

# The 11th NEDO-CDTI Joint Workshop

## “Technologies for Hydrogen Valley in Spain and Japan – Regional H2 Value Chain”

Towards techno-economic feasibility  
of hydrogen's value chain:

 quantum hydrogen Project

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TECHNICAL RESPONSIBLE FOR RENEWABLE  
HYDROGEN PROJECTS

CAPITAL ENERGY



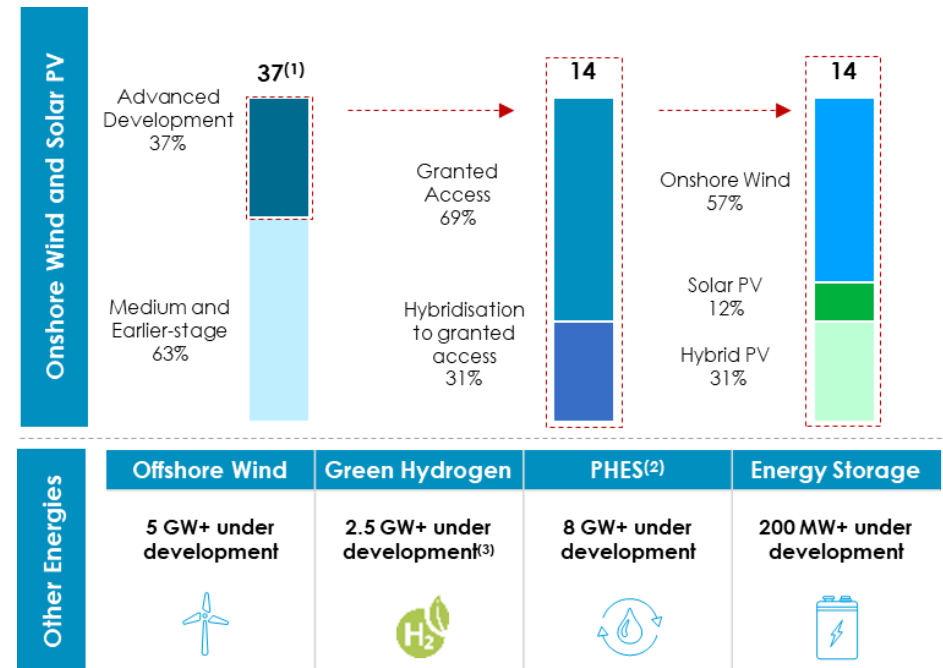


# Capital Energy, the Leading Integrated Renewable Energy Platform in Iberia

## Capital Energy at a Glance

- **Capital Energy** owns **one of the largest** greenfield renewable energy portfolios in Europe located throughout Iberia:
  - **~37 GW of onshore wind and solar PV** project portfolio including **~289 MWs in operation/construction** and **~14 GW in advanced development** with land and grid access secured.
  - Well positioned to leverage solar large pipeline and fully-resourced organisation and **deliver 15 GW operating portfolio towards 2028**
- **Unique portfolio** in terms of **scale, maturity, technology mix and geographical footprint**
  - **The largest onshore wind portfolio in Iberia** with complementary solar PV pipeline assets in premium locations in Iberia
  - **Advantageous early-mover position in other renewables energy technologies:** offshore wind, PHES(2), energy storage and green hydrogen
  - **Widespread Geographical Footprint** Across Iberia (presence in 44 out of 50 provinces in Spain and 9 out of 18 districts in Portugal)
- **Differentiated organisation and integrated approach: in-depth expertise across the entire value chain** (development, EPC management, commercialisation, financing, operations, energy management)
- Unrivaled team of highly talented and committed **355 FTEs** including **>230 developers and technical experts** on-the-ground, leveraging as well on solid **strategic partnerships** with global and local tier-1 supply and financing chain partners

## Capital Energy Asset Portfolio Overview (GW)



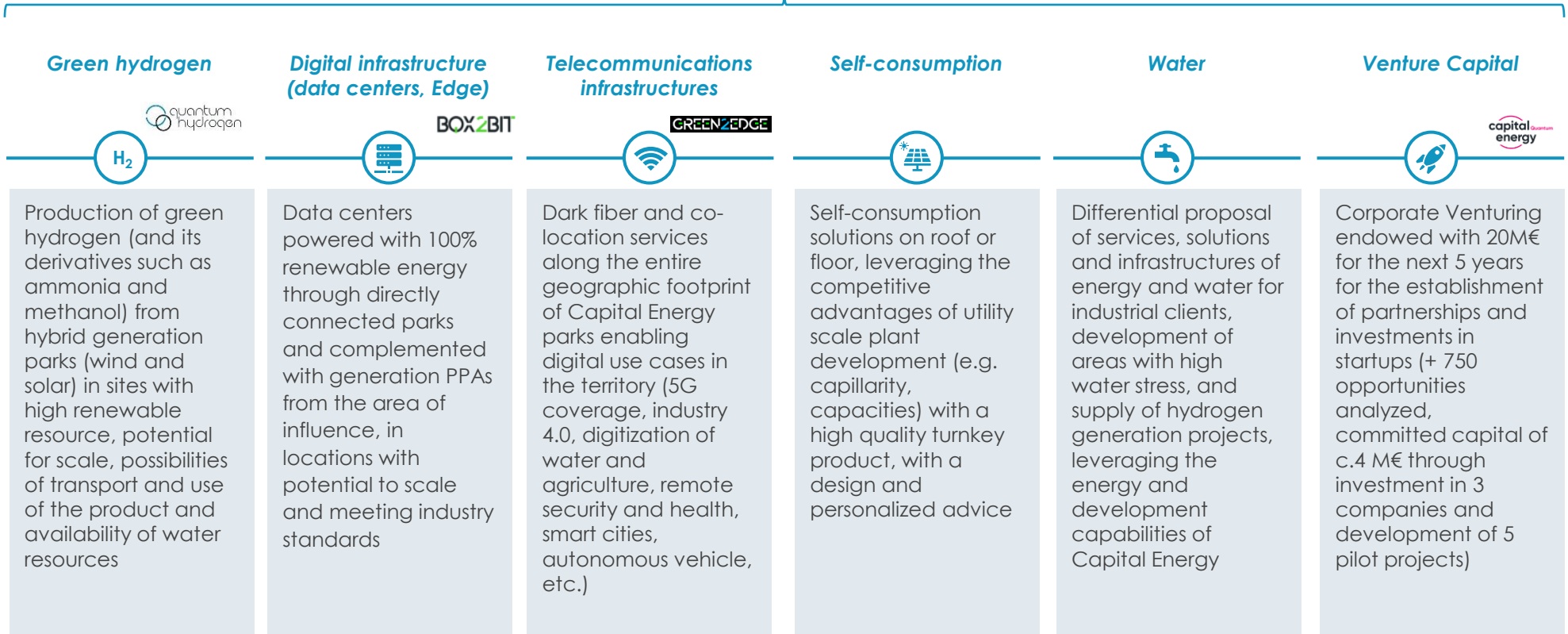
**Leveraging this leadership position in large renewable generation plants and infrastructures, new business lines have been launched in energy-intensive sectors, where sustainability is a key differentiating aspect, and where our widespread geographical footprint positions us with competitive advantages that are difficult to replicate in the market**

**Notes:**

1. **Advanced development** includes individual projects in operation, under construction and projects with land secured, approved grid access permits (i.e. granted access) in addition to solar PV hybridisation. **Medium stage** includes individual projects for which some or all the relevant development administrative milestones have been completed. **Early stage** includes individual projects currently undergoing preliminary studies (e.g., geotechnical or topographic characteristics of the required land, wind/solar resources, preliminary environmental assessment)
2. Pumped Hydro Electrical Storage
3. Of which +1 GW at an early stage with preliminary studies underway



# Capital Energy: beyond large renewable generation plants and infrastructures





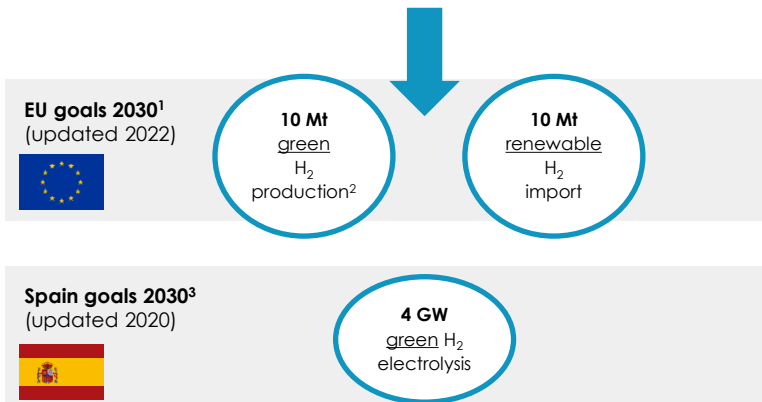
# Capital Energy, the Leading Integrated Renewable Energy Platform in Iberia

✓ Europe is betting on clean hydrogen to achieve its climate goals and Spain is in a privileged position for its production

## European H<sub>2</sub> regulatory context

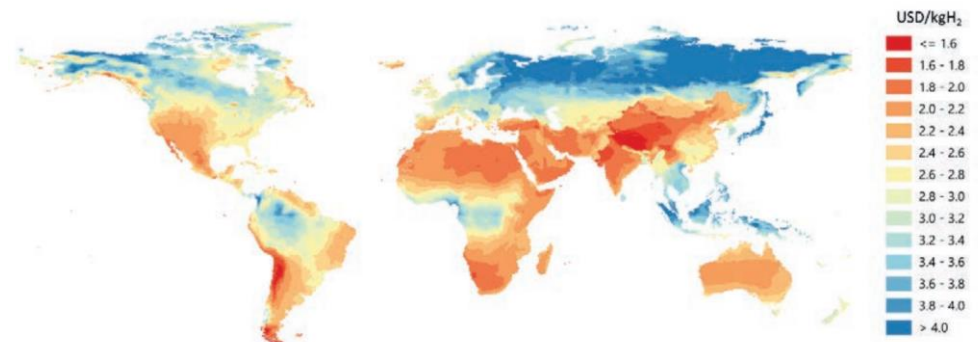
- European Green Deal – 2019
  - Fit-for-55 – 2020
  - EU Hydrogen Strategy – 2020
- Short, medium and long-term goals for Europe, amplified through **RePower EU - 2022**

**Repower EU - 22** sets to **reduce the demand for Russian gas** by the EU by 2/3 before the end of the year 2022



## Spain as a premium location for H<sub>2</sub> generation

- **Optimal conditions for H<sub>2</sub> generation:** lowest LCOH in Europe due to high renewable resource, availability of land and industrial and transport development
- **Favorable regulatory framework for green hydrogen development envisaged:** e.g., RD-L 14/22 Administrative procedure so that renewable gas production facilities can be connected to the transport and distribution pipeline network



Source: "The Future of Hydrogen". IEA. 2019

**Europe** is setting **ambitious growth targets**, deploying a **demanding regulatory framework** and **financial aids** to achieve them

**Spain** is positioning itself as a green H<sub>2</sub> generation and export hub due to its optimal conditions as a **renewable resource**, and the **planned regulation and infrastructure**

1) Repower EU updates Europe's 2030 targets from producing 10 Mton of renewable hydrogen (2020) to producing 10 Mton of green hydrogen and importing 10 Mton of renewable hydrogen  
 2) 10 Mton of green hydrogen production is equivalent to 65 GW ELZ (assuming 8,000h and an efficiency of 52 kWh/kg H<sub>2</sub>) or even 130 GW ELZ (4,000h)  
 3) Goals set in "Hoja de Ruta del Hidrógeno (2020)" – pending to be updated after the publication of the REPower EU - 22



# Quantum H2 is uniquely positioned to develop cost-effective hydrogen projects throughout Iberia with a short time-to-market



**Greenfield renewable projects not previously subsidized and additionality restrictions** → EU requirements met for “Green” H<sub>2</sub> certification<sup>1</sup>



**Hybrid (and on-grid) farms with possibility to self-consumption** → lower costs for hydrogen production (15-30% lower LCOH vs PV off-grid)



**Extensive project clusters with potential and room to scale-up** → potential for economies of scale for industrial projects (ammonia, methanol, etc.)



**CE's project pipeline with advanced stage of maturity (14 GW, including 8 GW of hybrid wind and solar projects)** → accelerated time-to-market



**Widespread presence across Iberia** → proximity to water, access to the natural gas grid network, potential H<sub>2</sub> offtakers and main logistic corridors for chemicals and industries

1) Although the draft Delegated Act on additionality envisions a transitional phase until 31.12.2026, CE-Hydrogen would meet the requirements to qualify H<sub>2</sub> as renewable even before that date

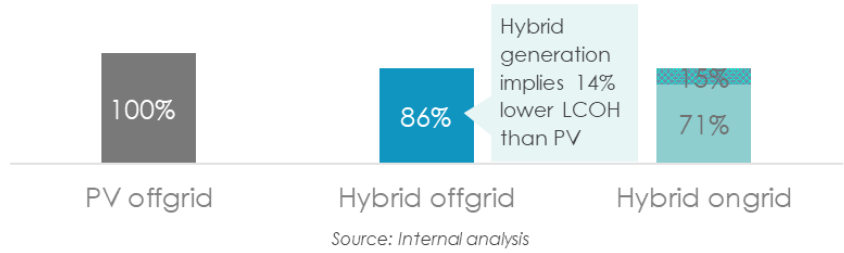


# ~70% of LCOH is driven by electricity cost where Quantum H<sub>2</sub> has a competitive advantage due to the position of its assets.



## Quantum Hydrogen owns assets with hybrid renewable resource (lower LCOE)

Comparative LCOH (€/Kg) by project type



## Pilot projects already underway

### Hystorenew

- Research on energy storage using hydrogen to facilitate decarbonization and integration of renewable technologies.
- Quantum Hydrogen leading the multisectoral and multidisciplinary R&D consortium formed by 8 leading companies and supported by 6 reference research organizations in Spain.

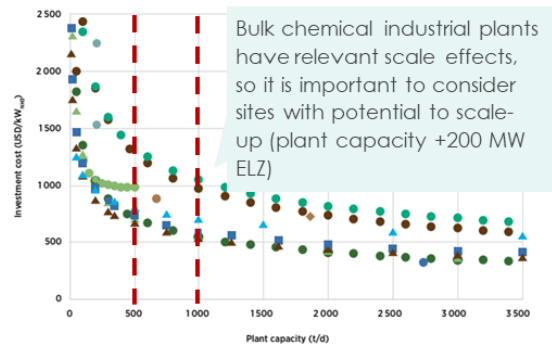


### Prometeo – La Encantada

- Validation of renewable H<sub>2</sub> production with SOE technology (25 kW-15 kg/d) for ammonia production, gas grid injection and energy storage.
- ENEA leading the multisectoral and multidisciplinary R&D consortium formed by 5 leading companies and supported by 4 reference research organizations in Europe.



## Quantum Hydrogen owns assets with potential to produce ammonia/methanol in a profitable scale



Note: Ammonia plant capacity (t/d) is directly linked to electrolysis capacity (MW). 500t/d equals to 200 MW ELZ with 8,000h and 50 kWh/kg H<sub>2</sub>  
 Source: Global Hydrogen trade to meet the 1.5°C climate goal-part 2". IRENA. 2022



# Quantum Hydrogen will install and operate an electrolyzer factory in Spain to supply its own projects and the EU market.

✓ The factory will assemble not only QH own stack development but also tier one companies

- **Potential bottleneck in electrolyzer manufacturing:** a lack of supply in the market is foreseen due to the large number of projects for the coming years and a production capacity that is still under development
- Regions such as the EU are seeking **energy independence** and reliability so will therefore promote the location of factories in this territory
- There are **component manufacturers that can supply the different parts**, and from Europe assemble them for the mass production of electrolyzers
- Spain has **differential assembly capabilities** in the automotive industry as well as industrial and O&G EPC know-how



There are more than **1.000 equipment and components companies** being the 4<sup>th</sup> auto components producer in Europe



**POWER ELECTRONICS**

- ✓ Own development with **CIDAUT** design
- ✓ Agreement with a component provider (under discussion)

**BALANCE OF PLANT**

- ✓ Agreement with a Spanish **EPC company** from the O&G
- ✓ Own development with CIDAUT design



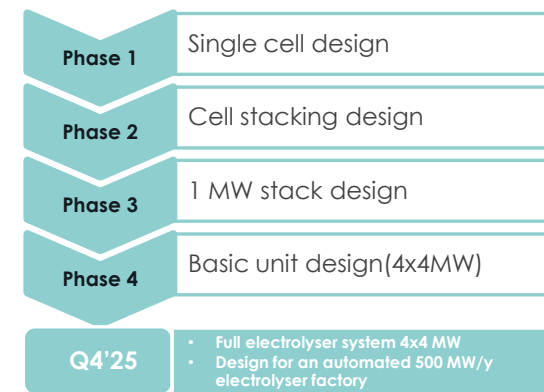
*Fully automated and standardized electrolyzer QH factory*

**STACK**

- ✓ "on the shelf" alkaline stacks
- ✓ Supply agreement with providers (tier 1)

**STACK**

- ✓ Own development with **CIDAUT** design
- ✓ Agreement with a component (cells, electrodes) provider





# Quantum Hydrogen seeks to develop green hydrogen at scale while anticipating early-stage market challenges

H<sub>2</sub> market insights

~70% of green H<sub>2</sub> production cost is driven by **electricity cost**, implying a differential value for the lowest cost of renewable generation

H<sub>2</sub> technology development and increased standardization could lead to **bottlenecks in equipment supply and project execution**

Hydrogen development requires **specialized technical personnel and strong development capabilities** (both for renewables and H<sub>2</sub>)



Quantum Hydrogen differential value proposition



## 1. Hybrid generation assets

Projects with **optimal H<sub>2</sub> generation conditions** to achieve the **lowest LCOH**:

- “**Green H<sub>2</sub>**” (additionality restrictions)
- **Hybrid** renewable generation assets (most of them with **granted access**)
- Potential to **scale-up in size**
- Advanced **stage of maturity**
- **Widespread presence** across Iberia



## 2. Strategic JVs and partnerships

Key **alliances and partnerships** around the H<sub>2</sub> ecosystem to secure **supply and cost control**:

- JV to standardize and mass-produce **electrolyzers** locally, securing European supply, reliability and independence
- JV with a local reference **EPC**, ensuring the proper **execution of renewable and hydrogen projects**



## 3. Holistic H<sub>2</sub> skillset

Extensive **experience to execute E2E renewable hydrogen** projects:

- Team with **proven experience in the entire H<sub>2</sub> value chain** and 2 H<sub>2</sub> pilot projects
- Strong **capabilities to develop large renewable projects** (CE, +230 developers and technical experts on-the-ground)
- Resources and solutions for **optimal energy and asset management**

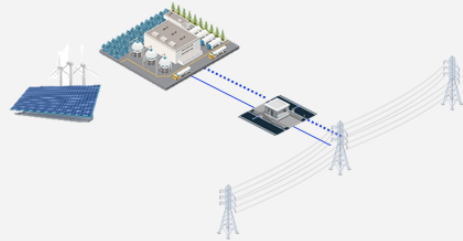




# Quantum Hydrogen is a pure H<sub>2</sub> player that develops, builds and operates 2 types of renewable H<sub>2</sub> generation assets



## On-grid renewable generation assets



The electrolyzer can either buy electricity from the grid (when it is more profitable to produce hydrogen) or sell any excess renewable generation (when it is more profitable to sell electricity)

*Initial perimeter Quantum H<sub>2</sub>*

**7 grid connected projects**  
**1.310 MW Electrolysis total**

## Off-grid renewable generation assets



The electrolyzer is only connected with self-consumption renewable power. There are multiple sites with an excellent renewable resource (without possible grid access). with the advantage of a lower land competition

**4 off-grid large scale projects**  
**1.000 MW Electrolysis total**

**15 off-grid small scale projects**  
**250 MW Electrolysis total**

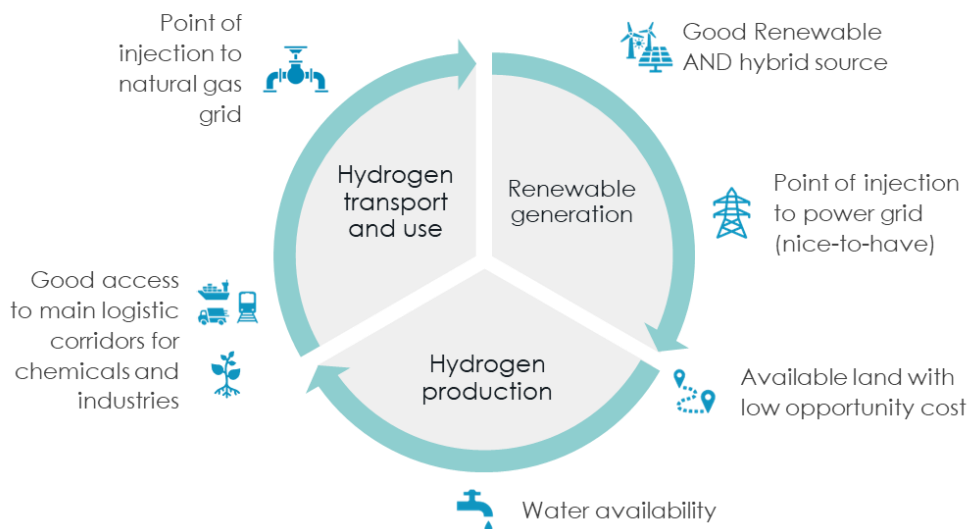


# MAIN CHALLENGE

## Hydrogen Business plant deployment



### Criteria used for the selection and prioritization of project sites



#### Good hybrid renewable resource



Given that the electricity cost represents more than 60-70% of the production cost, the availability of a high hybrid renewable resource in the area (solar and wind), the direct connection (possibility of self-consumption) as well as the potential use of curtailment are essential

#### Point of injection to power grid (nice-to-have)



Having a power evacuation point can improve the economics of the installation. The total renewable power to be installed can be higher than the evacuation power

#### Available land with low opportunity cost



Locations where there are no major land struggles (e.g. low competition or opportunity cost), low environmental impact, potential to scale-up in the future and industrial land available

#### Water availability



Sites with high possibility to have the required authorization for water collection

#### Good access to main logistic corridors for chemicals and industries



Sites close to railways, port, heavy traffic roads and hydrogen consuming industries to facilitate the transport and consumption of green hydrogen and its derivatives

#### Point of injection to natural gas grid



Being close to an evacuation point for injection into the existing natural gas network facilitates the transport of h2 as a gas



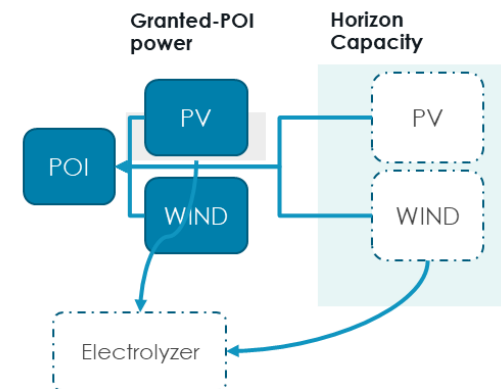
# On-grid projects total up to 1.3 GW of green H2 generation and more than 4.7 GW of associated renewable



## Quantum Hydrogen on-grid projects

Project	H <sub>2</sub>	Description	Location	Granted-POI + hybrid, MW <sup>1</sup>	Horizon, MW
Project 1	H <sub>2</sub>		Palencia	159	500
Project 2	H <sub>2</sub>		Sevilla	122	609
Project 3	H <sub>2</sub>		Burgos	118	141
Project 4	H <sub>2</sub>		Zaragoza	200	292
Project 5	H <sub>2</sub>		León	956	176
Project 6	H <sub>2</sub>		Tarragona	253	379
Project 7	H <sub>2</sub>		Soria	613	234

### Illustrative



Wind generator
 Solar PV generator
 Ammonia production
 Methanol
 Gas grid injection
 Good logistic

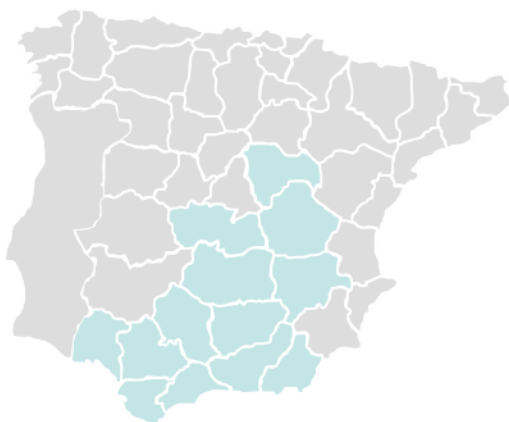
1) Granted - POI capacity it is not included in the valuation  
 2) Optimal sizing assuming a 33% success rate for the renewable Horizon power



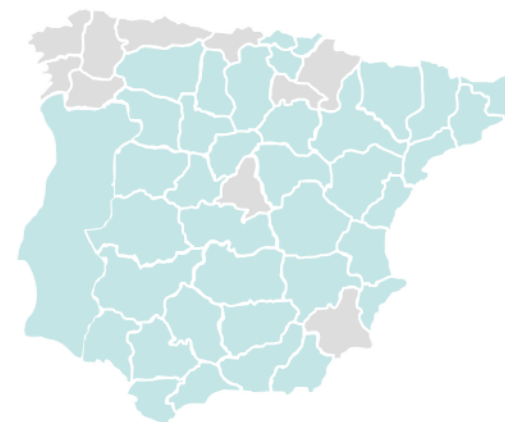
# Off-grid projects total up to 248 MW small scale green H2 generation and 1 GW industrial project



## Large scale off-grid industrial projects



## Small scale off-grid projects



Project	Location	On going	Electrolysis capacity. Total MW <sup>1</sup>	Total RE capacity. Total MW
4 projects	Confidential	Land plot negotiation	1,000	6,900

- ✓ Excellent renewable energy hybrid production (farm clusters) where there is no land tension since there is no point of injection to the national electric grid
- ✓ Water availability
- ✓ Logistic corridors
- ✓ Ammonia and/or methanol are considered as they are large locations with strong economies of scale

Project	Location	On going	Electrolysis capacity. Total MW <sup>1</sup>	Total RE capacity. Total MW
15 projects	Confidential	Land plot negotiation	248	1,500

- ✓ Excellent renewable energy hybrid production (farm clusters) where there is no land tension since there is no point of injection to the national electric grid
- ✓ Water availability
- ✓ Smaller scale to reduce time-to-market although with possibilities to scale-up: off-takers in industry and natural gas blending

1) Assuming a 33% success rate for the renewable Horizon power



# Ideas for a Japan – Spain collaboration

- ✓ Quantum Hydrogen aims to be an international player in the global hydrogen market leveraging its differential capabilities

## Quantum Hydrogen as an early mover in the global H<sub>2</sub> market

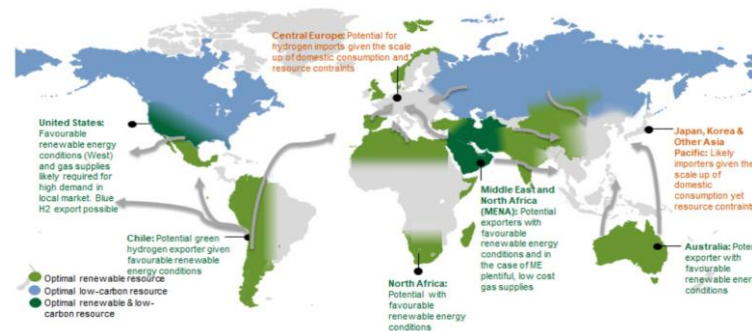
Quantum Hydrogen wants to be an early mover in locations with optimal H<sub>2</sub> generation conditions.

Currently, Quantum Hydrogen is negotiating specific locations in North America (United States and Canada), LATAM (Chile) and North Africa.

Growth in these countries is being considered both organically (through JVs and partnerships with local partners) and inorganically (through M&A transactions).

- ✓ Main proposals for Quantum H<sub>2</sub> collaboration

- Japan as offtaker of H<sub>2</sub>
- Japan as a supplier of electrolyzers
- Japan as a partner of Quantum Hydrogen to develop electrolyzer at Spain
- Japan as co-developer of our projects in Iberian/Africa/ SEA (South East Asia)/Americas (and/or us in Japan projects)



Hydrogen

水素が  
次世代エネルギー  
社会を切り拓く！



# THANK YOU

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