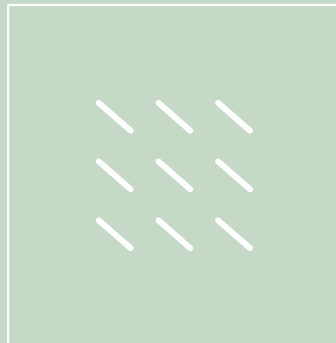




Scientific Symposium on Molten Salt Parabolic Throughs

edp



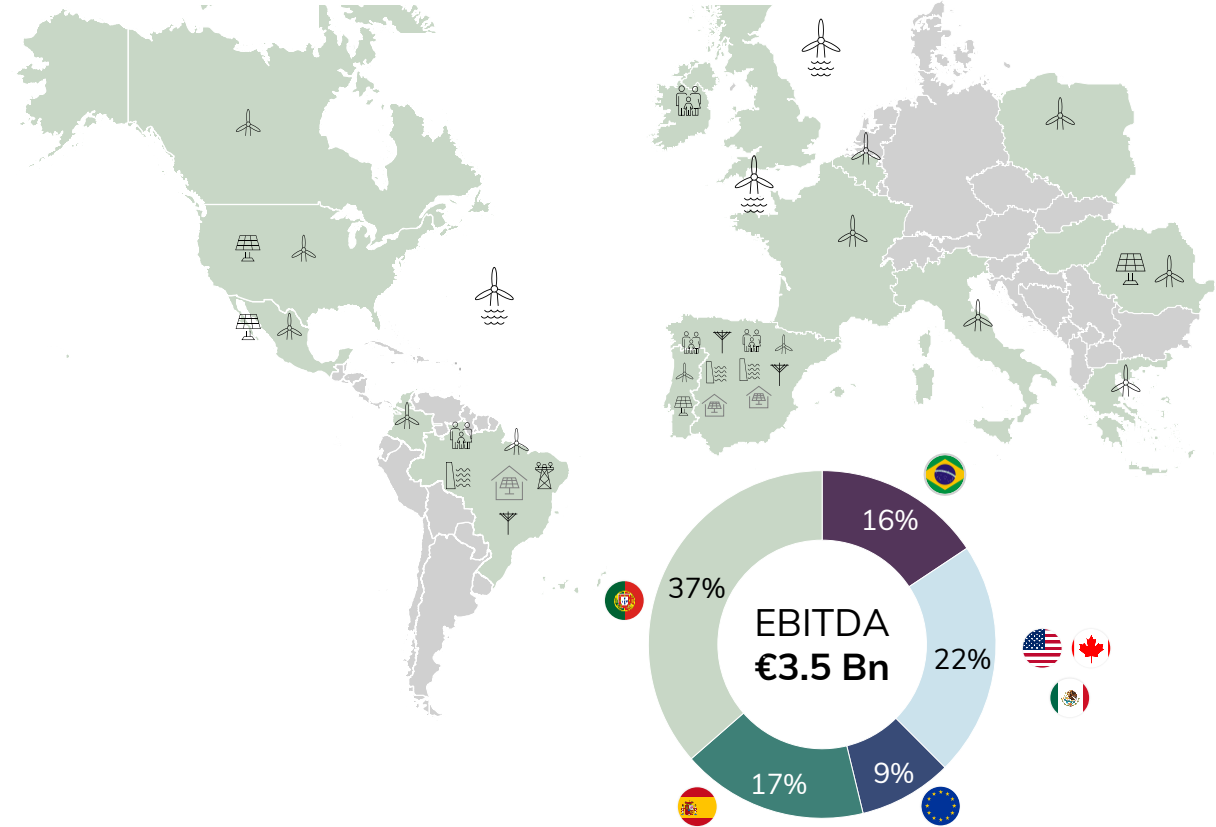
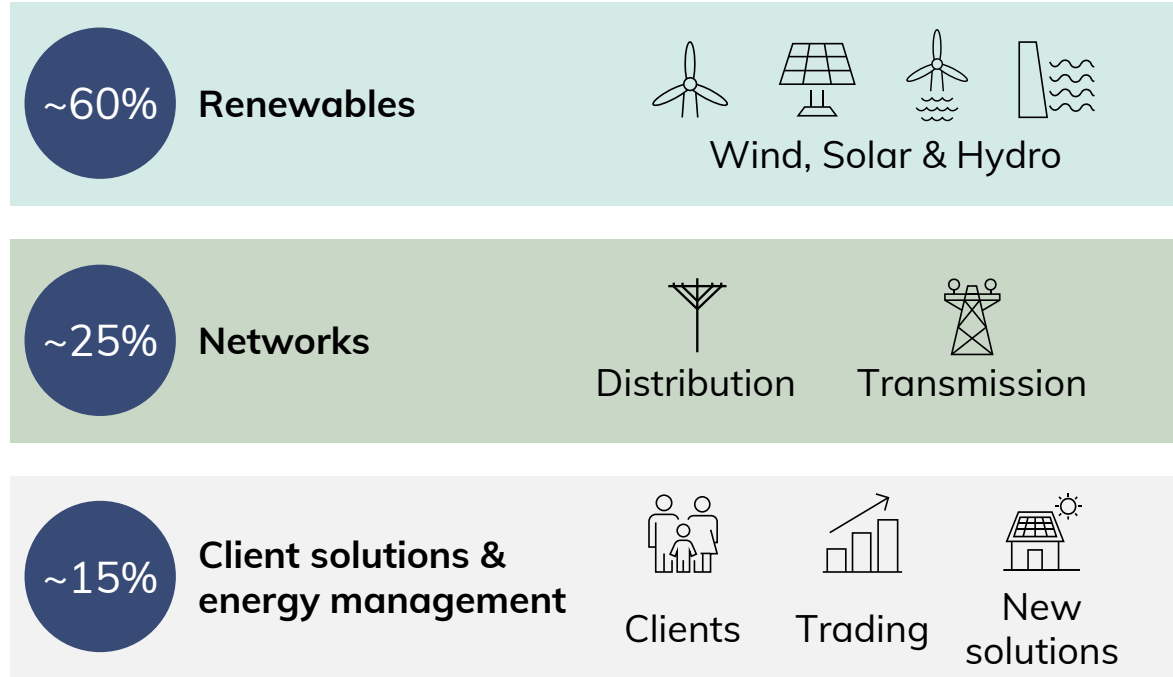
RES Integration and Flexibility

Key enabler for the energy transition

Oct 21st 2021

EDP is a global clean energy company, present in 20 countries throughout different stages of the value chain

% Weight on EBITDA 2020



Key indicators

Values as of 2020



1. Excludes Viesgo

2. Energy and services clients

Note: Excluding contribution from disposed portfolios in 2020 (6 hydro plants, B2C portfolio and 2 CCGTs in Spain). Excludes Viesgo in 2020.

EDP NEW stands for R&D in energy, through international collaboration and competitive EU funding



Focus on R&D in Energy

- Core focus in the Energy Sector
- Create possibilities for the EDP Group
... towards the energy transition



Sustainable growing operation

- Financial sustainability
- Sustainable growth
- 32 Researchers as of today (~40 by YE2021)



The H2020 Company

- #1 Company in Portugal in projects in H2020
- Activity in EU R&D scene
- “Place to go” for H2020, Green Deal, Horizon EU, etc.



Knowledge consolidation & transfer

- Knowledge teams
- Catalyst for technical experts for EDP
- Knowledge exchange initiatives with EDP/community



Foster strategic partnerships

- R&D cooperation with EDP/CTG Business Units (BUs)
- External Innovation Ecosystem including Universities, R&D, Industry, Technology, etc.

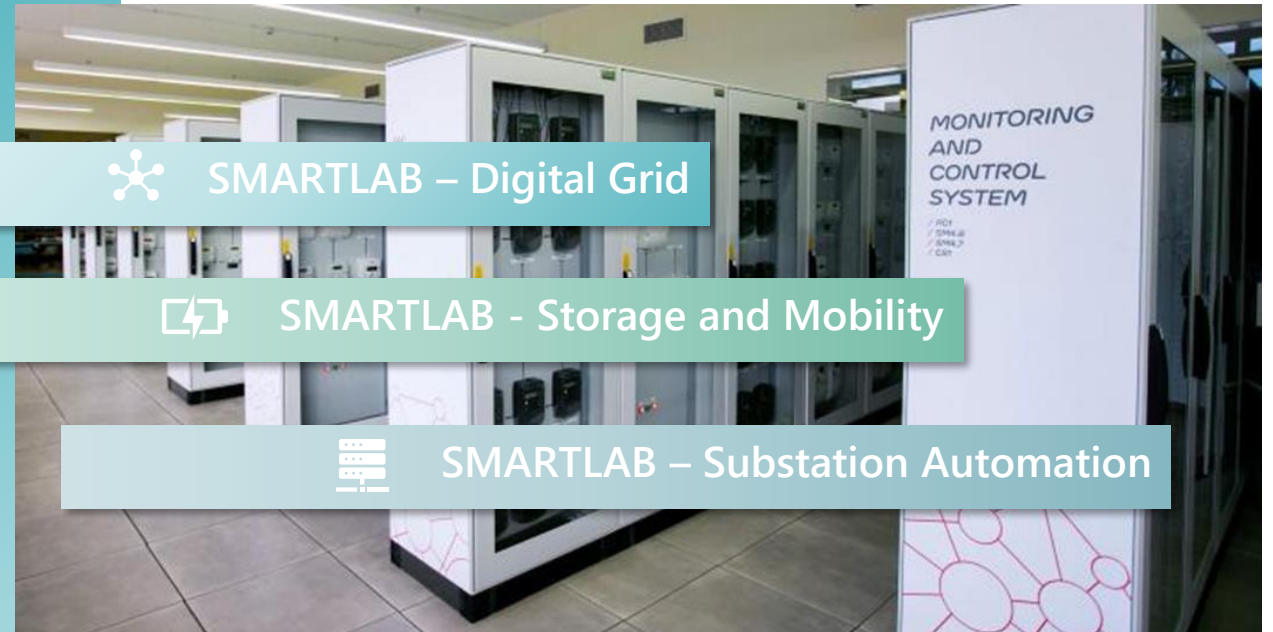
An umbilical connection with EDP Labelec enhances cutting-edge testing facilities for future energy systems

EDP Labelec

- > State-of-the-art testing & laboratory facilities covering electrical, chemical & environmental areas
- > Provision of laboratorial & consultancy services (e.g. grid studies, smart metering testing & validation)
- > New grid integration facility: SmartLab as a testing hub for technology demonstration & validation (e.g. microgrids, smart grid technologies, battery technologies, PV systems, EV charging)

Vision

Create multiple technology testing hubs for EDP in collaboration between EDP Labelec and EDP NEW



The world is facing unprecedented challenges

~10 Bn

world population in 2050
(+25% vs. today)

~50%

energy consumption
increase by 2050

+4 °C

temperature increase
in this century



Up to 1 Bn

environmental migrants
by 2050

Up to 2.5 m

sea level rise,
threatening >600 cities by 2100

**>7% GDP
per capita**

at stake in this century

... and needs to be transformed

We need a new decarbonized and electrified world...



... in which a new energy sector is required

~95%

renewables share in power generation in 2050

-100%

coal phase-out in global power by 2050

3x

global electricity demand growth by 2050

Zero-carbon

power sector by 2050



Clean



Affordable



Reliable

EDP is stepping up to the challenge with its ambitious “All green by 2030” strategy, just recently presented



Leading the energy transition
to create superior value

All green by 2030

By 2025

€24 Bn

CAPEX in energy transition

4 GW/yr

renewables deployed

Double

solar+wind installed capacity

Coal free

By 2030

>50 GW

renewables additions

100%

renewables generation

100%

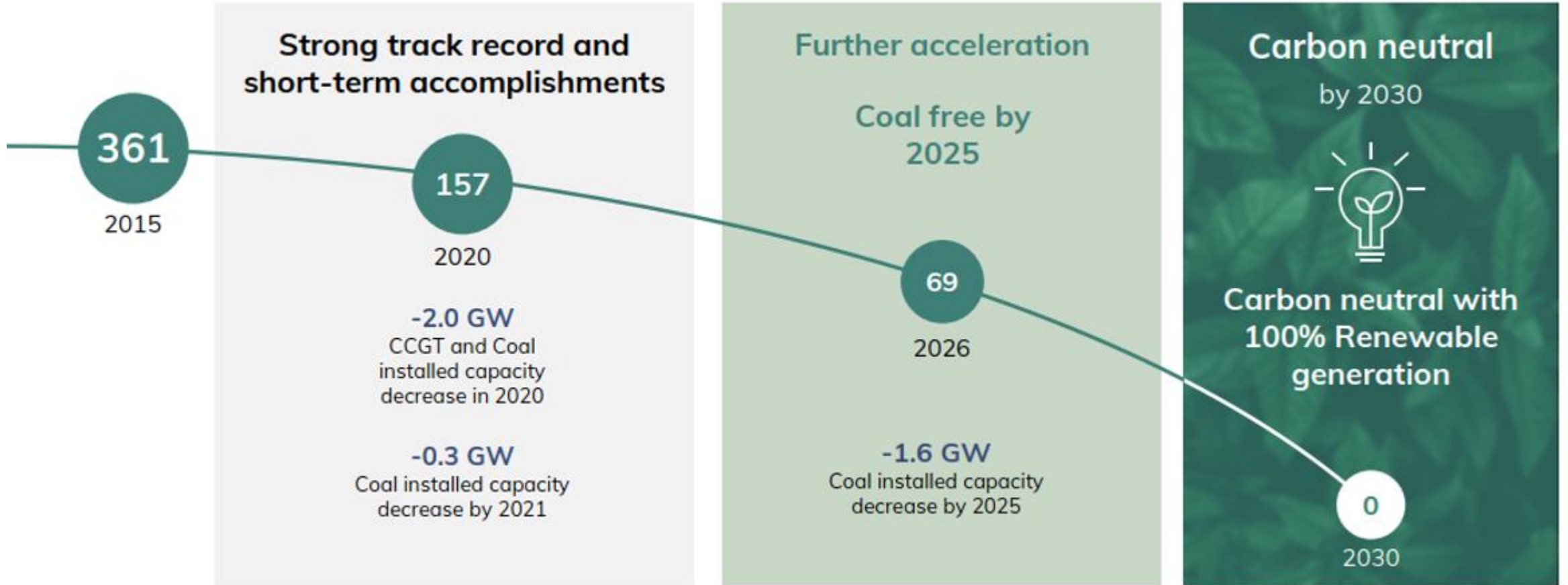
energy transition EBITDA

Carbon neutral

... on an accelerated path towards becoming carbon neutral

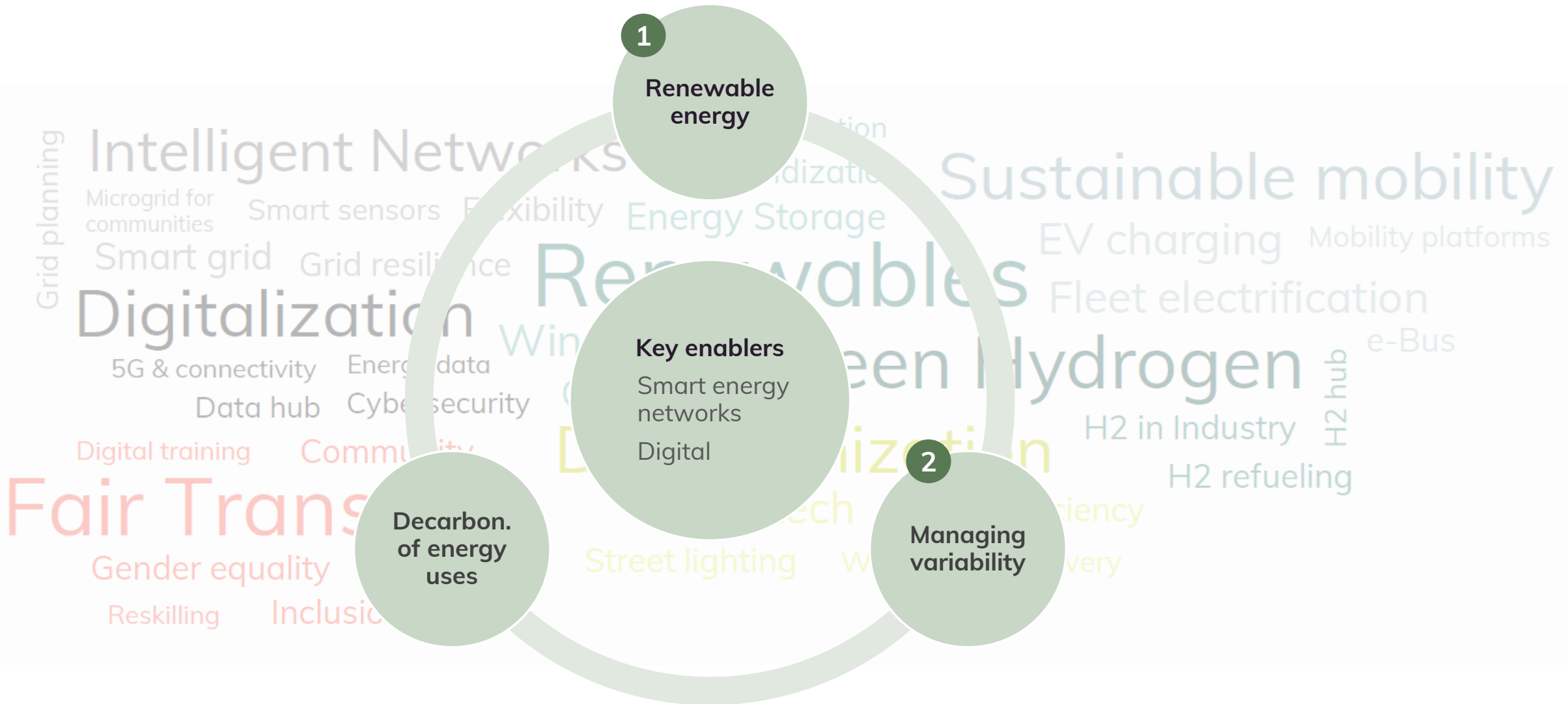
In 2005, share of Renewables in generation was 20%... Today >70%

Specific CO₂ emissions (gCO₂/kWh¹)



1. Scope 1 and 2

There is no silver bullet, but there is a growing consensus on the key energy innovation drivers towards a sustainable energy transition

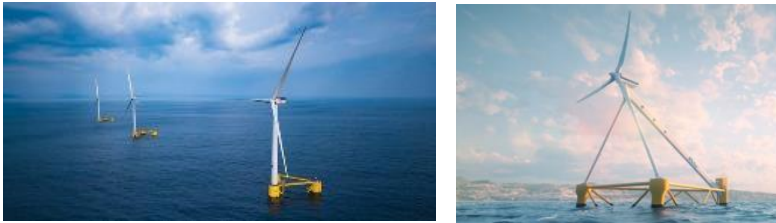


1

Beyond “conventional” wind and PV technologies there is a myriad of new avenues being explored: core R&D focus on emerging generation, advanced O&M, hybridization

RES Generation solutions

(Floating) Offshore Wind



Floating PV concepts

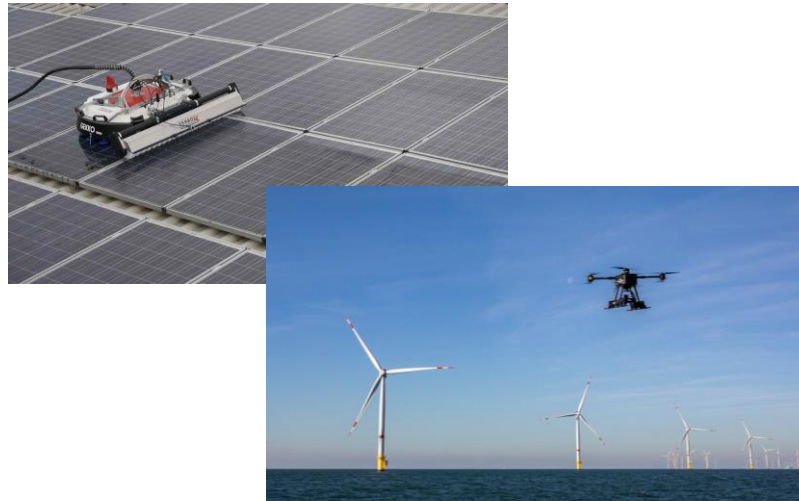


Innov. PV generation, enhanced / cheaper BIPV, CSP

Ocean (wave, tidal, OTEC) energy (?)

Advanced O&M and support tools

Robotized and autonomous maintenance and Inspections for on/offshore wind & PV, reducing OPEX, Increasing the safety



Digital data-based tools for better RES asset management (e.g digital twins towards advanced predictive Maintenance, enhanced performance of PV / wind, etc.)

RES Hybridization and Green H2

Hybrid RE power plants (floating offshore wind + ocean energy, e.g.) with advanced energy management systems



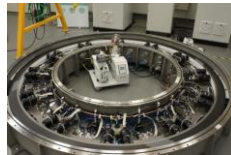
Renewable Hydrogen as feedstock and e-fuels
Hybrid electricity and heating solutions

2 To cope with the variability of renewable energy an integrated approach between technology, AI powered forecasting and new market mechanisms should be pursued

Storage

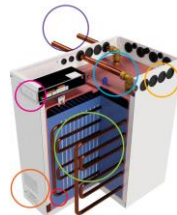
Electrochemical

- Li-ion batteries
- Flywheels
- Still new technologies emerging with lower costs and higher energy densities (e.g. NiZn)



Heat

- Higher efficiency and more flexibility for sanitary and heating hot water needs



Demand response

Gamification

- Client provides flexibility based on:
 - Price signals
 - Efficiency tips
 - Tokens



Automated

- Artificial intelligence capable of recognizing patterns and optimize clients' assets

Forecasting

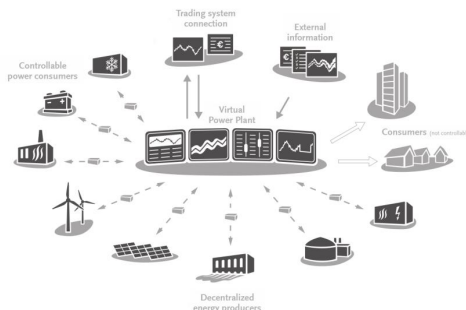
Renewable generation

	Centralized	Decentralized
Short-term	Improved network management and system balancing	Advantages for electricity market trading
Long-term	Reserve planning and operation management	Efficient placement of renewables

Demand

- Allowing for an optimal management of the system and understanding clients' needs

Virtual Power Plant



- Cloud-based power plant capable of aggregating different distributed energy resources
- Optimization module capable of potentiate each individual resource

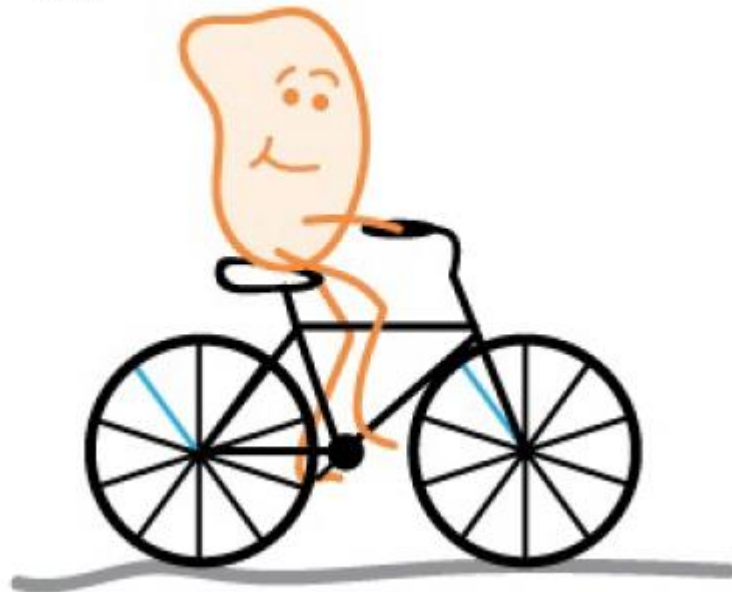
2 Power Systems 101 – Supply must equal demand at all time... or else...

Supply = Demand => 50 Hz

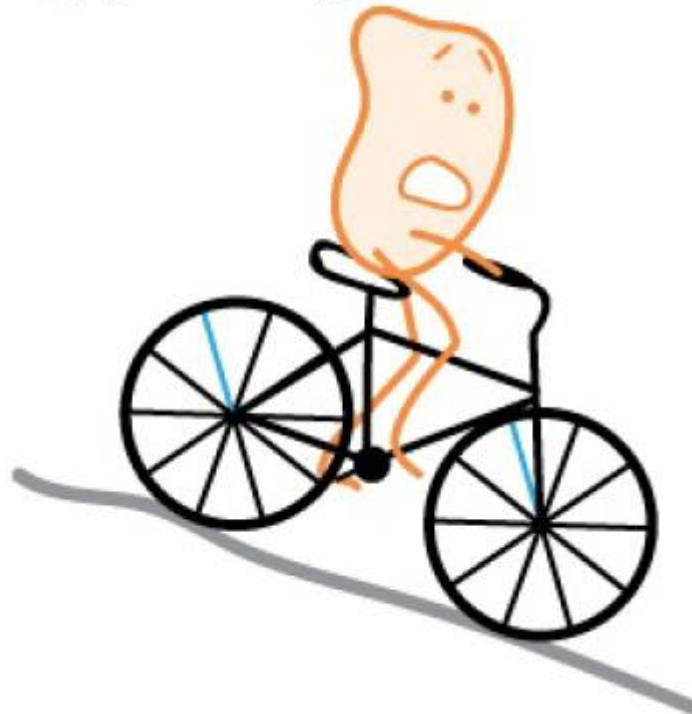
Supply > Demand => Freq. rise

Supply < Demand => Freq. drop

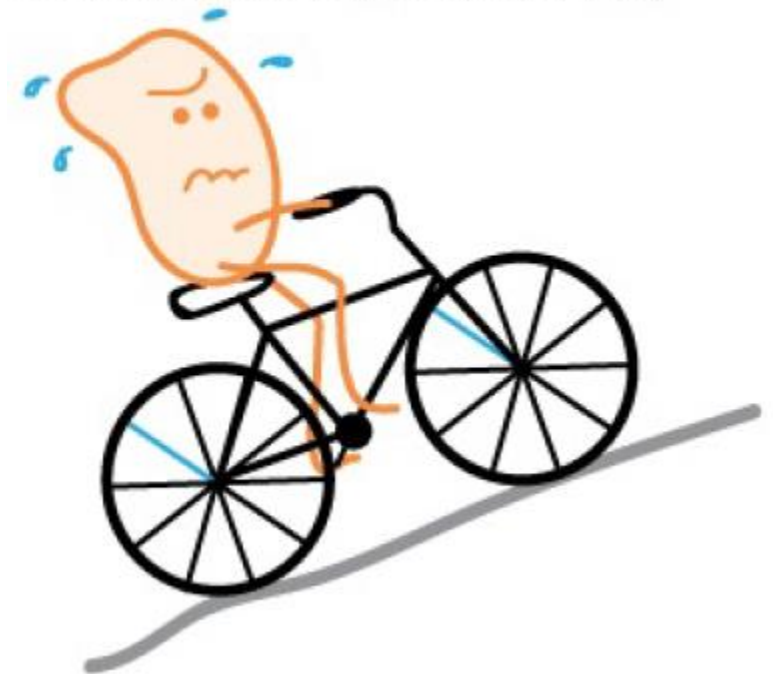
Supply and demand are balanced



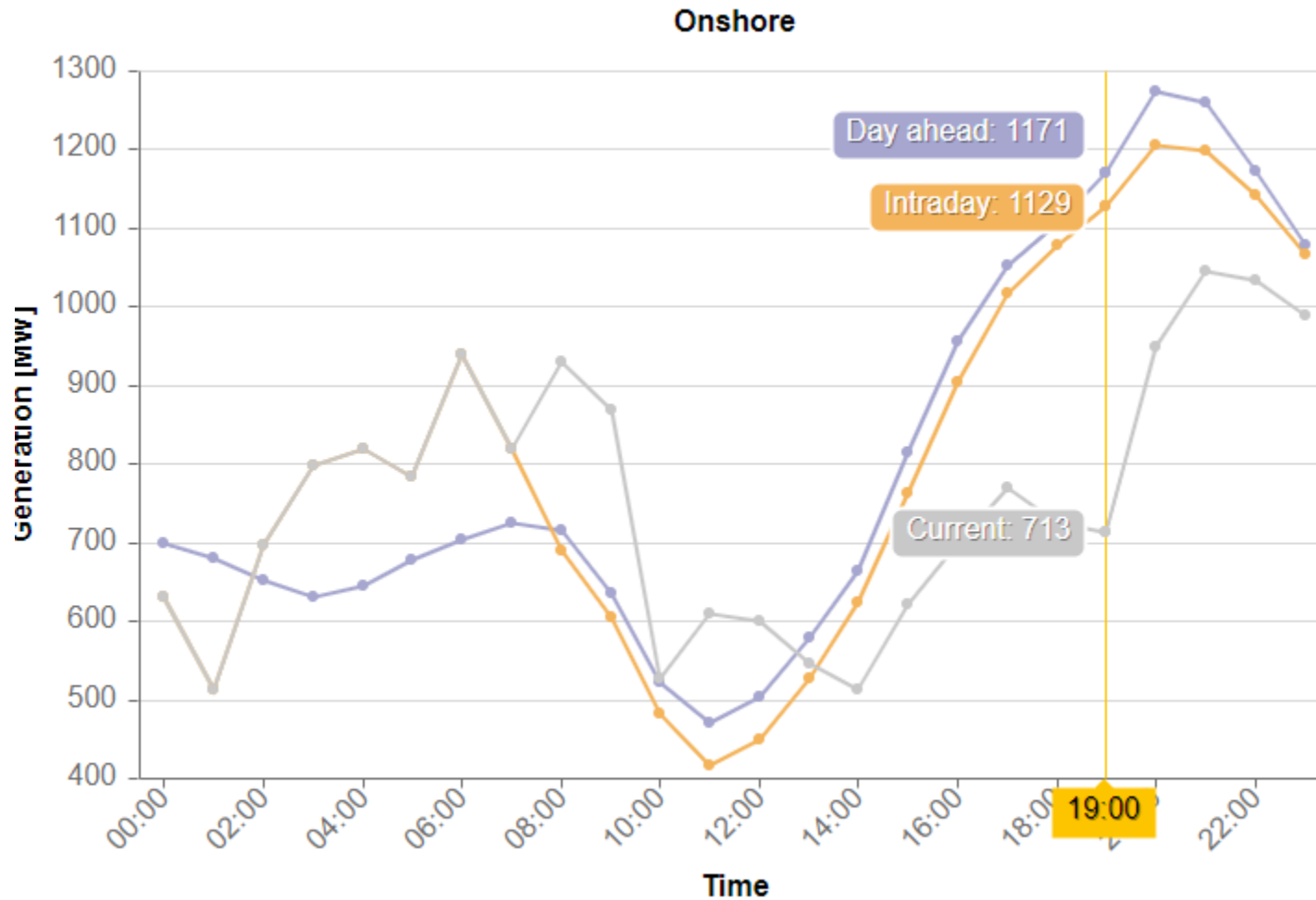
Supply is a lot bigger than demand



Demand is a lot bigger than supply



2 **Renewably energy generation is variable across time... Just a random day (1/10/2021) in Portugal... difficult to match estimates with real life**



2 A systemic approach is envisaged, managing different green generation technologies / sources and diverse flexibility resources

We're old and we might take some time to respond to orders, so we're cheaper!

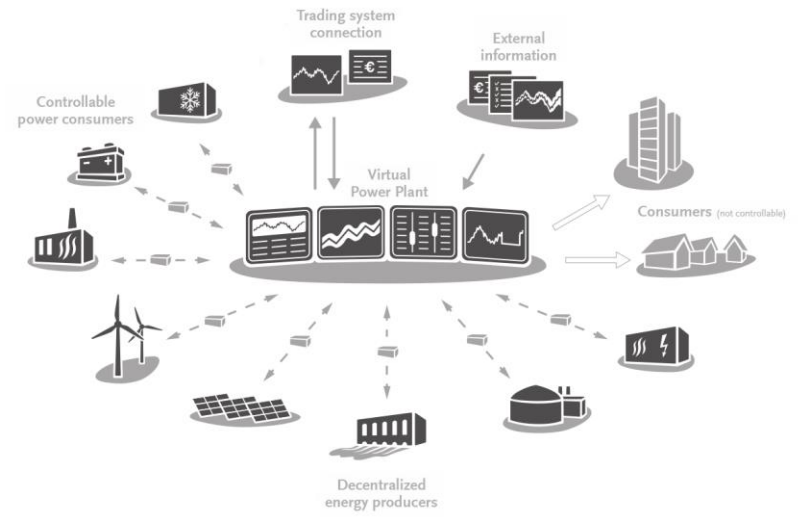


We're top performers! And that has a cost!

We're green, you don't need to pay us... BUT, we take no orders and we can stop at anytime!



Vs.



With several ongoing or recently secured projects in the areas of Renewables integration and flexibility

GreenH2Sines

Full-scale demonstration of green hydrogen production

Development and demonstration of a first-of-a-kind 100 MW alkaline electrolyser powered by renewables plants to be installed in Sines, Portugal

Project Budget | 77 M€

Timeline | Nov21 – Oct27*

Consortium | 13 partners

Coordinated by EDP



AI4PV

Artificial Intelligence in PV plants

Increasing the performance and optimizing O&M actions in PV plants using Artificial Intelligence tools to build digital twins

Project Budget | 1 M€

Timeline | Jul21 – Jun23*

Consortium | 4 partners

Coordinated by EDP NEW,
Demos in EDPR's plant in Portugal



EU-SCORES

Hybrid offshore renewables farms

Demonstration of multi-source parks across different European sea basins including Wind, floating PV, ocean energy and H2

Project Budget | 46 M€

Timeline | Sep21 - Aug25*

Demo in Portugal with WFA

Consortium | 17 partners



IANOS

Decarbonization of geographical Islands

Demonstrate solutions to increase islands' overall energy and resource efficiency. Demos in Terceira (Azores) and Ameland (NL)

Budget | 7M€

Timeline | Oct 20 – Sep 24

Consortium | 34 partners

Coordinated by
EDP NEW



EU-SYSFLEX

Flexibility as an enabler for more Renewables

Develop and demonstrate the role of flexibility from different sources to enable higher levels of Renewables in the European power system. 2 demos in PT: FlexHub and Virtual Power Plant

Budget | 25M€

Timeline | Nov 17 – Feb 22

Consortium | 34 partners

EDP NEW leads
Portuguese Demos



EU-SysFlex is a good example of large R&D and Industry collaboration towards the implementation of a RES-driven Europe

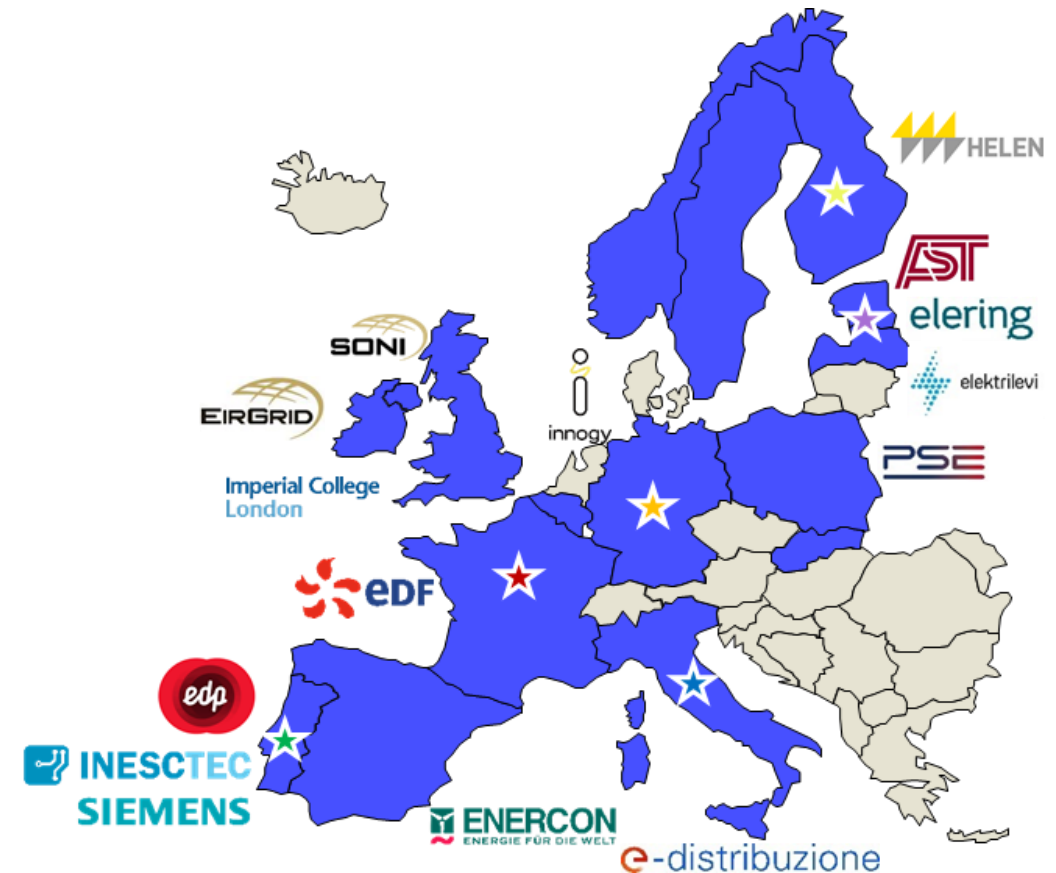


OBJECTIVES

- Enable **high share of variable RES (>50%)**
- Identify **scarcities and needs** – including system services and resources;
- Coordination of **flexibility resources**
- Develop a “**flexibility roadmap**”

KEY FACTS

- **34 partners** including TSOs, DSOs, Research, technology, including: **EDP (PT)**, EDF (FR), EirGrid (IE), Imperial College (UK), Siemens (DE), INESC TEC (PT)
- ENTSO-E, EDSO, Eurelectric, REN on the **Advisory Board**
- **6 Demos** (Portugal, Finland, Italy, Germany, France, Baltics)
- Project budget: **25 M€** - H2020 Financing of **~20M€**
- Implementation **2017-2022**

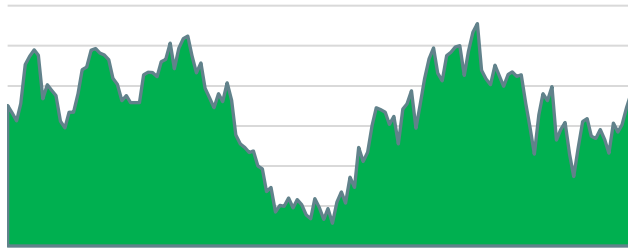


*The stars indicate the location of the 6 demos

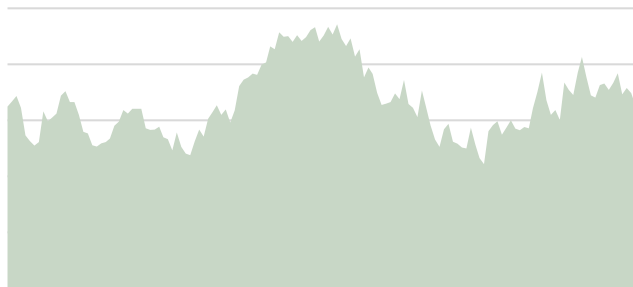
In the pursuit of the complementarity between variable and controllable generation lies important part of the RES integration challenge – the VPP

Combining different units' outputs...

...to act as one single unit



Intermittent



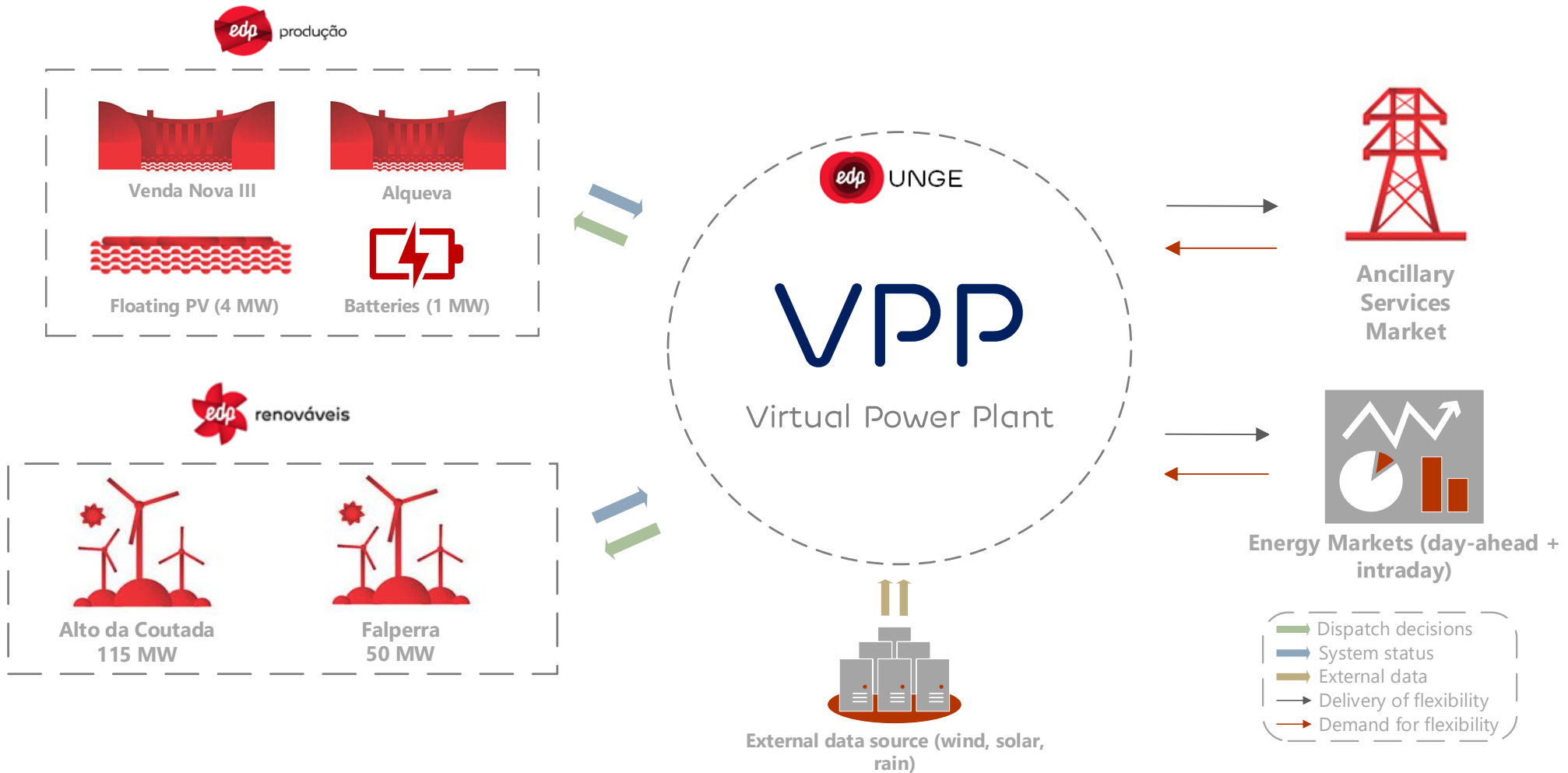
Controllable

+



“Self balanced” unit

Portuguese demonstrator designed and built a virtual power plant, integrating RES portfolio and optimizing wind / hydro generation



Final remarks

- Word and humanity are at risk. Immediate action is needed
- EDP is taking action, in a decarbonization path since 2005, but accelerating towards “All Green by 2030”
- Business as usual or incremental innovation will not solve the challenge
- There is no silver bullet but innovation, R&D namely in Renewable Energy and Managing RES Variability are key to achieve 2030 targets and beyond
- Integrated management of variable and controllable renewable energy generation is key to achieve the needed seamless RES integration
- R&D and INDUSTRY wide collaboration is paramount
- With a portfolio of 30+ R&D projects, some in partnership with U. Évora, EDP NEW is helping create possibilities to be a front runner in the Energy transition journey

joaogoncalo.maciel@edp.com

