Princeton ACEE/Efilliates Annual Meeting

Decarbonization of Natural Gas via Hydrogen

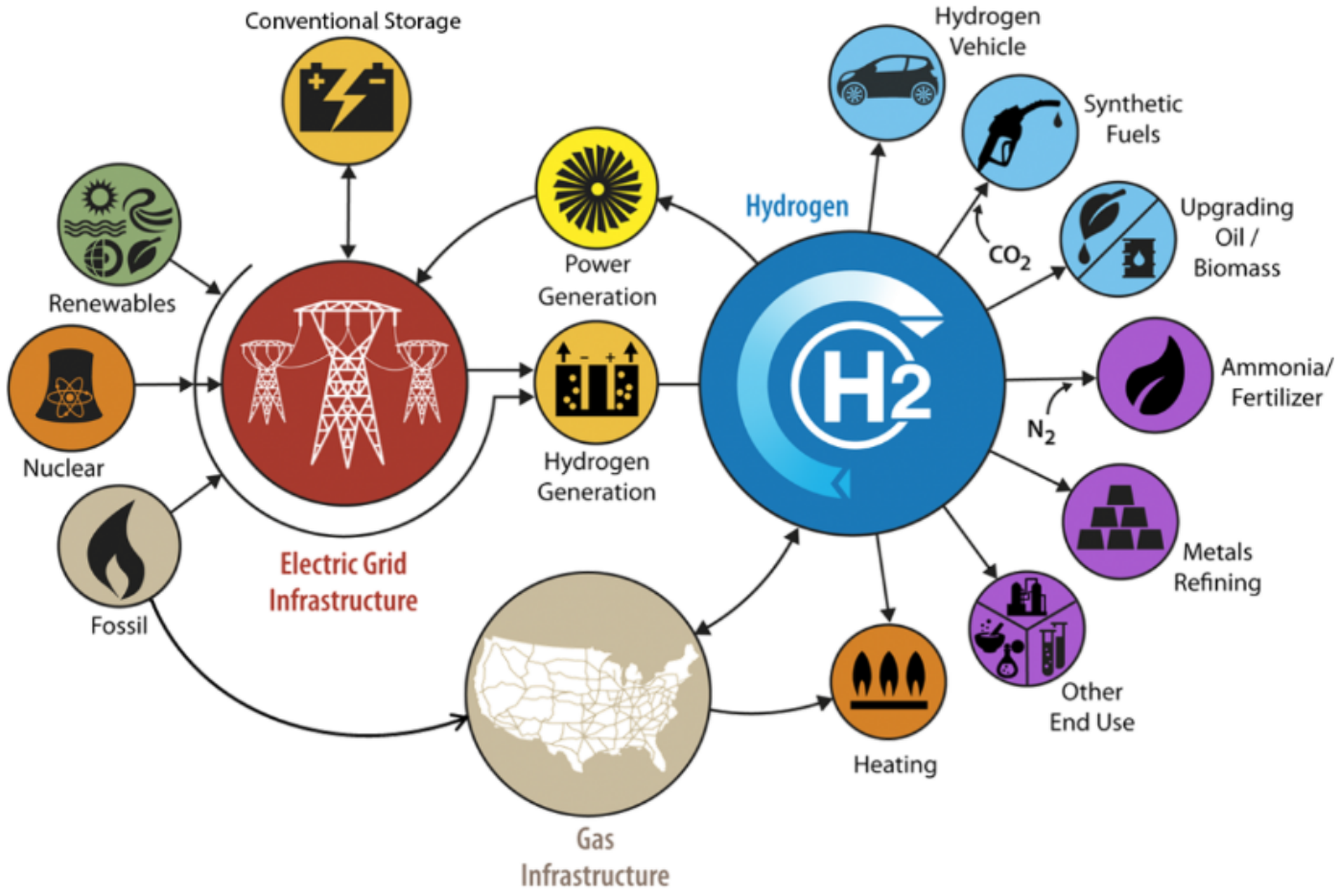
Energy lives here™

David C Dankworth

Natural Gas – Carbon => Hydrogen

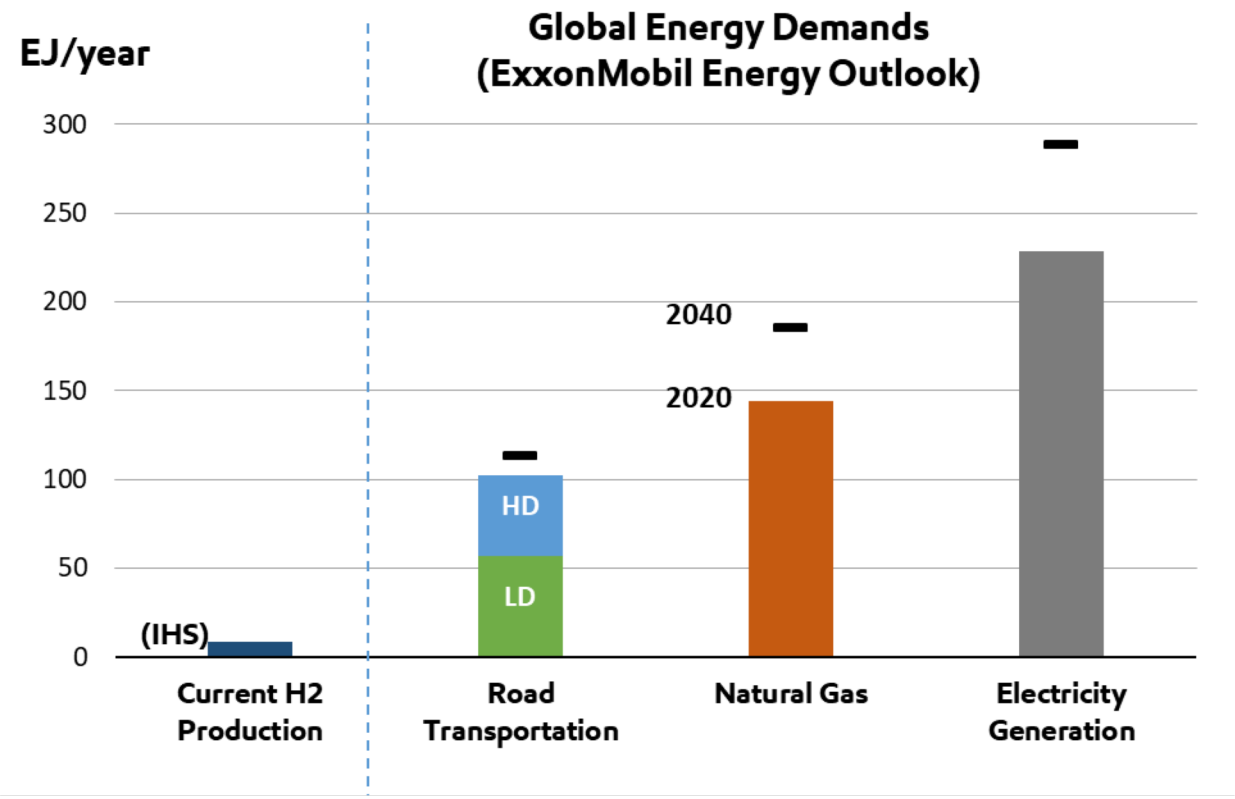
- Hydrogen has the potential to be a key low-carbon energy carrier.
- Enables zero emissions at end use.
- It’s possible to achieve very low CO2 impact during Hydrogen production.

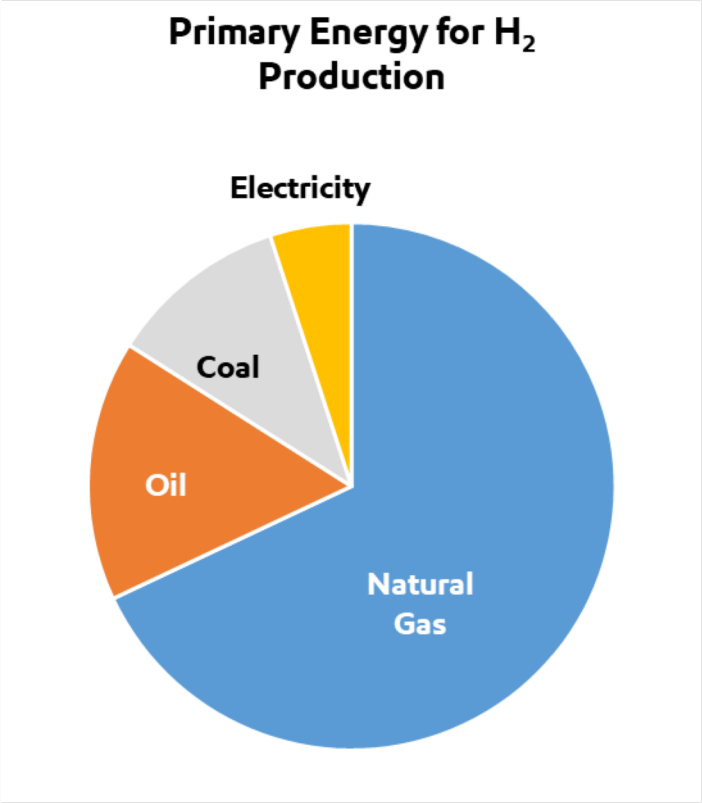
U.S. Department of Energy “Hydrogen at Scale”



Hydrogen Production and Use

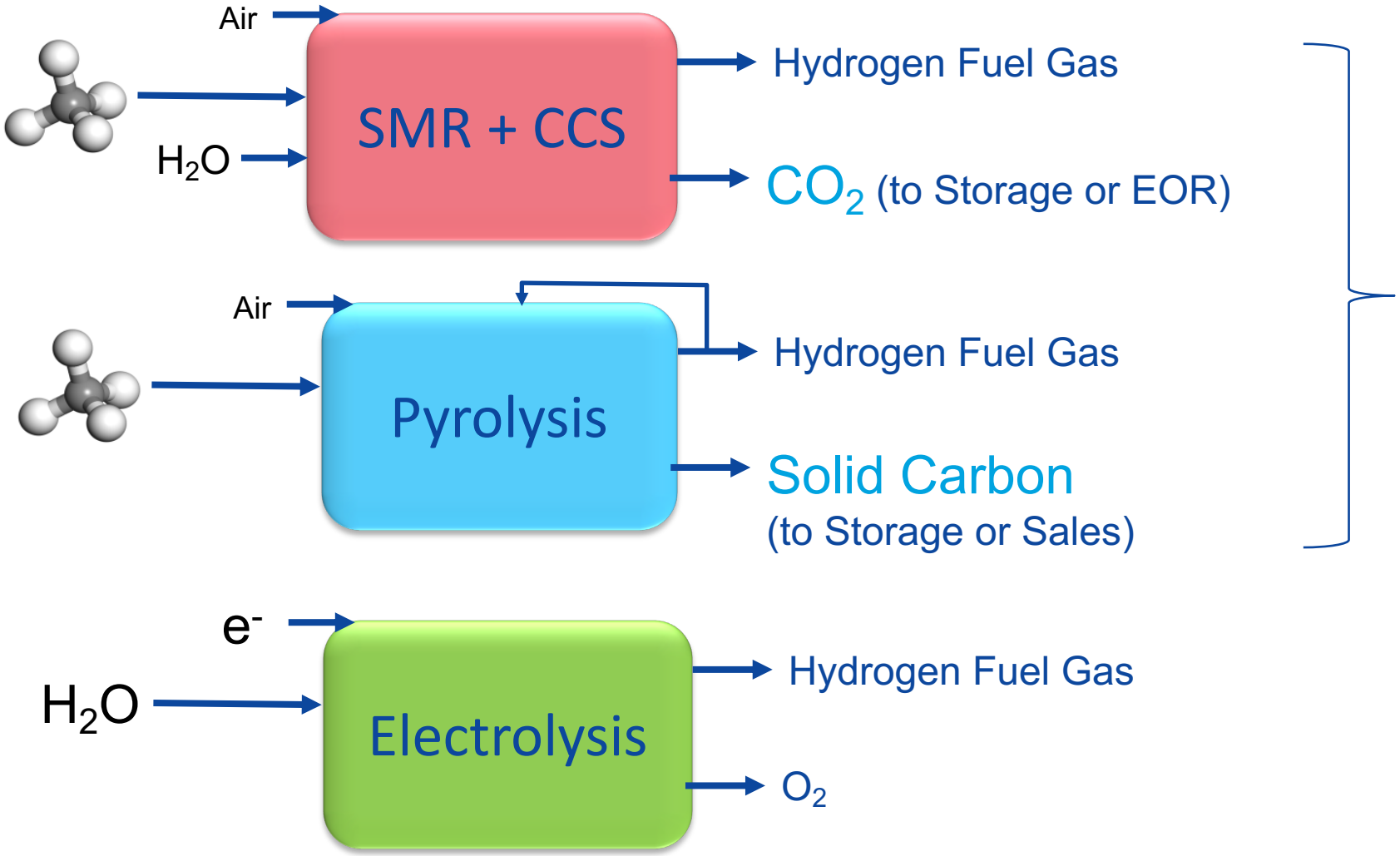
Current global H2 production: ~70 million metric tons per year





ExxonMobil

Options for Low CO_2 Hydrogen



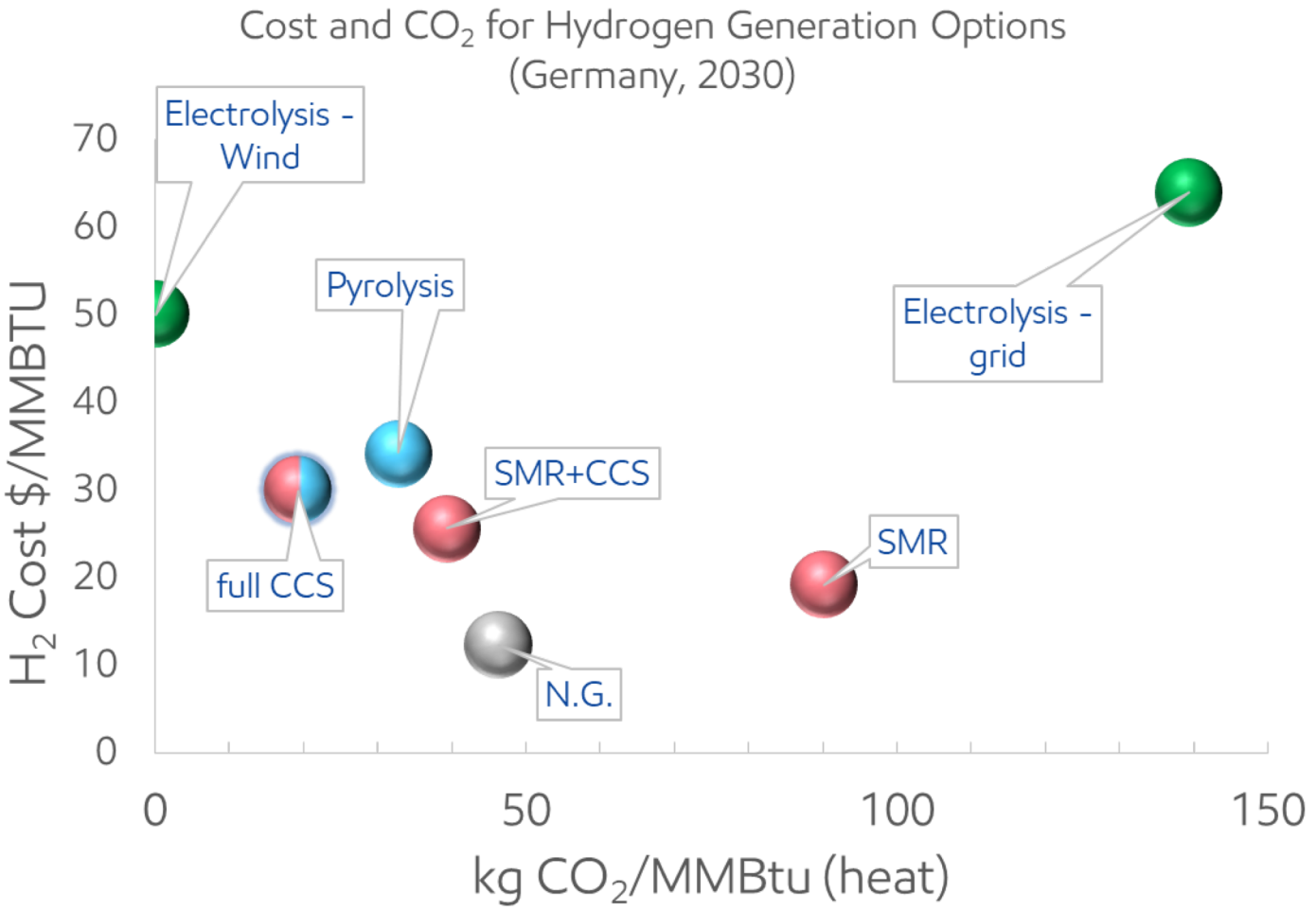
"Blue" Hydrogen
Fossil + Carbon Sequestration

"Green" Hydrogen
Water Splitting
(renewable electric power)

ExxonMobil

Low Carbon Hydrogen – Comparing the Options

- Electrolysis is highest cost option
- Hydrogen from NG carries GHG load from gas production and transport, will be location and source dependent.
- Improvements in Hydrogen Generation technology required for >50% impact vs direct firing.



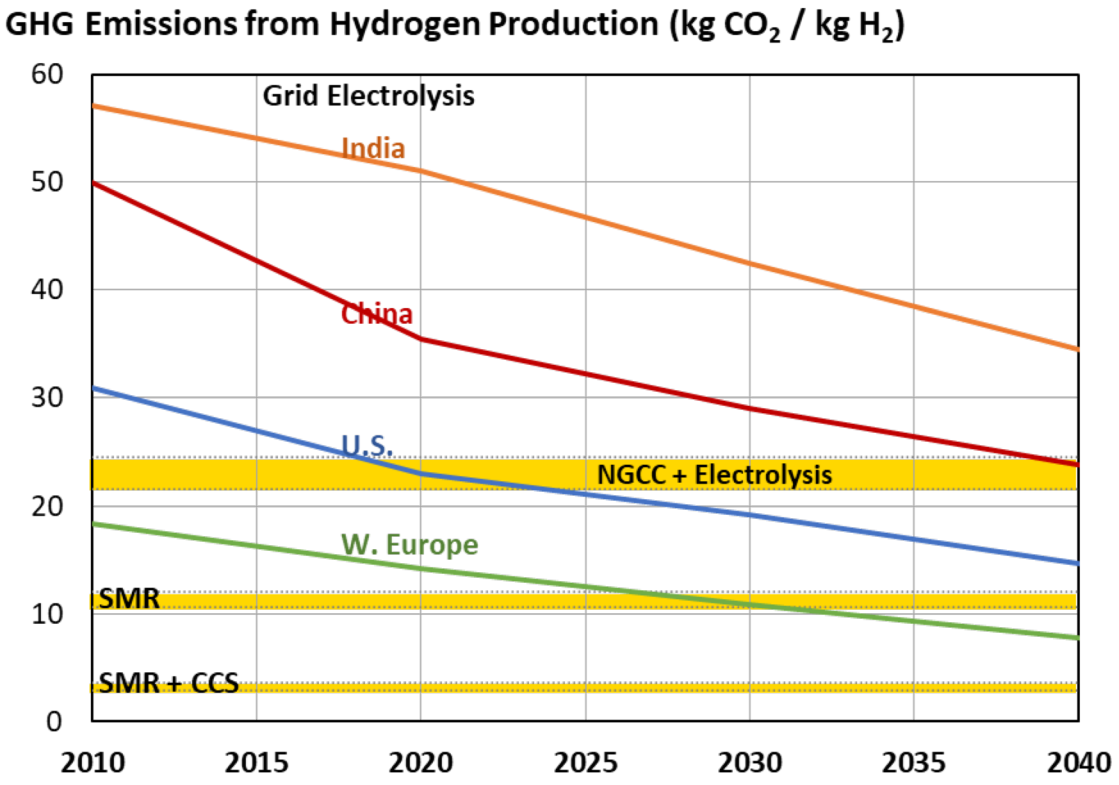
Based on 2030 Europe Outlook (Germany) for raw matl CO_2 footprint
Natural Gas Cost 12$/MMBTU, 0.46 t_{CO2}/t_{CH4} processing and transport

ExxonMobil

Machhammer et al, *Chem. Eng. Technol.* **2016**, 39, No. 6, 1185-1193
T. Keipi et al, *Energy Conv. & Mgmt*, **2018**, 159, 264-273

Hydrogen from Power?

- The source of power for P2G is critical to understanding the Life Cycle impacts of electrolysis with respect to GHG emissions.
- Steam reforming of methane combined with CCS is being investigated as a cost-competitive source of hydrogen compared to electrolysis using renewable energy



Source: ExxonMobil Energy Outlook and EMRE Analysis


ExxonMobil