Engineering Center of Compentences for Green Hydrogen

GESEL: Webinar Internacional “Tecnologia e Centros de Excelência de Hidrogênio em Portugal e Brasil” L – 12 janeiro 2022

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Head of H2 & Innovation
EDP Produção S.A.

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1 Technical Innovation

2 Full Engineering Partner

3 Global Service Provider

00

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

~57% Renewables

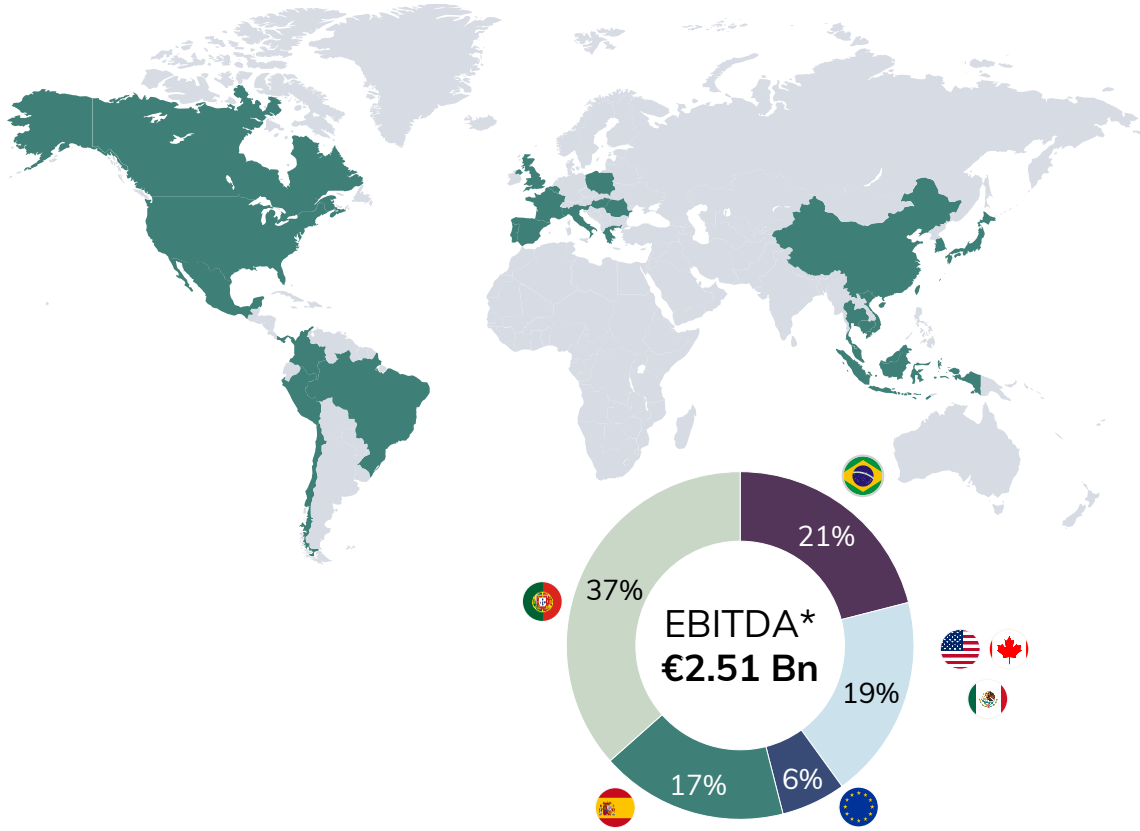
Wind, Solar & Hydro

~37% Networks

Distribution Transmission

~6% Client solutions & energy management

Clients Trading New solutions



Key indicators

*Values as of 9M 2021

Capacity installed	EBITDA	Net Profit	Employees	Clients
24.6 GW	€2.51 Bn	€0.5 Bn	12,232	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

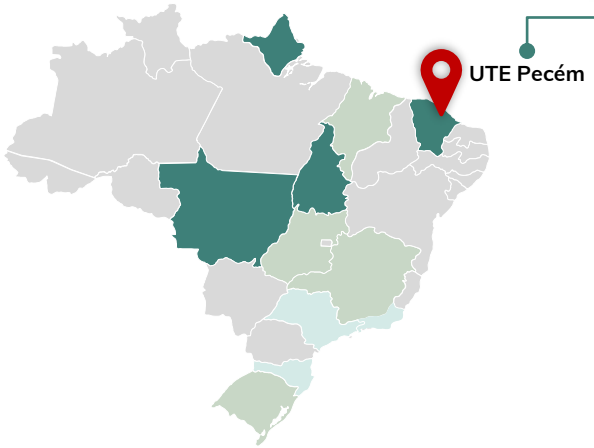
EDP Brasil

EDP Brasil

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

3.6MM Clients — **Distribution**
State of São Paulo, Espirito 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
- ✓ Demineralizated 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 Nº382):
- ✓ SO2: 1.250 mg/Nm3;
- ✓ Particulate Matter: 500 mg/Nm3

Highligts

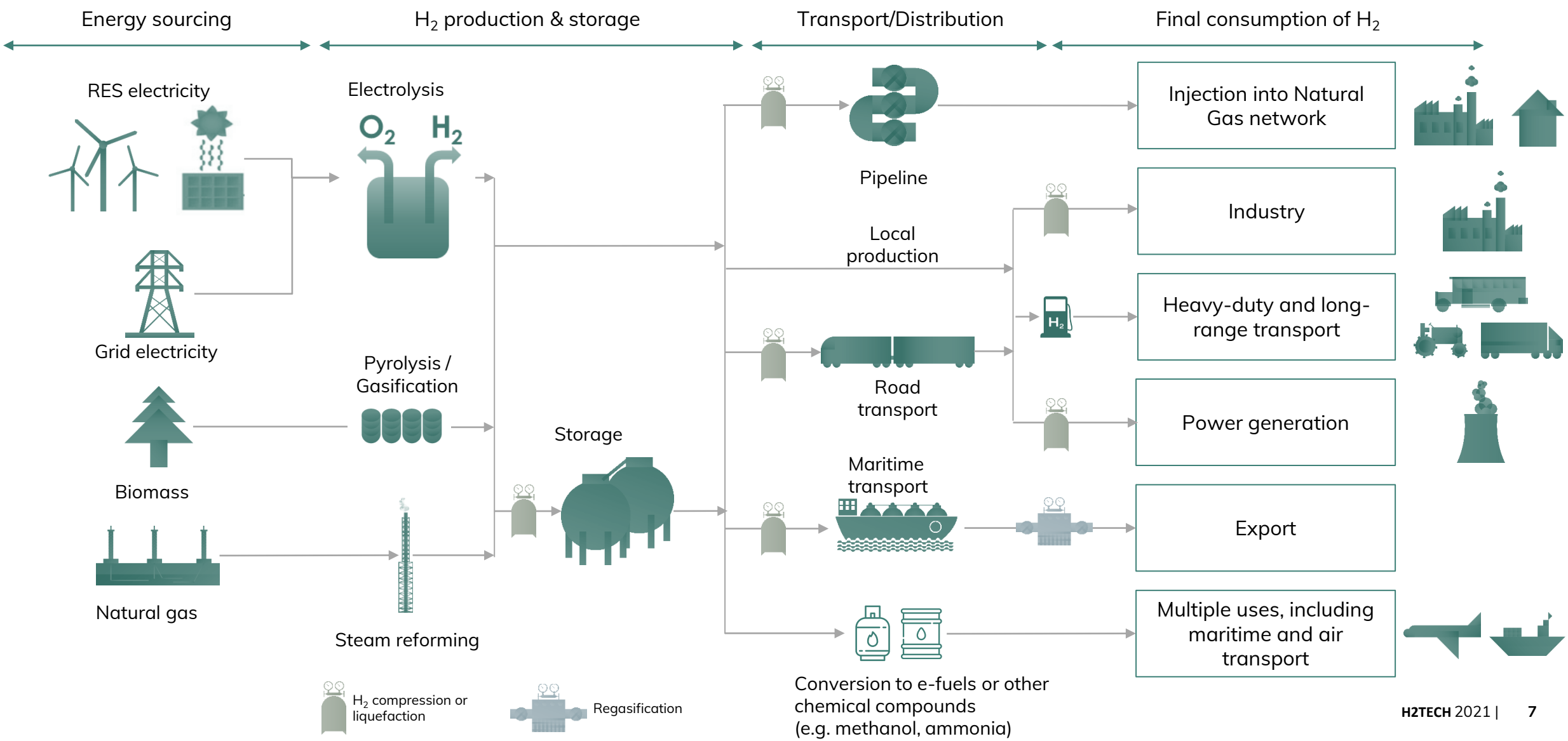
With over 20 years of experience, EDP is one of the largest private companies in the electricity sector operating throughout the value chain.

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 H_2

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

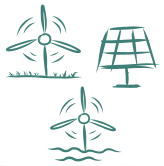
Specialized and dedicated teams on designing **hydrogen production and supply systems from electrolysis**

Clients

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

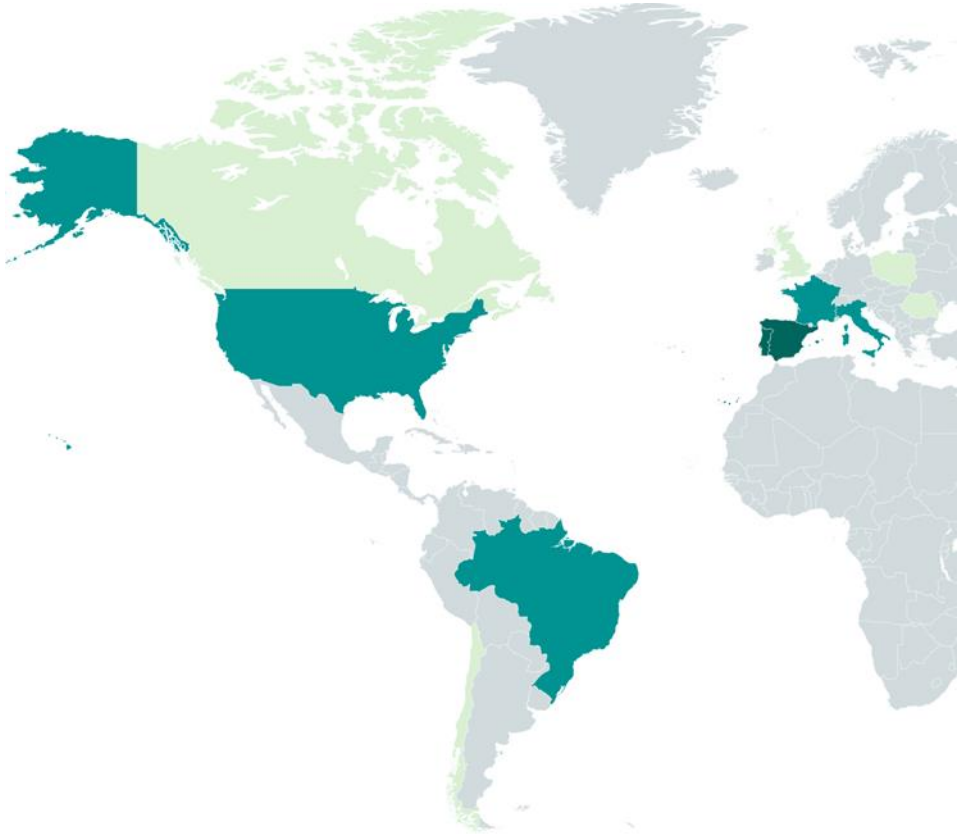
Renewable hydrogen complements existing decarbonization offerings, including energy efficiency, PPA, solar self-consumption and e-mobility

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 H_2 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 offering 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	• Leverage on existing infrastructure to develop large scale hubs, taking advantage of local industries and ports
Supply industrial or mobility consumers	• Establish small scale electrolysis units, dimensioned to individual offtakers or small hubs
Support existing and new RES assets	• Address potential issues of RES assets (low remuneration, grid constraints, permitting, others)
R&D	• 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, form project setup to O&M.

Global Service provider

Engineering structureed 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

	Preliminary talks	Preliminary technical meetings	Conceptual project design	Detailed project design	Project implementation
			Engineering, public funding, H2 offtaking contract negotiation		
H2BU	• Define priority geographies and markets • Be the contact point with commercial and asset teams	• Lead discussions with offtakers • Establish preliminary sizing of solution and assess business case	• Coordinate work with offtakers and other internal and external teams • Assess and review requirements • Refine business case and propose commercial agreement • Monitor compliance to applicable regulation • Assess and quantify project risks (environmental, business case, counterpart...) • Request licensing and permitting		• Manage project, ensuring compliance with projects' requirements, deadlines and budget
EDPP	• Provide generic unitary costs and technical parameters for initial business case assessment • Assess suppliers H2 equipment, facility and service providers as required		• Establish general technical requirements applicable in EDP Group and approve deviations • Participate in technical meetings with partners as required • Support the refining of the system requirements and costs • Support design of industrial setup • Support the identification and preparation of licensing and permitting requests		• Provide technical support on procurement processes • Accompany deployment works and identify and propose any necessary adjustments

01

H2 TECHNICAL INNOVATION

EDP is converting decommissioned Coal Fired Power Plants into H2 Hub

Sines in Portugal as a reference project

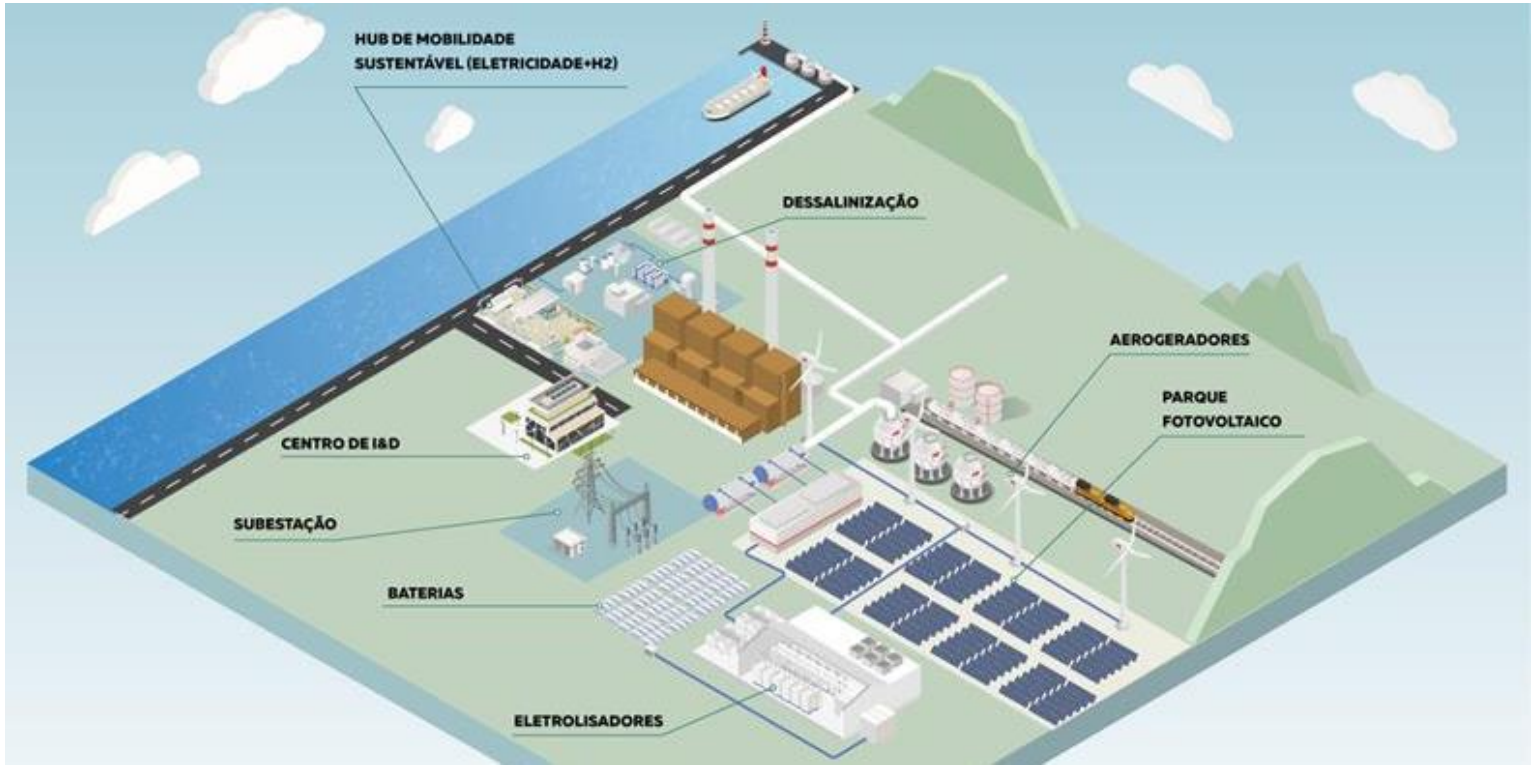
100 MW H2 local refinery and NG Grid

20 MW decarbonizing local industry

Green Ammonia new factory for fertilizers and energy carrier

R&D Center CoLab

H2 Mobility Hub heavy trucks



GREEN H2 will bring a new dynamic in Sines industrial area creating more than 5.500 jobs (direct and indirect) during constructin 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)
- **H_2 10 kton/y**
- **CapEx** (excl RES) **~150 M€**

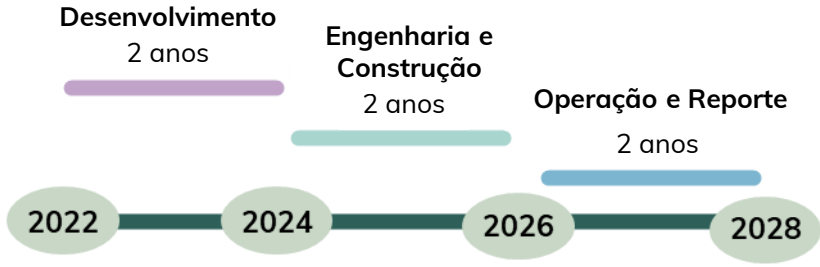
Partners:

Investment partners

Electrolyzer manufacturer

R&D partners

Project's artistic view



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

Principais Indicadores

Investiment
65 M€

Green H_2 consumption
2 kta

NH_3 Production
11 kta

Avoided CO_2
17 kta

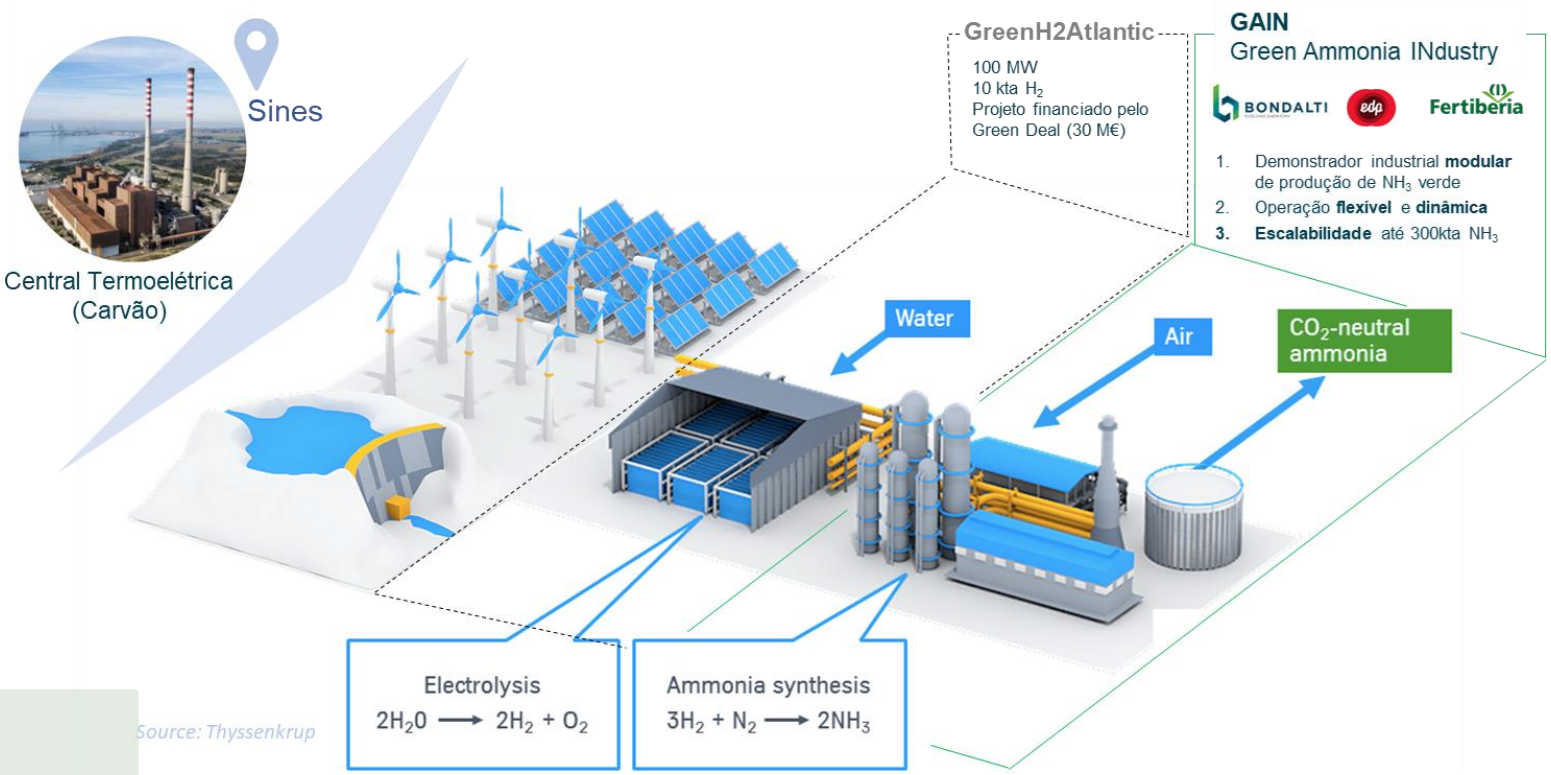
Job creation
33

Impact

2025 Import reduction 11 kta NH3 (6 M€)

2030 Import reduction 165 kta (83 M€) and export increase in 135 kta NH_3 (68 M€)

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



Parceiros

edp · BONDALTI · Fertiberia · HyLAB · ISQ

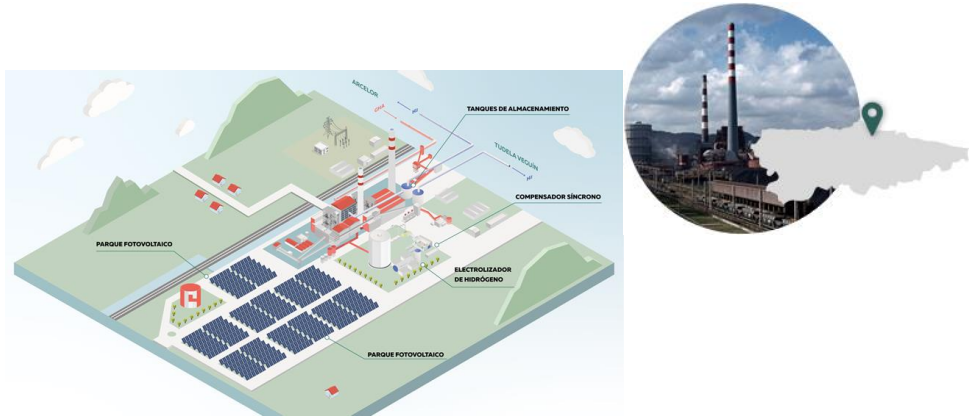
Decarbonization solutions for all ex-coal fired power plants

More than 1.500 M€ in decarbonization solutions

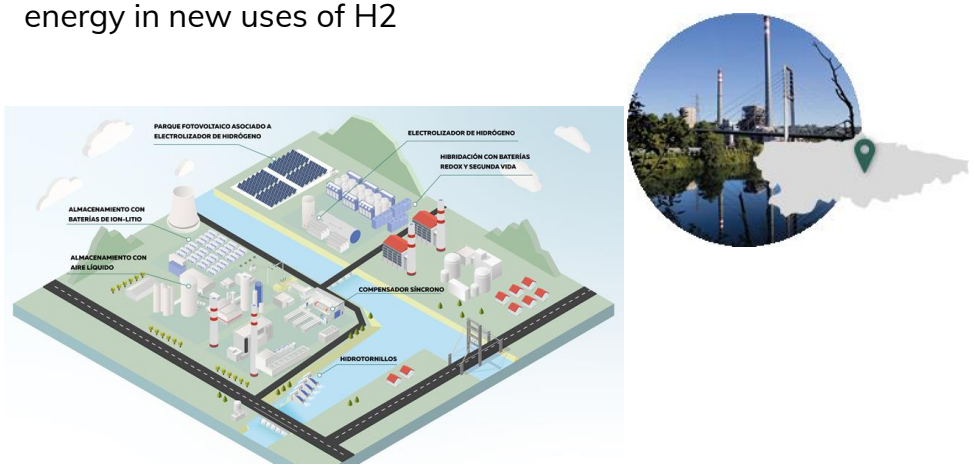
Puente Nuevo, the green energy of Cordoba

Los Barrios, supplier of green energy for the Algeciras bay

Aboño, H2 valley of Asturias



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

flexnconfu

International fora

DNV-GL-Recommended Practice for the certification of Electrolyser

DNV

Current Potentional 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 potentional partners
ITM-Linde
Société General
Nordex

Next potentional partners
MunichRe
FEST
Haldor Topsøe
Siemens-Energy
NEL

Training

Oferta formativa proposta ("Roadmap")

2022

	1T (Jan | Fev | Mar)	2T (Abr | Mai | Jun)	3T (Jul | Ago | Set)	4T (Out | Nov | Dez)	Comentários/ Observações
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]	Custos médios estimados por participante. Deslocações e estadias na Europa. Inscrições "Early Bird" ou para Grupos poderão permitir obter condições mais vantajosas
1.a Visitas técnicas a instalações industriais	◆ Visita a 1 instalação				Instalação e data a acordar com Dono/Operador do Ativo
1.b Visitas técnicas a instalações fabris		◆ Visita a 1 fábrica			Instalação e data a acordar com fornecedor
2. Conferência/seminário de espectro alargado			◆ Uma conferência		A selecionar após análise aprofundada do oferta disponível
3. Conferência ou curso específico				◆ Um curso	A selecionar após análise aprofundada do oferta disponível

Cenário - visita a 1 Instalação para 6 colaboradores + visita a 1 fábrica para 3 colaboradores + conferência de espetro 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)

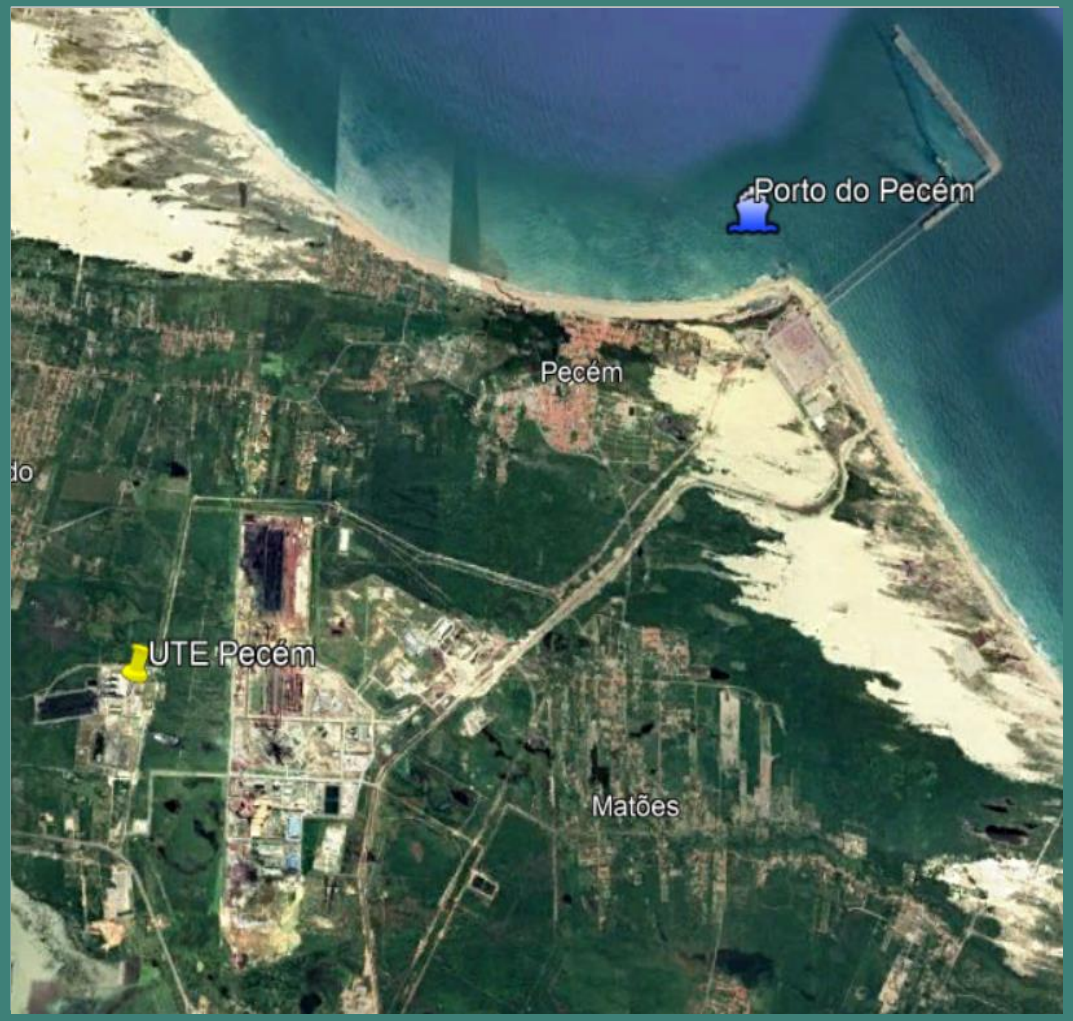
Deadline | 1Q-2Q 2022 (TBC)

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

European Clean Hydrogen Alliance

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

SMART

Estrutura: Tracker

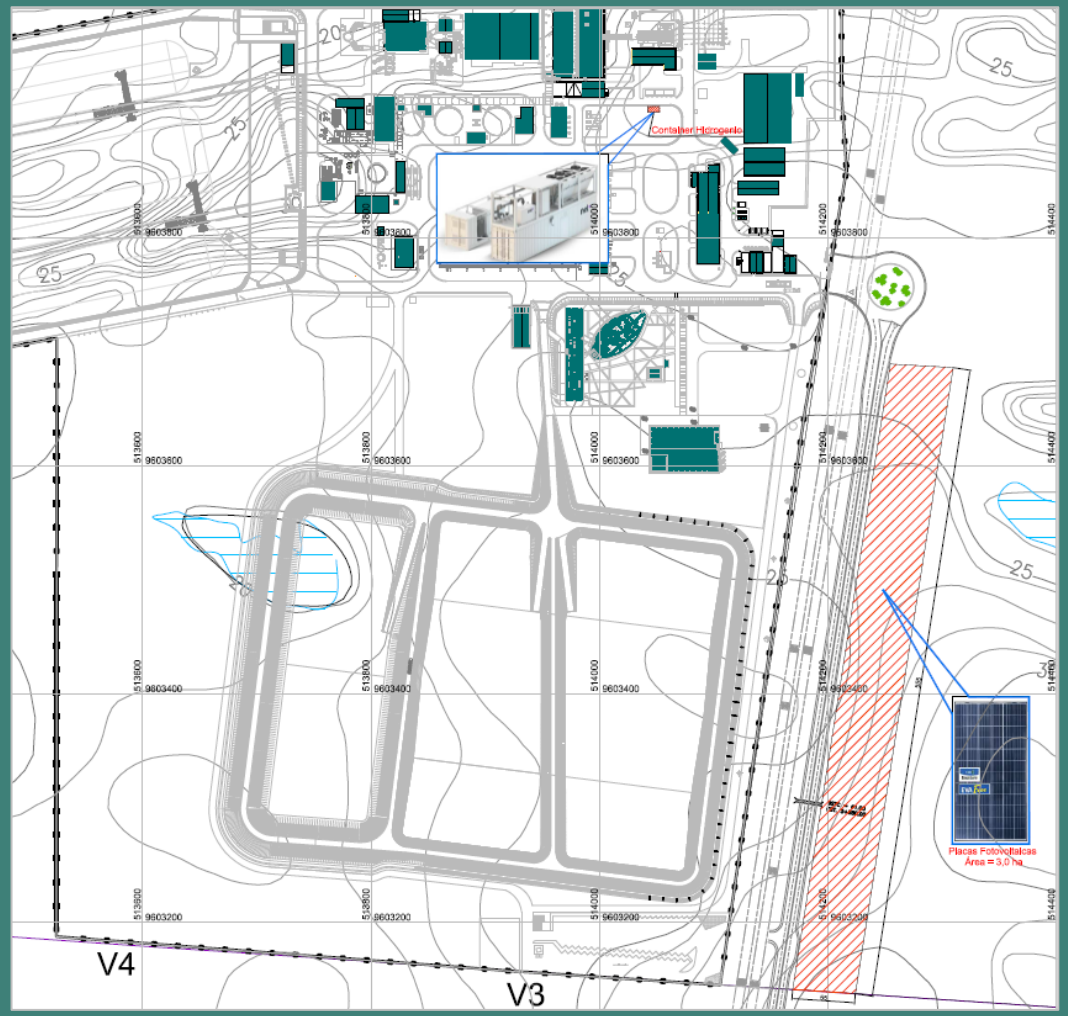
Potência instalada: 3MW

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

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edp
SMART

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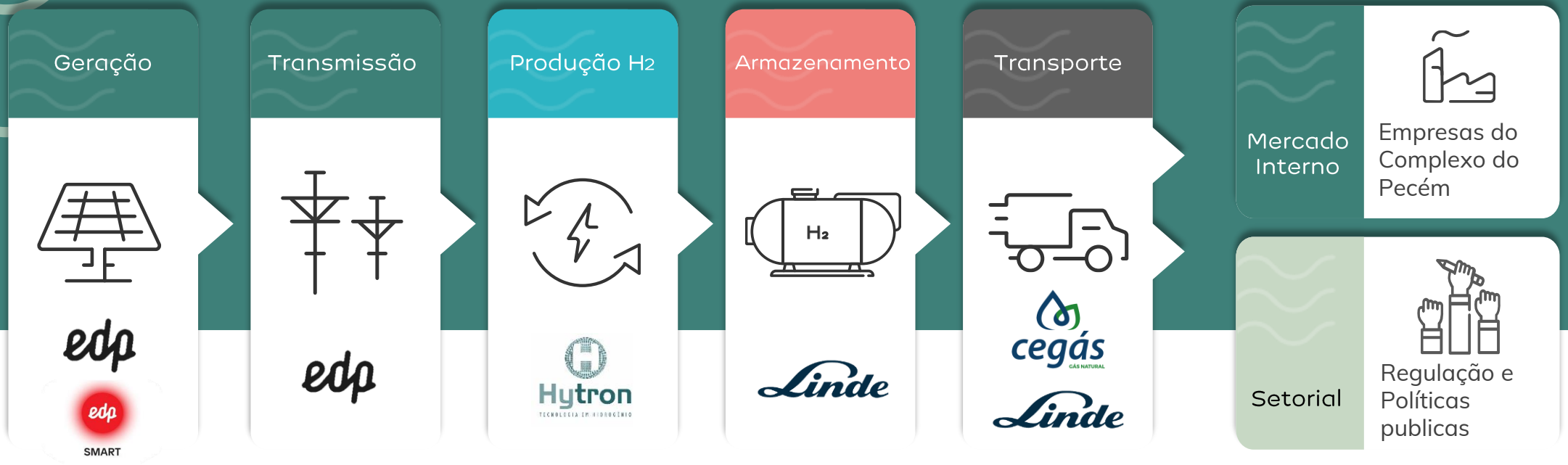
Sinergia entre empresas do grupo EDP

Brasil – Projecto Piloto Pecém
Estrutura Geral e Potenciais Parcerias

Integrantes e parceiros do projeto de P&D



Desenvolvido

A desenvolver

Proponente e Executoras

Coordenador Geral

Fornecedor eletrolisador

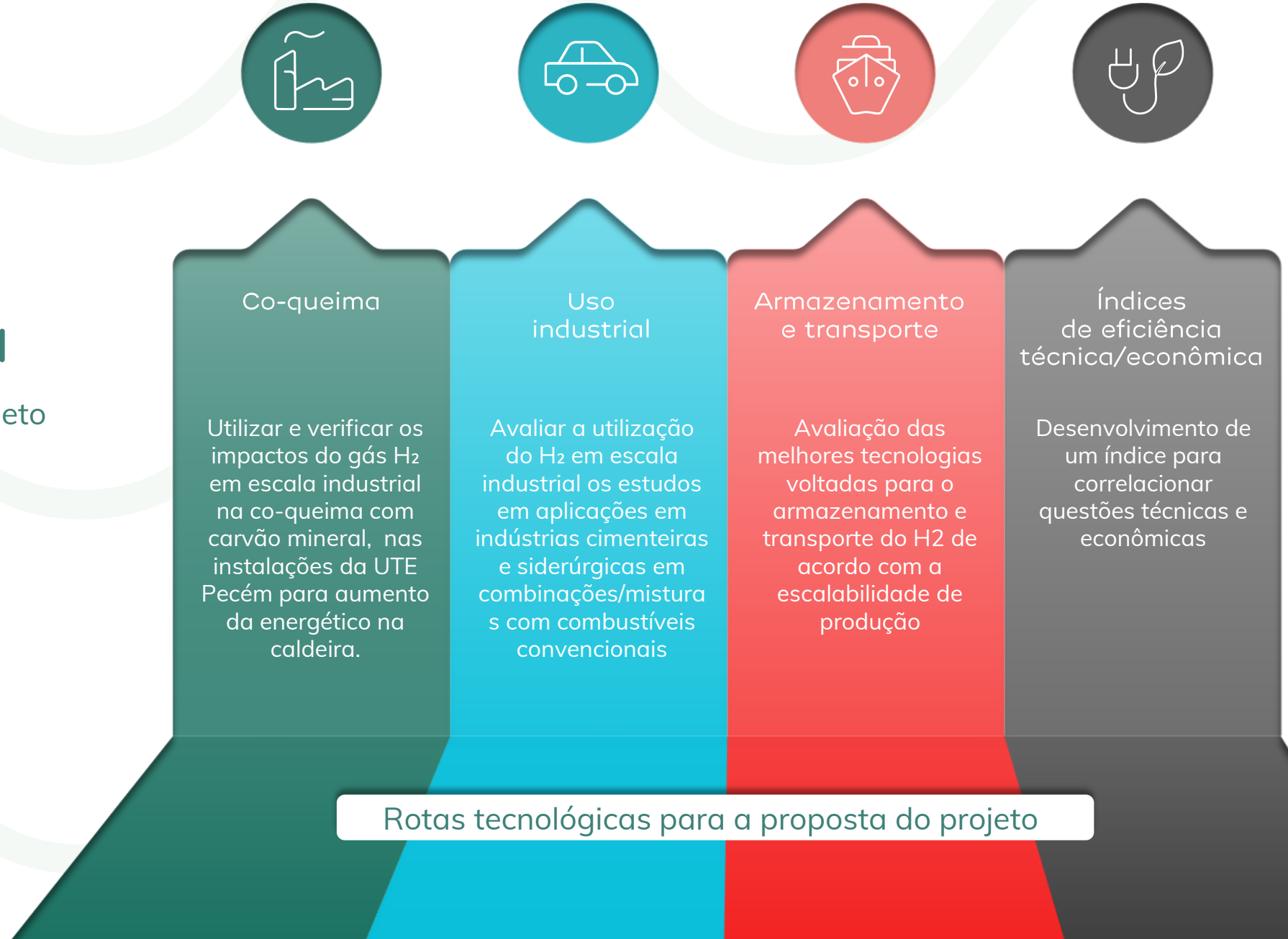
Coordenador Executivo

Coordenador Técnico

Parceiros estratégicos

Corrente tecnológica

Frentes tecnológica de projeto



Projeto Pecém H2V

Marcos do projeto até o momento

Início do projeto **Julho/21**

1° molécula de **H_2V** **Dezembro/22**

1

SEMACE

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

Hytron

Eletrólise

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

5

SMART

Usina Fotovoltaica

Aquisição da unidade fotovoltaica com potência de 3,0 MWp

Hard to abate sectors

Devoloping decarb solutions for industry with major players and experts (proposasl for Arcelormittal and Acerinox)

Steel Industry

InnoEnergy

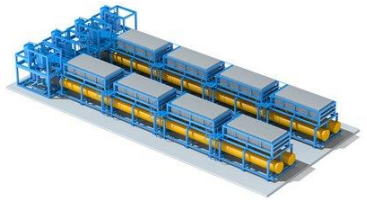
H2GreenSteel

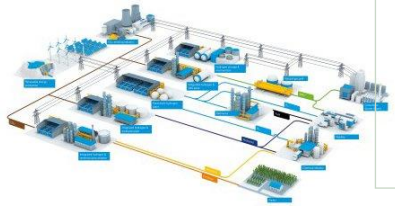
H2 Green Steel will produce 5M tons of CO2-free steel, mobilize 2.5B€ investments and create 10,000 jobs

Brazil largest steel producer in latam

Cement

Chemical & Synthetic Fuels





Green Ammonia

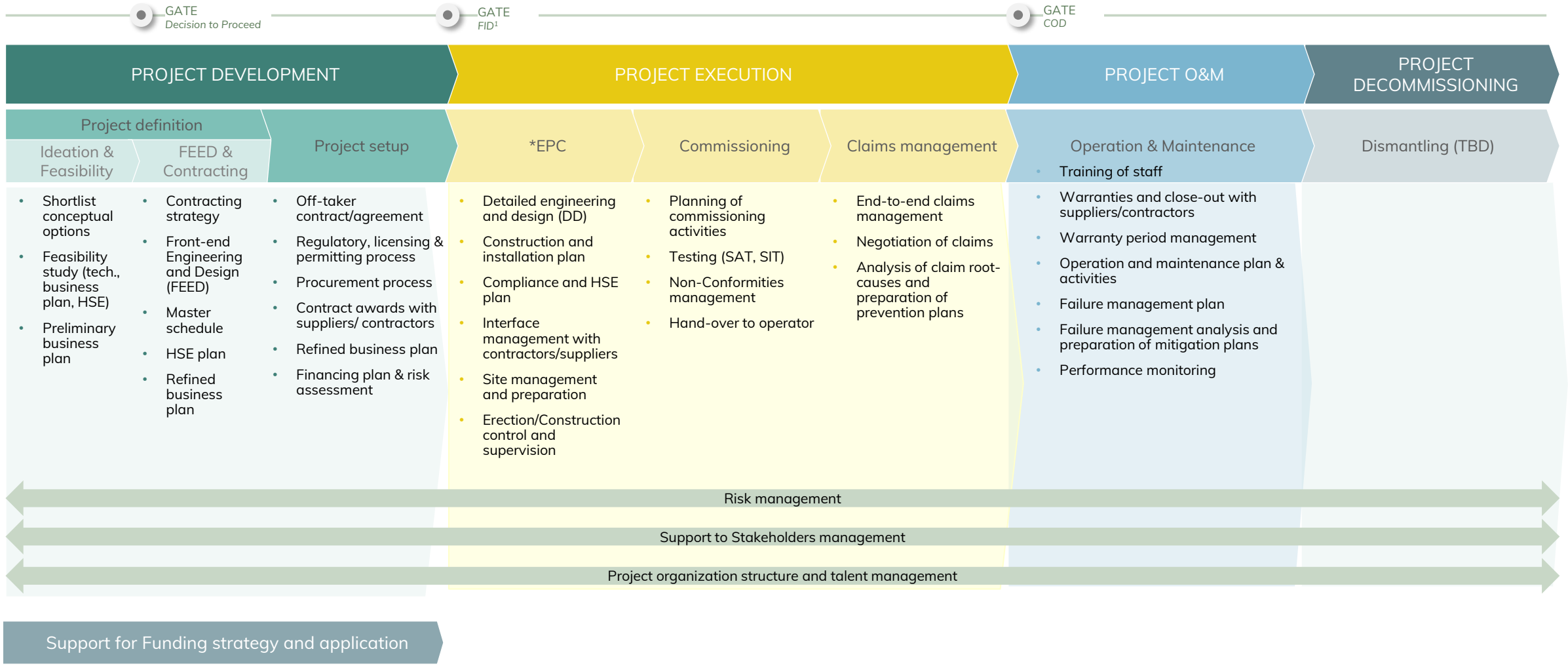
Electrical ammonia synthesis

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

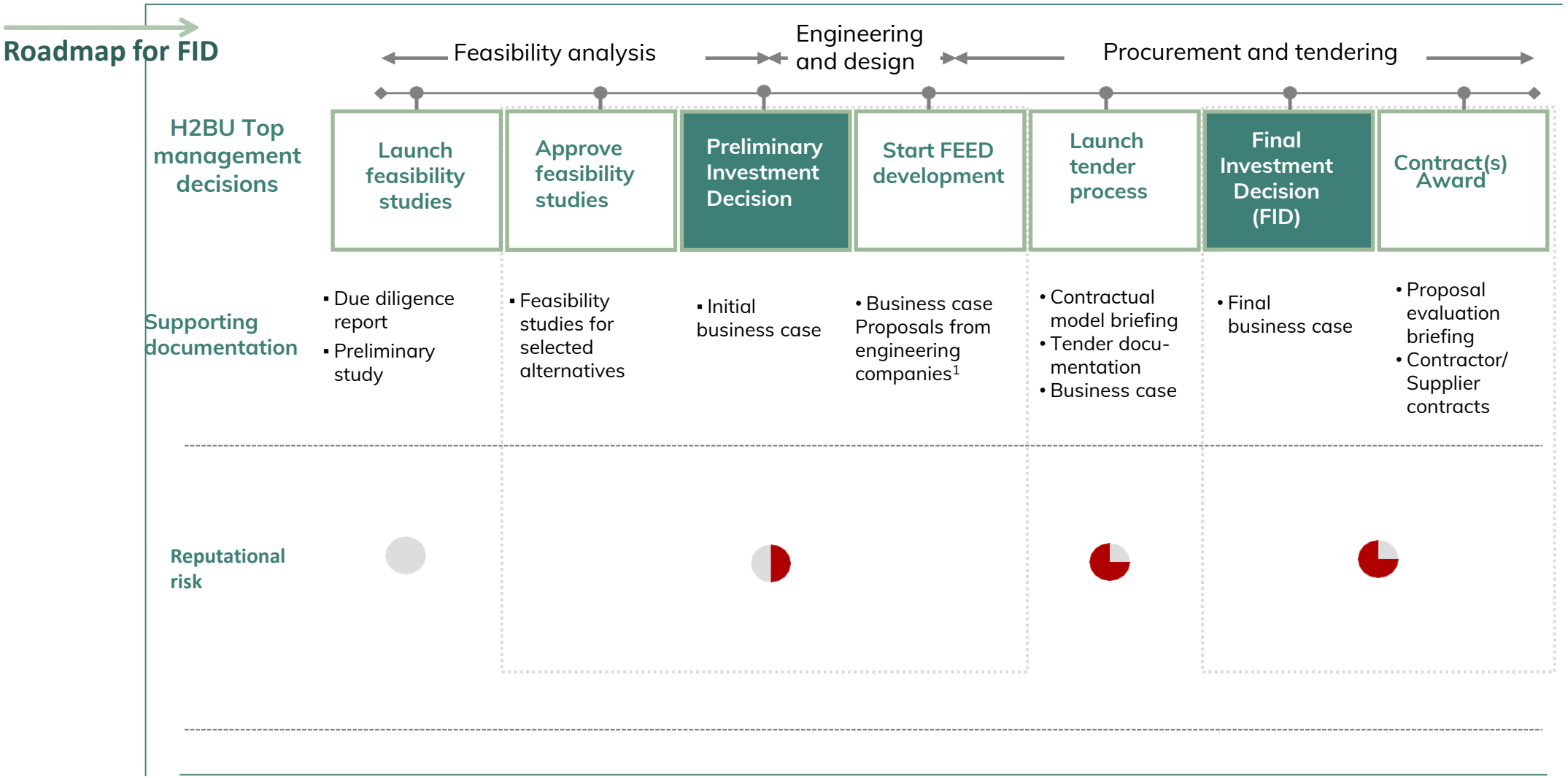
...requiring competences to be provided by internal business units

H2 development requires cross functional competence

Project Management	Process/Mechanical Engineering	Power Systems	C&I	Civil	Environment	Procurement
Client Management & Communication Managing resources Planning Cost Control Scope	Process design & Integration H2 technology System Configuration H2 I&D, Work Groups… Materials	Transmission Lines Substations Power Distribution Transformers Power Electronics	Energy Management Systems, Process Control Systems, Storage- Batteries	Plant layout Infrastructures Buildings Architecture BIM	Sustainability, Environment legislation Permitting	Contractual Tender Processes Comercial negotiation

Business Analytics	Safety	Commissioning	O&M	Licensing	Regulatory	Innovation	Risk
Energy Systems and market Modelling Prospective Studies Feasibility Studies (ecofin)	Safety Site Specific Conditions	Factory tests Site management Functional tests Performance Tests	Operation & maintenance standards	Permits legislation	Policy and regulatory affairs	New technologies I&D funding Battery Storage VPPs	Risk analysis

Actual effort is concentrated in activities prior to FID

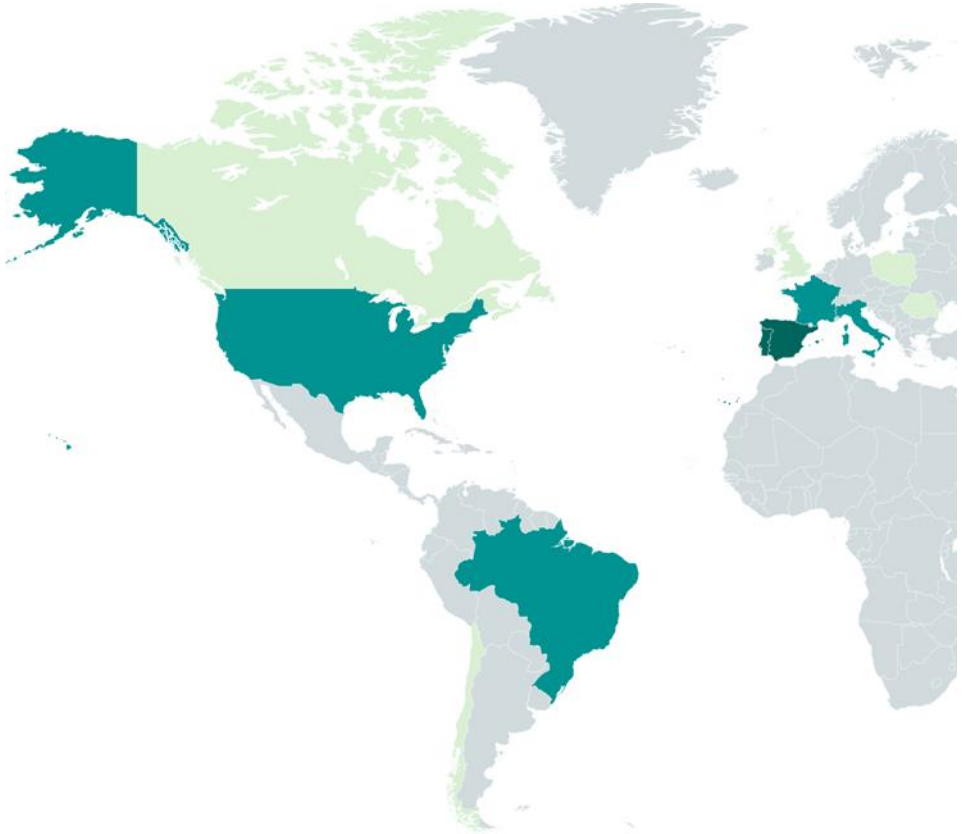


03

Global Service Provider

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

Project development by geography



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R&D	• Assess innovative technologies, capturing funds to support projects

Several service provider models may be used

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

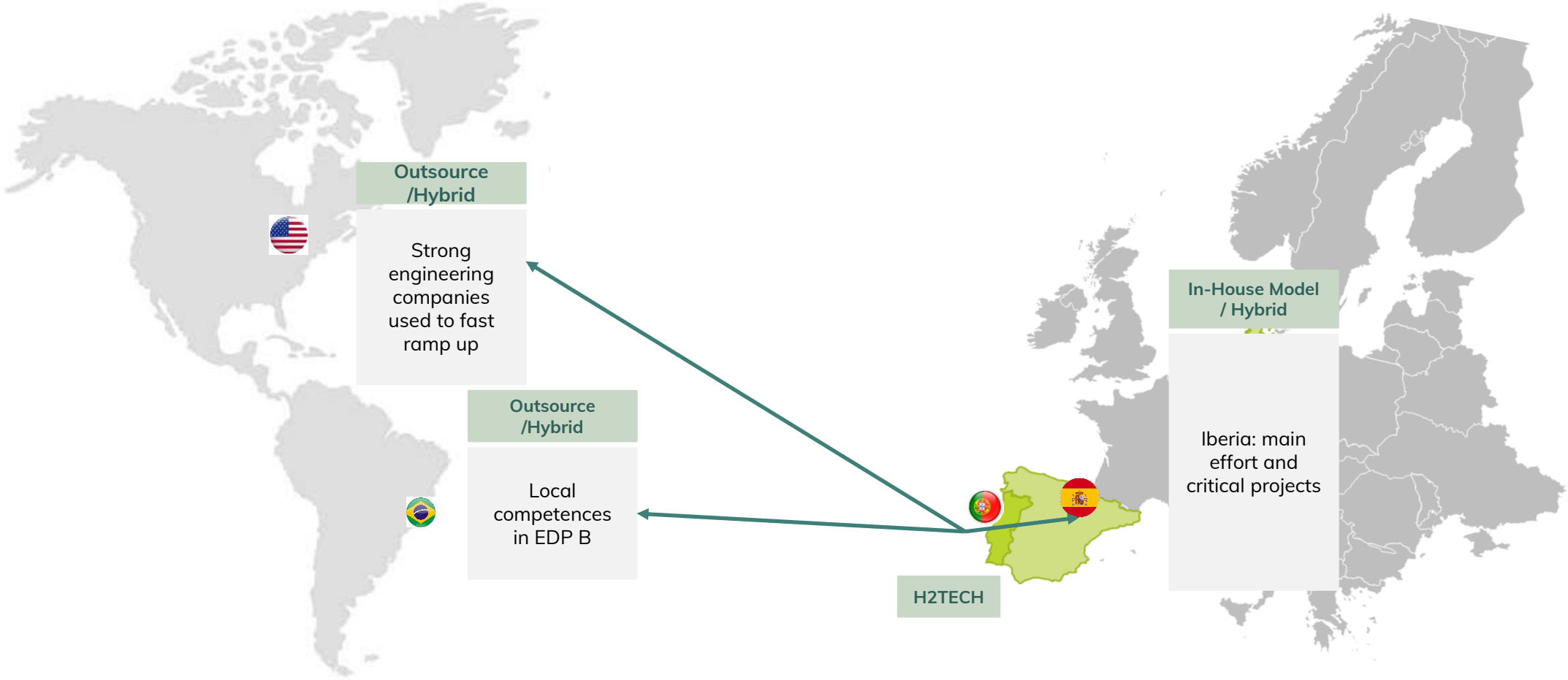
- **Internal capacity** and capabilities
- **Requests** from stakeholders
- **Complexity** and number and nature of stakeholders involved
- **Geography**

Technical design development models

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