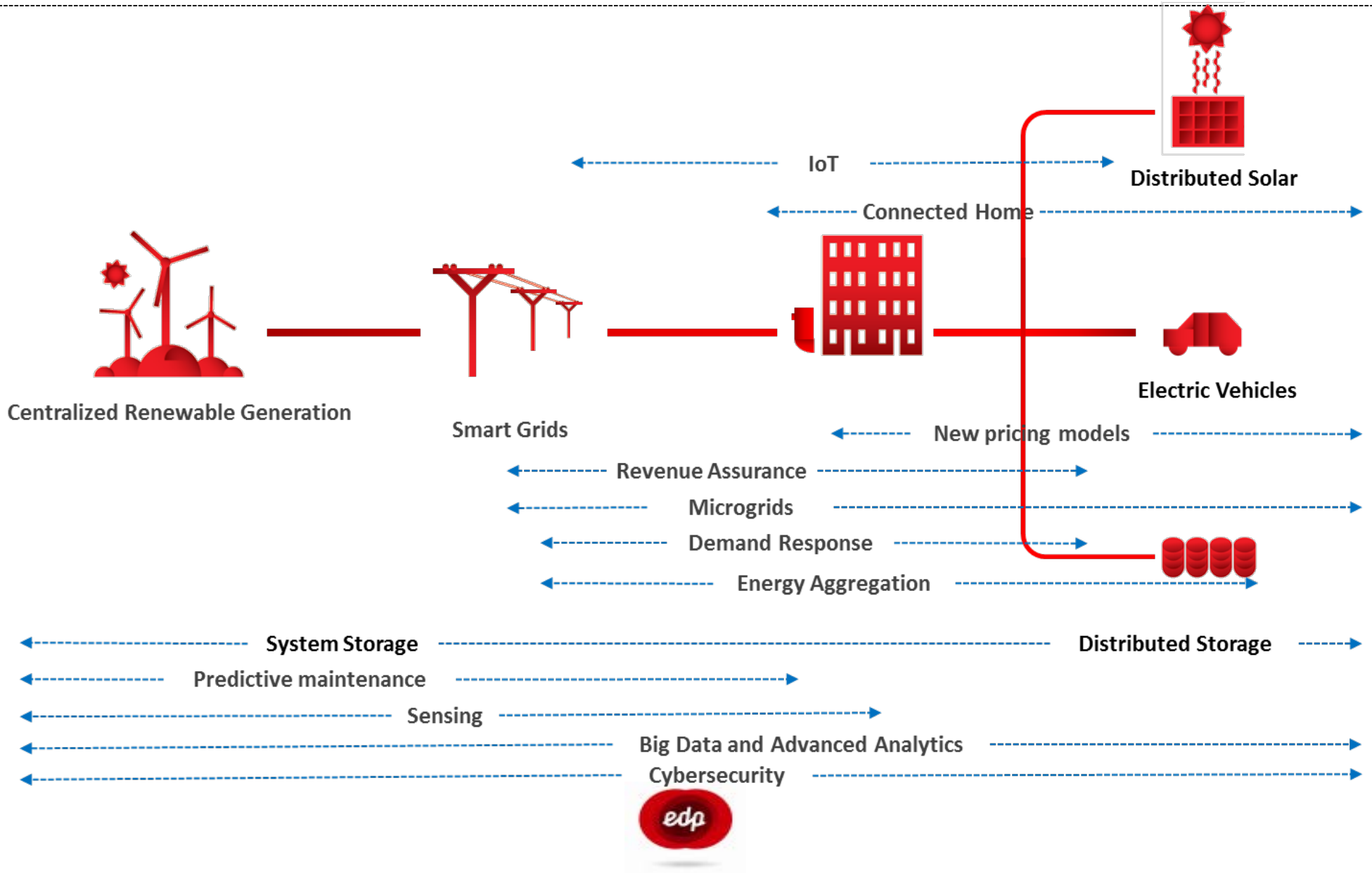
26M€
Invested

118M€
Funds Raised*

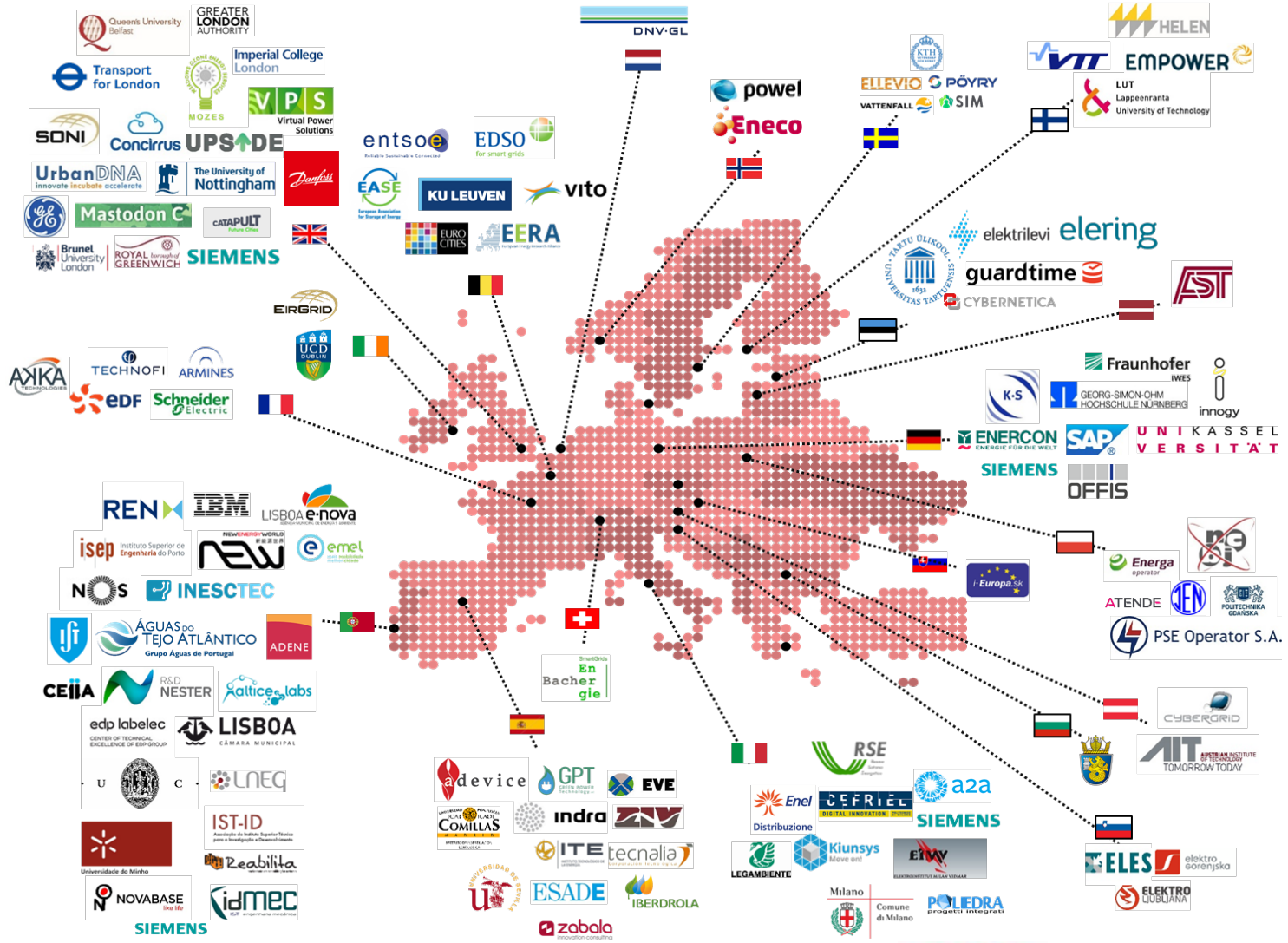
Expansion
Spain and Brazil*

* EDP Starter + EDP Ventures

Technology adoption is reshaping the energy sector with a growing wave of downstream innovation that will be key



EDP is present in a large number of European projects which involves multiple stakeholders



ETIP SNET

bridge HORIZON 2020

17 EU Associations

20+ Countries

280+ Partnerships

50+ Industry Companies

35+ DSOs

100+ R&D and Academia

EDP INNOVATION'S PRIORITIES

SMARTER GRIDS

Smart Grids Infrastructure
Energy Distribution Management

CLEANER ENERGY

Renewable Energy
Thermal & Big Hydro Generation

DATA LEAP

Cloud Computing
Big Data
Web 3.0
IoT
Advanced Analytics

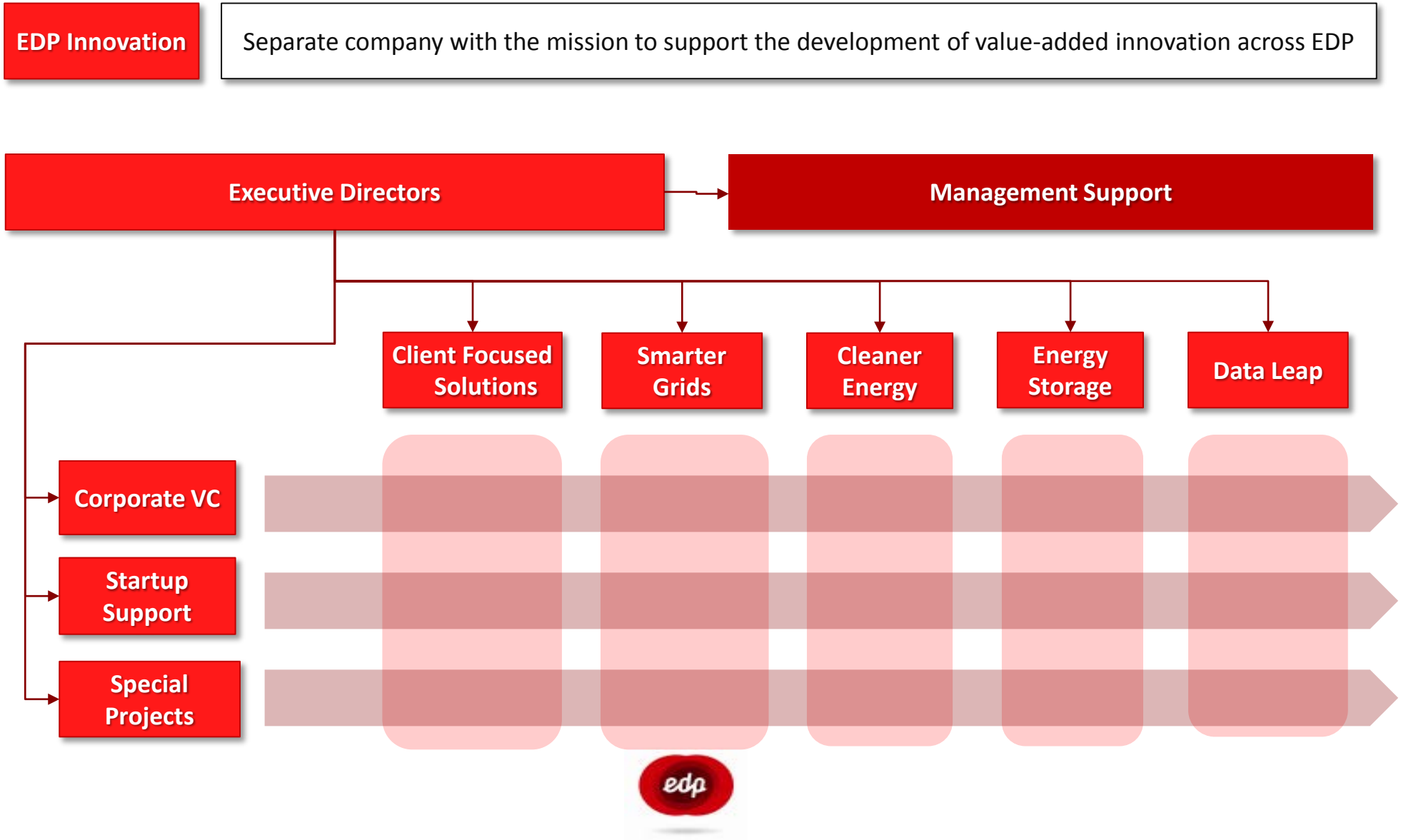
CLIENT-FOCUSED SOLUTIONS

Smart Pricing And Bundling
Energy Efficiency
Increase Electrification

ENERGY STORAGE

Battery Technologies
Storage Management And Control

EDP INNOVATION | ORG. STRUCTURE



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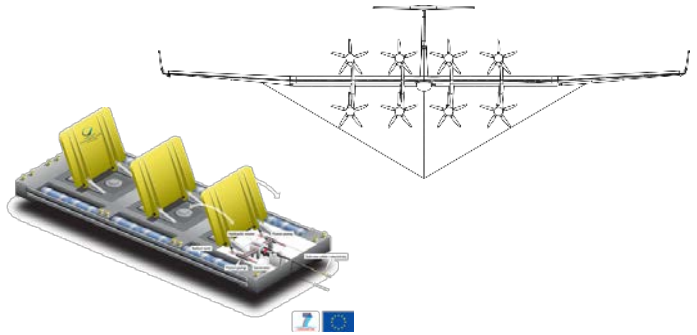
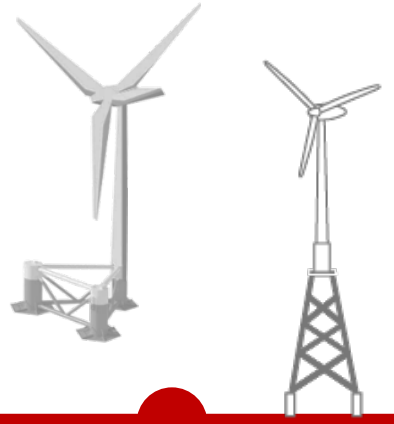
The WorkGroup addresses a large range of technologies, since early stage up to mature technologies. The challenges of each technology are dependent on the level of maturity

Technology main challenges and approach





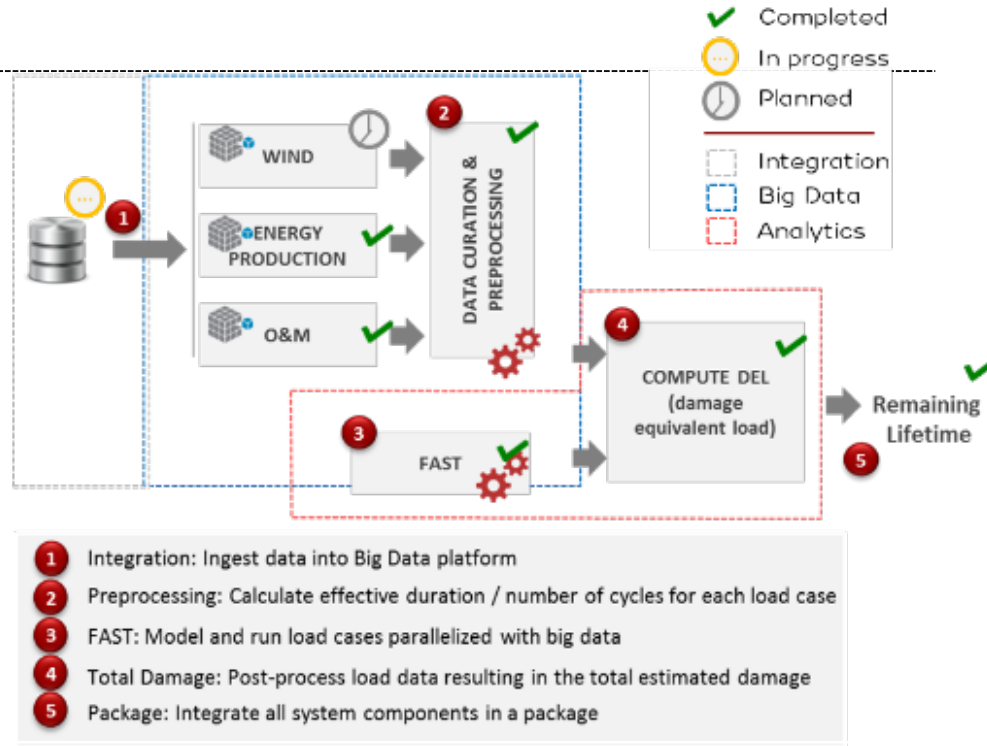
Early stage — Mature

	Wave Energy/ HAWE[1]/ Other energies	New Solar Technologies	Offshore wind	Onshore wind/Solar PV Conventional generation
MAIN CHALLENGES	Proof of concept	Validate technology Identify and quantify benefits	Tech to reach commercial stage Address specifi supply chain issues	Reduce LCOE Improve data and asset mngt strategies
APPROACH	Follow technology development Low man power allocation	Proactivity in identifying new opportunities Develop demonstration projects		Strong involvement of BUs to promote capture of benefits

EDPI and EDPR developed jointly a tool and methodologies to estimate the fatigue life consumption of current wind turbines

WIND TURBINE LIFE ESTIMATION

1. Define and develop methodology to estimate the fatigue life time of wind turbines
2. Estimate the remaining life time of the wind turbines
3. Define life extension methodologies



Project Details

- Approach in line with current industry standards from (e.g. DNV and DEWI)
- Enables data-driven decisions on asset replacement and decommissioning
- Computing fatigue damage based on actual conditions to enable data-driven decisions
- Implemented using a big data architecture which allowed to process sign amounts of data (for example, the Boquerón test site, with 75 turbines, has 11.5M O&M events and 27.6M wind data points for 7 years data with 10-minute granularity)

Main conclusions

- Tool is already in production and being used by EDPR
- The tool was applied to the Fonte de Mesa Wind Farm, which is already at the 21 year mark, showing that the operation can safely be extended up to 30 years (P90)
- Possibility to study operational strategies to maximize added value

Solar PV Laboratories (SunLab II) allow to analyze performance and test PV technologies

SunLab II

1. Solar PV laboratories installed in 4 different locations in Portugal, with different in different PV technologies and a fully equipped meteo station. Analyze performance and O&M issues.
2. Understand solar PV modules' performance (Degradation, soiling, long standing shading)

Main conclusions

Activity	Objectives	Results Overview
Degradation	Verify degradation of PV modules and compare final power with manufacturer specifications.	On-field degradation observed is around 0.52%, which is in line with the literature
Shadowing	Evaluate the impact of longstanding local shading on the degradation of PV modules.	Longstanding shadowing has showed 4% degradation (~7 months of local shadowing). Presence of a brown spot.
Meteorological	Understand the reliability of the data sources available (e.g. PVGIS).	SunLab meteorological data was compared against **PVGIS database, which was validated as reliable source**.
Soiling/Cleaning	Understand the impact of soiling on the PV modules performance and develop a predictive tool to optimize annual cleaning schedule.	Cleaning products showed a slight mitigation of soiling accumulation; Weather forecast showed to be a strong input on the definition of the cleaning schedule.

Open Data Policy

Making publicly available the data of a farms with the community will provide mutual benefits

Open Data Approach

- **Why opening data for the community?**
  - **EDP receives lots of requests to access data from startup and R&D institutes to test new products and methodologies**
  - **Collaborating in those Projects will provide mutual benefit for both parties involved**
  - **This tool intends to focus on the segment of universities and students, but also startups, new tools, etc.**
  - **The platform will implement a gamification mechanism to incentivize the community to improve the results**
  - **Open up the access to wind farm data can be a strong point for local governments and community acceptance**
  - **Open Innovation initiatives haves a strong resonance for corporate image**

Benefits for EDP

Insights

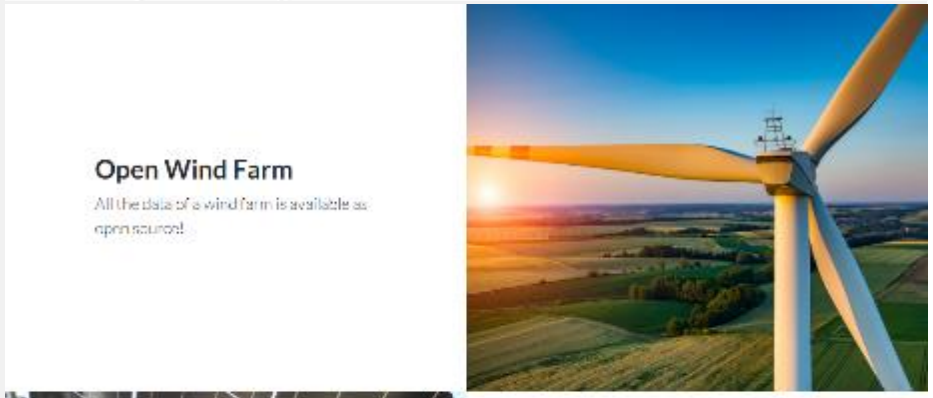
- Receive insights of data analysis methodologies
- Test and understand the potential of new tools and uses of available data

HR Potential

- Promote stronger collaboration with R&D institutes
- Identify HR potential

Collaborate

- Motivate community to share findings with us, through challenges
- EDP as a reference for R&D community



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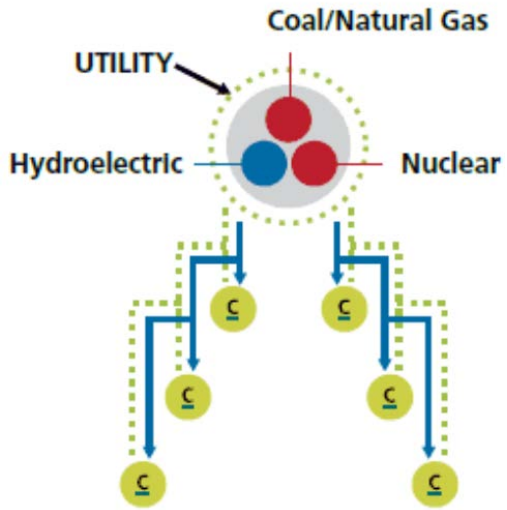
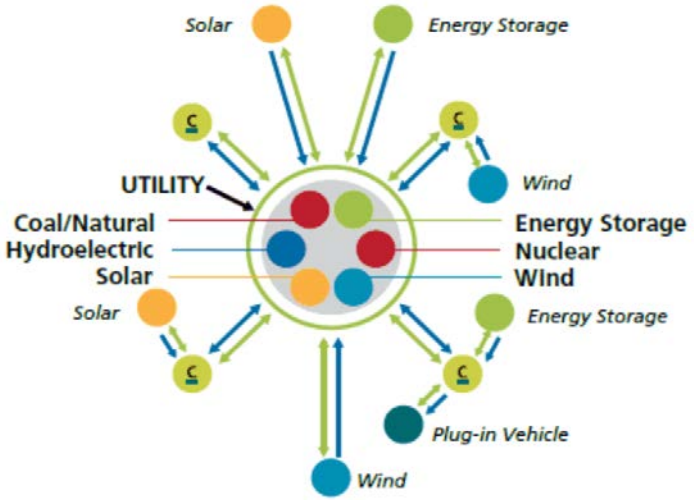
Distribution grids are under a profund change and the fast deploy of grid edge technologies will change the way grids will be managed… and lead to a grid (re)evolution.

Yesterday
(Centralized)



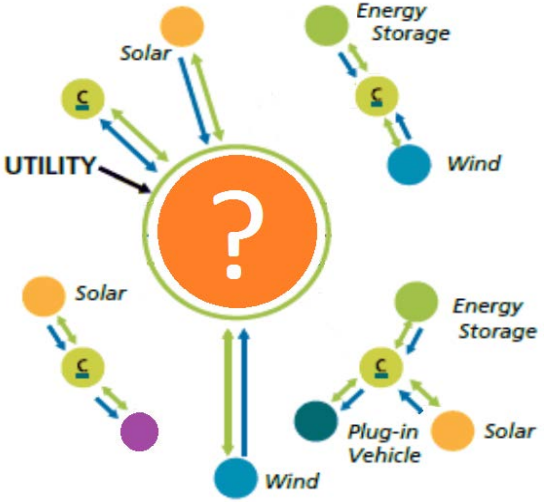
- Hierarchical
- Unidirectional flows

Today
(Decentralized)



- Distributed resources
- Centralized control
- Bidirectional flows

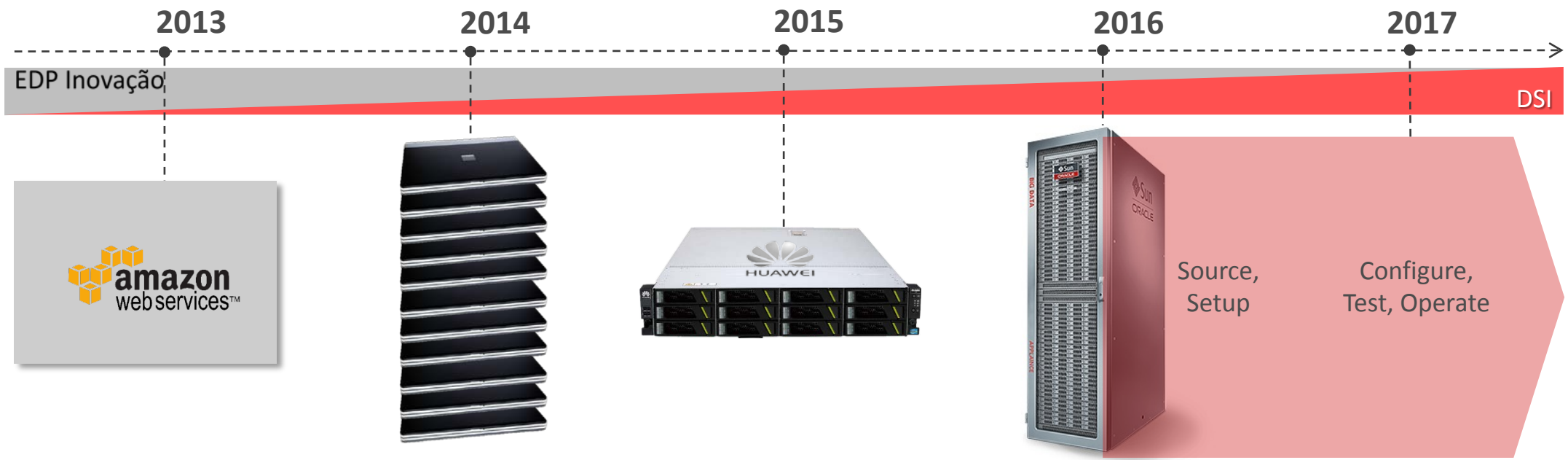
Tomorrow
(Hybrid)



- Transactive energy (P2P)
- Microgrids
- ‘Multidirectional’ flows

Adapted from: World Economic Forum March 2017 In collaboration with Bain & Company The Future of electricity New Technologies Transforming the Grid Edge and IBM

Replicating a big data scenario from an EDF paper, in 2013 started EDP's journey building in-house Big Data capabilities, and has since materialized in a corporate data lake implementation.



	Big Data Experiment	"Low-Cost" Big Data Cluster	"Enterprise" Big Data Cluster	Big Data Appliance
Purpose	Data aggregation experiment	R&D support	PREDIS project support	Corporate big data architecture
# Nodes	21	46	16	6
# Cores (CPU)	42	184	500	528
# Storage (TB)	17	7.5	350	459
Investment (€)	~50	~300	~118K	~719K

It was clear that it is fundamental to build an IT infrastructure capable of ingest, process, expose and act over the big data that utilities will receive in a “real time” paradigm

ON-EVENT COMMUNICATIONS

Data collection as it is generated

+

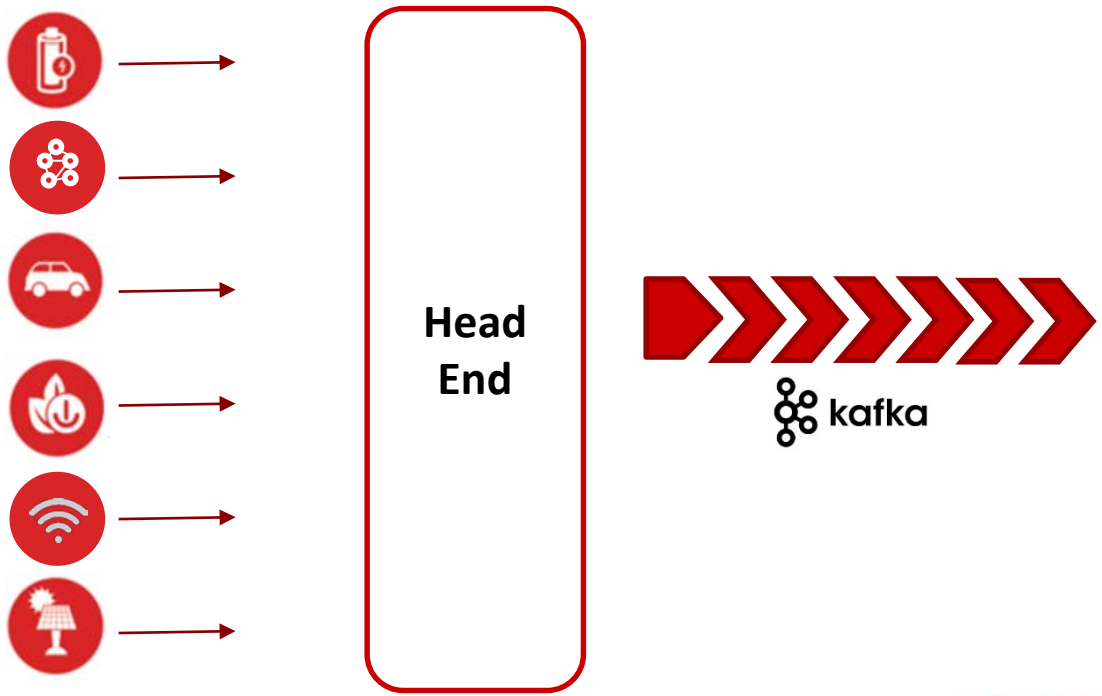
DATA INGESTION OF STREAMING DATA

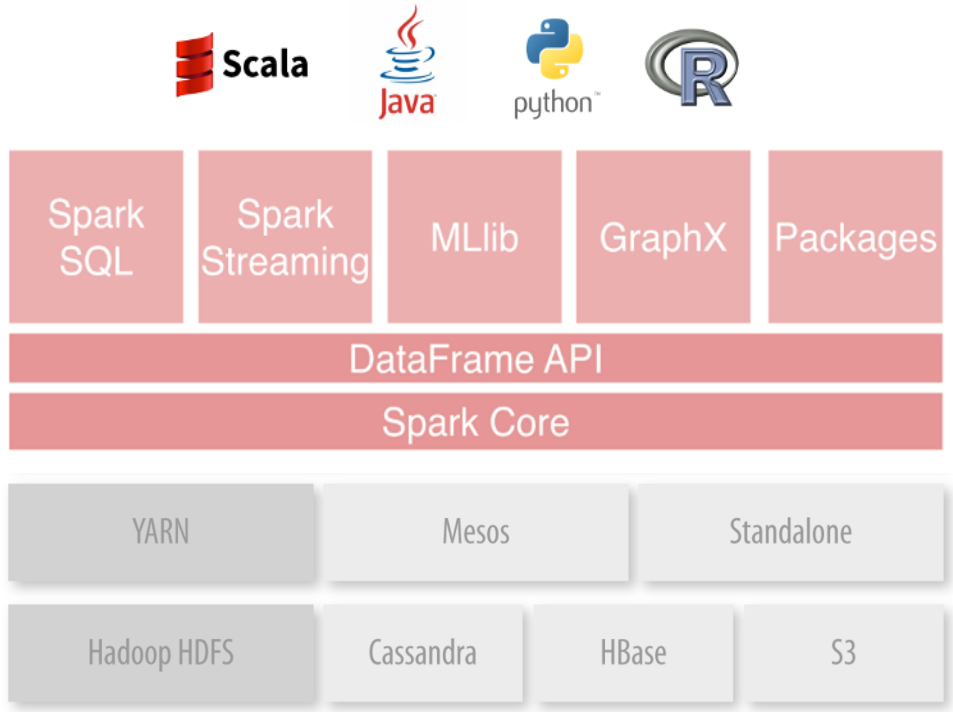
Push data to analytics platform in ‘real-time’

=

REAL-TIME ANALYTICS

Information available in Real Time, for multiple usages





With EDPD, PREDIS is producing disaggregated load forecasts at PT-level based on historical load profiles, seasonality and weather data

Outcome achieved so far

- Predictive model runs daily, considers temperature forecast, historic electricity loads, working days vs. weekends and national holidays, yearly and daily seasonality;
- Load forecasts are produced for every substation and distribution transformer with a 30-minute granularity, for a 5-day forecast range (limited by reliability of temperature forecasts);
- Current Mean Absolute Percentage Error (MAPE metric) is 12.9% for power transformers and 9.8% for substations;
- Parallel execution of model in big data cluster takes 5h42’ (scalable), vs. 23d18h16’ if calculations were performed sequentially.

Future improvements planned

- Incorporate dynamic grid topology in the predictive model (predictive model variations for each possible grid configuration), aiming at real-time energy balance;
- Incorporate regional holidays and events as input variable and add extra weather features (e.g. humidity);
- Incorporate renewable energy sources in PREDIS (cooperation with EDPR for wind generation forecast model and with Portuguese universities for PV forecast model).
- Extend forecast window to one month;
- Reduce mean error.

100.856
Power transformers

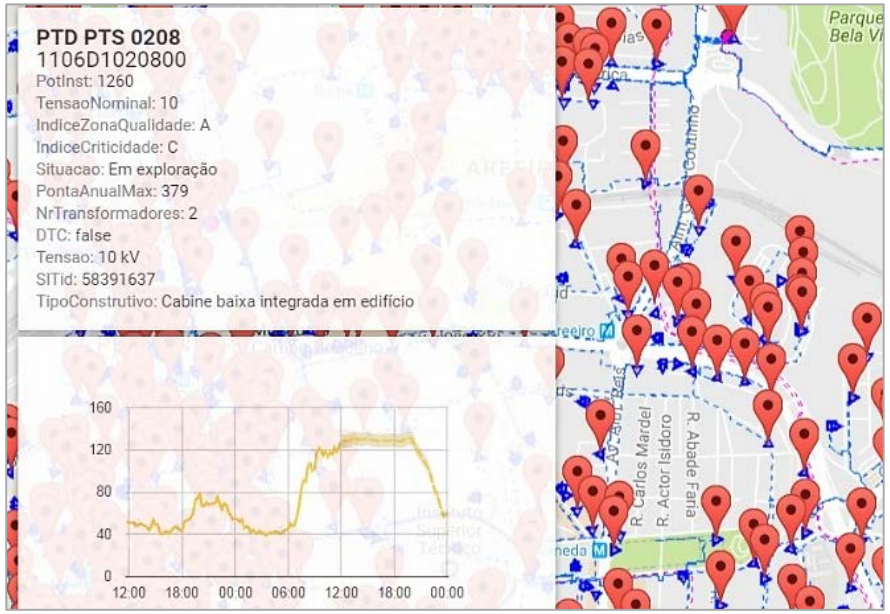
753
Substations

5 days
Forecast range

30 minute
Forecast granularity

~12%
Mean error

99,9%
Computing time reduction



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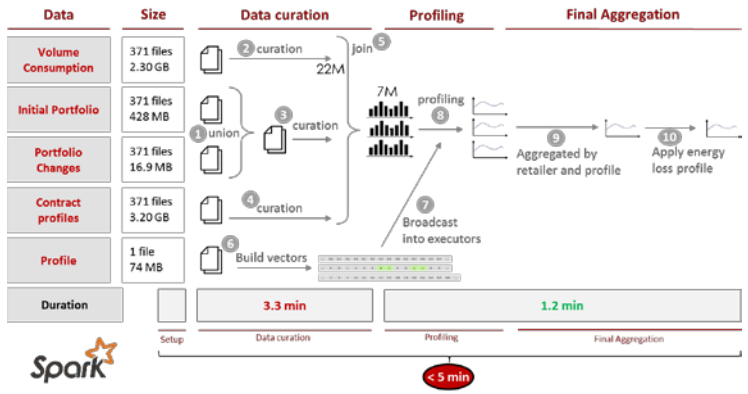
In the Big Data & Analytics subject area, EDP Inovação has been consolidating the technical competences and applying them to concrete use cases across the value chain

Energy settlement (EDP Distribuição)



Challenge: reconciliation of energy purchased from producers and energy sold to consumers, aggregated by retailer

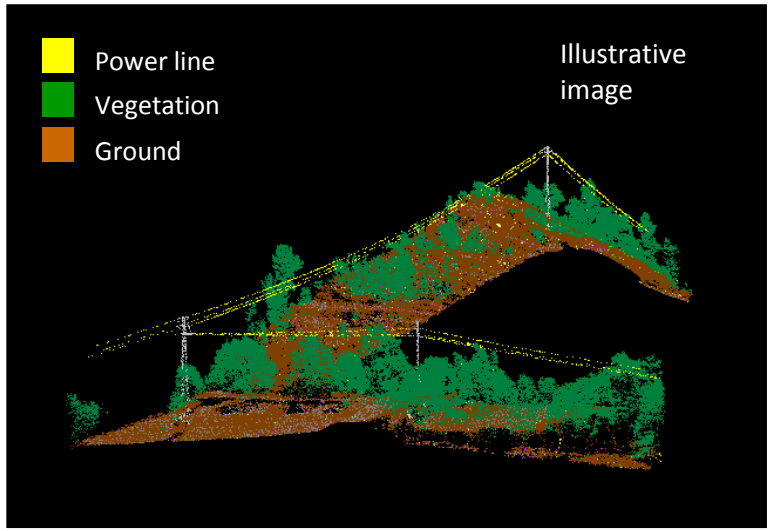
~6 GB
Data processed

>2 days
Original process

18 days
Investment

<5 minutes
Optimized process

Aerial line inspections (Labelec)

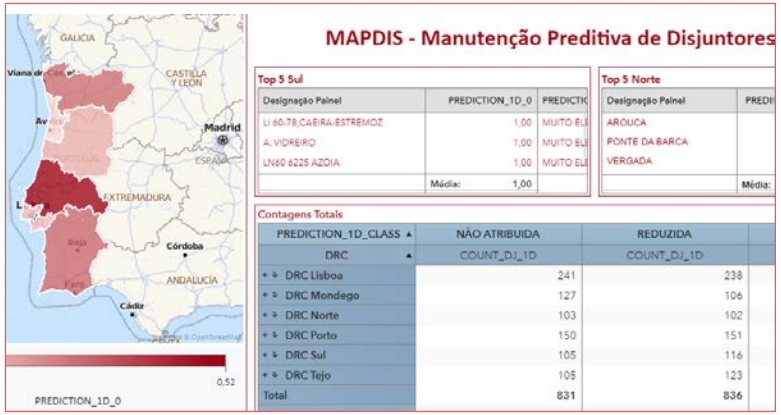


Challenge: classification of LIDAR data and images collected in aerial line inspections

1 FTE
automated

30%
Lower lead time

Predictive maintenance (EDPD, EDPP, EDPR & EDP Espanha)



9.000
Circuit breakers

Predict the circuit breakers with highest probability of failure in the next command and prioritize maintenance by risk. Estimate yearly savings: 0,5M€ - 1M€

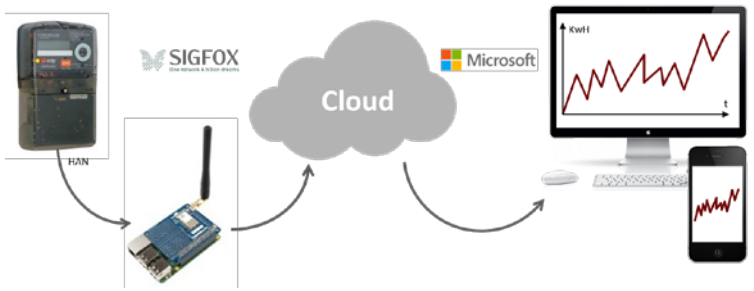
130.000
Power transformers

Predict the probability of failure of a power transformer optimizing the maintenance process

Non-exhaustive

In other areas such as Internet of Things and emerging technologies, projects have had more focus on research and discovery, focusing on specific business challenges or optimization opportunities

Hackathon (EDP Comercial, EDP Distribuição)

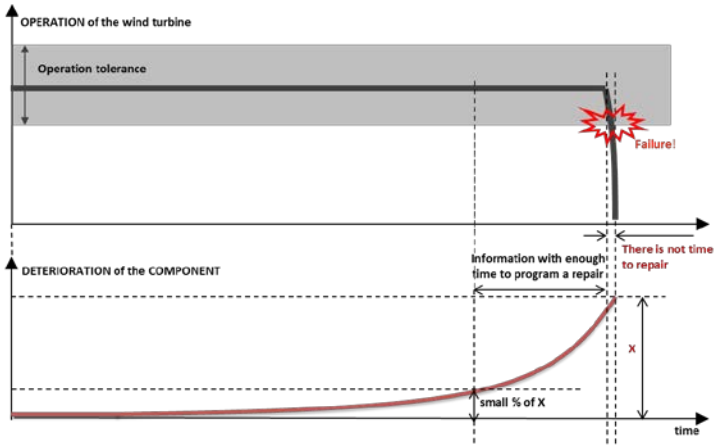


Challenge: Create a low-cost solution for monitoring home energy consumption, and deliver a minimum viable product in one week

37 Participants

1 Solution adopted

Hackathon *HackTheWind* (EDP Renováveis)

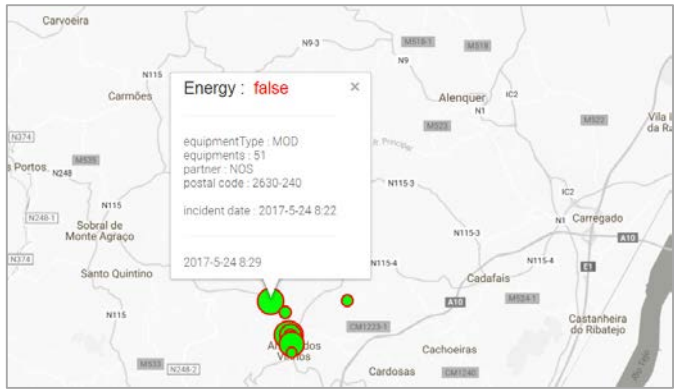


EDP Renewables challenged participants to predict wind turbine failures using SCADA and fault records from 1 wind farm in 24h

83 Participants

14 Projects

Sinapse (EDP Distribuição)



Challenge: Detect low-voltage outages and provide customers with service recovery estimates in near-real-time using partners (telcos, water utilities, SIBS)

3 partners And more to come

>1,8 million Live sensors to date

~55.000€ investment

0€ In new hardware

Non-exhaustive

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Blockchain

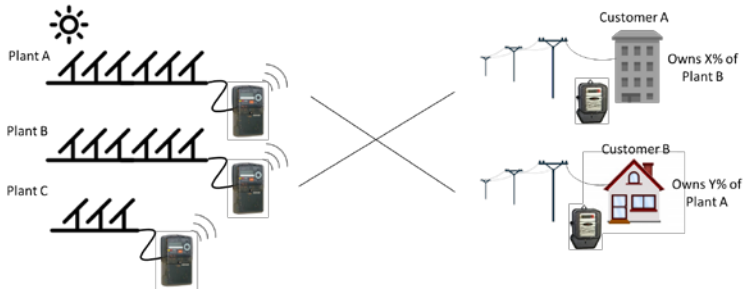
B9lab Academy – Blockchain education

Ethereum Developer Course

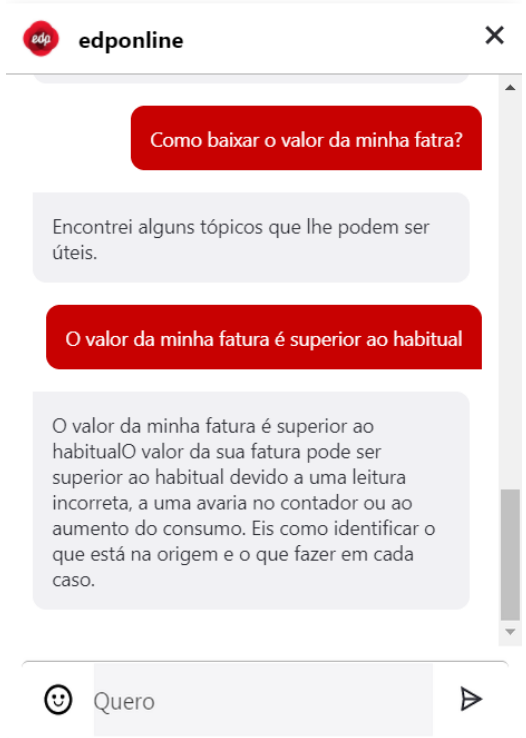
Strategy: to certificate people in Ethereum (blockchain-based technologies) through an online course by B9lab;

Definition and evaluation of a strategic vision for blockchain-based Smart Grid Platform with help of PWC.

Brasil PoC – netmetering and reconciliation between consumers and solar producers



Chatbots (EDP Comercial, EDP Valor, EDP-ES)



4 Prototypes

Try a prototype: mockedpenergia.azurewebsites.net

Virtual assistants (EDP Comercial)

Challenge: Integrate the re:dy ecosystem with Amazon's and Google's popular virtual assistants and cloud IoT platforms

Non-exhaustive

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To face this change in the relationship between EDP and this new energy consumer the area proposes to focus for the coming BP in four main streams: smart home & smart energy, electric mobility, digital customer engagement and innovative business models

The New energy consumer

Instant everything
anytime, anywhere

Hyper-relevant
Personalized interactions

Meaningful experiences
Lifestyle energy products and services

Collective consumption
Redefining ownership

Areas of focus

1 

Smart home & Smart Energy

2 

Electric Mobility

3 

Digital customer engagement

4 

Innovative business models

Drivers

Digitalization of the sector

International expansion / Digital retailer

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From Electric Mobility to Energy Storage for the Grid

V2G — Vehicle-to-Grid

EV market penetration is growing worldwide

Opportunity for using EV power battery to support the grid through decentralized flexibility:

- Local grid management
- Capacity markets
- Ancillary services

V2G market trials occurring now in Europe

ovo energy enel

Ongoing project running at EDP Headquarters

NISSAN MAGNUM CAP® ELECTRICAL POWER SOLUTIONS

2nd life — Use of depleted EV batteries for grid applications

- Rollout of worn batteries from 1st generation EVs starting now

Reuse for 2nd life  vs.  Recycle at end of 1st life

- Opportunity for reusing worn EV batteries on the grid
  - Over 70% of the original capacity is still available
- Cost competitive with new batteries
- Ongoing project to access performance and reliability

End of 1st life

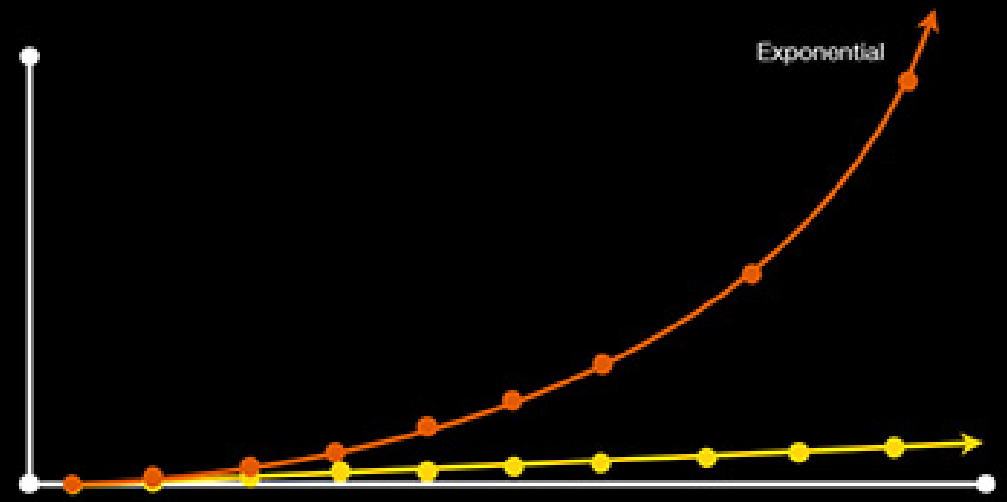
2nd life grid applications

Recycling at the end of 2nd life

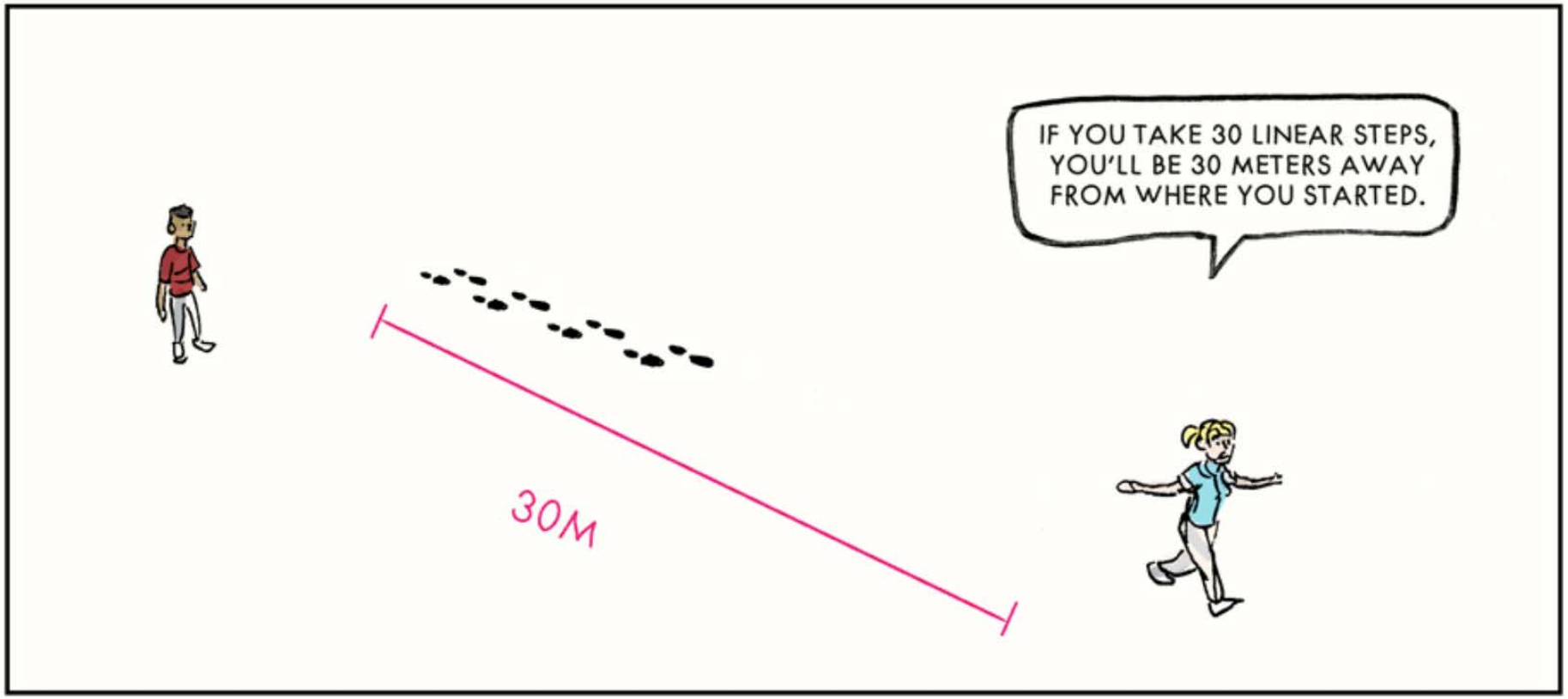
edp

Our blind spot comes from the fact that we have lived in a linear world.

But today's changes are exponential.

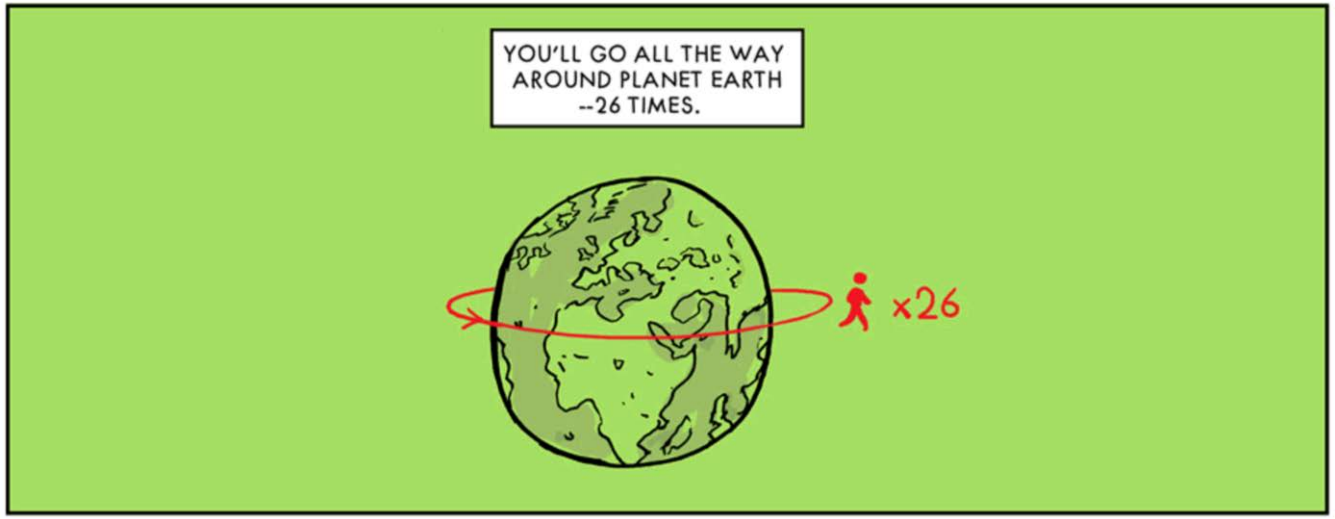


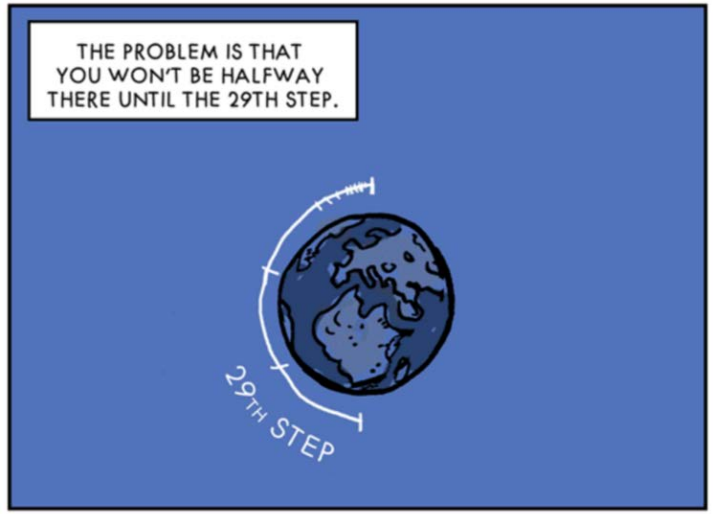
To grasp where things are going we will have to learn to think exponentially and it has never been easy



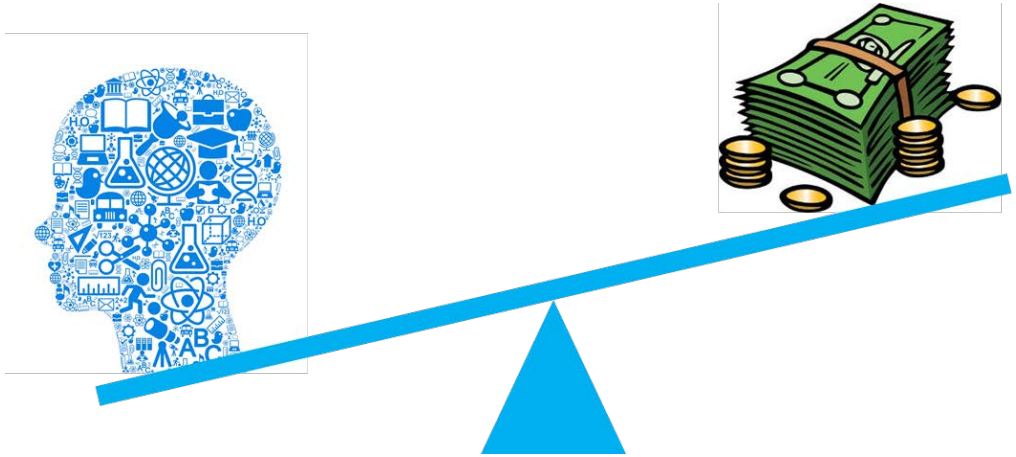
SOURCE: Singularity University

To grasp where things are going we will have to learn to think exponentially and it has never been easy

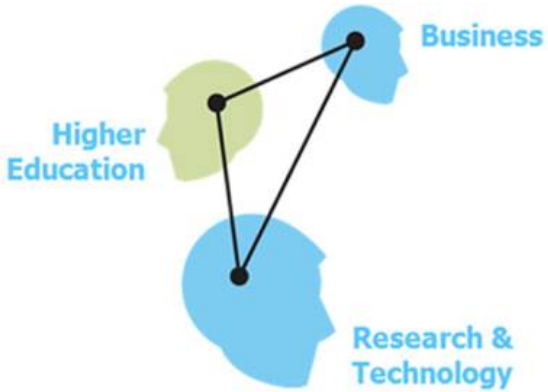




SOURCE: Singularity University



EDP is moving from a Capital Based Organization into a Knowledge Based Organization.



Thank you!


edp