

ΙΕΝΕ - 25ο Εθνικό Συνέδριο "Ενέργεια και Ανάπτυξη 2021",

3η Συνεδρία "Fit for 55,,

Προκλήσεις κι ευκαιρίες για την
απανθρακοποίηση του
ηλεκτροπαραγωγικού τομέα

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Mitsubishi Power Europe GmbH



- Decision to upgrade 2030 Climate targets in Dec. 2020
- European Climate Law adopted in June 2021
- Green Deal package (“Fit for 55”) with 12 initiatives presented in July 2021

→ policies and measures currently identified in the national projections are not sufficient to achieve the savings needed to meet the EU reduction target of at least 55% in 2030



Photo: Bloomberg SOTEU21

2020

- 20% GHG emissions
+ 20% renewable energy
+ 20% energy efficiency

2030*

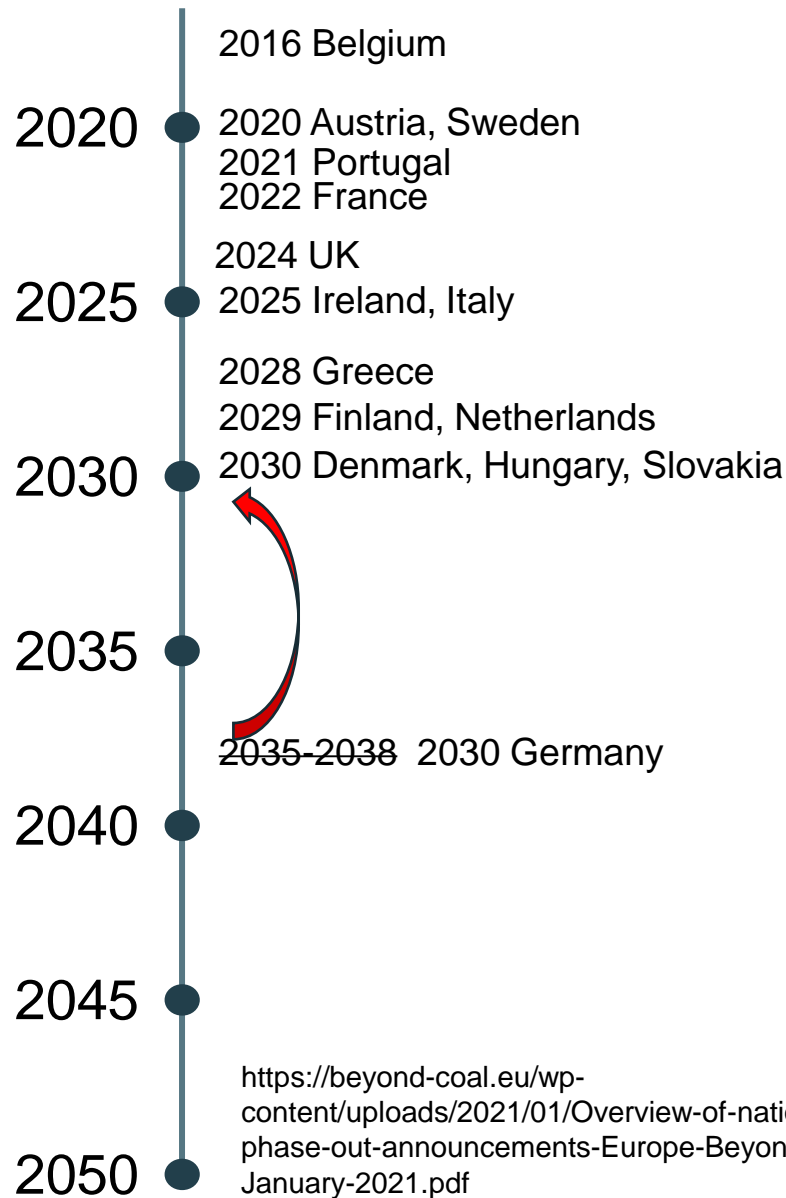
≥ - 55% GHG emissions
≥ + 32% renewable energy
≥ + 32,5% energy efficiency

2050

Climate neutrality

-» net zero GHG emissions
-» mandatory!

Coal phase out in Europe (examples)



New plants stopped 2020 after <10years!

> 5 GW old plants already stopped



Greek coal phase out date is 2028



Netherlands coal phase out is 2029

Plants need fuel switch or shut down



Mitsubishi Power involvement

- Power Train
- Steam Generators
- Air Quality Control Systems

Major trends (1/3): Ongoing fuel switches



Coal to Biomass



Coal to NG

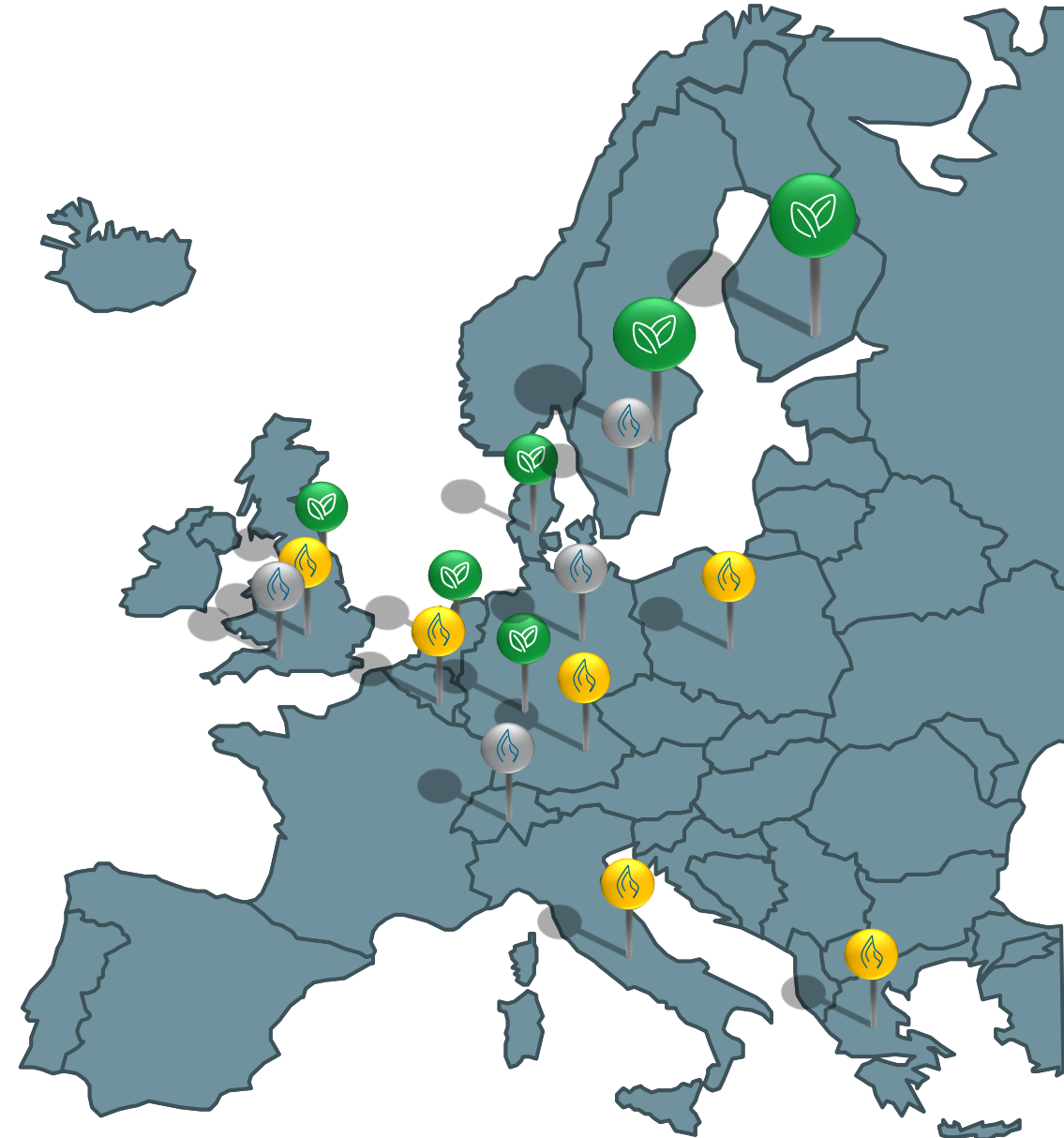


Coal to (CHP)

- Reasons to act
 - coal phase out
 - aging assets
 - CO2 price
 - capacity markets

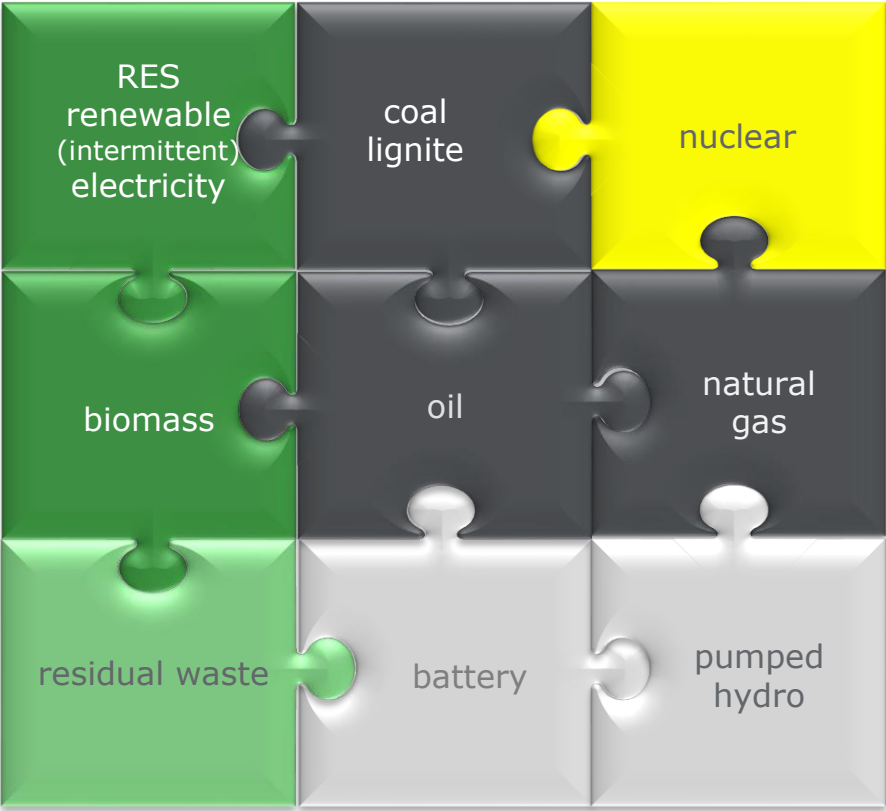
- Needs
 - Industrial CHP (steam & power)
 - Municipalities (heat grids)
 - Power Reserve

Market reality (today)

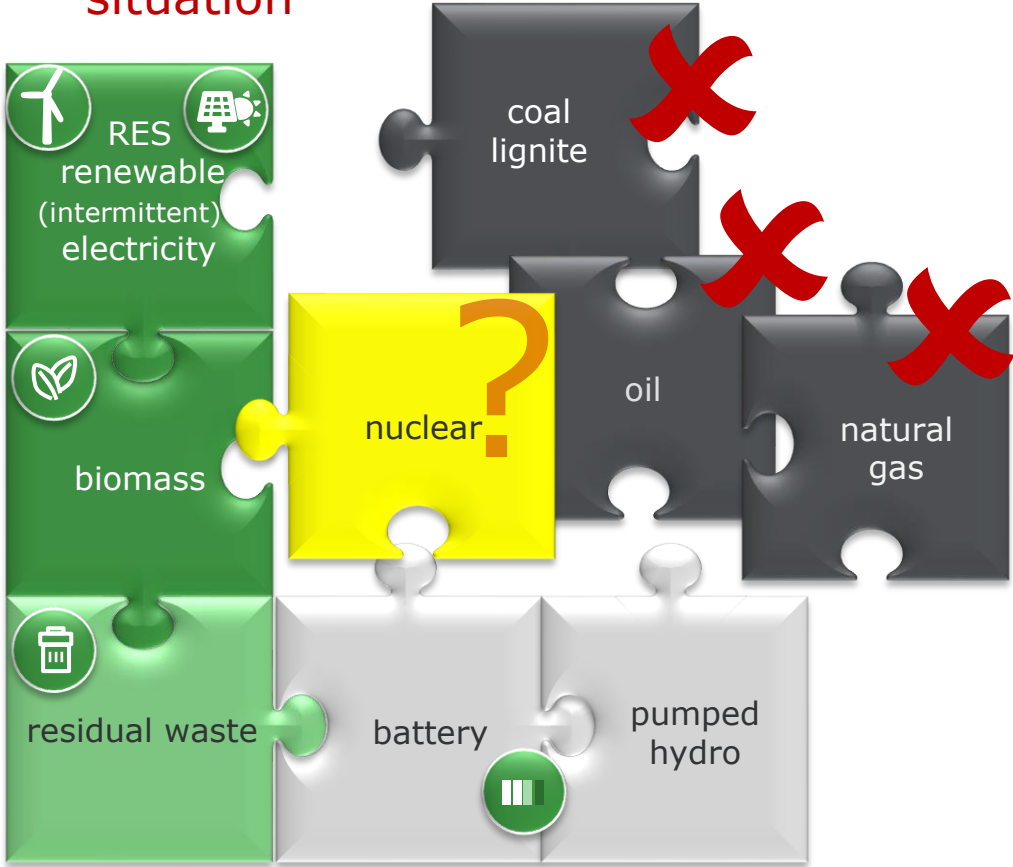


Carbon Neutrality in 2050. Thinking backwards from 2050

Yesterdays
situation



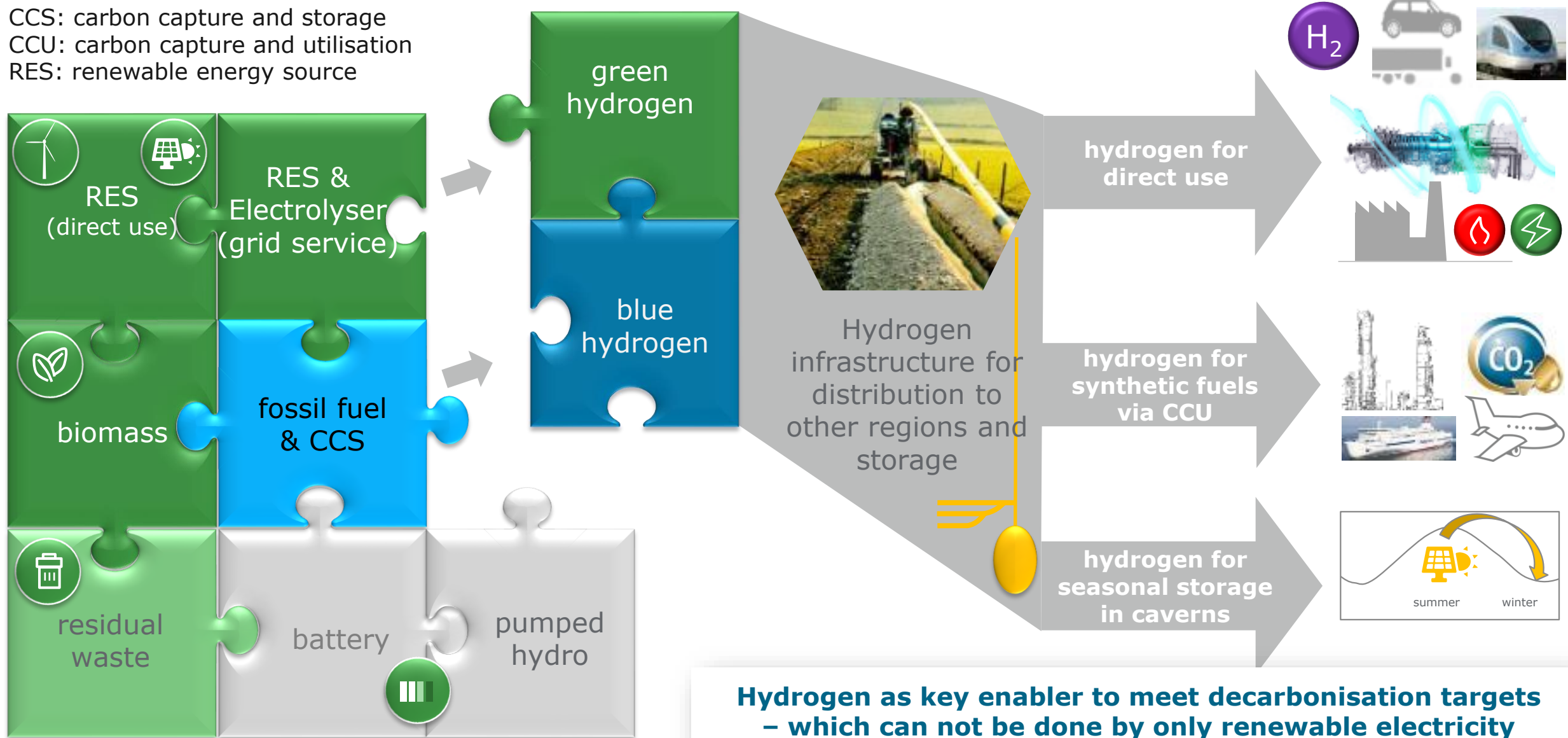
Tomorrows
situation



**How to serve all sectors: Transport,
Power, Industry, Heat ?**






Thinking backwards from 2050: Who can serve energy sector?

CCS: carbon capture and storage
CCU: carbon capture and utilisation
RES: renewable energy source



**Hydrogen as key enabler to meet decarbonisation targets
– which can not be done by only renewable electricity**

Major trends (2/3): Larger National Initiatives in EU

-  Blue Hydrogen  Green Hydrogen
-  Carbon Capture and Storage, CCS
-  Carbon Capture and Utilisation, CCU
-  Large Heat Pumps

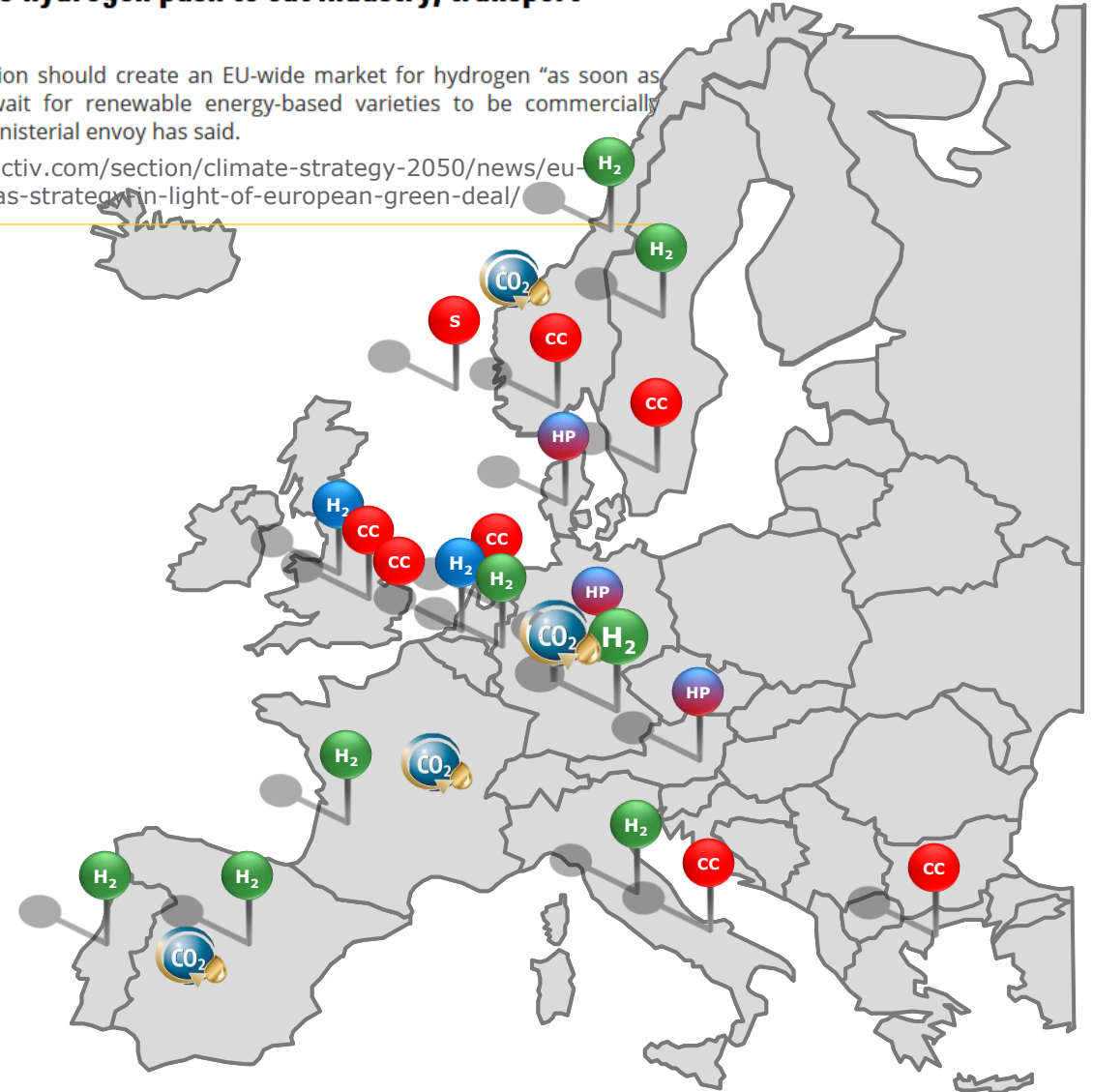
- Clusters considered as starting point of large scale hydrogen production, consumption and infrastructure
- Hundreds of km of hydrogen pipelines are existing there today in chemical industry!

Market creation, demonstration

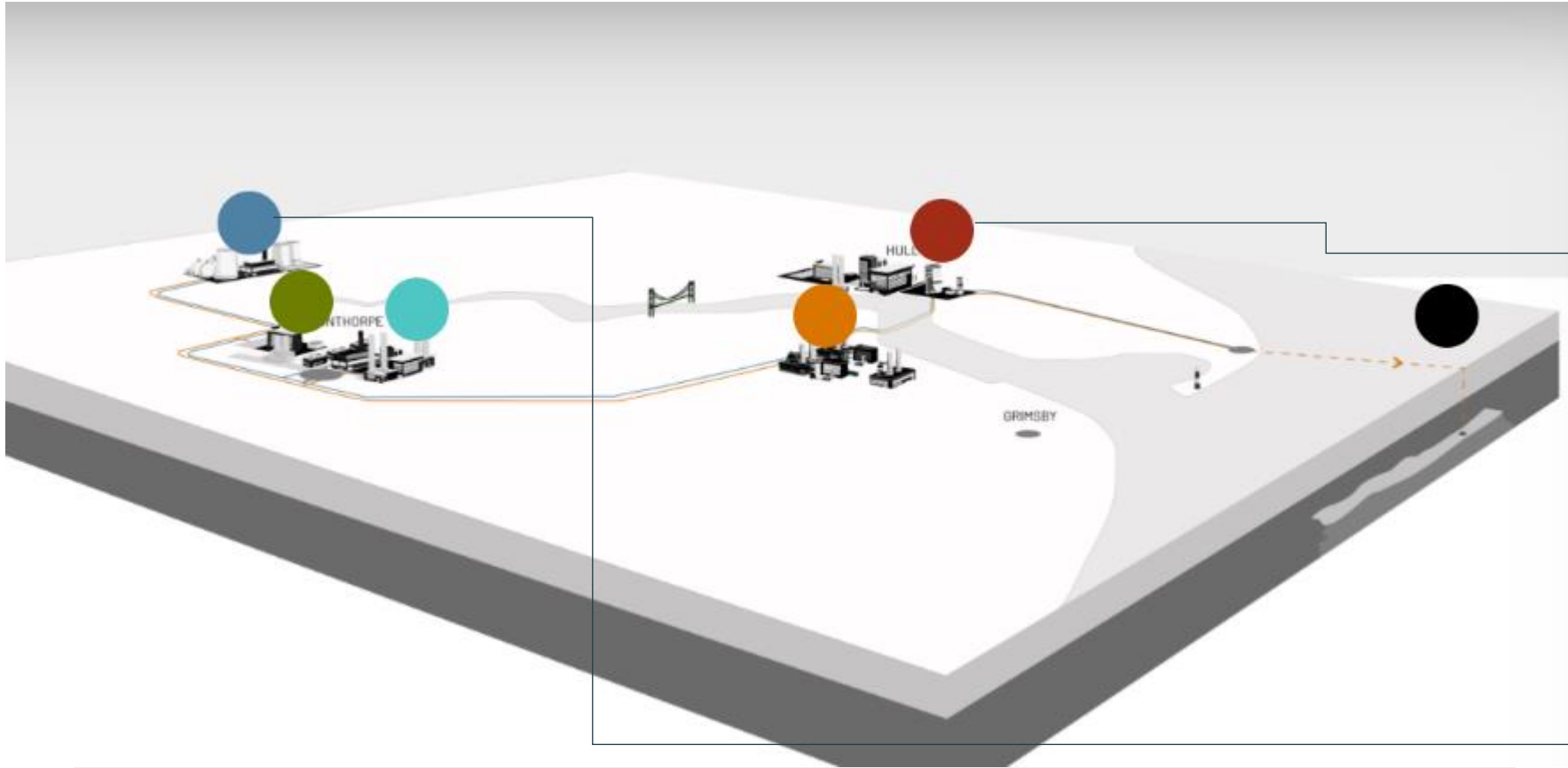
Dutch urge swift EU hydrogen push to cut industry, transport emissions

The European Commission should create an EU-wide market for hydrogen “as soon as possible” rather than wait for renewable energy-based varieties to be commercially available, a top Dutch ministerial envoy has said.

<https://www.euractiv.com/section/climate-strategy-2050/news/eu-rethinks-future-gas-strategy-in-light-of-european-green-deal/>



Projects in Europe: Zero Carbon Humber (UK)

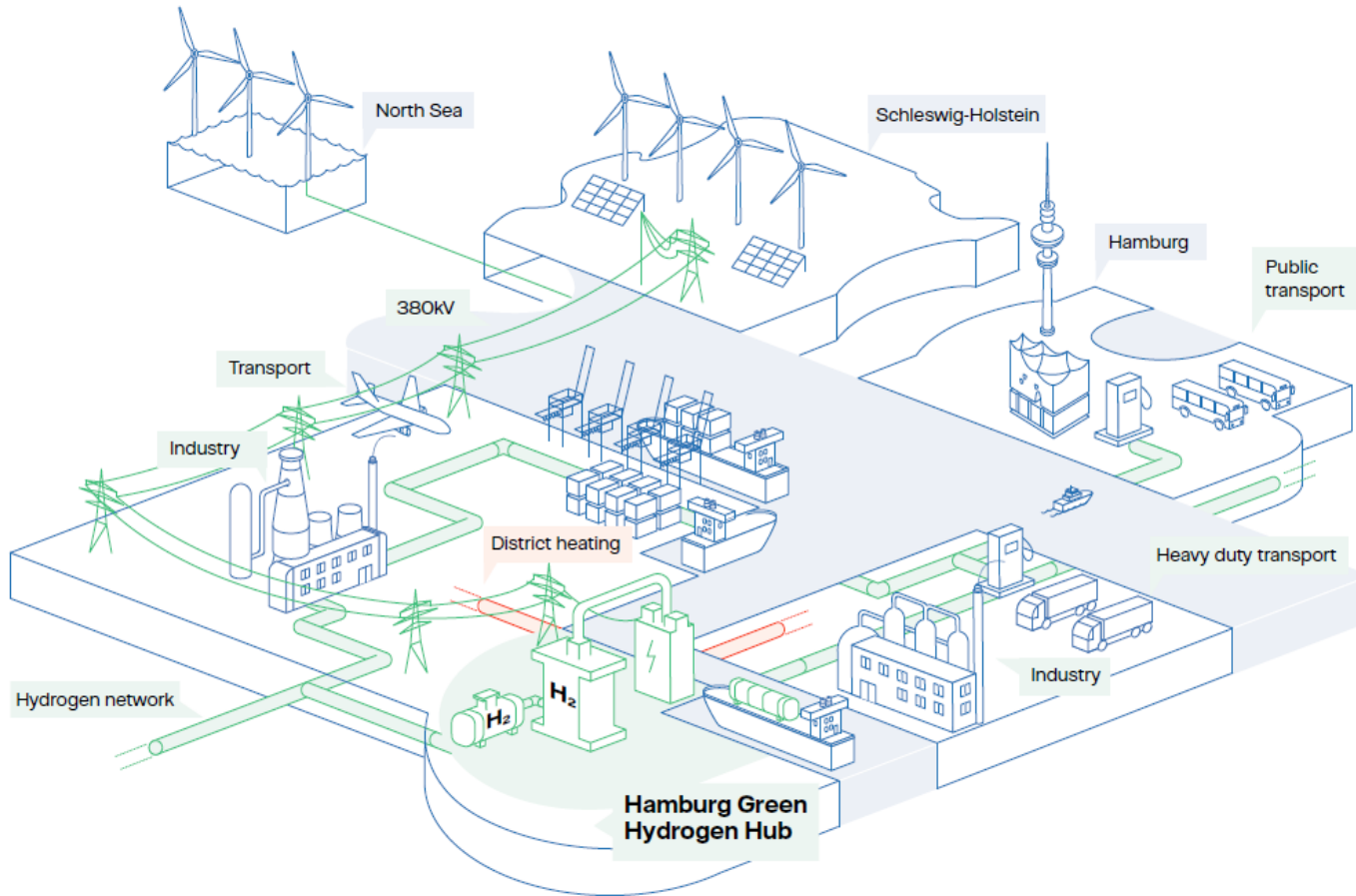


Mitsubishi Power will be converting 3 large scale gas turbines at Triton's Saltend Power Station to burn 30% hydrogen fuel mix.

MHI Engineering's carbon capture technology will be utilized at a bioenergy with carbon capture and storage (BECCS) pilot project at Drax Power Station. Implementing BECCS at Drax could deliver 16 million tonnes of negative emissions a year.



Hamburg Green Hydrogen Hub envisages transformation of former site of coal plant into green hydrogen production site with initial output of 100 MW and further development of site into a “Green Energy Hub”



| | |
|------------------------------|---|
| Electrolyzer Capacity | 100 MW (Option to increase to GW scale) |
| Grid connection | 380 kV (TSO 50Hertz) |

| | |
|-----------------|------------------|
| Location | Hamburg, Germany |
|-----------------|------------------|

- Green hydrogen for mainly in industrial applications, but also heavy transport
- 24hrs storage in 6km pipeline to match renewables
- Optimal utilization of electrolyser 'waste' streams:
 - Oxygen for industry
 - Waste heat for the Hamburg district heating grid (80°C, with HP increased to 180°C)

Project development partners:



Experience in US: Advanced Clean Energy Storage Project

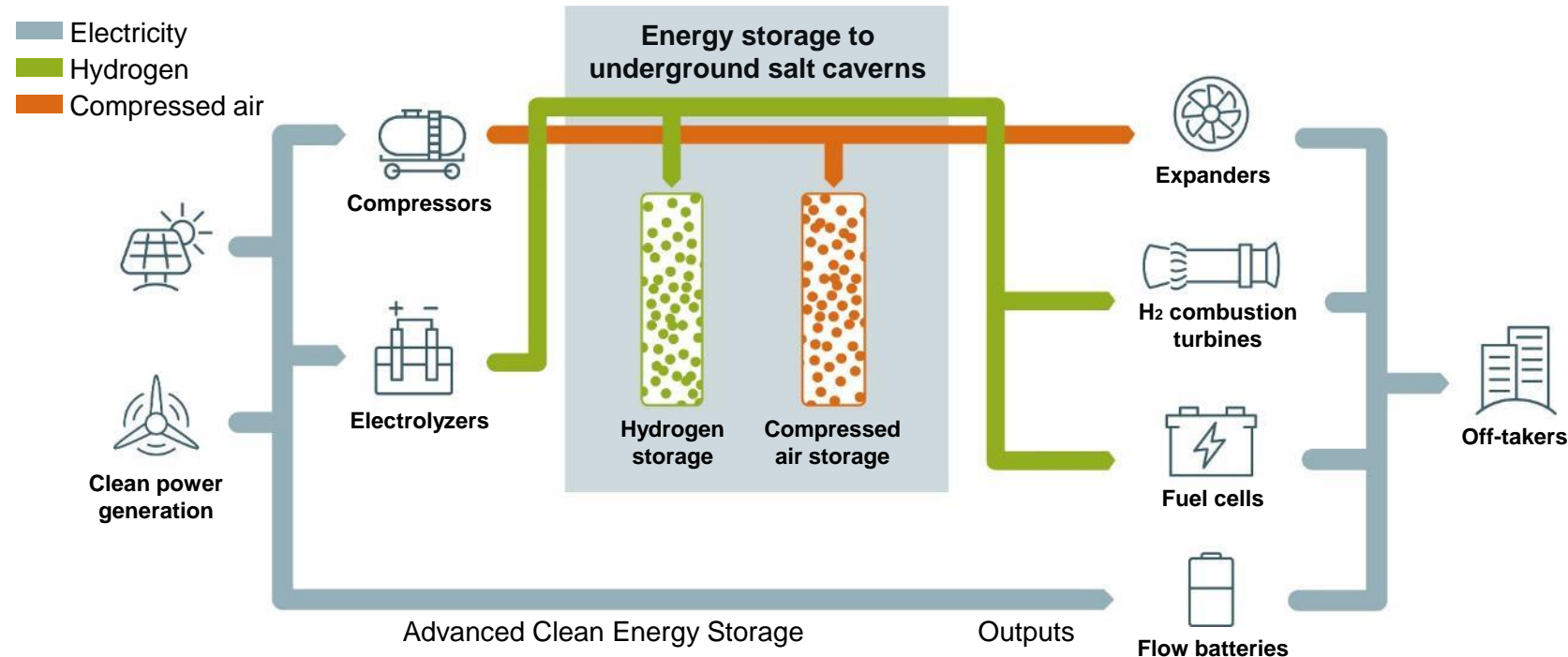
The Advanced Clean Energy Storage Project is the world's largest renewable energy storage project.

| | |
|-------------------------|-----------|
| Storage Capacity | 150GWh |
| Location | Utah, USA |

This project was launched in May 2019 by Mitsubishi Power, Magnum Development and the Governor of Utah.

This project using storage technology such as renewable hydrogen (**Green H₂**), compressed air, large scale flow batteries and solid oxide fuel cells.

Green H₂ and/or compressed air is planned to be stored in underground salt caverns in Utah.



Intermountain Power Agency orders Mitsubishi Power’s Hydrogen JAC Gas Turbines for Renewable Hydrogen Hub, a utility-scale project aiming to show a path towards 100% renewable power no later than 2045.



| | |
|-------------------|--------------------|
| Gas Turbine Model | M501JAC |
| Power Output | 840 MW (by 2 CCGT) |
| Location | Utah, USA |

- **Mitsubishi Power’s Hydrogen Gas Turbines** is central to Utah’s comprehensive decarbonisation plan: 1) fuel switch from coal to natural gas and 2) from natural gas to renewable hydrogen.
- Transition will start in 2025 using a mix of 30% hydrogen and 70% natural gas. This mixture will reduce carbon emissions by more than 75% compared to the retiring coal-fired technology.
- Between 2025 and 2045, the hydrogen capability will be systematically increased to 100% renewable hydrogen, enabling carbon-free utility-scale power generation.
- Power plant is connected to the Los Angeles power grid by an existing high voltage direct-current (HVDC) transmission line.

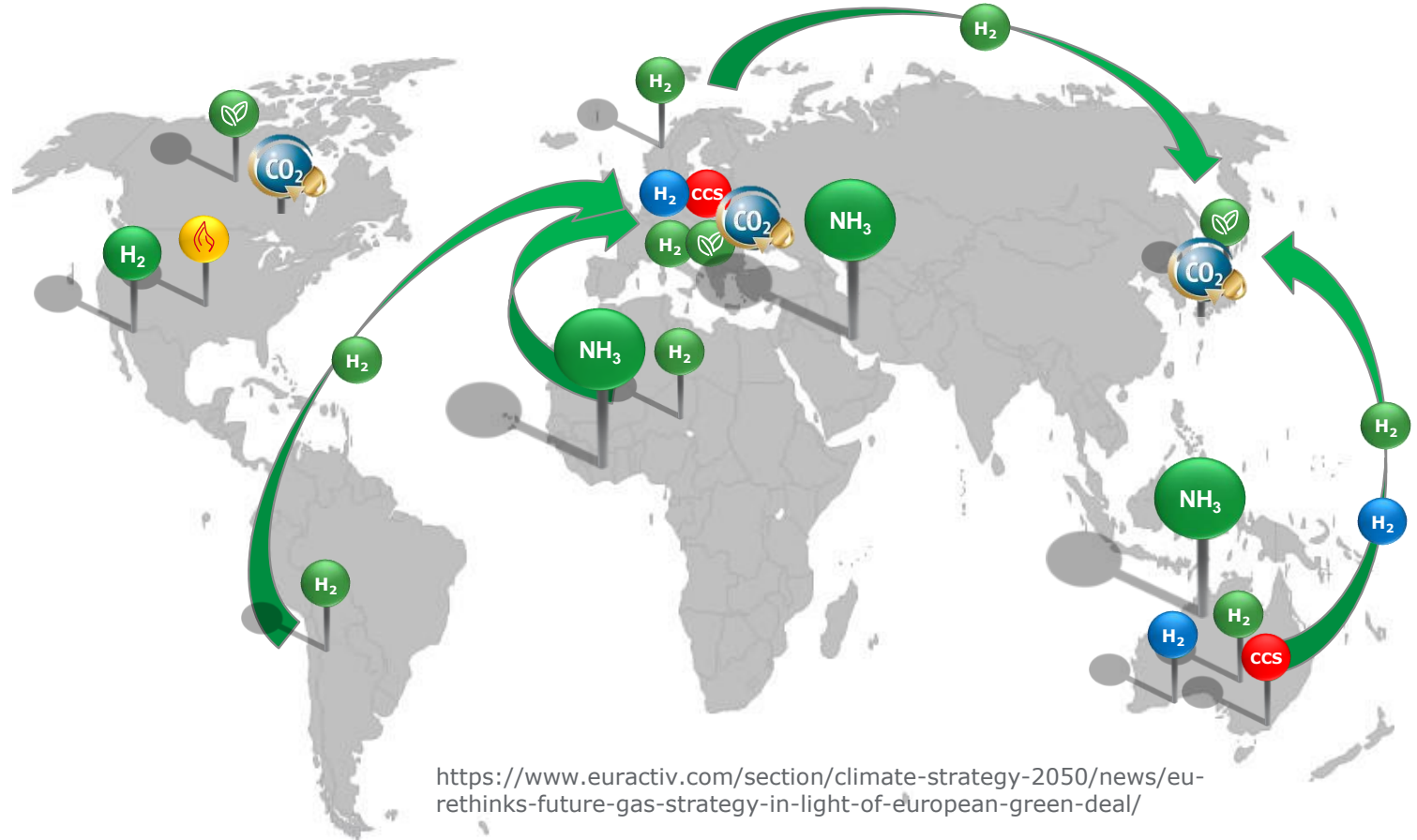
Today

- LNG trading (globally)
- Biomass import (EU)
- Coal to Biomass (Canada)
- Coal to NG (USA)
- Biomass & LNG import (Japan)

In future?!

- Hydrogen from sunbelt regions, "Desertec 2.0" in EU
- Hydrogen Import to Japan (blue, green)
- Ammonia as alternative energy carrier for shipping?

Hydrogen & NH₃ may become the future, global energy commodity!?



<https://www.euractiv.com/section/climate-strategy-2050/news/eu-rethinks-future-gas-strategy-in-light-of-european-green-deal/>

Researcher: 100% renewable energy requires 'a lot of green hydrogen'

The production of so-called green hydrogen from wind and solar electricity is seen as a potential game-changer for the transition to a 100% renewable energy system. But getting there will take some time and some intermediary solutions will be needed, says Daan Peters.

- European energy sector phases several challenges during the ongoing transformation process towards carbon neutrality
- New technologies are the key to successfully address to challenges. A portfolio of technologies is already available. For others “first of a kind” industrial scale demonstration is needed.
- Build a CO₂ and H₂ solutions ecosystem, utilize the challenges as opportunity for further growth
- Role of EU Member States is crucial:
 - Secure regulatory framework
 - Facilitating development for new infrastructure (e.g. H₂, CO₂ pipelines, H₂/NH₃ terminals)
 - Facilitating development for “First of a kind projects”

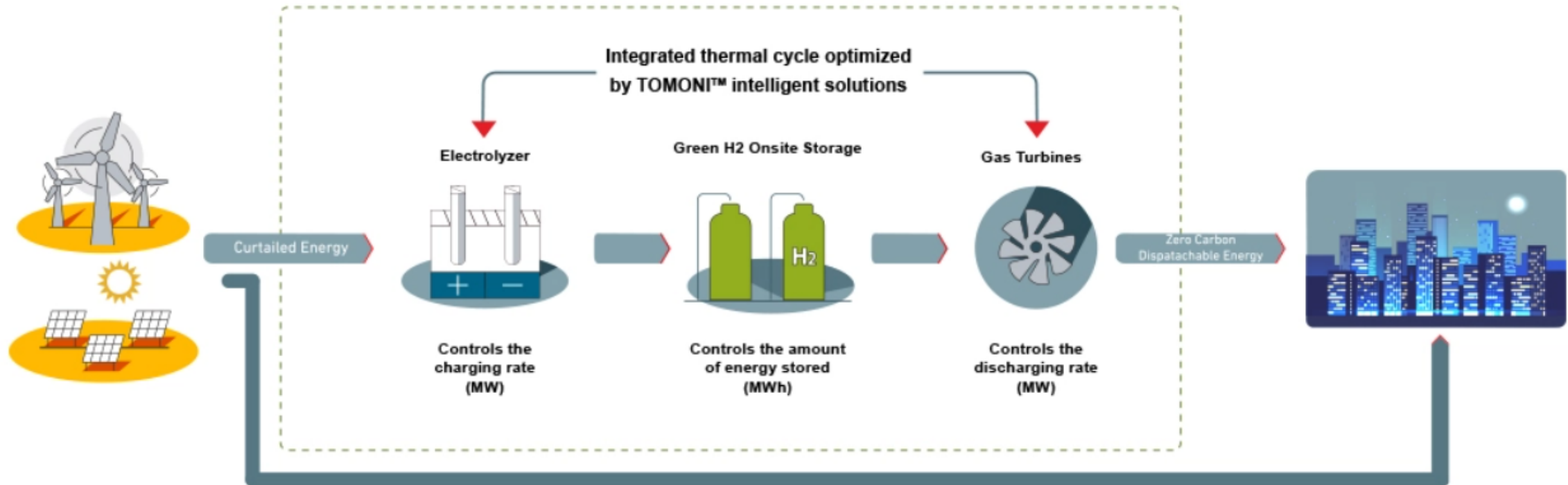


MOVE THE WORLD FORWARD

**MITSUBISHI
HEAVY
INDUSTRIES
GROUP**

Back-Up slides

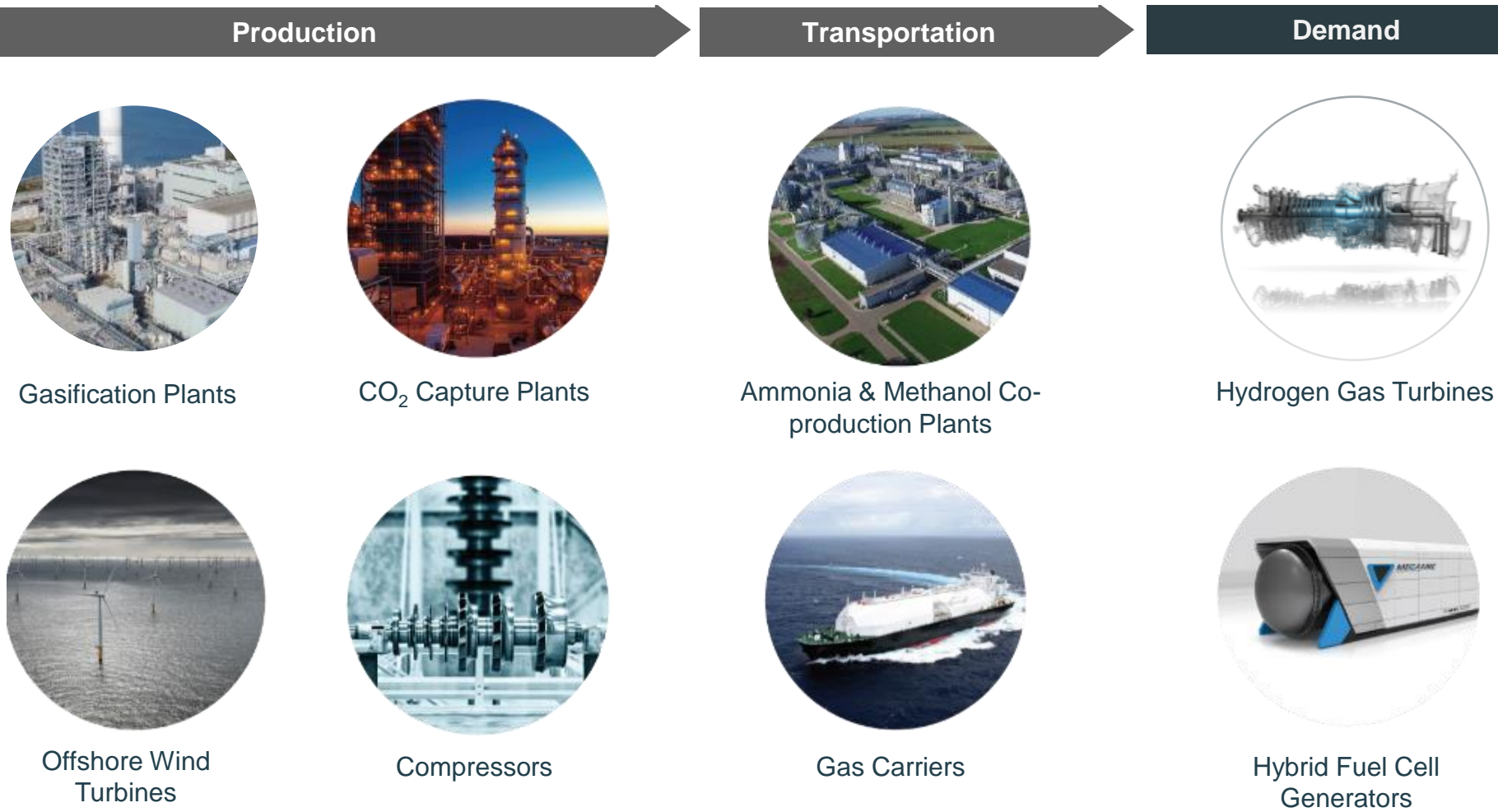
HYDAPTIVE™ STANDARD FLEXIBILITY PACKAGE



The Hydaptive™ package accelerates the path toward 100% carbon-free power generation

- › Technology adapts as the grid needs larger amounts of energy storage
- › Standard packages reduce the cost and complexity of decarbonization
- › Integrated technology adds flexibility to existing dispatchable power generation

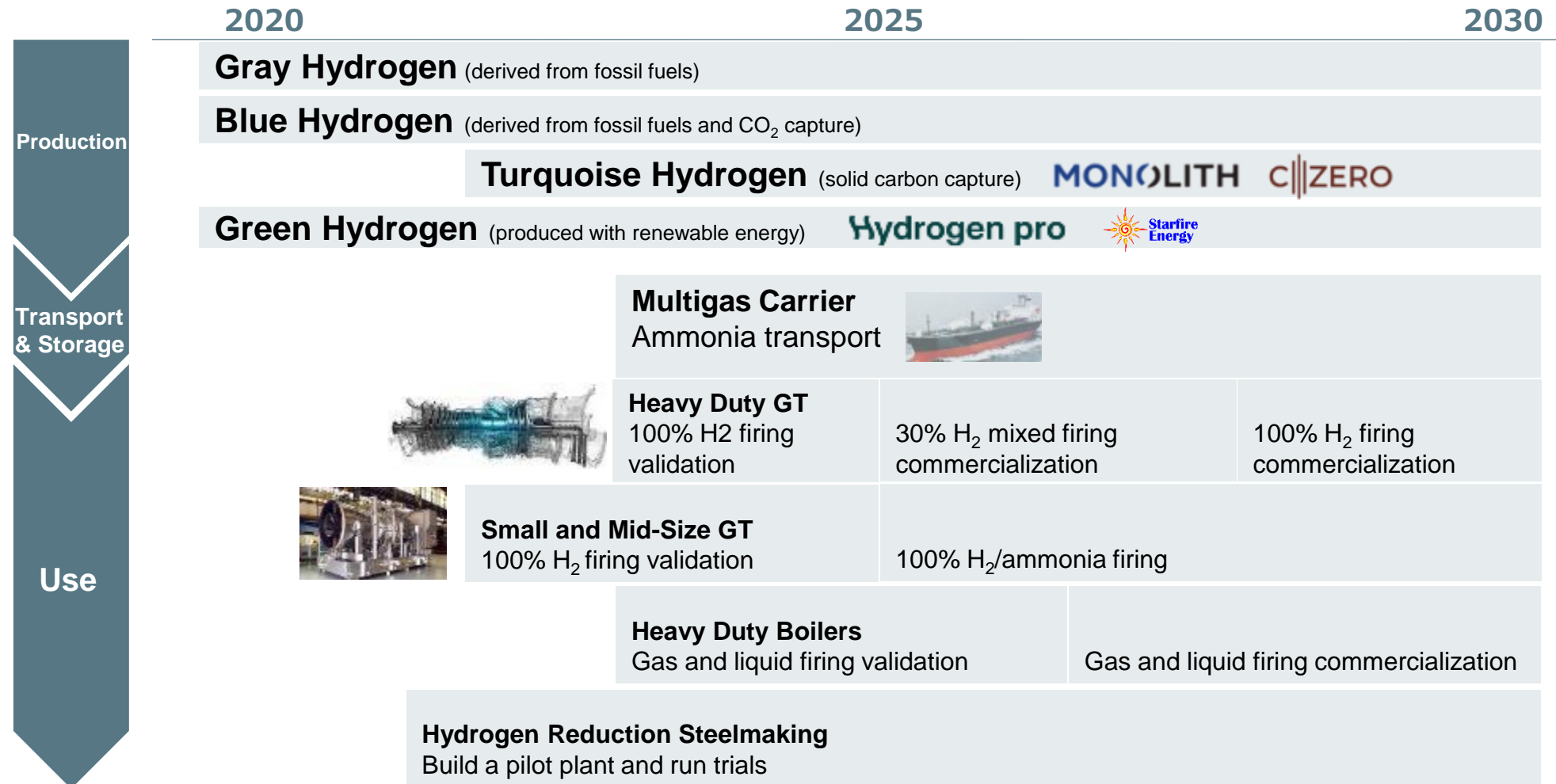
The MHI Group has a vast range of technologies and end-to-end solutions for the hydrogen supply chain



In addition, MHI Group has products for iron making, forklift, rocket, etc. that can be fueled by hydrogen.

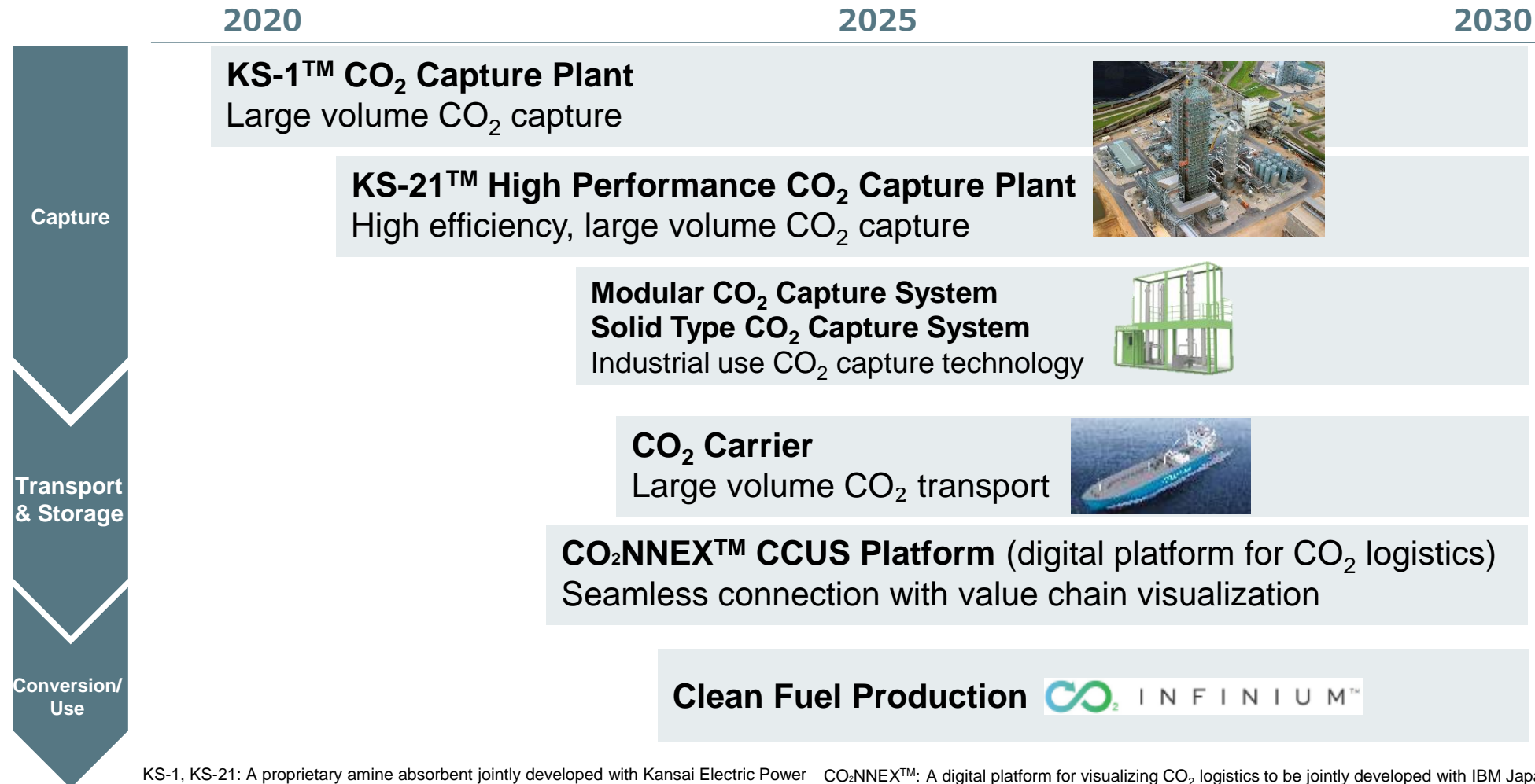
Build a Hydrogen Solutions Ecosystem

- Create a solutions ecosystem covering production, transport, storage, and use
- Develop key decarbonization technologies targeting 2025



Build a CO₂ Solutions Ecosystem

- Create a solutions ecosystem covering carbon capture, transport, storage, and conversion/use
- Expand carbon capture product lineup by 2023



KS-1, KS-21: A proprietary amine absorbent jointly developed with Kansai Electric Power CO₂NNEX™: A digital platform for visualizing CO₂ logistics to be jointly developed with IBM Japan