Hydrogen in energy decarbonisation scenarios; focus on industry

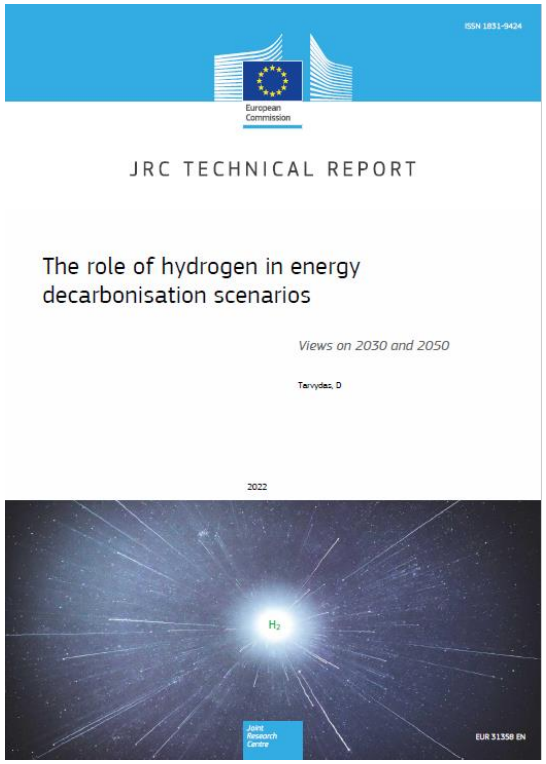
European Energy Network: Decarbonising Industry Webinar

9 March 2023

José Moya
Energy Transition Insights for Policy
Joint Research Centre

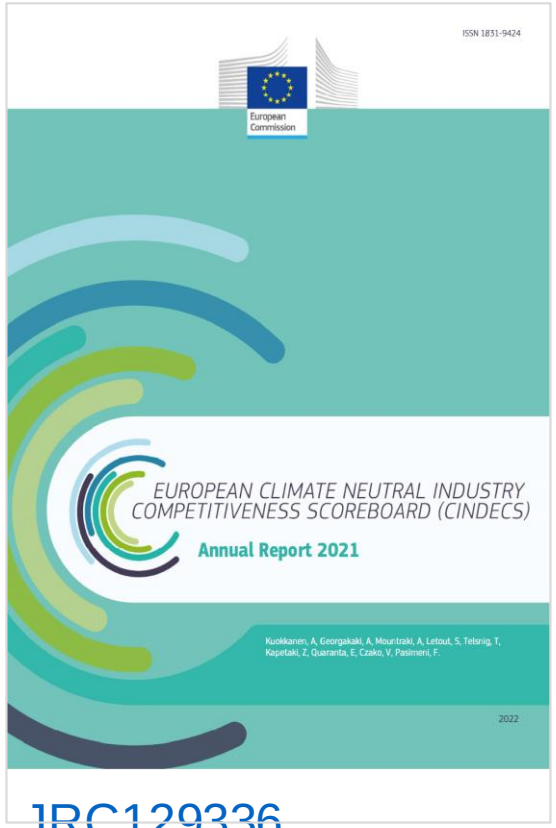
European

JRC reports in support of a decarbonised industry



[JRC131299]

[JRC127468]



[JRC129336]

[JRC130663]

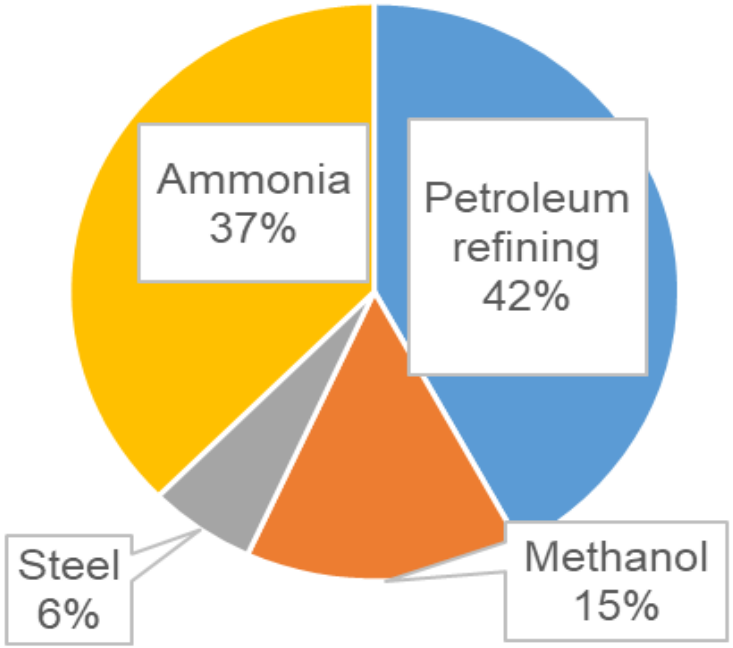
Other JRC reports on energy scenarios: [JRC118952], [JRC127122]

European Commission

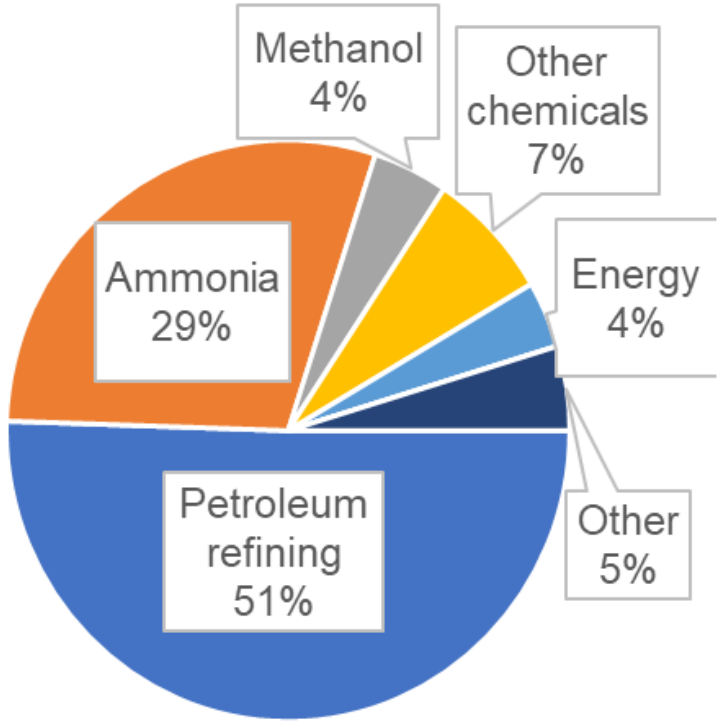
Increasing presence of hydrogen

- In last few years hydrogen became part of (almost) every energy future
- All new major energy scenario studies see a role for hydrogen
- The **EU hydrogen strategy** was published in 2020 COM(2020)331
- **10 of G20** members have hydrogen strategy. Another **8 in progress**
- **19 EU member states** have a hydrogen strategy
- (At least) **19** dedicated **hydrogen studies** were published last year
- Accelerating hydrogen in **REPowerEU** COM(2022)230
- Over 80 million web pages on hydrogen were created/updated last year

2020 hydrogen demand, global (left) and EU (right)



87 Mt

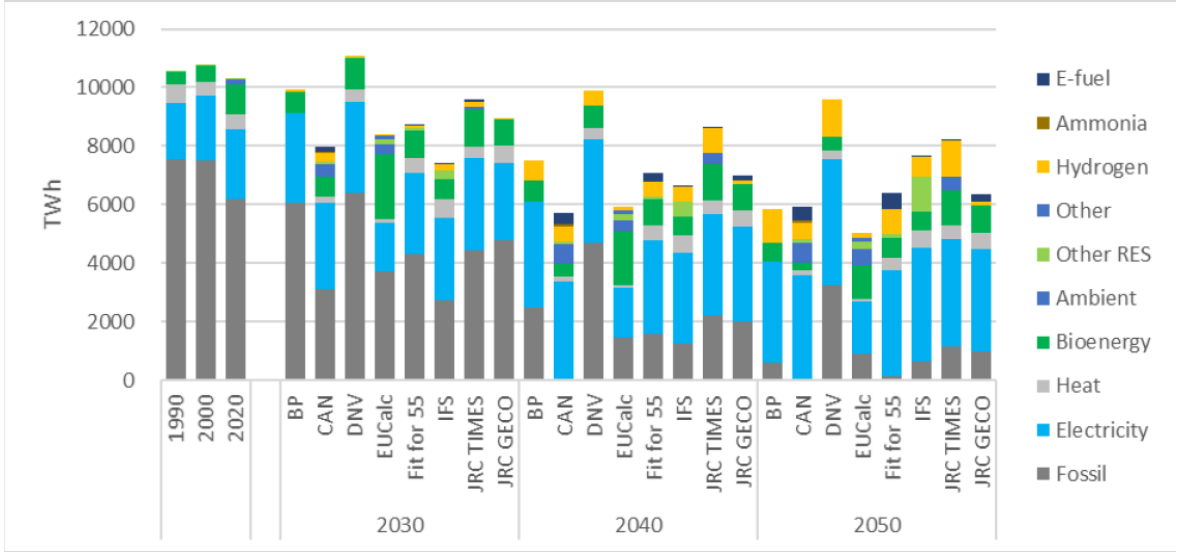


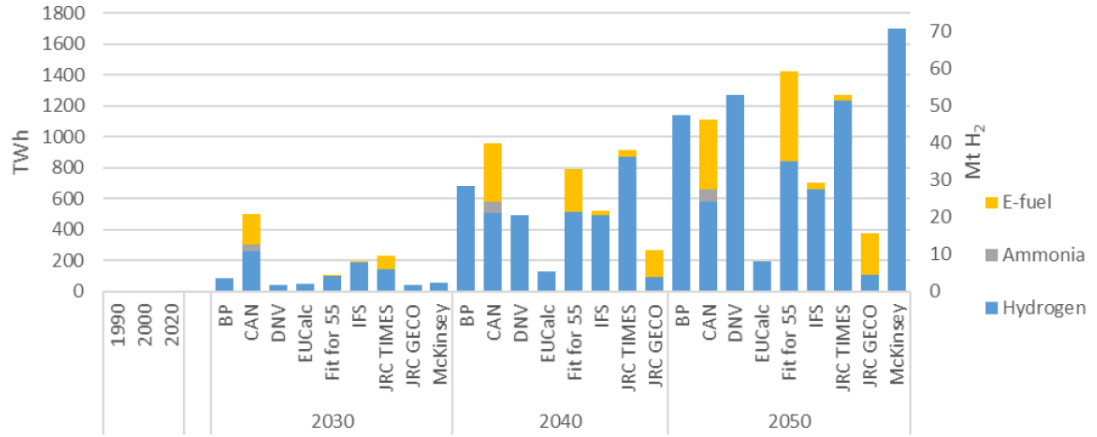
8 Mt

Source JRC (JRC131299)

European Commission

EU final energy demand

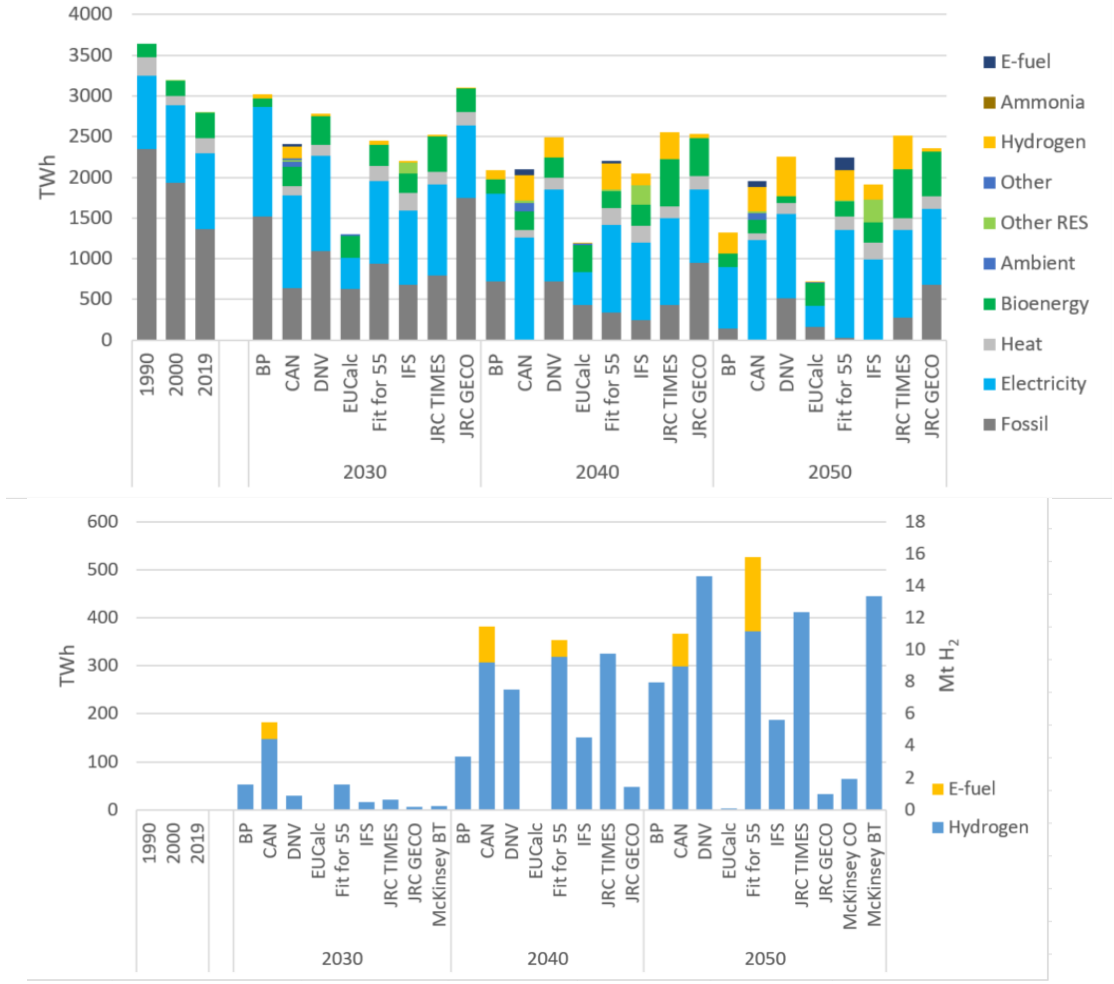




- There is a clear agreement on a decrease in final energy demand in the future, not in the intensity of the decrease.
- In 2030 hydrogen share ranges from 0.3% to 7.0% of final energy demand.
- In 2050 hydrogen share ranges from 1.5% to 19.8% in final energy demand

Source JRC (JRC131299)

EU hydrogen demand in industry

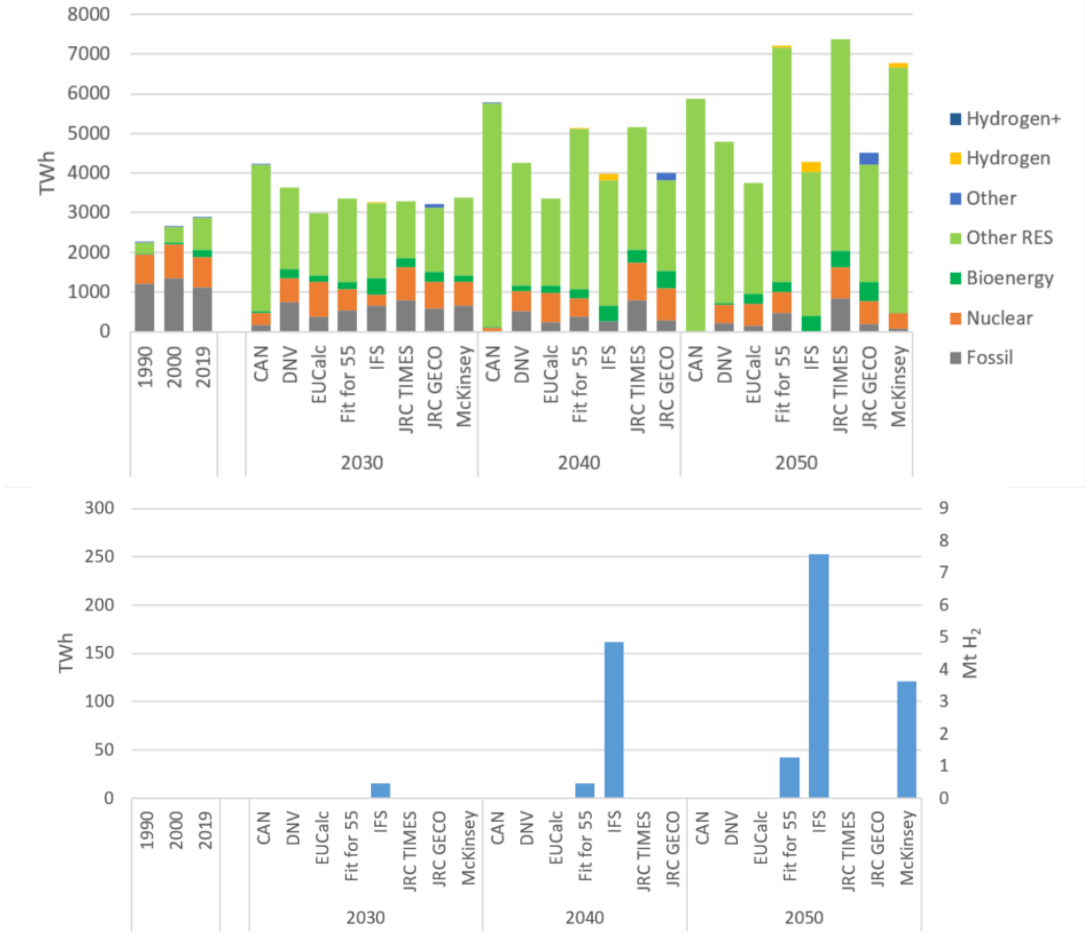


- Scenarios foresee an decrease in the energy demand in industry
- In 2030 hydrogen share ranges from 0% to 2% of final energy demand
- In 2050 hydrogen share ranges from 1% to 34% in final energy demand

Source JRC (JRC131299)

European Commission

Hydrogen in EU power generation



- All scenarios foresee an increase in power generation
- In 2050 90+% of power is low carbon, dominated by wind and solar
- Hydrogen power generation is available only in a limited number of scenarios
- While in absolute terms hydrogen usage for power generation is insignificant, it is essential for renewable integration

Source JRC (JRC131299)

Electrolysers capacity required in the EU

- By 2030, using 100% green hydrogen, the electrolyser capacity required to supply 500TWh of hydrogen amounts to around 260-300 GW.
- By 2030, to meet a maximum hydrogen demand of 957 TWh will require between 500-550GW of electrolyser capacity.
- By 2050, electrolyser capacities between of 700-800 GW and 1200-1400 GW will be required to satisfy an average and maximum hydrogen demand of 1600TWh and 2700TWh,.

Source JRC (JRC131299)

European Commission

Momentum shift in the steel industry towards decarbonisation

- All 5 top global steelmakers have net-zero targets:

Company	HQ location	2019 production (Mt)	2050 target
ArcelorMittal	EU	97	✓
Baowu	China	95	✓
Nippon Steel	Japan	52	✓
HBIS Group	China	47	✓
POSCO	South Korea	43	✓

Source: JRC

- But none of the next 15 largest steelmakers (mostly from China)

- In the EU, there is a clear trend towards hydrogen-based steelmaking:

Company	Country	Current primary steel capacity in EU (Mt)	Announced strategy
ArcelorMittal	Several	47	2030: Hydrogen + CCUS 2050: Hydrogen DRI
Thyssenkrupp	Germany	12	2030: CCUS + DRI 2050: Hydrogen DRI
Voestalpine	Austria	8	Hydrogen DRI
Tata Steel	Netherlands	8	Hydrogen DRI
SSAB	Sweden Finland	7	Hydrogen DRI
Salzgitter	Germany	5	Hydrogen DRI

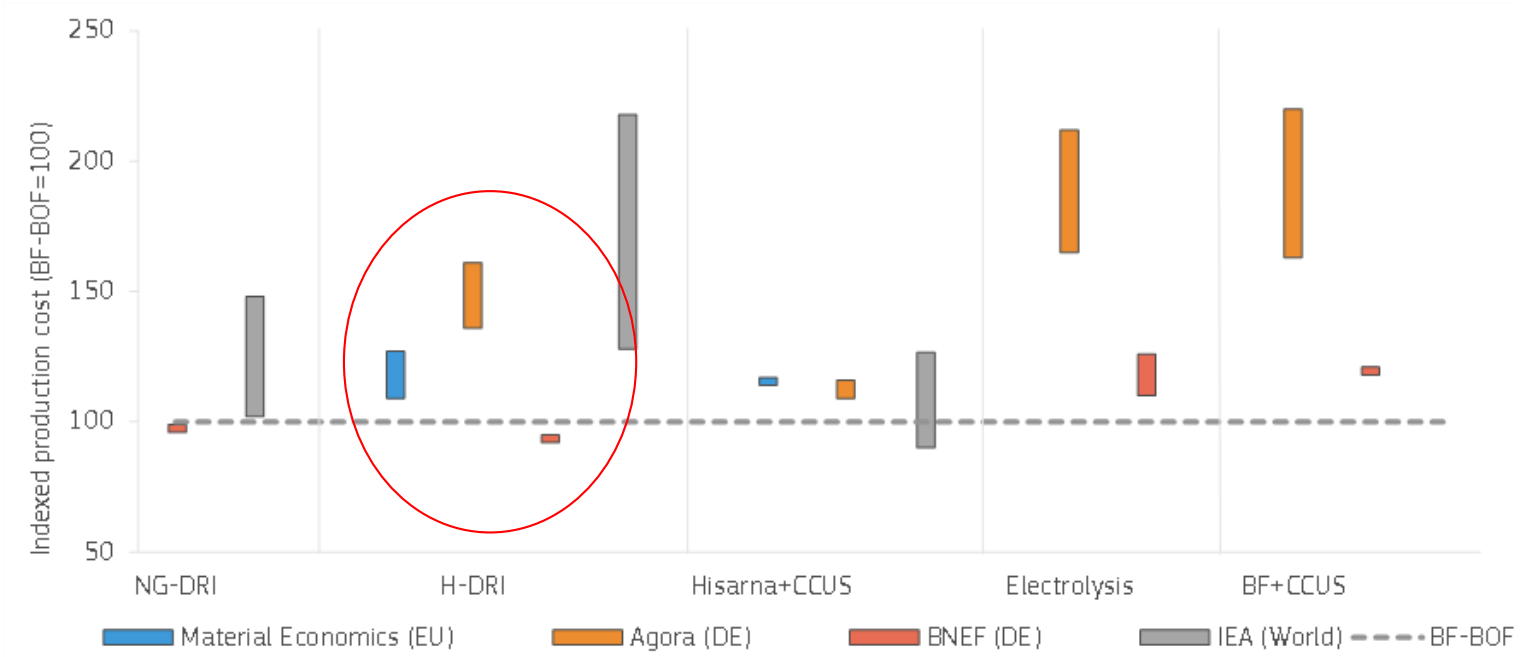
Source: JRC

Source JRC (JRC127468)

Future costs of low-CO_2 technologies for steel production

- Wide range
- Main variable: future cost of green H_2 and electricity (up to 45% of total cost)
- CapEx substantial: EUR 70-100 bn needed by 2050

Comparison of future levelised cost of low-CO_2 primary steel production technologies, indexed to current BF-BOF cost, from external sources



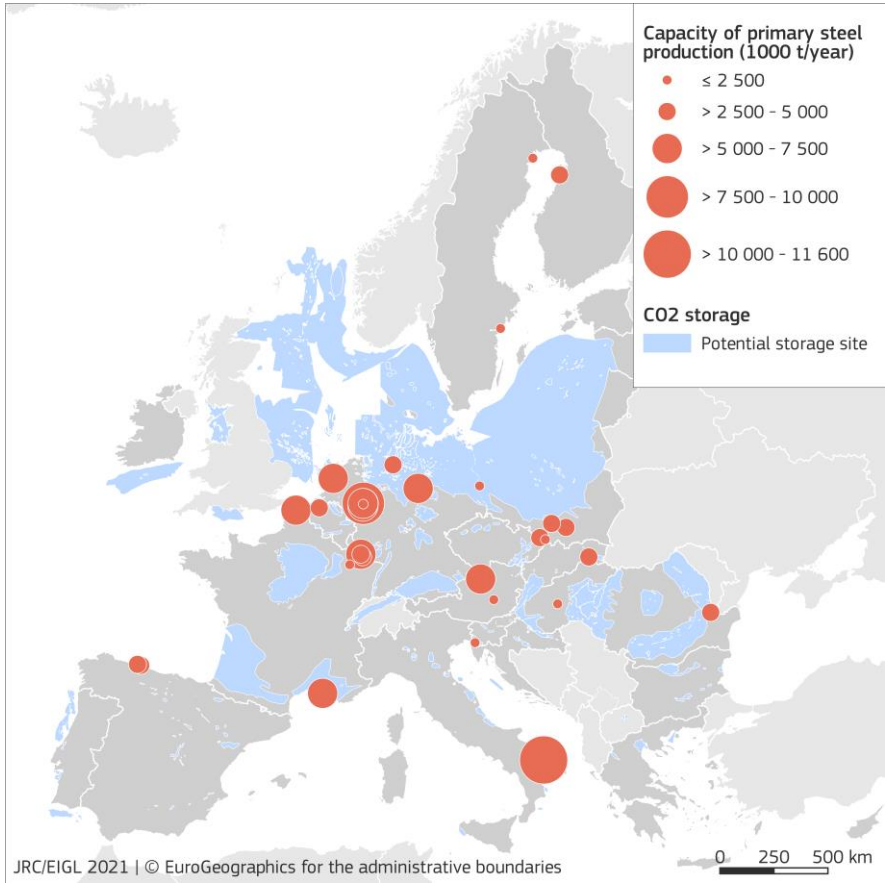
Source: JRC based on Agora Energiewende and Wuppertal Institute, 2021, BNEF, 2021; IEA, 2020; Material Economics, 2019

Source JRC (JRC127468)

European Commission

CCUS for CO_2-free primary steel as alternative for H-DRI

- Possible to retrofit, but with extensive process modifications
- >75% CO_2 reduction difficult
- CCU projects valorise CO_2 for synfuels and chemicals: full life-cycle needs to be considered!
- 6 projects in EU



Source: JRC/Energy and Industry Geography Lab

European Commission

Main messages

- Despite **current hydrogen** consumption is like **feedstock**, most of the expected consumption will take place as part of the final energy demand (in **industry** also for process requiring **high-temperature heat**).
- The challenges to accomplish the transformation: practically **non-existing transport infrastructure** and the required **electrolysers capacity**:

	on average	maximum demand
By 2030	260-300 GW	500-550 GW
By 2050	700-800 GW	1200-1400 GW

- Decarbonising the production of current hydrogen consumption as feedstock in industry can act like the spearhead of the new generation of electrolysers capacities.

Main messages (cont)

- European Climate Law: Climate neutrality by 2050
- Industrial assets have long lifetimes (20+ years for steel 40+ for cement). Reinvesting into current processes risks locking in emissions until 2050 or creates future stranded assets
- Current plants need to be replaced with low-CO_2 technologies: requires big investment decisions to be made this decade.
- Hydrogen is most promising decarbonisation option for the steel industry, though CCUS cannot be disregarded.

Keep in touch

EU Science Hub
joint-research-centre.ec.europa.eu

@EU_ScienceHub

EU Science Hub – Joint Research Centre

EU Science, Research and Innovation

EU Science Hub

@eu_science

European Commission

Thank you

European Commission

Main messages (cont)