Low Carbon Day
Hydrogen business strategy

Tomás Malango
Director of Hydrogen
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01. Hydrogen market vision
**01. Market Vision**

**Strong hydrogen market growth**

1. **Demand growth driven by low carbon H₂**
   - EU hydrogen demand – Market forecasts (M tons/yr)

   
<table>
<thead>
<tr>
<th>Year</th>
<th>EU - FCHJU1</th>
<th>€8.5 B H₂ production market size²</th>
<th>20</th>
<th>44</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td>20</td>
<td></td>
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<tr>
<td>2040</td>
<td>44</td>
<td></td>
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</tbody>
</table>

2. **Ambitious H₂ development targets in the EU and Spain, supported by public and private funding**
   - Public & private investment by 2030 (electrolyzers, storage, distribution)
   - Electrolyzer capacity by 2030

   - **EU**
     - 40 GW Electrolyzer capacity by 2030
     - 89-107 B€ Public & private investment by 2030
   - **Spain**
     - 4 GW Electrolyzer capacity by 2030
     - 9 B€ Public & private Investment by 2030 in H₂-related projects

3. **Recently launched "Fit for 55" regulatory package with ambitious targets supporting H₂ development**
   - Strong 2030 penetration targets
     - Min. 50% share of renewable H₂ consumption in industry
     - 2.6% minimum quota of RFNBO³ in transport
     - 0.7% e-fuels share in the aviation fuel mix (5% in 2035)
   - Discount tax rates for the use of renewable and low-carbon hydrogen for end-consumers (based on energy content)

4. **Further regulatory support still in progress**
   - Economic incentives to ensure low carbon H₂ competitiveness
   - Secondary regulation for H₂ and the 3rd Gas Package review including the contribution of H₂ to decarbonization of gas markets to be launched in December.
   - Technical requirements for production of H₂ and derivatives (e.g. renewable energy feed criteria, requirements on CO₂ for e-fuel production, etc.)

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1. EU-FCHJU forecast (Fuel Cell and Hydrogen Join Undertaking)
2. Market size estimated with 1.3 €/kg full grey (incl. capex) H₂ production cost (assuming natural gas cost of 20 €/MWh and excluding CO₂ price)
3. Renewable Fuel of Non Biological Origin – H₂ and H₂ derivatives (e.g. e-fuels)
Industry & transport lead market for renewable H₂

Industrial processes and heavy vehicles are the most promising short-term applications

Long-term H₂ penetration to be driven by regulation and technology

Lead H₂ development in the short term supported by regulation

Competitiveness of H₂ vs decarb alternatives (2030)

Large cost gap vs. incumbent

Competitiveness vs incumbent (2030)

Legend

Industry
Transport
Power & Heat

Bubble size is proportional to application's CO₂ emissions
01. Market Vision

Regulatory support & Refining competitiveness

EU regulation (RED II&III) can bring competitiveness to renewable H₂ produced for refineries

Industrial processes: competitiveness achieved in refining due to H₂ for fuel production being included as part of renewable targets in transport

<table>
<thead>
<tr>
<th>Hydrogen cost (€/kg H₂)</th>
<th>CO₂ price @ 60 €/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full grey H₂ production cost¹</td>
<td>1.3</td>
</tr>
<tr>
<td>Green H₂ cost 2020²</td>
<td>3.4</td>
</tr>
<tr>
<td>Green H₂ (incl. capex subsidies)³</td>
<td>3.1</td>
</tr>
</tbody>
</table>

¹ Natural gas price 20 €/MWh; range corresponds to CO₂ price (from 0 to 60€/ton)
² 100 MW electrolyser, 1200€/kW of CapEx (full project costs incl. electrical connection, civil, intermediate storage, project costs), 65% electrolyser efficiency, ~70% load factor, range corresponds to power price between 32 and 50€/MWh; additionally considers 6.4€/MWh grid toll.
³ H₂ capex subsidies 25% : effective capex 900 €/kw (Total capex 1200 €/kw)
## Hydrogen Competitiveness

Low-carbon H₂ expected to become competitive vs incumbent by 2030-35

### Conventional H₂

<table>
<thead>
<tr>
<th></th>
<th>EU</th>
<th>North Europe estimates</th>
<th>Spain estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H₂ production cost</strong> (€/kg)</td>
<td></td>
<td></td>
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<tr>
<td>Cost excl. capex (€/kg)</td>
<td>1.0-1.5</td>
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<td>1.3</td>
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<tr>
<td>CO₂ price (€/ton)</td>
<td>25-75</td>
<td>50-100</td>
<td>75-125</td>
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<tr>
<td>Prod. cost (incl. low price range CO₂)</td>
<td>1.3-1.8</td>
<td>1.9-2.2</td>
<td>1.9-2.4</td>
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<tr>
<td></td>
<td>1.4-1.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.6-2.1</td>
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### Low carbon H₂

<table>
<thead>
<tr>
<th></th>
<th>Low carbon H₂</th>
<th>Renewable H₂</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H₂ production cost</strong> (€/kg)</td>
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</tr>
<tr>
<td>Cost excl. capex (€/kg)</td>
<td>2.2</td>
<td>3.4</td>
</tr>
<tr>
<td>CO₂ price high range</td>
<td>1.7-2.2</td>
<td>2.1</td>
</tr>
<tr>
<td>Prod. cost (incl. low price range CO₂)</td>
<td>1.9-2.0</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>1.6-1.7</td>
<td>1.6-1.8</td>
</tr>
<tr>
<td></td>
<td>1.6-1.7</td>
<td>1.6-1.7</td>
</tr>
</tbody>
</table>

### EU

- **Current** H₂ production cost: **1.3-1.8 €/kg**
- **2030** H₂ production cost: **1.7-2.2 €/kg**
- **2035** H₂ production cost: **1.9-2.4 €/kg**

### North Europe estimates

- **Current** H₂ production cost: **2.5 €/kg**
- **2030** H₂ production cost: **1.9-2.0 €/kg**
- **2035** H₂ production cost: **1.9-2.0 €/kg**

### Spain estimates

- **Current** H₂ production cost: **2.1 €/kg**
- **2030** H₂ production cost: **1.6 - 1.8 €/kg**
- **2035** H₂ production cost: **1.3 €/kg**

### Notes

1. 20 €/MWh natural gas price
2. Considers carbon capture of 90% of total CO₂ produced
3. 100 MW electrolyser, 1200 €/kW of CapEx (full project costs incl. electrical connection, civil, H₂ intermediate storage, project costs), 65% electrolyser efficiency, ~70% load factor, electricity price 32 €/MWh, 6.4 €/MWh grid toll.
4. Low range: 100 MW electrolyser, 579 €/kW CapEx, 68% efficiency, ~70% LF, electricity price 25 €/MWh, 6.4 €/MWh toll; high range: 100 MW electrolyser, 760 €/kW CapEx, 68% efficiency, 70% LF, electricity price 30 €/MWh, 6.4 €/MWh toll.
5. CapEx 400 €/kw, 68% efficiency, LF ~70%; electricity price 20 €/MWh, 6.4 €/MWh toll, OpEx 24 €/kW
02.
Repsol position
02. Repsol Position

Repsol competitive advantages

Leveraging sources of competitive advantage...

- Main H₂ consumer (largest in Spain, and >5% share in the EU)
- Early entry @ scale
- Large potential scale
- Industrial asset base and capabilities
- Integrated position
  - Renewables
  - Commercial
- Iberian location – access to lower cost renewable
- Focused organization

... driving a differentiated market position

- Lower costs for H₂ and e-fuels
- Unique value proposition to end-customers
  - H₂ solutions
  - E-fuels
- Ability to attract partners
  - National
  - International
  - Technology
- Regulatory clout and presence
- Attractive equity story
Hydrogen consumption in Europe & Spain

Europe’s H₂ market (~6.6 M tons/yr, €8.5 B) represents c.9% of world market and is concentrated on ammonia and refinery uses.

- Refining: 41%, 2.7 M tons/yr, 56 CF 70%
- Ammonia: 36%, 2.4 M tons/yr, 13% CF 95%
- Chemicals - Methanol: 13%, 0.8 M tons/yr, 11% CF 95%
- Others: 11%, 0.7 M tons/yr, 56 CF 70%
- Total: 6.6 M tons/yr, 8.5 H₂ prod. market size (€bn), c.9% of world total

Spain’s H₂ market driven by refinery end-use, which accounts for 79% of total demand; market size ~ €0.8 B.

- Refining: 79%, 360 ktpa, 41 CF 95%
- Ammonia: 19%, 116 ktpa, 56 CF 70%
- Chemicals - Methanol: 2%, 13 ktpa, 79 CF 50%
- Other: 2%, 627 ktpa
- Total: 6.6 M tons/yr, 8.5 H₂ prod. market size (€bn), c.9% of world total

Hydrogen demand in Europe, 2020 (M tons/yr)

Hydrogen demand in Spain, 2019 (ktons/yr)

Source: IEA; Nexant

1. Capacity factor; Electrolyzer efficiency ~65%
2. Market size estimated with 1.3 €/kg full grey (incl. capex) H₂ production cost (assuming natural gas cost of 20 €/MWh and excluding CO₂ price)

The Repsol Commitment – Net Zero Emissions by 2050
02. Repsol Position

Present throughout the value chain

1,942 MW Renewable generation
299 MW Storage
552 MWeq H₂ Production

Geological storage

Biomethane production (steam reforming SBR)

Electrolysis

Photoelectrocatalysis

Power generation

Storage

INDUSTRY: refinery, ammonia, methanol, iron&steel industry

Bios & Waste

Hydrogen refuelling stations

E-Fuels

12 Hydrogen Refueling Station

2,7 MM l/year of e-fuels

1. Note: figures as of 2025
03. Ambition
03. Ambition

Current ambition aligned with “Fit for 55” targets

2025 objective

H₂ capacity objective, 2025 (GW)

<table>
<thead>
<tr>
<th>Repsol H₂ in own assets¹</th>
<th>3rd-party assets</th>
<th>Total ambition (updated)</th>
<th>Ambition in Strategic Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.45</td>
<td>0.10</td>
<td>0.55</td>
<td>+0.15</td>
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</table>

2030 ambition

Required H₂ capacity vs. ambition, 2030 (GW)

<table>
<thead>
<tr>
<th>Repsol min. regulatory requirement</th>
<th>Repsol H₂ in own assets</th>
<th>3rd-party assets</th>
<th>E-fuels</th>
<th>Total ambition (updated)</th>
<th>Ambition in Strategic Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land transport</td>
<td>1.5</td>
<td>1.0</td>
<td>0.5</td>
<td>0.4</td>
<td>1.9</td>
</tr>
<tr>
<td>Aviation &amp; Maritime</td>
<td>0.3</td>
<td>0.3</td>
<td>0.5</td>
<td>1.0</td>
<td>+0.7</td>
</tr>
</tbody>
</table>

- Deployment of electrolyzer capacity in own refineries to develop experience and scale
- Developing H₂ hubs around own sites
- Participation in pilots with 3rd-parties to develop positioning and know-how in new applications

- Fit for 55 proposal strongly support renewable H₂ development in Europe:
  - Transport: 2.6% minimum quota of RFNBO³ for all transport modes and minimum quota of 0.7% of e-fuels used in aviation by 2030 (5% by 2035)
  - Industry: 50% minimum share of renewable H₂ used for final energy and non-energy purposes in industry
- Current H₂ ambition in own-assets achieves minimum regulatory targets
- E-fuels plant to strengthen Repsol H₂ position and increase market share in a highly synergetic long-term business line
- Third party volumes to cover additional industrial needs

1. Including the e-fuel pilot plant in Petronor
2. SBR: Steam biomethane Reforming, renewable hydrogen production from biomethane
3. Renewable Fuel of Non Biological Origin – H₂ and H₂ derivatives (e.g. e-fuels)
04. Business roadmap
04. Business roadmap

Key financial metrics

Cumulative EBITDA (M€)

-14 1.244 2.369
2022-2025 2026-2030 2031-2035

Capacity, End-of-year (GW)
0.5 1.9 1.9

Cumulative CAPEX (M€)
967 1.582 72
2022-2025 2026-2030 2031-2035

Capex for stack replacement

Note: Considers 20 years lifetime for each project since commissioning, and no terminal value; does not include overhead costs; H₂ price estimated as cost of grey H₂ production alternative (steam reforming) + CO₂ cost + RED II green premium; e-fuel price estimated as diesel price alternative (including hydrocarbon taxes) + RED II green premium; amortization for projects with commissioning date before 2027 of 5 years, for other projects of 20 years; PPAs established before 2027 with high cost (+22€/MWh compared to the base cost of the PPAs signed afterwards)
Pipeline of projects up to 2025

Capex (M€)  
- Electrolyzers in Petronor, Cartagena & Tarragona (2022-24-25): 179
- Biogas in SMR plants across refineries (2025): 273
- E-fuel pilot plant in Bilbao (2024): 32
- Photoelec. in Puertollano (2025): 25
- Pilots in mobility & other industries (2023-25): 48
- Electrolyzers with local partners (2025): 54
- Total: 611

Capacity (MW)  
- Electrolyzers: 232
- Biogas: 200
- E-fuel pilot plant: 10
- Photoelec.: 0.2
- Pilots: 50
- Electrolyzers with local partners: 60
- Total: 552

Note 1: Capacities assume a 95% capacity factor;
Note 2: Equity share between 50% and 100% in projects deployed in Repsol refineries before 2025. Equity share for projects deployed in third-party assets in Spain of 50%. Equity share for international projects of 30%;

1. Assumes sizing of 3.25 MW renewable generation capacity per MW of electrolyzer (70% of Renewables power generation is dedicated H2 production, with the rest fed to the grid); Gross capacity assumes 100% of renewables development in projects in which Repsol's stake is >=50%.


The Repsol Commitment: Net Zero Emissions by 2050

~700 Renewables Capacity (MW)

1,795 Associated Renewables Net Capex (M€)
Production of e-fuels in Petronor

Development of worldwide reference plant to achieve commercial level and leading position in production of synthetic fuels

Investments:
Wind generation, electrolysis, e-fuels plant: €74 M

Production: 50 bbl/d

Partners
04. Business roadmap

SUNRGYZE – Renewable H₂ production technology

Repsol - Enagas partnership: technological development of disruptive and photo-electrocatalytic process for production of cost-competitive renewable hydrogen

- 100% renewable
- 100% CO₂ reduction vs conventional hydrogen.
- Based on the direct conversion of solar energy into chemical energy
- Collaboration with different public and private entities
- Co-funded by European Regional Development Funds (FEDER) and EU Innovation Fund

01. Module PEC with sun concentration

02. PEC cell

03. PEC cell [Detail]

Electrode (anode)

Separator

Electrolyte

Photoelectrode (photocathode)
04. Business roadmap

Spanish Hydrogen Network (SHYNE) Project

Repsol with great strengths to be the backbone of the Renewable Hydrogen roadmap and its sectoral integration, together with growing demand for H₂ in the coming years, and the role played by the European Funds, will lead Spanish national project.

Repsol’s objective is to **develop a national project** for the deployment of the renewable hydrogen vector, supported by public-private collaboration, which will take the form of the creation/boosting of:

- **3 hydrogen valleys** where they will develop specific renewable H₂ production projects and end uses in industry and transport, in addition to renewable Electricity Generation and Storage Projects.
- **2 Transversal Innovation Hubs and 1 Digitalisation and Knowledge Management Hub** with R&D&I and technological development, Knowledge Management and Digitalisation projects that guarantee a sustainable economy based on this energy vector.

**Multi-sectoral vision**

- Impacts in terms of ecology, job creation, knowledge and technological sovereignty
- Presence in 10 **Autonomous Regions**
- Investment of €3,230 M*

**Project aligned with both the EEFF and the Spain Can Plan**, especially with component 9, based on **technological and sectoral diversification and a coherent systemic approach**

**Tractor effect of SMEs**, with **40 partners** involved in the project and will be conveyed through **two relationship models**, strategic agreements and declarations of interest, to **facilitate the governance** of the project and **unify interests** of entities from different sectors and along the value chain.

* Total CAPEX. Repsol’s CAPEX is approximately 2,250 M€
Low Carbon Day

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