

The logo for Hydéal, featuring the word "hydeal" in a dark blue, lowercase, sans-serif font. The letters are closely spaced, with the 'y' and 'd' having a distinctive shape. The logo is positioned on the left side of a light blue rectangular background.

hydeal



Les promesses de l'hydrogène vert : le modèle HyDeal

Assemblée Générale du Pôle DERBI

12 avril 2022

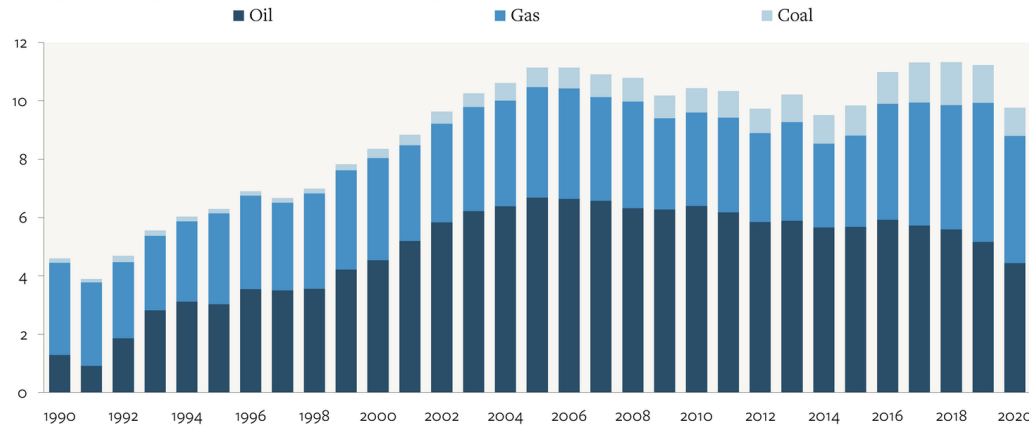
European energy security, prices and decarbonization: a survival game

Energy security and decarbonization: the 3,000 TWh Russian Question

Unserious Threat

Europeans increased their dependence on Russian oil, gas, and coal imports from Russia in the years after the invasion of Ukraine and annexation of Crimea. Things will only get worse if Nord Stream 2 comes online as planned.

Energy supplied by Russia to the EU27, exajoules per year

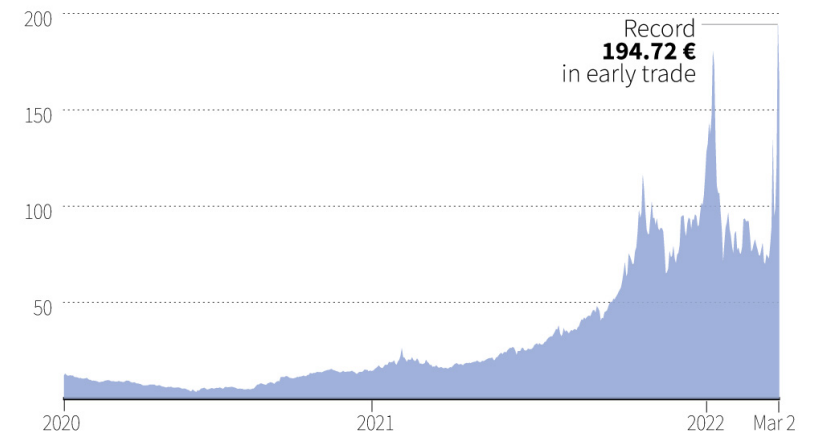


Source: Eurostat, BP Statistical Review of World Energy, Matthew Klein's calculations

European energy prices: What if the only way is up?

Natural gas price in Europe

Price changes on reference market* in euros per mWh



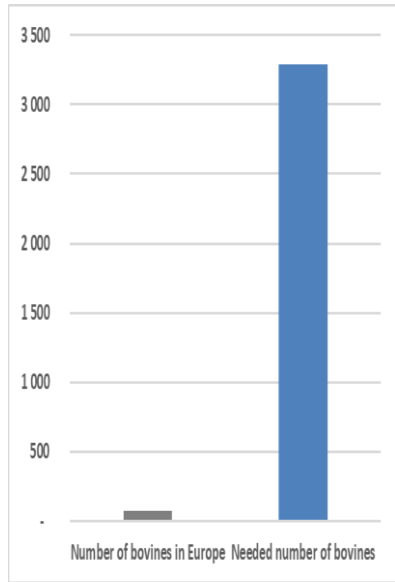
*Dutch TTF market (Title Transfer Facility)

Source: Intercontinental Exchange, prices at market close, except for March 2

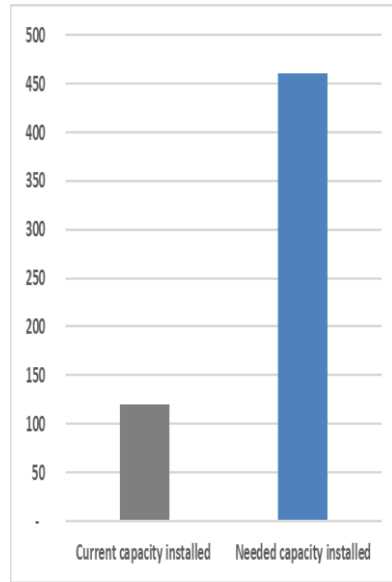


Addressing the Russian Question with volume, price and speed

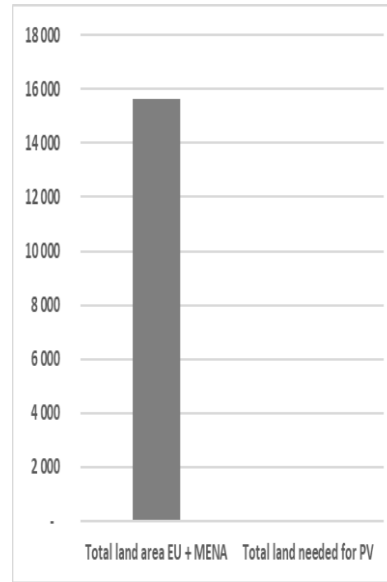
3,000 TWh: an exercise in realism



Biogas (number of bovines)



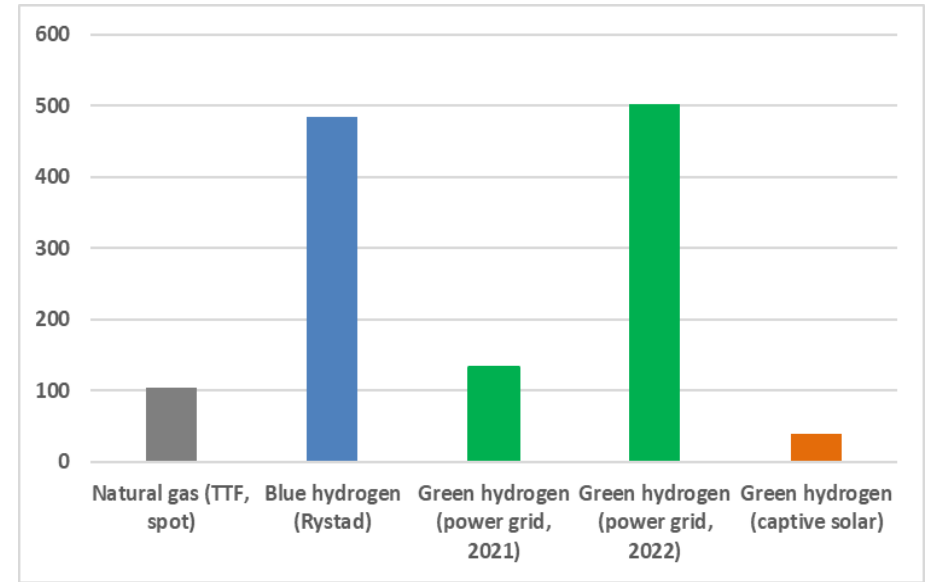
(Nuclear, GW)



(Solar, km²)

The hydrogen price chasm

€/MWh

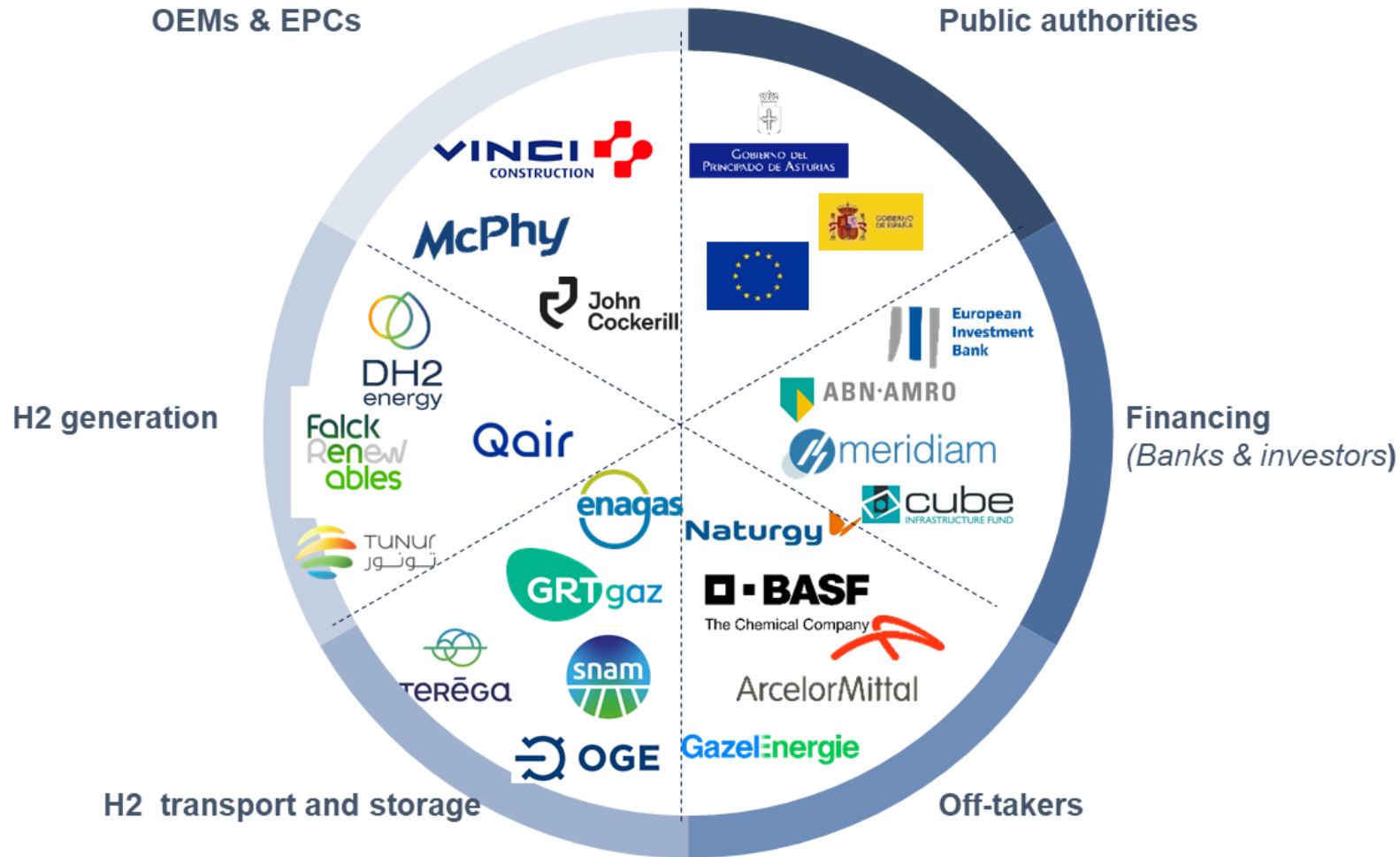


HyDeal Ambition: ranked by IRENA as world's largest green hydrogen project

- 1 HyDeal Ambition (67GW)..... Western Europe
- 2 Unnamed (30GW)..... Kazakhstan
- 3 Western Green Energy Hub (28GW) Australia
- 4 AMAN (16GW)^a.....Mauritania
- 5 Asian Renewable Energy Hub (14GW) Australia
- 6 Oman Green Energy Hub (14GW)^aOman
- 7 AquaVentus (10GW) Germany
- 8 NorthH2 (10GW).....Netherlands
- 9 H2 Magallanes (8GW) Chile
- 10 Beijing Jingneng (5GW) China
- 11 Project Nour (5GW)^a.....Mauritania
- 12 HyEnergy Zero Carbon Hydrogen (4GW)^a. Australia
- 13 Pacific solar Hydrogen (3.6GW) Australia
- 14 Green Marlin (3.2GW) Ireland
- 15 H2-Hub Gladstone (3GW)..... Australia
- 16 Moolawatana Renewable Hydrogen Project (3GW)^a - Australia
- 17 Murchison Renewable Hydrogen Project (3GW) - Australia
- 18 Unnamed (3GW)..... Namibia
- 19 Base One (2GW)^a.....Brazil
- 20 Helios green Fuels Project (2GW) Saudi Arabia

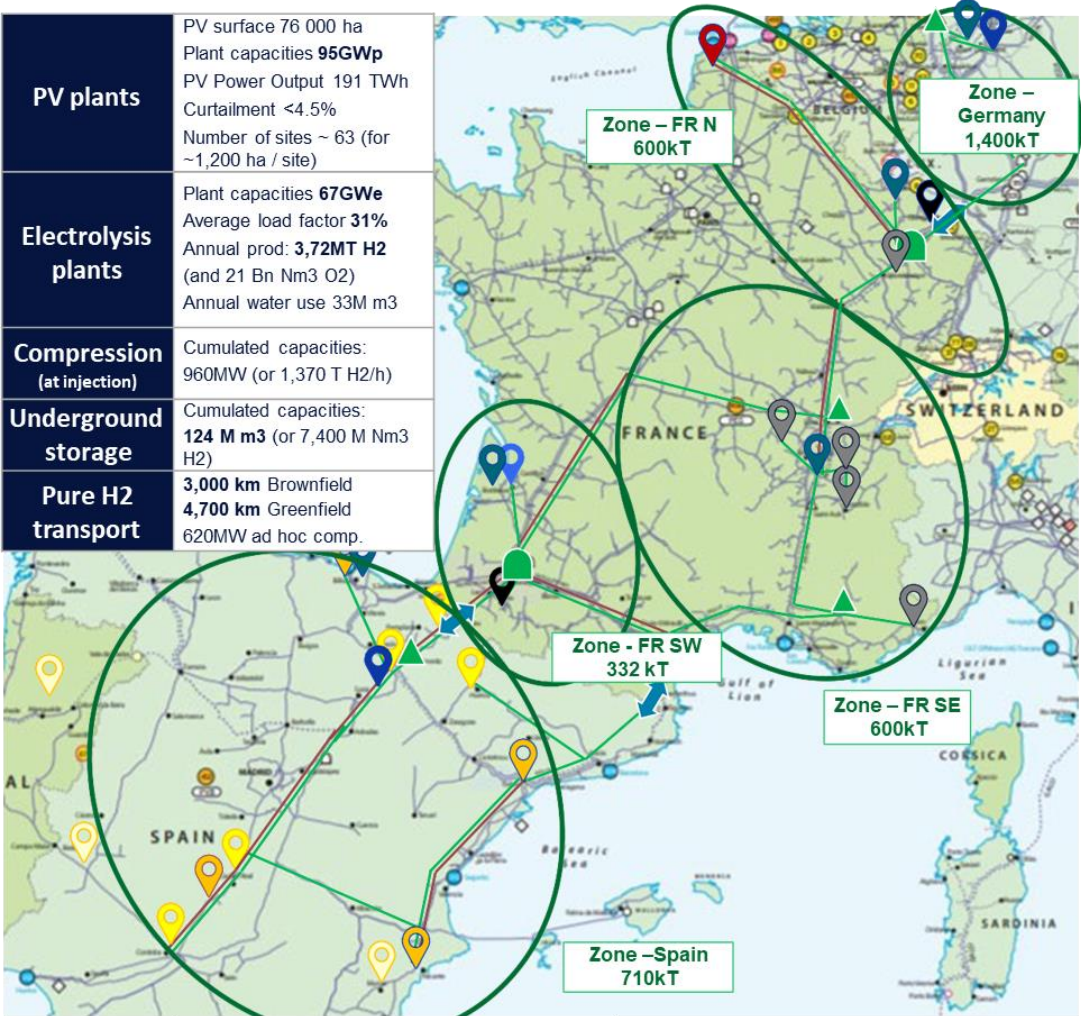


HyDeal Ambition: total vertical integration of green hydrogen value chain



HyDeal Ambition: 1/16th of the Russian Question in 2030 from just 0.02% of Europe's area

PV plants	PV surface 76 000 ha Plant capacities 95GWp PV Power Output 191 TWh Curtailment <4.5% Number of sites ~ 63 (for ~1,200 ha / site)
Electrolysis plants	Plant capacities 67GWe Average load factor 31% Annual prod: 3,72MT H2 (and 21 Bn Nm ³ O ₂) Annual water use 33M m ³
Compression (at injection)	Cumulated capacities: 960MW (or 1,370 T H ₂ /h)
Underground storage	Cumulated capacities: 124 M m³ (or 7,400 M Nm ³ H ₂)
Pure H2 transport	3,000 km Brownfield 4,700 km Greenfield 620MW ad hoc comp.



- Legend**
- 📍 Area to produce and inject H2 into the H2 pipeline
 - 📍 Non integrated areas

 - 📍 Non-assigned baseload off-take (**Exact off-takers and profiles to be determined**)
 - 📍 Ammonia production plants
 - 📍 Cement plant
 - 📍 Steel plant
 - 📍 Thermal plant
 - 📍 Fuel Cell hub (**Exact location to be determined**)
 - 📍 Refineries

 - 📍 Possible Storage sites – Salt Cavity
 - 📍 Possible Storage sites – Aquifer

 - Potential greenfield H2 pipe based on current NG grid
 - Potential brownfield H2 pipeline
 - ➡ Potential International connections

HyDeal project's setup and scale allow to activate the key levers to minimize costs and optimize bankability

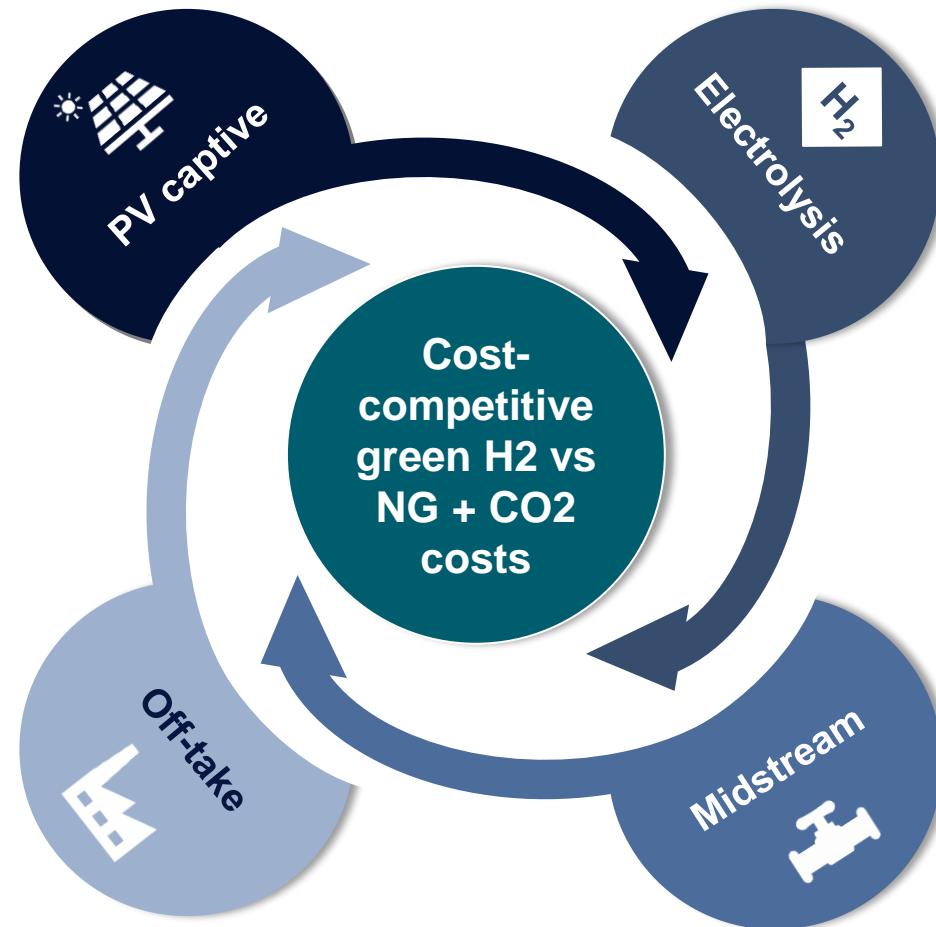
Solar PV

- **Cheapest RES energy for green H2 production** as long as electrolysis platforms are < 400€ / KW (preference for low-cost RES energies vs long load factors)
- **Utility scale projects** (0.5 - 1 GW), enabling cost reduction (optimized procurement & construction costs, sharing effects at BOP level...)
- **Captive production** with solar power supplied at LCOE level + internal connexion costs without paying grid fees

Off-take

- Proximity to an **offtake basin with large H2 needs** allowing a portfolio effect
- Off-takers with **long term contracts** allowing to guarantee the bankability of the project and optimize WACC
- Supply of H2 on site impacting CO2 '**scope 1**' emissions (no blending with NG)

hydeal



Electrolysis

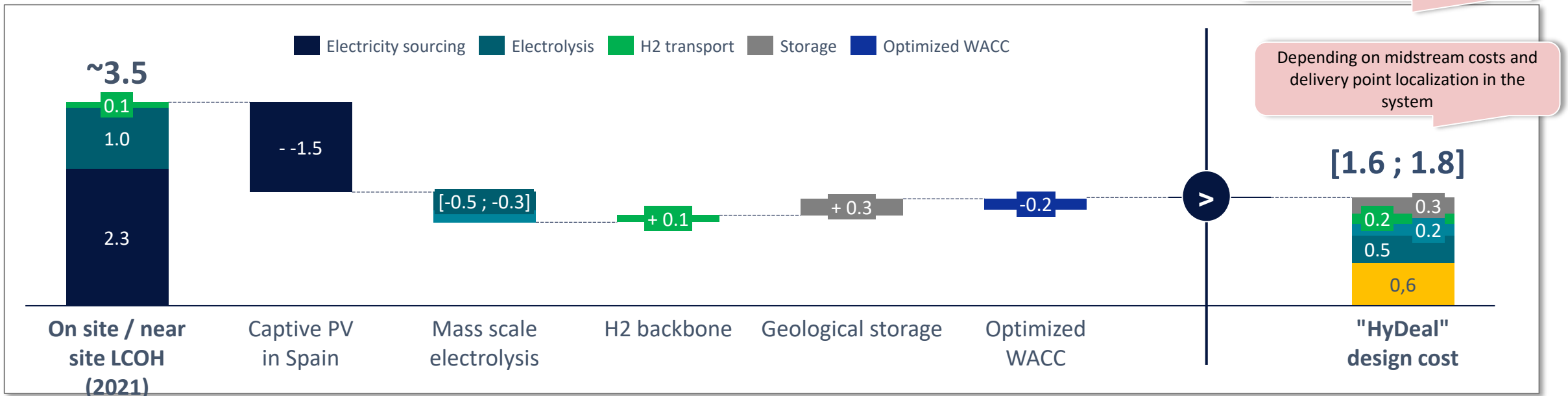
- **30 bar pressurized alkalyne technology** as most competitive solution in CAPEX on the mid-term allowing load following
- **Utility scale projects**, enabling to leverage key cost reduction levers (gigafactory, industrialized design, mutualization cost effects on BOP...)
- Discussion of sourcing contracts on a **fleet of permitted projects**, with standardized conditions, to allow to optimize sourcing conditions of electrolyzers and learning effects on erection

Midstream

- **Dedicated gas pipeline network** to supply H2 as cheapest conditioning and transport solution (vs. chemical carrier, ...) and **key conditions to link cheap generation sites versus demand**
- **Mass scale storage** (saline cavity) as most competitive solution to allow profiles transformation and supply security to off-takers

Total cost reduction with optimal green hydrogen system design

Waterfall between estimated current market costs in Spain versus optimal green H2 system design (HyDeal), LCOH in €/kg_{H2}



Vs 3.11 €/kg_{H2} taking a benchmark NG + CO₂ with current market conditions (03/11)¹

Depending on midstream costs and delivery point localization in the system

- Sourcing on the electricity market (~45€/MWh) – load factor 70 to 80%
- Electrolysis – 20 MW platform with 2MW stacks (0.9M€/MW)

- Cheapest RES energy for green H2
- Utility scale projects
- Captive production
- Load factor @ 31%

- Fleet effects, with standardized conditions
- Utility scale projects
- ~ 0,4 M€ / MW

- Dedicated gas pipeline network
- Key condition to link cheap generation sites versus demand

- Mass scale storage (saline cavity)
- Key condition to adjust profiles & supply security to off-takers

- Mutualizing LT offtake contracts
- Strong bankability of the project and optimized WACC (derisking effect)

"HyDeal" ambition optimal green H2 system design



¹ Based on current NG prices (~68€/MWh_{HHV} on 03/11/2021 – source TTF) and carbon price (~59,5€/t_{CO2} on 02/11/2021 – source EU ETS)
 P_{H_2} (€/kgH₂) = H₂ energy content (MWh/kg_{H2}) * P_{NG} (€/MWh) + H₂ energy content (MWh/kg_{H2}) * NG carbon emission factor (kg_{CO2}/MWh) * P_{CO2} (€/kg_{CO2})

HyDeal España: implementing HyDeal Ambition with the world's first integrated green hydrogen hub, delivering massive volumes from 2025

1

Supply of ~200kt to ~330kt* of low-cost green H2 by 2025 to 2030 to Asturias industrial players, with ArcelorMittal and Fertiberia as a **key first off-takers** supporting project development

2

Integrated H2 system (“hub”) approach, developing Up., Mid. and Downstream at the same time...

- ... allowing to develop large scale off-site green H2 generation plants, capturing the best cost production conditions...
- ... while bringing bankability to all project's assets

3

H2 demand aggregation logic into a single “portfolio” of large industrial off-takers...

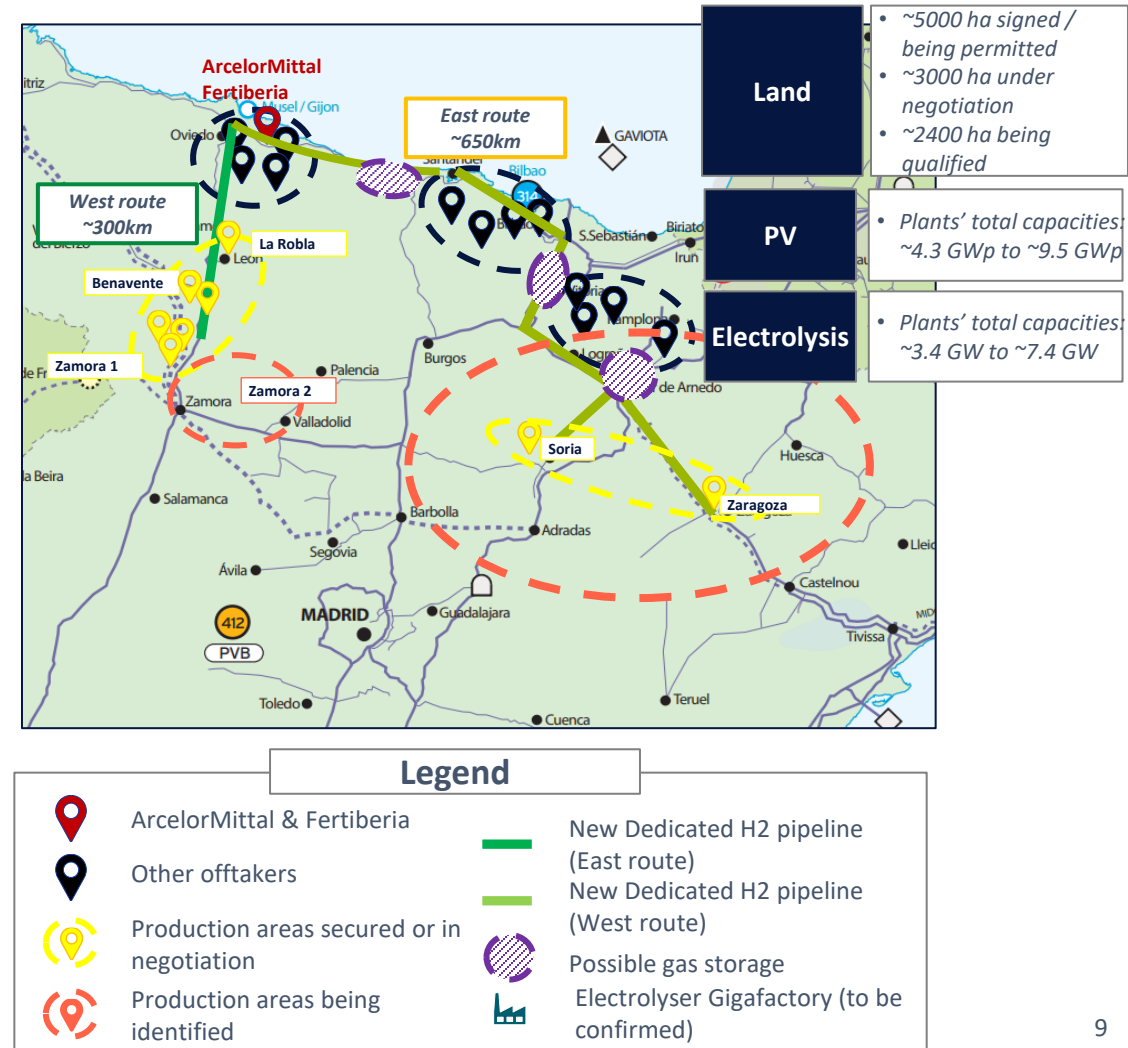
- ... unlocking scale potential and sharing effects on midstream cost
- ... mixing demand profiles to optimize system costs of supply
- ... allowing series effects on H2 plants building and learning curve
- ... Reducing the off-take and supply risk

4

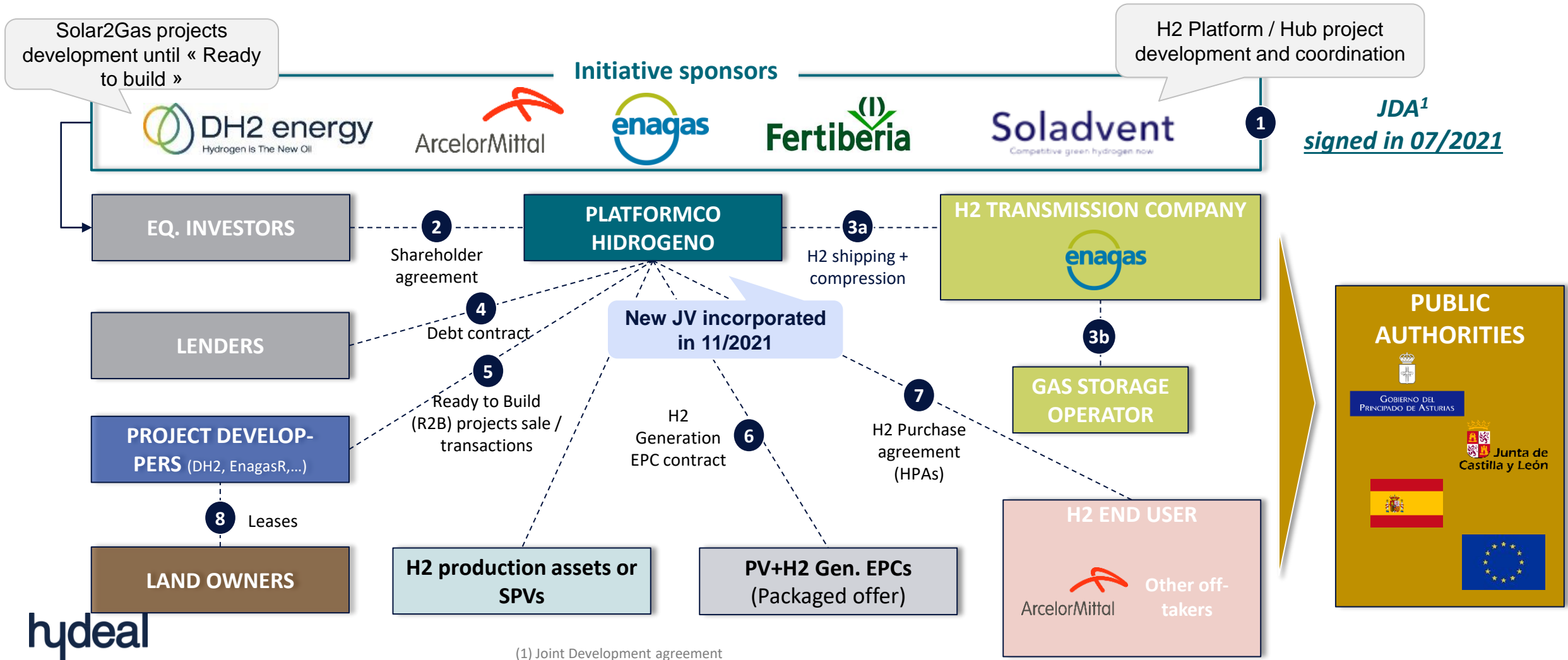
Captive solar to gas H2 generation plants, injecting into dedicated H2 transmission lines

- Among the most competitive green H2 generation sources in Europe**
- Direct impact on Off-takers “scope 1” and CO2 costs

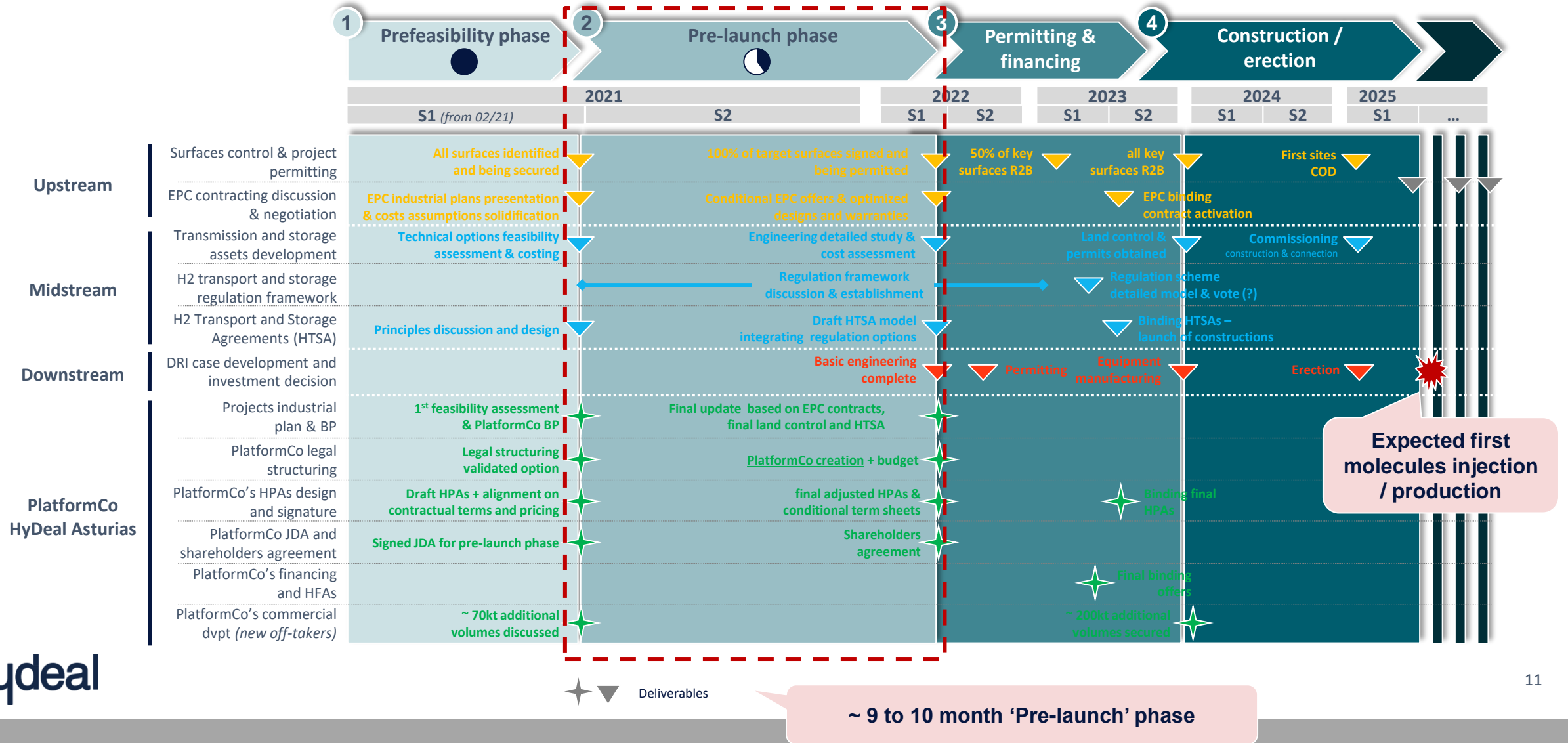
- *) Possibility to expand system development until 450kt with additional off-takes aggregation and system expansion
- **) For electrolysis installed costs < 400€/ Kw



HyDeal España: an industrial joint venture mobilizing massive financial resources



A 5-year industrial plan, and a roadmap to an initial FID by September 2022

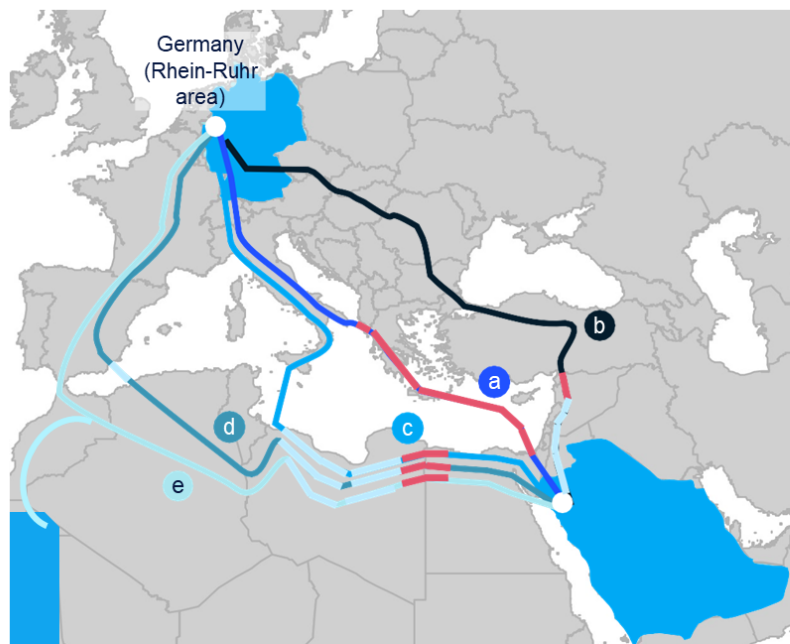


Vision 2030: a web of green hydrogen superhighways connecting the Mediterranean...

Re-purposing potential pipelines potentially constrained...

... amid a continued need to transport natural gas

Potential pipeline connections for H2 from KSA and Mauritania to key demand centers in Europe



█ Possible route for new-built pipeline
 █ Pipelines not existing today
 █ Capacity limiting pipeline section

Route and requirements	Capacity at limiting section today ⁵ , Mt p.a.
█ Direct offshore connection between Egypt and EU New offshore Hydrogen pipeline	4.4²
b Onshore route through Syria and Turkey Arab Gas Pipeline (Kilis-Halab part) connected to Turkey	1.3¹
c Connection through Libya Construction of a link between Egypt and Libya	0.9³
d Connection through Algeria Construction of a link between Egypt and Libya	0.4⁴
e Connection through Morocco Construction of a link between Egypt and Libya	0.9³

1. Max. throughput for 36-inch pipeline 2. Max. throughput for 48-inch pipeline 3. Max. throughput for 32-inch pipeline 4. Max. throughput for 24-inch pipeline 5. 100% utilization