

The H2 logo is centered within a white hexagonal outline. The 'H' and '2' are in a large, white, sans-serif font. The background of the slide features a green and white grid of binary code (0s and 1s) and a faint image of a globe.

Engineering Center of Competences for Green Hydrogen

GESEL: Webinar Internacional “Tecnologia e Centros de Excelência de Hidrogênio em Portugal e Brasil” L –

12 janeiro 2022

Miguel Patena

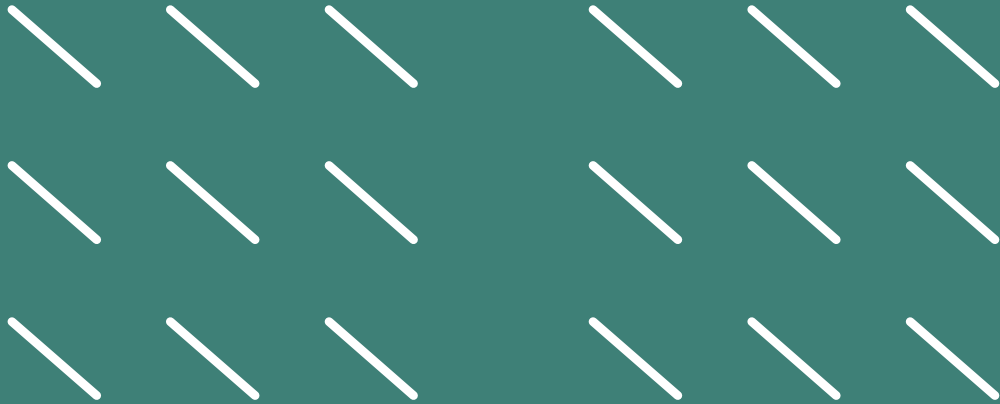
Head of H2 & Innovation
EDP Produção S.A.

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- 2 Full Engineering Partner
- 3 Global Service Provider

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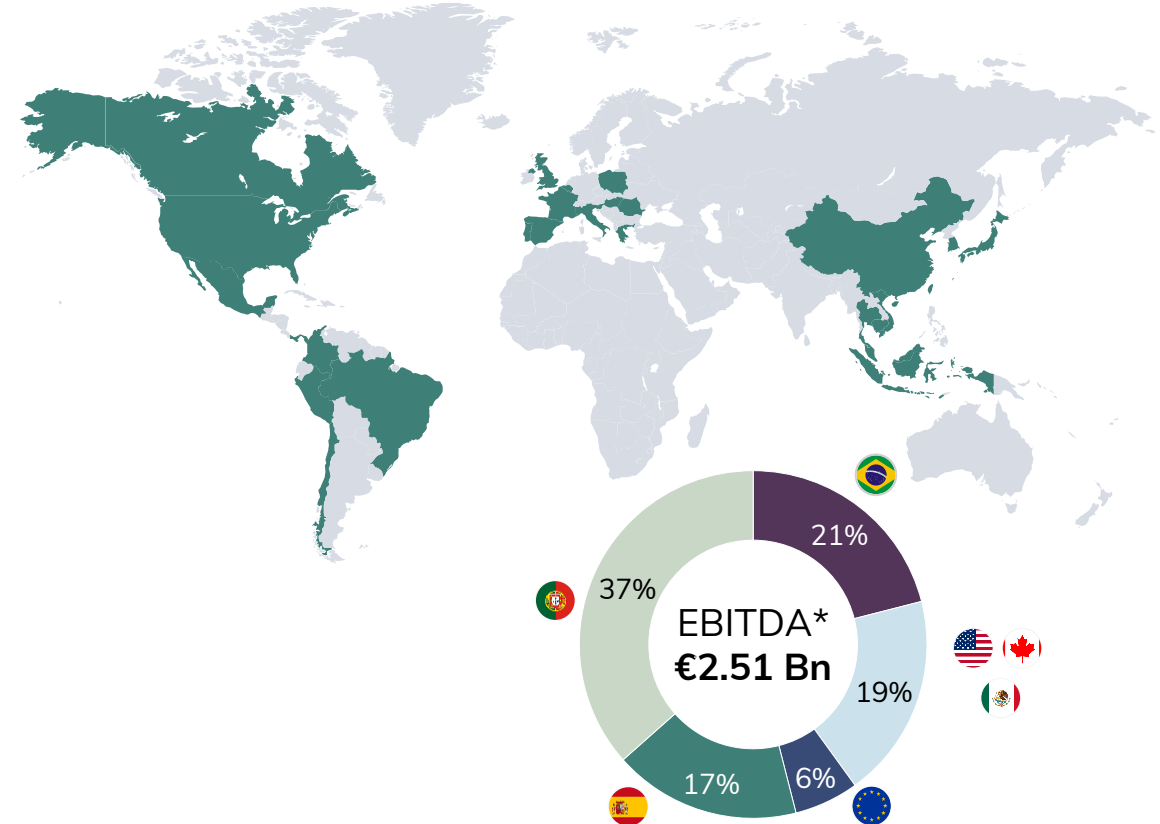
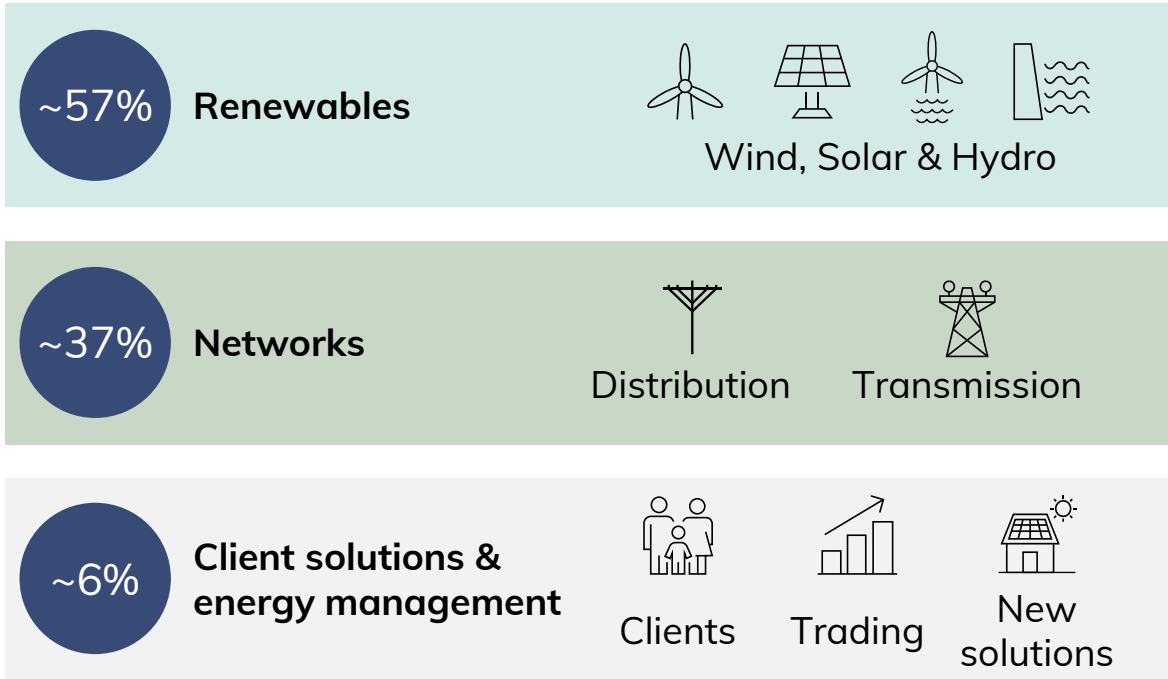
H2 in EDP



We are a global company, leader in the energy sector, present in 28 markets throughout different stages in the value chain



% Weight on EBITDA 9M21



Key indicators

*Values as of 9M 2021

Capacity installed

24.6 GW

EBITDA

€2.51 Bn

Net Profit

€0.5 Bn

Employees

12,232

Clients

9 Mn

EDP Brasil



Distribuição

- **03 Estados**
(SP, ES e SC)
- **24,4 TWh/ano**
2020 energia distribuída (SP+ES)
- **29,9%**
participação em ativo integrado (CELESC)
- **3,6MM**
de clientes (SP+ES)



Transmissão

- **8 Lotes**
- **1.924 Km**
- **512 Km**
em operação
- **1.412 Km**
em construção
- **Aquisição da Celg-T**
756 Km e 14 subestações



Geração

- **2,2GW**
Geração Hídrica 2020
- **0,72 GW**
Geração Térmica 2020
- **51,1MWp**
Capacidade instalada de Solar

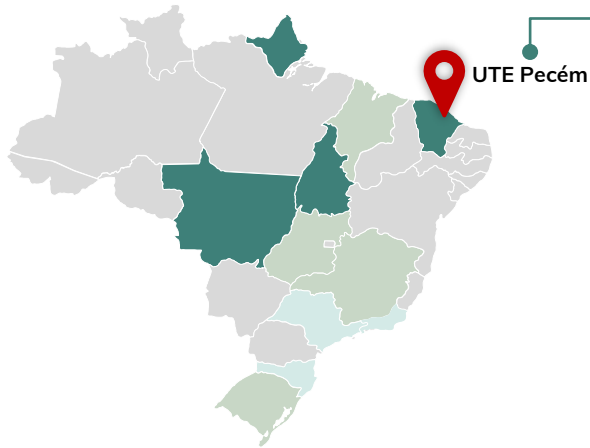
EDP Brasil

EDP Brasil

2,95 MW **Generation** Thermo, Hydro & Solar

3.6MM Clients **Distribution** State of São Paulo, Espírito Santo e Santa Catarina

2.483 km **Transmission** 1.500 km in operation
983,6 km under construction



Project data by unit – 2 X 360 MW

- ✓ Raw Water Consumption: 475 l/s
- ✓ Demineralized water consumption: 18 m3/h;
- ✓ Coal consumption (GCV: 6.000 Kcal/Kg): 135 ton/h;
- ✓ Steam characteristic : 1.200 ton/h @540 °C, 180 Bar;
- ✓ Condenser temperature: 42 °C @85mBar_g;
- ✓ Generating voltage: 19 kV;
- ✓ Transmission voltage : 230 kV;
- ✓ Emission parameter (according CONAMA N°382):
- ✓ SO2: 1.250 mg/Nm3;
- ✓ Particulate Matter: 500 mg/Nm3

Highligts

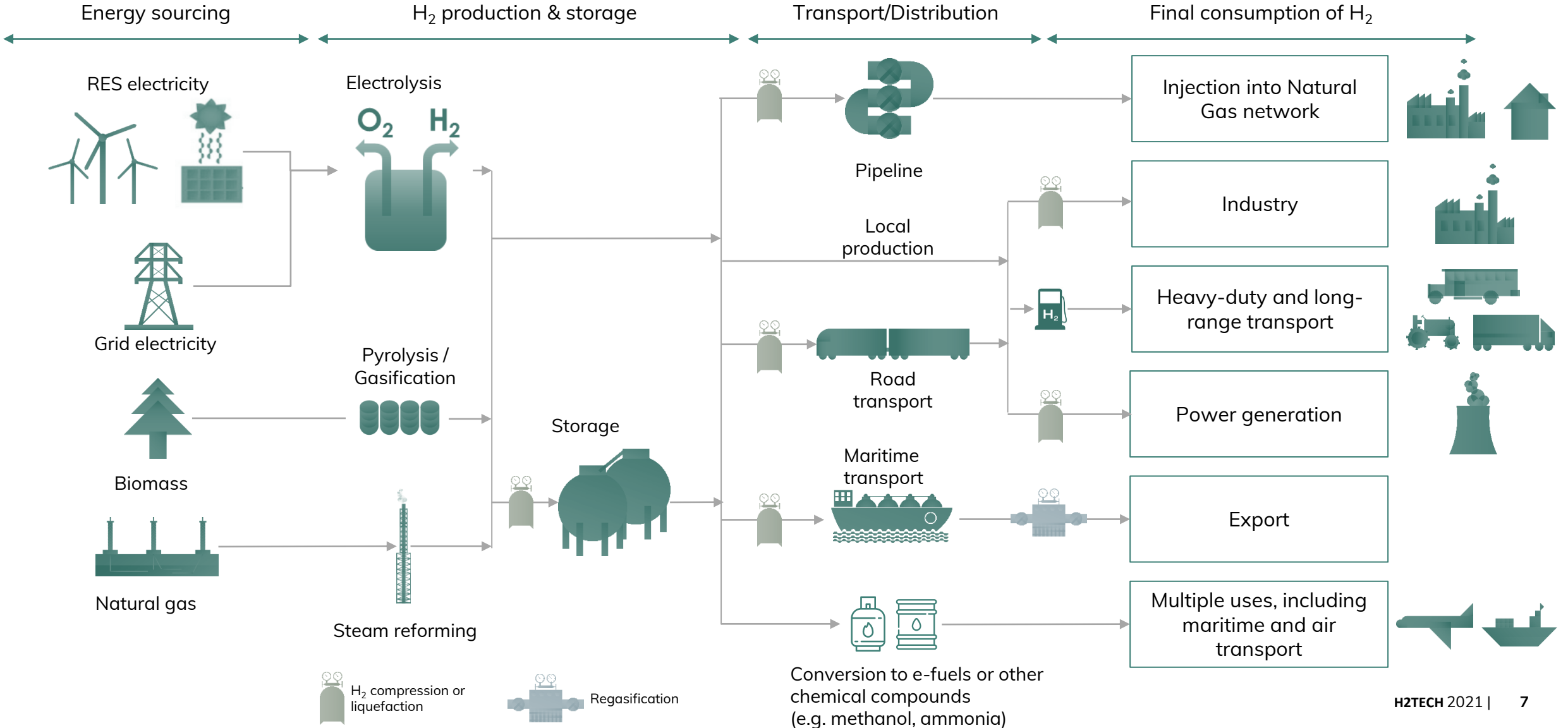
With over 20 years of experience, EDP is one of the largest private companies in the electricity sector operating throughout the value chain.

The Company, which has more than 10,000 direct and outsourced employees, has six hydroelectric and one thermoelectric generation units, in addition to operating in Transmission, Commercialization and Energy Services.

In 2020, it was elected the most innovative company in the electricity sector by the Valor Inovação ranking, by the Valor Econômico newspaper, and is a reference in Governance and Sustainability, having been included in the B3 Corporate Sustainability Index (ISE) for 15 consecutive years.

Pecém Coal Power Plant is located near the CE-085 highway at km 40.5, 13,2 km away from Porto Pecém

A complex value chain will be created to supply hydrogen to a variety of end-uses, including the potential transformation to other types of fuels



EDP has created a dedicated hydrogen business unit to ensure a consistent and integrated approach to the supply of renewable H₂

EDP Hydrogen Business

End-to-end approach on the development of hydrogen projects



Renewables

Cost effective RES deployment by leveraging on **EDPR's existing assets, pipeline and development teams**

Specialized and dedicated teams to design and **size renewables assets for hydrogen production**



Hydrogen

Technical knowledge center created to incorporate best in class EDP's engineering skills dedicated to hydrogen

Specialized and dedicated teams on designing **hydrogen production and supply systems from electrolysis**



Clients

Integrated view on clients' needs to decarbonize with cost-efficient solutions

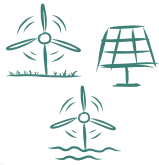
Renewable hydrogen complements existing decarbonization offerings, including energy efficiency, PPA, solar self-consumption and e-mobility

EDP can leverage on its capabilities and global presence to support the development of hydrogen projects and the creation of global market

Distinctive factors

Benefits for H₂ projects

Renewable generation



- Extensive track record in developing renewable projects, with experience in multiple RES technologies (onshore and offshore wind, and solar) with a global footprint

- Design cost competitive RES mix to maximize the load factor of electrolyzer
- Identification of potential RES locations

Conventional generation



- Over 40 years of experience in the construction and operation of hydro and thermal assets
- Excellence in engineering, with several projects within industrial clients and clusters

- Engineering skills to support the integration of H₂ in complex industrial processes
- Use of existing assets offers cost reductions

Retail and business models



- Vast client base, with multiple offerings for products and services
- Experience in establishing PPA and developing innovative business models

- Identification of potential offtakers and adaptability of contract structures
- Potential to include H₂ within a wider range of decarbonization solutions, to facilitate adoption

Innovation and partnerships

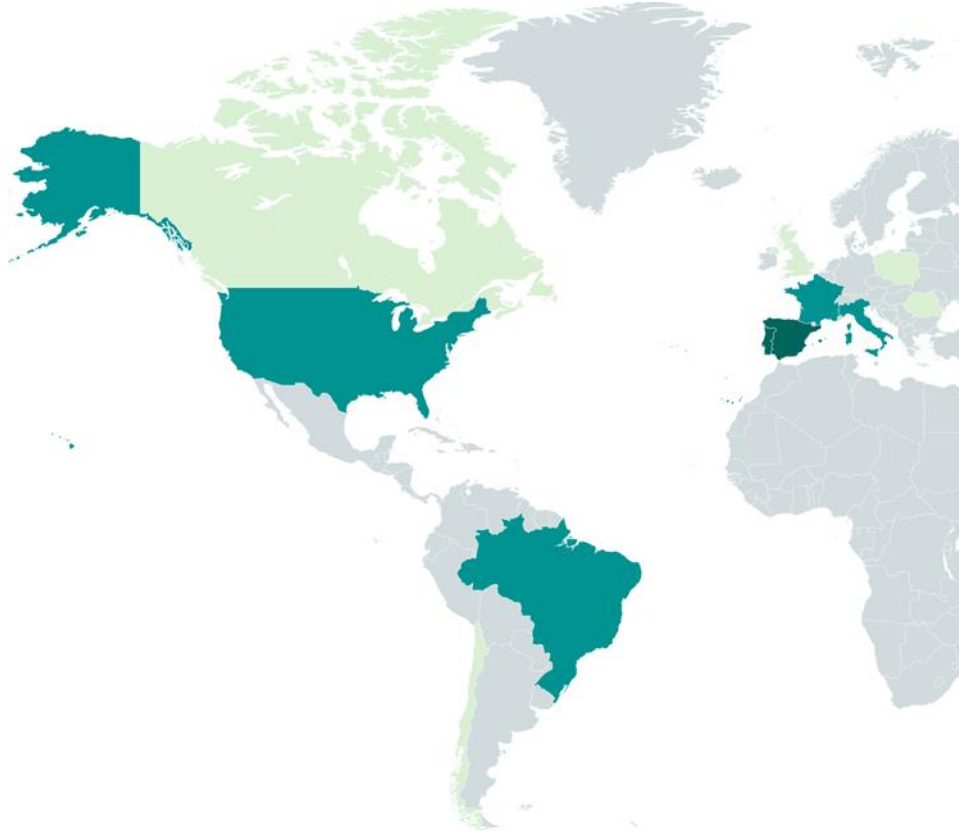


- Track record in scaling up technologies from pilot to market integration (e.g. WindFloat)
- Experience in large consortia with multiple stakeholders to capture funds

- Decrease project risk and investment needs through capturing of dedicated support mechanisms

Project development has been mainly focused on EDP's key geographies, exploring different opportunities

Project development by geography



- Building pipeline
- Assessing specific opportunities
- Other regions with potential interest (non-exhaustive)

Drivers for project origination

Transition of coal assets	<ul style="list-style-type: none">• Leverage on existing infrastructure to develop large scale hubs, taking advantage of local industries and ports
Supply industrial or mobility consumers	<ul style="list-style-type: none">• Establish small scale electrolysis units, dimensioned to individual offtakers or small hubs
Support existing and new RES assets	<ul style="list-style-type: none">• Address potential issues of RES assets (low remuneration, grid constraints, permitting, others)
R&D	<ul style="list-style-type: none">• Assess innovative technologies, capturing funds to support projects

H2 Business in EDP – H2BU Project Development and Origination

H2BU unit in EDP Renewables – main objectives

Business Development

Core geographies

- US
- Europe
- Others

Project development, design and deliver.

Strategy / Origination

Business Market segmentation

Business Models

H2 prospective studies

Trends and Analytics

Regulation

Regulation and Policy affairs

Representing EDP in H2 forums

Funding

M & A

Manage M&A

Growth Opportunities in Acquisitions;

Society and Contractual

And a competence center in EDP Produção : H2TECH

Providing excellence services in all project value chain

Technical Innovation

- New solutions
- Industry decarbonization needs
- Training
- Networking in H2 forums
- I+D programmes
- Pilot testing

Full Engineering Partner

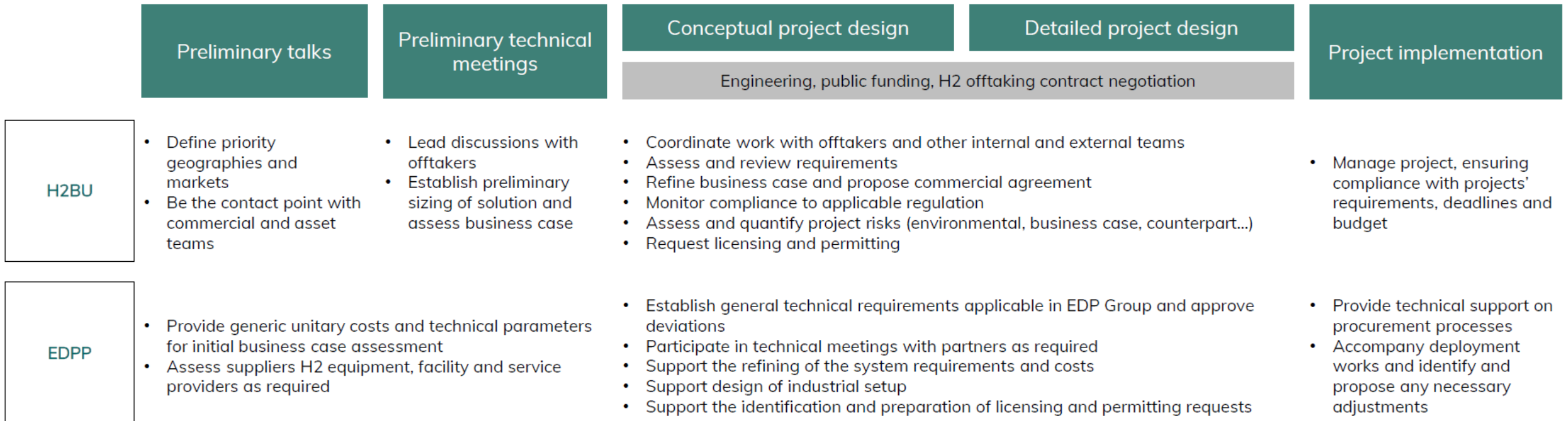
Services in all value chain of H2 projects, from project setup to O&M.

Global Service provider

- Engineering structured with critical competences for project setup and value proposition
- Providing services in all geographies
- Partnerships with local engineering companies

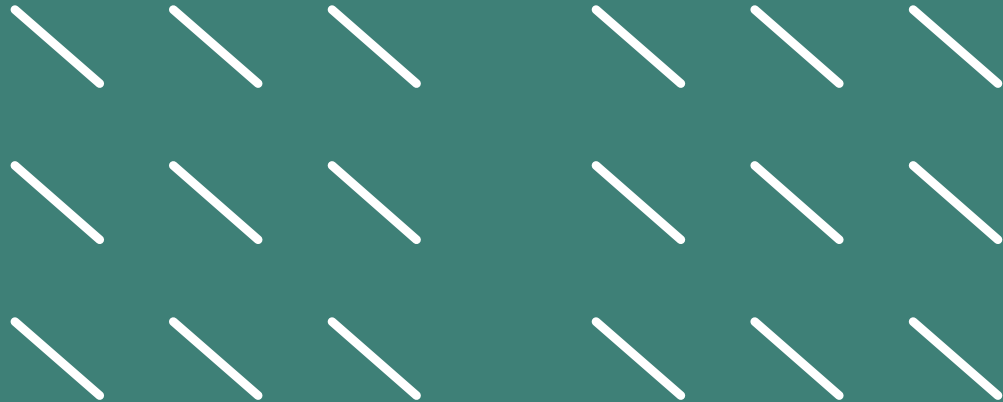
H2BU & H2TECH have different roles

Project Value chain requires participation of both units in order to meet best value proposition



01

H2 TECHNICAL INNOVATION



EDP is converting decommissioned Coal Fired Power Plants into H2 Hub

Sines in Portugal as a reference project

100 MW H2 local refinery and NG Grid

20 MW decarbonizing local industry

Green Ammonia new factory for fertilizers and energy carrier

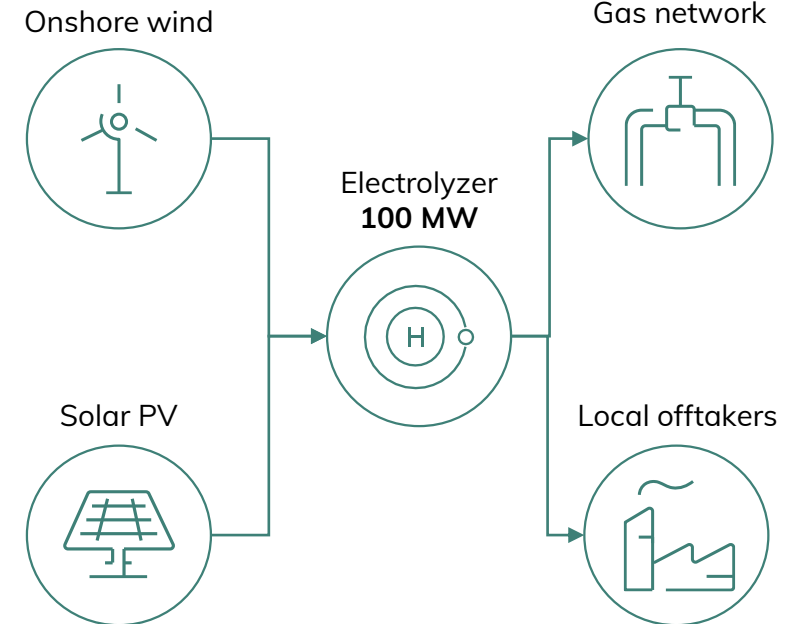
R&D Center CoLab

H2 Mobility Hub heavy trucks

Coal power plant



Hydrogen production hub



GREEN H2 will bring a new dynamic in Sines industrial area creating more than 5.500 jobs (direct and indirect) during construction and operation.

GREEN H2 ATLANTIC aims to develop 100 MW Green H2

- EU 30 M€ secured (1 of 3 projects selected in UE)
- 100 MW Green H2
- Renewable Energy in self consumption (100 MW solar + 100 MW wind)
- H₂ 10 kton/y
- CapEx (excl RES) ~150 M€

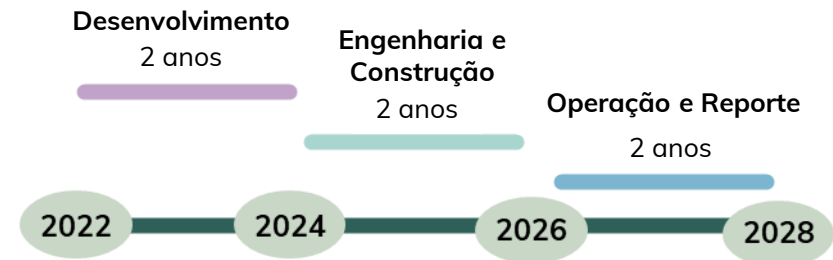
Partners:

Investment partners

Electrolyzer manufacturer

R&D partners

Project's artistic view



GAIN – Green Ammonia Industry – demonstrates new NH3 technology using green H2

Principais Indicadores

Investment
65 M€

Green H₂ consumption
2 kta

NH₃ Production
11 kta

Avoided CO₂
17 kta

Job creation
33

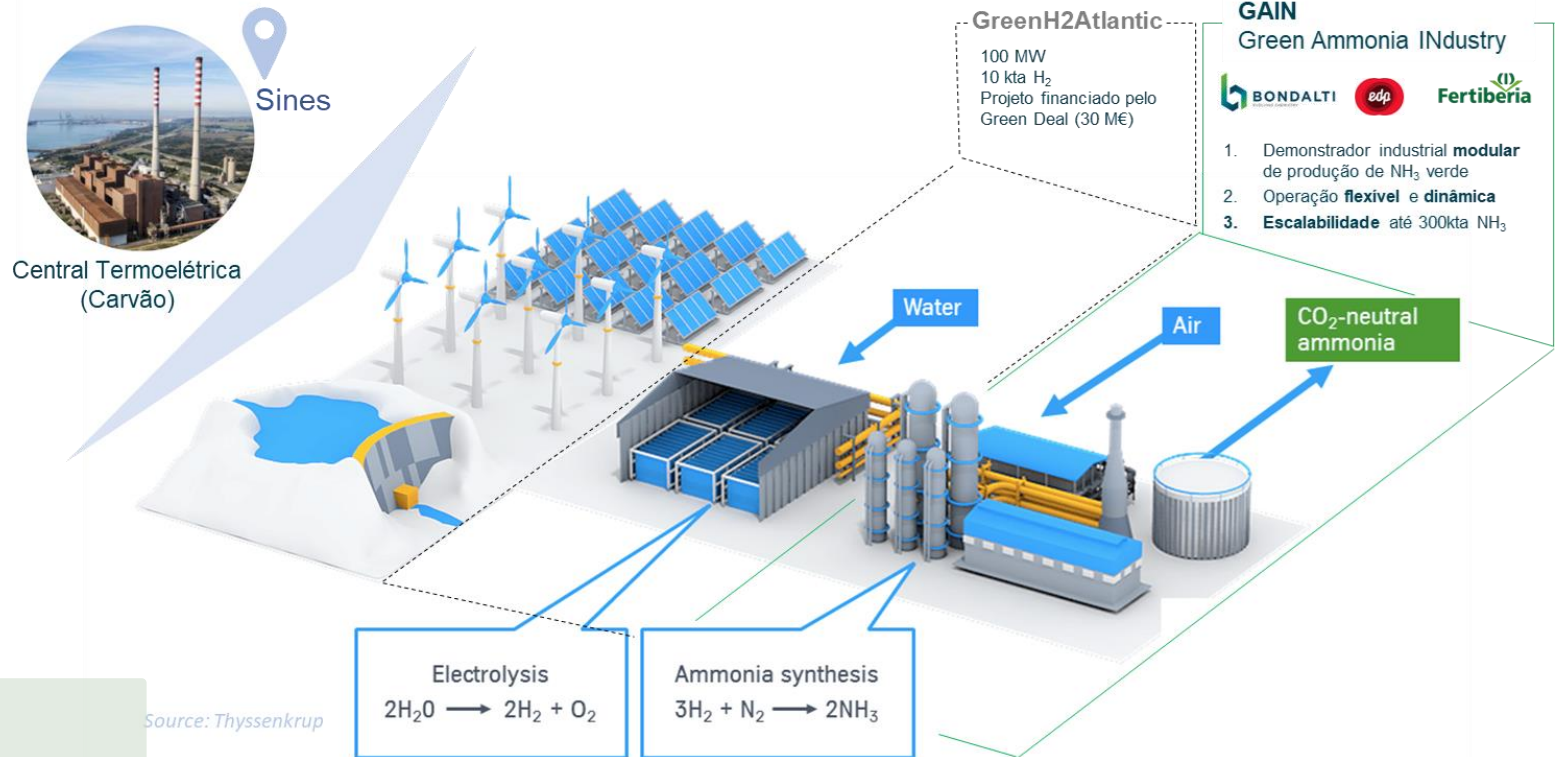
Impact



2025 Import reduction 11 kta NH₃ (6 M€)

2030 Import reduction 165 kta (83 M€) and export increase in 135 kta NH₃ (68 M€)

Proposta seleccionada para candidatura ao PRR-C5 Agenda mobilizadoras para inovação empresarial



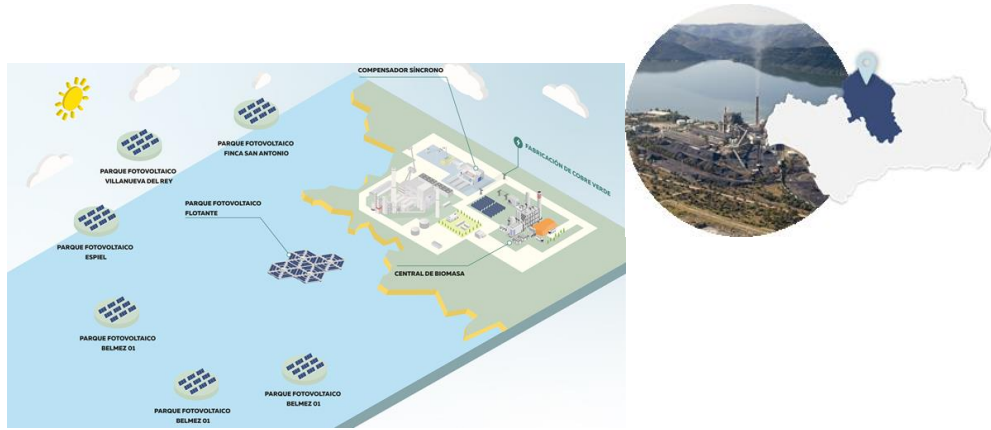
Parceiros



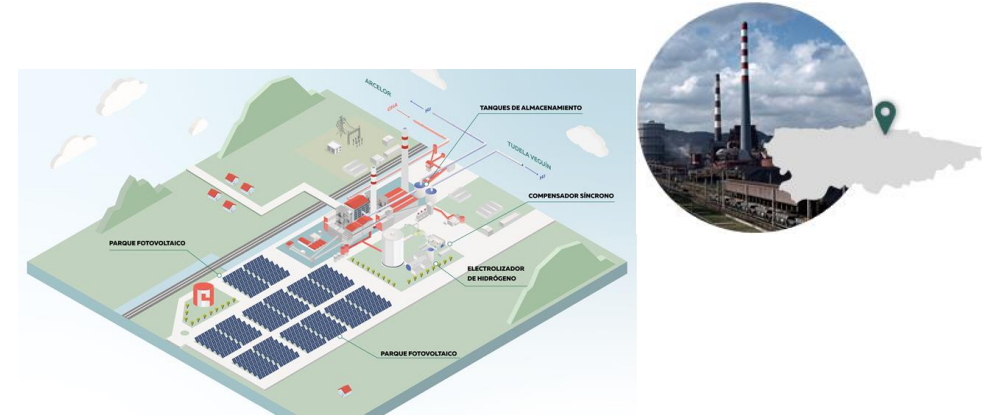
Decarbonization solutions for all ex-coal fired power plants

More than 1.500 M€ in decarbonization solutions

Puente Nuevo, the green energy of Cordoba



Aboño, H2 valley of Asturias



Los Barrios, supplier of green energy for the Algeciras bay



Soto de Ribera, center for the storage of renewable energy in new uses of H2



Technology & Innovation supported by pilot projects

About 3 GW of H2 projects under development

Pilot Projects



International fora

DNV-GL-
Recommended
Practice for the
certification of
Electrolyser



Current Potential Partners

Equinor Energy AS
Siemens Gamesa Renewable Energy A/S
Elogen
Industrie De Nora S.p.A
McPhy Energy
Fraunhofer
Shell Global Solutions B.V
NextChem
Clean Power Hydrogen Group Limited
EDP GESTÃO DA PRODUÇÃO DE ENERGIA SA
Sunfire GmbH
Green Hydrogen Systems
Hydrogen-Pro

1. introduction of the new participants and their expectations to the JIP

New potential partners

ITM-Linde
Société General
Nordex

Next potential partners

MunichRe
FEST
Haldor Topsøe
Siemens-Energy
NEL

Training

Oferta formativa proposta ("Roadmap")

2022	1T			2T			3T			4T			Comentários/ Observações
	Jan	Fev	Mar	Abr	Maio	Jun	Jul	Ago	Set	Out	Nov	Dez	
Estimativa orçamental	€ 1.200 [deslocação, estadia e AC]			€ 1.200 [deslocação, estadia e AC]			€ 2.900 [inscrição, deslocação, estadia e AC]			€ 2.200 [inscrição, deslocação e estadia]			
1.a Visitas técnicas a instalações industriais	♦ Visita a 1 instalação												Costes médias estimados por participante. Deslocações e estadias na Europa. Inscrições "Early Bird" ou para Grupos poderão permitir obter condições mais vantajosas
1.b Visitas técnicas a instalações fabris				♦ Visita a 1 fábrica									Instalação e data a acordar com Osovo/Generator do Alvaro
2. Conferência/seminário de espectro alargado							♦ Uma conferência						Instalação e data a acordar com Tomcedor
3. Conferência ou curso específico										♦ Um curso			A seleccionar após análise aprofundada da oferta disponível
Cenário - visita a 1 Instalação para 6 colaboradores + visita a 1 fábrica para 3 colaboradores + conferência de espectro alargado para 2 colaboradores + curso específico para 3 colaboradores													

I+D Horizon Europe

In Hydrogen, EDP NEW and EDP Produção have also started to assess with EDPRH2BU the opportunities under the Clean Hydrogen for Europe

Draft Work Programme 2021-2022 released for comments



47 Call Topics

2 priorities identified

15+ calls of interest

Offshore production of Green Hydrogen

Scope | demonstrate offshore production and export/use of hydrogen as a first multi-MW step towards large-scale offshore renewable hydrogen production
Opportunity for EDP | Follow-up to pre-FEED study in project BeHyond, led by NEW
Grant | 20 M€ (TBC)
Deadline | 1Q-2Q 2022 (TBC)

Hydrogen Valley

Scope | Set up a Hydrogen Valley, an area where H2 serves more than one sector/application in mobility, industry and energy. To cover H2 value chain, from H2 production to storage, transport & distribution to various off-takers
Opportunity for EDP | Complement to the GreenH2Atlantic projects, creating a H2 Valley in the Sines region
Grant | 25 M€ (TBC)
Deadline | 1Q-2Q 2022 (TBC)

15+ calls focused on H2 technology and training. To be explored, namely through Hylab.

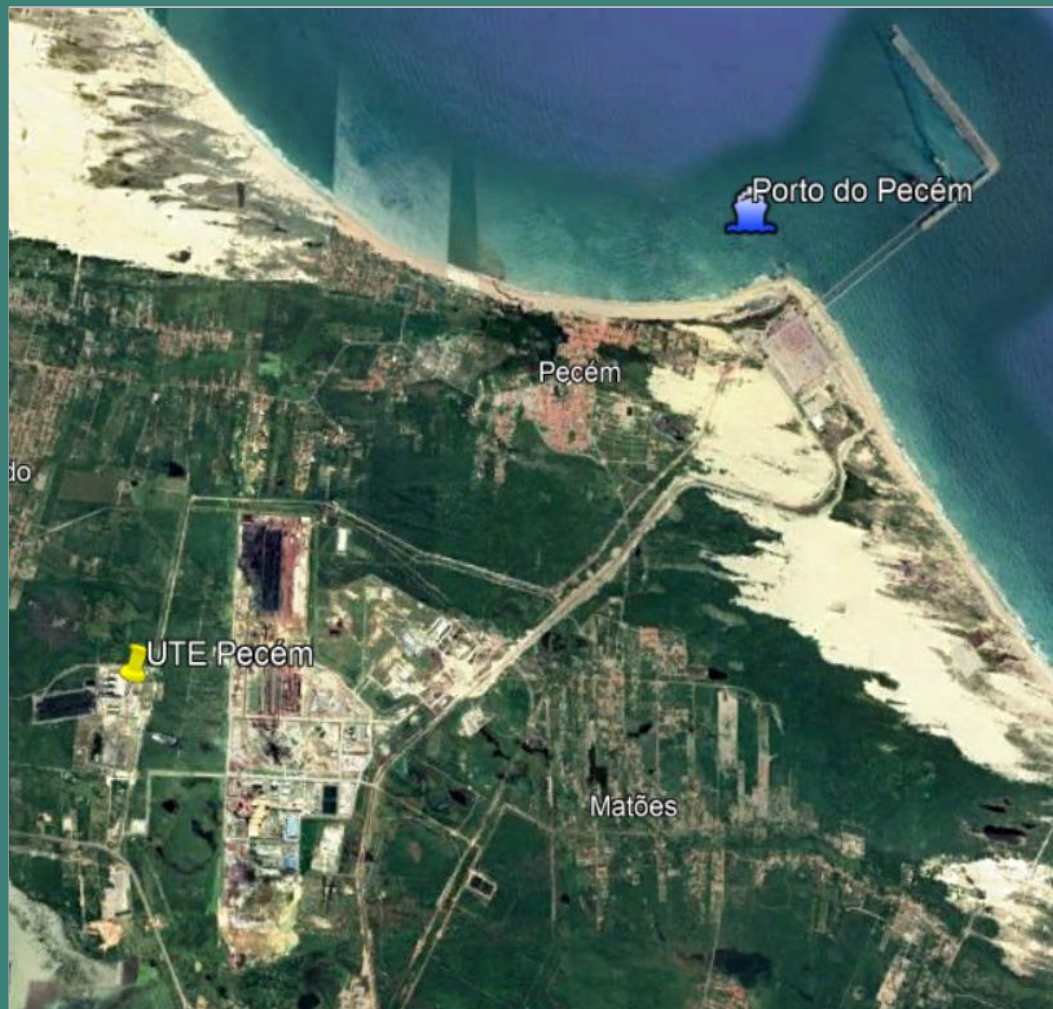
European Clean Hydrogen Alliance

NEW



Tecnologia de produção e abastecimento

Eletrolisador de 1,25 MW e UFV 3MW



Modelo: HyPEM

Potência instalada: 1,25 MW (modular)

Produção de H₂: 22.3 kg/h ou 250 Nm³/h

Eficiência: 75%

Eletrolisador: membrana (PEM) – livre de cáusticos



Estrutura: Tracker

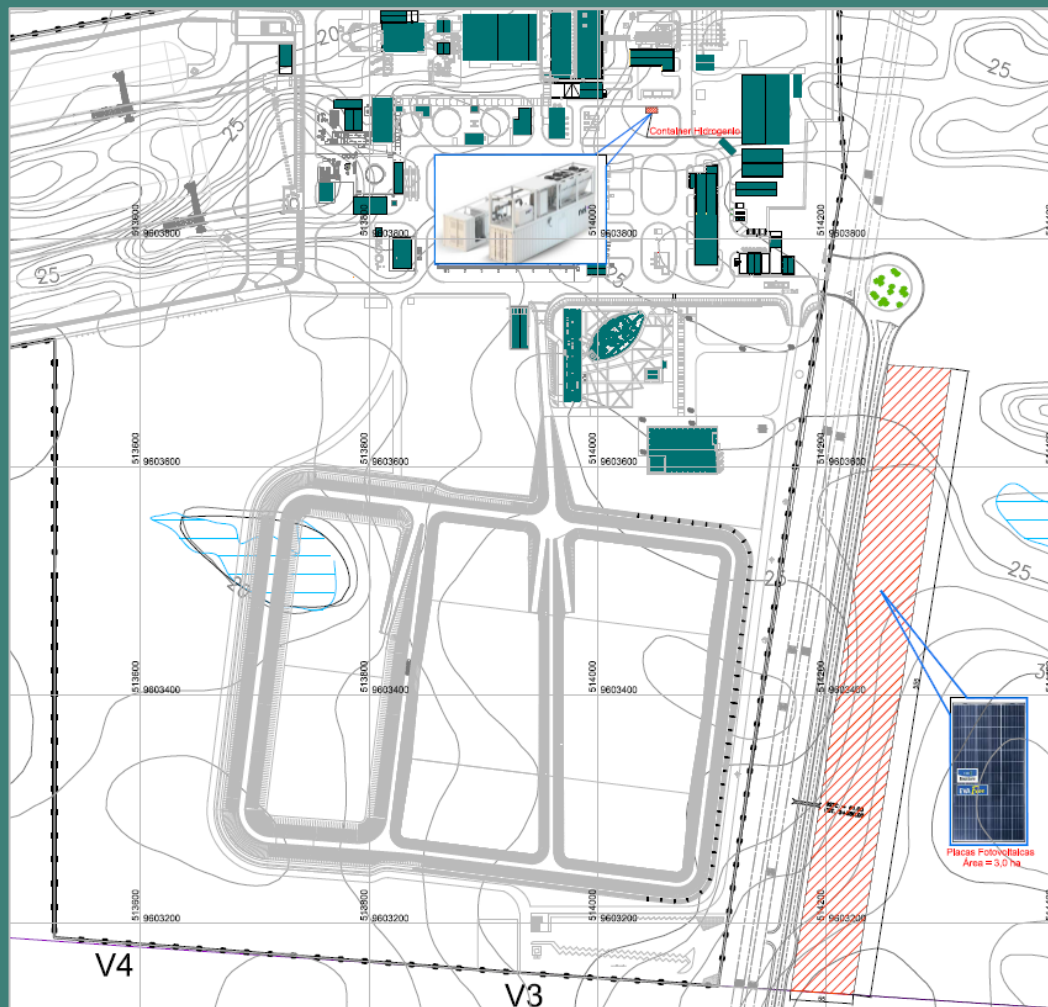
Potência instalada: 3MW

Dedicação exclusiva para abastecimento do eletrolisador

Sinergia entre empresas do grupo EDP

Tecnologia de produção e abastecimento

Eletrolisador de 1,25 MW e UFV 3MW



Hytron

TECNOLOGIA EM HIDROGÊNIO

Modelo: HyPEM

Potência instalada: 1,25 MW (modular)

Produção de H₂: 22.3 kg/h ou 250 Nm³/h

Eficiência: 75%

Eletrolisador: membrana (PEM) – livre de cáusticos

SMART

Estrutura: Tracker

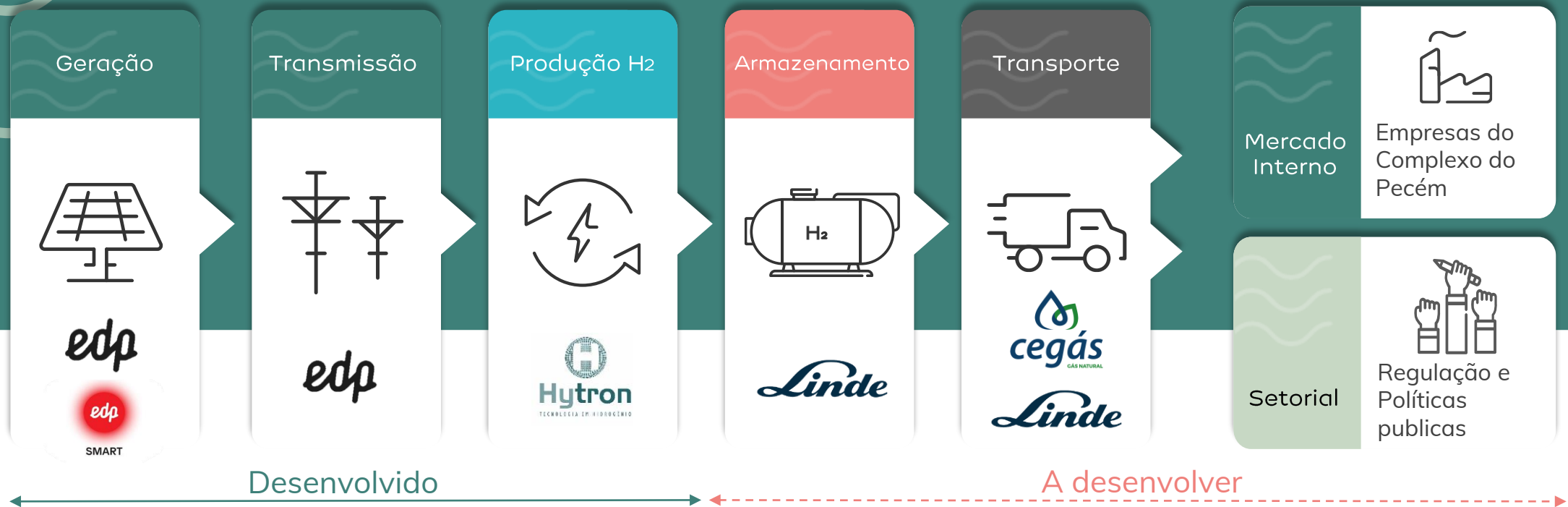
Potência instalada: 3MW

Dedicação exclusiva para abastecimento do eletrolisador

Sinergia entre empresas do grupo EDP

Brasil – Projecto Piloto Pecém Estrutura Geral e Potenciais Parcerias

Integrantes e parceiros do projeto de P&D



Proponente e Executoras

Parceiros estratégicos



Coordenador Geral



Fornecedor eletrolisador



Coordenador Executivo



Coordenador Técnico





Corrente tecnológica

Frentes tecnológica de projeto

Co-queima

Utilizar e verificar os impactos do gás H₂ em escala industrial na co-queima com carvão mineral, nas instalações da UTE Pecém para aumento da energético na caldeira.

Uso industrial

Avaliar a utilização do H₂ em escala industrial os estudos em aplicações em indústrias cimenteiras e siderúrgicas em combinações/misturas com combustíveis convencionais

Armazenamento e transporte

Avaliação das melhores tecnologias voltadas para o armazenamento e transporte do H₂ de acordo com a escalabilidade de produção

Índices de eficiência técnica/econômica

Desenvolvimento de um índice para correlacionar questões técnicas e econômicas

Rotas tecnológicas para a proposta do projeto

Projeto Pecém H2V

Marcos do projeto até o momento



Início do projeto
Julho/21

1



Licença

Emissão da Licença
Ambiental
de Instalação

2



Governo

Apresentação do
Projeto ao
Governo do Estado

3



Visita

Visita do CEO e
VP às futuras
instalações

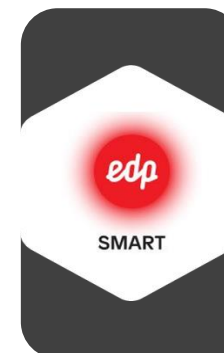
4



Eletrólise

Aquisição da
unidade de
eletrólise com
potência de 1,25
MW

5



Usina Fotovoltaica

Aquisição da
unidade
fotovoltaica com
potência de 3,0
MWp

1º molécula
de H₂V
Dezembro/22

Hard to abate sectors

Developing decarb solutions for industry with major players and experts (proposals for Arcelormittal and Acerinox)

Steel Industry



H2GreenSteel

H2 Green Steel will produce 5M tons of CO2-free steel, mobilize 2.5B€ investments and create 10,000 jobs



The industrial initiative, backed by EIT InnoEnergy, will build the world's first large-scale fossil-free steel plant in Boden-Lössele, north Sweden, using green hydrogen.

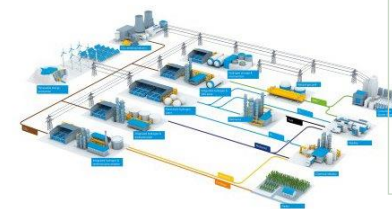
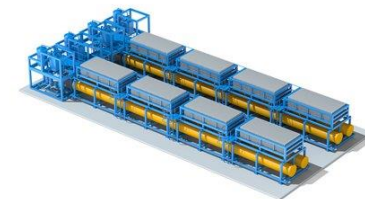


Brazil largest steel producer in latam

Cement



Chemical & Synthetic Fuels

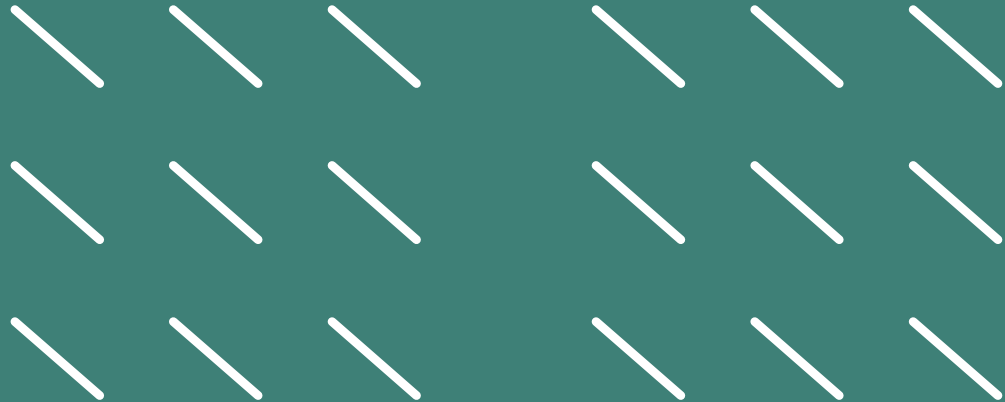


Green Ammonia
Electrical ammonia synthesis

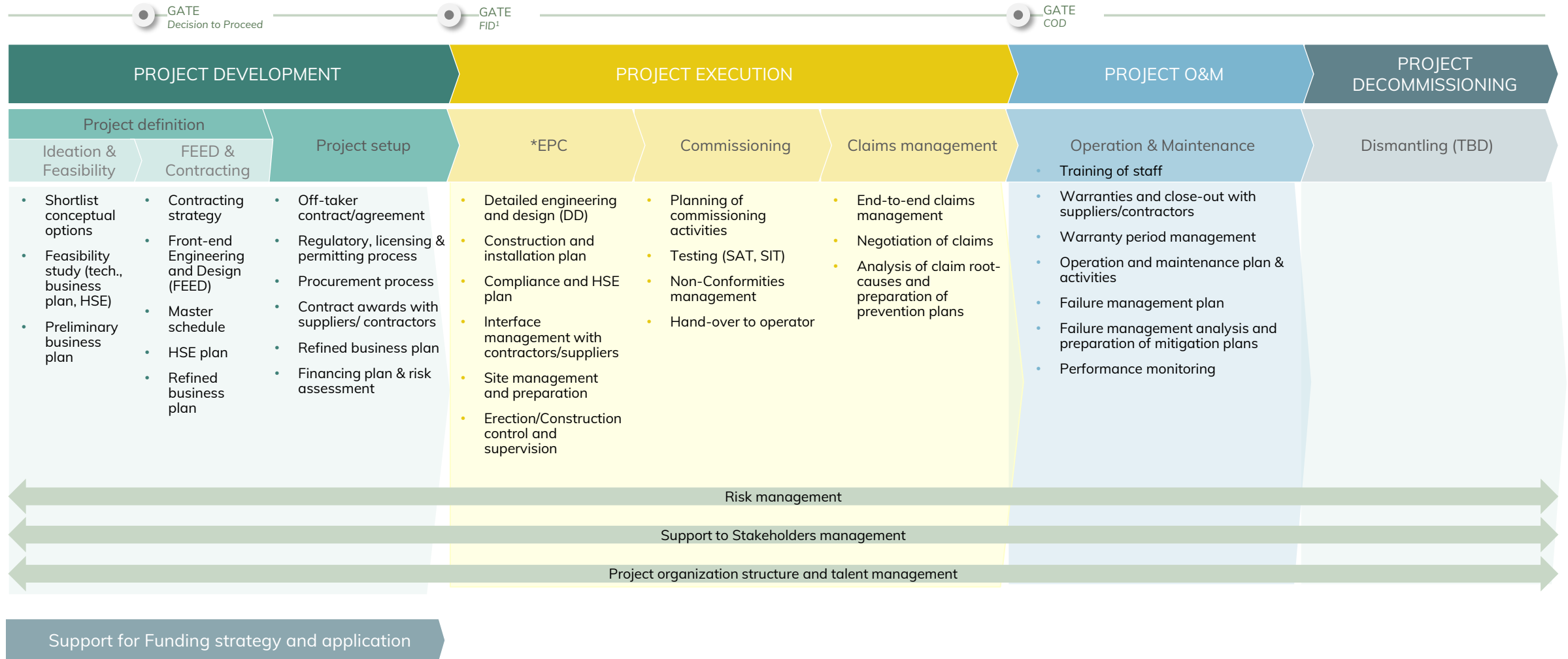
looking for process transformation rather than pure fuel substitution

02

Full Engineering Partner



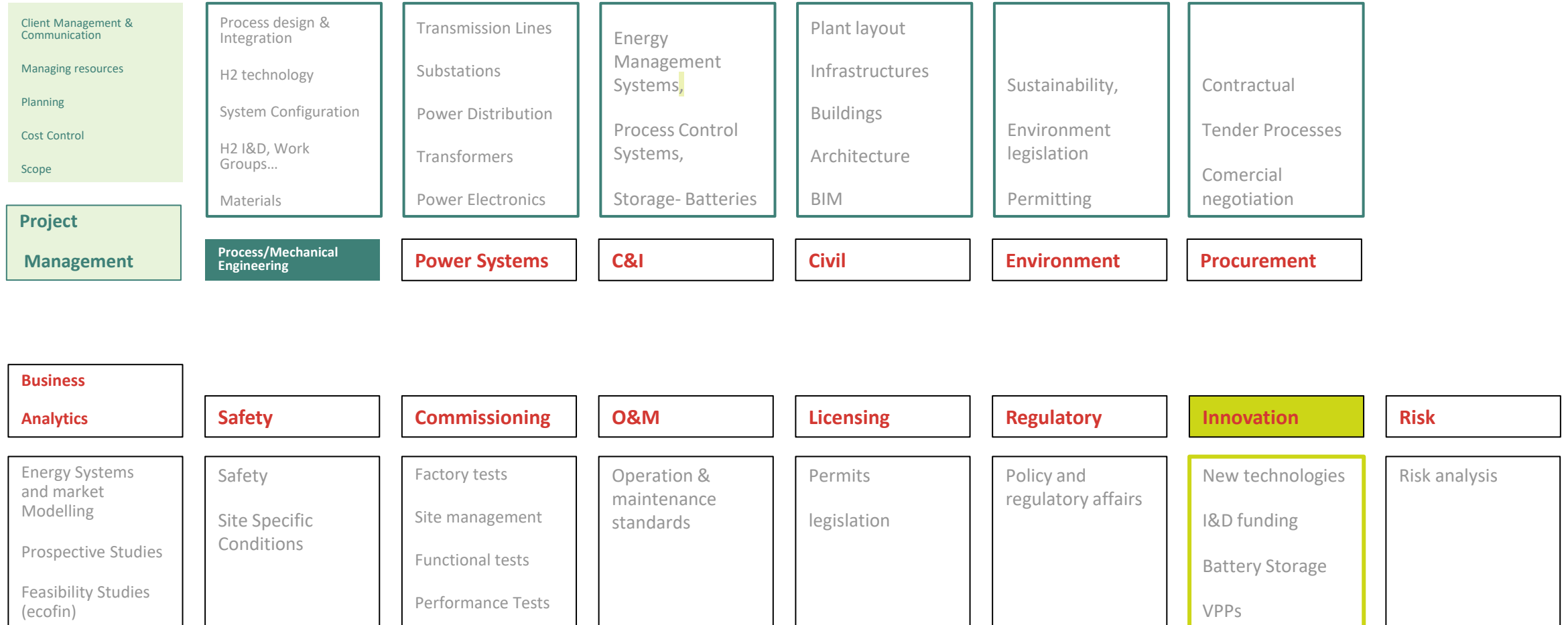
Work Breakdown Overview: H2TECh supporting business needs in all value chain



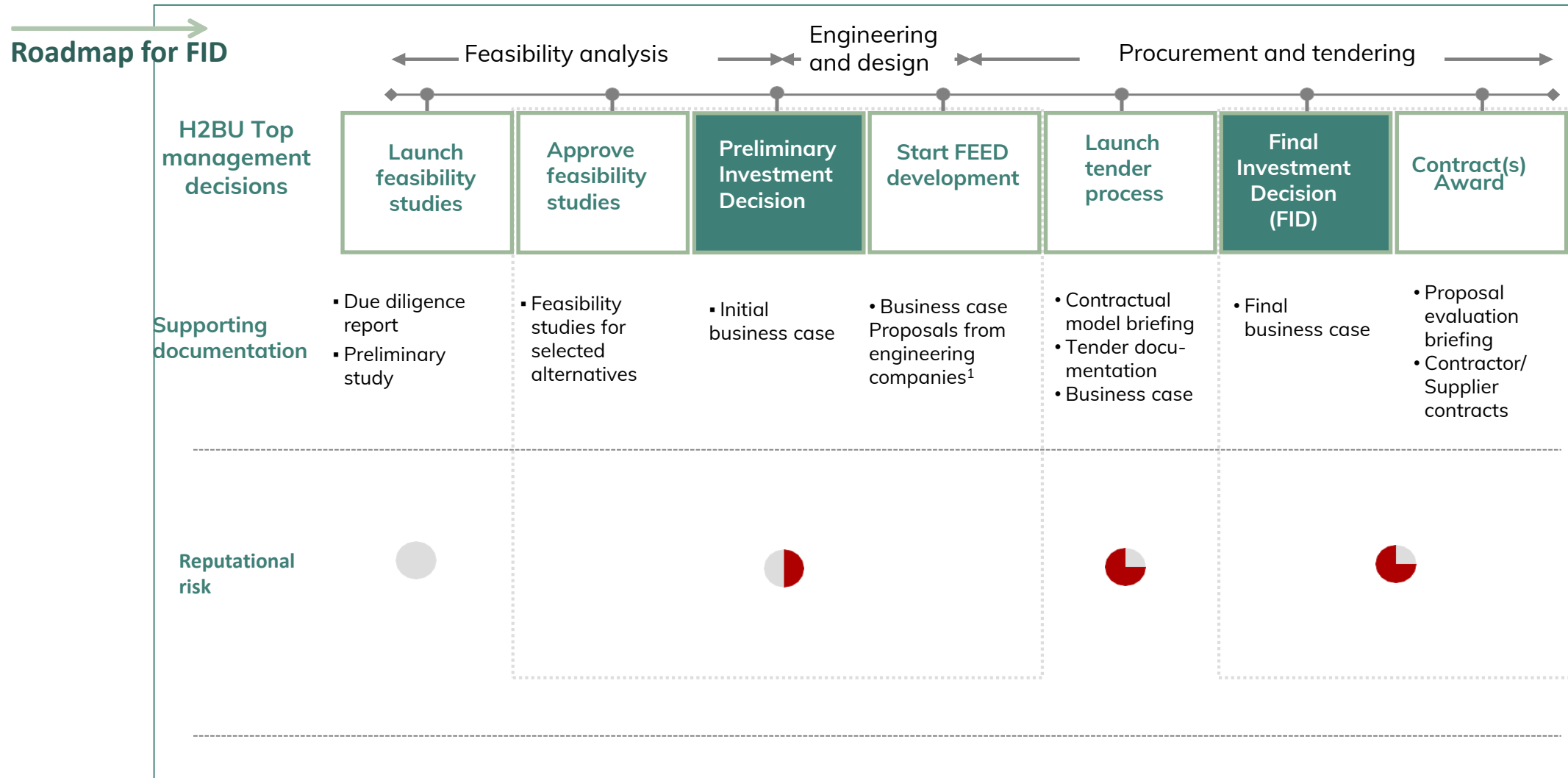
FID – Final Investment Decision, defined at H2BU as the moment when the first key contract is signed
 COD – Commercial Operation Date
 EPC – Engineering, Procurement, Construction

...requiring competences to be provided by internal business units

H2 development requires cross functional competence

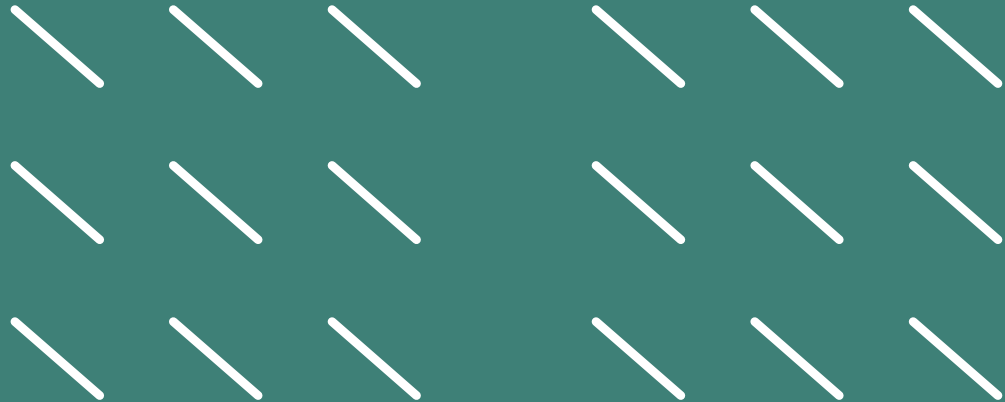


Actual effort is concentrated in activities prior to FID



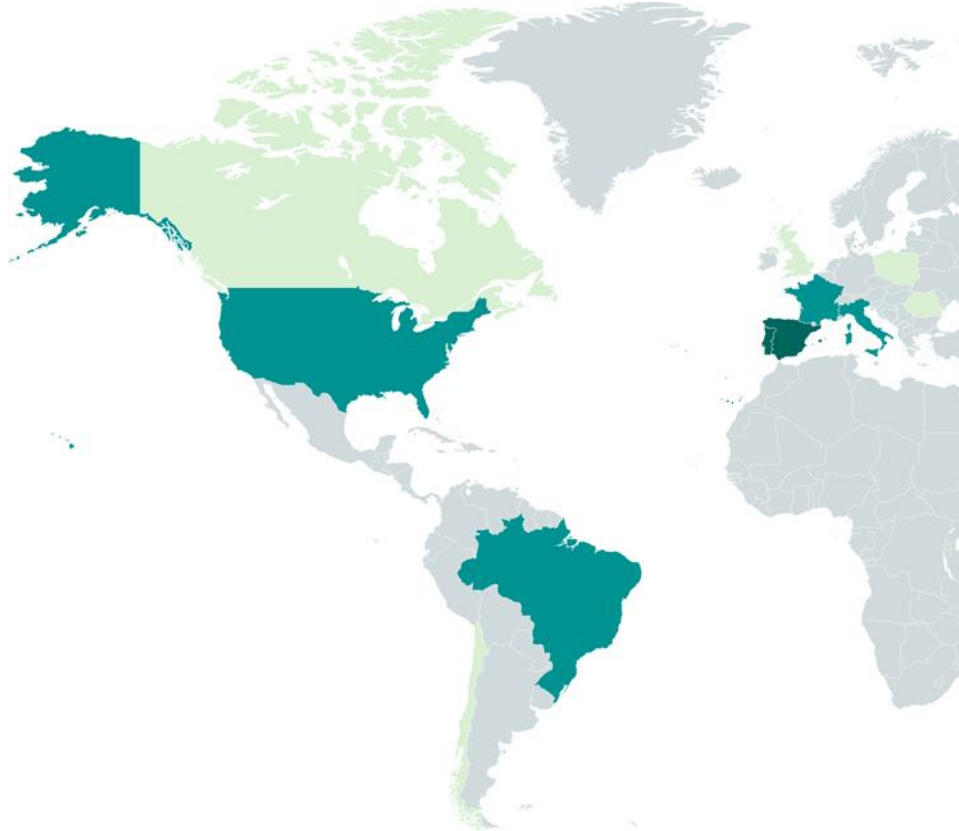
03

Global Service Provider



Project development has been mainly focused on EDP's key geographies, exploring different opportunities

Project development by geography



- Building pipeline
- Assessing specific opportunities
- Other regions with potential interest (non-exhaustive)

Drivers for project origination

Transition of coal assets	<ul style="list-style-type: none">• Leverage on existing infrastructure to develop large scale hubs, taking advantage of local industries and ports
Supply industrial or mobility consumers	<ul style="list-style-type: none">• Establish small scale electrolysis units, dimensioned to individual offtakers or small hubs
Support existing and new RES assets	<ul style="list-style-type: none">• Address potential issues of RES assets (low remuneration, grid constraints, permitting, others)
R&D	<ul style="list-style-type: none">• Assess innovative technologies, capturing funds to support projects

Several service provider models may be used

Technical design development models

Technical design can have **3 different models** based on the degree of **externalization of design** activities

During the **design preparation**, a specific model needs to be selected based on key factors

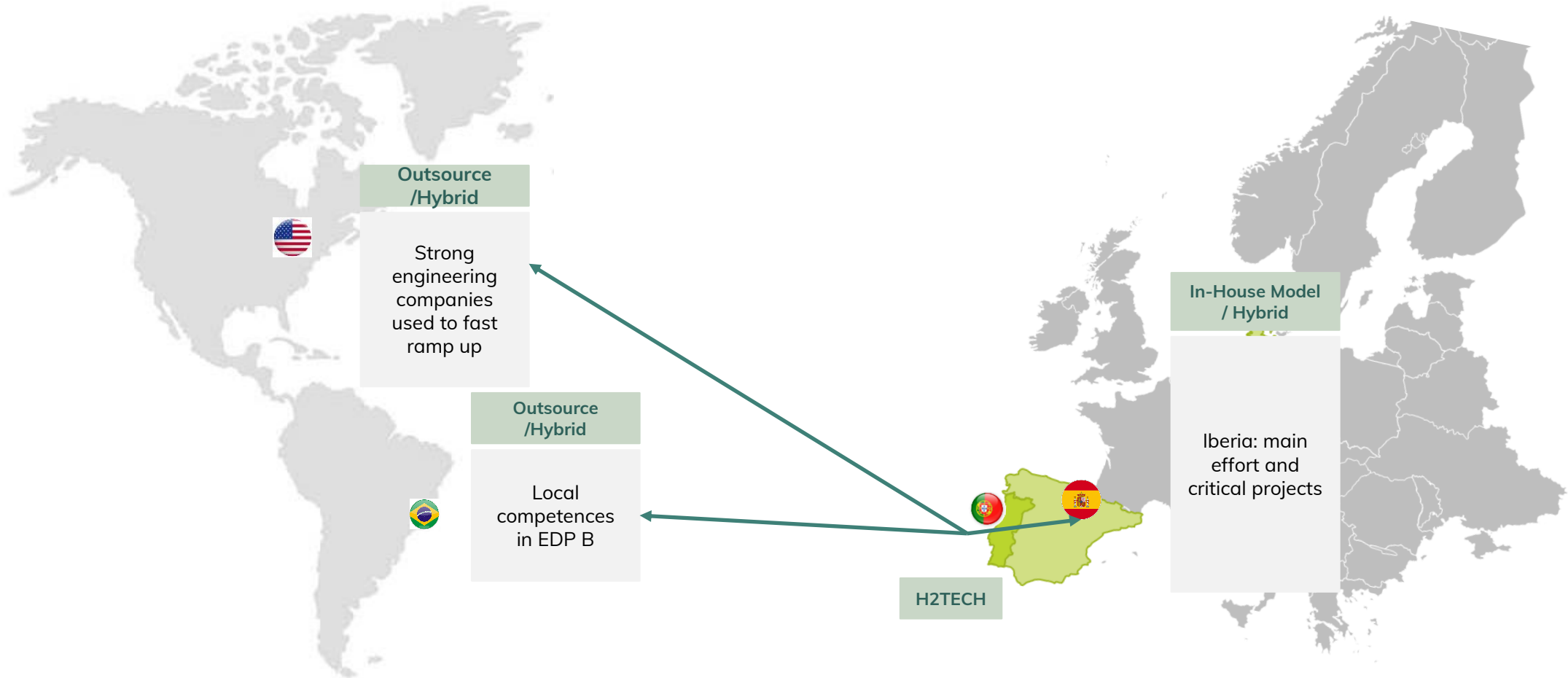
- **Internal capacity** and capabilities
- **Requests** from stakeholders
- **Complexity** and number and nature of stakeholders involved
- **Geography**

In-house	Create the design for most of the parts of the design with internal engineering teams
Hybrid	Design part of the project internally and another part externally (e.g., BoP internally and Eletrolyser externally)
Outsource	Outsource most of the design of the project's elements to specialized design companies



H2TECH providing global services to EDP

While keeping critical competences in H2TECH PT – learning curve with hybrid engineering models





EDP H2TECH