EDP Leading the Energy Transition through Innovation

About us

11.6K
employees

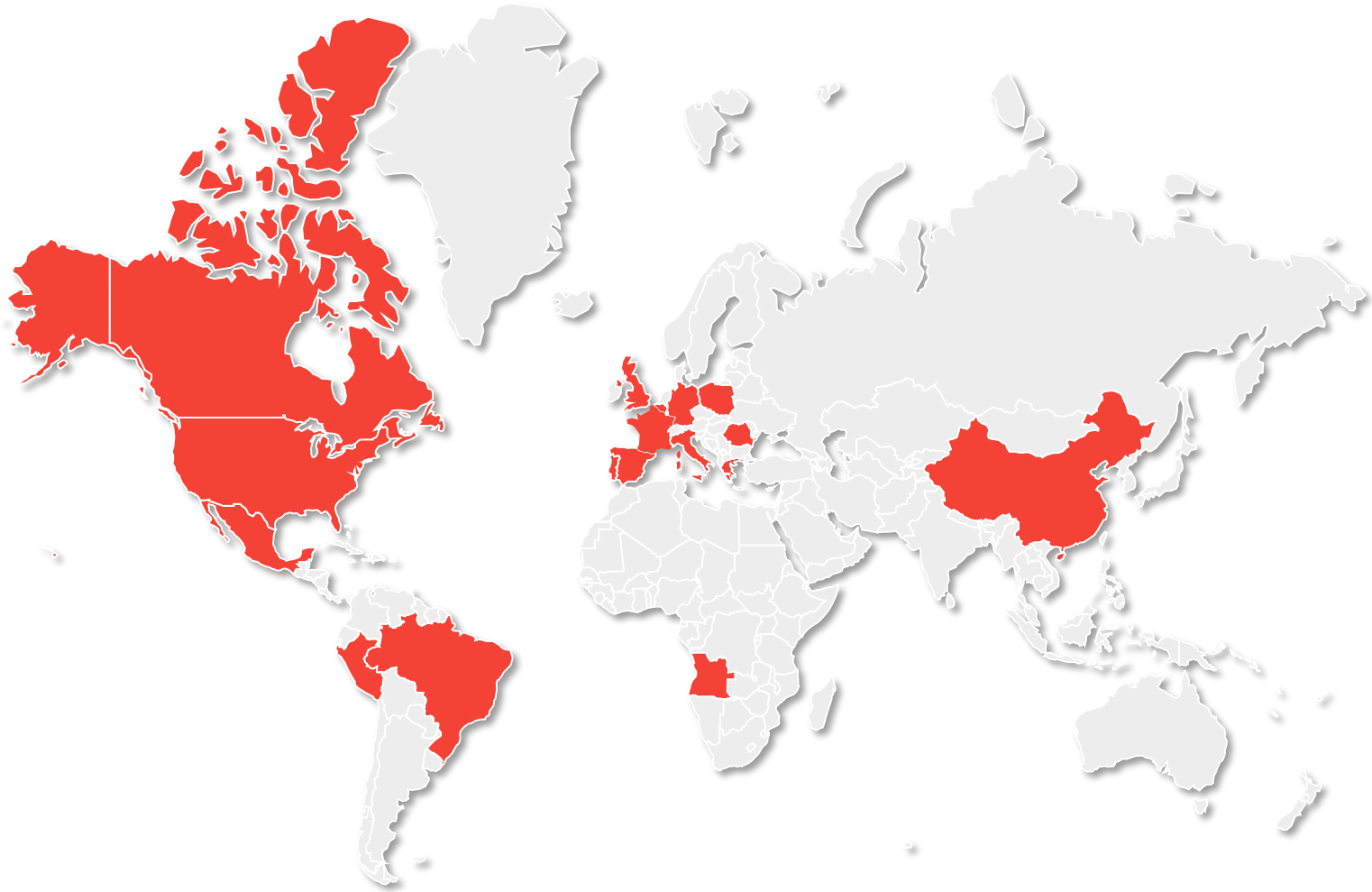
19
countries

27GW
capacity installed

72TWh
electricity produced

11.6M
clients

4th
world wind player

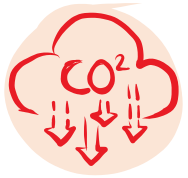


Leading the energy transition to create superior value

EDP 2030 Vision

- Decarbonization
- Digitalization
- Decentralization

>90% renewables generation

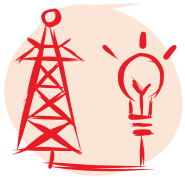


Reduce 90% specific emissions (vs 2005 levels)

Become coal-free

>4 Mn decentralized solar PV panels installed

>1 Mn clients with e-mobility solutions

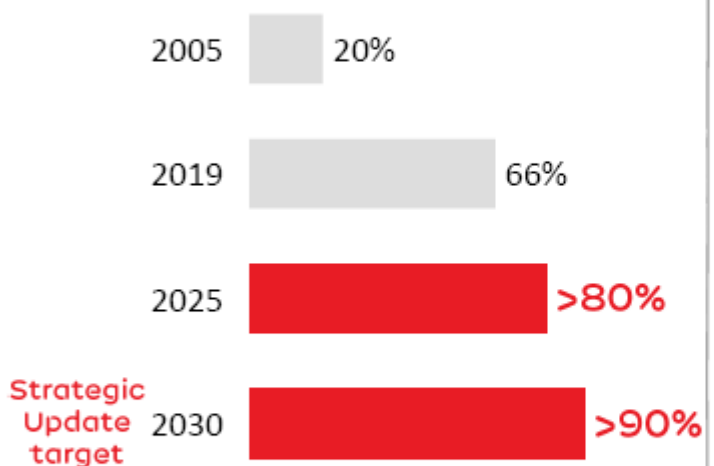


100% smart grids (in Iberia)

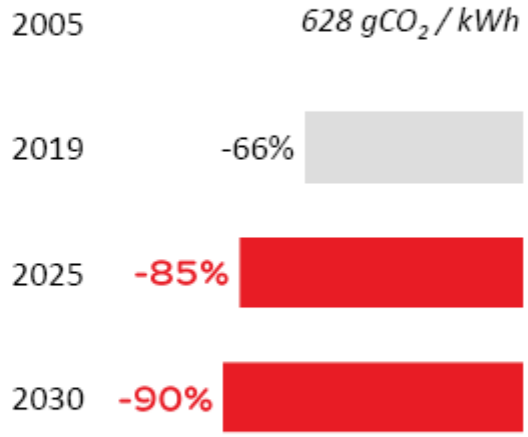
Green positioning

Our Decarbonization Commitments

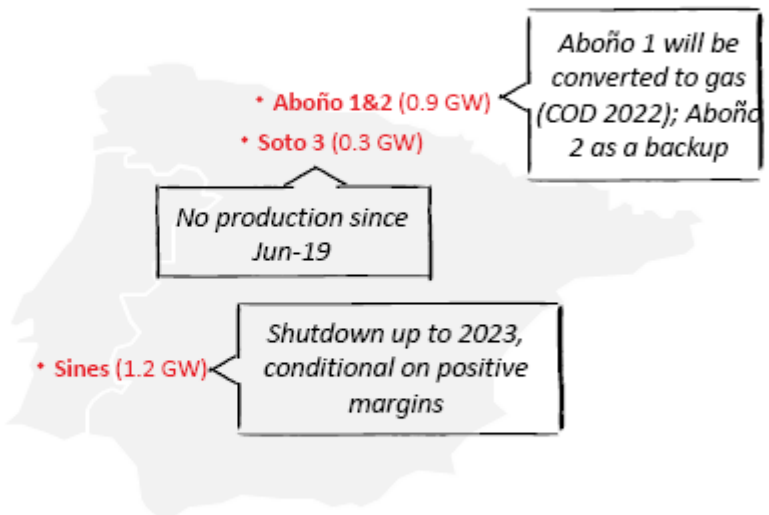
% renewables generation



Specific emissions (vs 2005 levels)



Become coal-free before 2030



2019 Performance**: Penalized by **weak hydro resources in Portugal

Coal production in Iberia 2019: -49% YoY

2050: Net zero emissions commitment

BUSINESS AMBITION FOR 1.5°C | OUR ONLY FUTURE

EDP Innovation

INNOVATION WORK GROUPS PROJECTS 2019

About edp innovation

Tech groups

Cleaner Energy

Smarter Grids

Client focus solutions

Energy Storage and Flexibility

Data Leap

Innovation Tools

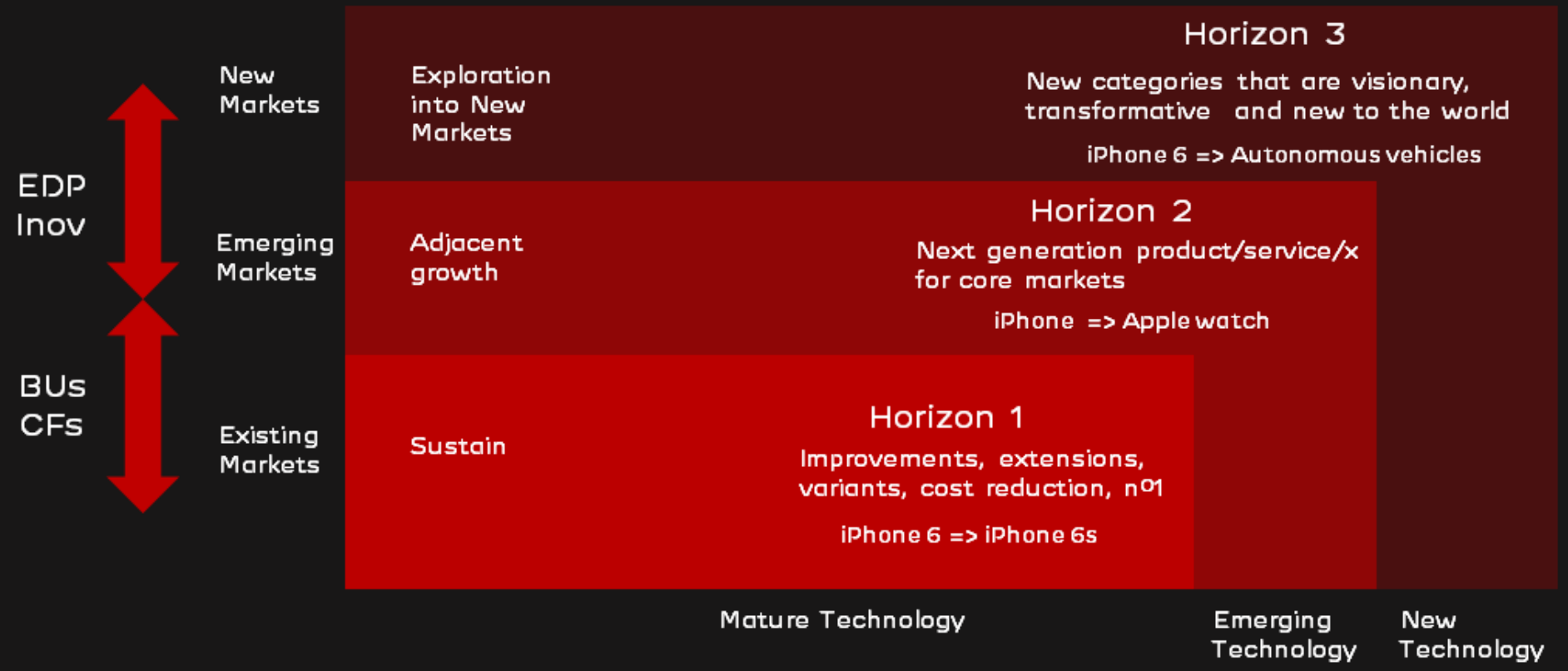
EDP Ventures

Startup Engagement

Business Transformation

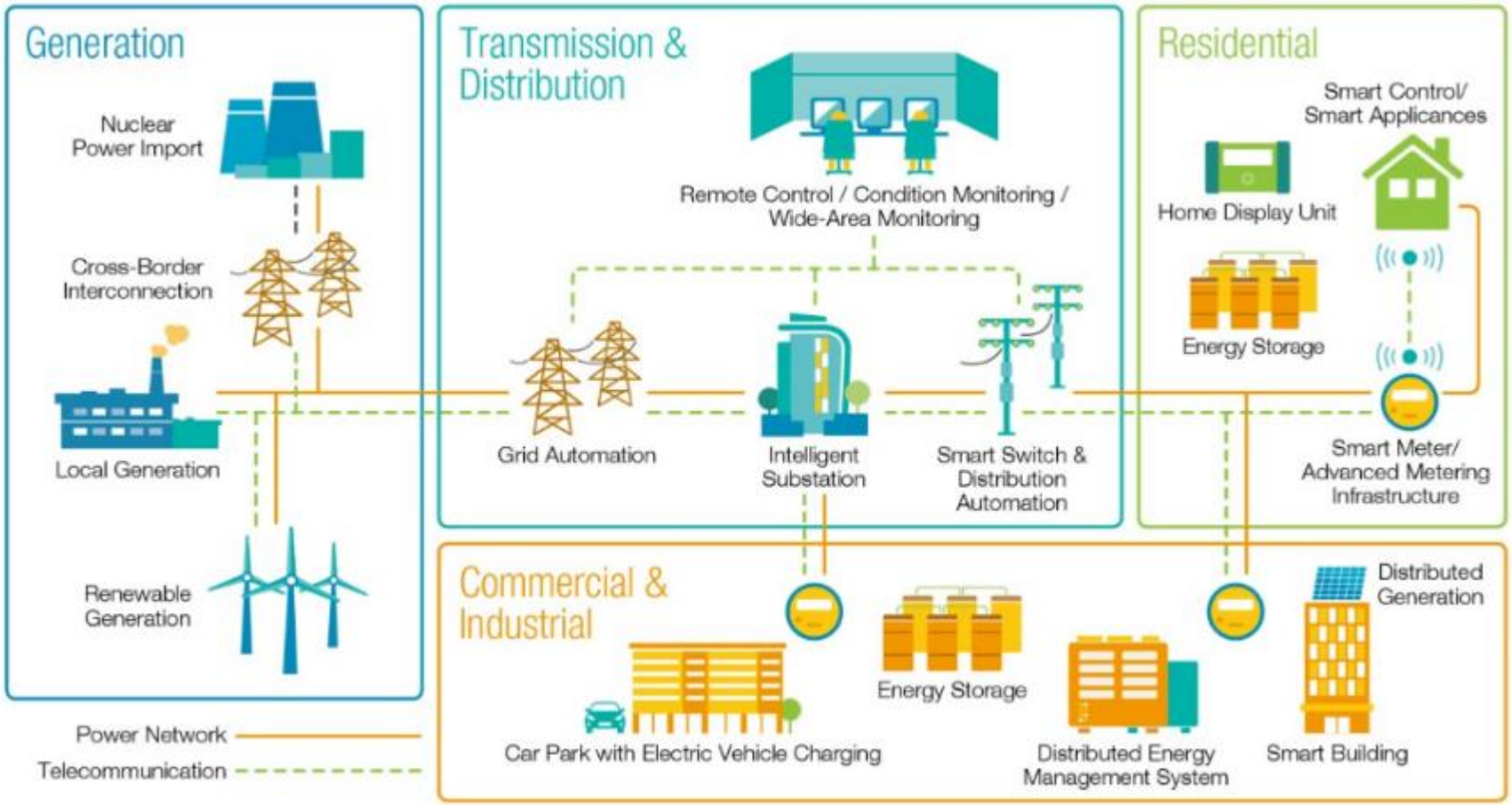
Different Time Frames.

Different Focus



The power sector is changing at a swift pace…

… We need to anticipate the trends



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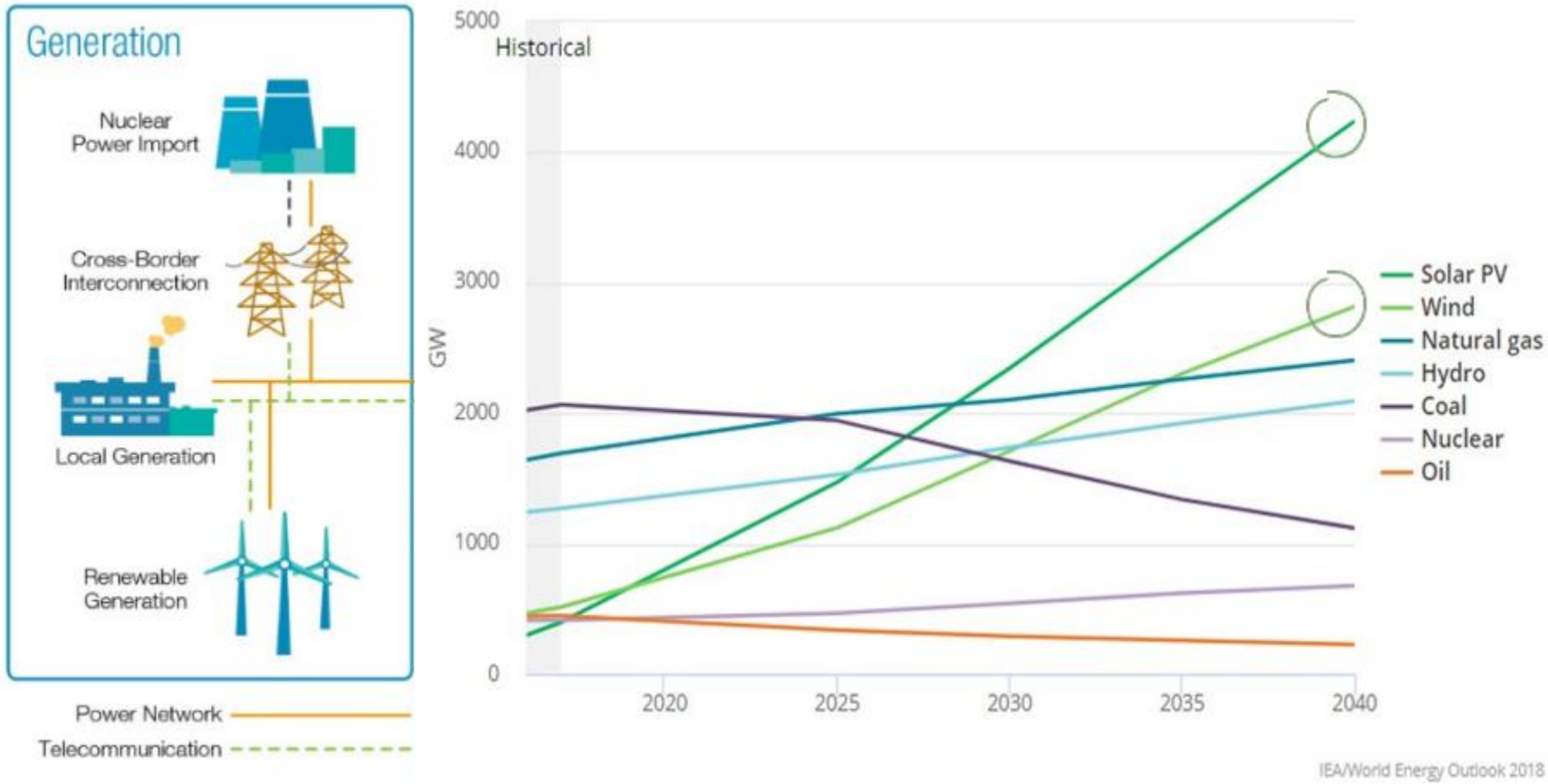
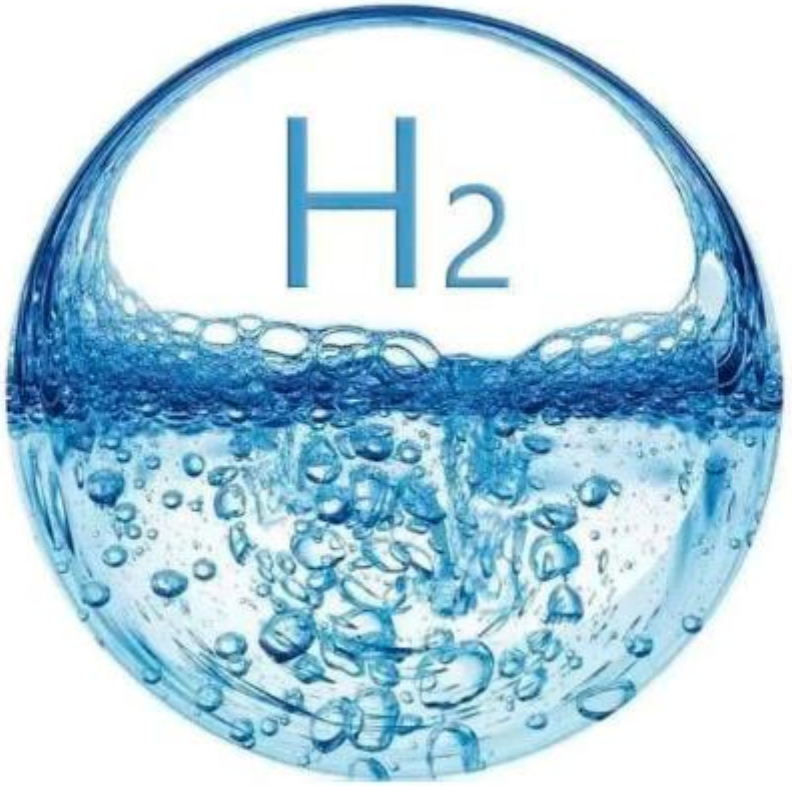


Renewable Energy sources will increase significantly in the next decades leading to excess of energy in certain periods of time

Renewable Energy is driving a new energy vector!



There are some obstacles to worldwide electrification that can lead to the development of a hydrogen economy

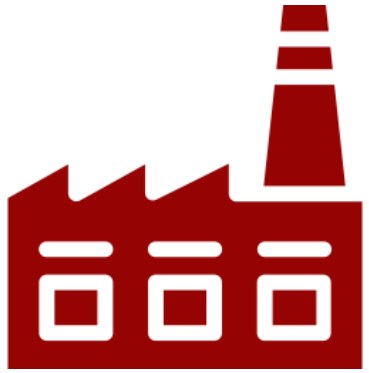
Share of fossil fuel usage

AVIATION

100%

SHIPPING

100%



INDUSTRY

> 75%

Hydrogen produced today has origin in carbon intensive sources. As a decarbonization vector, Blue and Green H2 technologies have to reach maturity

Production of H_2 today

Black/Grey hydrogen

Uses fossil fuels to produce hydrogen using thermochemical processes:

- Coal or biomass gasification
- Steam methane reforming (SMR)

Blue hydrogen (low carbon H_2)

Produced using the same energy source and process as grey hydrogen but adding CCS[(1)] to reduce emissions.

- *CO_2 reduction can reach up to 90%*
- *CCS remains to be fully proven and can add a significant cost to the process*
- *Value chain for CO_2 need to be developed*

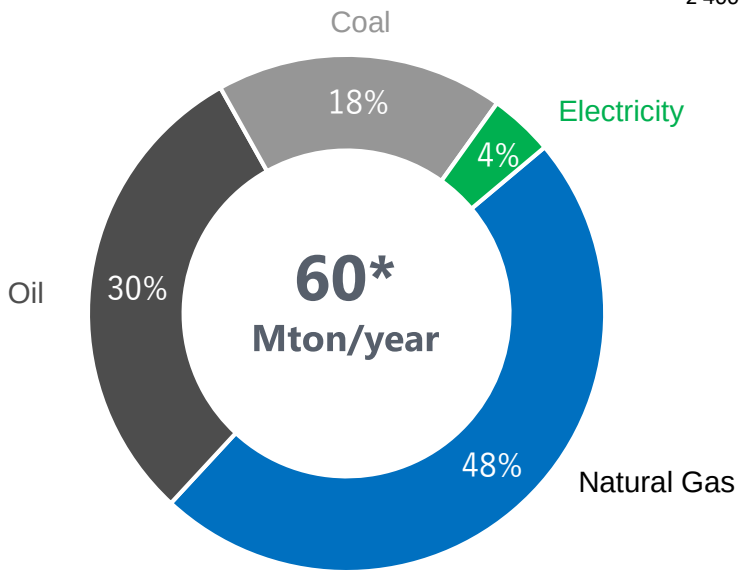
Green hydrogen (zero carbon H_2)

Electrical energy is used to dissociate water into hydrogen and oxygen through electrolysis process.

- **Alkaline electrolysis (AEC)**
- **Proton exchange membrane electrolysis (PEM)** – *Preferred for RES coupling due to dynamic response time and wider load ranges*
- **Solid Oxide Electrolysis (SOEC)**

Share of energy sources used globally to produce hydrogen [2018, %]

*2 400 TWh

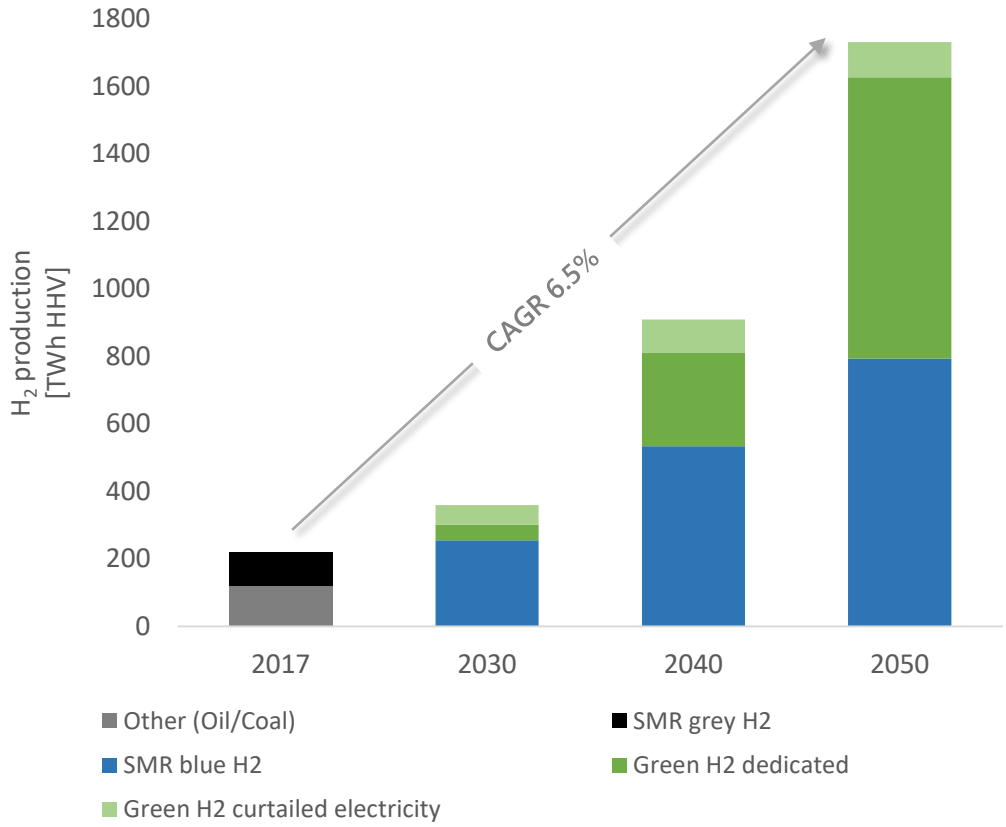


(1) CCS: Carbon Capture and Storage

Source: NREL, Shell, Hydrogen Council, IRENA, H21 North of England, National Hydrogen Roadmap Australia

Hydrogen supply is expected to reach ~1 800 TWh_{HHV} by 2050. Electrolysers capacity is expected to reach 300 GW mostly located in Northwest Europe

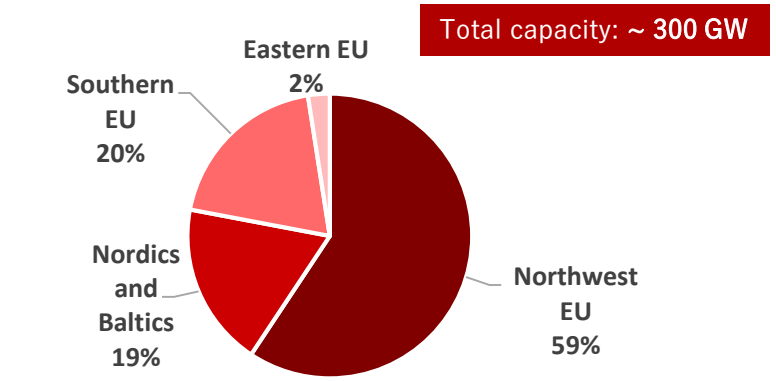
Hydrogen supply per technology
Europe: 2017-2050



Hydrogen Supply

- Currently in Europe, more than 200 TWh_{HHV} of grey H_2 is produced, increasing to ~1800 TWh_{HHV} in 2050.
- In the next decade, grey H_2 is expected to be converted to blue. As we move **towards 2050, green H_2 will assume a greater generation share** (>50%).
- **Dedicated green H_2 will reach 250 GW**, mostly using **offshore wind**. Production of green H_2 from curtailed electricity is limited.
- **59% of green H_2** will be produced in **Northwest EU** and 20% in Southern EU.

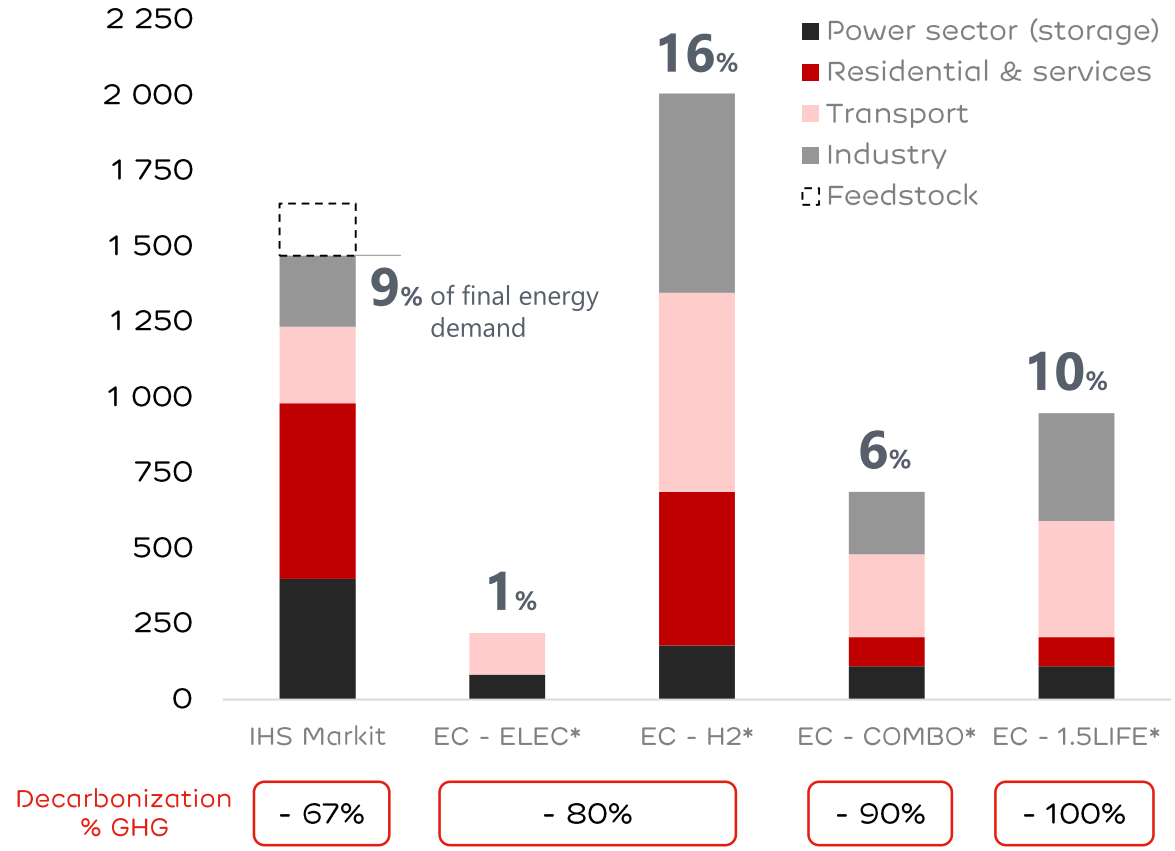
Electrolyzers capacity per geography by 2050



Source: IHS Markit, Hydrogen: The missing piece of the zero-carbon puzzle

Hydrogen will be a fundamental piece to achieve carbon neutrality and can account up to 16% of final energy demand in 2050

Consumption of hydrogen by sector and H2 percentage of final energy demand in EU 2050 [TWh, %]



ELEC – Electrification in all sectors
H2 – Hydrogen in industry, transport and buildings
COMBO – Cost-efficient combination of options
1.5LIFE – Based on COMBO, with lifestyle changes and increased resource and material efficiency
*These scenarios do not include feedstock
Source: EC – A Clean Planet for All, IHS Markit

- Hydrogen plays an increasingly important role with the growing ambition of decarbonizing the economy
- **Hydrogen deployment is intrinsically related to the strategy adopted** to achieve the decarbonization targets

  IHS Markit low decarbonization through H_2 is justified by a high share of oil fuels for transportation sector, specifically for aviation and marine demand

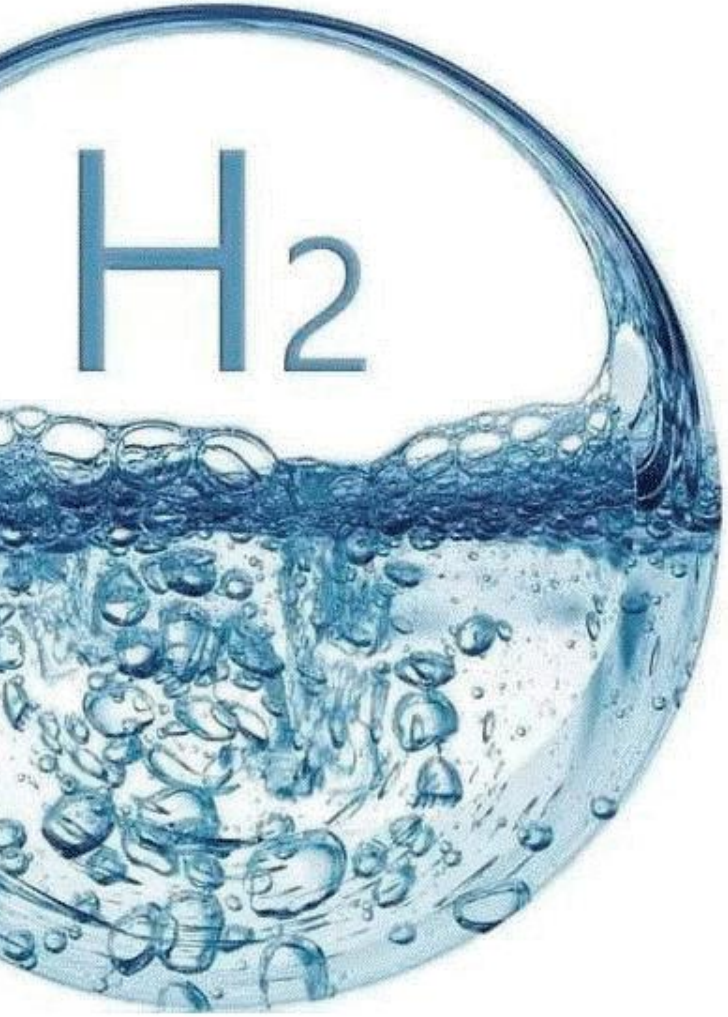
- Heating is pointed as the first sector to be converted to H_2 through blending with natural gas

Exploring

New Business Opportunities

16%

H2 in final energy demand. Europe, 2050



Rationale

- **Decarbonisation puzzle piece** | Address hard-to-decarbonise downstream sectors
- **Empowering renewables** | Handle renewables' intermittency and stabilize renewables' revenue
- **Storage and flexibility** | Can serve as an energy buffer and a strategic energy reserve

EDP Action Plan

Power-to-hydrogen in CCGT

Test the power-to-H2-to-power concept to enhance CCGT's flexibility

Offshore hydrogen-wind coupling

Study a solution to produce hydrogen from offshore wind

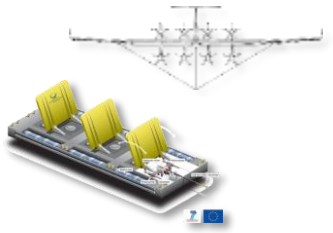
Hydrogen exporting hub and industrial cluster

Promote a national hydrogen industry and export renewable energy

Innovation is not a lone affair. Open to new ideas.

Promoting a Portfolio

Diversified and Efficient



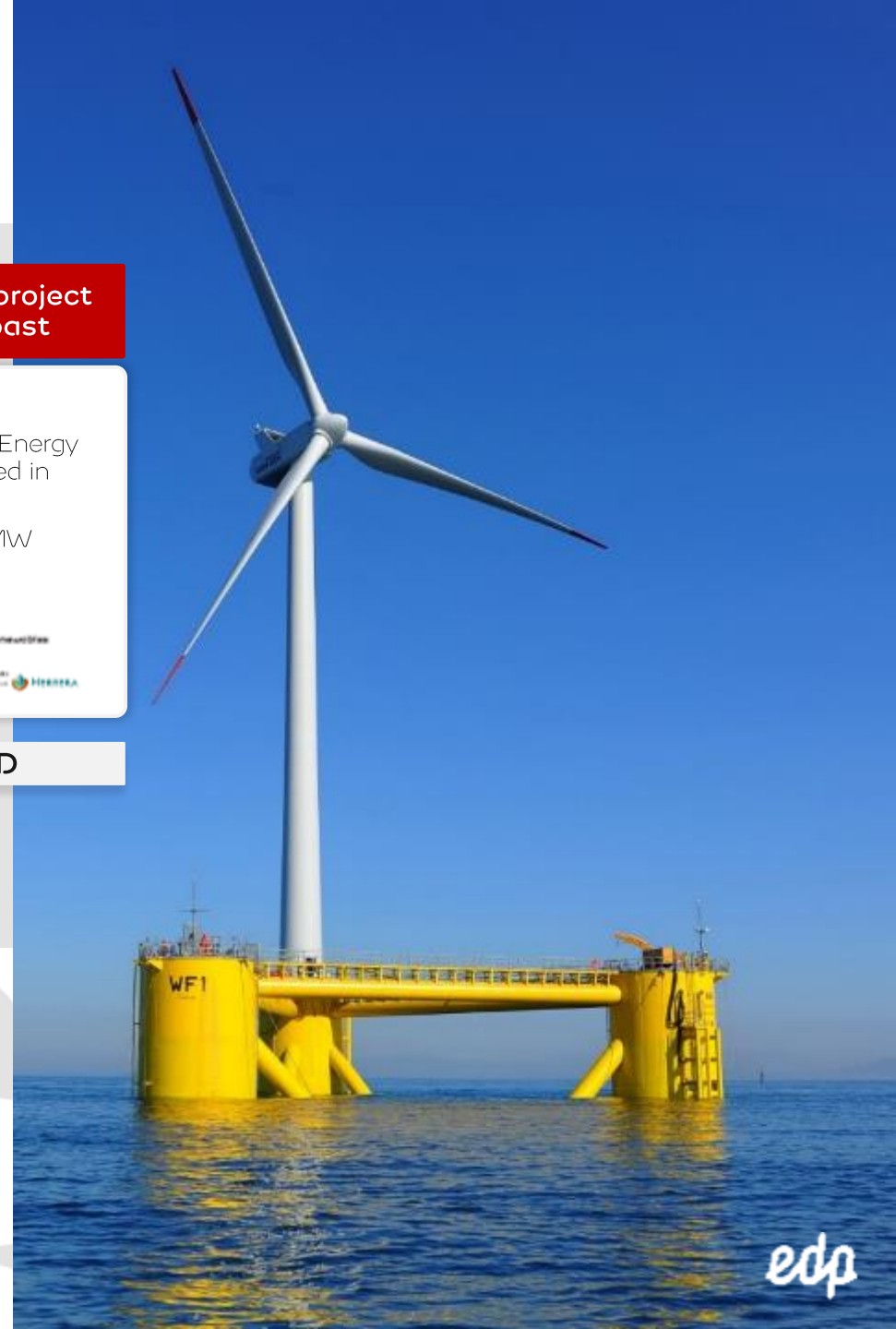
Early stage — Mature

Wave Energy/ HAWE[1]/ Other energies	New Solar Technologies	Offshore wind	Onshore wind/Solar PV Conventional generation
EDP'S APPROACH			
• Proof-of-concept	• Validate technology • Identify and quantify benefits	• Technology to reach commercial stage • Address specific supply chain issues	• Reduce LCOE • Improve data and asset management strategies

Promoting a Portfolio

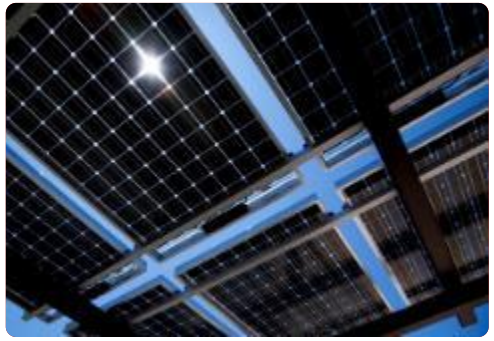
Diversified and Efficient

WindFloat 1	WindFloat Atlantic	Les éoliennes flottantes du golfe du Lion	Wind offshore project Redwood Coast
• WF1, with a 2 MW wind turbine, completed 5 years of high-availability operation. • The prototype was successfully decommissioned in July 2016, completing a succeeded proof of concept	• Precommercial floating wind park • 25MW (3 x 8.4MW) • Location: Viana do Castelo • Bankability demonstration	• Pre-commercial project awarded by the French Government • 30MW (3 x 10MW) • Location: Leucate, Mediterranean	• Public-private partnership with Redwood Coast Energy Authority awarded in March 2018 • 150MW with 8+MW turbines
2011 - 2016	2019 COD	2020-21 COD	2024 COD



Innovation

Knowledge-Driven

Solar PV – SunLab I/II	Floating Solar PV	Solar CPV – CPVLab	Solar Glass-Glass and Bifacial
Project focused in ***increasing the knowledge about solar PV panels*** but ***also its O&M*** (including soiling, degradation and longstanding shadowing) and its impact in the business case of solar farms	EDPP is **testing a Floating PV** plant, with potential for places where the available land is scarce, sharing costs of grid connection and potential for increased efficiency.	Test ***concentrated solar PV technologies*** with potential in the medium term to **acquire knowledge on *performance and O&M*** of this technology.	***Test and demonstrate new PV solar technologies*** that can improve efficiency of solar plants and change radically the business model.
			
O&M	New Technology		