ANIMP
ASSOCIAZIONE NAZIONALE DI IMPIANTISTICA INDUSTRIALE

Componentistica per l’Idrogeno

Gruppo di Lavoro - Avvio attività

4 Febbraio 2021

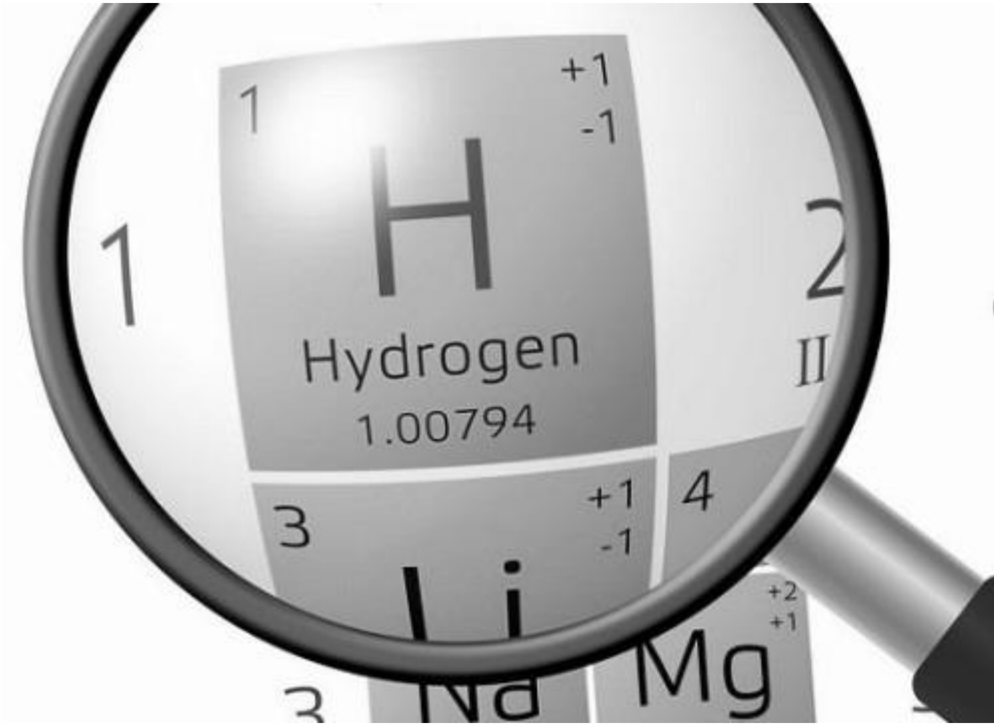
Agenda

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**



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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 mercati, 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

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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. Quale **R&D** sarà necessaria per soddisfare le nuove specifiche tecniche (temperature, pressioni, …) anche tramite nuovi materiali?
8. Quali potenziali **incentivi** per R&D?
9. In quali categorie merceologie è prevedibile **maggiore domanda e “colli di bottiglia”**?
10. Quali **economie di scala** saranno necessarie per raggiungere competitività di costo nelle principali merceologie critiche?

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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:
   - B1) Hydrogen Green production
   - B2) Hydrogen Blue production
   - B3) Hydrogen Grey production
   - B4) Carbon Capture
   - B5) Hydrogen Storage
   - B6) Hydrogen Transportation
   - B7) Hydrogen Vessels
   - B8) Smart Cities and Hydrogen

C) Matrice di mappatura dei **FORNITORI** e relative:
   - **categorie** di fornitura
   - **esperienze** previe (referenze, …)
   - **competenze distintive** (R&D, …)

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Contatti per candidatura a intervista durante il mese di Febbraio 2021

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Agenda

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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[1]

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[2] globally since 2017, in new segments, e.g. heavy duty and rail

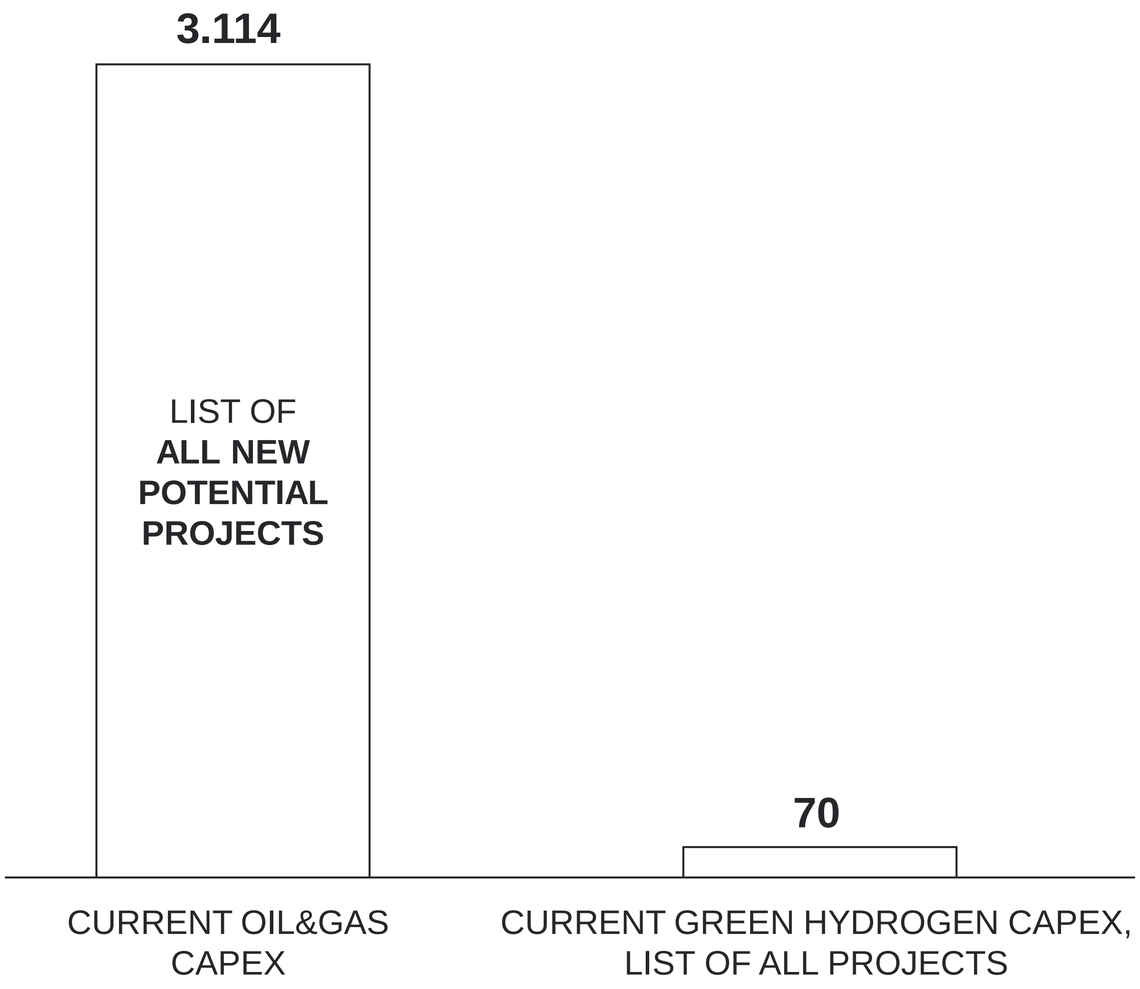
1. Based on 18 country roadmaps announced as of publication
2. Not exhaustive

Source: Hydrogen Council

Green Hydrogen CAPEX today

GREEN HYDROGEN

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

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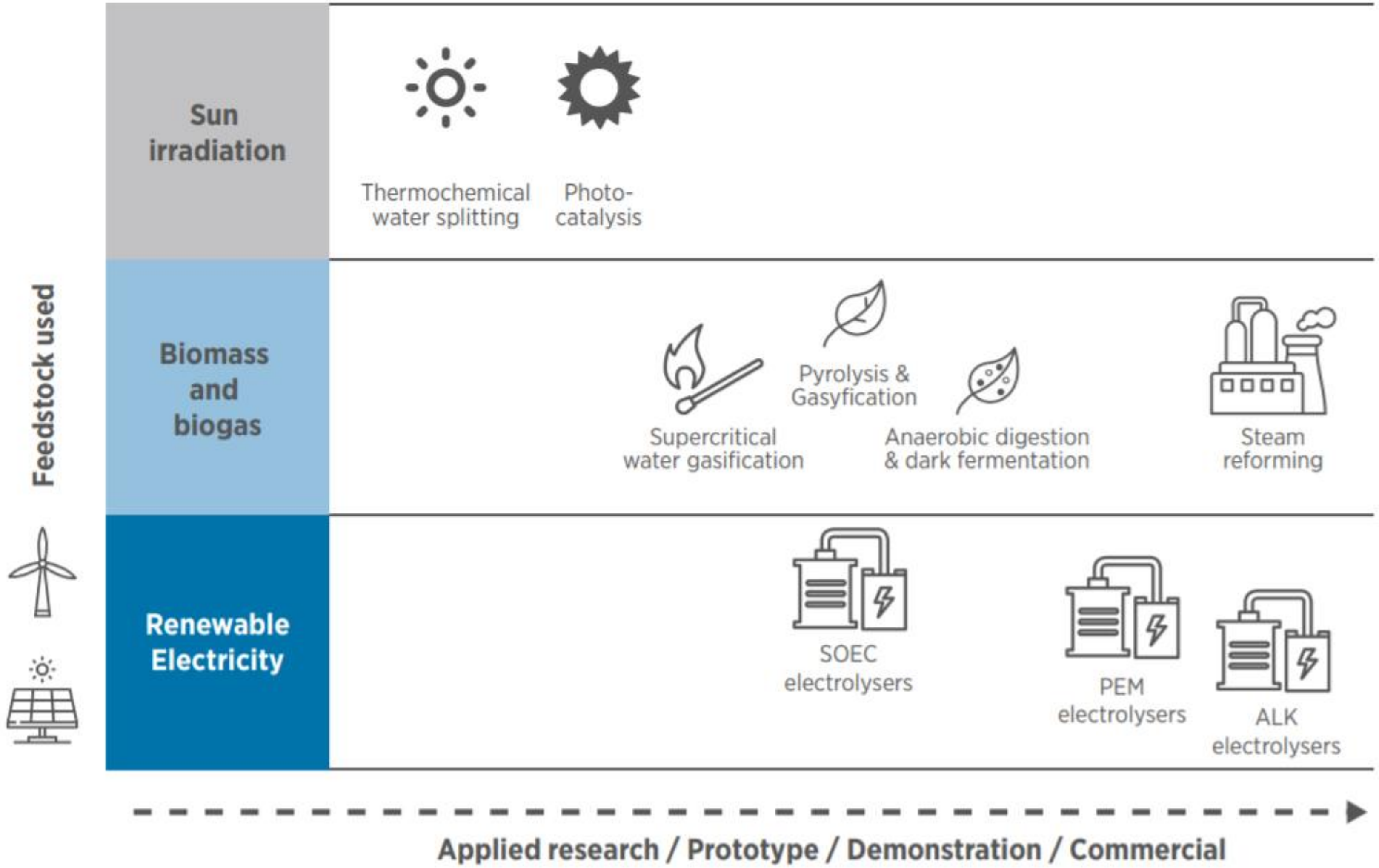
Source: Institute for Energy Economics and Financial Analysis (IEEFA)

Renewable Hydrogen production pathways and current levels of maturity

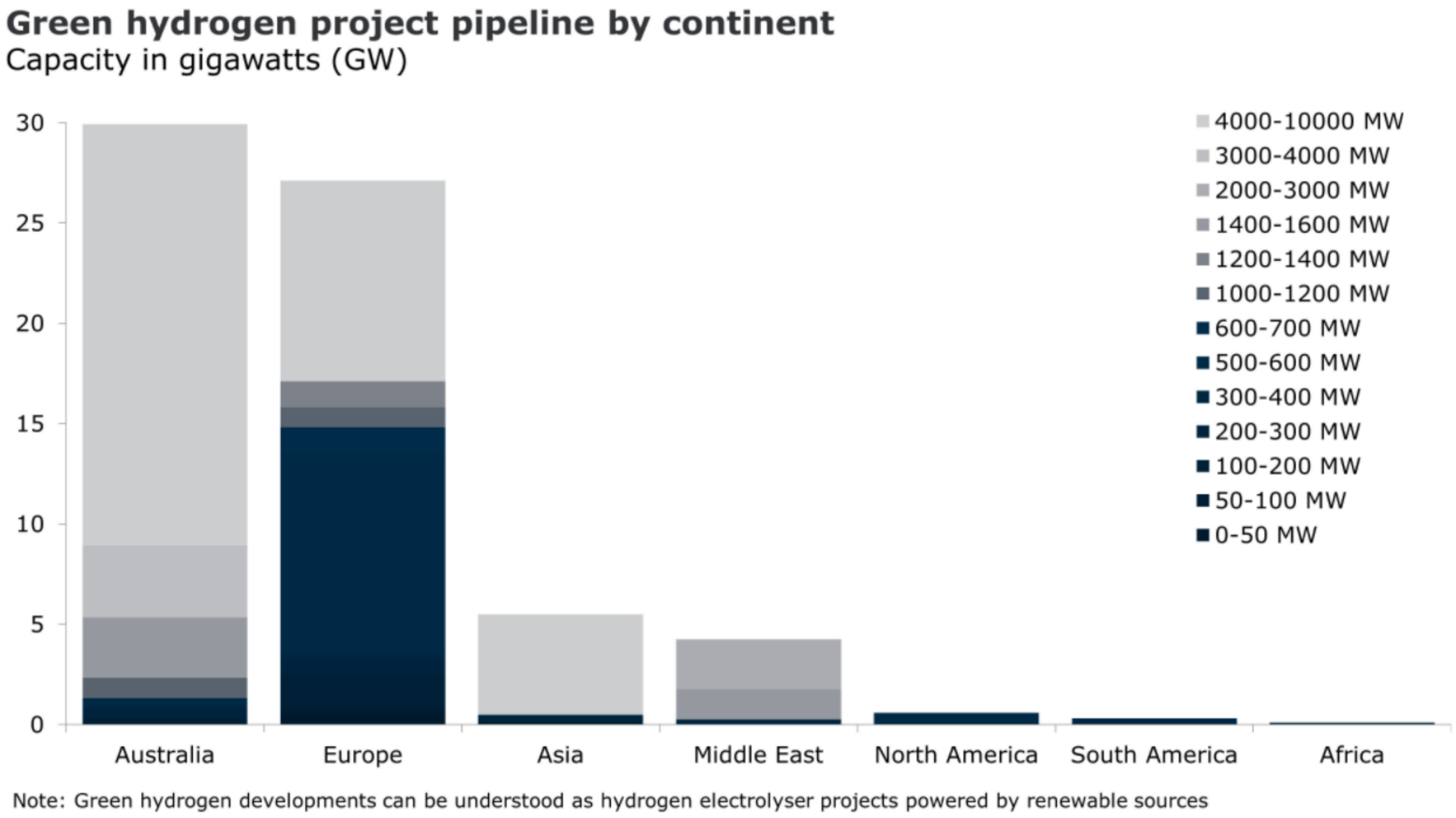
GREEN HYDROGEN



Source: IRENA

Green Hydrogen project pipeline is growing

GREEN HYDROGEN



- 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

Source: Rystad

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

Source: IEEFA

Major Green Hydrogen projects summary - Example

GREEN HYDROGEN

	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

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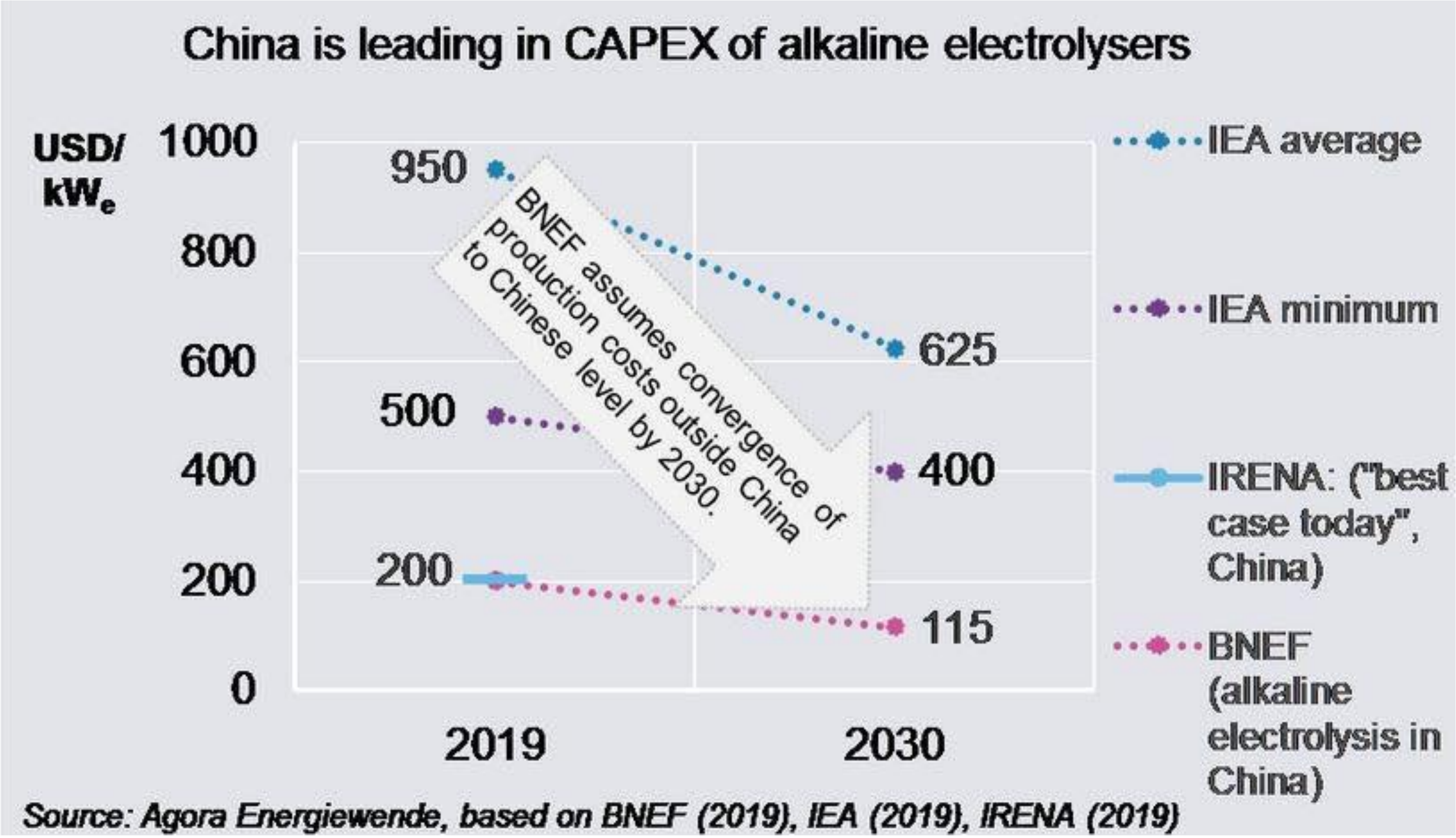
Source: IEEFA

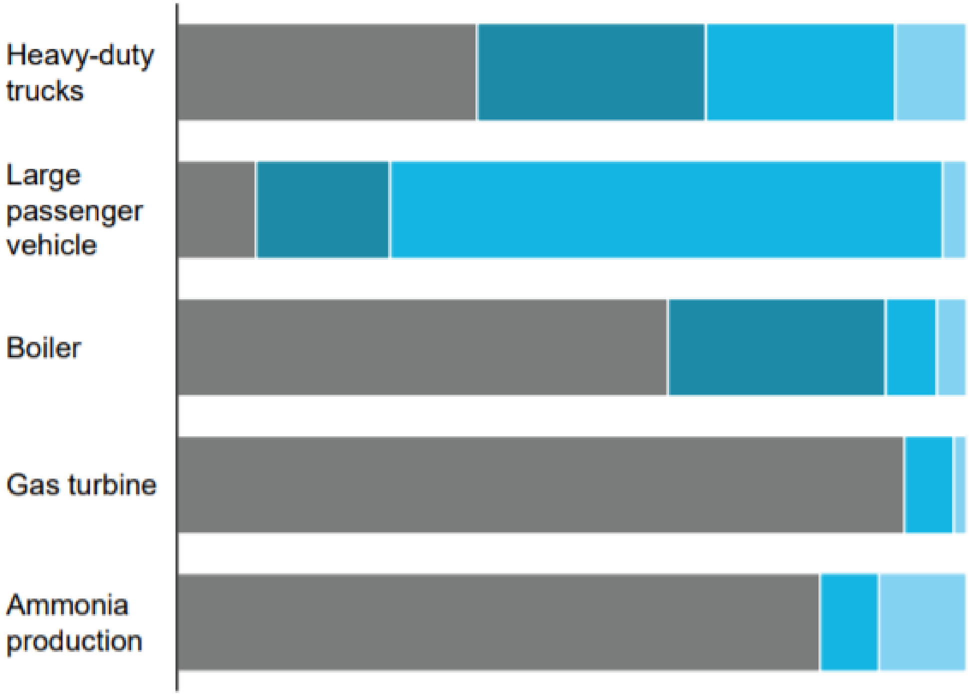
The future of Hydrogen rests on cost reduction



… and **system safety** assurances

Relevant cost drop expected in the next decade

Cost breakdown of hydrogen applications
Percentage of total cost 2020

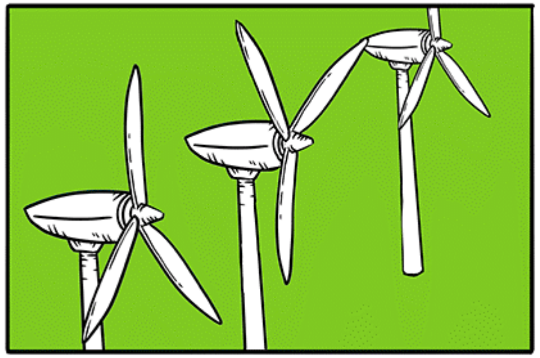


Application	Cost drop 2020-30, Percent	Cost reduction levers to reach target
Heavy-duty trucks	-50%	Scale-up of full supply chain; Industrialisation of fuel cell and hydrogen tank manufacturing
Large passenger vehicle	-45%	Industrialisation of fuel cell and hydrogen tank manufacturing; Scale-up and utilisation of HRS
Boiler	-45%	Lower-cost hydrogen from renewables; Higher pipeline network utilisation due to scale-up of demand
Gas turbine	-35%	Scale-up of system size and manufacturing of electrolysers for green hydrogen production
Ammonia production	-45%	Scale-up of system size and manufacturing of electrolysers for green hydrogen production

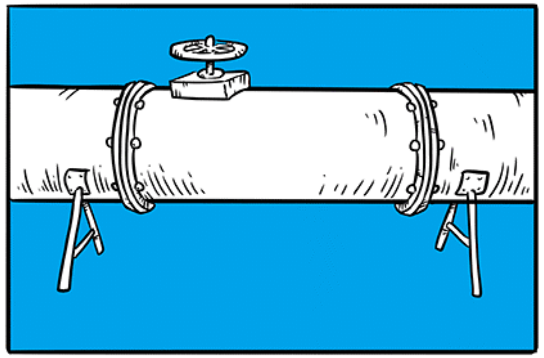
1. Assumes 50/50 blend of low-carbon and average renewable hydrogen

Source: Hydrogen Council

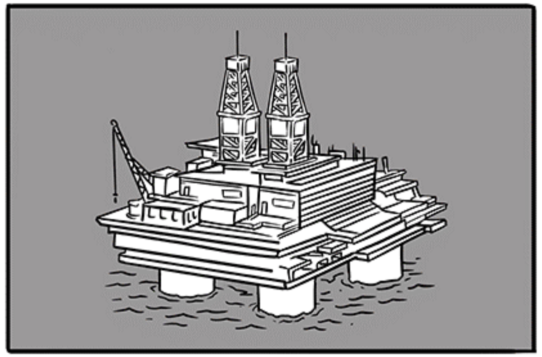
Main type of Hydrogen Production plants



Green hydrogen
Made from renewable electricity, no CO_2 emitted



Blue hydrogen
Made from natural gas, CO_2 emissions captured and stored

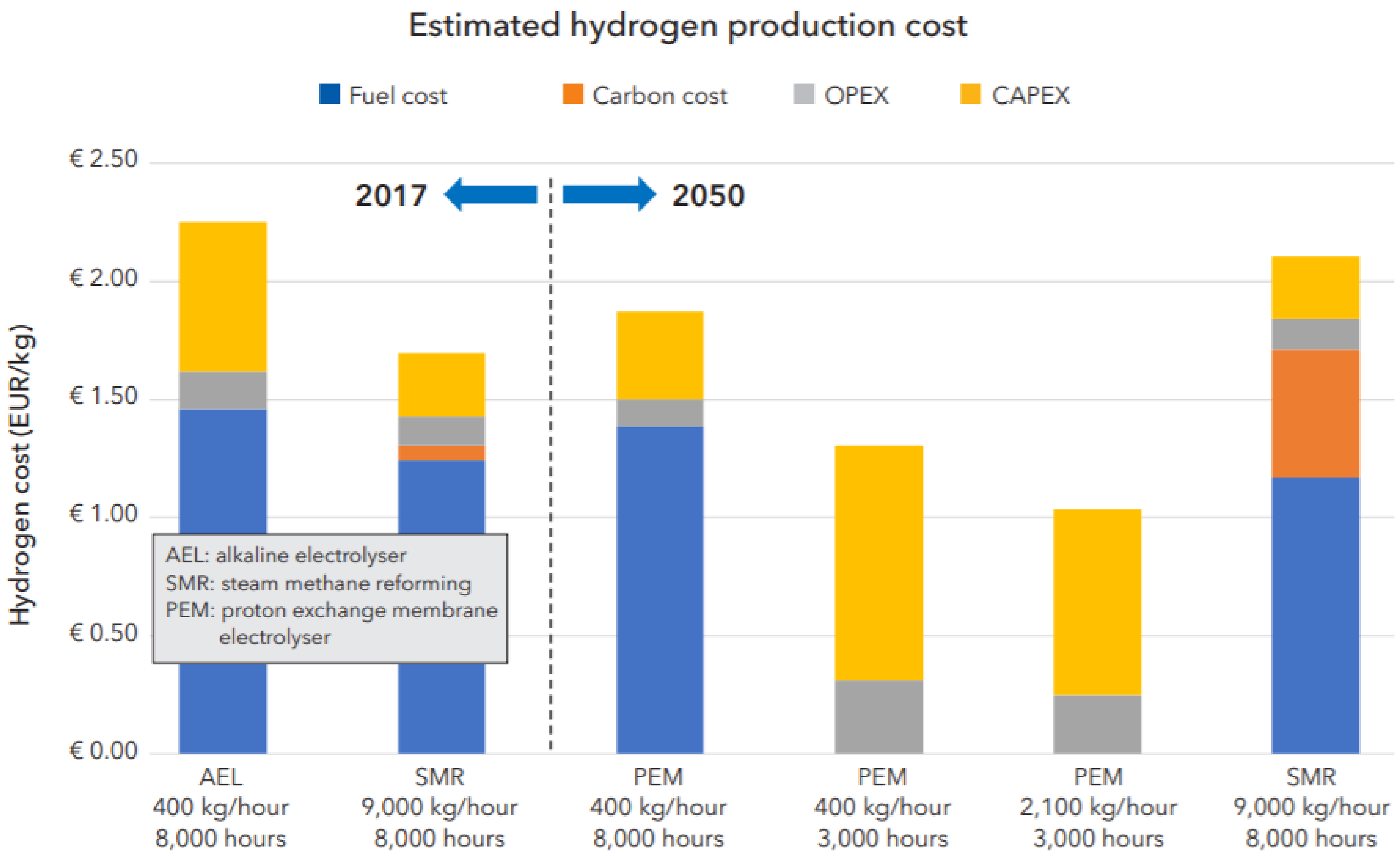


Grey hydrogen
Made from natural gas, CO_2 emitted into the atmosphere

Brown hydrogen
Made from coal, CO_2 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

Source: DNV

Types of Hydrogen storage

Liquefied (storage tanks)

- Liquefied hydrogen is cooled to approximately -253°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 materials16 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 m3

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

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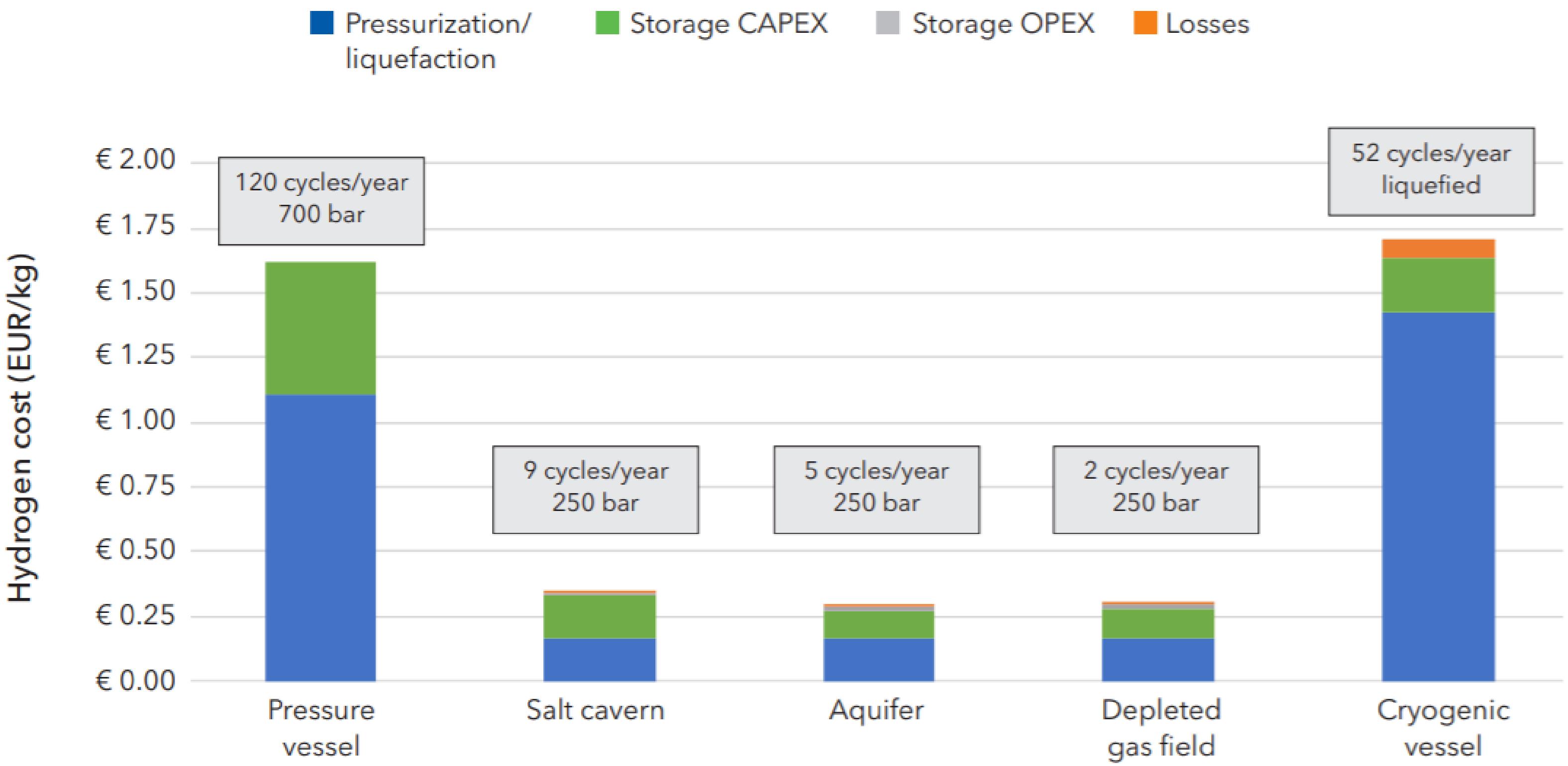
Expected evolution of the cost of Hydrogen Storage

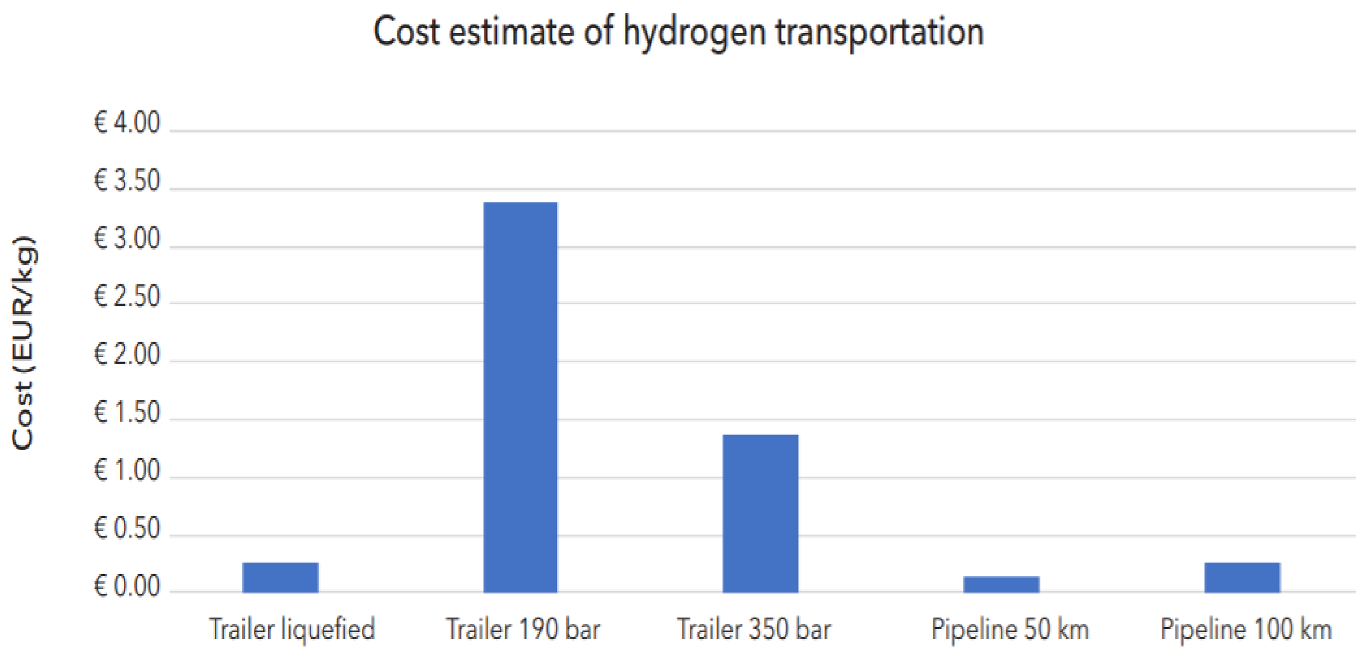


- Hydrogen **can be stored over a long period of time without significant losses**
- Currently most feasible options for hydrogen storage:
  - liquefied (**tanks**)
  - pressurized (**pressure vessels**)
  - pressurized **subsurface storage** (e.g., salt caverns or depleted gas fields)
  - **solid form**, 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**

Source: DNV

Expected evolution of the cost of Hydrogen Transportation

HYDROGEN TRANSPOR-TATION



- 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**

Source: DNV

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