Linde

Enabling the energy transition

June 2022

Making our world more productive

Introduction to Linde

- The leading industrial gases and engineering company, combining technology and operational excellence
- Formed in 2018 with the merger of Linde AG and Praxair, Inc – two world-class companies with nearly 140 years of shared history and successful achievements
- Best-in-Class Safety Performance

Our Mission

We live our mission of **making our world more productive every day**. Through our high-quality solutions, technologies and services we are making our customers more successful and helping to sustain and protect our planet.

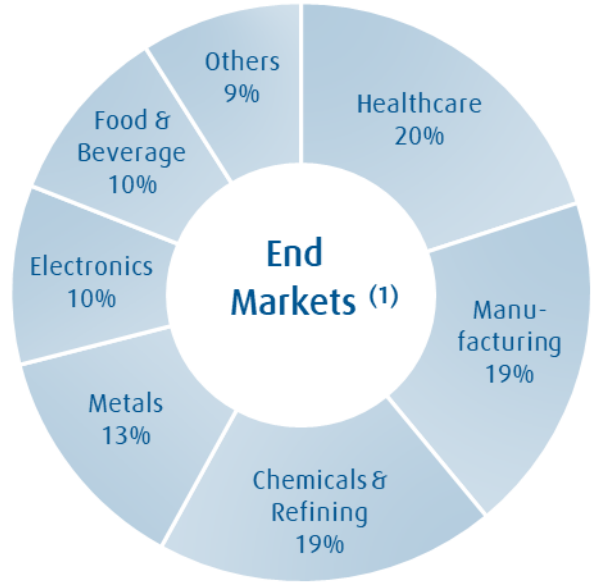
100+
countries
Enabling strong, complementary positions in all key geographies and end markets

~75,000
employees
Achieving our full potential, individually and collectively

$27 billion
2020 sales
Established presence where customers are and where their operations are growing

6,500+
active patent assets worldwide
Leading with innovative products, solutions and technologies

2020 SALES



(1) Total sales excluding Linde Engineering

Linde's success

Based on engineering and operation synergies

Linde Engineering
Technology focused

Air Separation

Hydrogen/Syn Gas

Olefins

Natural Gas

6,100 engineers

5,600 operators

Leveraging Synergies

Linde Gas On-site Business
World class operations

HyCO Tonnage Plants

ASU Tonnage Plants

CO2 Plants

ECOVAR Std Plants

— Position as technology leader with full EPC capability is advantage over other gas companies.

— Complements engineering know-how with the operational expertise required to design and run plants reliably.

— Symbiosis in both directions: Gas Division is the Engineering Division's biggest customer.

Linde owns & operates >1500 production plants worldwide and thereof >500 production plants in EMEA

>400 On-site Production Sites

Thereof EMEA approx. 110 Sites

35 countries with On-site production

Thereof in EMEA 21 countries

Approx. 5000 Operations Personnel

Thereof EMEA approx. 1300 Personnel

>350 ASUs

Thereof EMEA approx. 160 ASUs

>90 HyCO plants

Thereof EMEA approx. 50 HyCOs

>950 ECOVAR plants

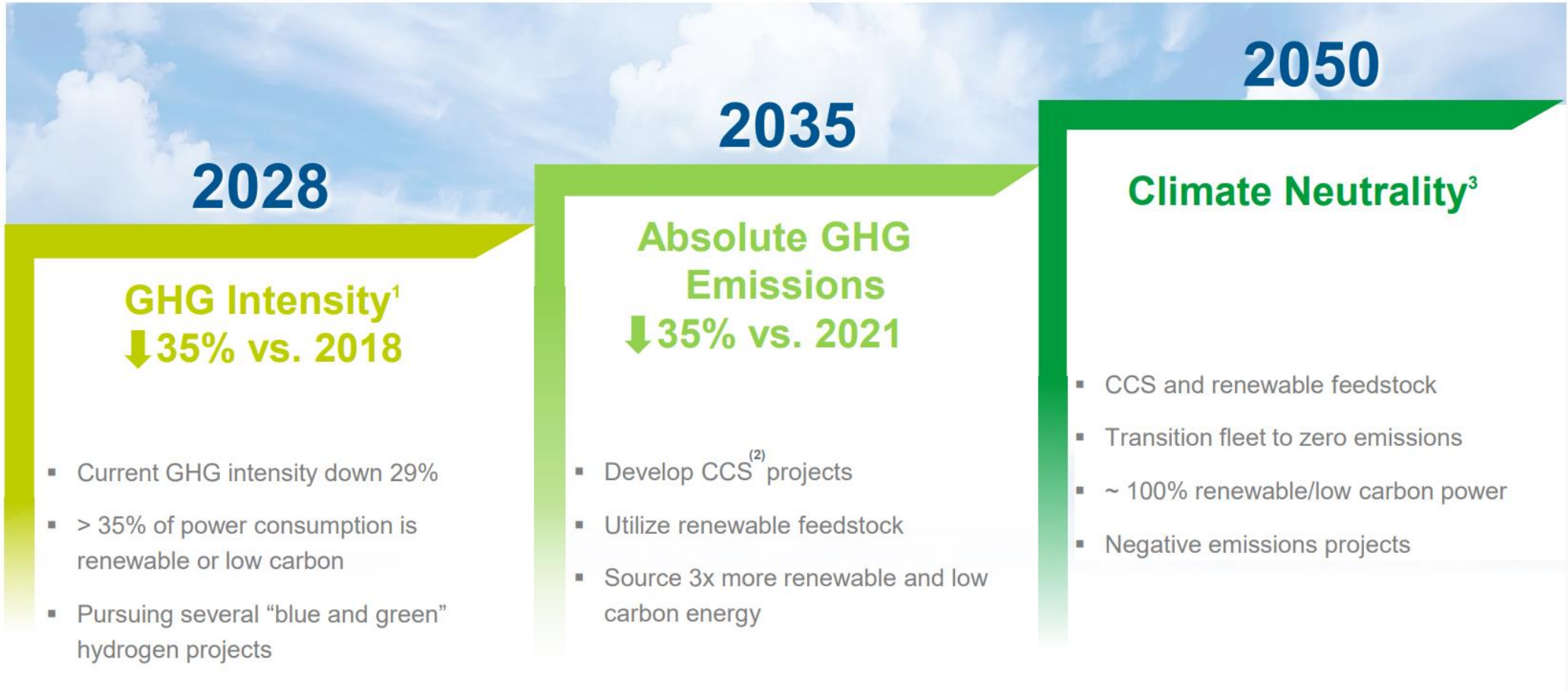
Thereof EMEA approx. 400 ECOVARs

>150 CO2 plants

Thereof EMEA approx. 40 CO2 plants

4

Introduction to Linde
Roadmap to Climate Neutrality



Aligned with the Paris Accords

1) GHG emissions / Adj. EBITDA; 2) Carbon capture and sequestration; 3) Requires strong policy and regulatory support

Linde is uniquely positioned across the Clean Energy value chain

Grey H_2 | Blue H_2 | Green H_2 | H_2 Distribution, Conditioning & Application

	H_2 Inputs	H_2 Production	H_2 Distribution	H_2 Conditioning
Clean Energy value chain	Natural Gas	SMR, ATR... ...with CCS	Liquefication, Trailers, Pipelines, Underground storage	H_2 refueling stations, Equipment & Tech Offerings
	Renewable Power, Water	Electrolysis		
Linde's Clean Energy Role	Partner	**Leader in all production** technologies	**Leader in all distribution** (technology & scale) incl. H_2 cavern	**Leader in H_2 fueling**

50+ years experience

World-class technology

150+ SMR / PSA

80+ electrolyser

1,000 km+ pipeline

1,600+ trailers

200+ refueling stations

170 TPD+ LH2

$2+ billion in H2 sales

Linde is a leader across the value chain, agnostic to the hydrogen color, and uniquely positioned with leading technology in all segments

Source: Linde Analysis

Hydrogen Fueltech GmbH for hydrogen mobility

Decarbonize transportation.

Linde subsidiary (100%), supplier of hydrogen infrastructure solutions
⇨ reliable H2 supplies through state-of-the-art fueling station systems

Compression
(ionic compressor)

Pumping
(cryo-pump)

Stand-alone dispenser
(350/700 bar)

Integrated dispenser
(700 bar mobile fueling)

Service/Maintenance
(smart operation)

✓ >160 fueling stations installed worldwide

Supply for H_2 cars

✓ Supplier of the world's biggest hydrogen bus depot in California

Supply for H_2 busses/trucks

✓ >1.5 million fuelings of cars, buses & forklifts

Supply for H_2 forklift trucks

✓ Supplier of the world's first H_2 station for passenger trains

Supply for H_2 trains

Membranes at Linde Engineering

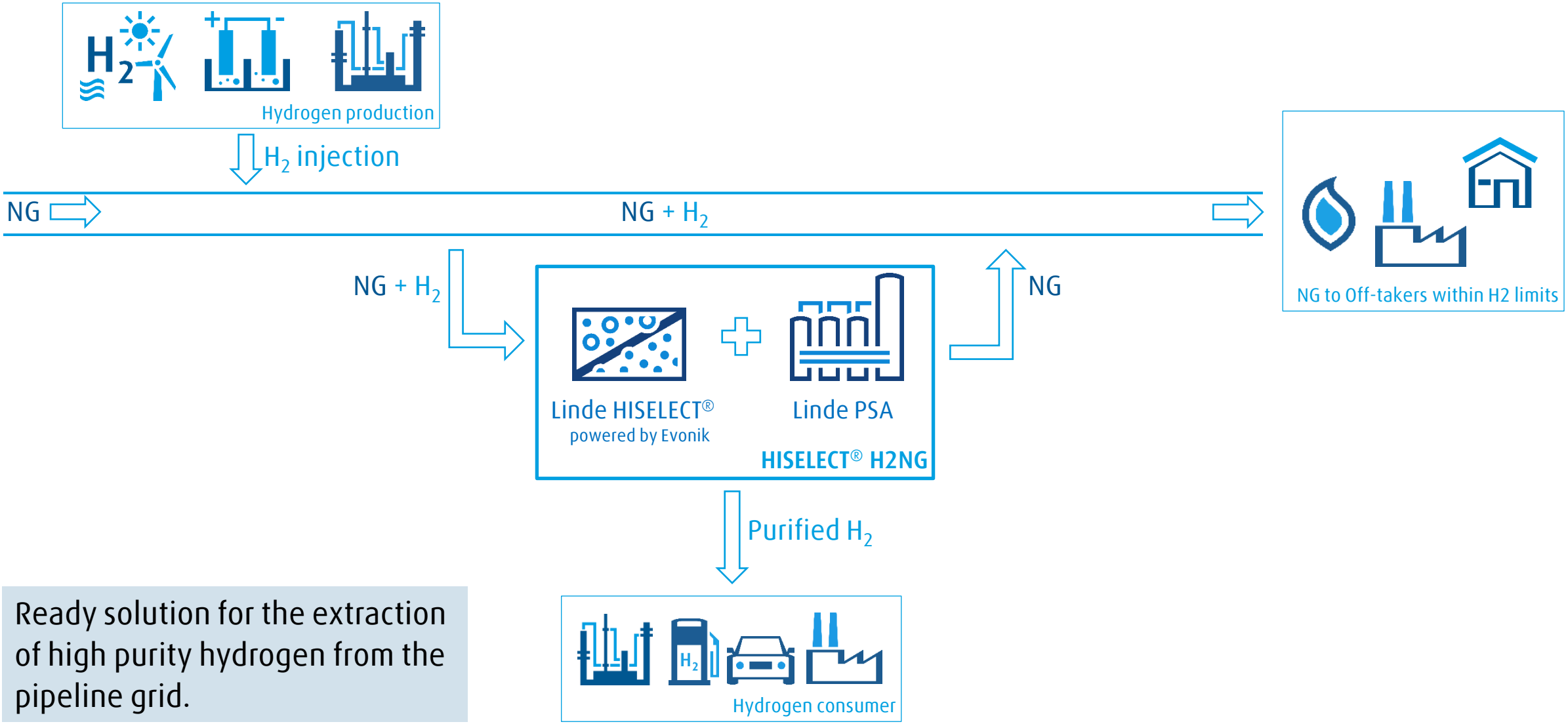
Strategic partnership between Evonik & Linde

Monomer Polymer → Hollow Fibers → HISELECT® Membrane Technology → Combining Gas Processing Technologies → Process Engineering Excellence → Customised Gas Processing Plants

Leveraging synergies by integrating the HISELECT® powered by Evonik high-performance membranes into Linde's gas processing technology portfolio

Hydrogen extraction from hydrogen blended natural gas by HISELECT® H2NG.

Basic concept.

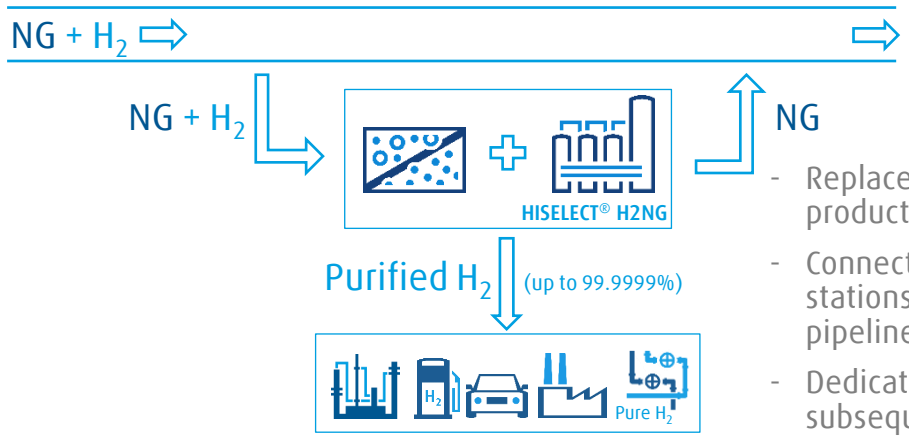


Ready solution for the extraction of high purity hydrogen from the pipeline grid.

Hydrogen extraction from hydrogen blended natural gas.

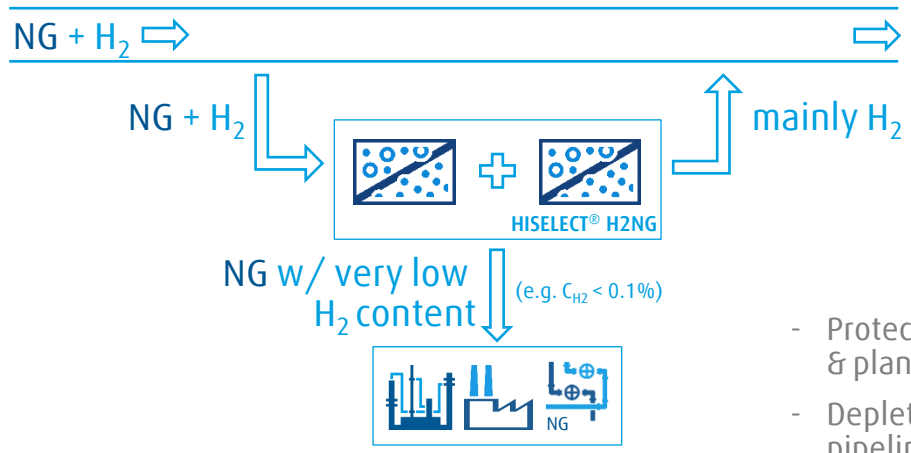
Four major use cases & example applications – tailored to the requirement.

Extraction of purified H_2



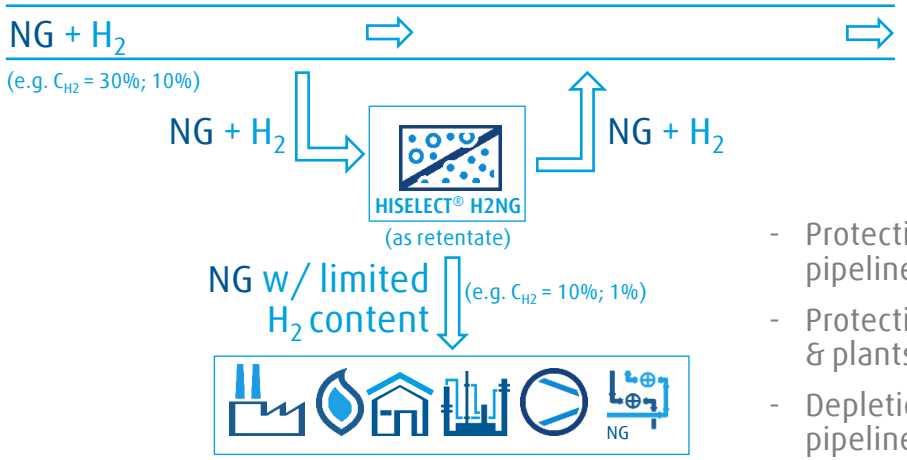
- Replacement of on-site H_2 production or H_2 bulk supply
- Connection of H_2 refueling stations or branched pure H_2 pipeline network
- Dedicated extraction of H_2 for subsequent liquefaction and shipping

H_2 removal for (pure) NG supply



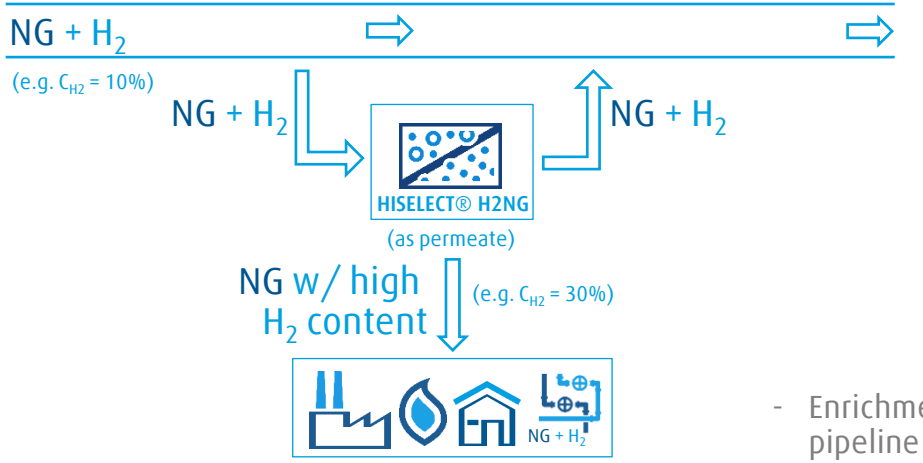
- Protection of chemical sites & plants from H_2
- Depletion of H_2 in branched pipeline networks

Depletion of H_2



- Protection of NG fuel-driven pipeline compressors from H_2
- Protection of chemical sites & plants from H_2
- Depletion of H_2 in branched pipeline networks

Enrichment of H_2



- Enrichment of H_2 in branched pipeline networks

Making our world more productive

Enabling the energy transition

GTAI GERMANY TRADE & INVEST

FOCUS ON GERMANY:
OPPORTUNITIES FOR INVESTMENT AND COOPERATION IN THE GERMAN HYDROGEN ECONOMY

WATERSTOFNET WEBINAR, 30.06.2022

Raphaël Goldstein (Dipl.-Ing. Univ.)
Senior Manager Investor Consulting
Chemicals & Materials
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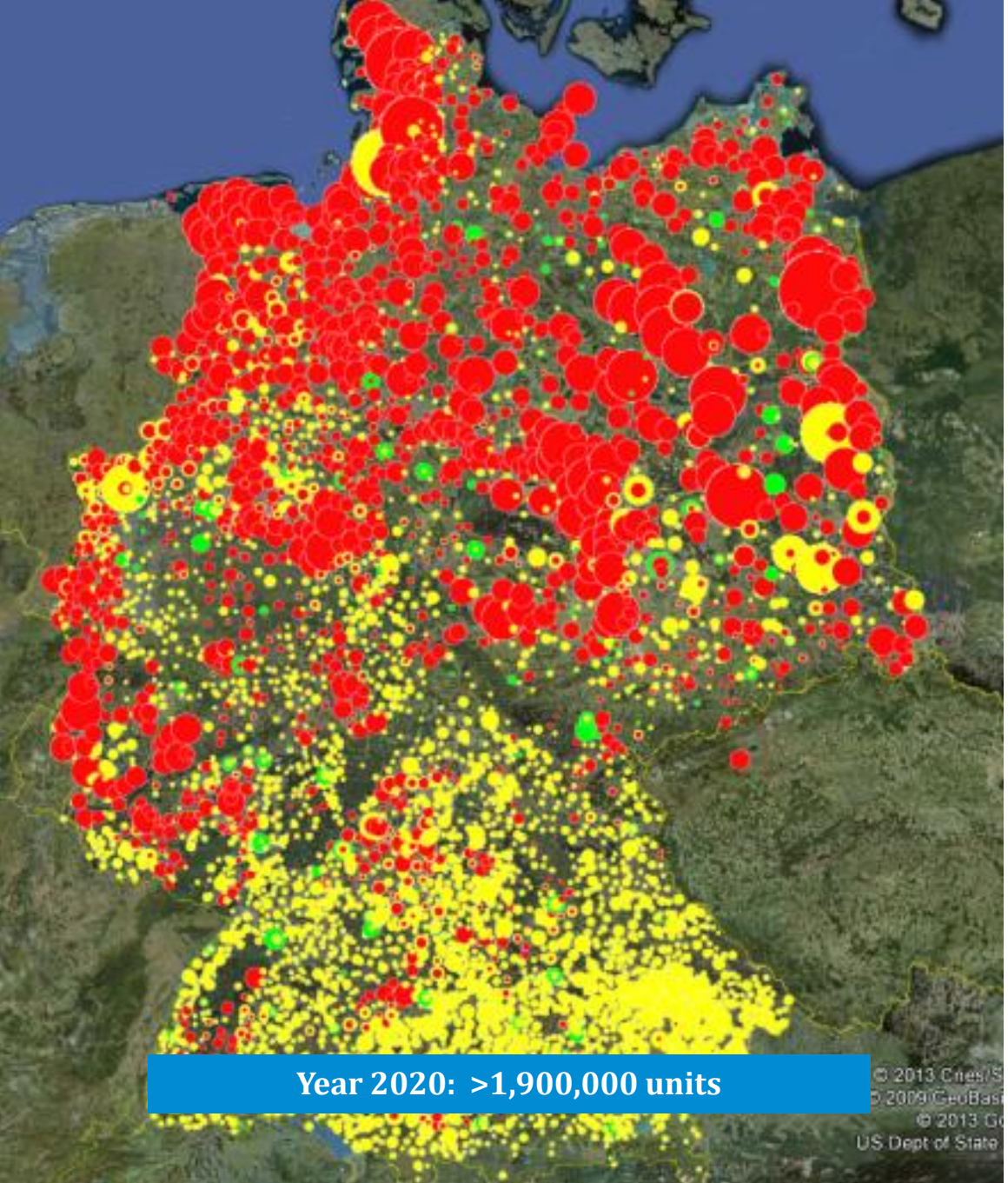


Growth in Renewables

Feed-in tariff creating fast growth

- **Wind energy**
- **PV**
- **Biomass**

The circle **diameter** is proportional to the electrical capacity.

Sources: 50HertzT, TenneT, Amprion, TransnetBW, internal data

Energy

69%

Germany imported 69% of its primary energy consumption. 92% of it is based on fossil ressources (oil, gas and hard coal)

Chemical industry

18%

Approximately 18% of these fossil ressources are used as raw material (mostly crude oil and gas). The chemical industry is also the largest consumer of natural gas followed by the metal sector

Sources: 9 AGEB (Mai 2022), ChemManager, VCI 2017

What about emissions?

The opening balance sheet for climate protection

"…The previous climate protection measures are insufficient **in all sectors**…"

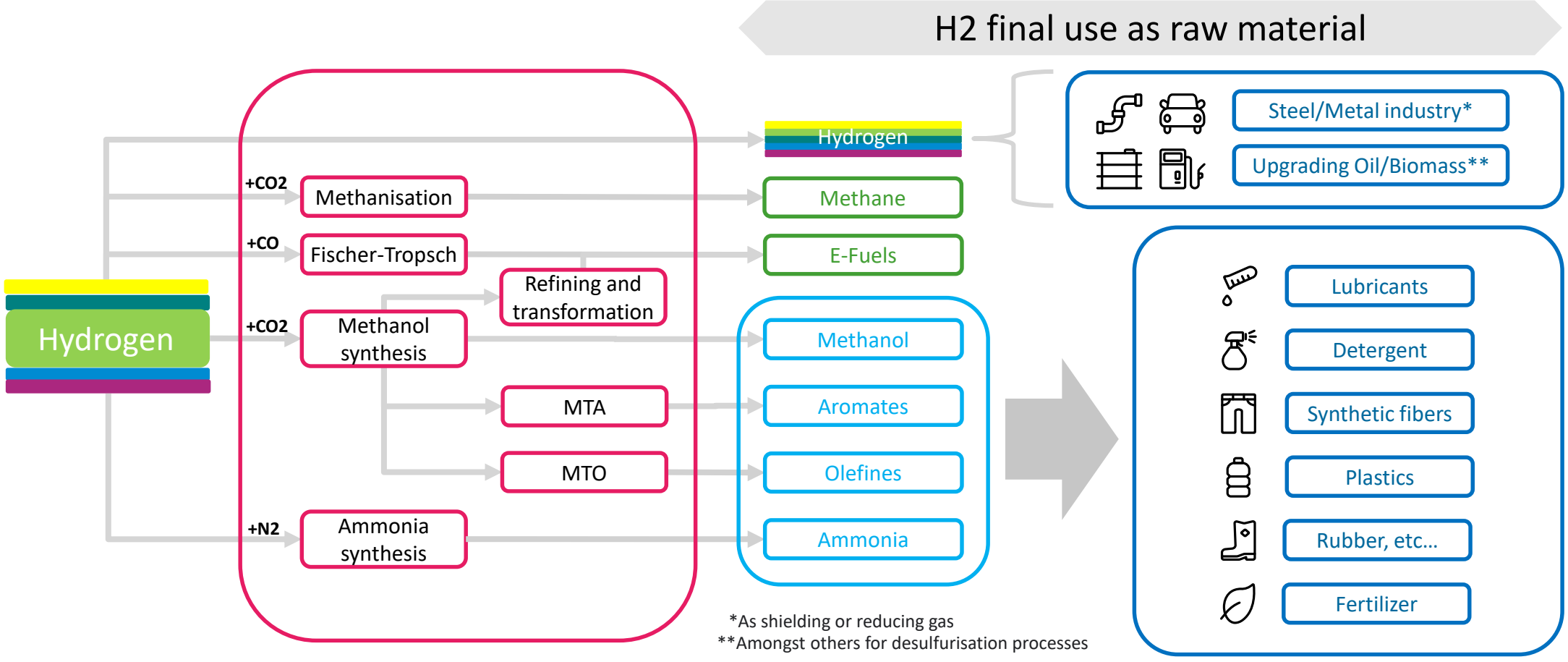
"…we need to t**riple the speed of our emissions reductions** and do a lot more in less time…"

"…What we are doing now lays the foundation for **bringing climate protection and prosperity together**…"

Sources: BMWK 2022

From basic to final product

Greening the whole value chain with H2 and new processes



Source: VCI, Dechema, SWP, BMU 2021, KEI 2021, GTAI research 2022

Germany's National Hydrogen Strategy

Supporting the development of hydrogen markets

H_2 production

- Expected H_2 demand of 90-110 TWh by 2030
- 2030 target of up to 10 GW of H_2 capacity

Transport sector

- Priority on air and maritime
- Transport sector renewable energy target beyond EU Directive
- 2% e-kerosene quota by 2030

Industrial sector

- Carbon Contracts for Difference
- Markets for climate-neutral products
- H_2-based long-term decarbonisation strategies

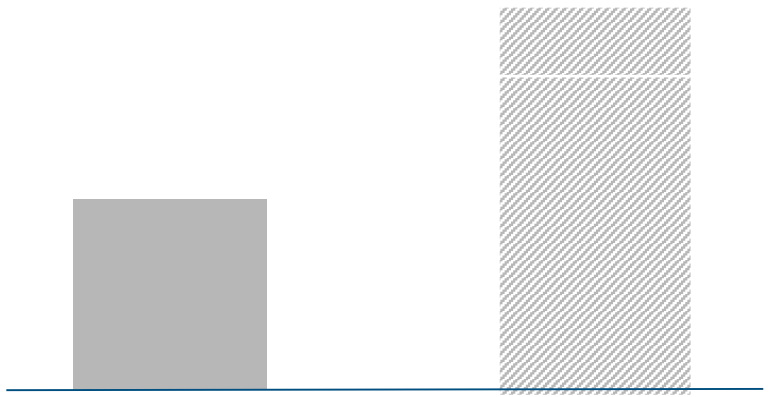
International cooperation

- Importing renewable energy from beyond EU
- €2 bn in funding for pilot projects in partner countries

Source: Guidehouse 2020 based on BReg 2020 & BMWK 2020

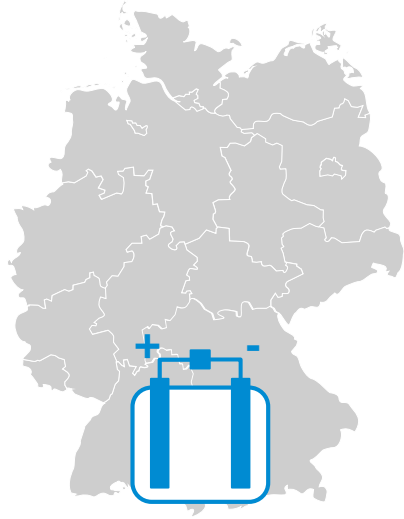
Domestic hydrogen market and import demand

Hydrogen (H_2) volumes foreseen for 2030



55 TWh
Germany's H_2 demand 2020

90-110 TWh
H_2 demand expected 2030



10 GW
Green H_2 production capacities planned for Germany by 2030

Import demand 2030:
up to 82 TWh H2,
~ 45 TWh green H2

28 TWh
Green H_2 domestic production 2030

Source: Guidehouse 2020 based on BReg 2020 & BMWK 2020

Hydrogen-IPCEI

Important projects of common European interest

- H_2 Production
- Infrastructure
- Industry Use
- Mobility Use
- Pipeline

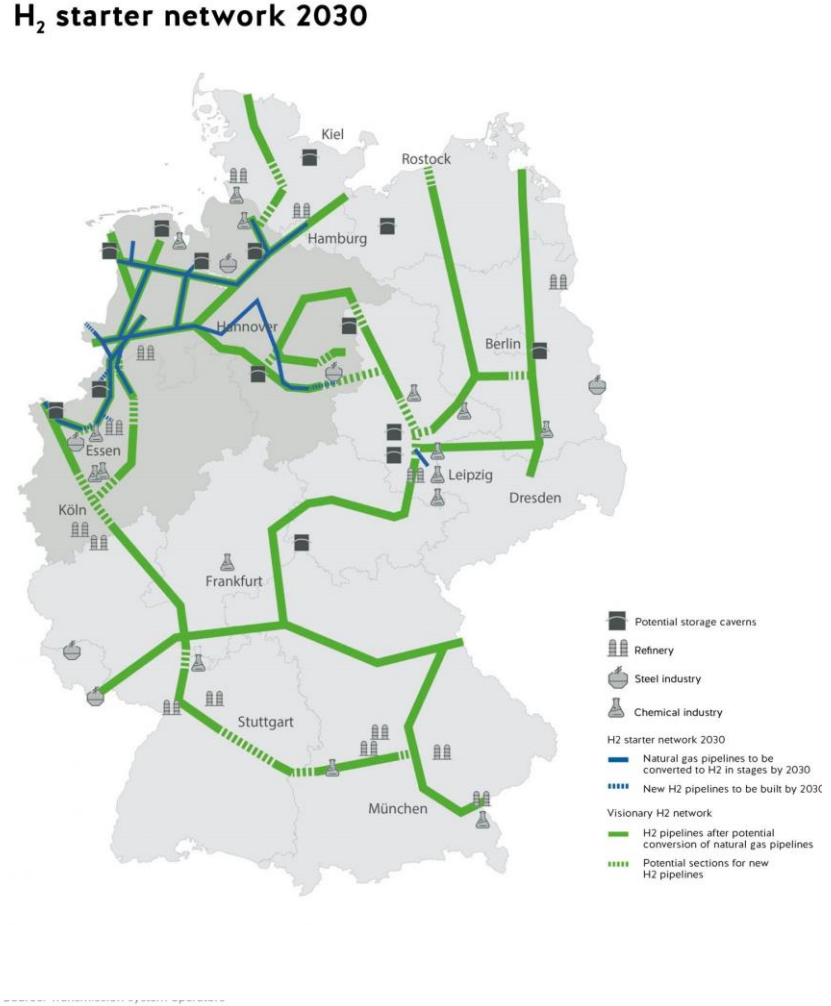
Implementation of the National Hydrogen Strategy

- BMWK and BMDV have selected 62 large-scale hydrogen projects to receive government funding
- Over 8 billion EUR available in federal and state funding
- The projects represent the entire value chain of the hydrogen market
- They represent the starting points of the German H2 economy

Source: BMWK 2021

A new hydrogen infrastructure

A pipeline network to supply the German industry

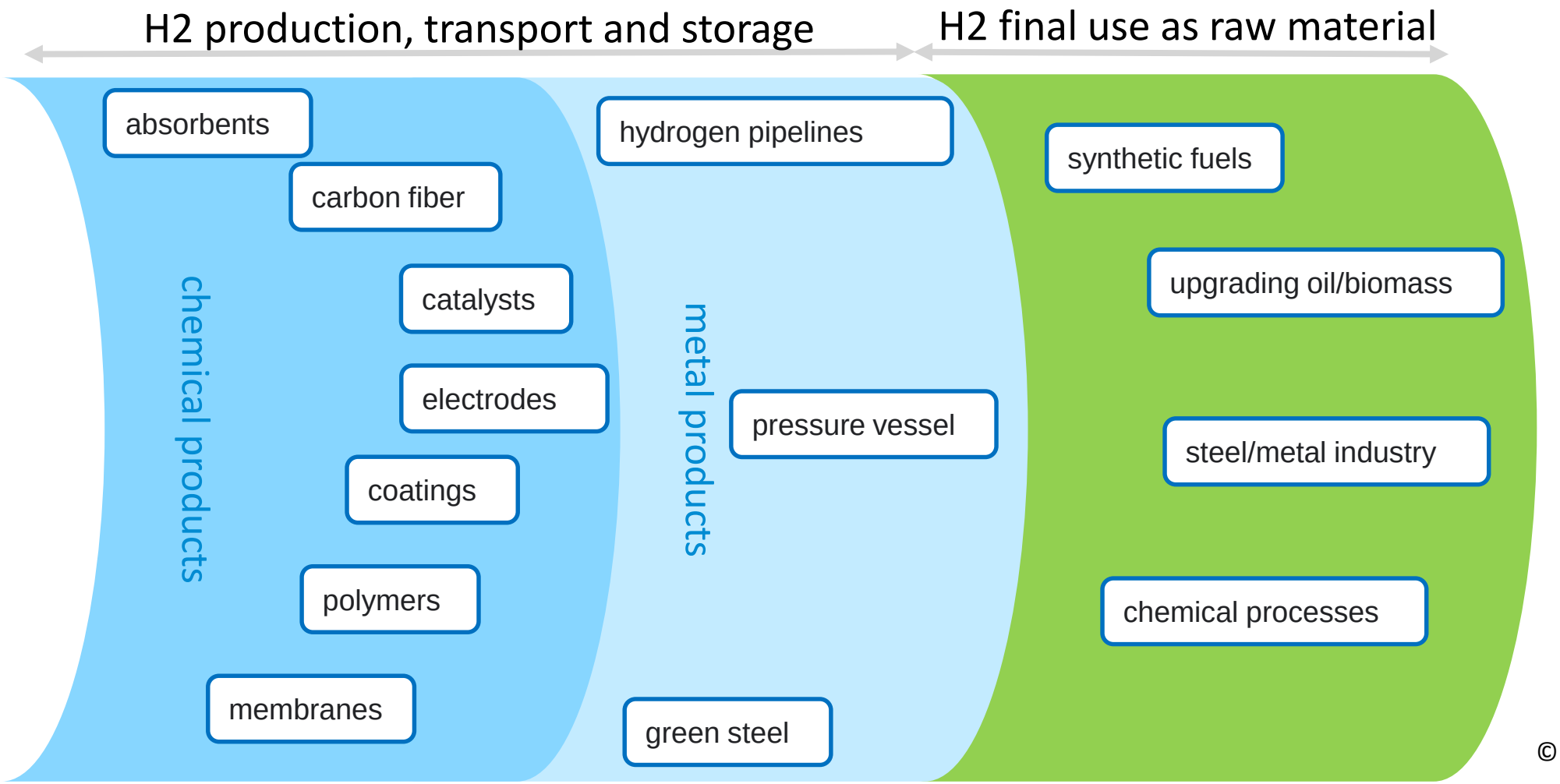


- Wind (offshore) will play an important role for the generation of H2
- The NG infrastructure will be repurposed for hydrogen transport in connection with the European hydrogen backbone
- Storage capacity and 2 H2 pipeline networks already exist and will be further developed
- H2-ready LNG terminals are being built to import gas and H2 from overseas

Source: BMWK 2021, FNB Gas 2021, Chemical Parks in Germany (gtai.de) 2022

Investing in the H2 economy

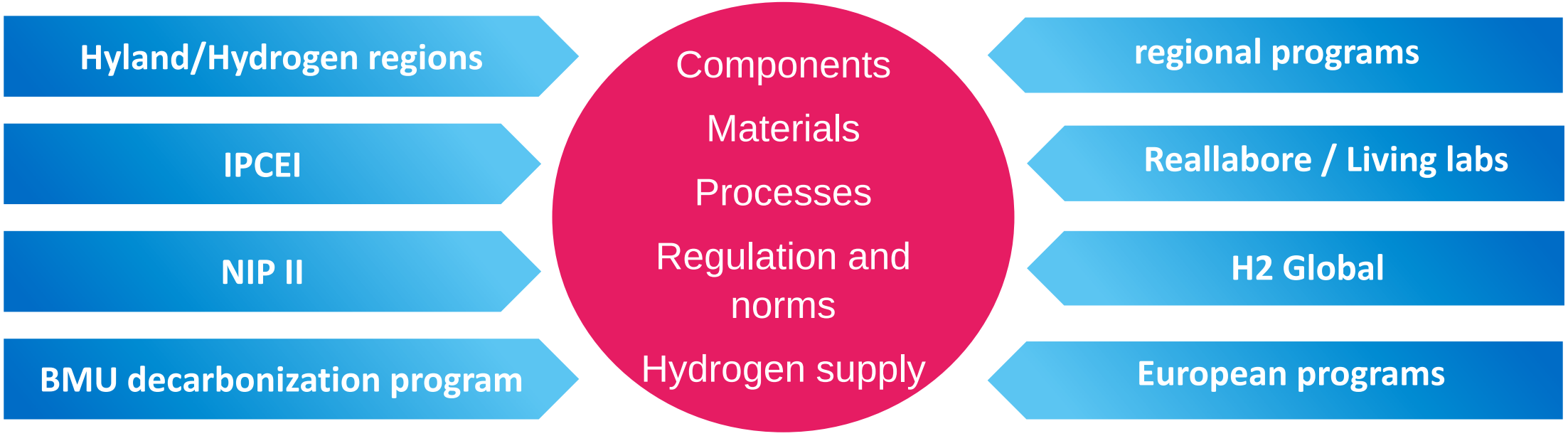
From H2 production to H2 final use, from materials to devices



Source: SWP, IKV 2021

Cooperation is key to decarbonize industry

Many funding possibilities for investment or RnD



Sources: BMU, BMWK,, NOW GmbH, European Commission 2021

"Groene Waterstof en mobiliteit"

Neem deel aan de zakenreis
van 17–20/10/2022
en ontdek de waterstof-sector
in Middel-Hessen, Duitsland!

Meer informatie:
https://www.energiewaechter.org/belgian-french-registration

Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag

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Contact Us

Germany Trade & Invest is the economic development agency of the Federal Republic of Germany. The company helps create and secure extra employment opportunities, strengthening Germany as a business location. With more than 50 offices in Germany and abroad and its network of partners throughout the world, Germany Trade & Invest supports German companies setting up in foreign markets, promotes Germany as a business location and assists foreign companies setting up in Germany.

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SUPPORTED BY THE FEDERAL MINISTRY FOR ECONOMIC AFFAIRS AND ENERGY
ON THE BASIS OF A DECISION BY THE GERMAN BUNDESTAG.

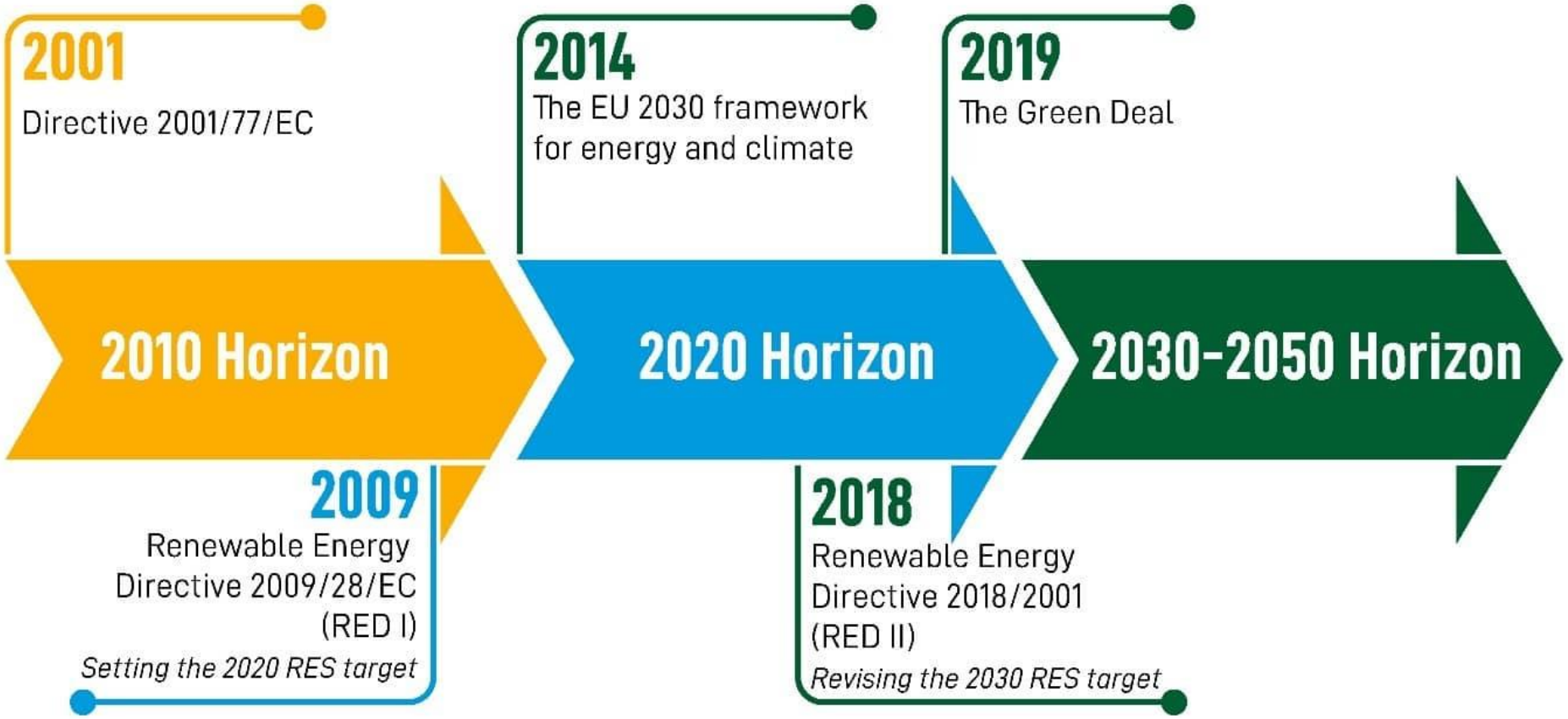
Davine Janssen

30 juni 2022

Additionality principle & the Renewable Energy Directive

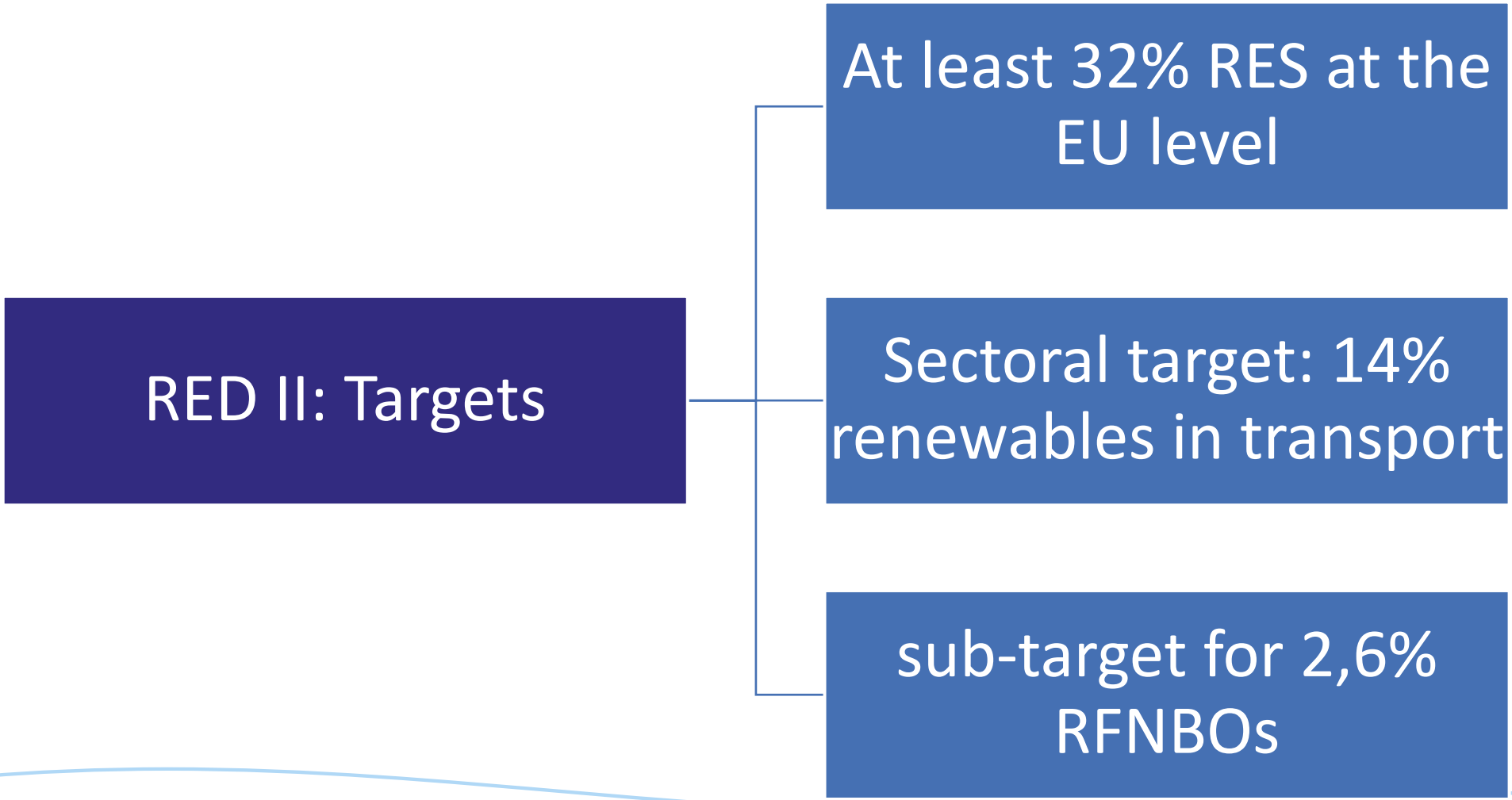
reactions from the hydrogen community

WaterstofNet

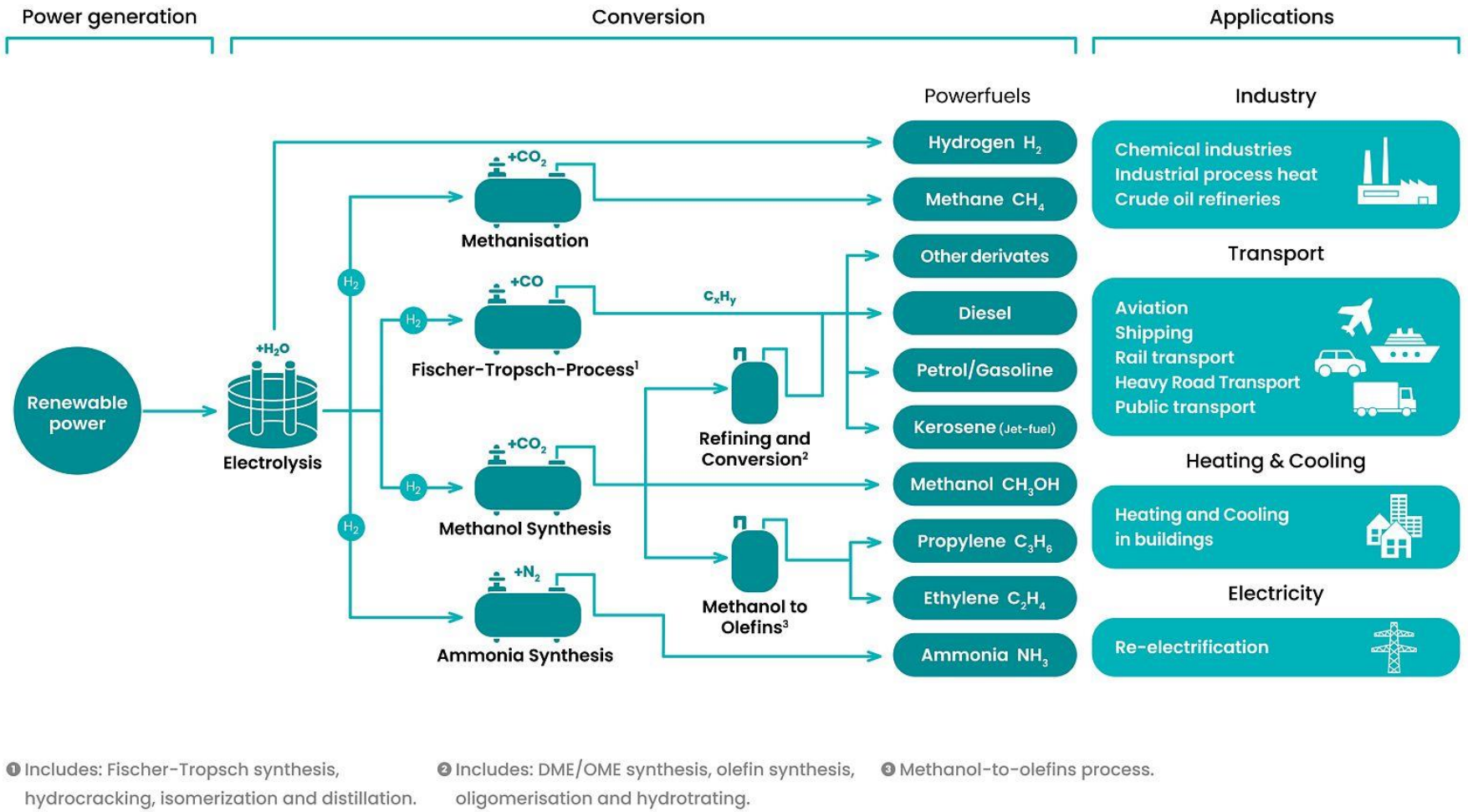


Source: Florence School of Regulation, "Renewable Energy in the European Union", https://fsr.eui.eu/renewable-energy-in-the-european-union/

Renewable Energy Directive II



Renewable Fuels of Non Biological Origin



❶ Includes: Fischer-Tropsch synthesis, hydrocracking, isomerization and distillation.

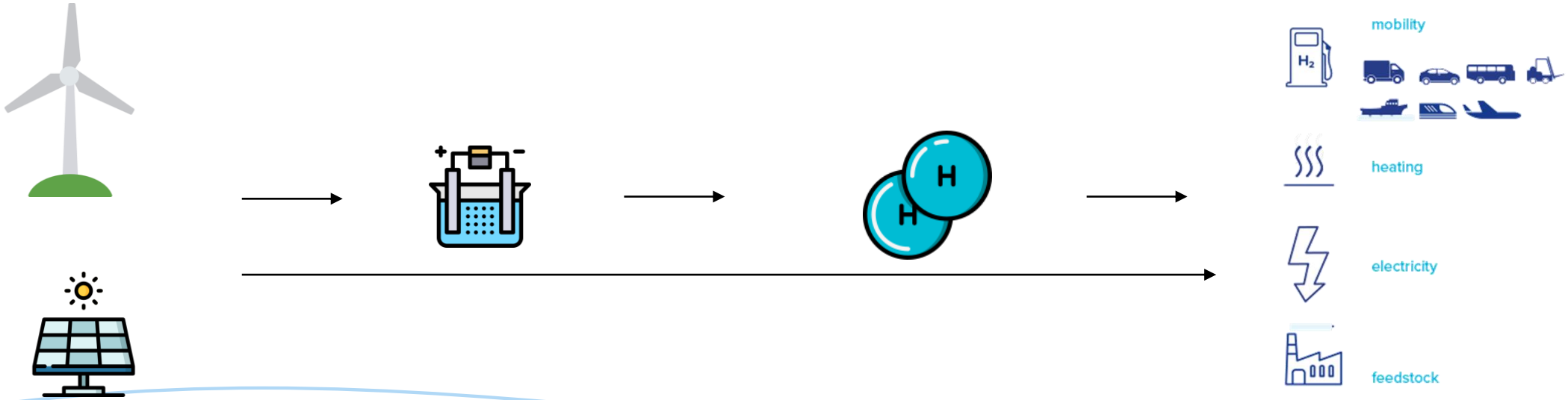
❷ Includes: DME/OME synthesis, olefin synthesis, oligomerisation and hydrotrating.

❸ Methanol-to-olefins process.

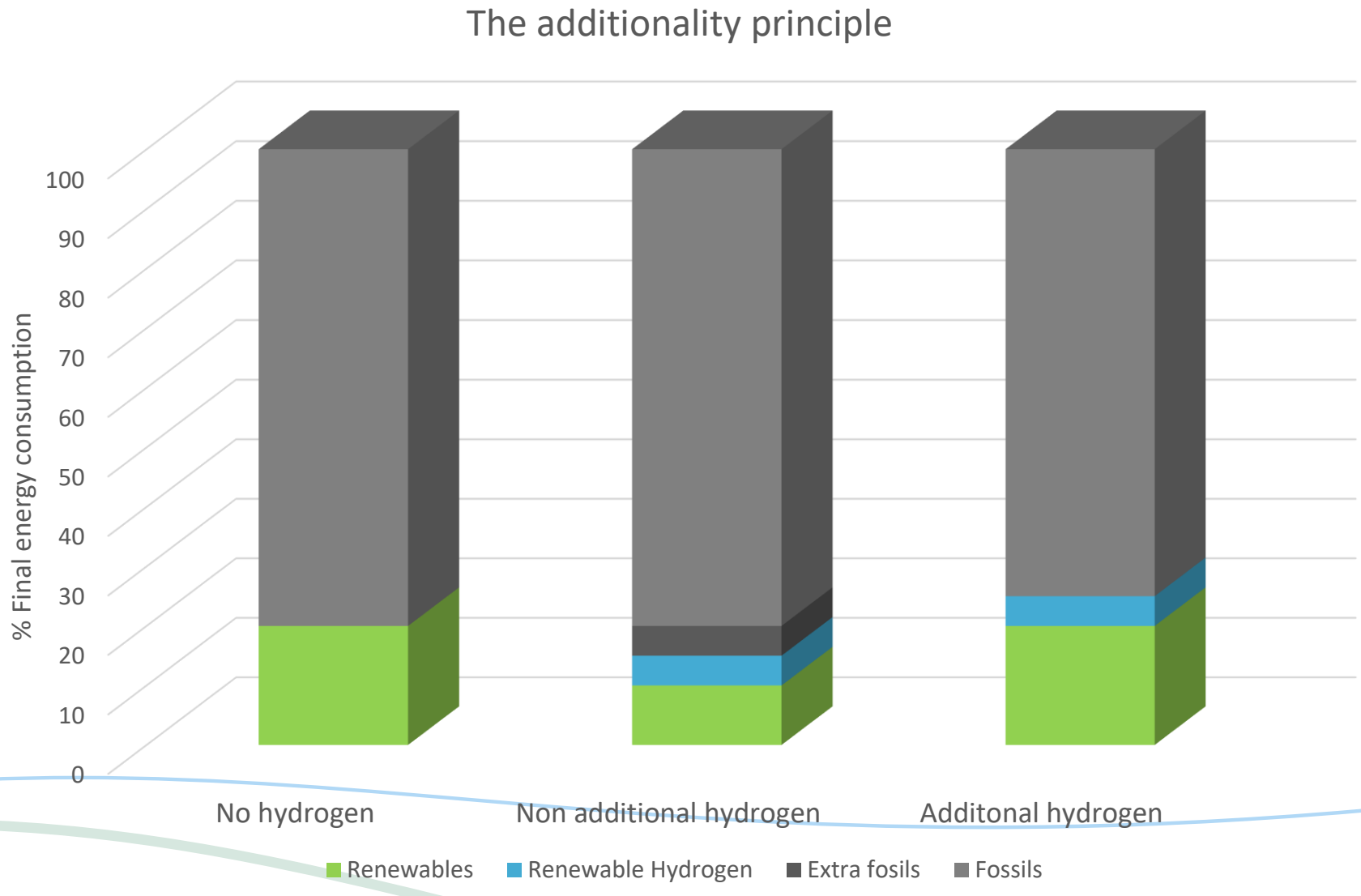
Source: https://www.powerfuels.org/powerfuels/

The additionality principle

- States that green H2 should be produced from **new (additional) renewable electricity capacity** to avoid an indirect increase in demand for fossils due to **conversion losses**
- The principle was introduced in RED II, but the exact methodology for how it shall be implemented was published in a **delegated act** (May 2022)
- The proposed delegated act was open for **public consultation** until 17 June

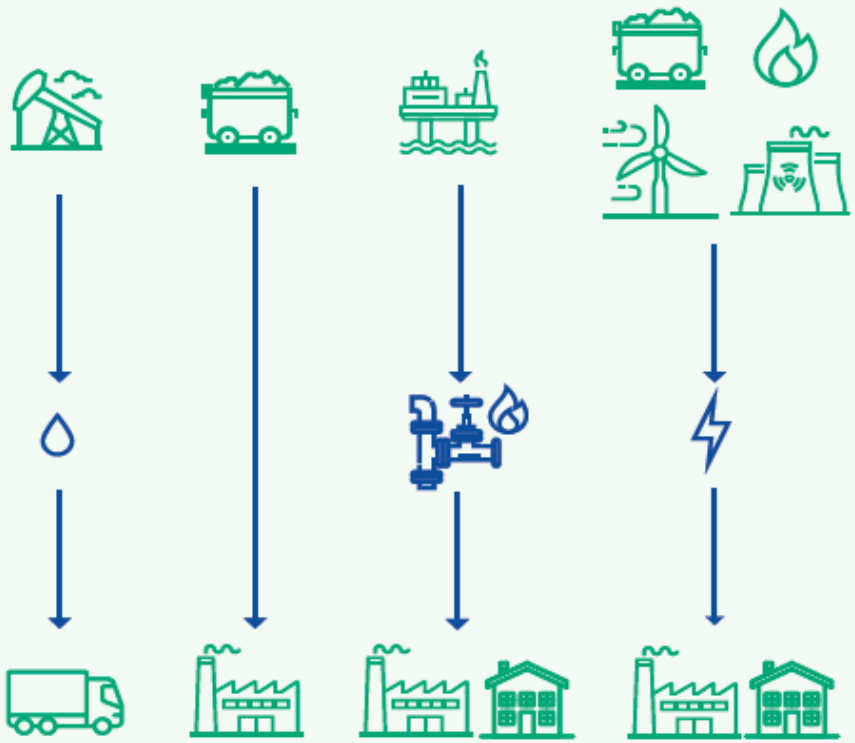


The reasoning (simplified):



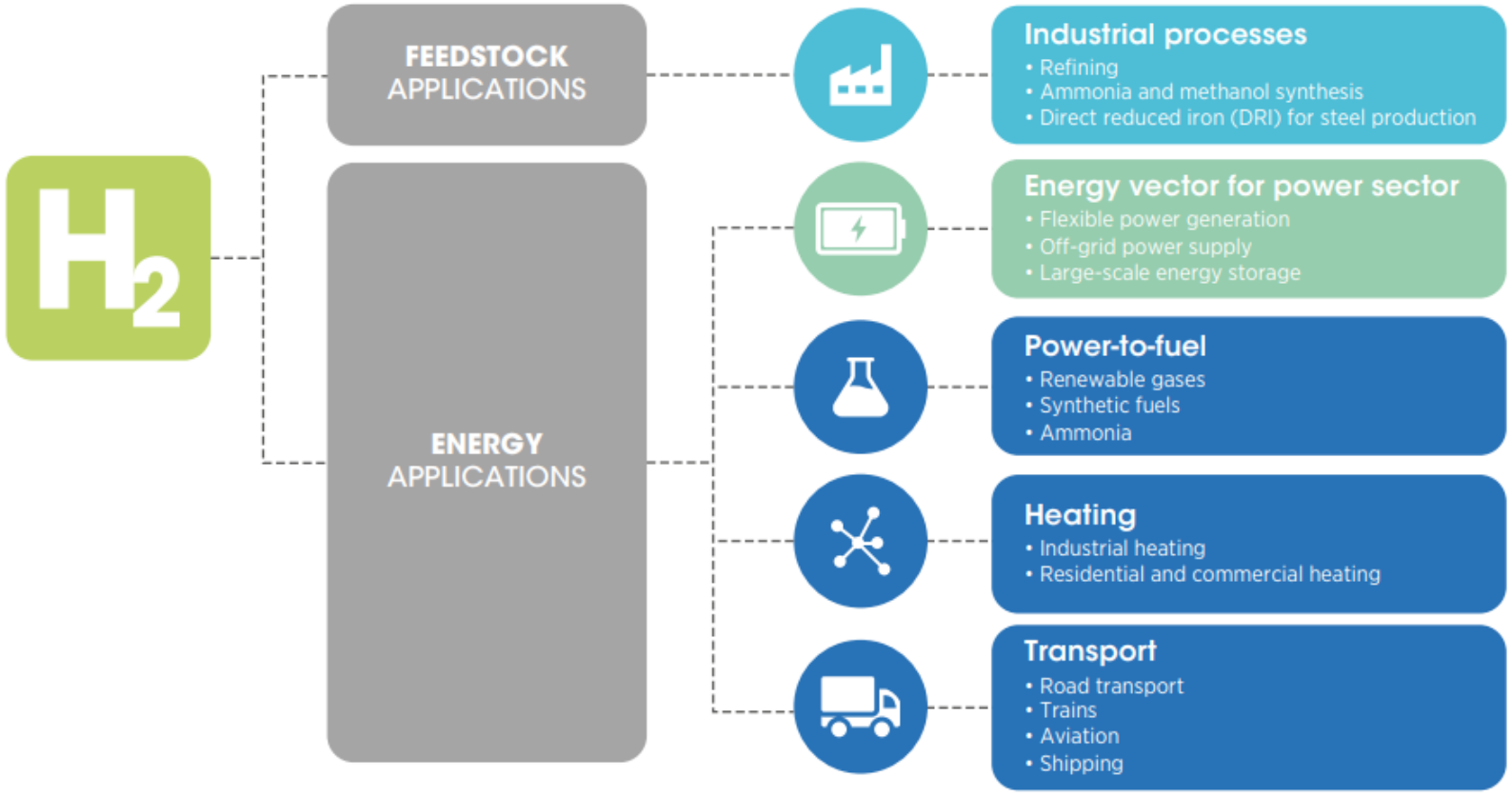
Energy system efficiency

Energy system integration & hydrogen as a key enabler



Hard to abate sectors

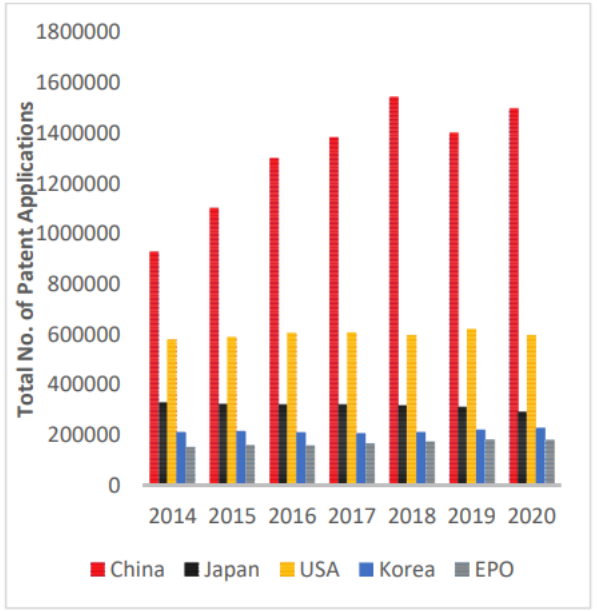
Figure 1: Potential market opportunities for green hydrogen identified by IRENA Coalition for Action

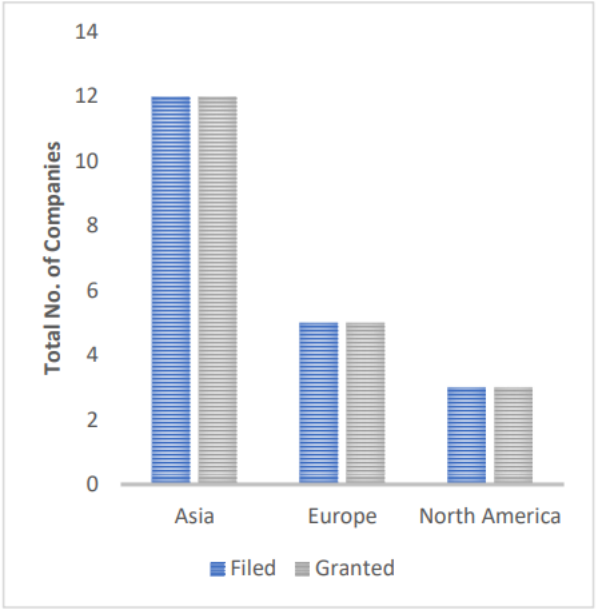


Source: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/May/IRENA_Coalition_Green_Hydrogen_2021.pdf

Innovation and technological leadership

Figure 3.1.2: Published patent applications by top 5 offices for the years 2014 to 2020.





Source: Fuel Cell and Hydrogen Observatory https://fchobservatory.eu/sites/default/files/reports/Chapter%205%20-%20Patents%20-%202022%20Final.pdf

Emission Trading System

- ETS already covers applications of electricity sector
- → thus already protects against “excessive” production of hydrogen relative to the available renewable electricity, through market mechanism
- Other sectors do not abide by these rules

→Power Purchase Agreements and Guarantees of origin to proof the use of renewable electricity should be enough

Summary of arguments against the additionality principle

- Hydrogen could allow for the **uptake of more renewables** through
  - Avoided curtailment
  - Avoided congestion
  - → hence increasing the efficiency of the energy system as a whole
- Hydrogen technologies will **need to be developed now** if we want to reach climate neutrality, as they are especially important for the hard to decarbonise sectors
- And: electrolysers are still **highly innovative**; developments could be hampered by administrative burden at this stage

→Rules highly debated, mostly with regards to the strictness of

- Temporal correlation
- Geographical correlation
- Small installations
- Etc.

Delegated act RED article 27.3

- In case of direct connection to RES
  - RES must come into operation **max. 36 months before start hydrogen production**
- In case of grid connection, three main options:
  - RE in energy mix of the bidding zone was **>90% in previous year**
  - Power Purchase Agreements of Green electricity provided that:
    - The RES did not receive operational or investment support **(from 2027 onwards)**
    - Temporal correlation: **production within the same hour,** either:
      - A) een **actual hourly correlation** of the RE coveredby the PPA **(monthly)**
      - B) **Interposition of storage** charged during the same hour as RE production **(monthly)**
      - C) production during an hour when **electricity prices arelower than 20€/Mwh or 0,36 of the CO2-price**
    - Geografical correlation: elec. from neighbouring bidding zones only **when elec. prices are equal or higher** or in concers an **offshore bidding zone**
  - Proof of **downward redispatching by the TSO**.
- **Transitional clause (art. 7)**
- **Grandfathering clause (art. 8)**

WaterstofNet calls on the Commission:

- To **suspend all requirements** laid out in this Delegated Act until an Impact Assessment has been made.
- Or, **at least, extend grandfathering** to
  - Include contents of transitional clause, and
  - To installations built until 2030 instead of 2027
- A review of the Delegated Act by 2030 could then **re-evaluate the need** for and impact of the delegated act based on experiences from the first projects
- **Exception for small installations** (e.g. up to 25 MW) for compliance with all rules

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Bedankt voor uw aandacht!

Thank you for your attention!

WaterstofNet