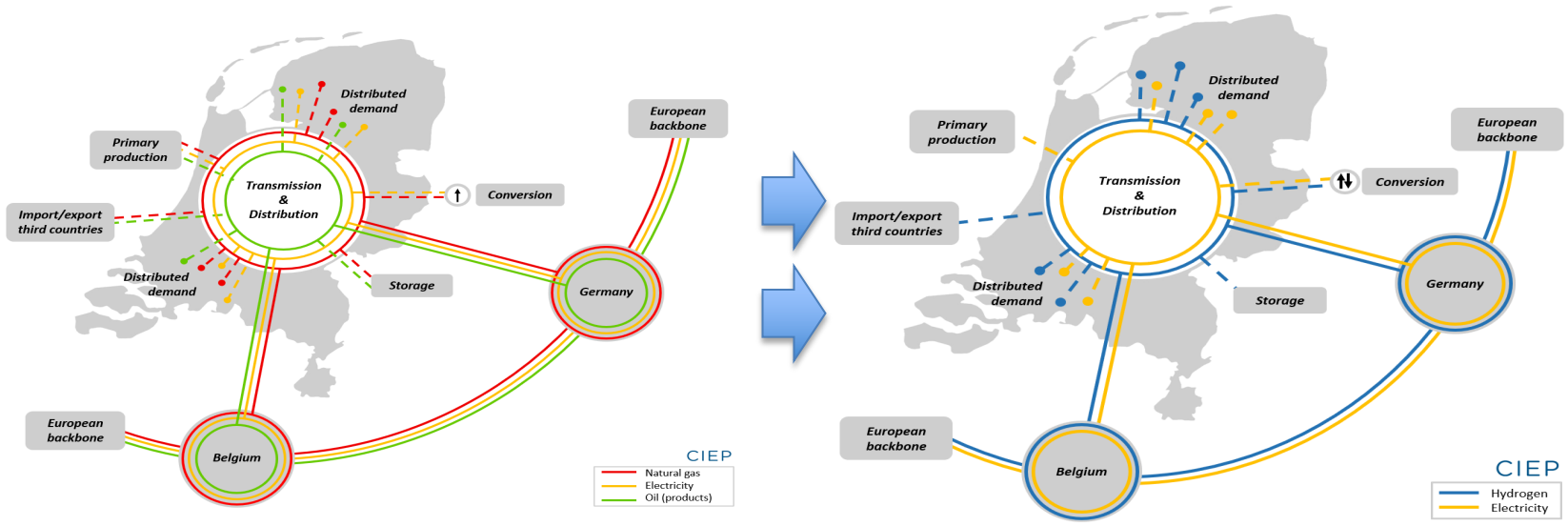
CLINGENDAEL INTERNATIONAL ENERGY PROGRAMME | CIEP

Hydrogen, the missing link in the chain, and why the Netherlands is well positioned

Coby van der Linde,

I&W 16 March 2021



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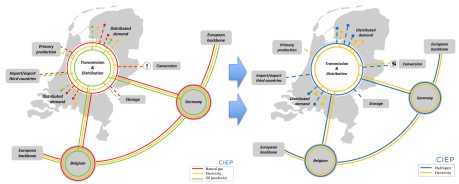
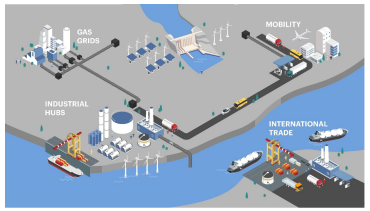


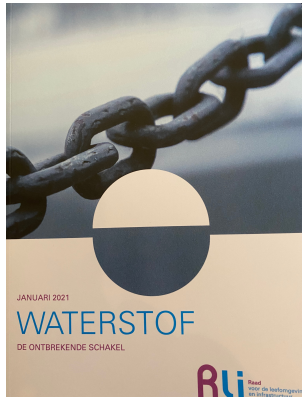
From the old towards a new energy system?

Do we need more than electricity?



- Opportunities for hydrogen markets

  Where and how to kickstart hydrogen development?

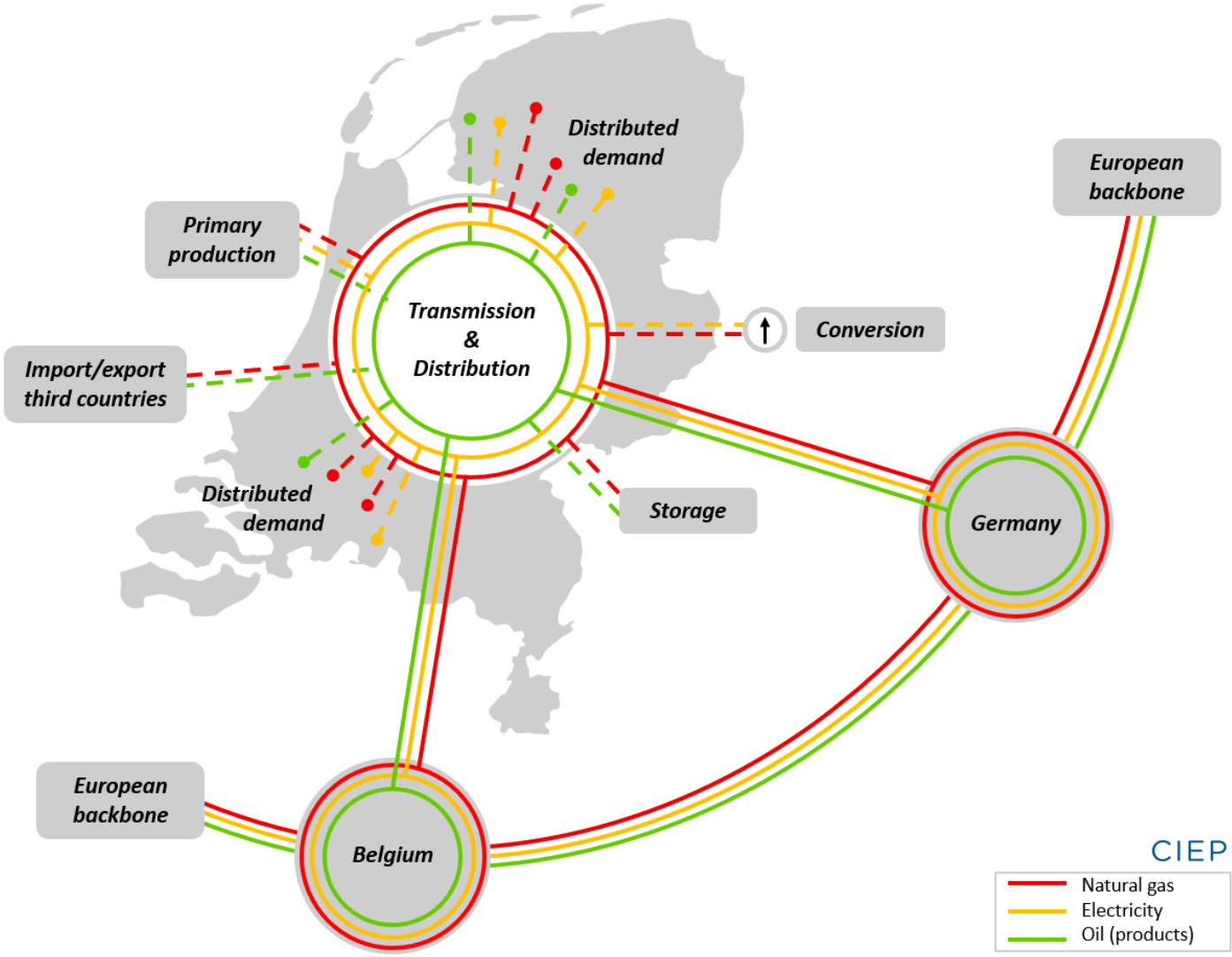


- Stimulating the hydrogen economy

  Facilitating the hydrogen market

Current system

- Example of The Netherlands
- Natural gas, electricity and oil (products) fulfil systemic functions
- Equivalent patterns around the world
- By design or by evolution?

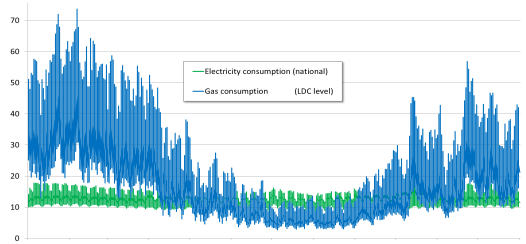


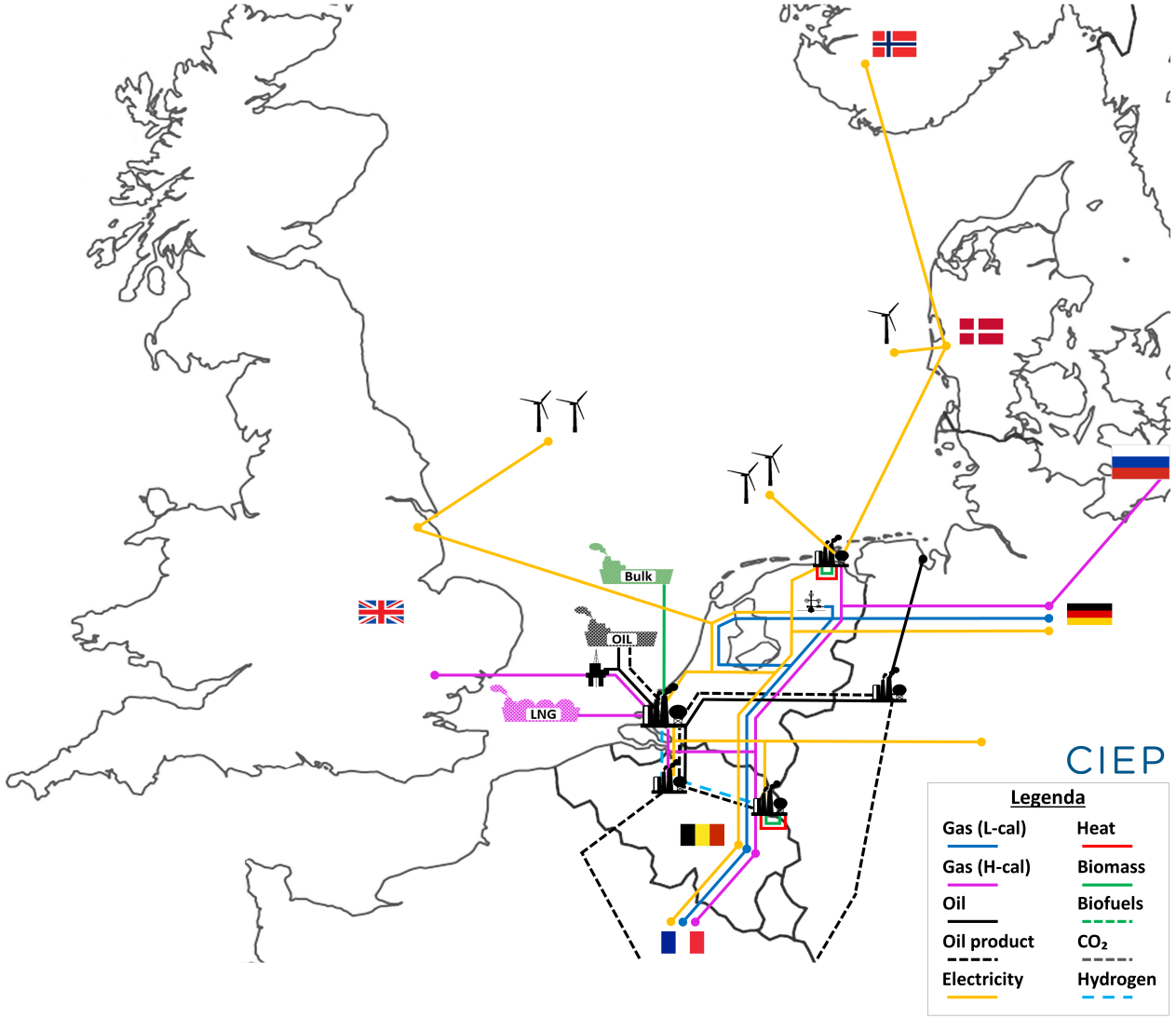
Current system

- **Around the North Sea**
- **Primary energy production** by natural gas, oil and electricity
- **Integrated markets**

  Both regionally and globally

  By pipelines, cables and shipping
- **Dimensions of the various energy flows** in the form of electricity, gasses, liquids often under-estimated, including the issues how to integrate all the offshore wind into the energy system at the lowest societal cost

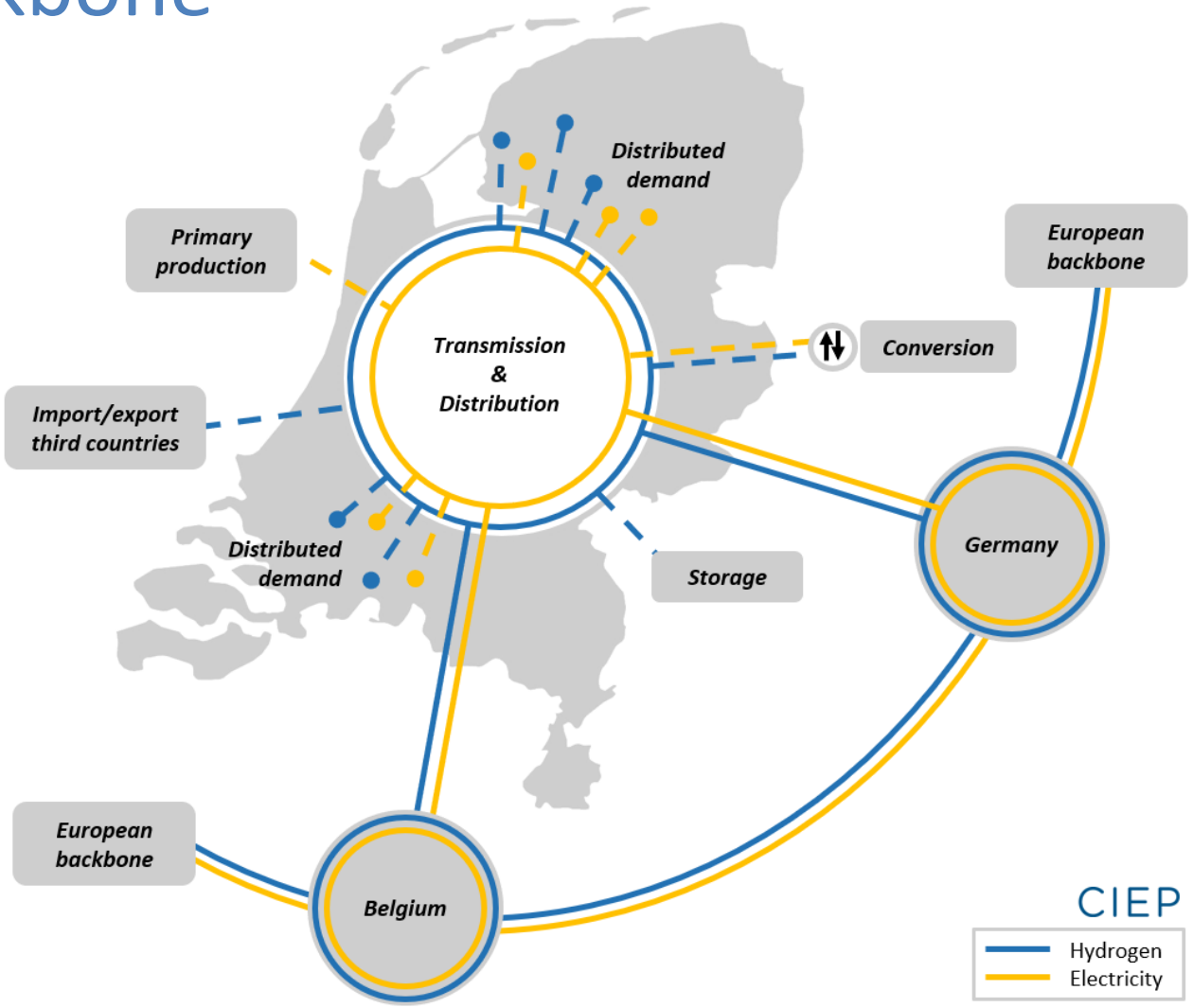




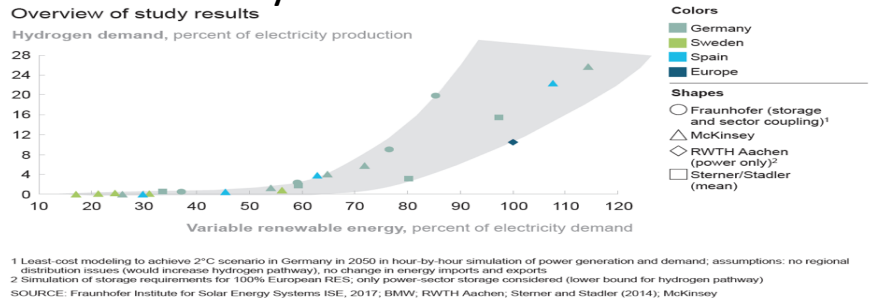
Potential 2050 energy backbone

- Hydrogen and electricity jointly meeting all systemic functions
- Hydrogen as new default solution for companies and consumers for various energy functions
- Strengths and weaknesses of one, compensated by the other

  (both ways)



More RES in system demands more H2



1 Least-cost modeling to achieve 2°C scenario in Germany in 2050 in hour-by-hour simulation of power generation and demand; assumptions: no regional distribution issues (would increase hydrogen pathway), no change in energy imports and exports
2 Simulation of storage requirements for 100% European RES; only power-sector storage considered (lower bound for hydrogen pathway)
SOURCE: Fraunhofer Institute for Solar Energy Systems ISE, 2017; BMW; RWTH Aachen; Sterner and Stadler (2014); McKinsey

Frank Wouters/Ad van Wijk: https://frank-wouters.com/author/frankwouters1/

Systemic functions of energy carriers

Current system

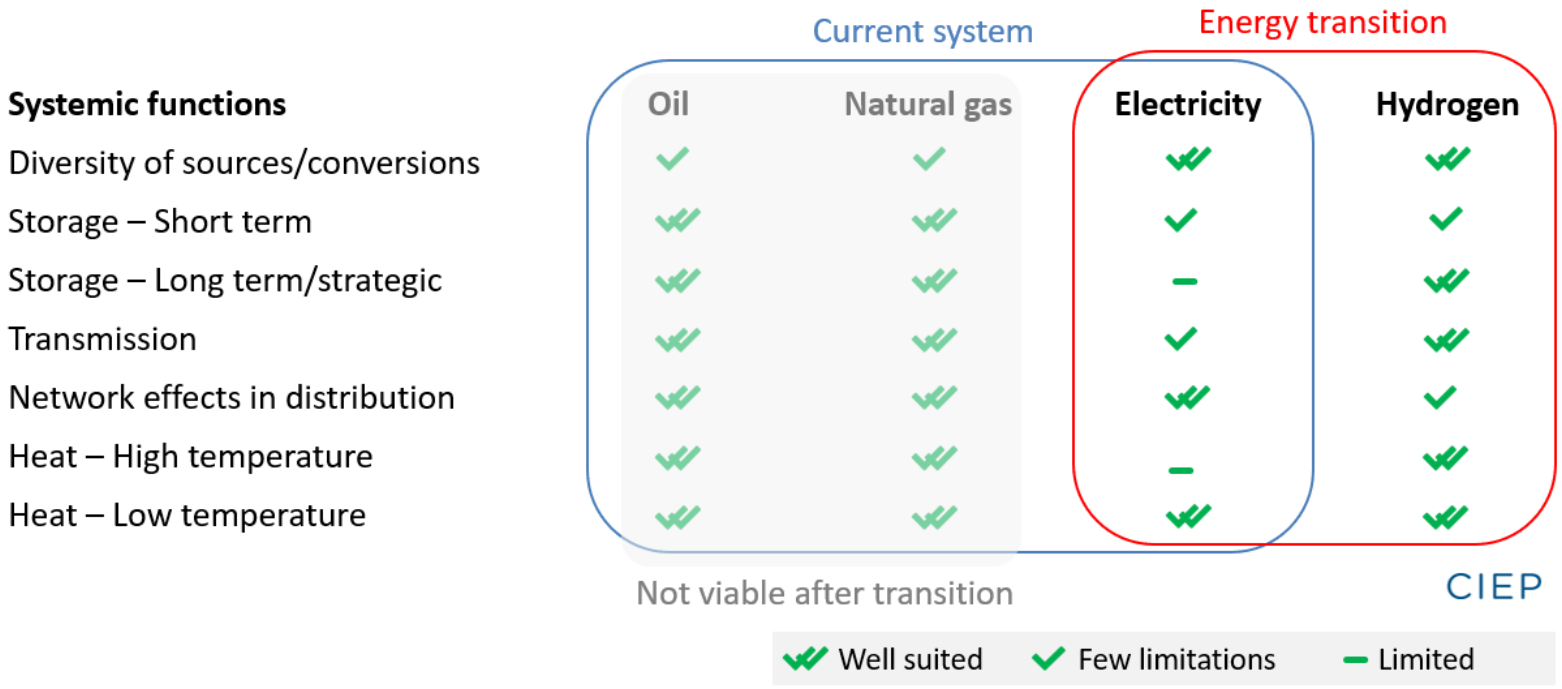
Systemic functions	Oil	Natural gas	Electricity
Diversity of sources/conversions	✓	✓	✓✓
Storage – Short term	✓✓	✓✓	✓
Storage – Long term/strategic	✓✓	✓✓	–
Transmission	✓✓	✓✓	✓
Network effects in distribution	✓✓	✓✓	✓✓
Heat – High temperature	✓✓	✓✓	–
Heat – Low temperature	✓✓	✓✓	✓✓

CIEP

✓✓ Well suited ✓ Few limitations – Limited

- In general, there are few energy carriers fulfilling systemic functions
- *Default solutions* for companies and consumers
- All systemic functions must be fulfilled for a robust and effective energy system
- Transportation costs differ substantially between electrons and molecules; investment costs to enlarge the electricity system is very costly

Different energy carriers fulfilling systemic functions



- The energy transition puts pressure on use of unabated oil and natural gas in system roles, in industry CCS may be a solution but households imply widely dispersed emission points
- Still: all systemic functions must be fulfilled for a robust and effective energy system
- Hydrogen supplementing electricity

  Scalable, versatile in production and use, molecule so feedstock use and benefits for transport and storage

Potential around the North Sea

- Primary production of electricity

  Solar, (offshore) wind

- Integrated markets with different energy carriers

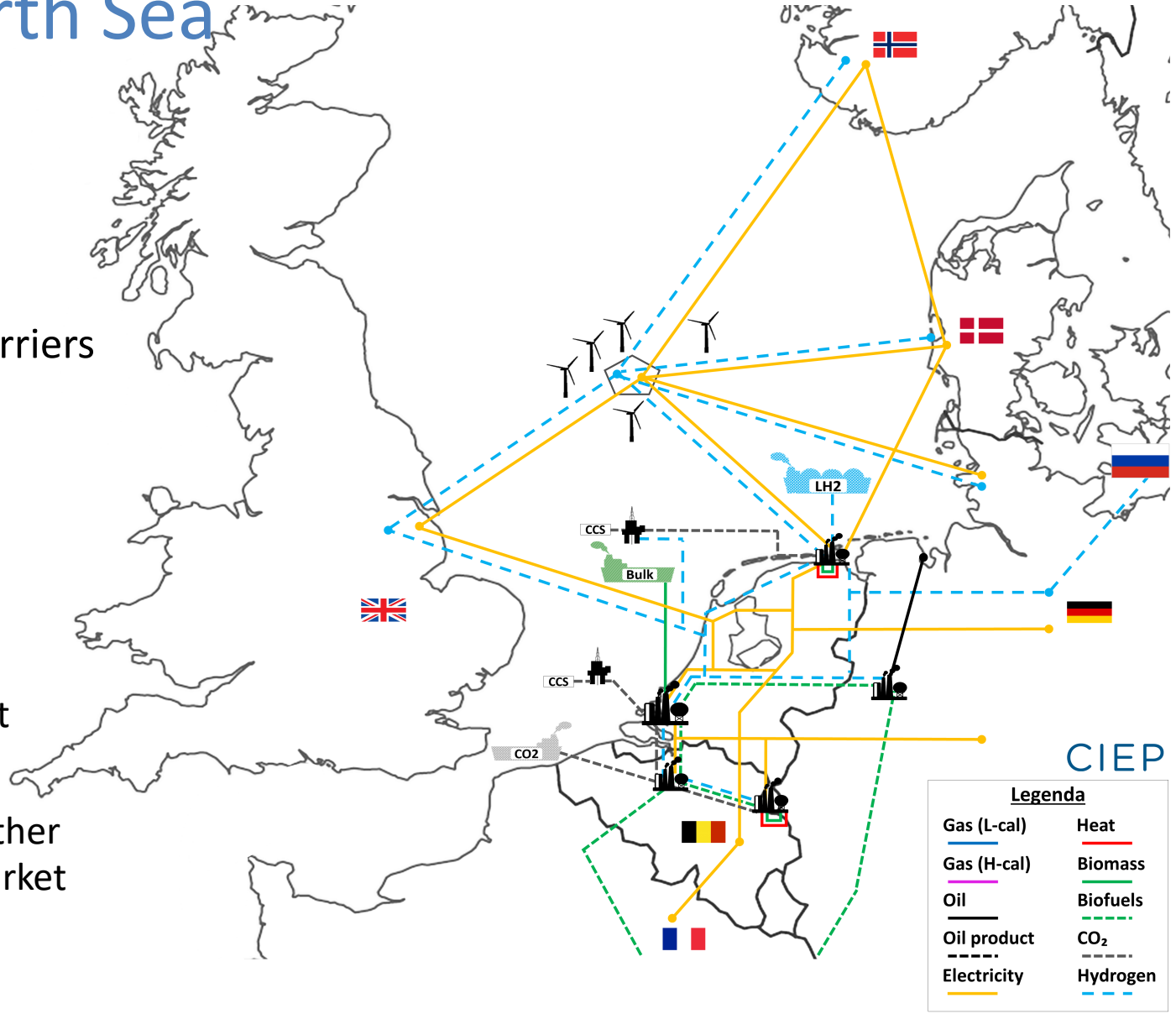
- Energy trade by hydrogen(carriers)

  Pipeline or ship

  H_2, Ammonia, LOHC, etc

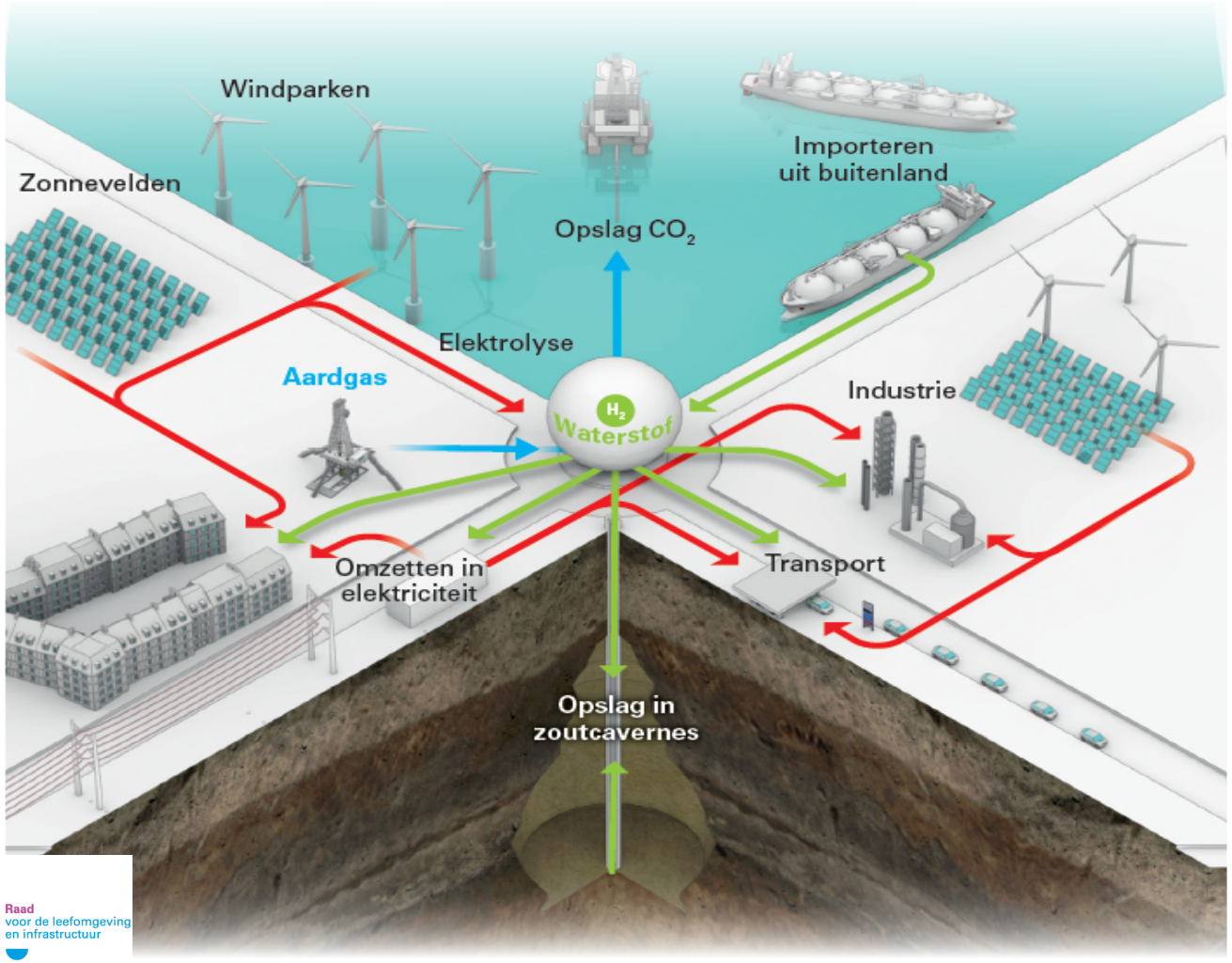
- NW Europe ideally placed to kick start H2 market

- Decarbonisation of heat and transport could further increase demand for hydrogen, opening new market opportunities for offshore wind



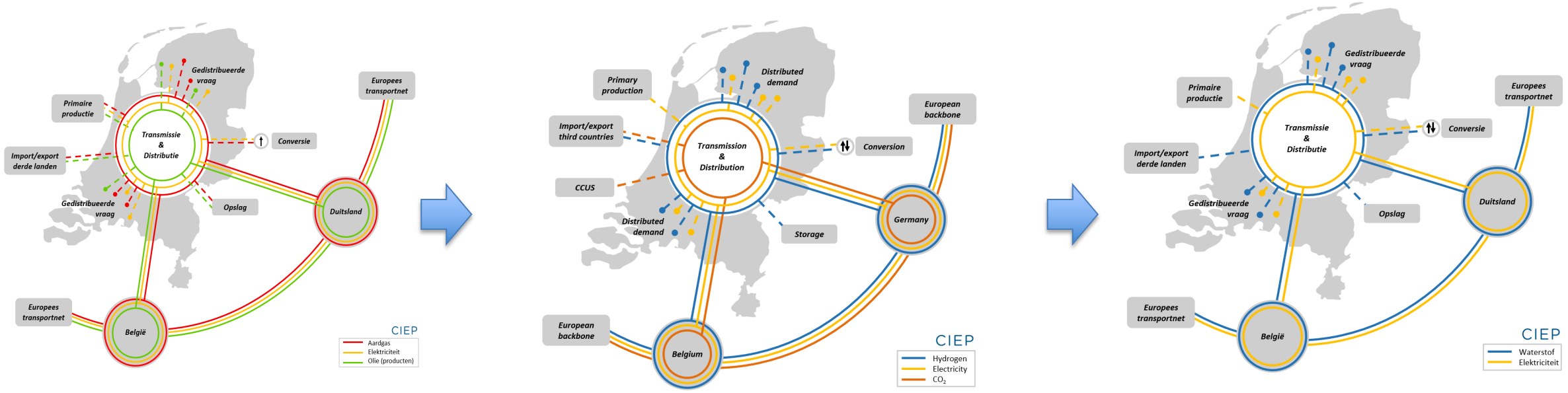
RLI report: Hydrogen is the lynchpin in a future low carbon energy and resource system

Economische sectoren	Waterstoftoepassingsmogelijkheden
Industriesector	Hogetemperatuurwarmte Grondstof voor materialen
Energiesector	Flexibele opslag en transport van energie
Transport- en mobiliteitssector	Brandstof voor vervoermiddelen
Sector gebouwde omgeving	Verwarming van huizen, tapwater



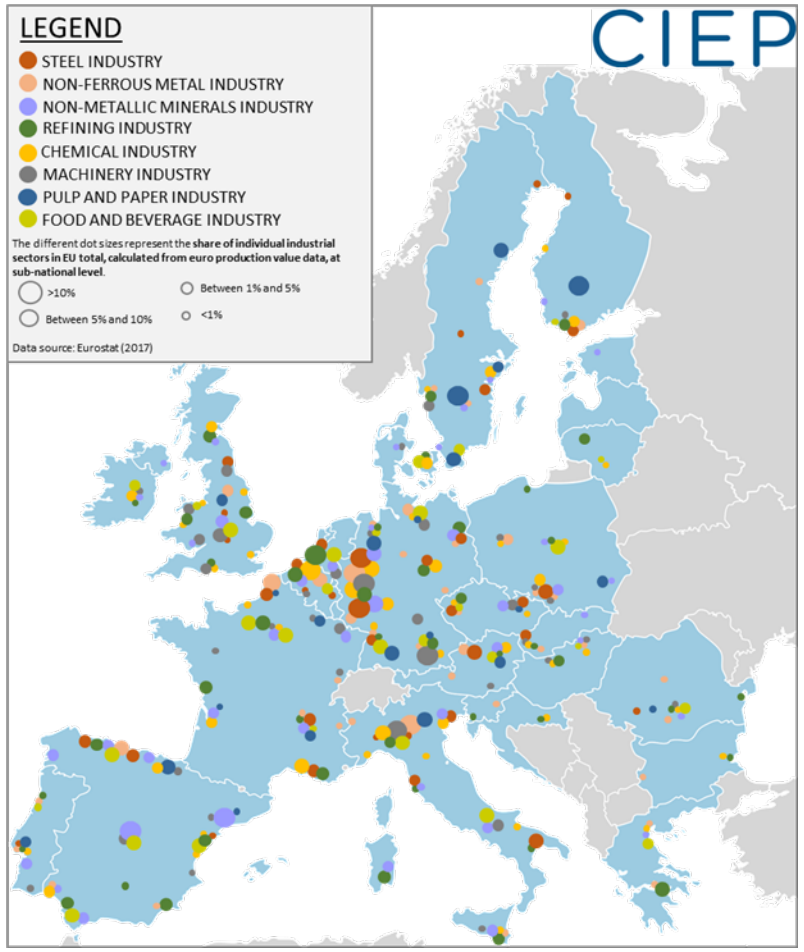
Raad voor de leefomgeving en infrastructuur

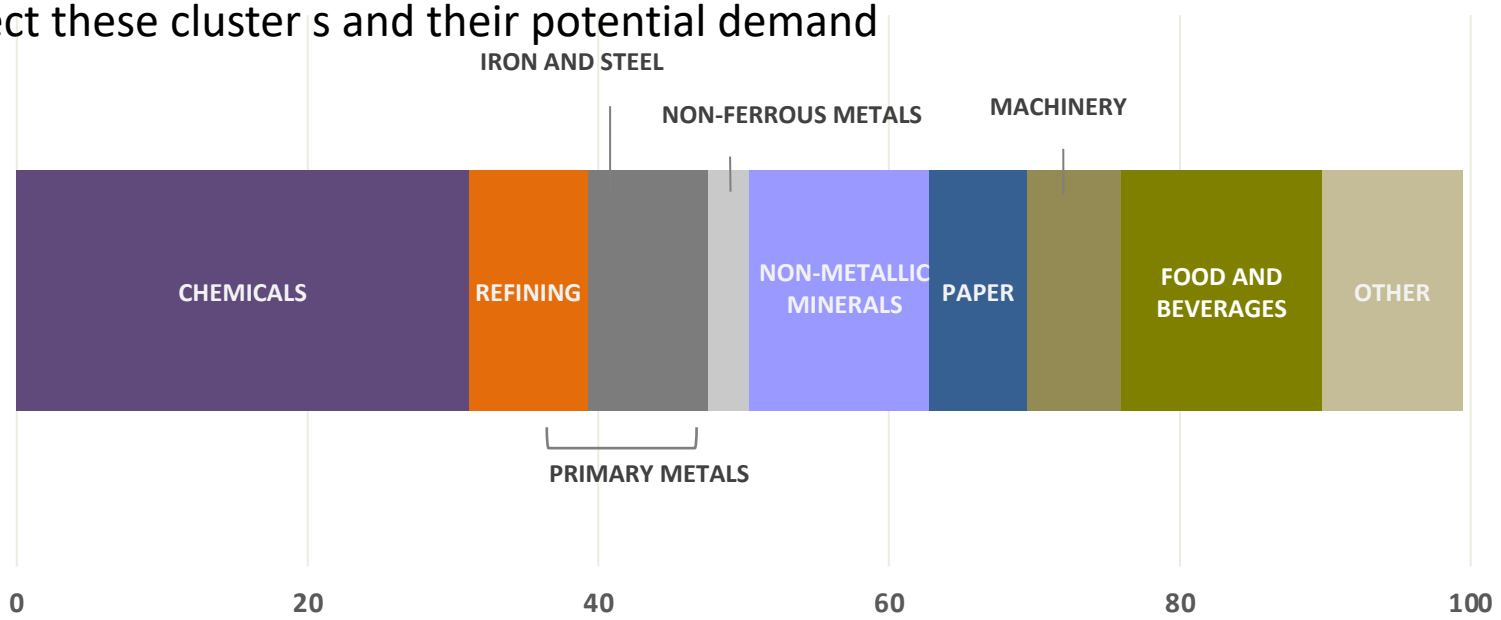
From the current energy system backbone to a new one – with CCUS and blue hydrogen as a necessary intermediate step to go from old system to the new one to achieve 2030 and 2050 goals



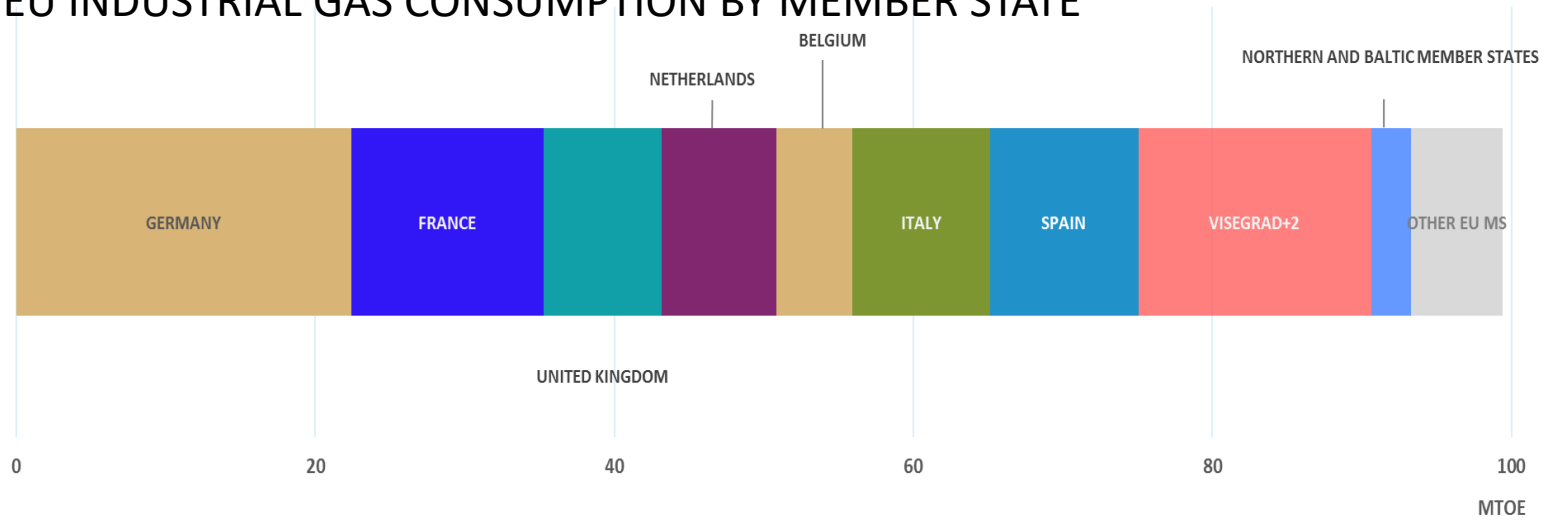
Ambitious targets for 2030 imply we have to use all technologies to create both scale in demand and supply and transportation to create a low carbon H2 market and empower industry to become a flywheel for a low carbon NW European H2 market.

For instance, use the large concentration of EU Industrial Natural Gas Consumption (By Industrial Sector) in NW Europe and the deep gas grid to connect these cluster s and their potential demand



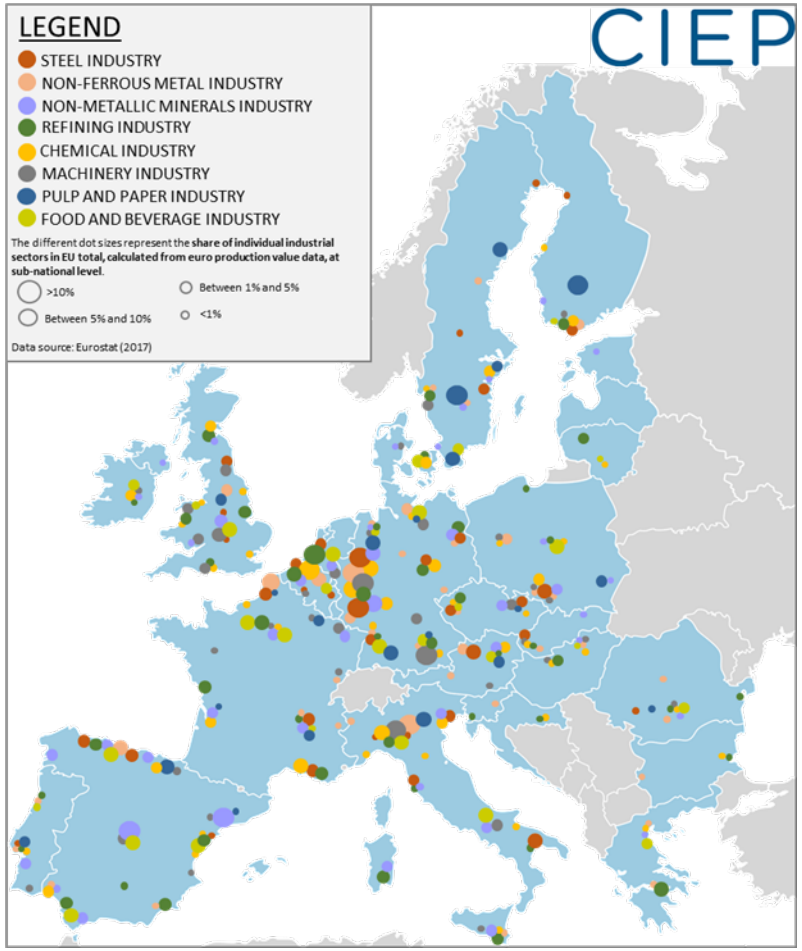


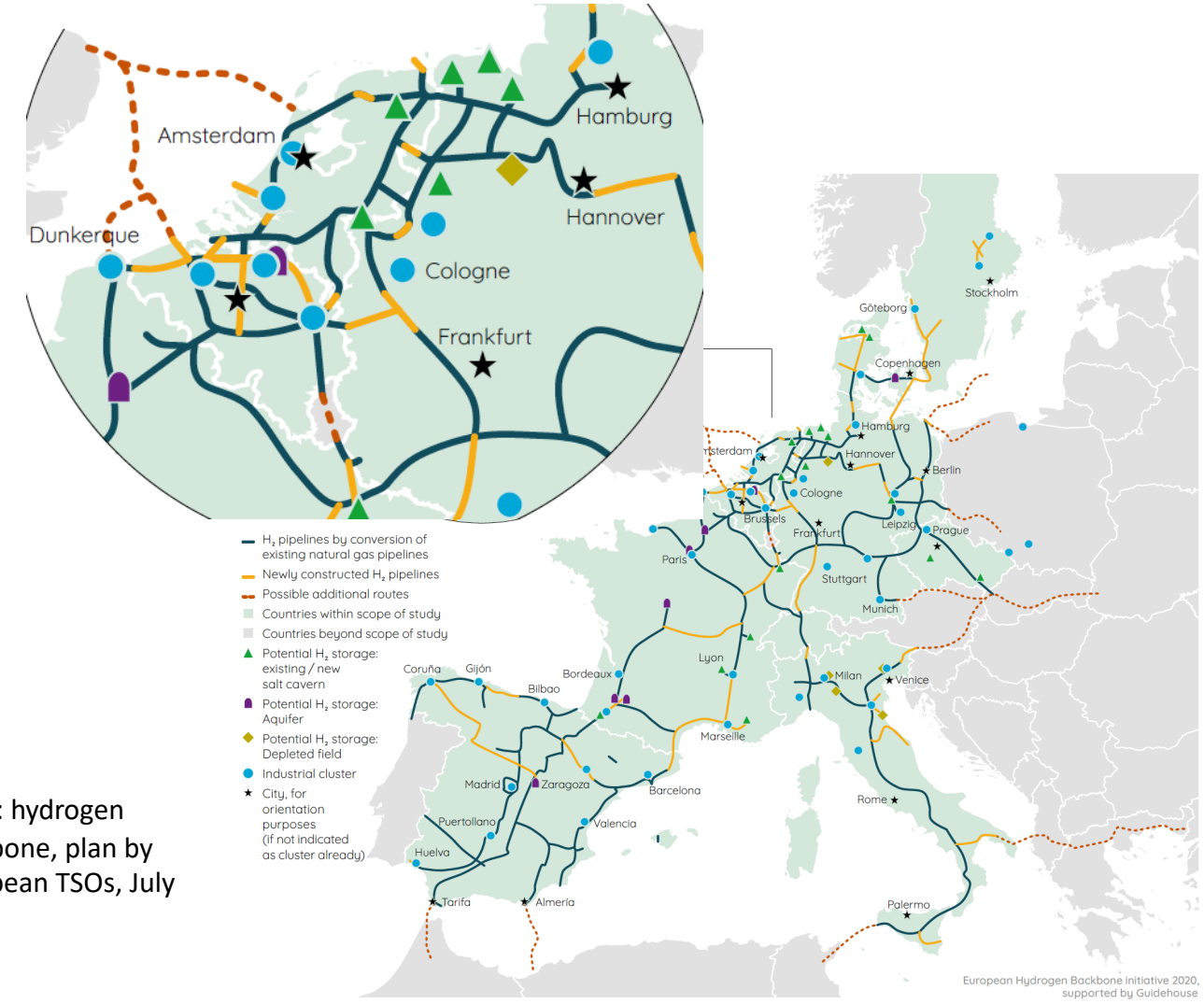
EU INDUSTRIAL GAS CONSUMPTION BY MEMBER STATE



Source: CIEP, 2015 data

Role of Industry: connecting the ‘dots’, wind and solar potential and generating transportation volume and demand which help reduce the societal costs for other applications in mobility and heating





From: hydrogen backbone, plan by European TSOs, July 2020

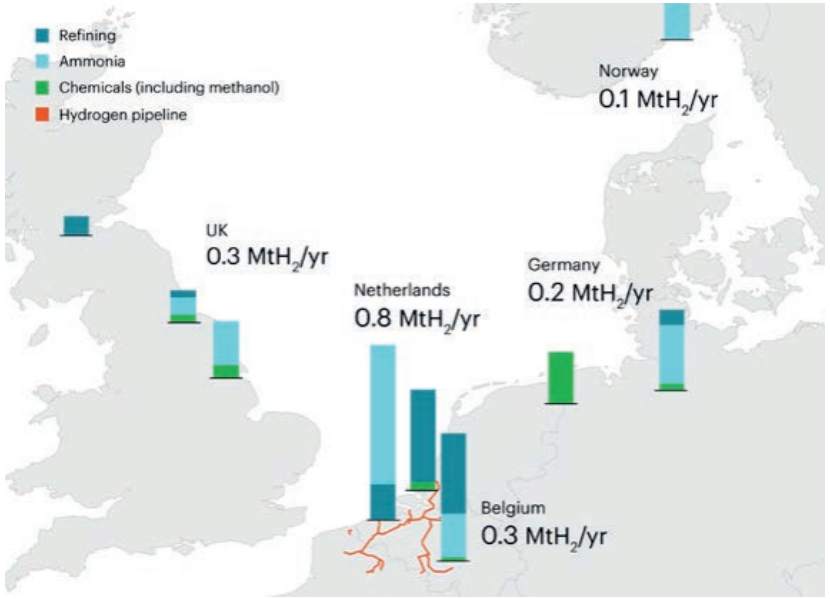
Industrial hubs

- Concentration of
  - energy and hydrogen demand (57% of current H2 demand is in NW Europe)
  - Infrastructure (natural gas, H_2, electricity)
- Opportunities for
  - Hydrogen imports/export
  - CCS in offshore fields
  - Offshore wind
- Nuclei for further market development
- Developed by e.g. New Zealand, UK, NL, France

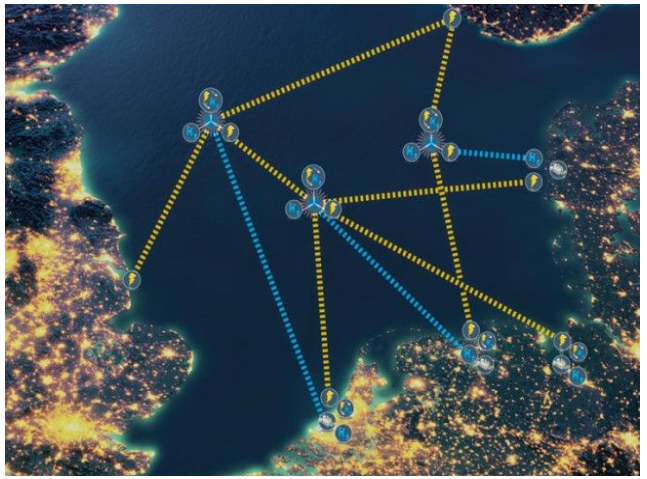
- *In combination with reuse of gas network,*

  unique opportunity for the Netherlands

North sea hydrogen demand capacity by sector an pipeline infrastructure, 2018

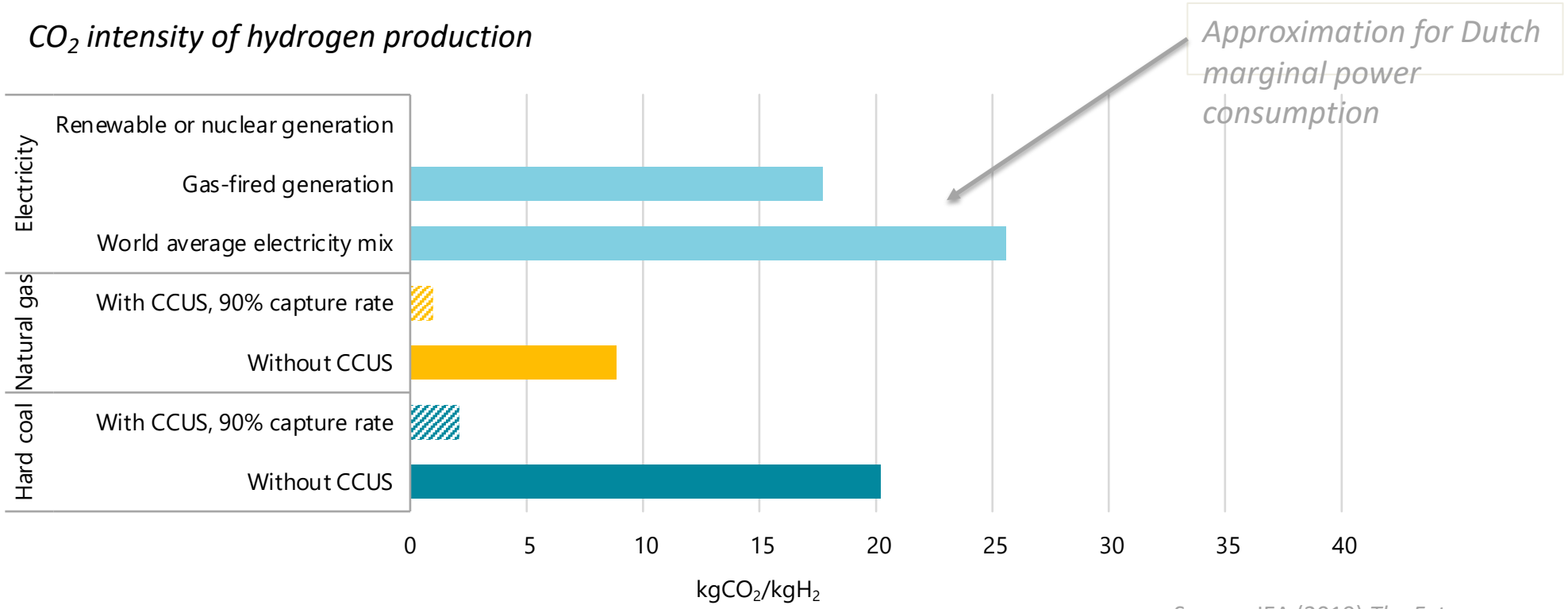


Source: IEA, The Future of Hydrogen, 2019



Source: NSWPH, 2019

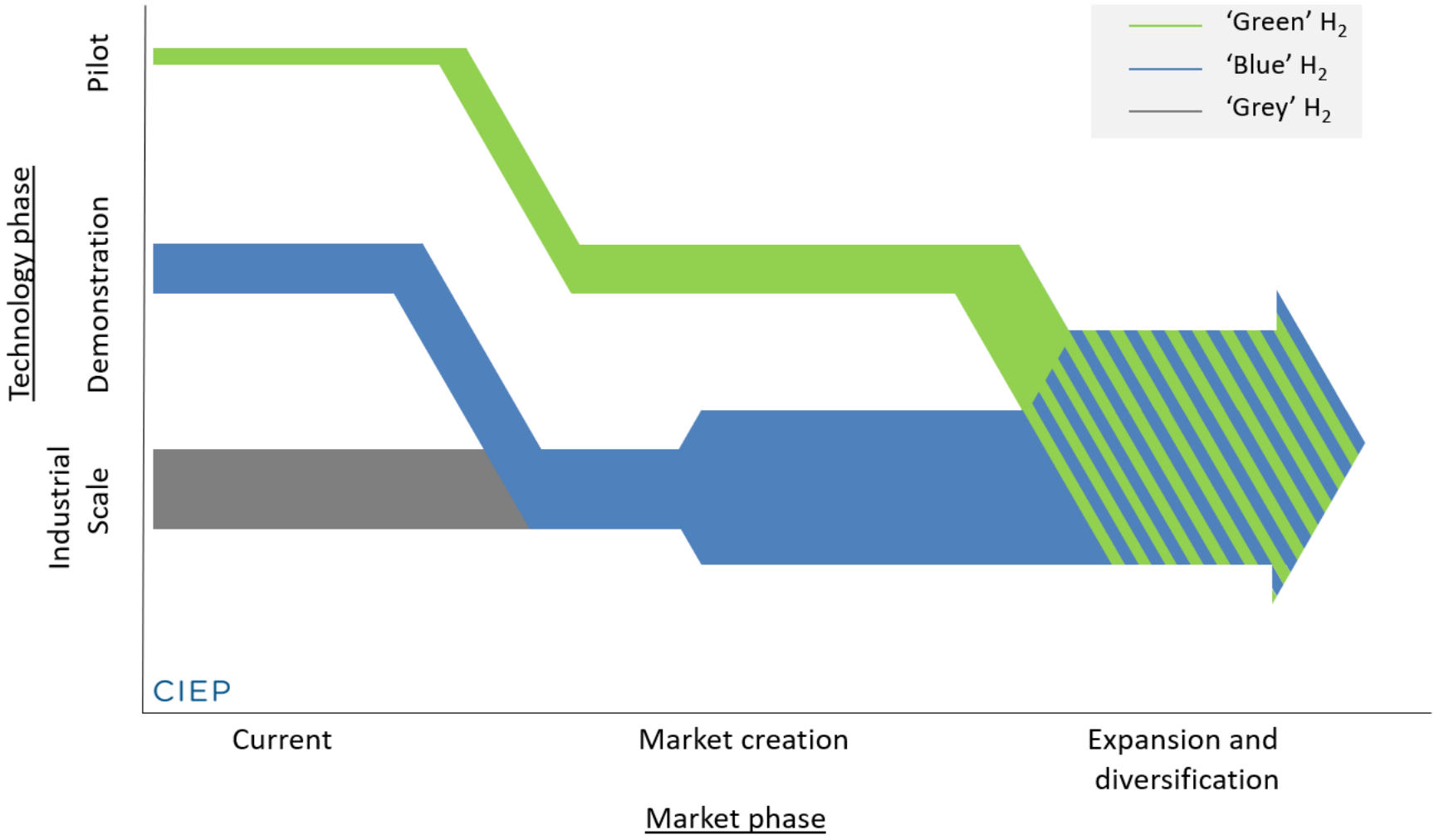
Hydrogen from electrolysis using the grid can help to scale up the technology, but policies temporarily in the way due to mismatch in time



Source: IEA (2019) *The Future of Hydrogen*

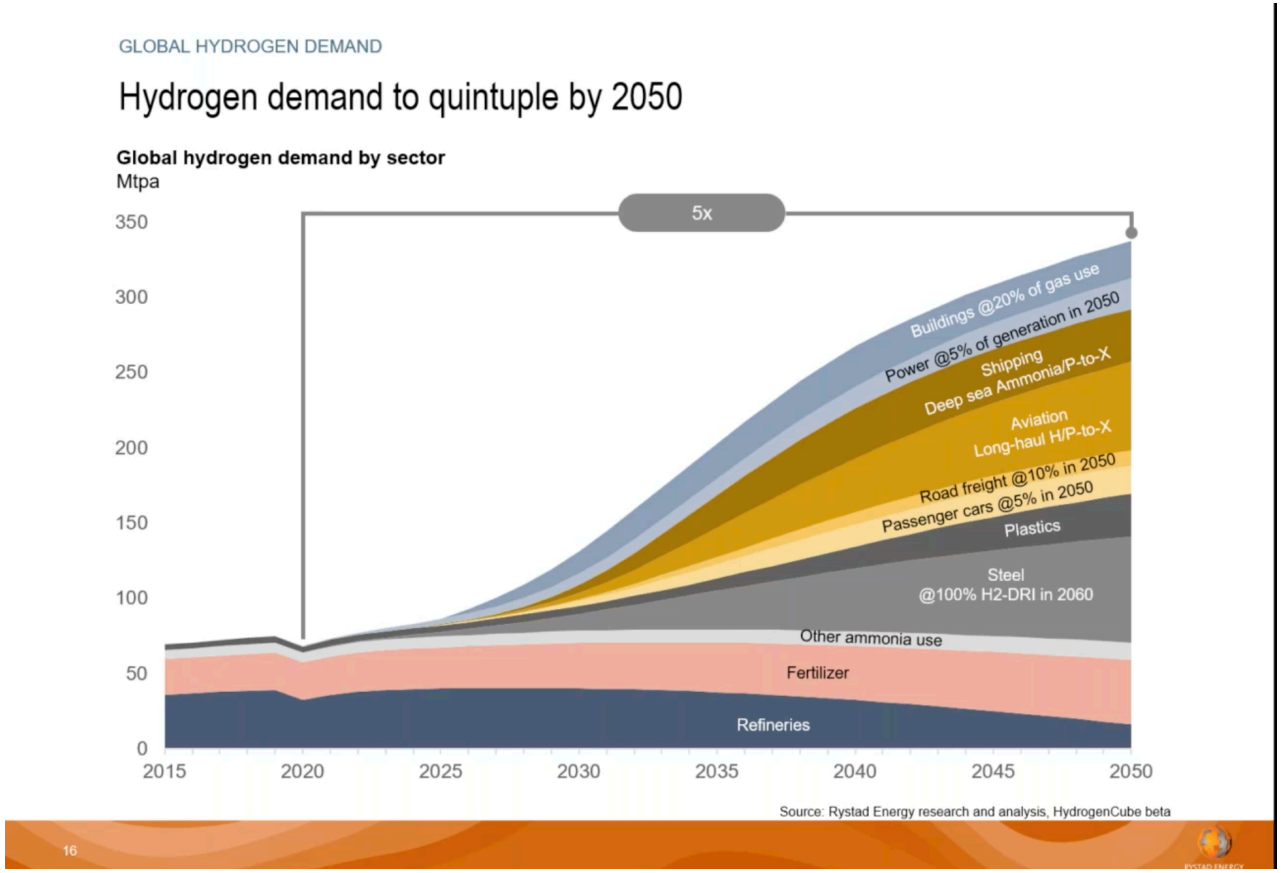
- Electrolysis only clean if low-carbon electricity is used
- With current average power mix, production with natural gas and CCS has lower GHG emissions

The development of a hydrogen market in phases



RLI report: Approach H2 also from a strategic perspective

- International trade opportunities and the potential to create a H2 hub in the Netherlands, using both the location in NW Europe to handle sustainable energy and resource flows
- Geopolitical uncertainties; H2 market will bring more suppliers into the market
- Sustainable Dutch industry
- Promote innovation and also let markets do their work
- Domestic production creates comfort in terms of security of supply



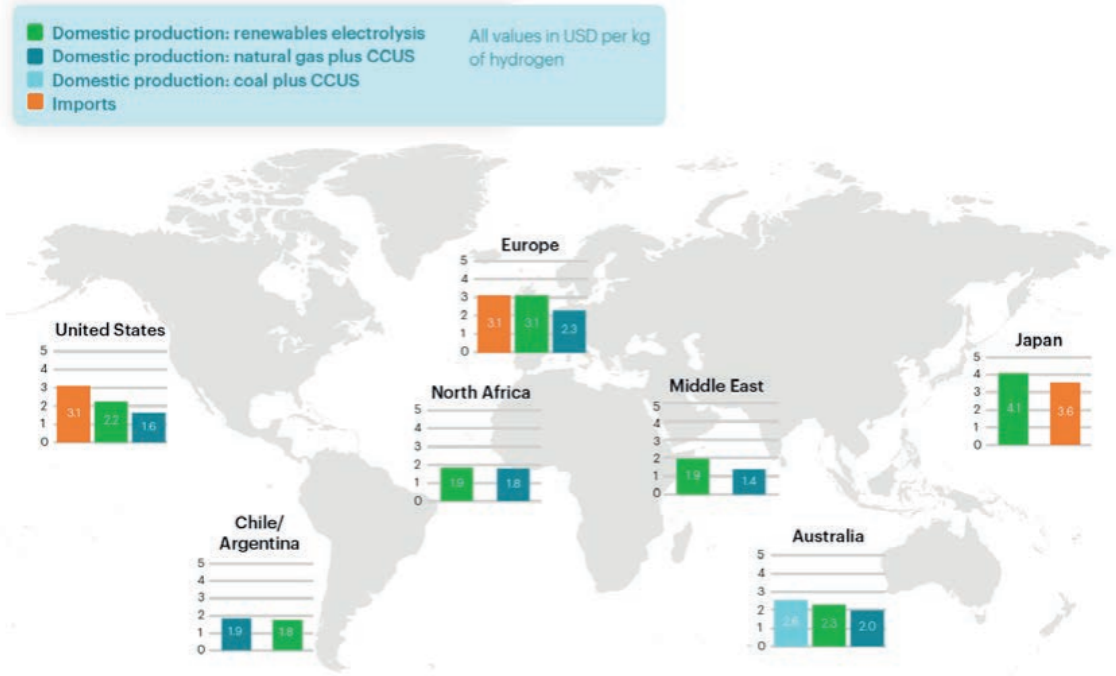
International trade

- Export
  - Trade income, monetizing natural resources/conditions
  - Existing energy-exporters (e.g. Middle east, Australia)
  - New entrants (e.g. North Africa, Chile)
  - Synergies with domestic decarbonization?

- Import
  - Decarbonizing energy imports
  - Diversification of energy supply
  - Cost optimization, hedge with domestic production

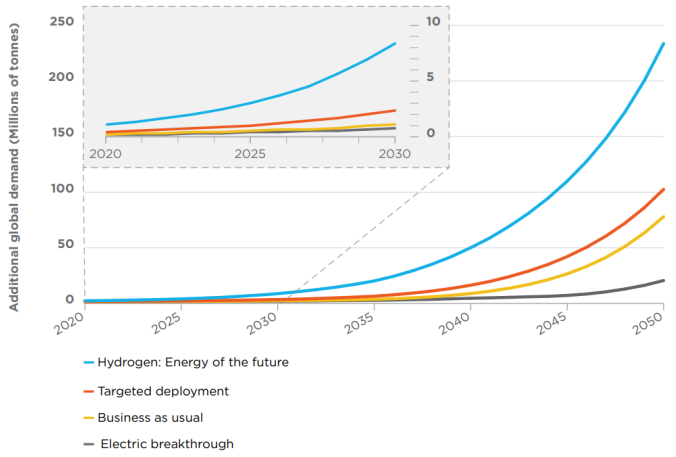
- Developed by e.g. Australia/Japan, Morocco

Routes for hydrogen trading with long-term costs compared to domestic production



Source: IEA, The Future of Hydrogen, 2019

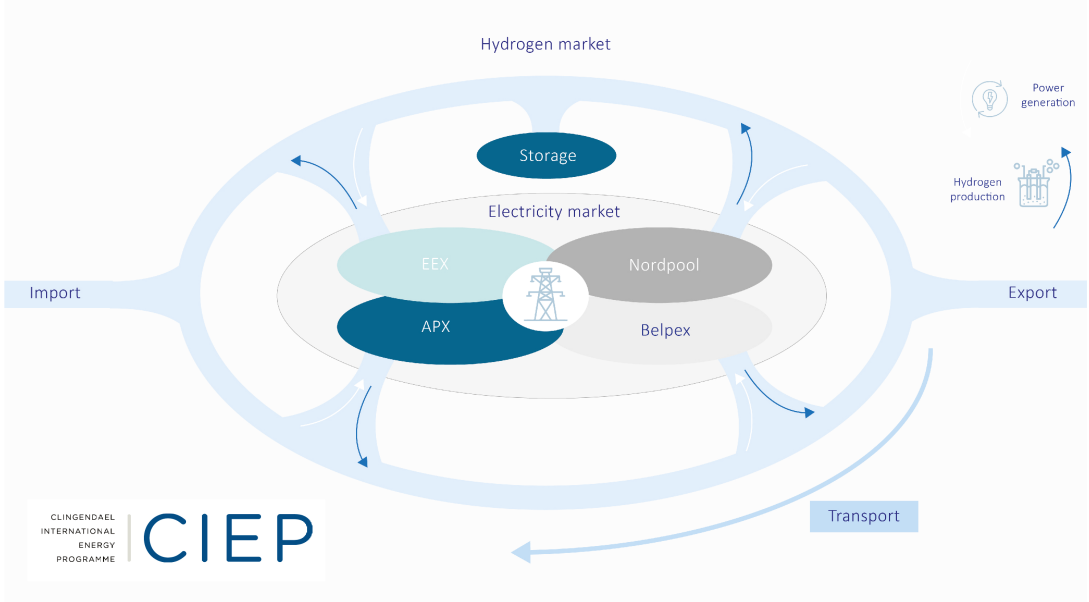
Figure 2.1 Global hydrogen market growth scenario outcomes



How the internal EU E-H2 market could work in the future

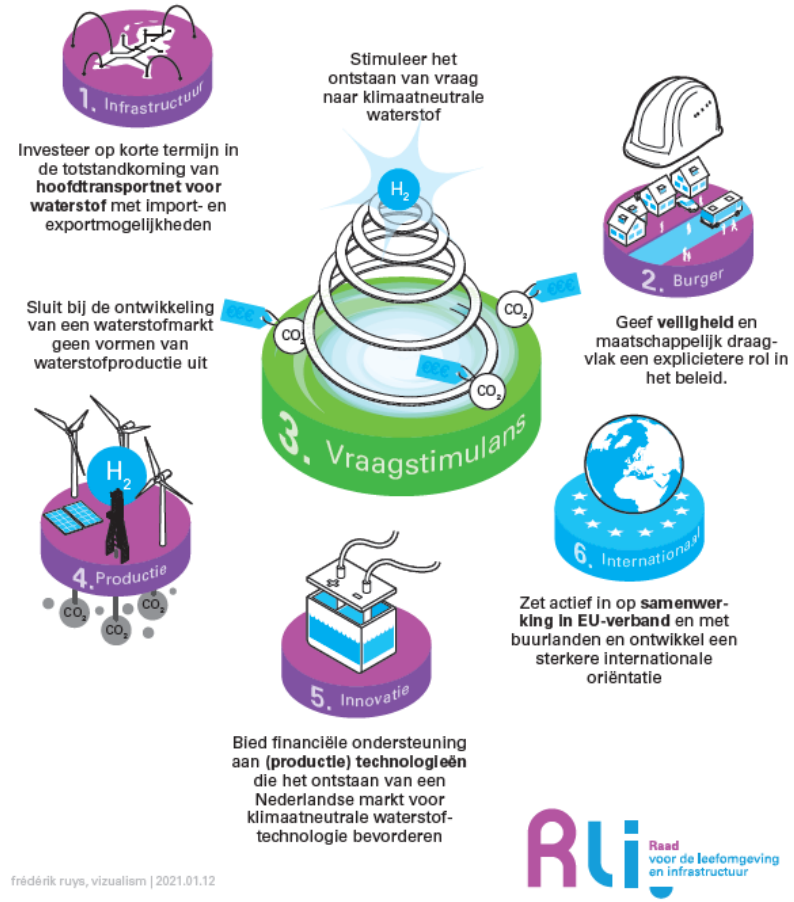
- **A beautiful Day in May:**
  - Much sunshine inland EU, cloudy, little wind coast
  - E imports/exports between markets limited by crossborder transmission capacity
  - Prices diverge---inland E, coast tap into H2 for power generation

- **A Grey Day in November:**
  - Coast much wind, inland no sun, no wind
  - E imports/exports between markets limited by crossborder transmission capacity
  - Price divergence
  - E consumption at coast, H2 in f.i. Germany



Keeping up with ……..our neighbours

- **Large sums earmarked**: France, UK, Germany have earmarked large sums to stimulate their H2 economies. France installed a hydrogen council, the UK a substantial hydrogen investment fund
- **Building back better**: Part of the earmarked investment funds in neighbouring countries comes from the Covid-recovery fund in EU, the Netherlands has yet to apply…
- **Societal cost in the short and long run**: The Netherlands is focusing on the cheapest CO2 emissions avoided, and loses sight of the strategic first big steps to get the H2-ball rolling
- **Market dynamics not always understood** – discussions about earmarking certain production for certain uses may be far too directive- aim is to lower Dutch total emissions- include both heat and transportation
- **Maintain focus on the logic of H2 developments and avoid cherry-picking**: the SDE++ and two investment funds and other arrangements run the risk of losing sight of the important strategic big initiating steps in production, transportation and demand to create the beginnings of a low carbon H2 market



Conclusion

- Clean molecules can help create a clean, reliable and affordable energy system
- Due to scale and current renewable power limitations for ‘green’, a hydrogen pathway along ‘blue’ seems logical but is no excuse not to quickly help scale up ‘green’
- Offshore wind potential, Gas grids and Industrial hubs are opportunities for coastal industrial clusters and their hinterland, like the one in the Netherlands, to kick-start the hydrogen economy, start trading and lower the costs for introducing low carbon H2 in transportation and heating
- Neighbouring countries are quickly catching up in organising their H2-economies, the Netherlands should start moving to realise its plans and become part of the NW European H2 developments
- Domestic supplies, imported supplies, transportation and growing demand for low carbon H2 are all crucial to develop and make H2 available for all types of demand (see RLI report for more details)