



ASSOCIAZIONE NAZIONALE DI  
IMPIANTISTICA INDUSTRIALE

# Componentistica per l'Idrogeno

*Gruppo di Lavoro - Avvio attività*

4 Febbraio 2021

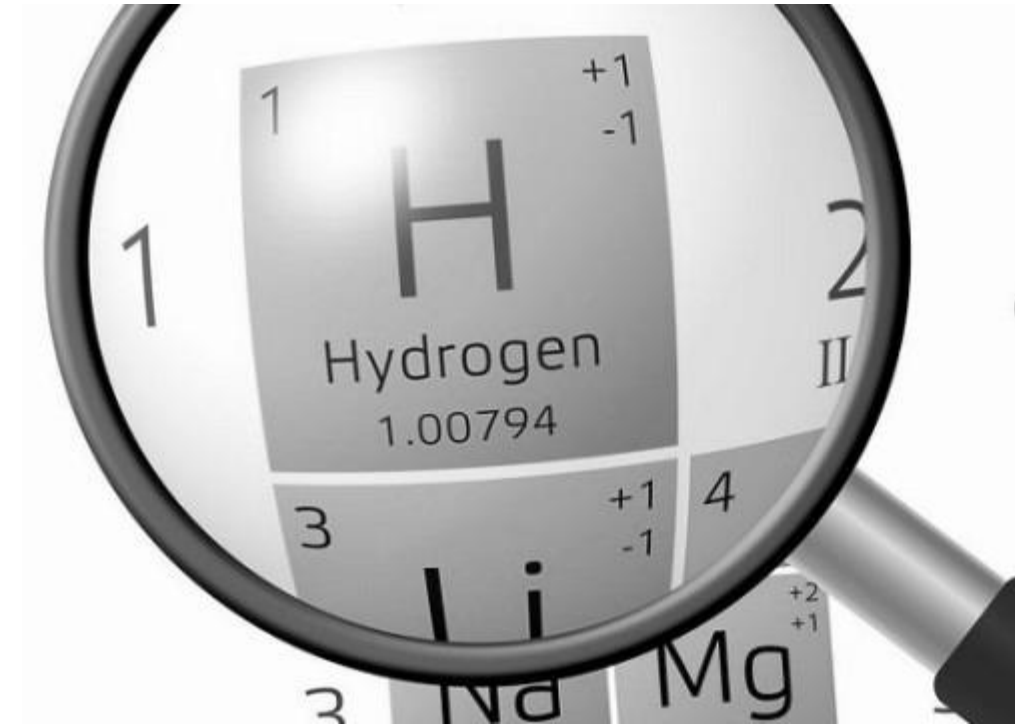
# Agenda

Avvio delle attività del Gruppo di Lavoro

Materiale introduttivo a supporto

# Contesto

- L'idrogeno, l'elemento più semplice della tavola periodica, diventerà il tassello mancante dell'urgente **transizione energetica** verso la **carbon neutrality** entro il 2040/2050?
  - L'idrogeno è diventato un pilastro della strategia del Green Deal Europeo, soprattutto in qualità di Green Hydrogen per giocare un **ruolo nelle industrie "hard-to-abate" come l'acciaio e la chimica**
  - L'idrogeno è ricompreso nei futuri **piani di R&D** e investimento delle principali **Energy Co.** a livello **internazionale**
- Numerose **sfide** per l'Hydrogen Economy
  - **più tecnologie sono in concorrenza** tra loro
  - la **filiera della componentistica** ha tipicamente bisogno di **anni per adattare** - qualora necessario - la **propria base produttiva**



# Obiettivi di questo Gruppo di Lavoro in ambito Idrogeno

Fornire un primo set di risposte ai principali interrogativi che stanno emergendo nella Filiera

Scenari e macro trends di mercato, applicazioni, principali normative

***Argomenti coperti dalla Sezione Energia ANIMP***

*Webinars, workshop*



Cosa è richiesto alla componentistica:

- **Impianti e Progetti**
- **Componenti**
- **Fornitori**
- **Competenze**

*Gruppo di lavoro con contributo attivo di tutti i soci interessati*



# Focus sulla Filiera di fornitura, dettagliato necessità già identificate in altri Gruppo di Lavoro

## PRIORITÀ PER LO SVILUPPO DELLA FILIERA IDROGENO IN ITALIA

### REPORT H2IT

*Strumenti di Supporto al Settore Idrogeno | Fase 1*

H2IT

ASSOCIAZIONE ITALIANA IDROGENO E CELLE A COMBUSTIBILE

NOVEMBRE 2020

[LINK PER DOWNLOAD DEL REPORT](#)

*Estratto pag. 55 del Report*

### MAPPATURA DELLE AZIENDE ESISTENTI SU TUTTA LA FILIERA

Una mappatura sempre aggiornata delle aziende che rientrano nella filiera è utile per permettere a queste di mettersi più rapidamente in contatto e quindi sviluppare prima soluzioni efficaci. Una soluzione già sperimentata in altri settori industriali è quella di costituire distretti industriali dove le aziende con competenze diverse si collegano per portare avanti un progetto unico, ognuna contribuendo con il proprio bagaglio di esperienza. Si tratta quindi di creare le condizioni per ricreare questo schema vincente anche sul settore Idrogeno al fine di massimizzare l'impatto sull'economia nazionale. Oggi è possibile aggiornare questo schema mettendo in contatto aziende ed enti di ricerca in maniera virtuale, costruendo veri e propri distretti industriali virtuali più efficaci ed efficienti.

Per favorire questo processo di creazione di distretti industriali è necessario partire da una mappatura delle aziende e centri di ricerca nazionali esistenti e di mettere questi in rete, al fine di favorire la nascita di insiemi in grado di occuparsi di un problema o di uno sviluppo. Esiste poi un numero forse più elevato di aziende che hanno già un loro mercato elettivo diverso, ma che hanno tecnologie e prodotti che possono essere impiegate nel settore con notevoli miglioramenti economici e qualitativi. È importante riuscire a portare anche queste all'interno del gruppo dei soggetti che operano nel comparto idrogeno.

Distretto industriale virtuale

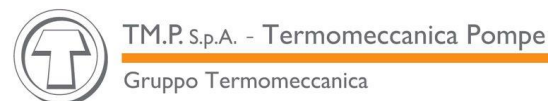
# Principali domande a cui dare risposta assieme

1. Quali le principali **applicazioni** attese?
2. Quali **categorie merceologiche** saranno necessarie?
3. In quali **categorie di fornitura** è necessario aggiornare ed integrare la gamma prodotti?
4. Quali i **componentisti** italiani ed Europei nelle rispettive categorie di fornitura?
5. Chi saranno i **Clienti** per la componentistica?
6. Quali **barriere all'entrata** (certificazioni, qualifiche, ...)
7. In quali categorie merceologie è prevedibile **maggiore domanda e “colli di bottiglia”**?
8. Quali **economie di scala** saranno necessarie per raggiungere competitività di costo nelle principali merceologie critiche?
9. Quale **R&D** sarà necessaria per soddisfare le nuove specifiche tecniche (temperature, pressioni, ...) anche tramite nuovi materiali?
10. Quali potenziali **incentivi** per R&D?

# Partecipanti al GdL «Componentistica per l'Idrogeno»

Hanno sinora dimostrato interesse nel partecipare:

PRELIMINARE



L'adesione è gratuita ed il Gruppo di Lavoro è sempre aperto a nuovi partecipanti e a potenziali collaborazioni con altre Sezioni ANIMP e Associazioni (e.g. H2IT Italia)

# Attività per avvio lavori «Componentistica per l'Idrogeno»

- Febbraio: set di interviste da remoto (tramite Teams)
- **Prossima riunione di Gruppo entro fine Febbraio** per creazione di **sotto-gruppi di lavoro** con piano delle attività
- **Incontri mensili**

*Per la realizzazione delle attività è atteso il tradizionale contributo di tutti (End Users, Contrattisti, Componentisti, Università, Enti di Ricerca, Consulenti)*

## 0) **Tassonomia** comune

A) Mappatura dei **PROGETTI** e degli **IMPIANTI**

B) Mappatura delle **CATEGORIE merceologiche** e loro incidenza media in ciascuna tipologia di impianto

C) Matrice di mappatura dei **FORNITORI** e relative:

- **categorie** di fornitura
- **esperienze** previe (referenze, ...)
- **competenze distintive** (R&D, ...)



# Attività per avvio lavori «Componentistica per l'Idrogeno»

|                                                                                                           | Gen21 | Feb21 | Mar21  | Apr21 | Mag21  | Giu21 | Lug21 | ... |
|-----------------------------------------------------------------------------------------------------------|-------|-------|--------|-------|--------|-------|-------|-----|
| <b>0</b> Tassonomia comune                                                                                |       |       |        |       |        |       |       |     |
| <b>A</b> Mappatura dei PROGETTI e degli IMPIANTI                                                          |       |       |        |       |        |       |       |     |
| <b>B</b> Mappatura delle CATEGORIE merceologiche e loro incidenza media in ciascuna tipologia di impianto |       |       | Fase I |       | Fase 2 |       |       |     |
|                                                                                                           |       |       |        |       |        |       |       |     |
| <b>C</b> Matrice di mappatura dei FORNITORI                                                               |       |       |        |       |        |       |       |     |

# Tipologie di impianti

PRELIMINARE  
PER DISCUSSIONE

## “UPSTREAM”

### Green Hydrogen production

- Alkaline Electrolyser (AEL)
- Proton Exchange Membrane (PEM) electrolyser
- Solid Oxide Electrolyser Cell (SOEC)

### Carbon Capture & Storage (CCS) for Blue Hydrogen production

### Grey Hydrogen production

- Refining
- Ammonia

## “MIDSTREAM”

### Hydrogen Transportation

- Blended Hydrogen Pipelines
- Full Hydrogen Pipelines
- Trailer mounted vessel, pressurized
- Trailer mounted vessel, liquefied

### Hydrogen Storage

- Liquefied (storage tanks)
- Pressurized (pressure vessels)
- Pressurized subsurface storage (e.g. salt caverns or depleted gas fields)

## “DOWNSTREAM”

### Hydrogen Power Generation

- Hydrogen Fuel Blend Turbines
- Full Hydrogen Turbines

### Hydrogen Smart Cities

- Mobility and Fuelling stations
- Distribution Grid

### Hydrogen Naval Vessels

### Hydrogen Trains

# Agenda

Avvio delle attività del Gruppo di Lavoro

Materiale introduttivo a supporto

# Hydrogen is gaining momentum

## Drivers of renewed interest in hydrogen



**Stronger push to limit carbon emissions**

**10**

Years remaining in the global carbon budget to achieve the 1.5°C goal

**66**

Countries that have announced net-zero emissions as a target by 2050



**Falling costs of renewables and hydrogen technologies**

**80%**

Decrease in global average renewable energy prices since 2010

**55x**

Growth in electrolysis capacity by 2025 vs. 2015

## Indicators of hydrogen's growing momentum



**Strategic push in national roadmaps**

**70%**

Share of global GDP linked to hydrogen country roadmaps to date<sup>1</sup>

**10 m**

2030 target deployment of FCEVs announced at the Energy Ministerial in Japan



**Industry alliances and momentum growing**

**60**

Members of the Hydrogen Council today, up from 13 members in 2017

**30+**

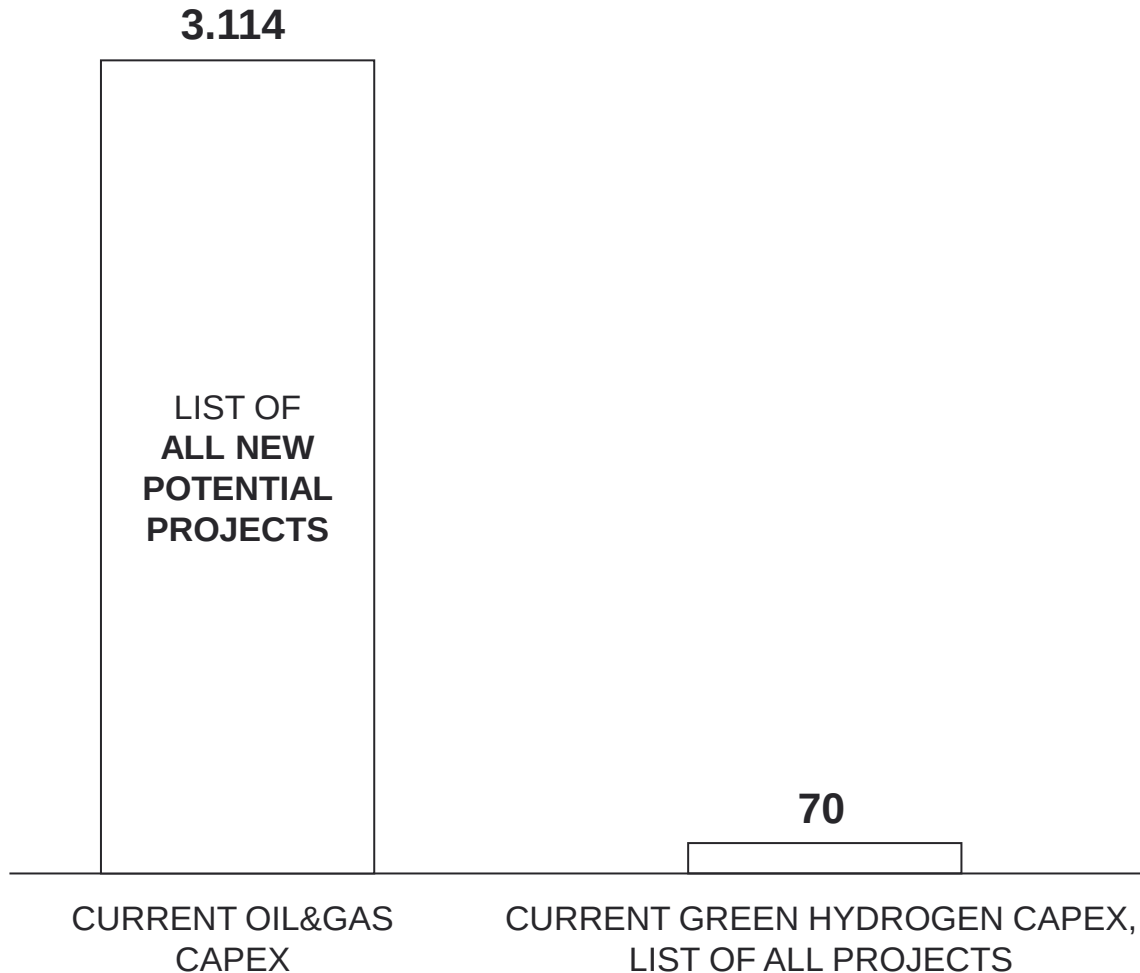
Major investments announced<sup>2</sup> globally since 2017, in new segments, e.g. heavy duty and rail

1. Based on 18 country roadmaps announced as of publication

2. Not exhaustive

# Green Hydrogen CAPEX today

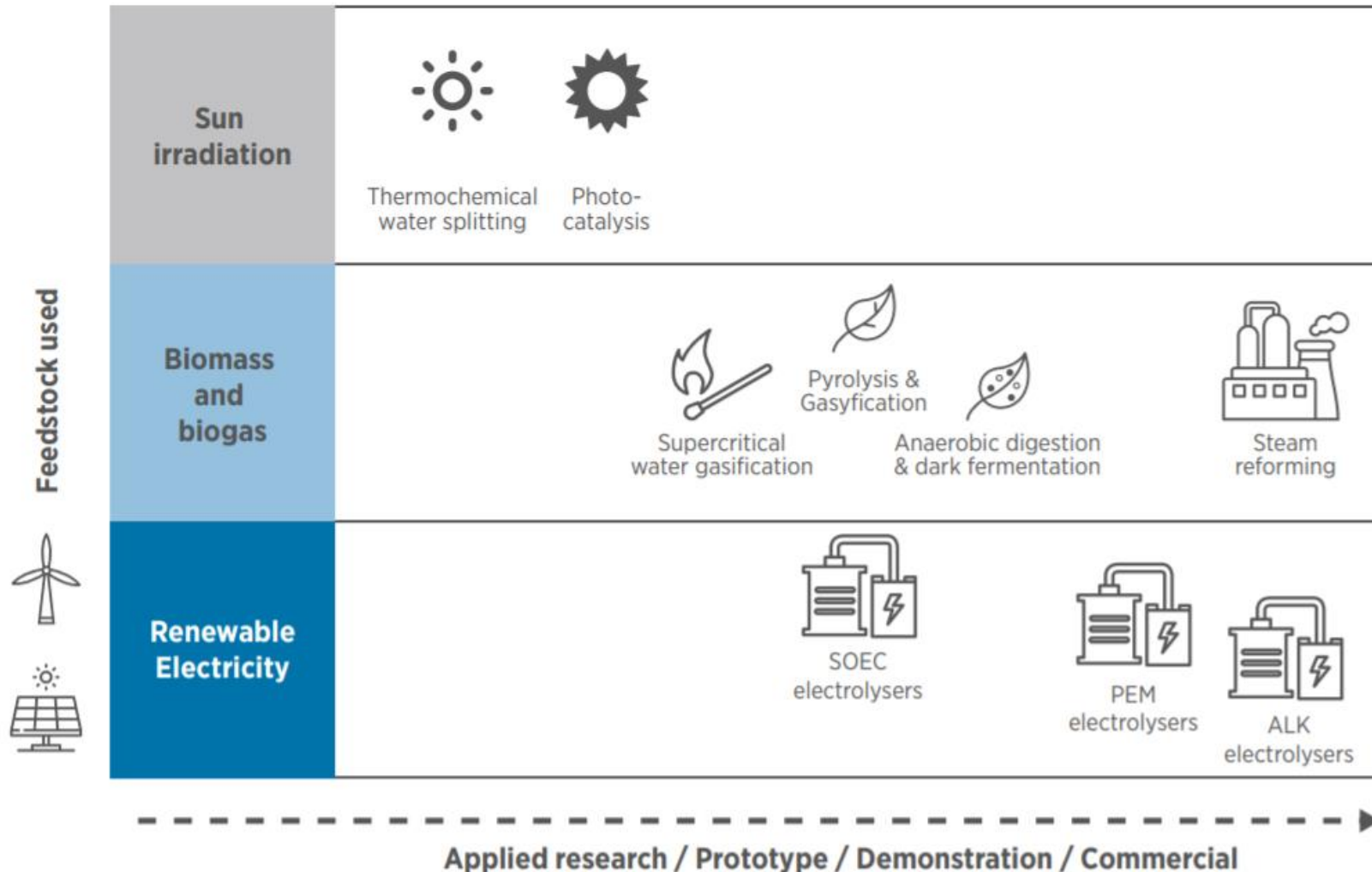
CAPEX for equipment and services, 2019-2023, Billion €



- Presence of around **50 green hydrogen projects under development worldwide**
  - a planned annual production capacity of 4 million tons of hydrogen
  - total renewable power capacity of 50 GW
  - **combined capital cost estimated at €70 billion**
- Project statuses
  - Mainly at an **early stage**, with just 14 having started construction and 34 at a study or memorandum-of-understanding stage
  - Many of the **projects could face delays** due to uncertain financing, cumbersome joint venture structures and unfavorable seaborne-trade economics
  - large scale facilities starting up in 2022-23 and 2025-26

# Renewable Hydrogen production pathways and current levels of maturity

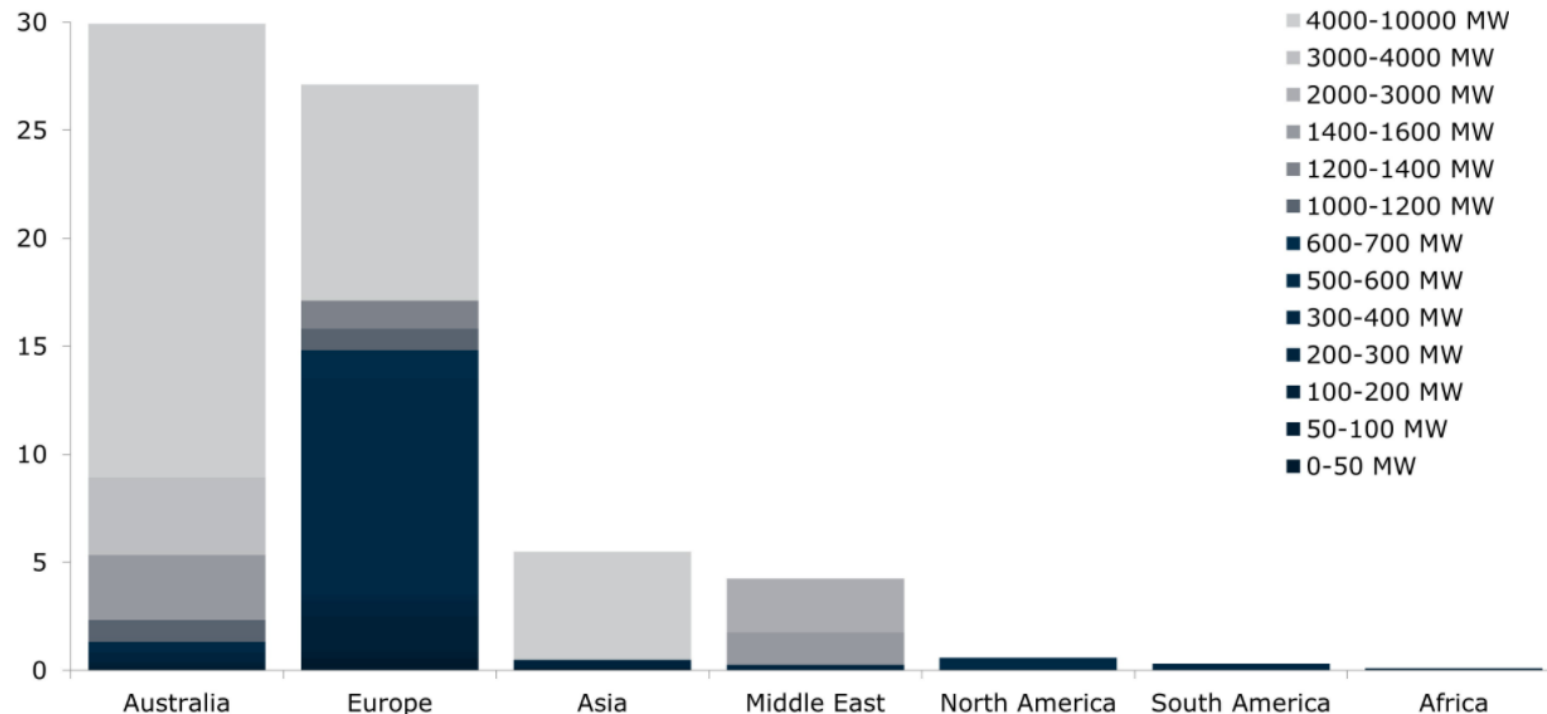
GREEN  
HYDROGEN



# Green Hydrogen project pipeline is growing

GREEN  
HYDROGEN

**Green hydrogen project pipeline by continent**  
Capacity in gigawatts (GW)



Note: Green hydrogen developments can be understood as hydrogen electrolyser projects powered by renewable sources

- Electrolyzer efficiency to be materially improved, but in the meantime, there is more than enough **policy-driven investment** to stop thinking about it as a “future” thing
  - The **European Union** aims to **push as much as 470 billion euros (\$550 billion) toward hydrogen infrastructure**
  - **China, Japan and South Korea** will all likely use hydrogen to achieve recent pledges to slash emissions
  - **Saudi Arabia** plans a \$5 billion hydrogen-based ammonia plant powered by renewable energy.
- **‘The hydrogen wars’** because of the way **governments are racing to subsidize these projects to be a leader** and lock in market share



# Green Hydrogen projects today

GREEN  
HYDROGEN

| Projected Start | Status      | Name                           | Country     | Locale             |
|-----------------|-------------|--------------------------------|-------------|--------------------|
| 2021            | In progress | Hydrogen Energy Supply Chain   | Australia   | Latrobe, VIC       |
| 2021            | In progress | Hazer Commercial Demo. Project | Australia   | Woodman Point, WA  |
| 2022            | In progress | Arrowsmith Primary Plant       | Australia   | Dongara, WA        |
| 2025            | Study       | H2-Hub                         | Australia   | Gladstone, QLD     |
| 2026            | Study       | Hydrogen Superhub              | Australia   | WA                 |
| 2026            | Study       | BP                             | Australia   | WA                 |
| 2026            | Study       | Pacific Solar Hydrogen         | Australia   | Nth Callide, QLD   |
| 2026            | Study       | Neo                            | Australia   | NSW                |
| 2027            | Study       | Asian Renewable Energy         | Australia   | Pilbara, WA        |
| 2027            | Study       | Murchison Renewable            | Australia   | Kalbarri, WA       |
| 2021            | MOU         | Iberdrola                      | Spain       | Puertallano        |
| 2023            | Study       | Amprion-OGE                    | Germany     | Emsland            |
| 2025            | MOU         | Hygreen                        | France      | Provence           |
| 2025            | Study       | RWE                            | Germany     | Lingen             |
| 2025            | Study       | Nouryon-Tata Steel             | Netherlands | Rotterdam          |
| 2025            | Study       | BP-Nouryon                     | Netherlands | Rotterdam          |
| 2025            | MOU         | Hyport Oostende                | Belgium     | Ostend             |
| 2026            | In progress | H2V Dunkirk                    | France      | Dunkirk            |
| 2026            | Study       | H2H Saltend                    | UK          | Hull               |
| 2026            | Study       | Crosswind                      | Netherlands | Rotterdam          |
| 2026            | Study       | Statkraft                      | Norway      | Mo Industrial Park |
| 2027            | Study       | NorthH2                        | Netherlands | Eemshaven          |
| 2027            | Study       | Westkuste 100 phase 1          | Germany     | Schleswig-Holstein |
| 2027            | Study       | Hamburg                        | Germany     | Hamburg            |

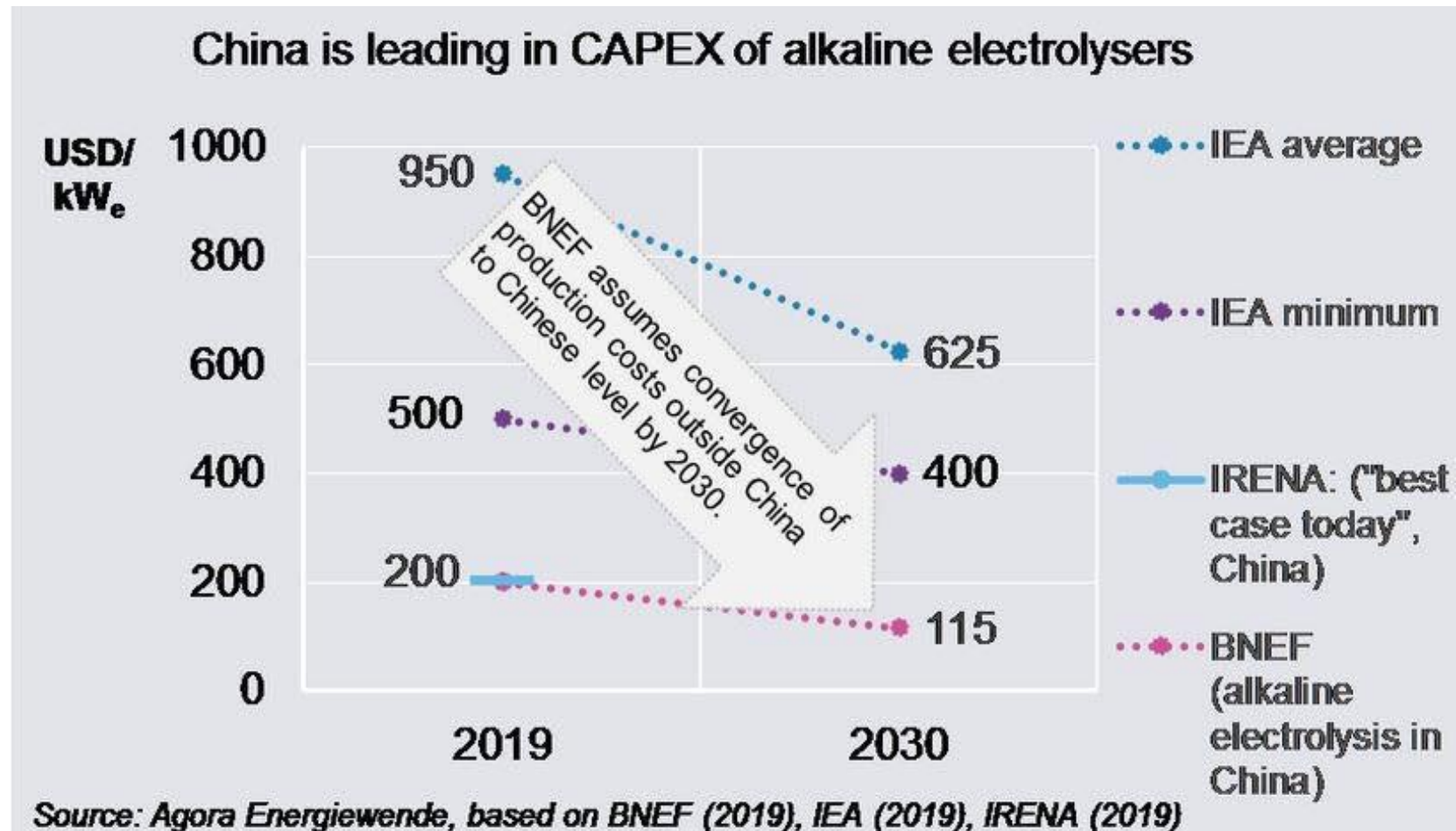
| Projected Start | Status      | Name               | Country      | Locale            |
|-----------------|-------------|--------------------|--------------|-------------------|
| 2027            | In progress | Nouryon-Gasunie    | Netherlands  | Delfzijl          |
| 2030            | Study       | Sines              | Portugal     | Sines             |
| 2021            | In progress | Baofang Energy     | China        | Ningxia           |
| 2022            | In progress | Jingneng Power     | China        | Inner Mongolia    |
| 2022            | In progress | Zhangjiakou Guyuan | China        | Hebei             |
| 2023            | MOU         | Huadian-Kohodo     | China        | Shandong          |
| 2023            | MOU         | Hebei Government   | China        | Hebei             |
| 2023            | In progress | Shanxi Datong      | China        | Shanxi            |
| 2023            | In progress | Sungrow            | China        | Shanxi            |
| 2023            | In progress | Hefei Sunshine     | China        | Shanxi            |
| 2023            | In progress | Zheneng Group      | China        | Zhejiang          |
| 2024            | MOU         | Hebei Construction | China        | Inner Mongolia    |
| 2025            | MOU         | Panda Green Energy | China        | Xinjiang          |
| 2020            | Operational | FH2R               | Japan        | Fukushima         |
| 2022            | MOU         | Hyosung-Linde      | South Korea  | Ulsan             |
| 2019            | Operational | AHEAD Demo Plant   | Brunei       | Sungai Liang      |
| 2025            | MOU         | APD-Neom           | Saudi Arabia | Tabuk             |
| 2028            | Study       | Hyport Duqm        | Oman         | Duqm              |
| 2029            | MOU         | MASEN              | Morocco      |                   |
| 2021            | In progress | Nikola             | USA          |                   |
| 2022            | Study       | Okeechobee         | USA          | Florida           |
| 2022            | MOU         | SGH2               | USA          | Lancaster, CA     |
| 2025            | Study       | Intermountain      | USA          | Utah              |
| 2020            | In progress | Air Liquide Canada | Canada       | Becancour, Quebec |
| 2022            | In progress | H2V Energies       | Canada       | Becancour, Quebec |
| 2024            | Study       | Sundance Hydrogen  | Canada       | Chetwynd          |



# Major Green Hydrogen projects summary - Example

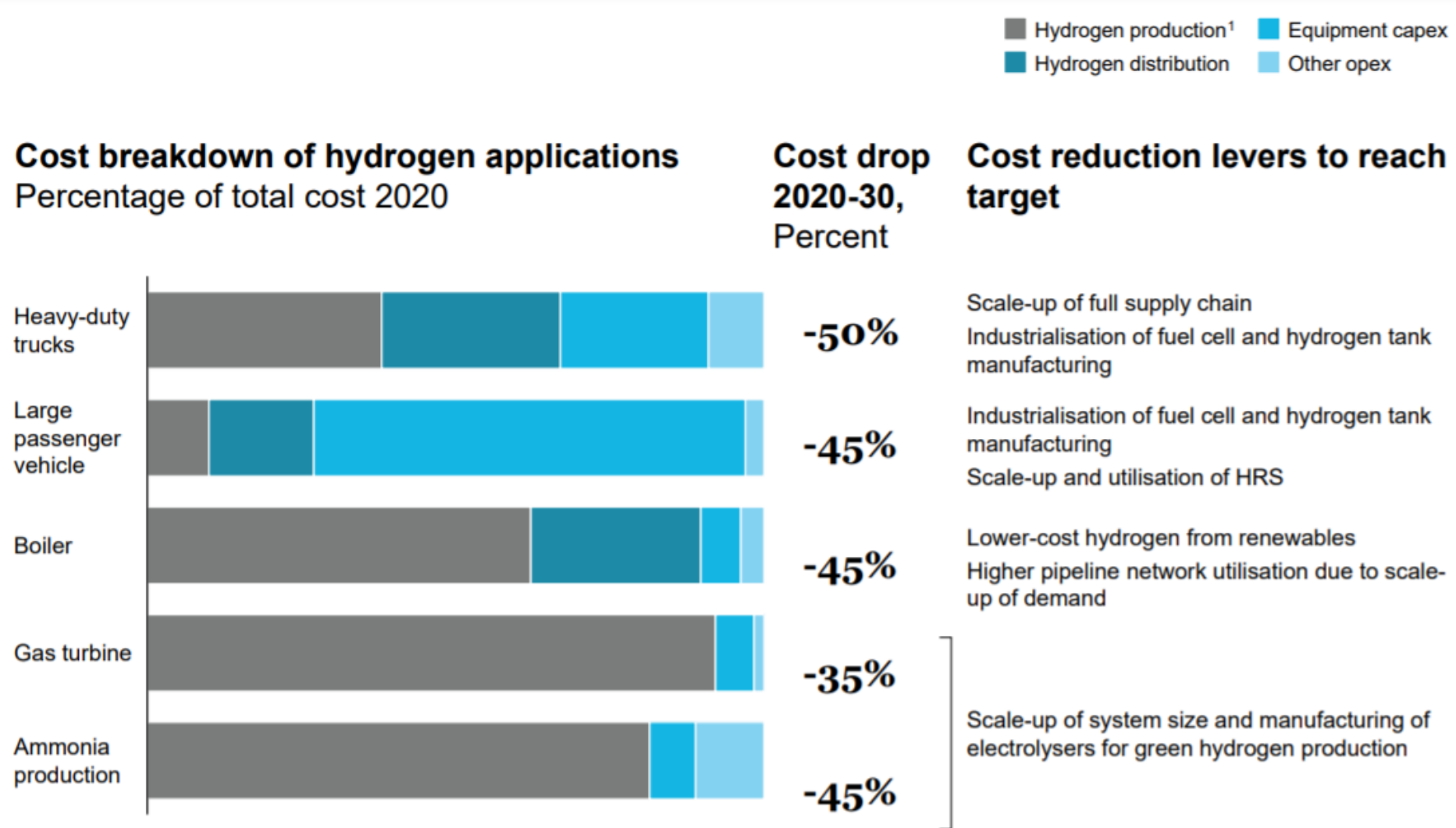
|                    | Unit    | Arrowsmith    | Jingneng    | Iberdrola  | Sundance | NEOM         |
|--------------------|---------|---------------|-------------|------------|----------|--------------|
| Country            |         | Australia     | China       | Spain      | Canada   | Saudi Arabia |
| Status             |         | Proceeding    | Proceeding  | Proceeding | Planning | MOU          |
| Target start       |         | 2022          | 2022        | 2023       | 2024     | 2025         |
| Type               |         | Green         | Green       | Green      | Green    | Green        |
| Renewable capacity | GW      | 0.2           | 5.0         | 0.1        | -        | 4.0          |
| Capex              | US\$bn  | 0.3           | 3.3         | 0.2        | 0.2      | 7.0          |
| H2 production      | Kt/yr   | 9             | 183         | 7          | 22       | 207          |
| Delivered H2 cost  | US\$/kg | 5.5           | 3.4         | 3.2        | 3.3      | 3.0          |
| No of owners       |         | 1             | 1           | 2          | 3        | 3            |
|                    | Unit    | Hyport Ostend | H2H Saltend | AREH       | Hygreen  | NorthH2      |
| Country            |         | Belgium       | UK          | Australia  | France   | Netherlands  |
| Status             |         | MOU           | Planning    | Planning   | Planning | Study        |
| Target start       |         | 2025          | 2026        | 2027       | 2030     | 2027-40      |
| Type               |         | Green         | Blue        | Green      | Green    | Green        |
| Renewable capacity | GW      | -             | -           | 11.0       | 0.9      | 10.0         |
| Capex              | US\$bn  | 0.2           | 1.5         | 15.0       | 1.2      | 20.0         |
| H2 production      | Kt/yr   | 18            | 125         | 562        | 13       | 800          |
| Delivered H2 cost  | US\$/kg | 3.3           | 1.7         | 5.1        | 3.2      | 3.3          |
| No of owners       |         | 3             | 1           | 4          | 3        | 3            |

# The future of Hydrogen rests on cost reduction



... and **system safety** assurances

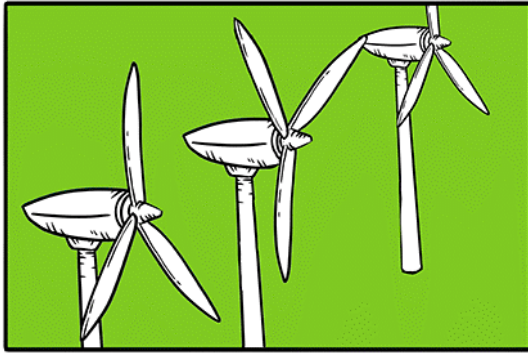
# Relevant cost drop expected in the next decade



1. Assumes 50/50 blend of low-carbon and average renewable hydrogen

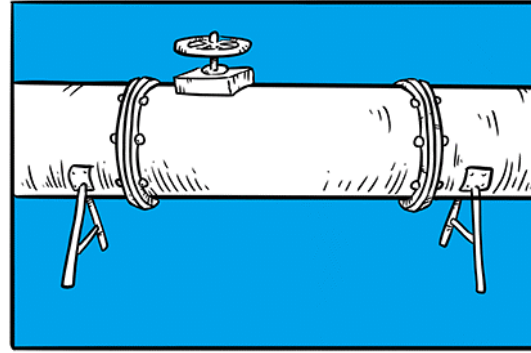
# Main type of Hydrogen Production plants

HYDROGEN  
PRODUCTION



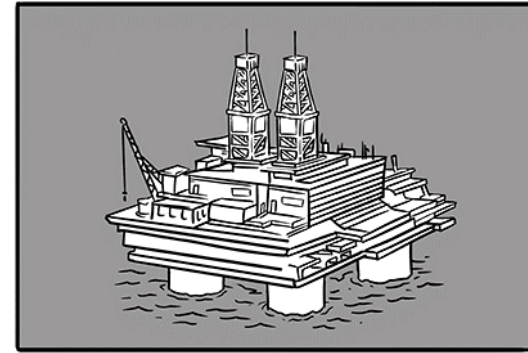
## Green hydrogen

Made from renewable electricity, no CO<sub>2</sub> emitted



## Blue hydrogen

Made from natural gas, CO<sub>2</sub> emissions captured and stored



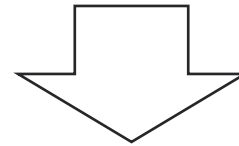
## Grey hydrogen

Made from natural gas, CO<sub>2</sub> emitted into the atmosphere



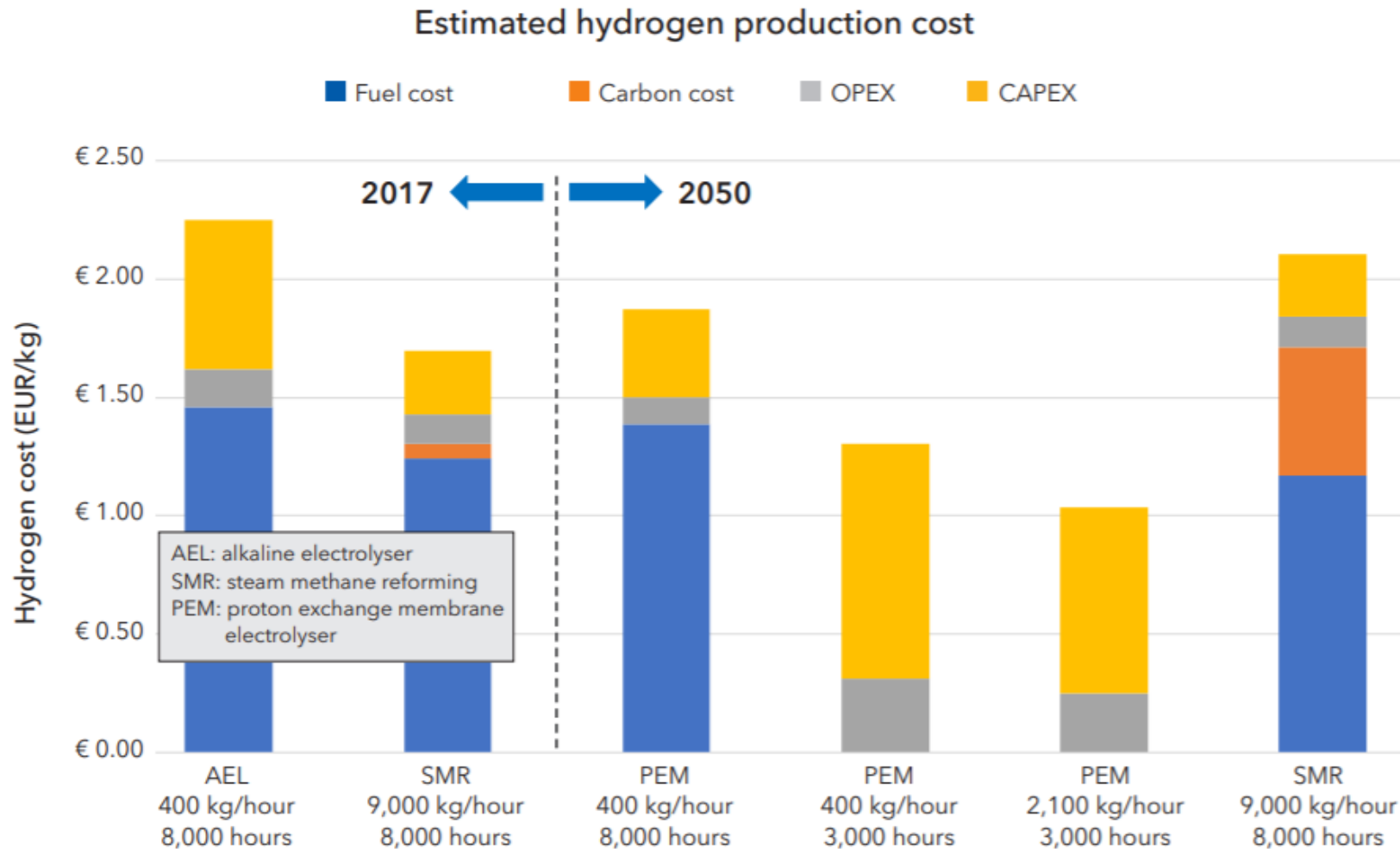
## Brown hydrogen

Made from coal, CO<sub>2</sub> emitted into the atmosphere



Mapping of equipment categories and their average incidence in each type of plant

# Expected evolution of the cost of Hydrogen Production



- Currently, the reference production method for hydrogen is the **reforming of natural gas with steam** (steam methane reforming, or **SMR10**)
  - This process is mature and has been used in the bulk chemicals industry (e.g., for ammonia production) for many years.
  - SMR produces pure hydrogen at a pressure of approximately 20 bar.
- The electricity-based reference technology is **electrolysis**:
  - current mainstream technology is the **alkaline electrolyser (AEL)**
  - expected to be replaced by the **proton exchange membrane (PEM) electrolyser** in a decade
  - **solid oxide electrolyser cell (SOEC)** an even more distant option

# Types of Hydrogen storage

## Liquefied (storage tanks)

- Liquefied hydrogen is cooled to approximately  $-253^{\circ}\text{C}$ 
  - In this state, it is under near atmospheric pressure, so **storage tanks do not require pressure strength**
  - must be heavily insulated to minimize the evaporation losses caused by thermal leakage (boil-off).
- Another issue for cryogenic storage tanks is **tank's resistance to expansion and contraction**, as well as the resistance to **structural degradation** due to hydrogen embrittlement
  - These issues can be solved by a **careful choice of materials and careful construction**

## Pressurized (pressure vessels)

- Storage in pressure vessels is also a proven technology with a history of more than 100 years
  - New combinations of metallic, polymer, and composite materials<sup>16</sup> are allowing for higher pressure
  - **Composite pressure vessels** can withstand pressures up to 1,000 bar and are near commercial production
- Due to the **high pressures**, the **volume per vessel is limited** and it will be below 1 m<sup>3</sup>

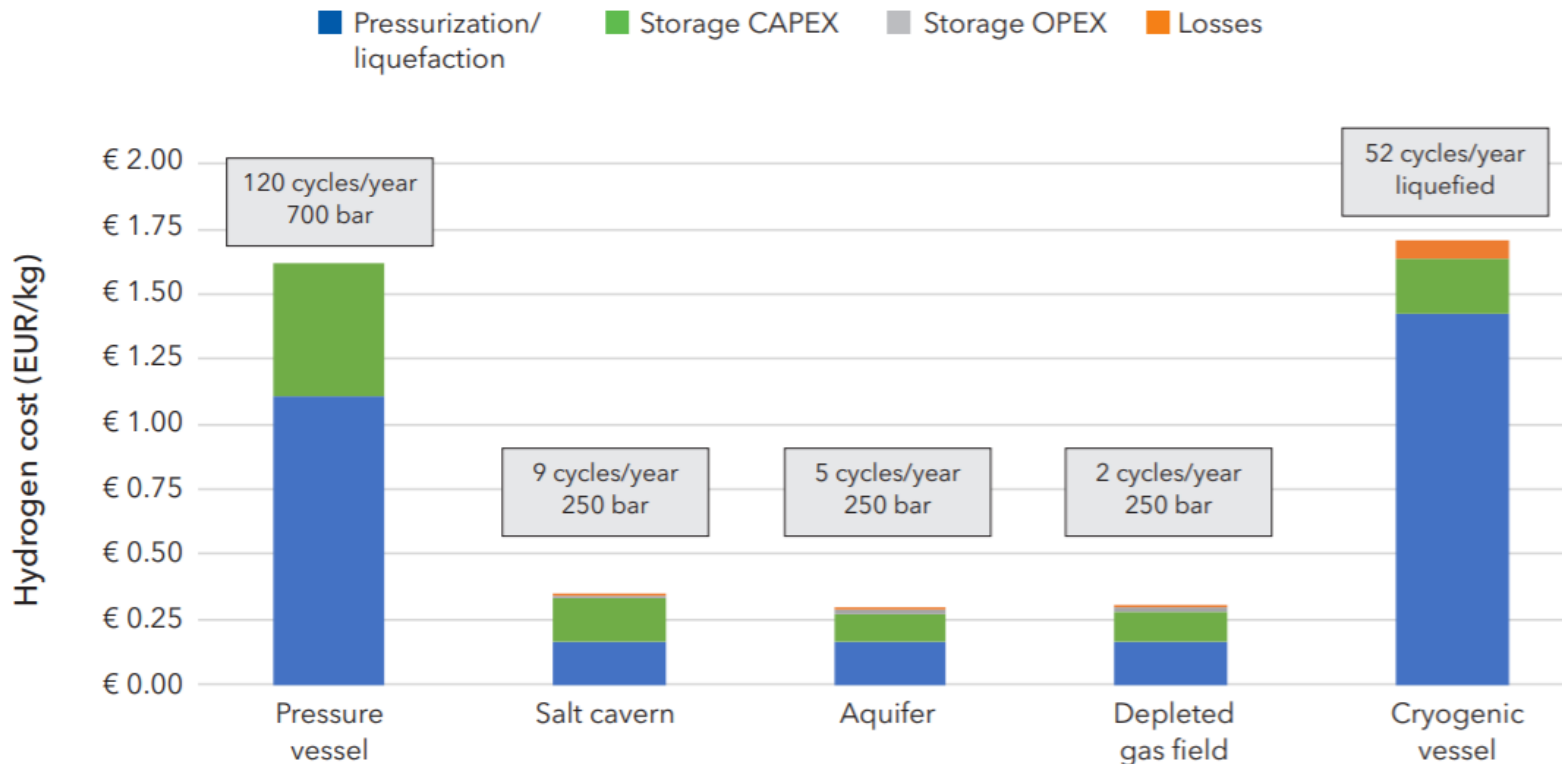
## Pressurized subsurface storage (e.g. salt caverns or depleted gas fields)

- The storage pressure currently varies between 100-150 bar and may exceed 250 bar for very deep reservoirs or aquifers



# Expected evolution of the cost of Hydrogen Storage

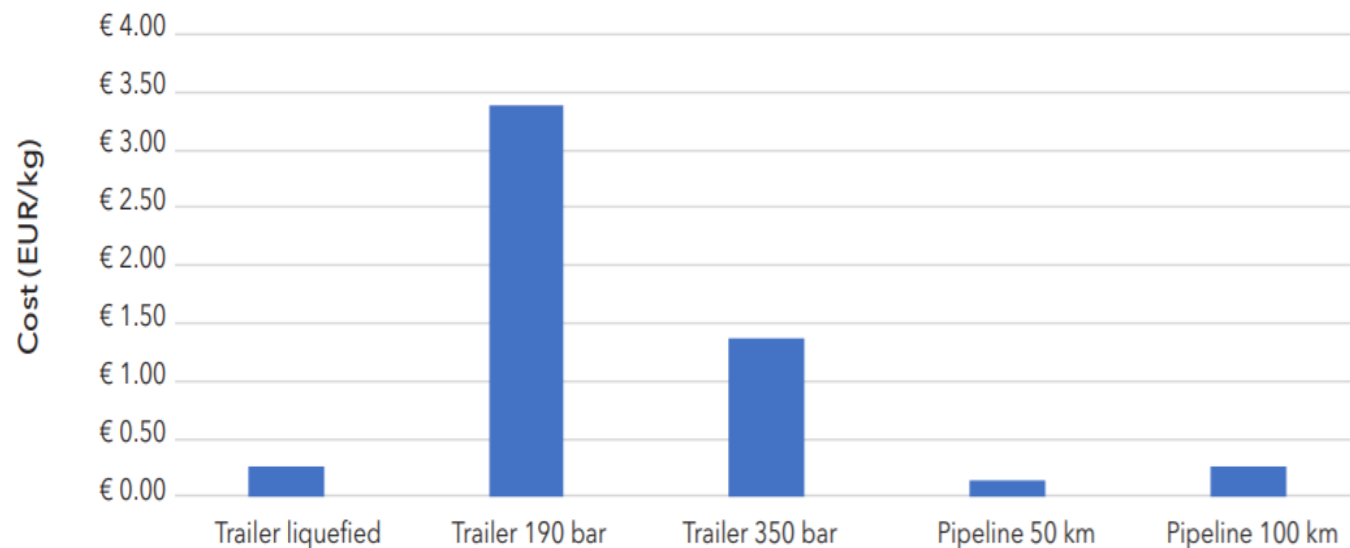
HYDROGEN  
STORAGE



- Hydrogen can be stored over a long period of time without significant losses
- Currently most feasible options for hydrogen storage:
  - liquefied (**tanks**)
  - pressurized (**pressure vessels**)
  - pressurized **subsurface storage** (e.g., salt caverns or depleted gas fields)
  - **solid form**, by absorption by or adsorption to a variety of potential materials such as metal hydrides - not a mature technology yet
- For large volumes and long duration storage (> months) **subsurface storage** seems to be the only feasible option (apart from possibly chemical storage, e.g., as ammonia)
  - Important storage parameters beside investment cost (CAPEX) and operation cost (OPEX) are the **storage losses and the storage usage** (number of cycles per year)
  - Highest costs of storage are the **costs to post-process hydrogen after production, so it can be stored**

# Expected evolution of the cost of Hydrogen Transportation

Cost estimate of hydrogen transportation



- General options for transportation of hydrogen are:
  - by **pipeline** (pressurized) - **Air Liquide**, for example, already has an **extensive network of more than 2,700 km of pipelines** in Northwest Europe
  - **trailer mounted vessel, pressurized**
  - **trailer mounted vessel, liquefied**
- **Pressurized transportation by trailer** is significantly more expensive than by pipeline for a 100 km transportation range. **Ships and trucks** can transport hydrogen
- **Liquefied transportation costs** are comparable with pipeline transportation cost. Liquefied transportation incurs other cost, however, such as boil-off and transfer losses (up to 25%) and additional fuelling station cost
- One important issue is that transporting hydrogen under elevated pressure (>7 bar) in hard steel pipes can cause embrittlement and subsequent leakage issues. Also, **leakage issues may occur at joints and valves**





ASSOCIAZIONE NAZIONALE DI  
IMPIANTISTICA INDUSTRIALE