BCCI workshop on 12 November 2020:
Increasing energy efficiency and Hydrogen Economy - the contribution of the chemical industry to a 'climate-neutral economy'

The European Chemical Industry - a major hydrogen consumer and producer

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Policy context: EU Climate Policy and Green Deal

Climate policy is a key element of the European Green Deal – a package of measures ranging from cutting greenhouse gas emissions, to investing in research and innovation, to preserving Europe's natural environment.

Climate initiatives under the Green Deal include:

- European Climate Law to enshrine the 2050 climate-neutrality objective into EU law

The Commision provided an impact assessment, analyses the national energy and climate plans, and of stakeholder contributions to the public consultation used for ….

- a new EU ambition for 2030 ('Target Plan') to reduce greenhouse gas emissions.

EU Climate Policy and Green Deal timelines

Early 2021, the Commission will adopt a new EU strategy on adaptation to climate change on climate-proofing, resilience building, prevention and preparedness, risk management practices...

By mid 2021, the Commission will review and, where necessary, propose to **revise all relevant policy instruments (ETS, EED, ETD, RED, …)** to deliver additional greenhouse gas emissions reductions...

EU policy context: Timing…and Hydrogen

Purpose

Increasing the EU's 2030 GHG target (at least 50% and towards 55%)

Hydrogen accounts for less than 1% of Europe's present energy consumption…is mainly produced through highly carbon-emitting pathways, known as **'grey'** hydrogen, and used as feedstock….

However, **clean hydrogen** is expected to play a **key role in the decarbonisation of sectors** where other alternatives might not be feasible or be more expensive. This includes **heavy-duty and long-range transport and energy-intensive industrial processes**.

EU policy context: Expectations for Hydrogen (EU Hydrogen Strategy 8 July 2020)

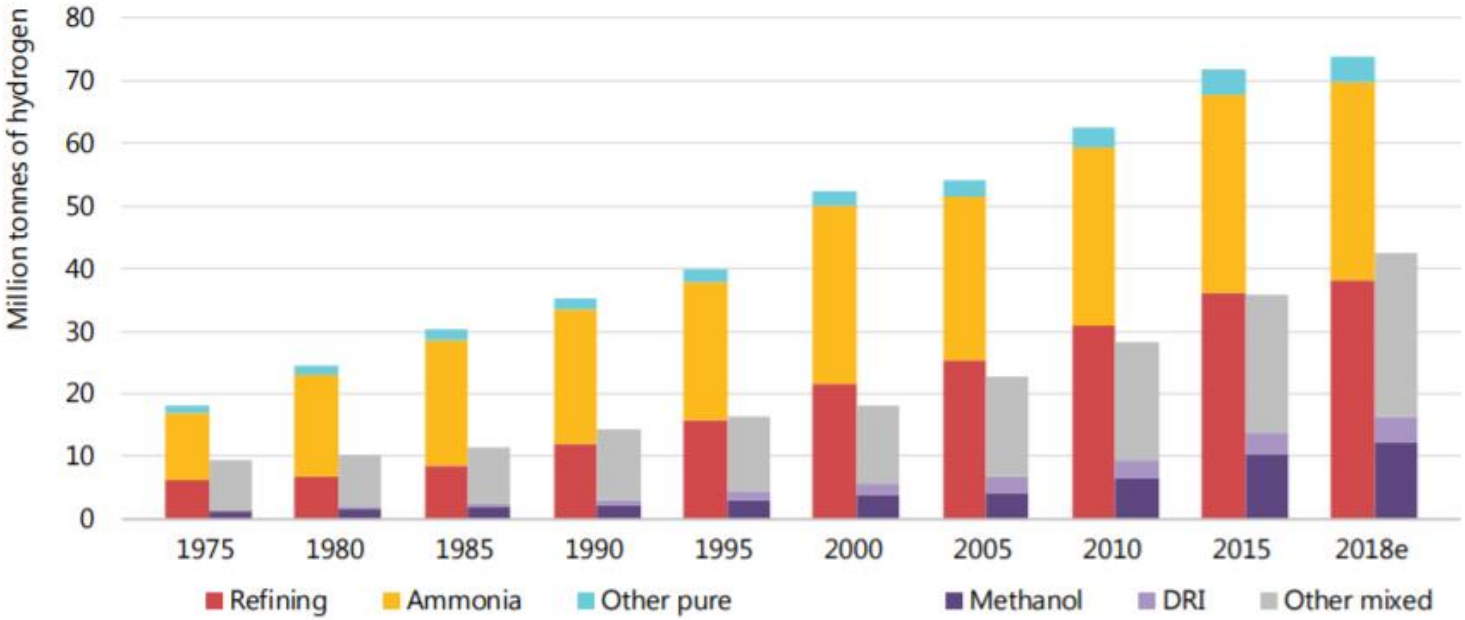
EU expectations for **renewable ('green') hydrogen, produced through electrolysis from water using renewable electricity**:

- providing emission-free energy and feedstock for the mobility sector and industry
- long-term and large-scale storage, and flexibility to the energy system.
- supporting the integration of renewable electricity generation, as it decouples energy production from usage in both location and time
- balancing electricity demand and supply: important for electricity grid management, for isolated or stand-alone regions of the EU, or for specific and local uses, concentrated in a city or restricted area

Meanwhile, numerous EU member states have published their individual Hydrogen strategies.

Global picture: H2 demand

- The IEA estimates for 2018 a world demand of 70 Mton/year in pure form and additional 45 Mton/year in other forms



Notes: DRI = direct reduced iron steel production. Refining, ammonia and "other pure" represent demand for specific applications that require hydrogen with only small levels of additives or contaminants tolerated. Methanol, DRI and "other mixed" represent demand for applications that use hydrogen as part of a mixture of gases, such as synthesis gas, for fuel or feedstock.

Source: IEA 2019.

Around 70 MtH_2/yr is used today in pure form, mostly for oil refining and ammonia manufacture for fertilisers; a further 45 MtH_2 is used in industry without prior separation from other gases.

H2 in Europe

In the European Union (EU), it is estimated that 108 Billion Nm3 of hydrogen (**9,6 Mt**) is **used as feedstock** every year, mostly in the refining and chemical industries.
Hydrogen used as chemical feedstock is **produced from natural gas**, which is converted into hydrogen via **Steam Methane Reforming** (SMR) and then directed to ammonia and methanol production. Hydrogen is currently not directly used as an energy source in the chemical industry but is commonly **combusted for energy as a component of other gases such as syngas and process off-gases**.

The chemical industry is also a **major producer** of hydrogen as industrial gas, with approximately 150 Billion Nm3 (13,3 Mt) produced every year. In the EU, merchant hydrogen is almost exclusively produced by SMR of natural gas but it also occurs as by-product in:

- Steam cracking
- Propane de-hydrogenation (PDH)
- Chlor-alkali electrolysis

EUROSTAT Production data (PRODCOM code 20111150 : 1.4 Mton/year in 2019 (15 Billion Nm3) of which about 60 % is reported to be sold. Biggest producing country is Germany: 0.4 Mton/year.

Petrochemicals Europe analysis:
estimated H2 production

Source	Amount (Mt/yr)	Remark
On purpose (dedicated)	**5.5**	
Fertilizers	**3**	Fertilizers Europe estimate
Refineries	**1.1**	Concawe estimate
Dedicated production as listed in EUROSTAT	**1.4**	This number may include some hydrogen t listed above under fertilizers and refineries
Byproduct (not on purpose)	**> 3.1-3.2**	
Refineries	**2.4**	Concawe estimate
Steam Crackers	**0.4**	Based on input to steam cracker ETS benchı
Chlor-alkali	**0.3**	Euro Chlor estimate
Chemicals (excl steam crackers and chlor-alkali)	**0.1-0.2**	Petrochemicals Europe estimate
Others (steel,…)	**?**	Estimated to be small (<5 % of total hydı production in EU)
TOTAL (on purpose and byproduct) (excluding others)	**8.6-8.8**	Low side of estimate reflects potential d counting of some on purpose produced hydı reported under fertilizers and refineries bu included in EUROSTAT data.

Petrochemicals Europe analysis:
estimated H2 demand

Demand	Amount Mt/yr	Remarks
Production of ammonia	3	Fertilizers Europe (estimate)
Refining	4.8	Concawe estimate Most of this is used for feedstock. May also include a small part that is used as fuel in the refinery
Used in chemical industry for hydrogenation reactions	< 0.5	Cefic estimate
Used as fuel in chemical industry	<0.9	Cefic estimate based on production of hydrogen as a byproduct
Others (steel, food, ...)	?	Estimated to be small compared to total consumption in EU
Total (excluding others)	**< 9.2**	

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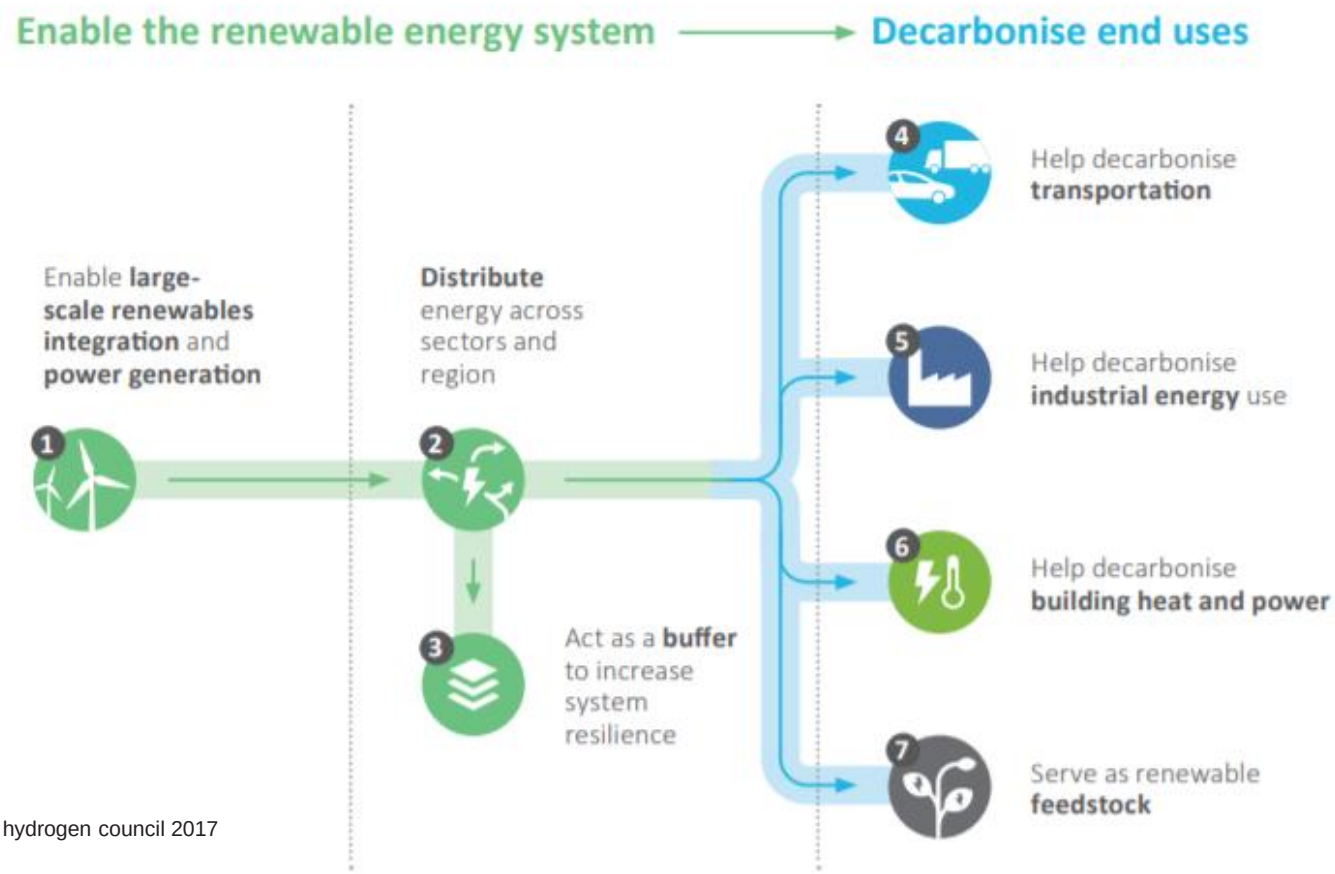
Ambitions for H_2

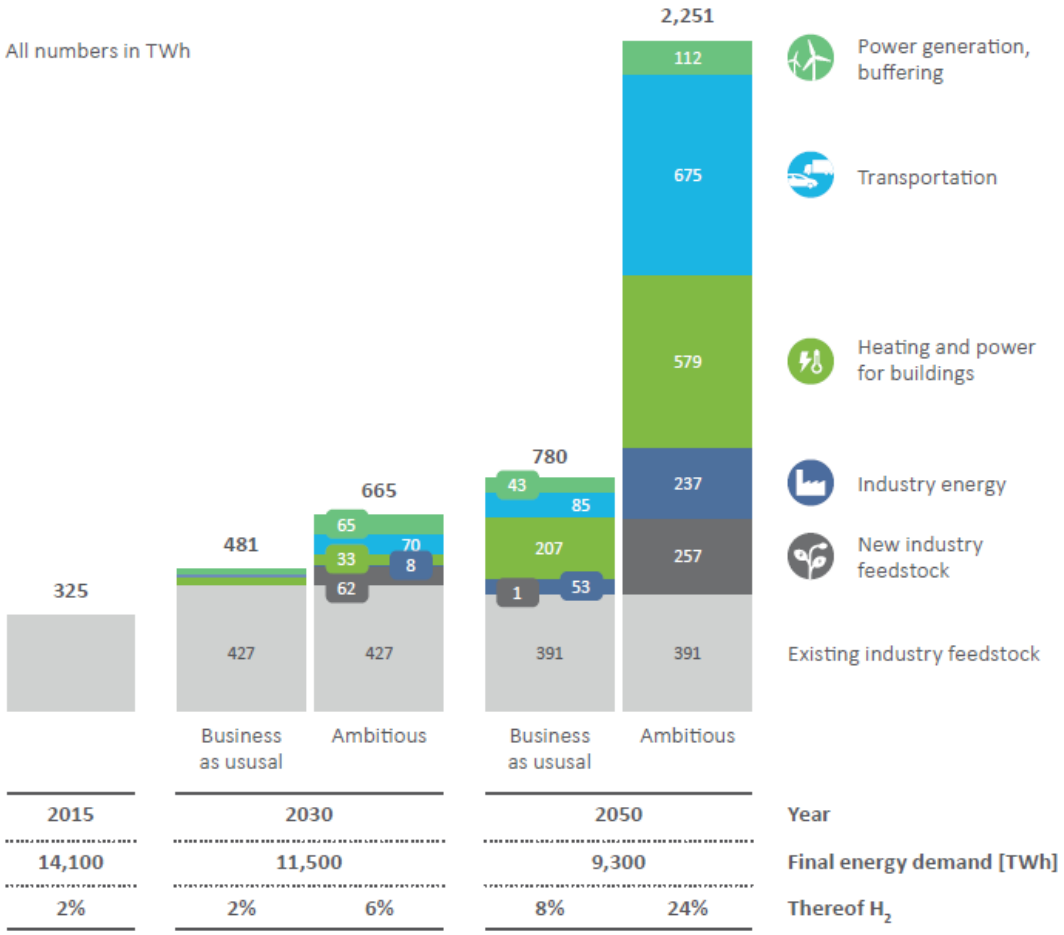
What could be the role of Hydrogen?



Source hydrogen council 2017

Ambitions for the use of Hydrogen

European Union ‘Hydrogen roadmap Europe, a Sustainable Pathway for the European Energy Transition (FCH JU, 2019)

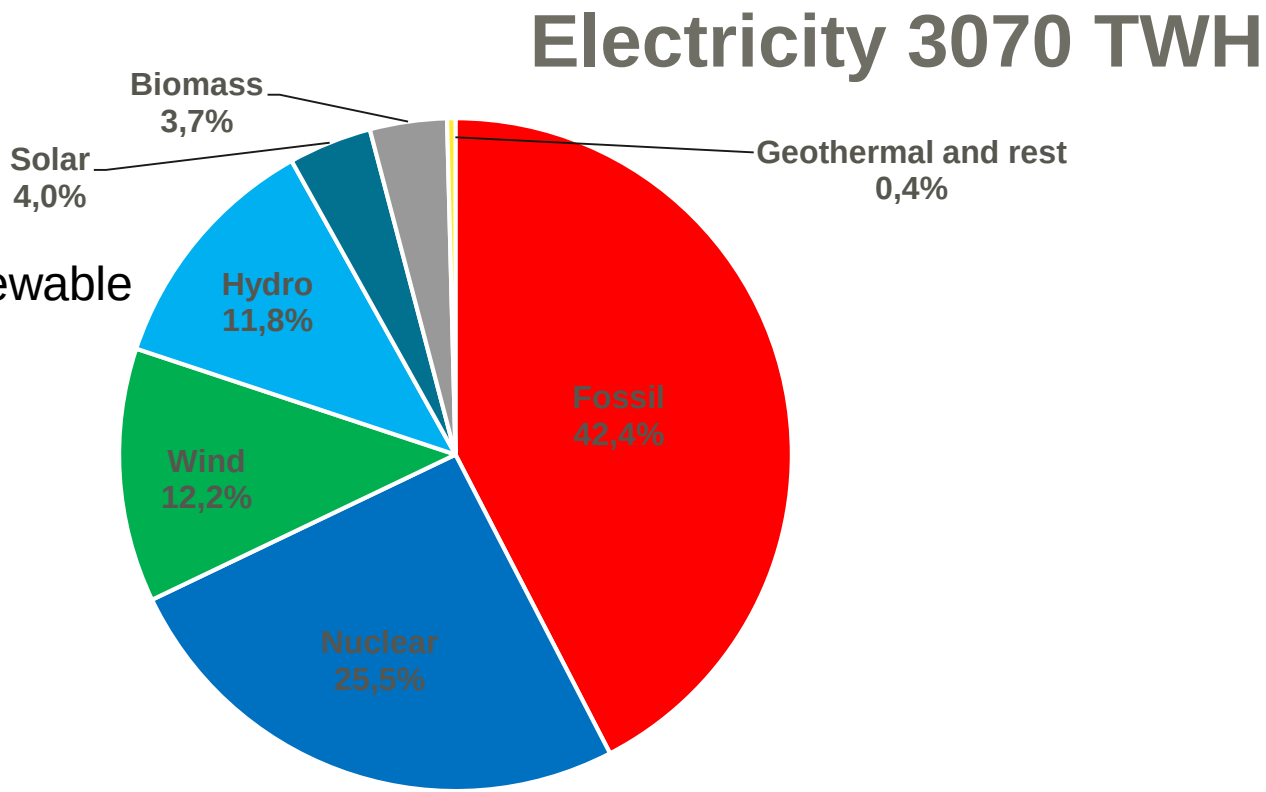


Hydrogen consumption and ambitions

- Todays production approx. 325 TWh
  - equals approx. 8 million ton H_2/year (H2 strategy mentions 9.8 Mt)
- Based on the Hydrogen for Europe roadmap in 2050 we could need 19 – 55 Mt H_2
- If all has to be produced via water electrolysis it would require 1235 – 3575 TWh of carbon neutral electricity
- Equivalent to todays total EU electricity production…

EU electricity production (2018)

32.1% is renewable



petrochemicals europe

Gap closing between current market and EU ambition?

- EU ambition: COM H2 strategy communication
  - By 2024: up to 1 Mton of 'green' H2 (at least 6 GW electrolysers)
  - By 2030: up to 10 Mton of 'green' H2 (at least 40 GW electrolysers)

- 'Hydrogen Europe' roadmap:
- By 2030: EU domestic 40 GW electrolyser capacity (6 GW 'captive market' hydrogen production at the demand location) and 34 GW hydrogen market (hydrogen production near the resource).
- By 2030: Another external 40 GW electrolyser capacity in North Africa and Ukraine (includes 7.5 GW hydrogen production for the domestic market and a 32.5 GW hydrogen production capacity for export).
- …so that renewable hydrogen can become cost competitive with fossil ('grey') hydrogen …total investments in electrolyser capacity 25-30 billion Euro, creating 140,000-170,000 jobs in manufacturing and maintenance of 2x40 GW electrolysers…

- Some 'green H2' projects in the pipeline:
  - Shell REFHYNE project : 10 MW→ 1.3 ton/year H2 (0.13 ton H2/year/MW)
  - Nouryon project : 20 MW → 3 ton/year H2 (0.15 ton H2/year/MW)
  - North Sea Hub project : 63 MW → 8.6 ton/year H2 (0.14 ton H2/year/MW)

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H2 in Europe and the EU chemical industry

Our industry is currently among the largest producer and user of Hydrogen. When we use Hydrogen, it can be both as a source of energy or as a feedstock.

Implications:

- Dedicated infrastructures and limitation of blending
- Molecule valuation: **Hydrogen is precious and usage should focus where it adds most value**
    - Hydrogen used as energy source rather where direct usage of electricity is not a better option

H2 in Europe and the EU chemical industry

Support needed

- Several types of incentives could support alternative production methodologies but should guarantee industry an internationally competitive supply of energy
- A solid and credible certification framework should be created to track the developments in hydrogen production and develop climate-friendly hydrogen production
- Once the growth of climate-friendly hydrogen starts to accelerate, regulators and competition authorities will have to ensure that the hydrogen market is subject to a sufficient degree of competition
- Infrastructure should be carefully planned to safeguard gas quality requirements, allow safe and efficient transport, and build on the potential of hydrogen as a storage solution
- **Support in research and innovation** will encourage progress on innovative technologies such as methane pyrolysis and water photolysis
- **No extra restrictions for users should be imposed on the origin of hydrogen** (similar to electrification). This would lead to even more expensive hydrogen costs, would hamper further technological developments of hydrogen appliances. Cefic proposes a consistent accounting framework to integrate CCU - without making a distinction between different sorts of hydrogen.