# Global Hydrogen Trends and Opportunities

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1

## Background

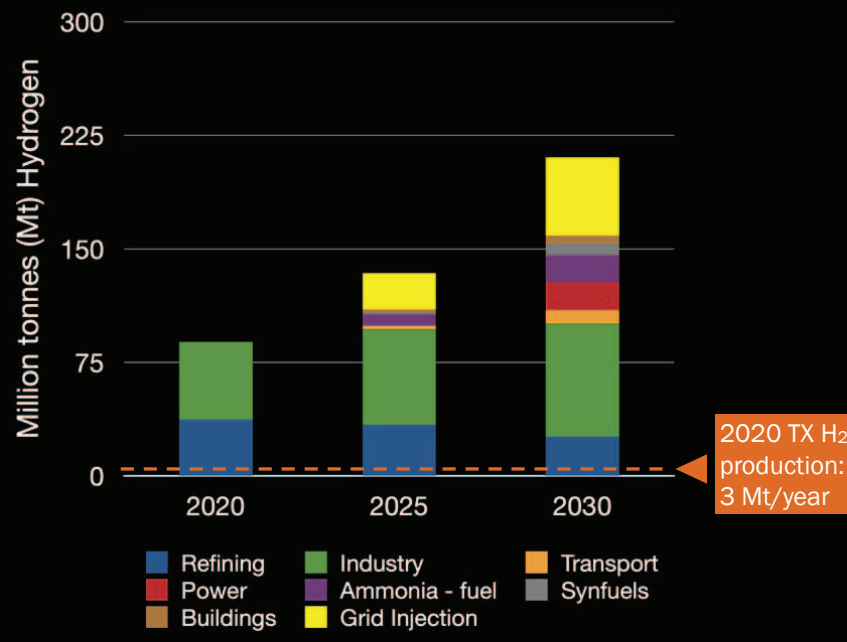


2

# Hydrogen is increasingly being considered a key decarbonization tool

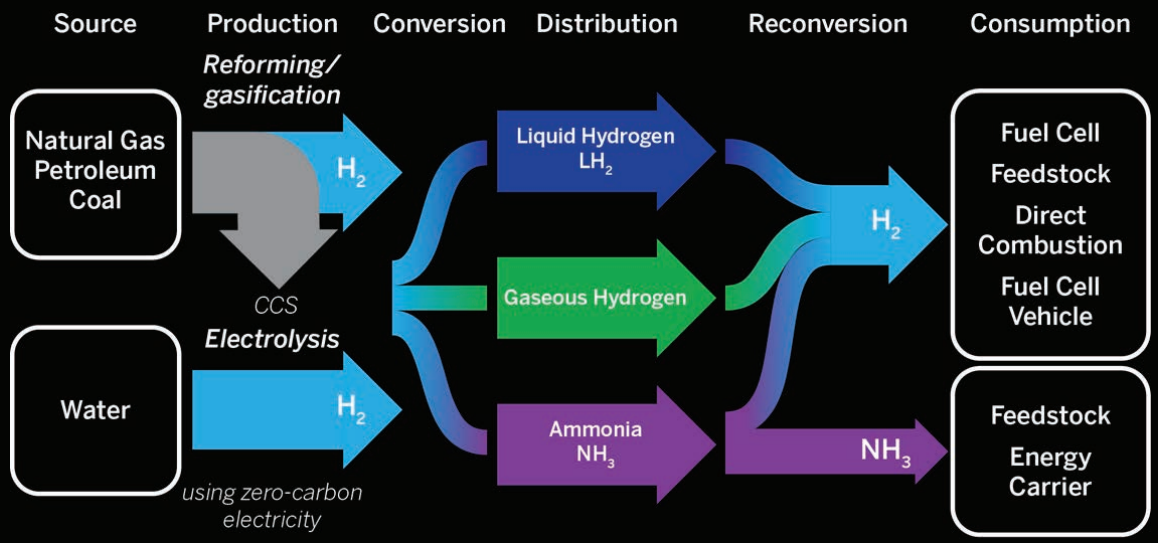
- Hydrogen ($H_2$) releases no greenhouse gases when used
- Can serve as a fuel, feedstock, or energy carrier
- Potential emission reduction applications across many sectors (industrial, transportation, electricity)

**Global hydrogen demand by sector in the IEA Net Zero Scenario**



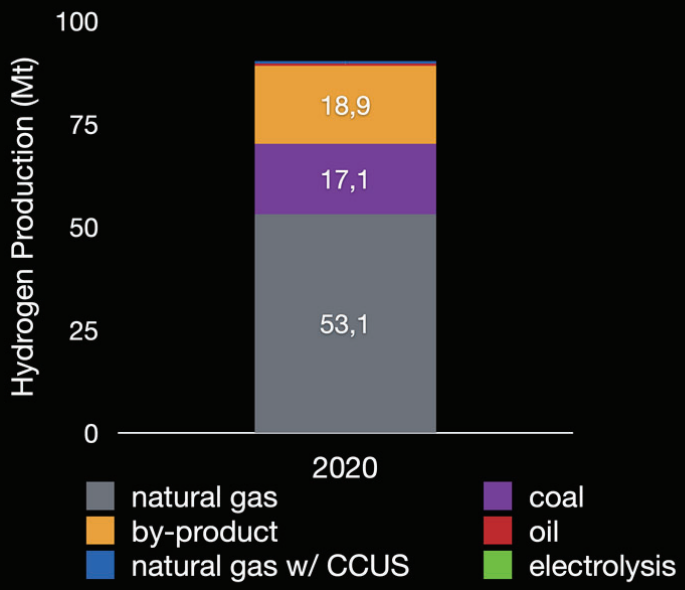



# Energy usage and emissions across the hydrogen supply chain are an important consideration for its use




Hydrogen supply chain may look like some version of this - illustrative of different supply chain components

# Current hydrogen production methods emit greenhouse gases




- 59% of global hydrogen produced by steam methane reforming (SMR) of natural gas → ~9 kg $CO_2$/kg $H_2$
- 19% of global hydrogen produced from gasification of coal → ~19 kg $CO_2$/kg $H_2$
- Only 0.7% of global hydrogen production from steam methane reforming of natural gas with carbon capture and storage (CCUS) → ~0.9 - 3.6 kg $CO_2$/kg $H_2$
- Negligible production of hydrogen from electrolysis



# Hydrogen production coded by 'color' misses some key considerations

**Steam Methane Reforming (SMR) of Natural Gas 'Grey Hydrogen'**

- Splits methane ($CH_4$) to produce $H_2$ with a by-product of $CO_2$
- ~9 kg $CO_2$/kg $H_2$ (at point of production)
- Must also consider upstream emissions
- Continued reliance on fossil fuel feedstocks
- ~95% of US hydrogen production

**Steam Methane Reforming (SMR) of Natural Gas with CCUS 'Blue Hydrogen'**

- Adds carbon capture and storage (CCUS) to SMR
- ~0.9 - 3.6 kg $CO_2$/kg $H_2$ (depending on capture rates)
- Must also consider upstream emissions
- Continued reliance on fossil fuel feedstocks

**Electrolysis with Renewable Electricity 'Green Hydrogen'**

- Uses electricity to split water ($H_2O$) into $H_2$ and $O_2$
- Lifecycle emissions are dependent on electricity emissions
- Renewable electricity use yields zero-carbon hydrogen
- Negligible amount of global production currently

# Title search: Global Hydrogen Trends and Opportunities

Also available as part of the eCourse
2023 Renewable Energy Law eConference

First appeared as part of the conference materials for the
18th Annual Renewable Energy Law Institute session
"Trends and Recent Activity - Hydrogen Energy Projects"