DALLA RIVOLUZIONE INDUSTRIALE
ALLA RIVOLUZIONE ENERGETICA

Il ruolo dell'idrogeno nella transizione ecologica

LUIGI CREMA

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Fondazione Bruno Kessler

CAMERA DI COMMERCIO INDUSTRIA ARTIGIANATO TURISMO E AGRICOLTURA DI TRENTO
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Le sfide della Filiera Idrogeno

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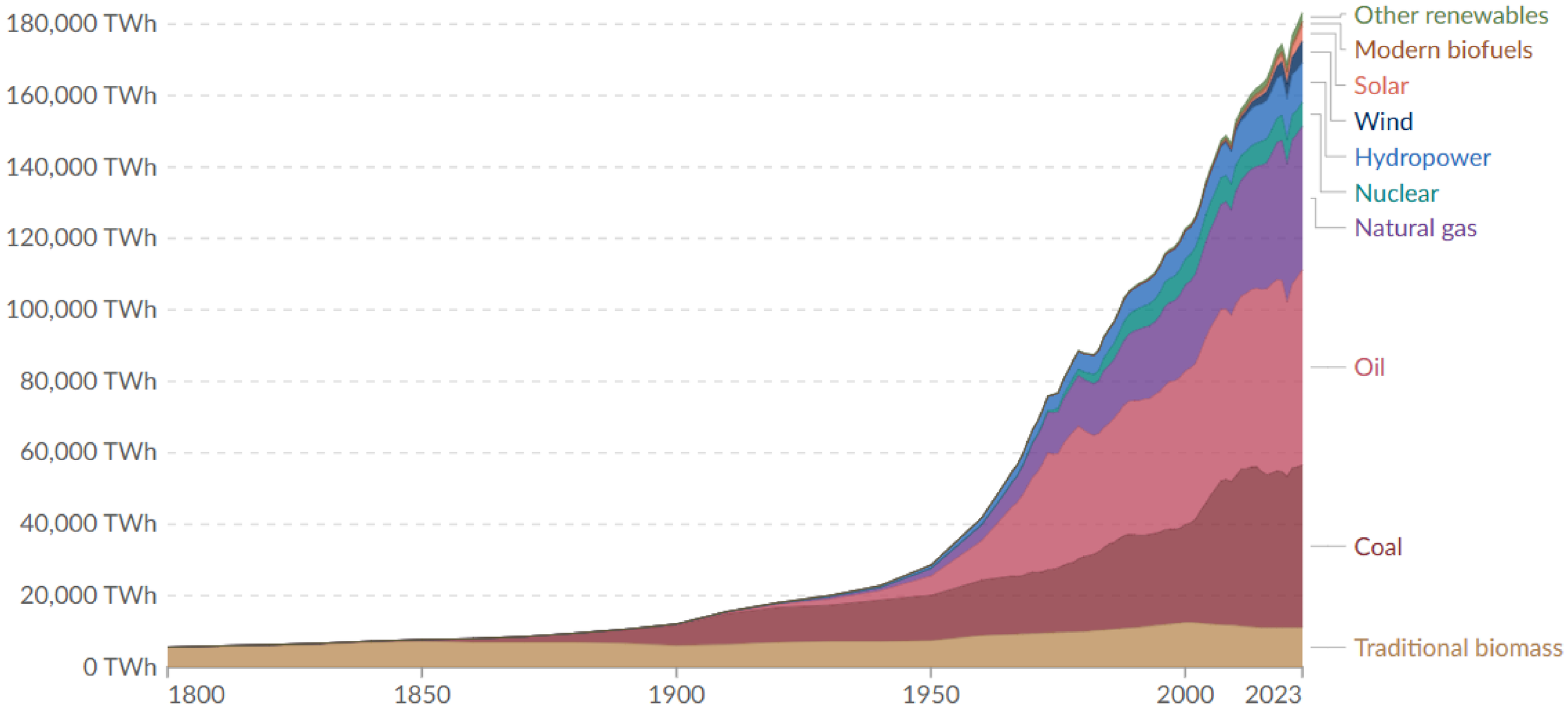
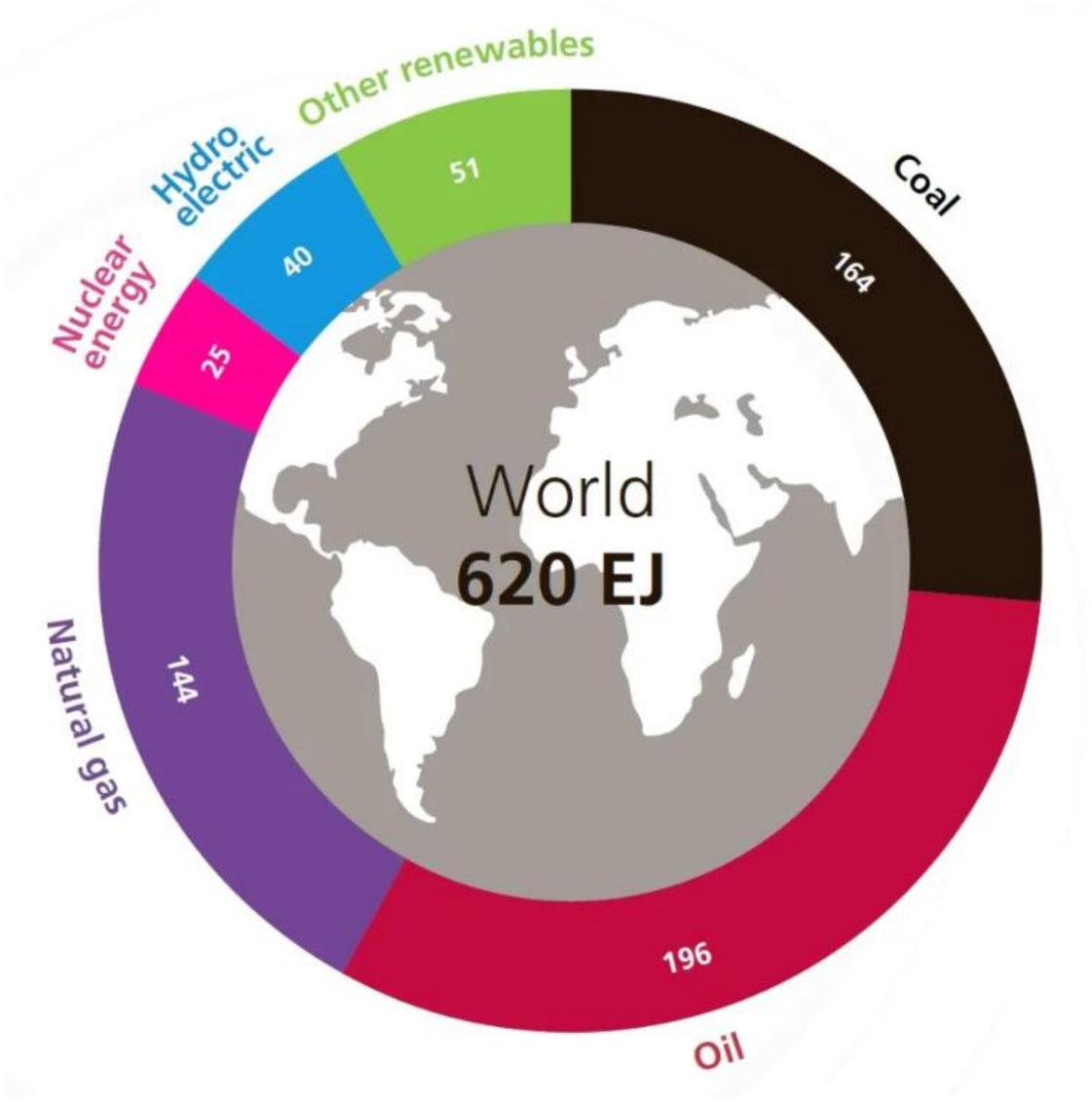
Transizione energetica

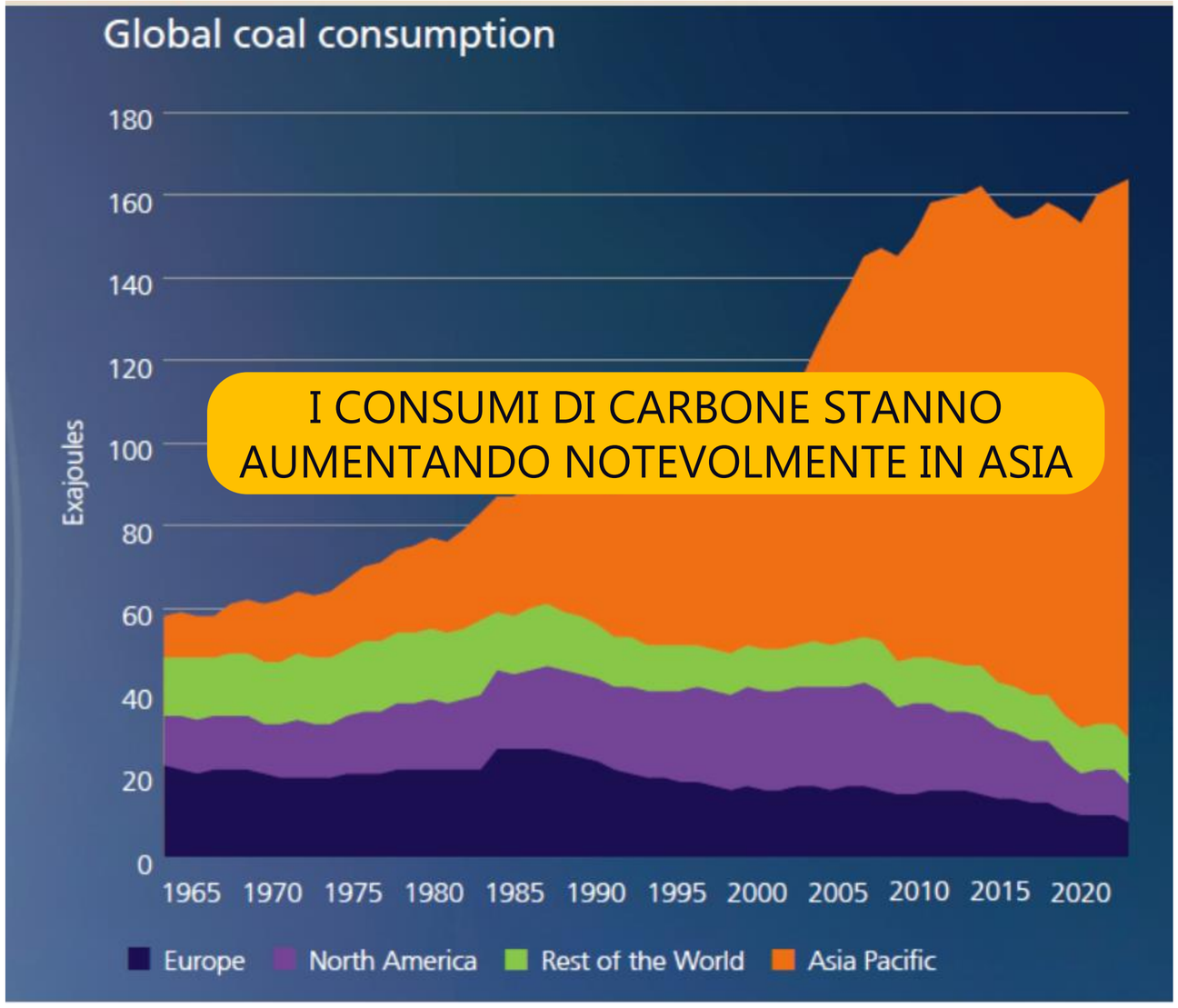
Consumo globale di energia primaria per fonte

Source: Energy Institute - Statistical Review of World Energy (2024)



Il consumo energetico è dominato dai combustibili fossili per oltre l'80%





HEADWINDS AGAINST CLIMATE POLICIES

BlackRock Quits Major Net Zero Alliance Ahead of Trump Inauguration As Number of Wall Street Lenders Shying Away From Sustainability Efforts Grows

BY MARTINA IGINI | AMERICAS | JAN 13TH 2025 | 3 MINS

EARTH.ORG IS POWERED BY OVER 150 CONTRIBUTING WRITERS

Morgan Stanley to leave sector climate coalition

By Reuters

January 2, 2025 10:33 PM GMT+1 · Updated 4 months ago

(Image: Shutterstock)

FINANCE

Wednesday, 19 March 2025 10:53

Japan's Biggest Bank to Exit Climate Alliance

› Green Finance Under Trump 2.0: West Retreats, East Rises?

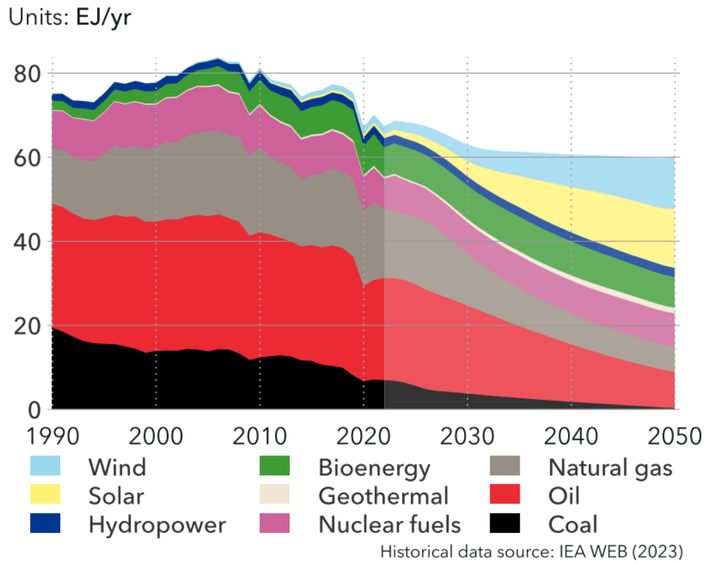
The Australian

Macquarie (ASX: MQG) quits Net Zero B…

The risk is that the current US administration will induce Global financial institutions to shy away from fighting the climate change, but for how long? And at what cost for citizens?

Unione Europea – Proiezioni sui bisogni energetici

Consumo energetico primario europeo per fonte

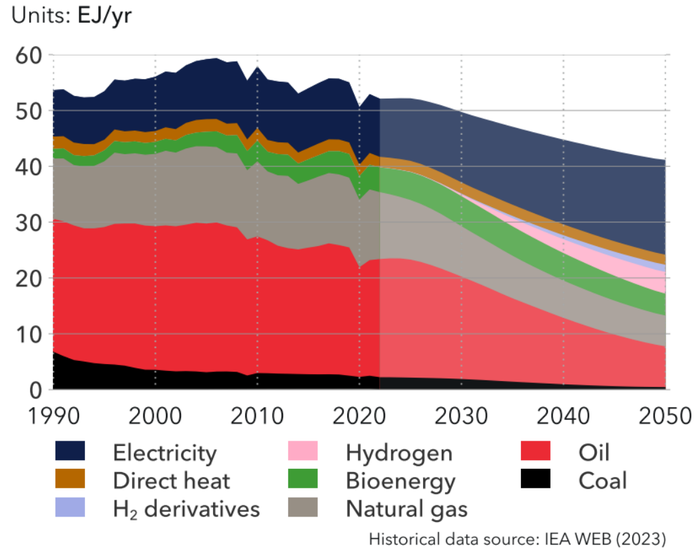


Energy Source (2023)	TWh/year
Wind	516.8
Solar PV	258.4
Hydropower	581.4
Bioenergy	2067.2
Geothermal	64.6
Nuclear	2002.6
Natural Gal	4586.6
Oil	6718.4
Coal	1938.0

Source: Energy Transitions Outlook 2023, DNV GL

La dipendenza dell'UE dai combustibili fossili è ancora alta >70%

Domanda energetica finale europea per vettore energetico



Energy Source (2023)	TWh/year
Electric power	2890
Heating	530
Bioenergy	1252
Natural Gas	3324
Oil	5877
Coal	601

Unione Europea – Potenziale delle rinnovabili

Consumo finale di energia elettrica rinnovabile 2022

Technology	TWh/year	% on total renewable energy
Tidal energy	0.51	0.04%
Bioliquids	3.31	0.29%
Concentrated Solar Thermal	4.54	0.39%
Geothermal	6.43	0.56%
Offshore wind	**52.67**	**4.58%**
Biogas	52.89	4.60%
Solar PV	**205.11**	**17.82%**
Solid Biomass	105.90	9.20%
Onshore wind	**373.64**	**32.47%**
Hydropower (not pumped)	345.77	30.05%
Total	1150.78	

Source: Dashboard – Renewable energy in Europe 2023, European Environment Agency

2022	Energy	Installed capacity
Tecnology	**TWh/year**	**GW**
Solar PV	205.3	236[1]
Wind (onshore + offshore)	575.8 (488.3+87.4)[2]	255 (225+30)[2]

[1]Source: Global Market Outlook For Solar Power 2023-2027, Solar Power Europe

[2]Source: Wind energy in Europe, Wind Europe

2027	Energy	Installed capacity (+increase from 2022)
Tecnology	**TWh/year**	**GW**
Solar PV	513.3	546 (+337*)
Wind (onshore + offshore)	900.9	399 (+144*)

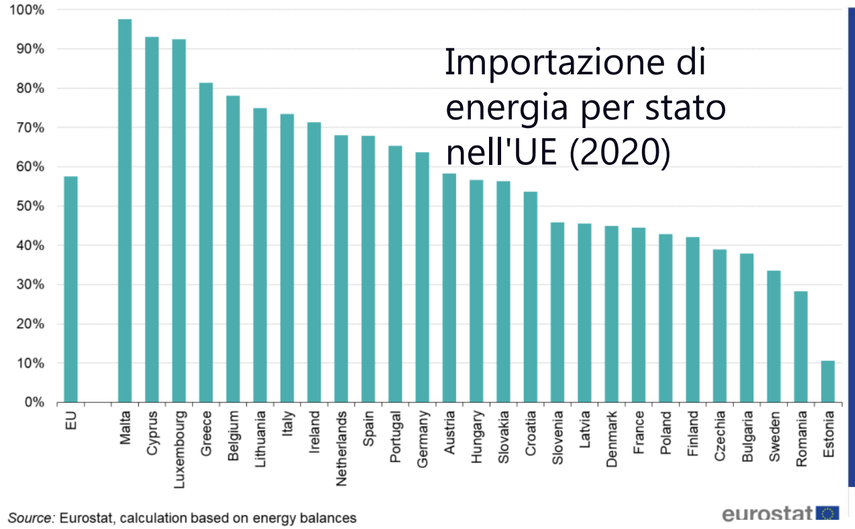
*Source: Renewables 2022, IEA

Average utilization factor	%
Solar PV	10
Wind (onshore + offshore)	26

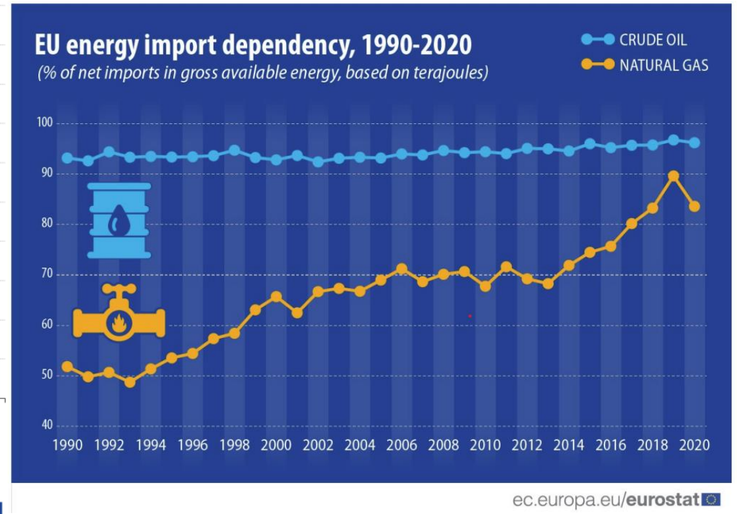
MAX EU capacity	GW
Solar PV	~14 000
Onshore	~12 000

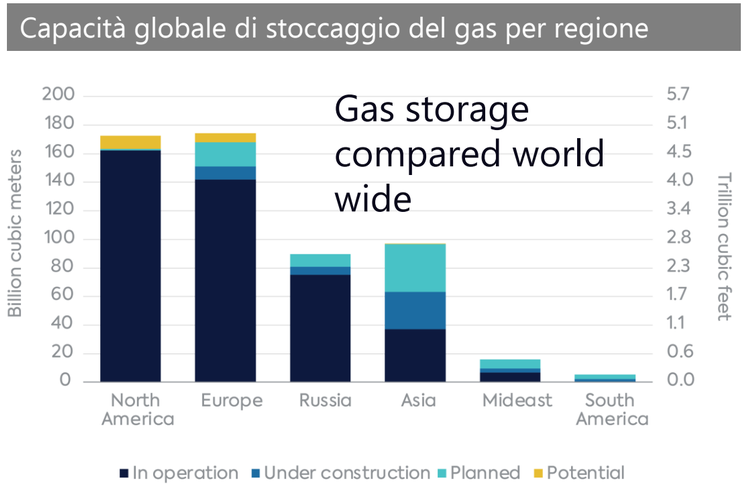
Source: Generation Lulls from the Future Potential of Wind and Solar Energy in Europe, Ryberg (2019)

Unione Europea – Bisogni di deficit, importazione e stoccaggio

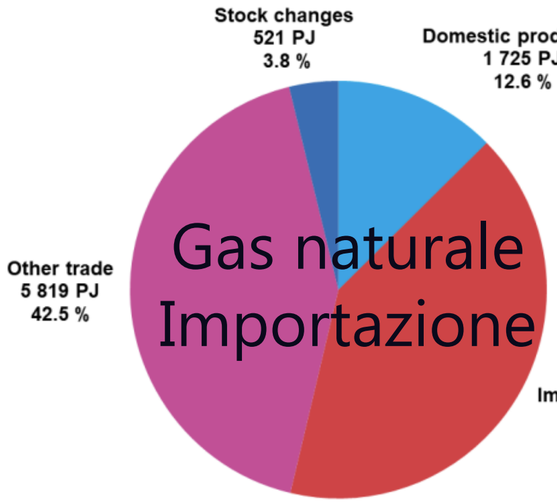


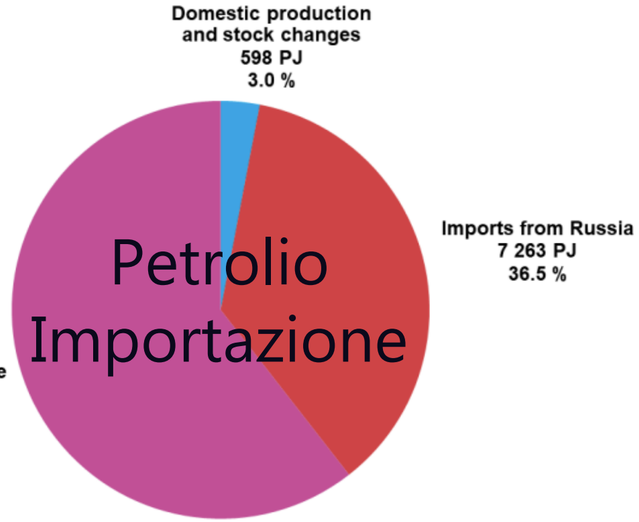
Source: Eurostat, calculation based on energy balances

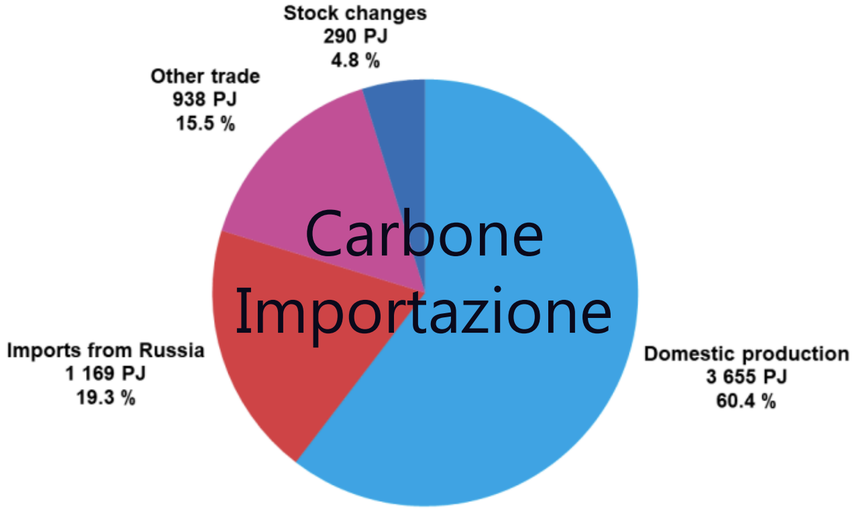




Source: Cedigaz, as of January 2022.

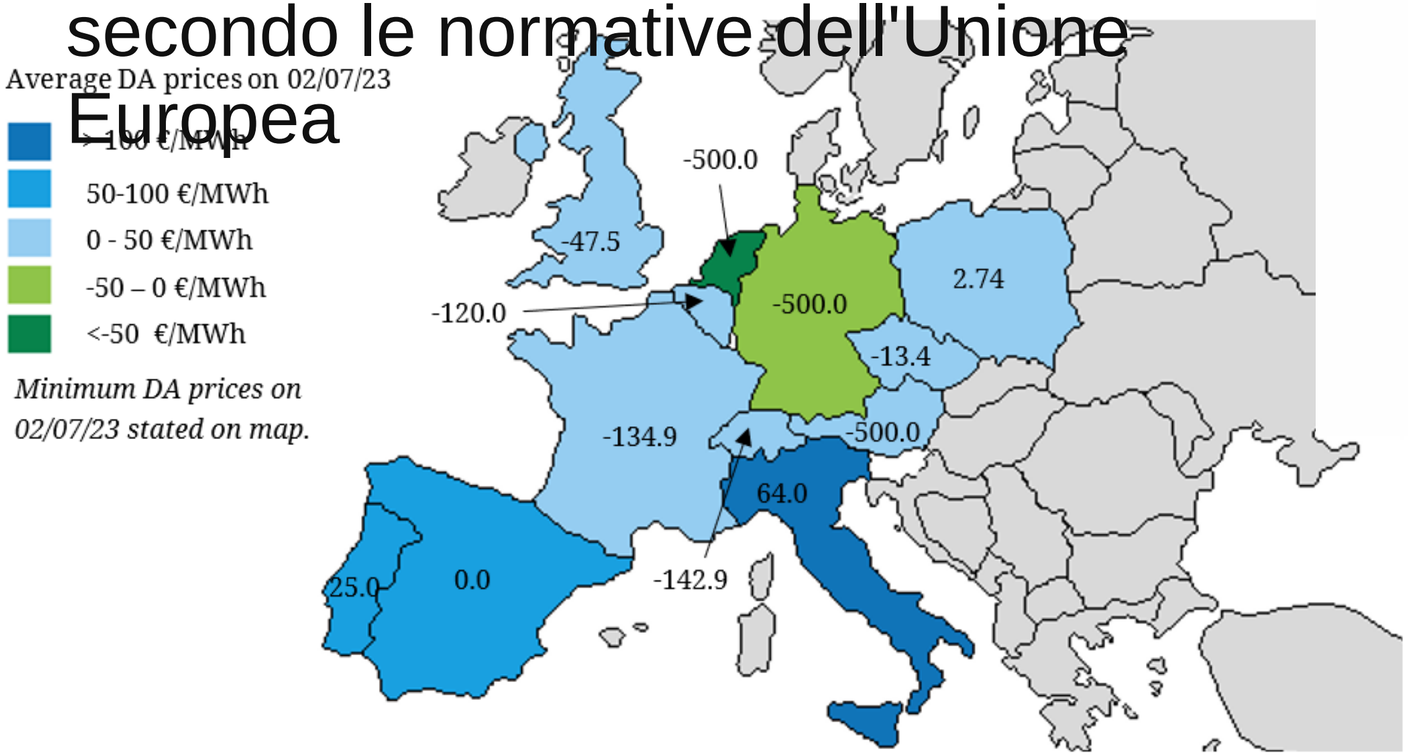






RINNOVABILI e PREZZI NEGATIVI DELL'ENERGIA

I prezzi negativi nei Paesi Bassi, Germania e Austria hanno raggiunto
-500€/MWh, il prezzo minimo secondo le normative dell'Unione Europea

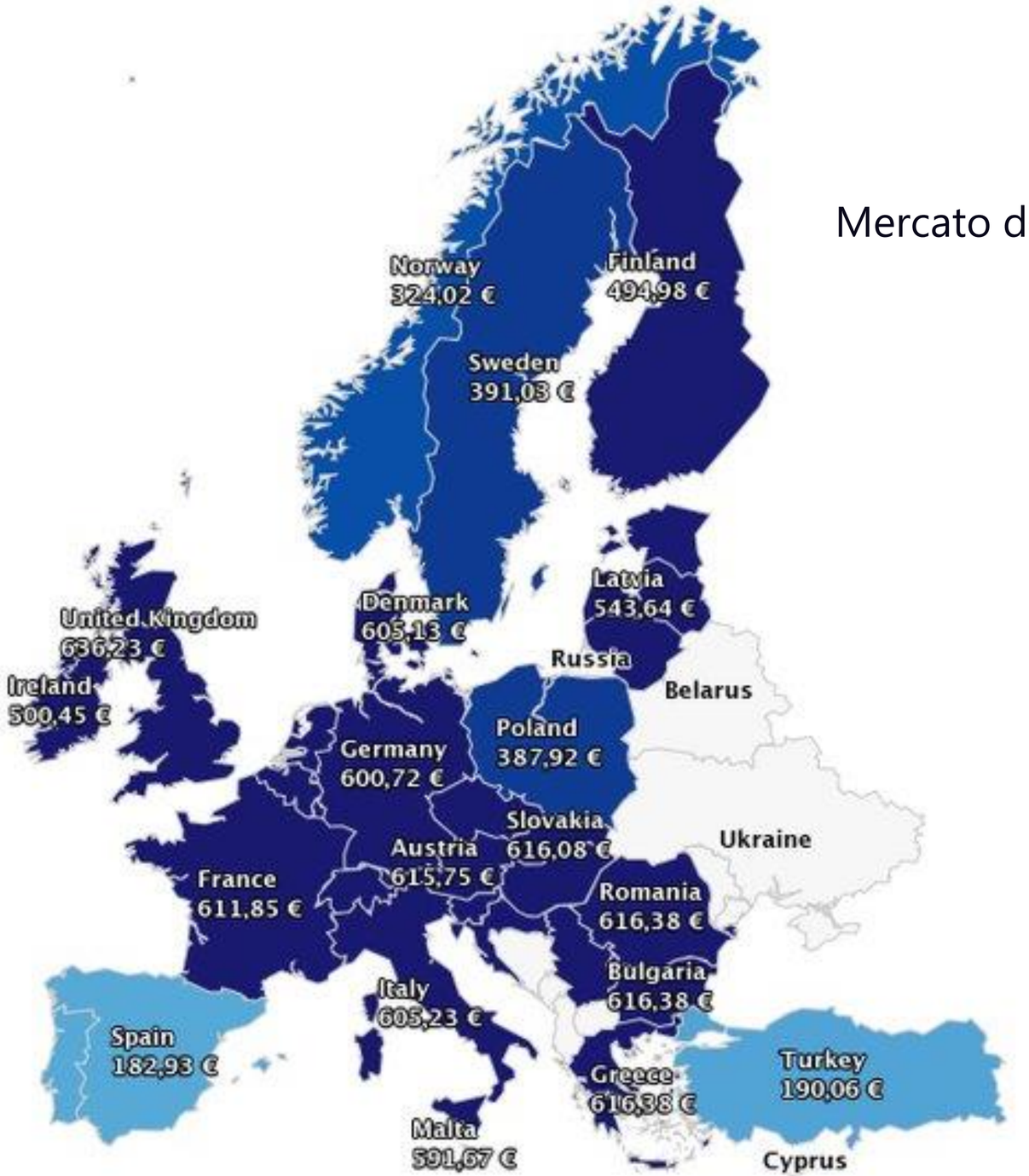


Source: ENTSO-E

Queste sono condizioni molto negative per le multiutility

RINNOVABILI E SOTTOPRODUZIONE

Dall'altra parte, quando le rinnovabili non sono disponibili, i prezzi di mercato possono diventare insostenibili!!
L'imprevedibilità dell'approvvigionamento energetico è un problema importante!!



Energy Curtailment

- In 2040 between 100 and 310 TWh of renewable generation are estimated to be at risk of being curtailed due to bottlenecks in the grid.
- Warnings were echoed by Draghi's report on European competitiveness.

Source: JRC – European Commission

Oggi l'UE ha un consumo energetico finale di circa 9000 TWh

Perché l'idrogeno?

COME AFFRONTARE LE RINNOVABILI E L'INTERMITTENZA? L'IDROGENO È IL MATTONE DI QUALSIASI SOLUZIONE!

Hydrogen Europe Research

6 Other: serve as feedstock, Decarbonize building heating

Sostenere la decarbonizzazione di tutti i settori ad alta intensità energetica, dove l'elettrificazione non può essere la soluzione unica e praticabile, essendo un elemento fondamentale per gli eFUELs

Riducendo in gran parte l'investimento nella rete elettrica e risolvendo il problema della domanda di ricarica elettrica

Decarbonize transport **4**

5 Decarbonize industry energy use

Nelle industrie ad alta intensità energetica, come materia prima o nella produzione di riscaldamento di alta qualità per processi industriali

Hydrogen

Nel medio e lungo raggio, tramite oleodotti o tramite portatori di idrogeno

Distribution of energy across regions **2**

3 Increase system resilience acting as buffer

Attraverso lo stoccaggio sotterraneo e stagionale, la gestione della domanda di energia da pick, la regolamentazione della rete, P2G e P2P

Risoluzione della variabilità e imprevedibilità delle RES, riduzione dell'energia, gestione lato della domanda, trasporto energetico su larga scala e a lunga distanza

1 Facilitate Renewable Integration

Source: Hydrogen Council

Hydrogen Strategy

#EUGreenDeal

European Commission

ONE OPPORTUNITY FOR THE FUTURE ENERGY SYSTEM

L'IDROGENO È UNA PRIORITÀ IN EUROPA

Nella nuova era politica del cambiamento energetico, l'idrogeno è al servizio dell'ambiente e dell'economia

Coordinamento politico

Quadro giuridico

Strumenti

"*Hydrogen will be key for the industrial sectors* […] Next Generation EU should invest in Hydrogen."

Ursula von der Leyen
EC President

"Hydrogen could be a *golden opportunity for our economy* […] H2 rocks, and I am committed to making it a success!"

Frans Timmermans
Executive Vice President

"The European hydrogen alliance is part of the new industrial strategy for Europe. Hydrogen will be an important technology for European industry in the coming years"

Thierry Breton
Internal market Commissioner

Una soluzione economicamente sostenibile per la migliore efficienza dei costi del sistema energetico @

L'idrogeno è incluso in una lunga lista di documenti di posizione sulla politica energetica per la transizione energetica verso NET ZERO, come risorsa chiave per raggiungere l'obiettivo

McKinsey & Company

03 Apr 2025, 11:30 Benjamin Wehrmann | Germany

Lower renewables, hydrogen buildout could
y's energy transition
y

Article
Solving the
more order

OECD Environment Working Papers No. 245

Bridging the clean energy investment gap: Cost of capital in the transition to net-zero emissions

Cian Montague, Kilian Raiser, Moongyung Lee

https://dx.doi.org/10.1787/1ae47659-en

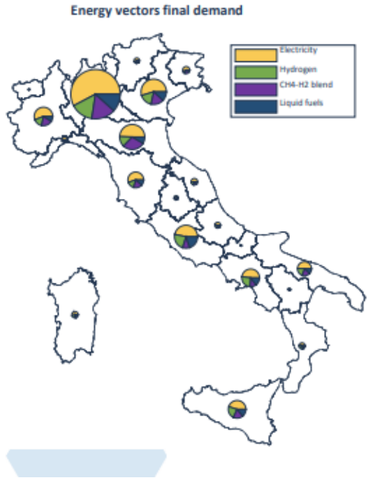
McKinsey & Company

Il ruolo dell'idrogeno: analisi della modellizzazione integrata dei sistemi energetici

S. Campanari, M. Motta, P. Colbertaldo, F. Fattori, F. Parolin, F. Mezzera

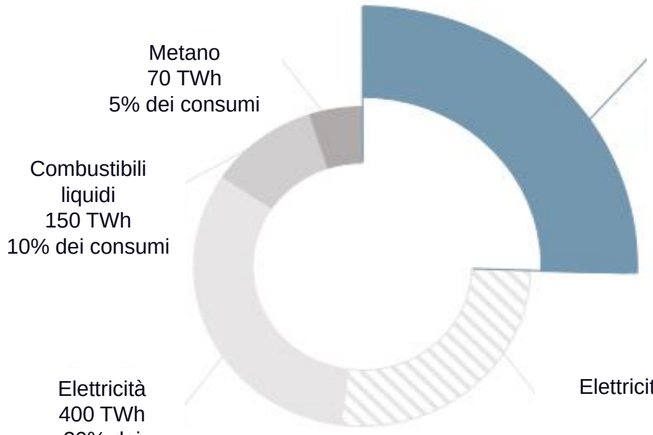
Studio del POLIMI sul sistema energetico nazionale:

- Raggiungimento di NET ZERO @ 2050
- Sicurezza di approvvigionamento
- Sviluppo rinnovabili secondo potenziali nazionali
- Analisi sulle reti e i nodi reali nazionali
- Raggiungimento di obiettivi legati al **minor investimento** con analisi multi obiettivo



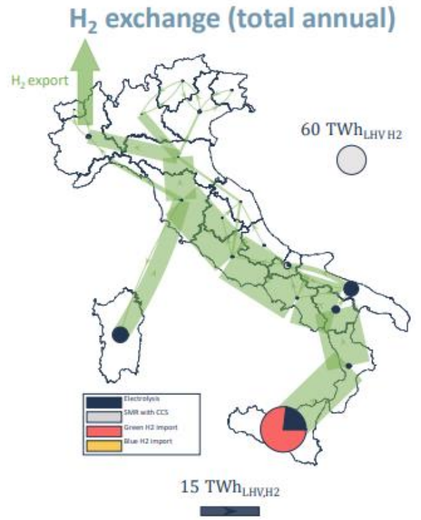
Consumi finali attesi @2050 NET ZERO

Energy vector	Annual consumption (final uses + conversion)	Uses	Variation from 2020
Electricity (production RES + thermoelectric +import)	~ 900 TWh_e/y	*Direct final demand (~450 TWh_e/y)+ electrolysis + CO_2 capture units*	3x
H_2 (domestic electrolysis or SMR + import)	~ 300 TWh_{LHV}/y (~ 10 Mt_{H2}/y)	*Direct final demand for mobility (~170 TWh_{LHV}/y) + industrial feedstock demand (~15 TWh_{LHV}/y) + thermoelectric power generation, civil heating, industry*	New vector
CH_4 [1] (domestic biomethane + domestic NG + import NG)	~ 73 TWh_{LHV}/y (~ 8 mld Sm^3/y)	*Civil heating, industry, thermoelectric power generation, H_2 production via SMR+CCS*	-90%
Liquid fuels [2]	~ 180 TWh_{LHV}/y	*Mobility and industrial feedstock*	-80%

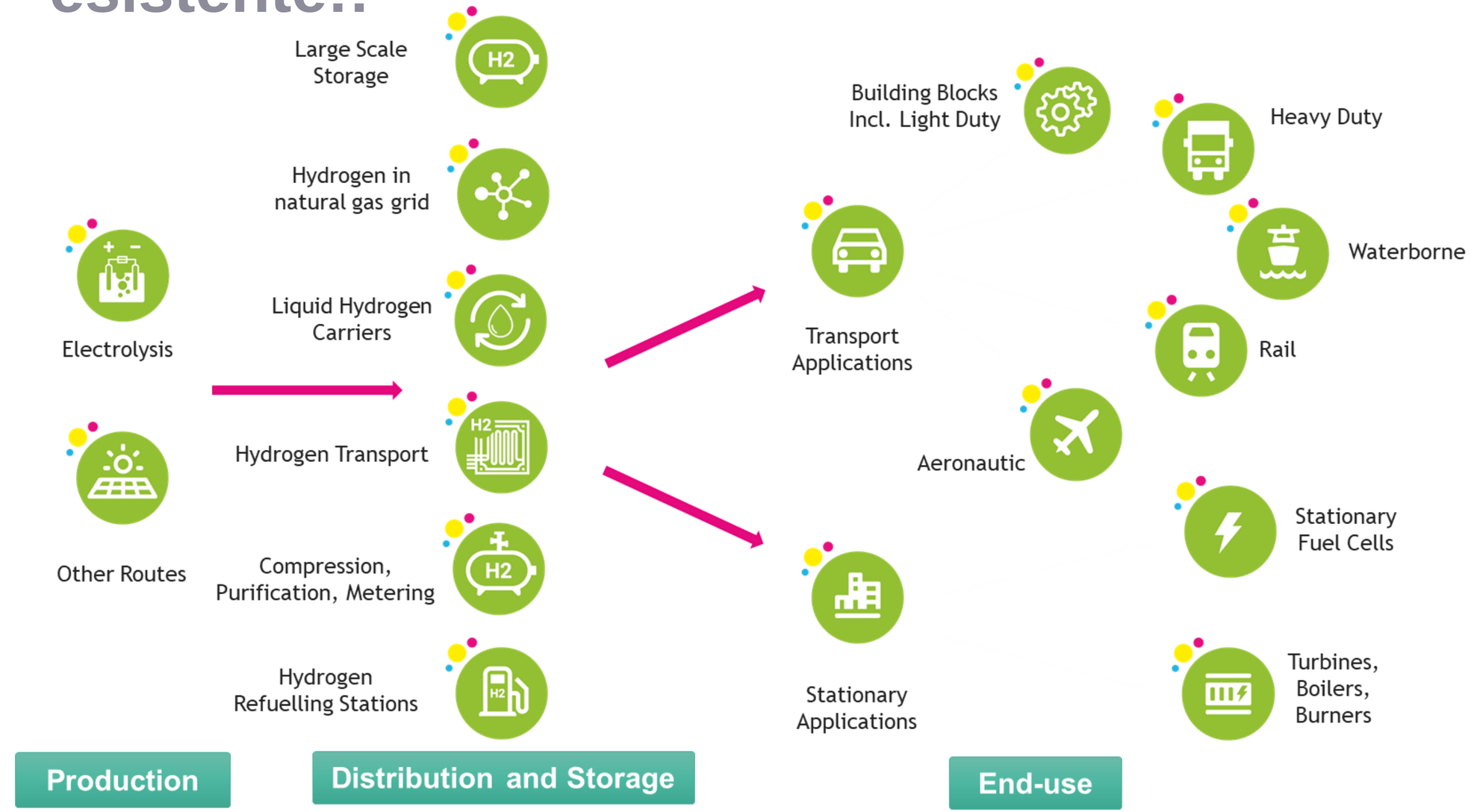


Idrogeno
370 TWh/y
20-25% dei consumi

Elettricità per la produzione idrogeno
390 TWh
30% dei consumi



Idrogeno: non un prodotto per un mercato esistente!!



Source: Clean Hydrogen Partnership

WHOLE VALUE CHAIN

SEVERAL TECHNOLOGIES

REGULATIONS, CODES and STANDARDS

MARKET FRAMEWORK

INCENTIVES AND ECONOMICS

INFRASTRUCTURES

SCALING UP, INDUSTRIALIZATION and EARLY MARKETS

Sfide per lo sviluppo del settore dell'idrogeno

COSA MANCA / COSA E’ RICHIESTO

Competitività tecnologica

- Ricerca
- Innovazione
- Start-up
- Primo sviluppo industriale

Crescita industriale

- Piena prontezza tecnologica
- Incentivi
- Bancabilità
- Infrastrutture (ad esempio, HRS)

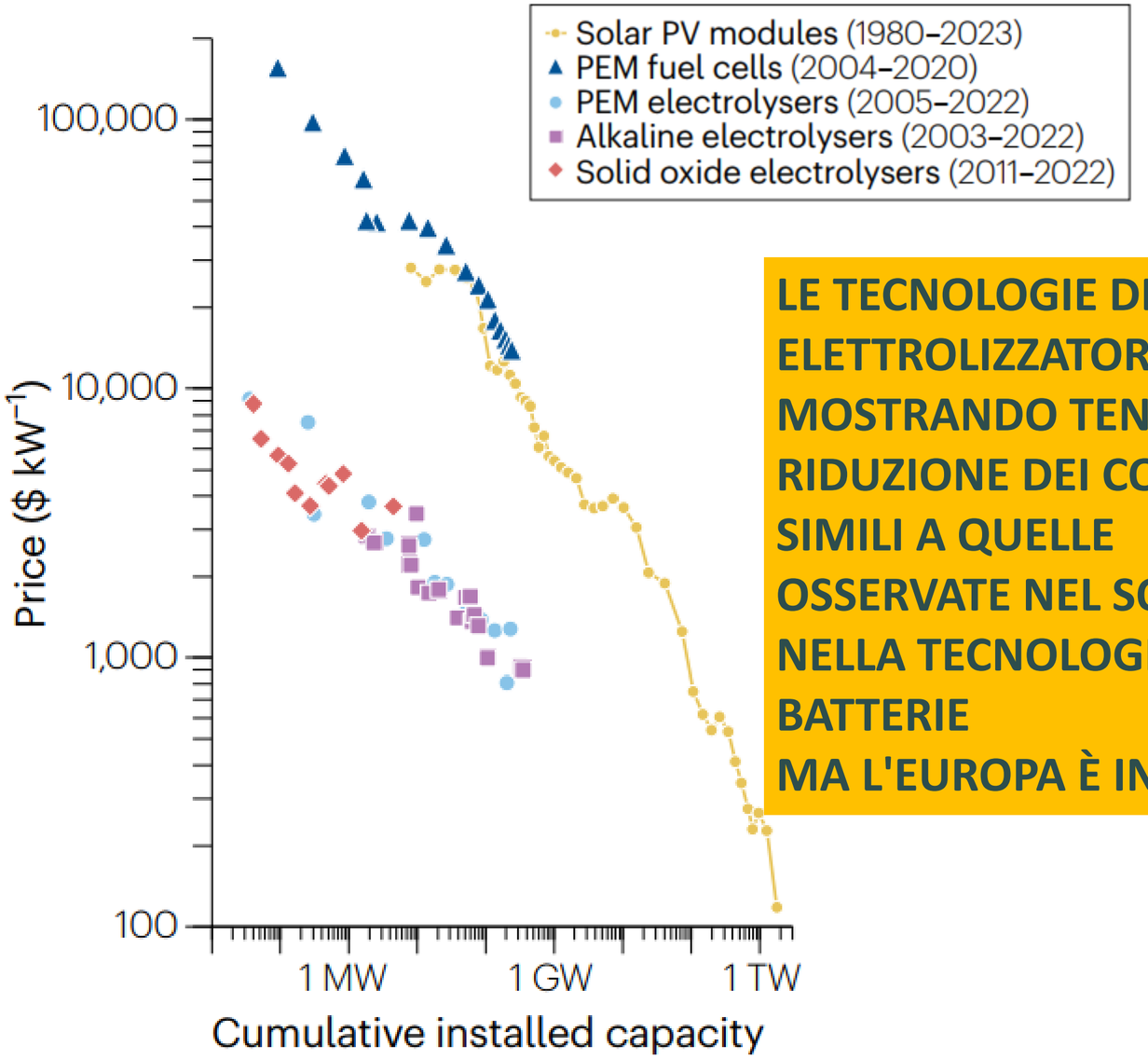
Sostenibilità economica

- Investimenti
- Sostegno pubblico per il deficit di finanziamento
- Politiche industriali
- Sviluppo iniziale dei mercati

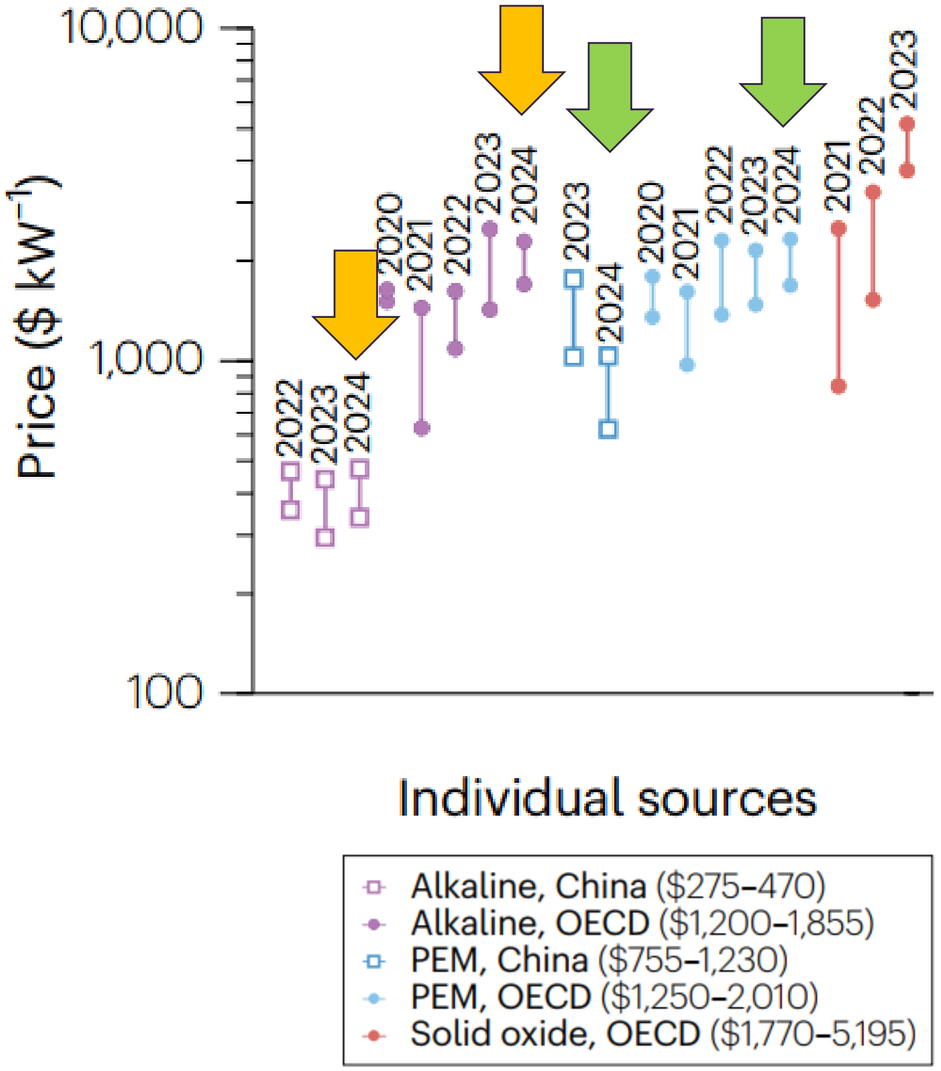
Attivazione di mercato

- Standardizzazione
- Politiche e quadro normativo
- Valli dell'idrogeno ed ecosistemi regionali
- Stimolare la domanda e contratti a lungo termine

SCALABILITÀ INDUSTRIALE E CURVE DI APPRENDIMENTO



LE TECNOLOGIE DEGLI ELETTROLIZZATORI STANNO MOSTRANDO TENDENZE DI RIDUZIONE DEI COSTI SIMILI A QUELLE OSSERVATE NEL SOLARE E NELLA TECNOLOGIA DELLE BATTERIE
MA L'EUROPA È INDIETRO



Source: IEA 2024

LCOH è vincolato da 3 elementi principali

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Exhibit 14 | Renewable hydrogen from electrolysis production cost scenarios[5], USD/kg hydrogen

Cost of renewable hydrogen with varying LCOE and load factors
USD/kg H_2

< USD 2/kg | USD 2-3/kg | USD 3-4/kg | > USD 4/kg | Viable medium-term (<2030)

LCOE	Capex electrolyser	USD 750/kW					USD 500/kW					USD 250/kW				
UDD 0/MWh		5.7	2.8	1.9	1.4	1.1	4.2	2.1	1.4	1.1	0.9	2.8	1.4	0.9	0.7	0.6
USD 10/MWh		6.1	3.3	2.4	1.9	1.6	4.7	2.6	1.9	1.5	1.3	3.2	1.9	1.4	1.2	1.0
USD 20/MWh		6.6	3.8	2.8	2.4	2.1	5.2	3.0	2.3	2.0	1.8	3.7	2.3	1.9	1.6	1.5
USD 30/MWh		7.1	4.2	3.3	2.8	2.5	5.6	3.5	2.8	2.5	2.2	4.2	2.8	2.3	2.1	2.0
USD 40/MWh		7.5	4.7	3.8	3.3	3.0	6.1	4.0	3.3	2.9	2.7	4.6	3.2	2.8	2.6	2.4
USD 50/MWh		8.0	5.2	4.2	3.7	3.5	6.5	4.4	3.7	3.4	3.2	5.1	3.7	3.2	3.0	2.9
USD 100/MWh		10.3	7.5	6.5	6.1	5.8	8.9	6.7	6.0	5.7	5.5	7.4	6.0	5.6	5.3	5.2
Load factor		10%	20%	30%	40%	50%	10%	20%	30%	40%	50%	10%	20%	30%	40%	50%

SOURCE: McKinsey

È NECESSARIA UNA RIDUZIONE DEI COSTI

- Capex: gli elettrolizzatori PEM attuali costano circa k€ 1,5/kW, mentre quelli alcalini costano circa 1,2
- Entrambi costano molto meno in Cina (25-30%)
- Si prevede che la riduzione dei costi segua un percorso simile a quello dei pannelli solari fotovoltaici
- Il percorso verso 2-3$/kg è ragionevolmente realizzabile

Source: RMI for OECD produced electolysers

Come intende l'UE sviluppare il settore dell'idrogeno

Repower EU e ulteriori politiche/iniziative richiedono un cambiamento di paradigma nel modo in cui affrontiamo la situazione attuale, in termini di tempismo, entità e azioni

LIVELLO EUROPEO

- Approccio strategico per un piano continentale;
- Obiettivi comuni in termini di impatto;
- Supporto ai fattori chiave che abilitano.

LIVELLO NAZIONALE

- Azioni politiche coordinate;
- Sviluppo della catena del valore dell'idrogeno;
- Risorse industriali e territoriali.

LIVELLO REGIONALE

- Attuazione delle politiche;
- Avviare le valli dell'idrogeno;
- Supporto alle infrastrutture chiave e alle iniziative locali.

The European Hydrogen Backbone
Ruolo strategico per l’Europa

MUOVERE ENERGIA CON MOLECOLE COSTA 10 VOLTE MENO RISPETTO AGLI ELETTRONI

L'UE Hydrogen Backbone ha l'obiettivo di collegare i settori di uso finale con impianti di produzione di idrogeno a basso costo, sia nell'UE che nell'altra UE

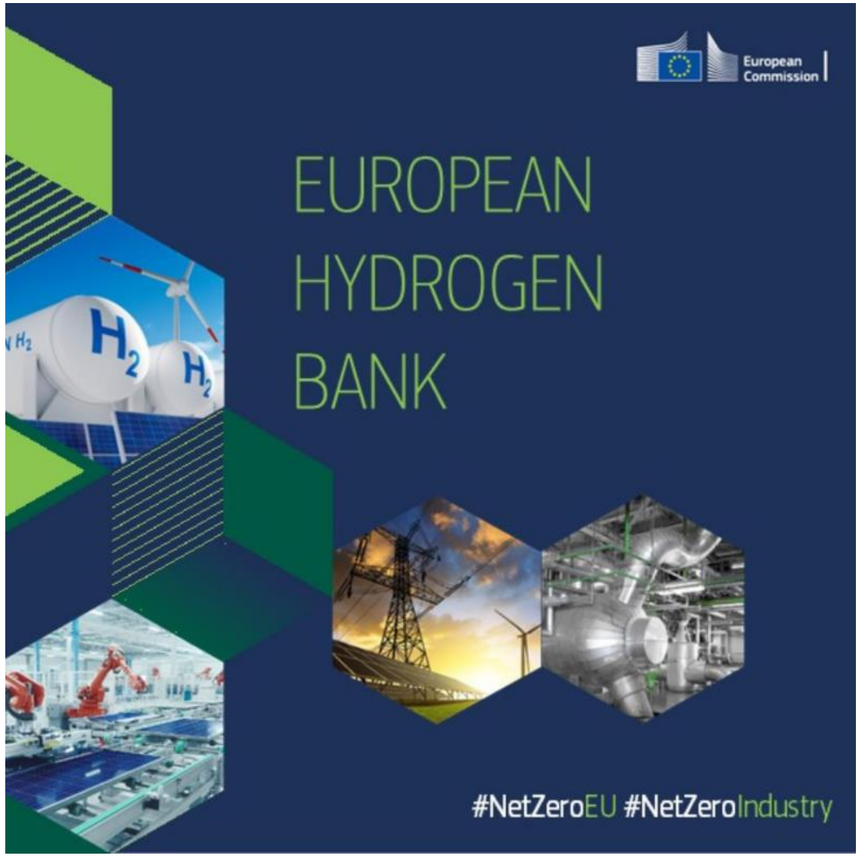
EHB - EU Hydrogen Backbone identifica 5 corridoi principali per lo sviluppo della rete europea di trasporto idrogeno

Lunghezza: 53.000 km

Paesi attraversati: 21
2/3 da gasdotti ritrasportati
Investimento: 83 – 143 B€ @2040
Costi di trasporto per 1 kg di idrogeno: 0,3 € / 1000 km
Domanda annua di H2 nell'UE: 1.640 TWh

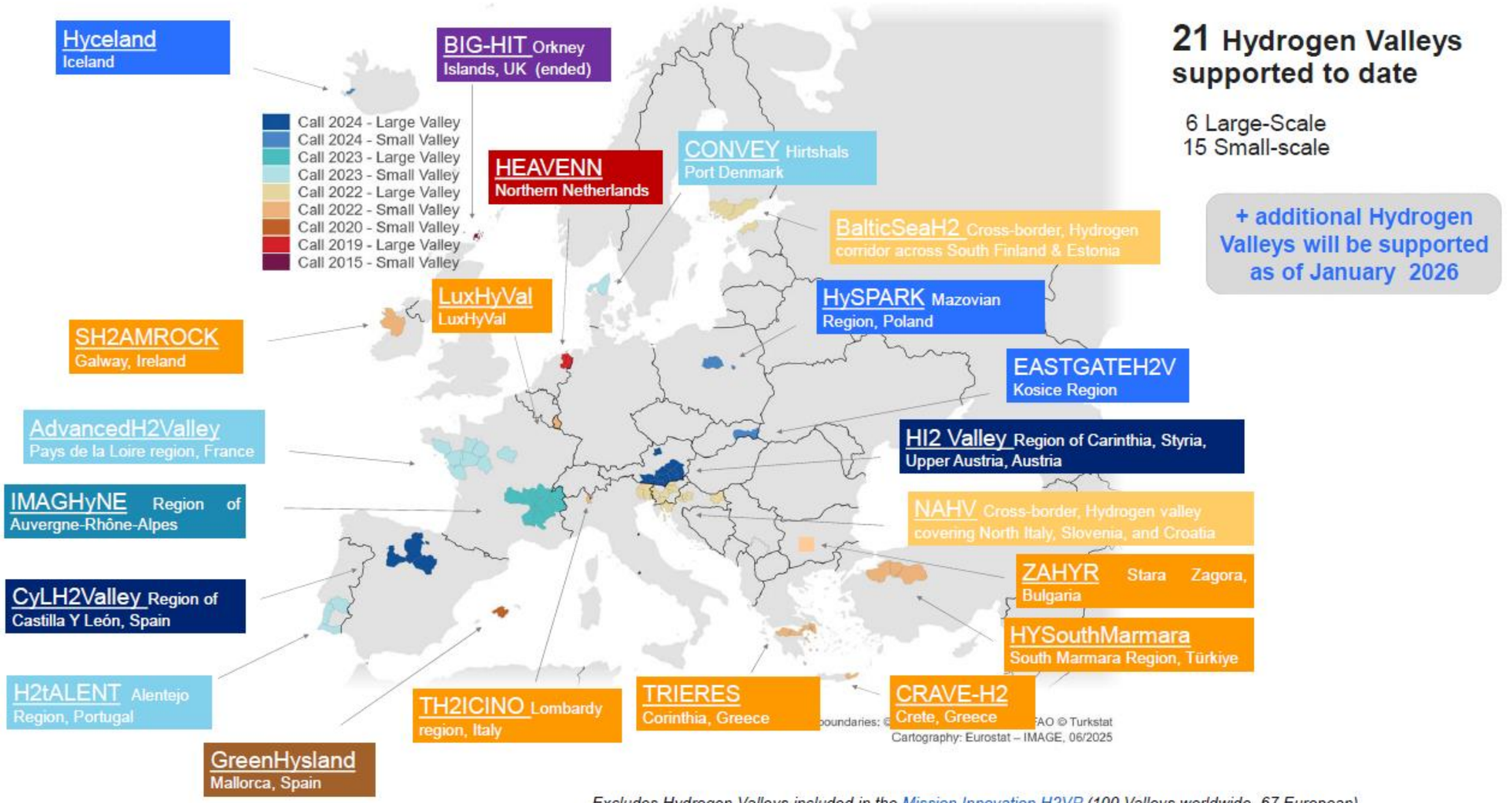
4 Mt H2 dal corridoio sud @ 2040
Infrastrutture realizzate per H2 (Italia): >60%

Incentivi UE – La Banca dell'Idrogeno dell'UE



- Terza asta EHB aperta per circa 1 miliardo di euro
- Aste pecedenti da 0,2 €/kg 0,6 €/kg
- PROGETTI GENERALI: Spagna (8), Germania (2), Paesi Bassi (1), Finlandia (1)
- PROGETTI MARITTIMI: Norvegia (3)
- 2,2 Mton H2 in 10 anni
- Capacità di gara tra 7,5 e 560 MW

Hydrogen Valleys | Sviluppare ecosistemi locali



21 Hydrogen Valleys supported to date

6 Large-Scale
15 Small-scale

+ additional Hydrogen Valleys will be supported as of January 2026

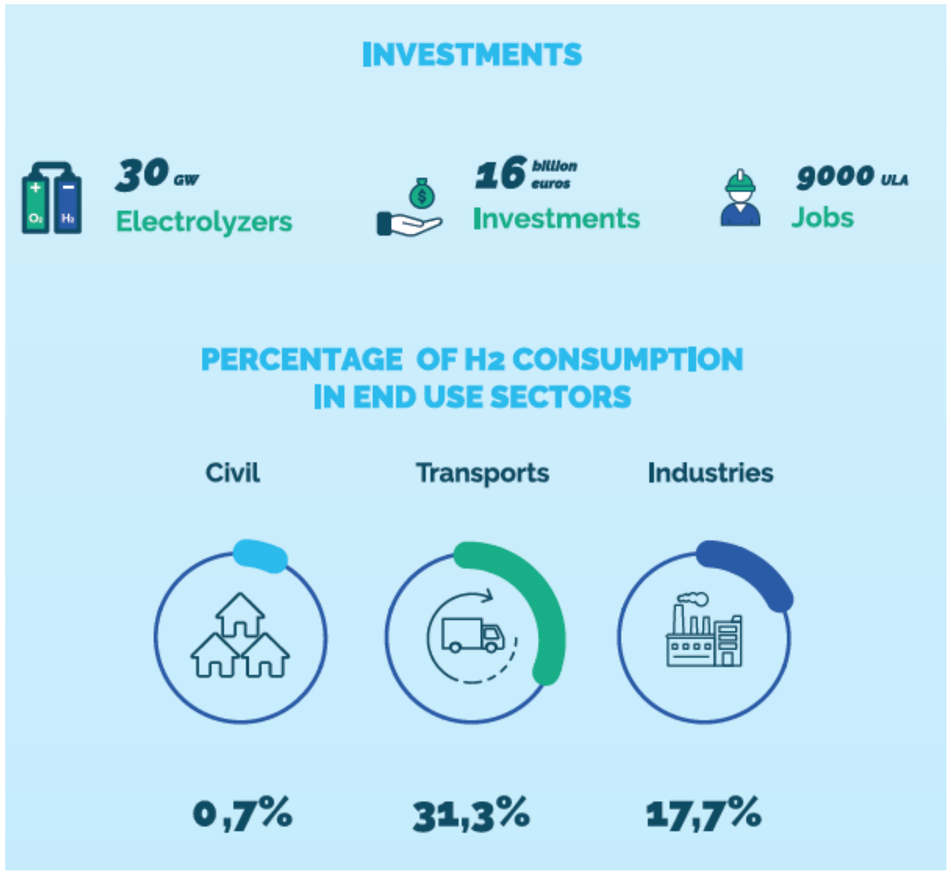
Excludes Hydrogen Valleys included in the Mission Innovation H2VP (100 Valleys worldwide, 67 European)

Quadri politici in Italia

Strategia Italiana sull'Idrogeno | Novembre 2024

1. DECARBONIZZAZIONE DEGLI USI FINALI
2. INTEGRAZIONE DEL SISTEMA ENERGETICO
3. CREAZIONE DI UNA CATENA DI APPROVVIGIONAMENTO FORTE E COMPETITIVA
4. AUMENTO DELLA SICUREZZA ENERGETICA
5. HUB ENERGETICO
6. SISTEMA DI CERTIFICAZIONE
7. RICERCA E INNOVAZIONE

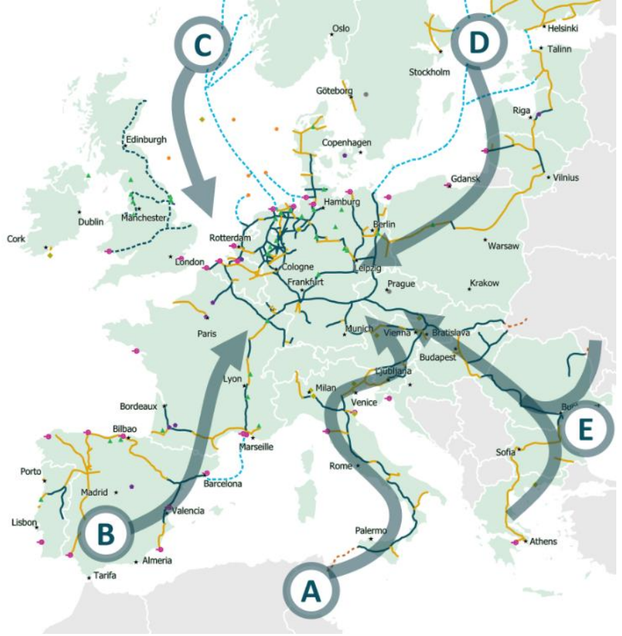
Scenario ad alta diffusione (30% importazioni) entro il 2050:



Resilient and Recovery Facility Plan Funded Projects

The EU Hydrogen backbone & SouthH2Corridor

The corridor that connects North Africa to Central Europe



The SouthH2 Corridor is a 3,300km network entirely dedicated to the transport of hydrogen that connects North Africa, Italy, Austria and Germany

Project based on the collaboration between 4 TSOs

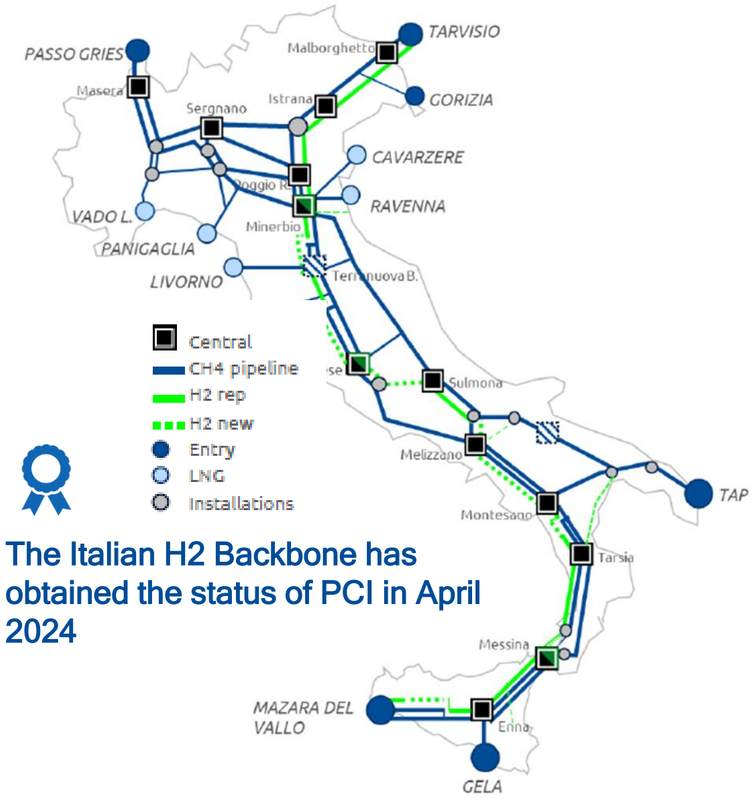
- **Snam** - Italian H2 Backbone
- **TAG** - H2 readiness of the TAG pipeline system
- **GCA** - H2 backbone WAG + Penta-West
- **bayernets** - HyPipe Bavaria - The Hydrogen Hub

Import/export capacity

Import: 448 GWh/d from North Africa (4.4 Mtpa)
Export: 150 GWh/d to Germany (1.5 Mtpa)

3300 km Length of network

>65% Share repurposed infrastructure



The Italian H2 Backbone has obtained the status of PCI in April 2024

Supporting partners[1]

Verbund · TotalEnergies H2 (a company owned by TotalEnergies and eren) · AKER HORIZONS · voestalpine · WACKER · OMV · VNG · RWE · bayernets · TUNUR · ABO WIND · WIEN ENERGIE · ChemDelta Bavaria · AUSTRIA AG · RHI MAGNESITA · Westlake Vinnolit

1. Lista completa https://www.south2corridor.net/support-us

Il Centro Sustinable Energy in FBK

CENTER ON SUSTAINABLE ENERGY
BACKGROUND

Focus and Approach

Investment in 2 top tech priorities: Hydrogen and Battery Technologies and their relationships with the energy transition

Pull approach: problem solving, open minded towards the needs of our stakeholders

One stop shop for innovation: two integrated value chains: from advanced materials, to design, engineering and validation, to large systems and demos

Strategic Presence

Support to National and EU platforms: in the main Italian and European associations, in partnerships and platforms on Hydrogen and Battery technologies

Large projects: long-term, large-scale initiatives of high relevance for the EU and strategic collaboration with the manufacturing industry in hydrogen and battery technologies

Support for Political Institutions : on national and regional plans, on future energy scenarios and defining the necessary support policies

Drivers and Values

TEAM: competent and young team (<35Y average, 100 FTE)

COLLABORATION: Tailored tools such as co-design, co-development, shared infrastructure, strategic partnerships with LE, PMI and Newco/STARTUP (98% SELF FUNDING)

LABS & FACILITIES: In Rovereto, large scale facilities and labs for technology validation up to the relevant industrial scale (about 20.000 m2 of new facilities under construction)

CENTER for SUSTAINABLE ENERGY

VALUE PROPOSITION and ONE SHOP STOP

Research on Advanced Materials

Multiscale Numerical simuations

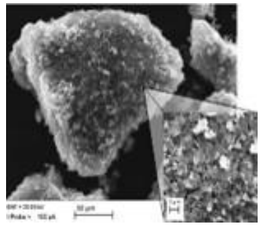
Developmen t of new components

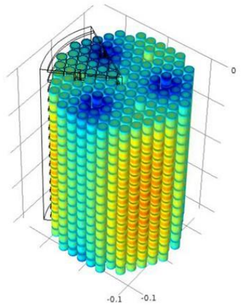
Whole cycle Advanced engineerin g

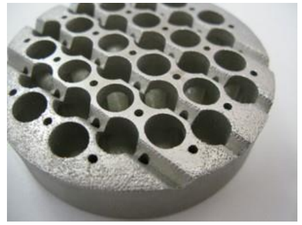
Developmen t of integrated Systems

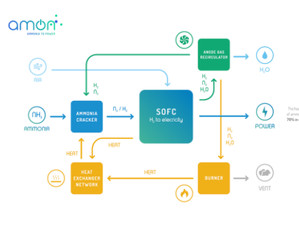
Technolog y validation at relevant industrial scale

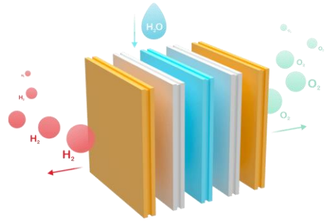
Territorial initiatives / H2 Valleys

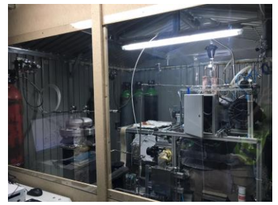












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2 TECH PRIORITIES

HYDROGEN

H_2 PRODUCTION

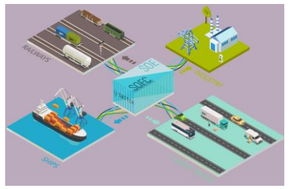
- All electrolysis technologies (PEM, Alk, AEM, SOE)
- Innovative and advanced materials
- Component development and system design
- Validation at the relevant industrial scale

LOGISTICS AND STORAGE

- key techniques for distribution, use of ammonia
- Hydrogen storage: from small to large scales, solid-state to underground

END USES

- Heavy duty vehicles, (e.g., trains, buses, trucks), HRS
- Territorial ecosystems, hydrogen valleys
- Hard to abate sector, e.g., refineries, steel making, ammonia, paper, cement, ceramic, glass



BATTERIES

REDOX FLOW BATTERIES

- develop new redox electrolytes: abundant and low cost, reasonable performance, safe and non-toxic, recyclable
- design flow cells by optimizing each component, develop and test innovative solutions for RFB cells and stacks

LITHIUM ION

- Life-cycle approach from design to end of life
- Second life testing and qualification
- Validation of cells, stacks and modules

SOLID STATE BATTERIES

- develop innovative materials for SSB testing

HYBRID ENERGY STORAGE SYSTEMS

- develop and test hybrid storage systems to comply with end use specifications using different storage solutions

NEW LABs & INFRASTRUCTURES
TESSLabs & B Factory

By PROGETTO MANIFATTURA, Green Tech Factory Rovereto (TN)

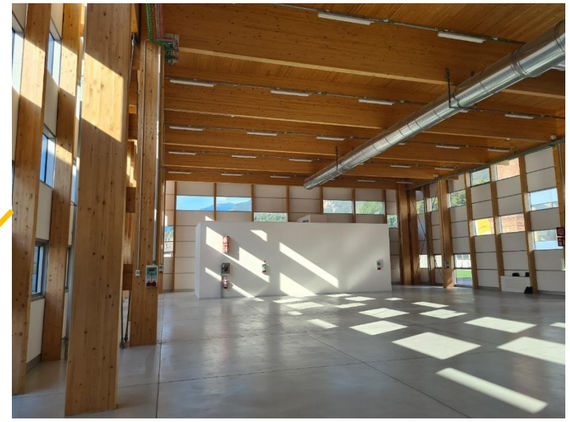
TESSLabs

- H2 Lab
- Battery Lab
- Chemistry Lab
- Small support electro-mechanical
- Buildings Lab

- Modelling Lab

MODULE B6

- Engineering and Territorial initiatives



MODULE B6/P1

- H2 and Battery Laboratories
- From cell to large stacks - test benches
- Test for Containerized systems

CENTER for SUSTAINABLE ENERGY

NEW CENTER Rovereto – Ex Arcese Articolati

Centre SE layout
In Rovereto industrial area
closeby **Rovereto South** motorway exit

- Indoor spaces: 5000 m^2
- Offices and support areas: 1200 m^2
- Laboratories: 3200 m^2
- Technical areas: 600 m^2

Outdoord facility: 13.000 m^2
- Testing facility: 8000 m^2
- Technical areas: 2000 m^2
- Parking: 2000 m2

Offices: 100 people

- From W to MW
- Relevant industrial scale
- Customized Benches
- Advanced controls (SIL and HIL)
- Value chain techs

New Center SE in Rovereto


CENTER FOR
SUSTAINABLE ENERGY

thank you.