THE OXFORD INSTITUTE FOR ENERGY STUDIES

Hydrogen developments around Europe

ERCST webinar
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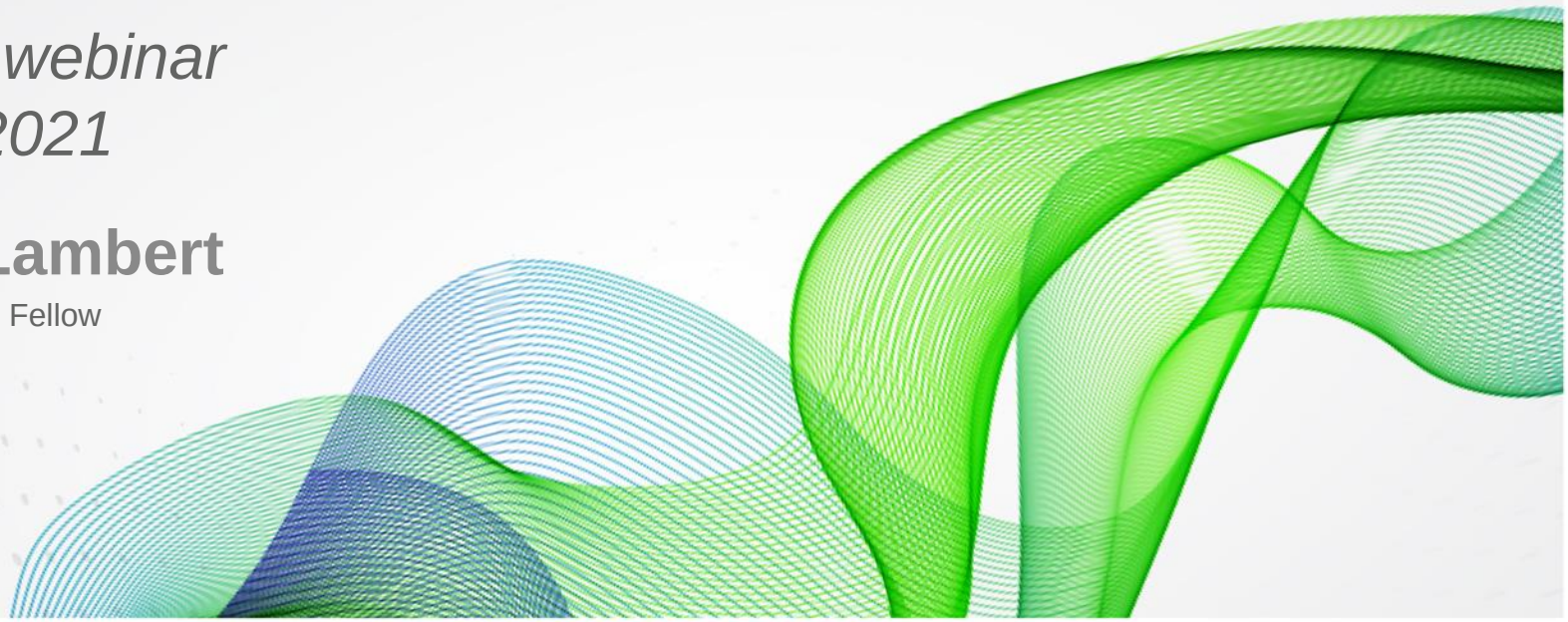


Hydrogen in Europe – approaches vary by country

- Recent paper compares 6 major gas-consuming countries:
  - France
  - Germany
  - Netherlands
  - Italy
  - Spain
  - United Kingdom
- National hydrogen strategies published by 4 countries, while Italy and UK to finalise soon
- Different approaches in different countries (in contrast with natural gas market?)
- Policy approaches still under development
- Very wide range of demand forecasts in all markets even to 2030 and certainly to 2050
- Supply approaches similarly variable

Hydrogen Strategies and Policy Drivers vary by country

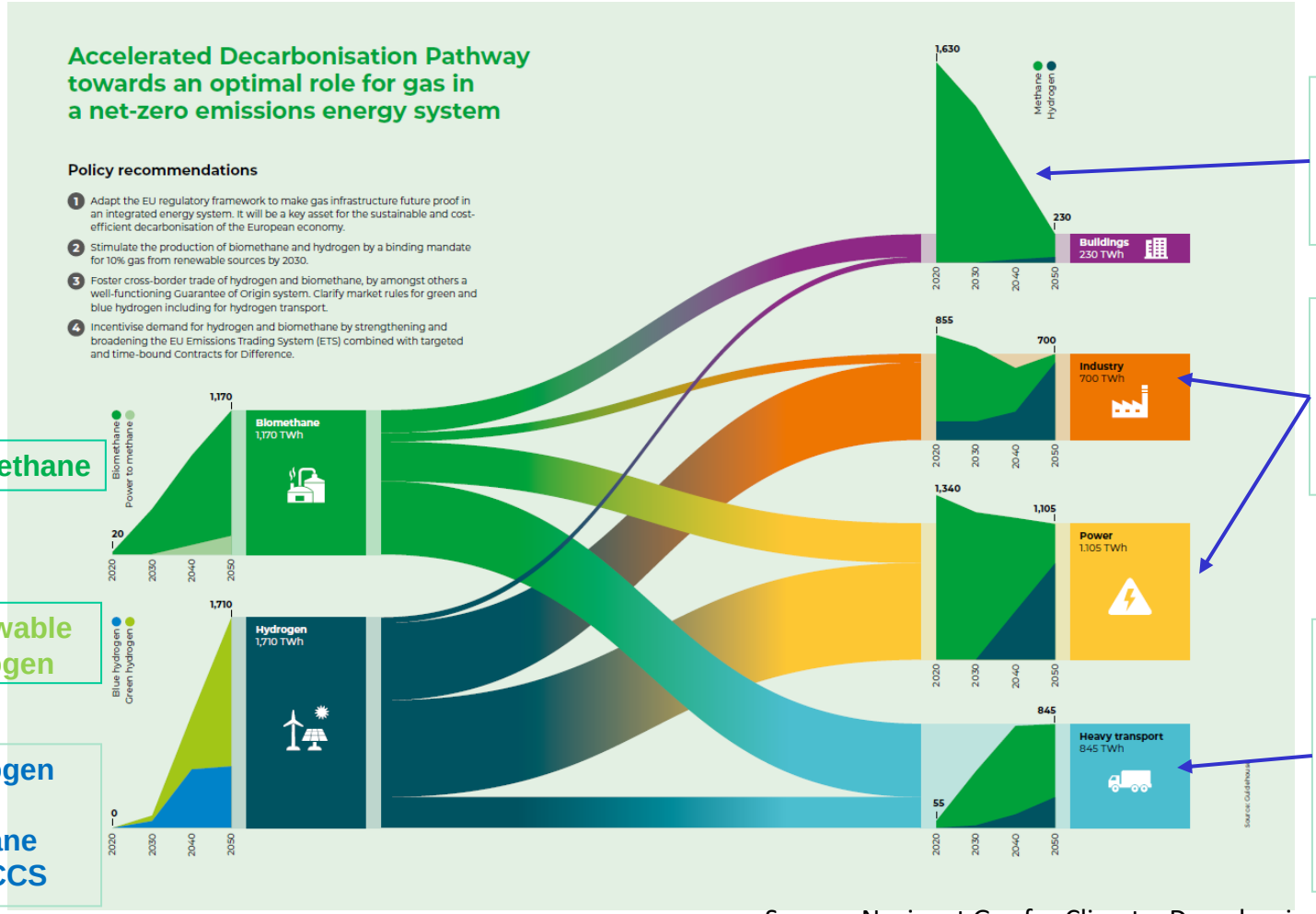
Publication	June 2018 & Sept. 2020	June 2020	March 2020	April 2020	Sept. 2020 (SNAM)	1H 2020 (CCC)
H2-Technology						
Technology Leadership						
Hydrogen for export						
Imports of hydrogen						

Source: Authors' analysis of country publications

- **Italy published "preliminary guidelines for a national hydrogen strategy" Dec 2020 – final version expected soon**
- **UK "Ten Point Plan for a Green Industrial Revolution Nov 2020" – Hydrogen strategy expected by mid-2021**
- **Green hydrogen long term goal, with blue hydrogen (UK / NL), nuclear powered hydrogen (France) as stepping stones**
- **Contrasting views on potential cross border trade**

Hydrogen in context of other gaseous fuels

No role for unabated natural gas in Europe by 2050: Growing consensus on significant role for renewable gases



Biomethane

Renewable Hydrogen

Hydrogen from Methane with CCS

Significant decline of methane use in buildings – hybrid heat pumps?

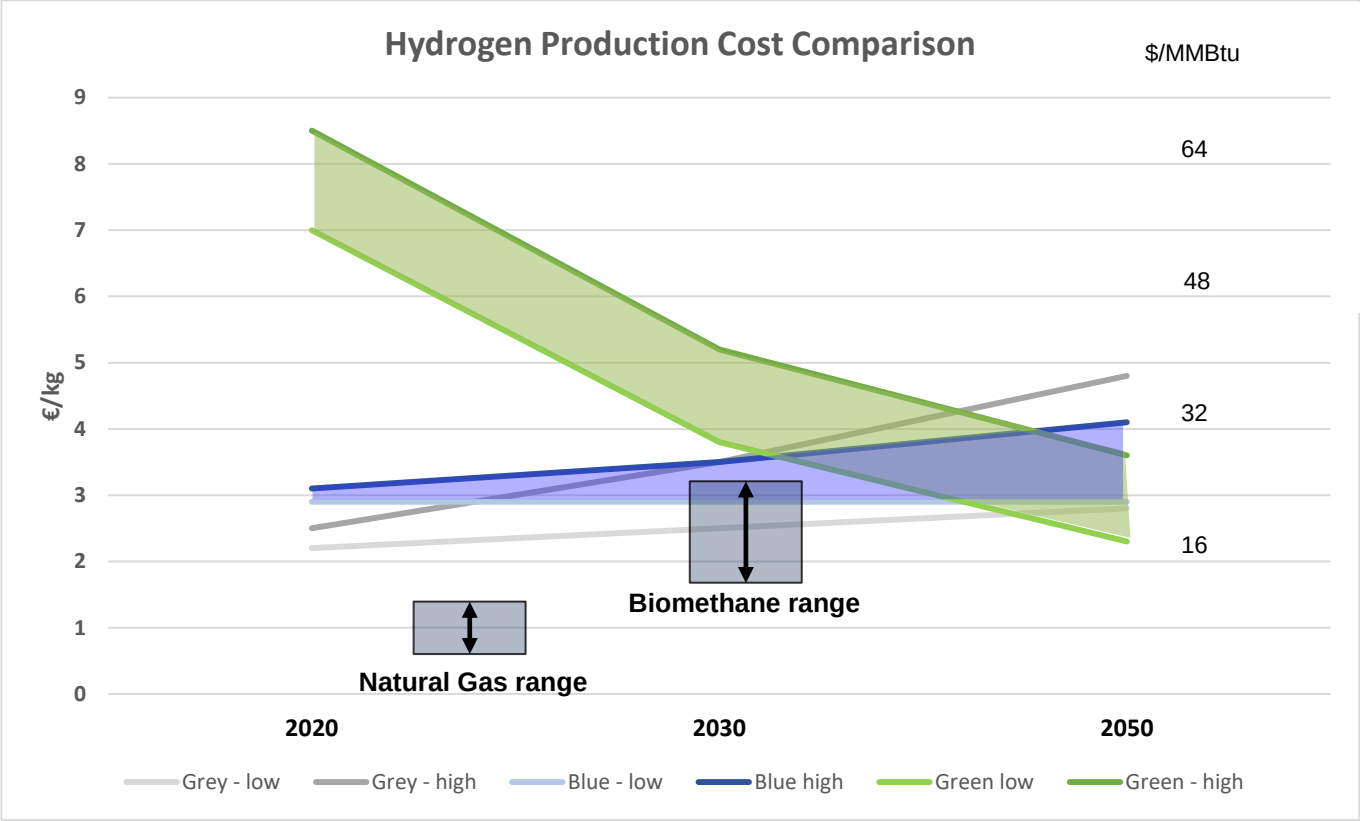
Industrial use and balancing power grid shifts from methane to hydrogen

Overoptimistic view of potential role of gas in transport?

Current policy tends to support renewable gas in transport

Source: Navigant Gas for Climate, Decarbonisation Pathways April 2020

Green and Blue hydrogen costs expected to converge …but at a premium to methane



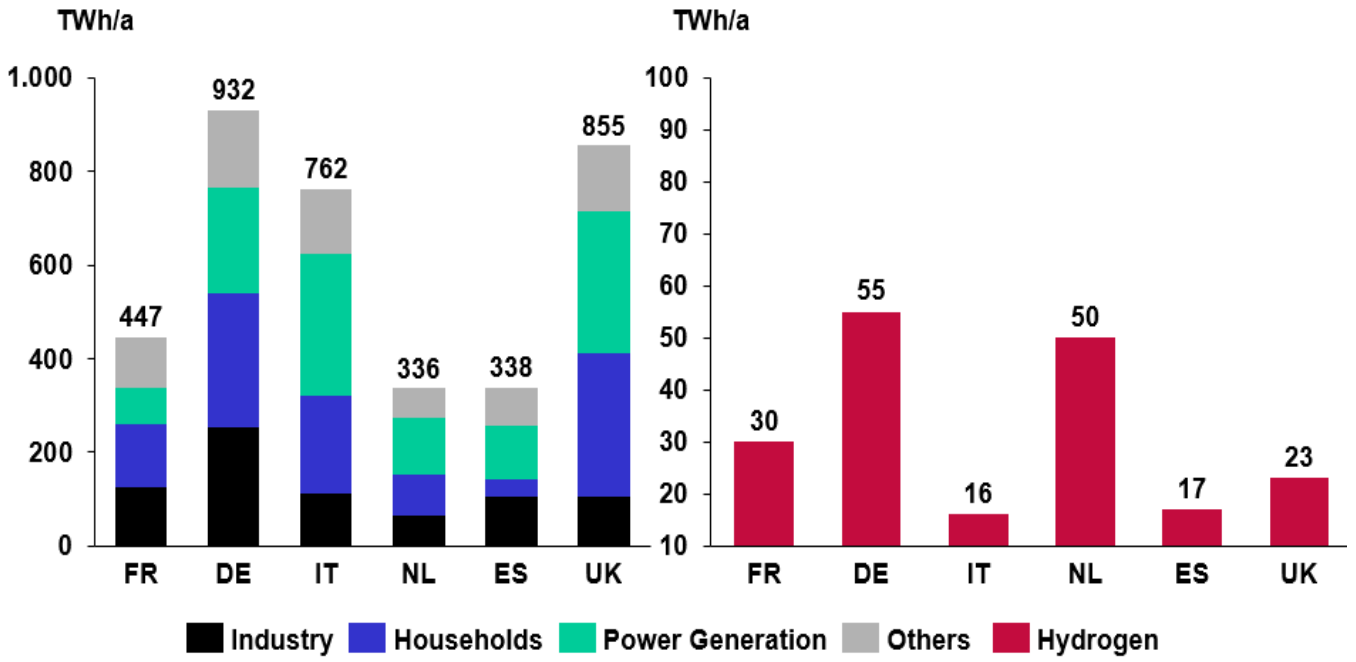
- Green hydrogen currently small scale and high cost
- Blue hydrogen relatively small premium over Grey

"Grey" = SMR without CCS
"Blue" = SMR with CCS
"Green" = Electrolysis from renewable energy

1 EUR/kg =~25 EUR/MWh
= ~ 8$/MMBtu

Source: OIES analysis, Zero Emissions Platform Nov 2019, includes assumed carbon price

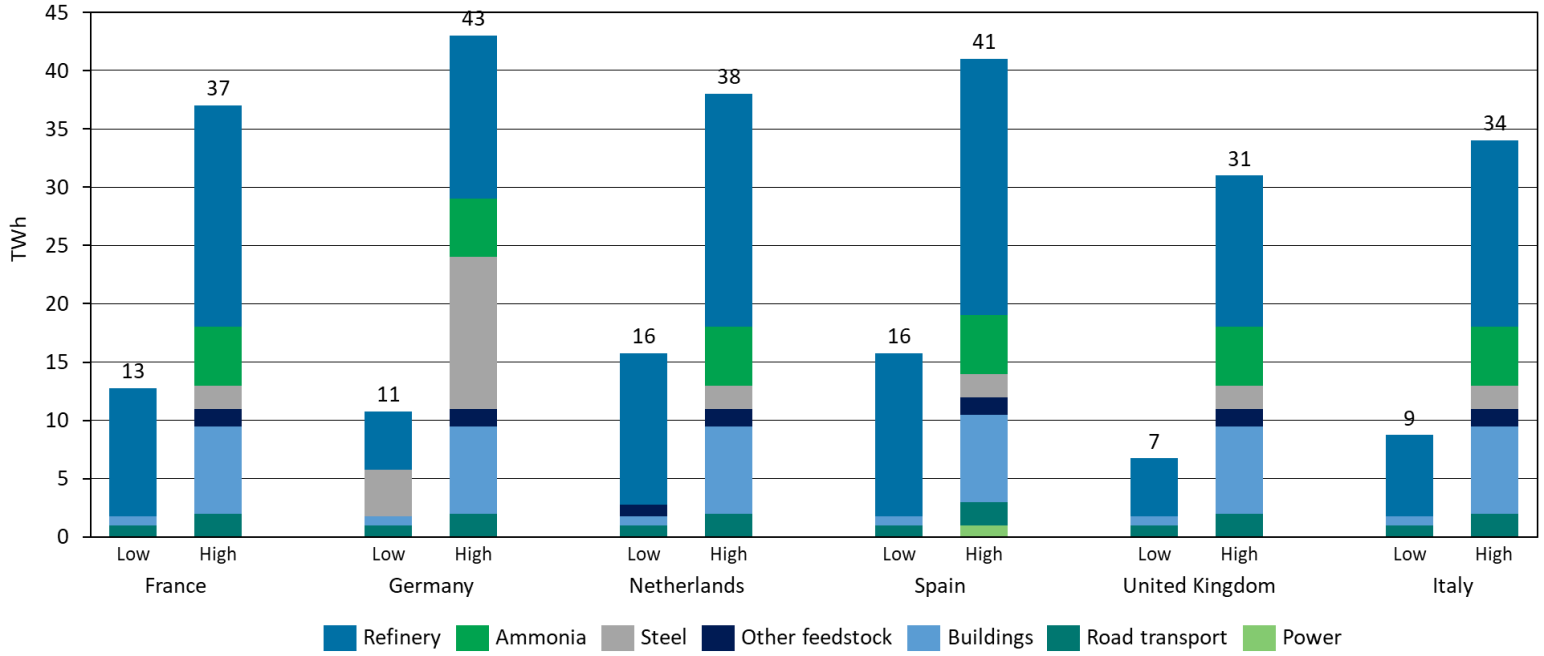
Significant hydrogen demand already exists



Source: Eurostat / Authors' analysis

- … particularly in Germany and Netherlands, but an order or magnitude less than current natural gas demand
- Nearly all in industrial sector: oil refining, petrochemicals, ammonia for fertiliser
- >95% produced from fossil fuels (either integrated with oil refining or from Steam Methane Reforming of natural gas).
- ~10 tonnes CO_2 per tonne hydrogen

Incredibly wide range of low hydrogen demand forecast for 2030 – just 9 years away!



Source: authors' analysis of FCH JU (Aug 2020)

- Wide range driven by varying assumptions of hydrogen penetration by demand sector (e.g. buildings 0.75 to 7.5% penetration, transport 1 to 2%, ammonia 0 to 5%)
- Even top of range is not significantly more than current grey hydrogen demand
- Volume of demand will not constrain low-carbon hydrogen supply
- Priority to create viable business cases for large scale low-carbon hydrogen production (1GW capacity at 3000 full load hours = 3TWh per year)

Hydrogen Market Model not yet clear

- Government policy needs to drive move away from fossil fuels – otherwise no commercial business case
- Similarities to early days of gas / LNG business?
  - Large infrastructure investments paid back over several years
  - Long-term contracts underpin revenue stream (with take or pay?)
  - Investments by joint ventures to spread risk
  - Revenue from creditworthy entities (governments / large utilities)
  - Often direct negotiation with governments
- Additional risks to be managed, e.g.:
  - Uncertain carbon pricing – who pays? Carbon Contracts for Differences?
  - Revenue stream dependent on government policy – stability guarantees?
  - Subsequent projects likely to be significantly lower cost – auctions for government support?
  - Long-term risk of CO_2 sequestration – low probability / high impact?
- Little similarity with liberalised (well-established) gas markets
- **Too many options?**

Thank You! / Q&A

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