

Υδρογόνο – Η γέφυρα μεταξύ Ορυκτών Καυσίμων και Βιώσιμης Ενεργειακής Μετάβασης

Θάνος Στούμπος

Δντης ΙΠΡΕΤΕΑ – ΕΚΕΦΕ ΔΗΜΟΚΡΙΤΟΣ

Μάνος Σταματάκης

Ερευνητής ΙΠΕ – ΙΤΕ

Μέλη της Επιτροπής του ΥΠΕΝ για τη χάραξη Εθνικής Στρατηγικής για το Υδρογόνο



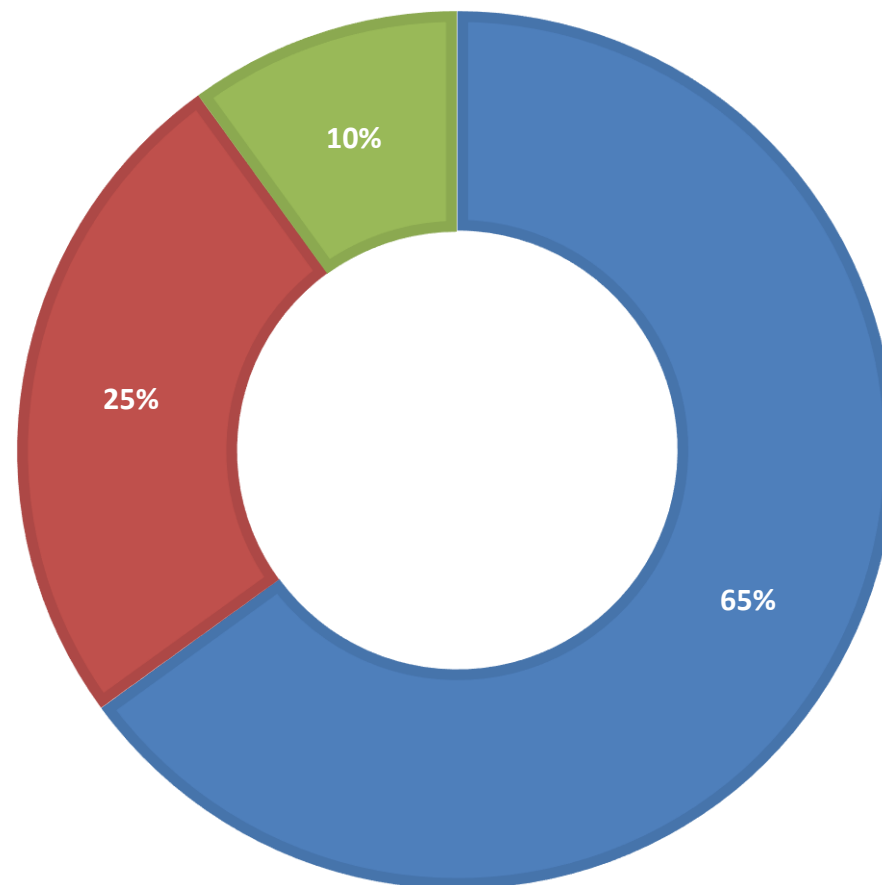
"Πιστεύω ότι το νερό θα είναι, μία μέρα καύσιμη ύλη. Το Υδρογόνο και το Οξυγόνο, από τα οποία συντίθεται το νερό, αν χρησιμοποιηθούν ξεχωριστά ή σε συνδυασμό θα προσφέρουν μία ανεξάντλητη πηγή θερμότητας και φωτός, με ισχύ μεγαλύτερη από εκείνη του άνθρακα... Το νερό είναι ο μελλοντικός άνθρακας!"

Ιούλιος Βερν
Η μυστηριώδης νήσος, 1875

Hydrogen demand by industry

H2 DEMAND BY SECTOR

INDUSTRY SECTOR	KEY APPLICATIONS
CHEMICAL	<ul style="list-style-type: none"> • Ammonia • Polymers • Resins
REFINING	<ul style="list-style-type: none"> • Hydrocracking • Hydrotreating
IRON & STEEL	<ul style="list-style-type: none"> • Annealing • Blanketing gas • Forming gas
GENERAL INDUSTRY	<ul style="list-style-type: none"> • Semiconductor • Propellant fuel • Glass production • Hydrogeneration of fats • Cooling of generators



■ Chemical ■ Refining/Iron & Steel ■ General Industry



How Hydrogen empowers the Energy Transition

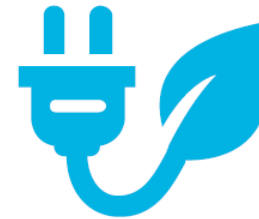
HYDROGEN COUNCIL | SEPTEMBER 2017

Hydrogen is a clean, safe and versatile energy carrier

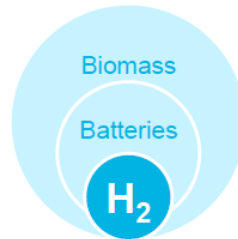
Can be transported over long distances,
allowing the distribution of energy between countries



Produces clean power and/or heat
for transport and stationary applications



Can be produced without a carbon footprint through electrolysis or SMR + CCS



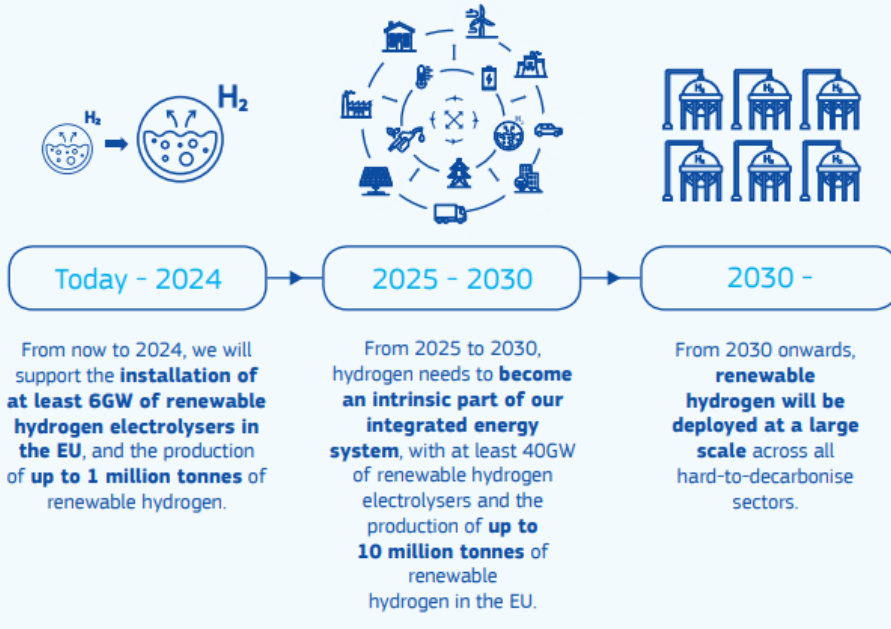
Has a high energy density, making it suitable for long-term storage



Required as a clean feedstock in industry when recycling captured CO₂

EU Position on Hydrogen

The path towards a European hydrogen eco-system step by step :



How can hydrogen be promoted in Europe?



- The production of clean hydrogen needs to be increased **by creating a sustainable industrial value chain.**



- We should **boost the demand for clean hydrogen** coming from industrial applications and mobility technologies.



- Clean hydrogen needs a **supportive framework, well-functioning markets and clear rules**, as well as dedicated infrastructure and a logistical network.



- **Promoting research and innovation** in clean hydrogen technologies is crucial.



- Europe we will secure **cooperation opportunities with neighboring countries and regions of the EU** and work to establish a global hydrogen market.

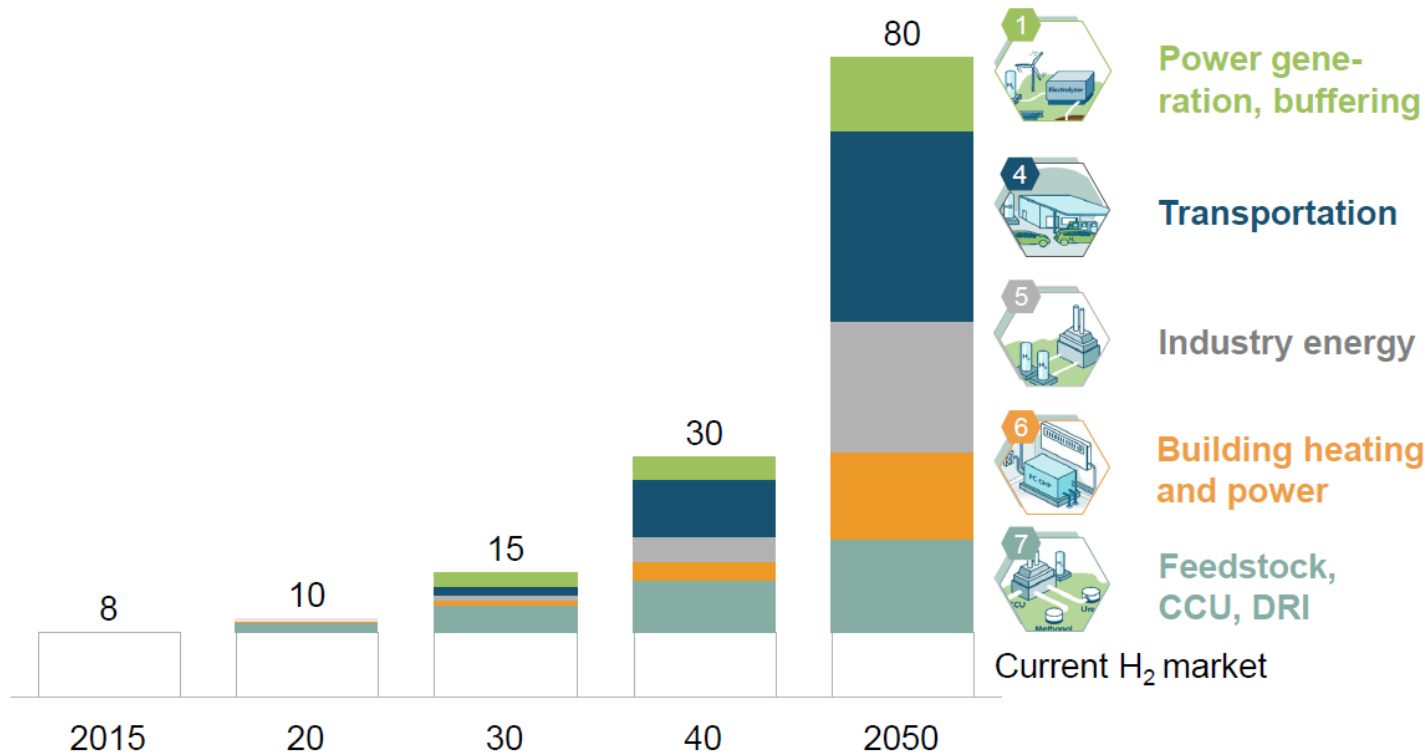


- The **European Clean Hydrogen Alliance** will help build up a robust pipeline of investments.

European Commission “A Hydrogen Strategy for a Climate-Neutral Europe”, 2020. https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf

By 2050, hydrogen can enable major CO₂ emission reductions

Global Energy demand supplied with hydrogen, Exajoule (EJ)



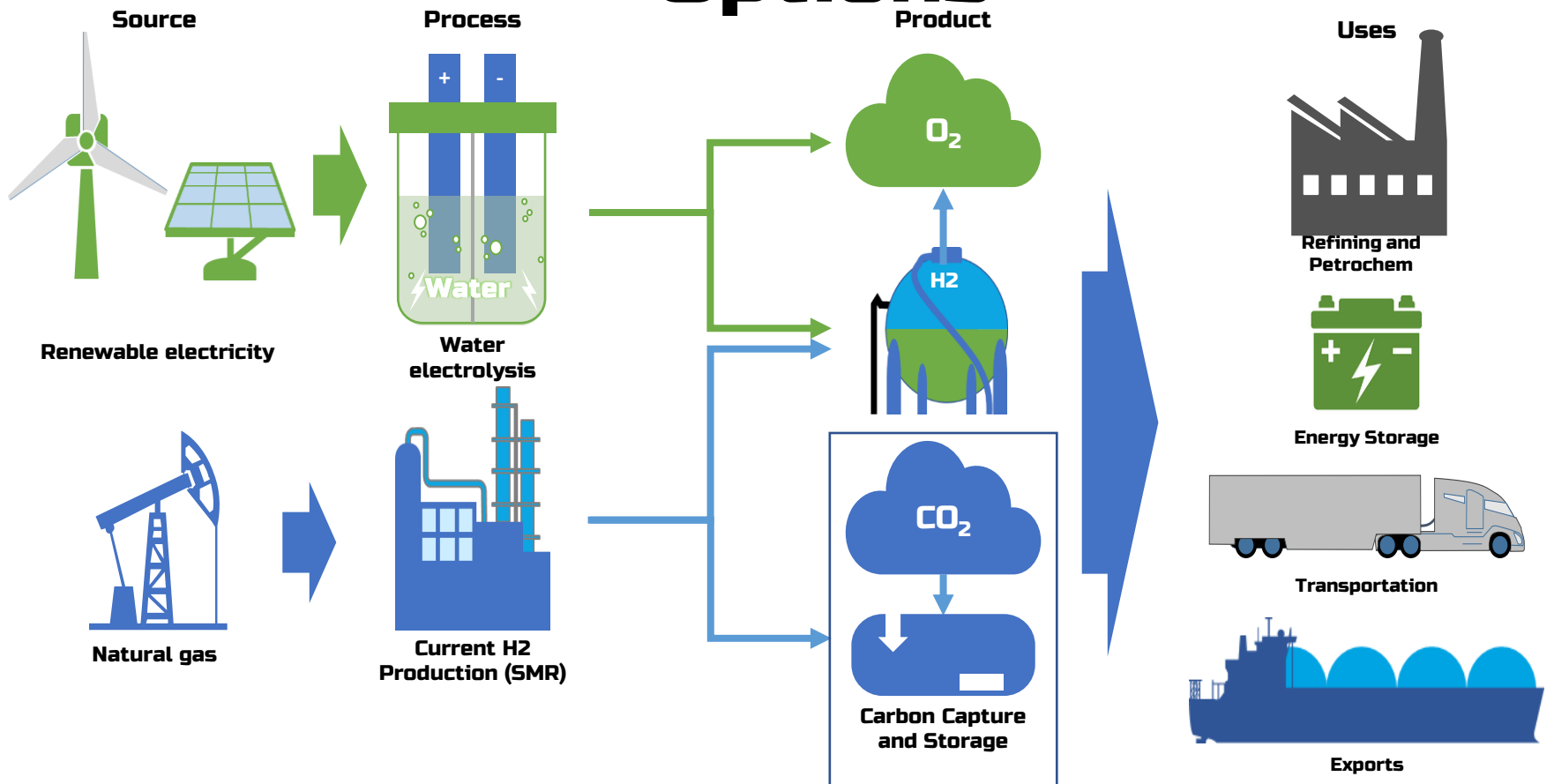
13%
of total energy demand in 2050

7.5 Gt
annual CO₂ abatement in 2050

1 Excluding feedstock

SOURCE: Hydrogen Council, IEA ETP Hydrogen and Fuel Cells CBS, National Energy Outlook 2016*

Typical Clean Hydrogen Production Options



Steam Methane Reforming (SMR)

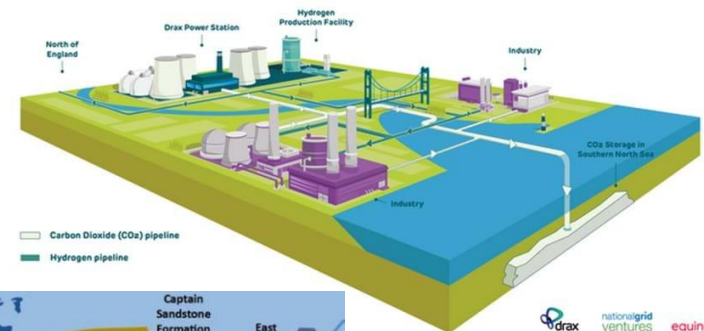
- SMR technology splits natural gas (NG) into mixture of hydrogen, CO and CO₂
- Industries use SMR technology to deliver large quantities of H₂ and CO with remaining CO₂ being released to atmosphere
- The process is mature with systems capable of producing up to 100s of metric tonnes per day of H₂/CO
- Currently over half the worlds hydrogen is derived from NG feedstocks



SMR and Carbon Capture Utilisation and Storage (CCUS)

- Capturing the CO₂ produced by SMR can decarbonise the process
- Captured CO₂ can be stored in underground geological features or used
- **If CO₂ is captured/used, HYDROGEN IS BLUE**
- Many large scale CCUS projects are being developed, and the UK is seeking to become world leading in CCUS technology.

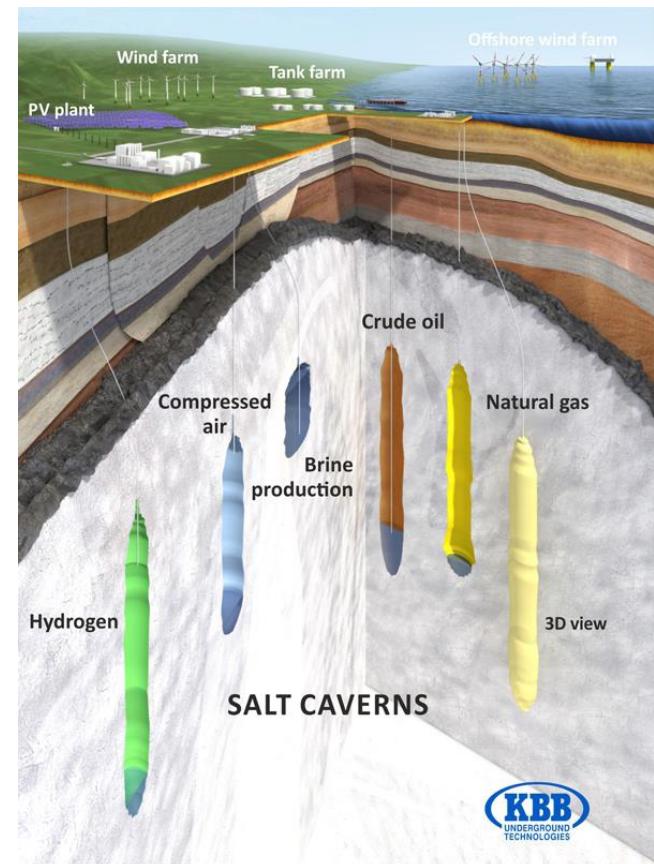
WHAT A ZERO CARBON CLUSTER COULD LOOK LIKE IN THE HUMBER REGION



The **Acorn Project** will capture about 200,000 tonnes of CO₂ from the St Fergus Gas Terminal

Salt Caverns for Gas Storage

- Used to store gases including hydrogen since the 1950s
- Sites have traditionally been developed after salt extraction by the chlorine industry
- Over 30 caverns in use in the UK today
 - mainly used for NG
 - 1 in use for hydrogen
 - internal wall properties prevent leakage and contamination of the hydrogen
- Lowest cost direct storage mechanism for large hydrogen volumes
- Possibility to use Larne salt caverns for hydrogen storage



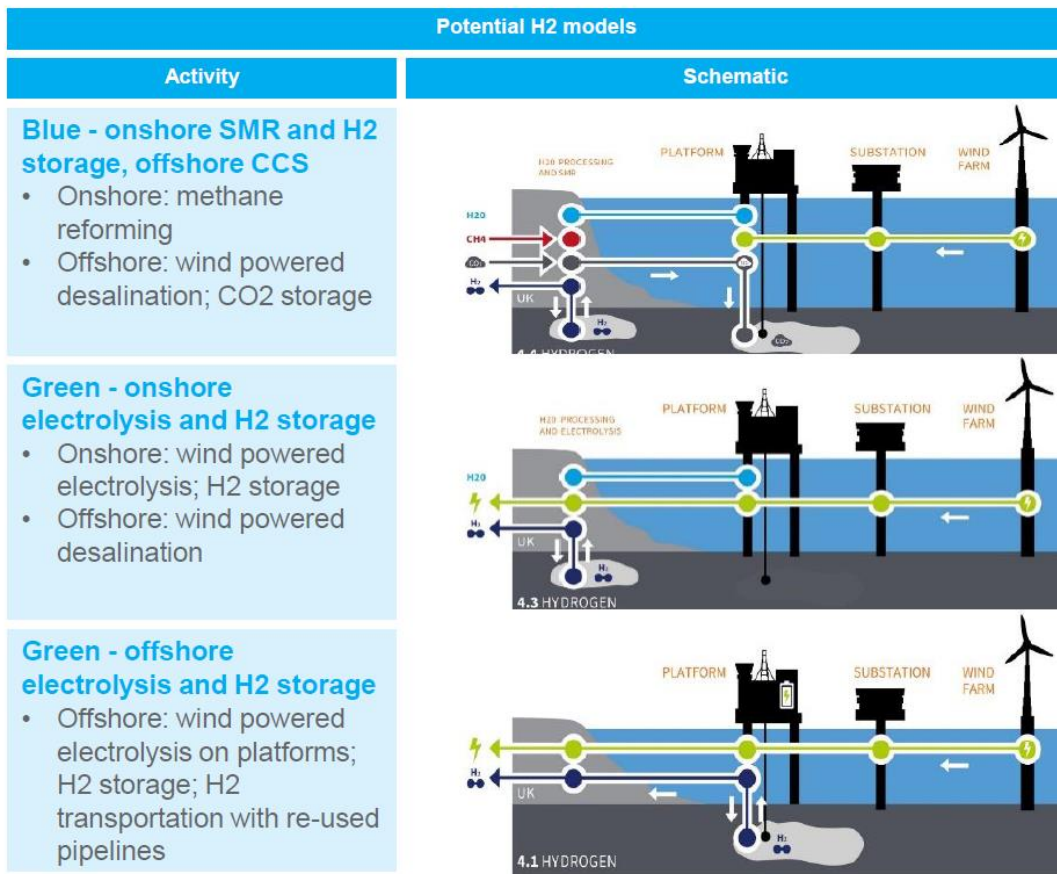
Supporting the energy transition: initial findings on Hydrogen

Onshore proven but still upside

Offshore to be piloted (Q13a in Netherlands)

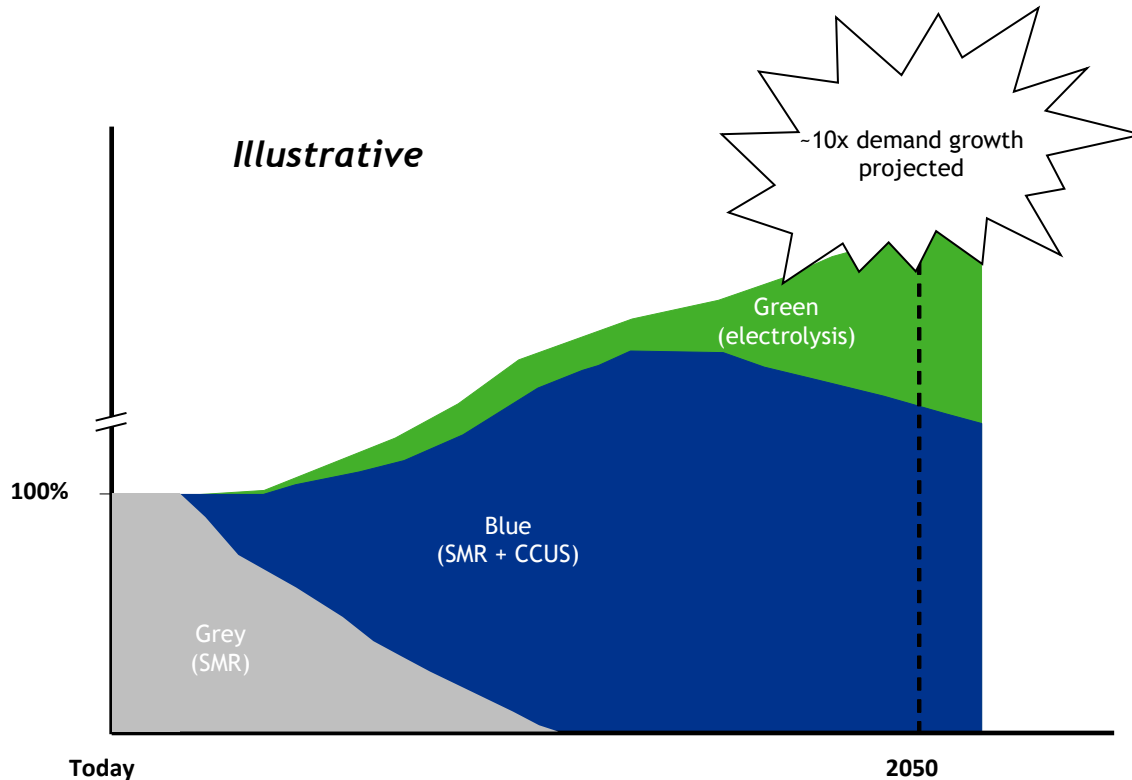
Re-use potential: SNS, EIS and NNS

Larger hubs can help capture full potential:
Shetland, Orkney, SNS, EIS and NNS



Hydrogen market capture strategies are customized by region

Hydrogen demand and mix over time



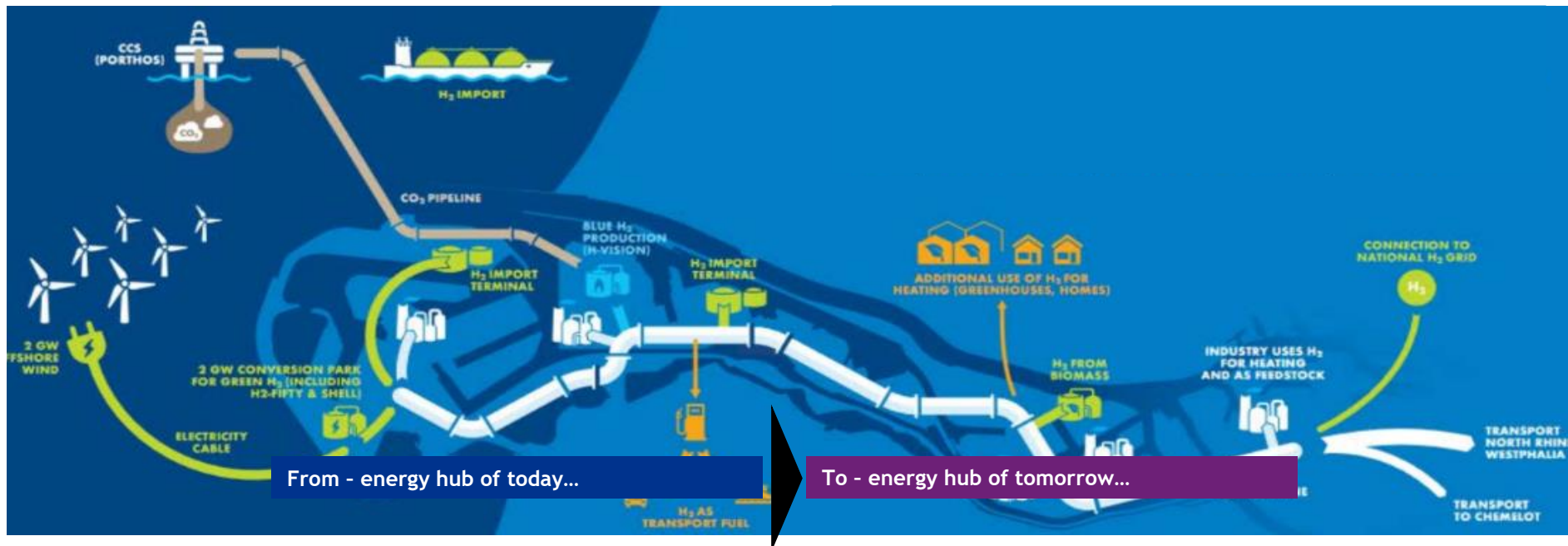
Regional Hydrogen Strategy Drivers

- Goals: 2050 net zero or similar
- Funding: Carbon fees or other
- Leverageable assets (blue)
 - H₂ system
 - At-scale CCUS hub
- Leverageable assets (green)
 - Geologic storage
 - Low power prices

Global Hydrogen Market Enablers

- Cost and supply chain improvements; e.g.,
 - Electrolyzers
 - Renewables
- H₂ and renewable synergies

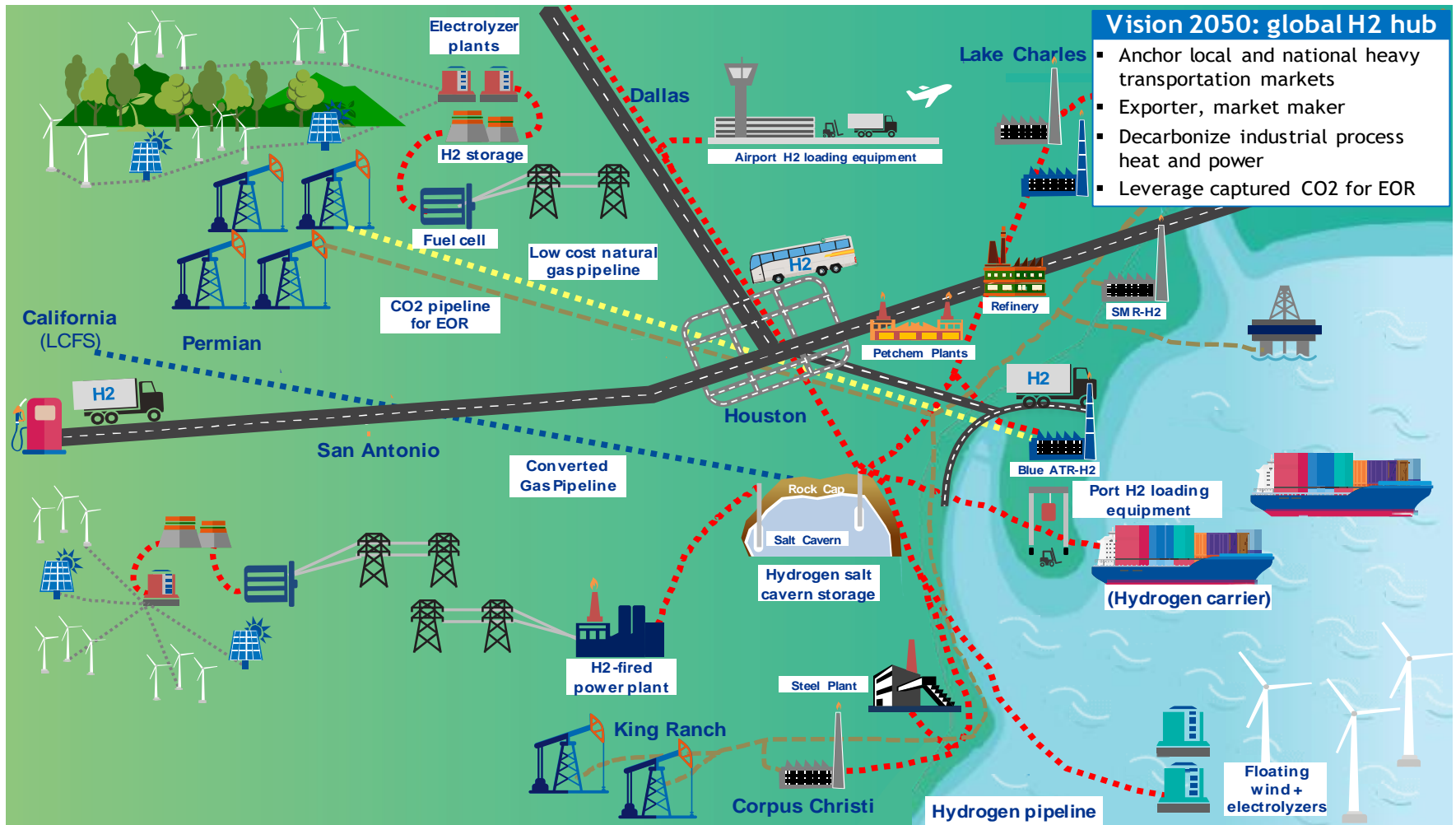
For example, Rotterdam is transforming from a global O&G to hydrogen hub, following this grey to blue to green pattern



- Refining hub
- European gateway and logistics point
- Global market clearing point (e.g., refined products, bunker fuel)

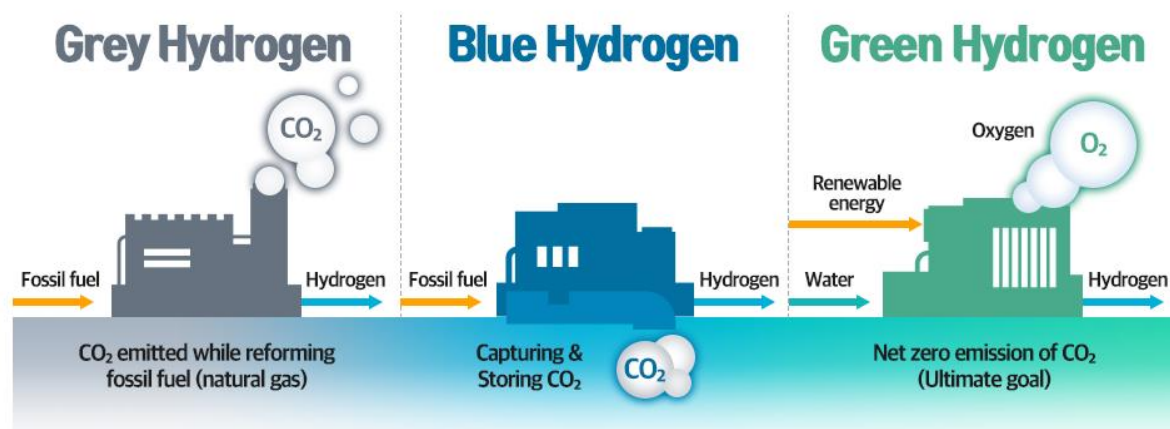
- Clean (blue and green) H₂ production hub
- H₂ gateway and logistics point with Northwest Europe
- Trading market for H₂ with pricing transparency

'Houston's Hydrogen Hub Vision'



Long – term Outlook on Hydrogen Technologies in Greece

- Develop a Roadmap for real scale deployment of FCH technologies



- Support training and educational technologies on FCH applications => through collaborations e.g. between IPR/FORTH, NCSRDI, Universities, Industry, SMEs => create a National Hydrogen Cluster
- Attract private financing for deploying large – scale FCH projects
- **Disseminate and promote the technology to the commercial sector, citizens and engage local and regional stakeholders for large-scale implementation of FCH projects**



Acknowledgements

INRASTES-NCSRD wishes to acknowledge the co-financed by the European Regional Development Fund of the EU, and Greek national funds **project H2TRANS** (T1EDK-05294) under the call RESEARCH – CREATE – INNOVATE



Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης

IPR-FORTH wishes to acknowledge

Hellenic Petroleum (HELPE)

➤ *for a 5-Year support of its activities, through a sponsorship Agreement in place between HELPE and IPR-FORTH*



IPR-FORTH is Sponsored by > **HELLENIC PETROLEUM**