Hydrogen and Canada's Energy Future: Opportunities, Challenges, Next Steps

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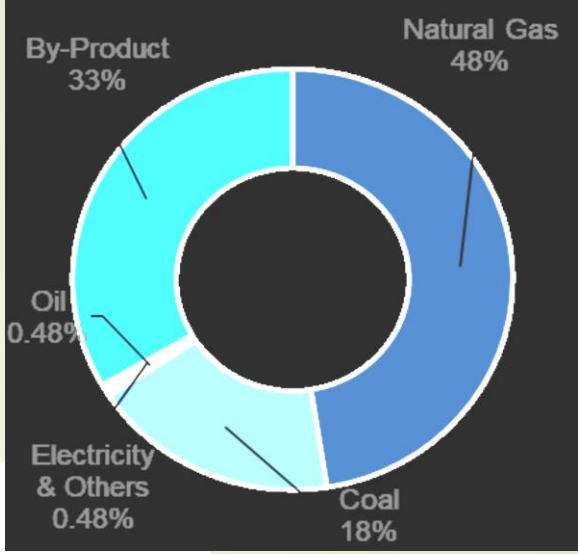
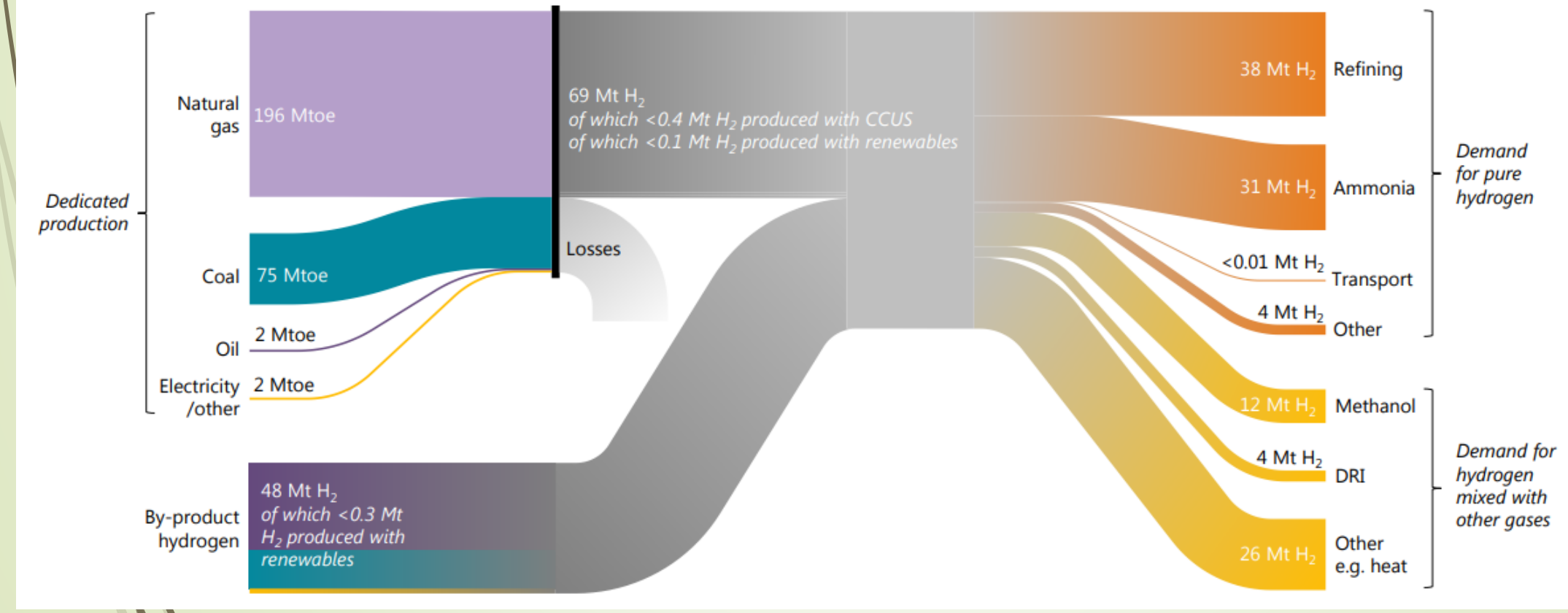
Hydrogen "colours" and Value Chain

Grey H2: from fossil fuels (NG, coal, oil, by product)
Blue H2: from NG with CCS
Green H2: from renewables
Purple H2: From nuclear



Global Hydrogen production by energy source

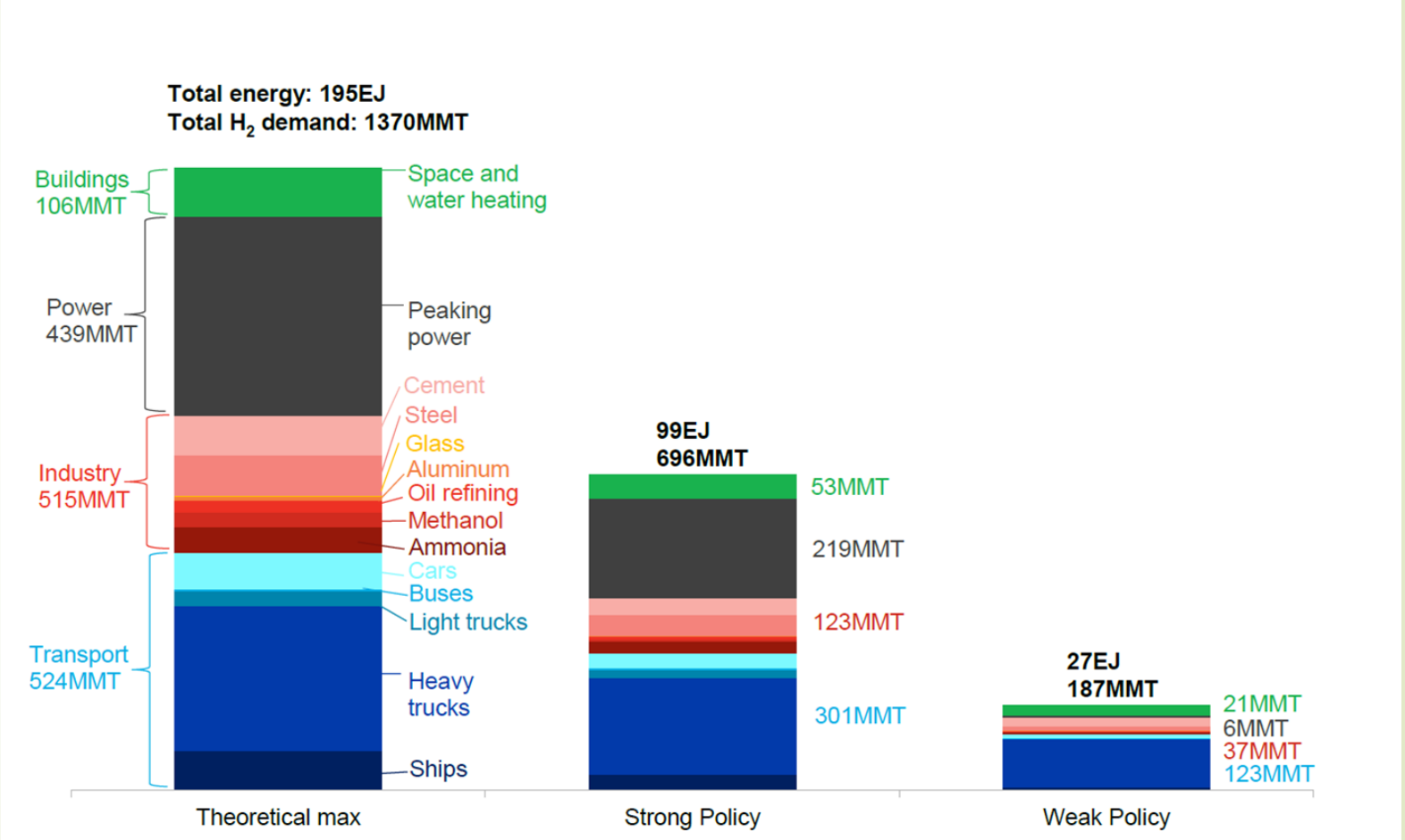
Figure 6. Today's hydrogen value chains



Source: The Future of Hydrogen, IEA Report, June 2019

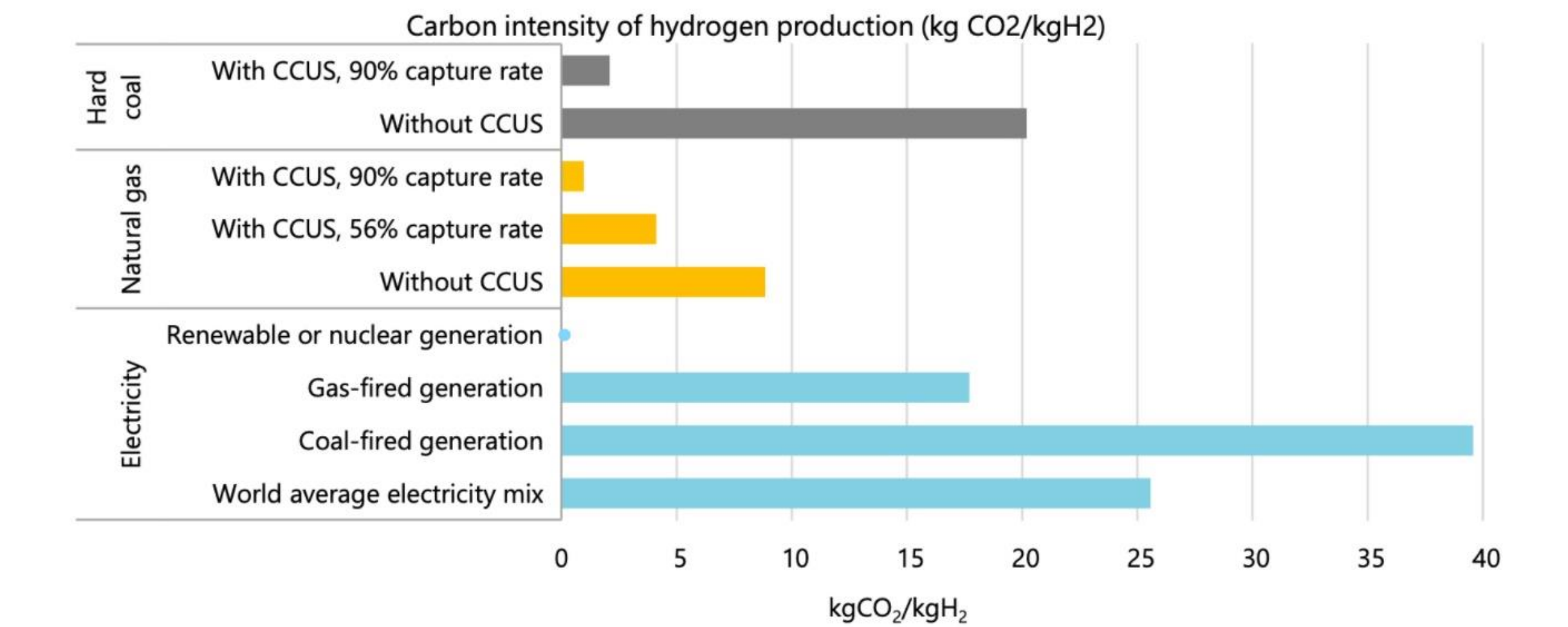
How and how much Hydrogen is currently produced?

- Canada produces ~**3 MMT/yr.**
- USA produces **~10 MMT/yr**.
- Global capacity is **~ 70 MMT/yr.**
- Global capacity of electrolyzers is **~0.2 GW**
- Achieving competitive hydrogen from electrolysis requires deployment of ~**70 GW**
- In the **decarbonisation scenario**, about 1/5th of the electricity generated in 2050 is converted to hydrogen for use in industry and transport sectors. Electricity generation would need an increase globally by 50%!



Source: Hydrogen Economy Outlook, Bloomberg NEF, March 2020; used with permission

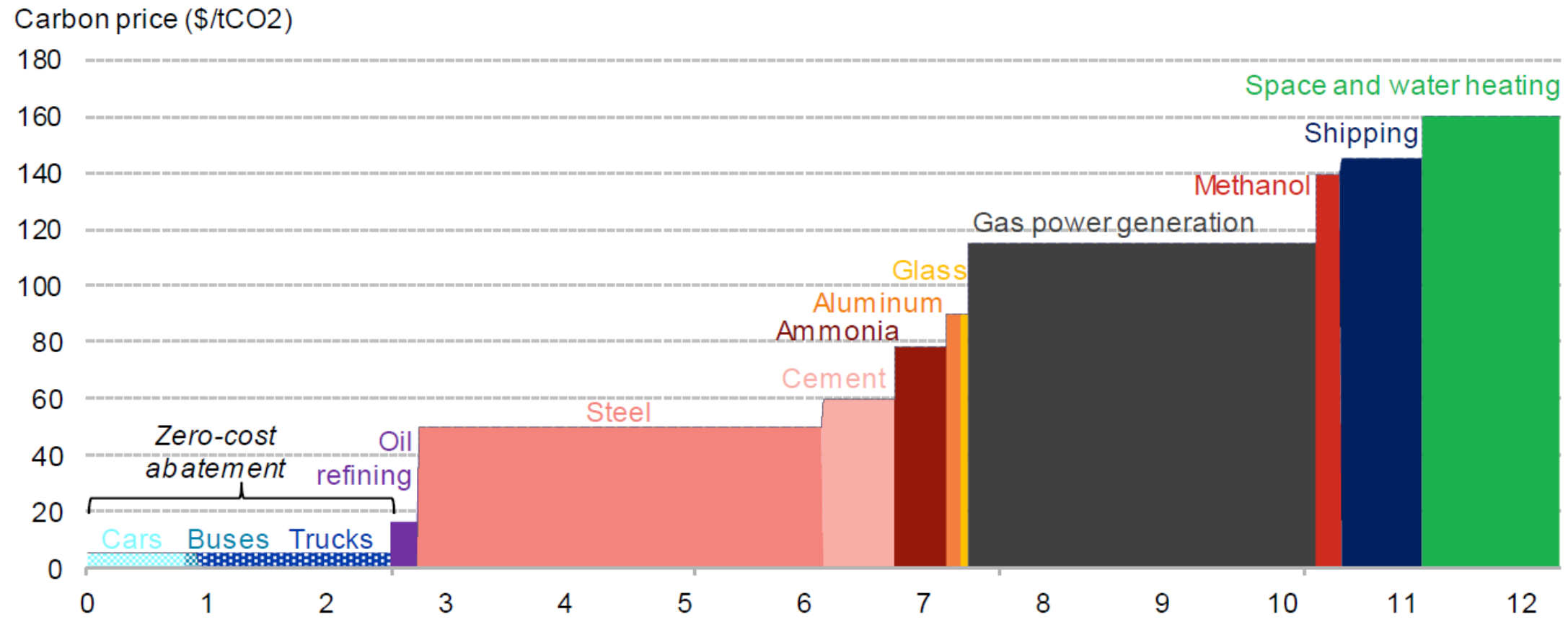
Carbon Intensity of Hydrogen Production (kg CO2/kg H2)



Source: IEA 2019 Report

Marginal Abatement Cost by Sector

Figure 7: Marginal abatement cost curve from using $1/kg hydrogen for emission reductions, by sector in 2050



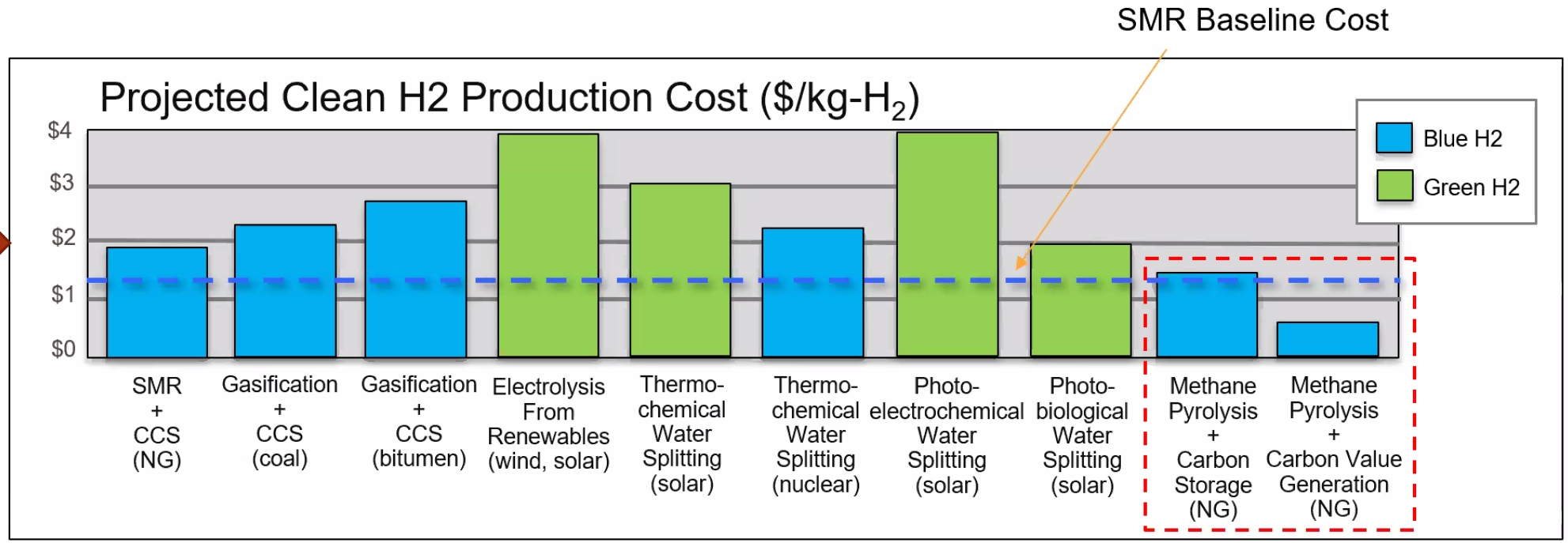
Source: Hydrogen Economy Outlook, Bloomberg NEF, March 2020; used with permission

Cost comparison by Method of Production

Technology Analysis

EKONA

Target



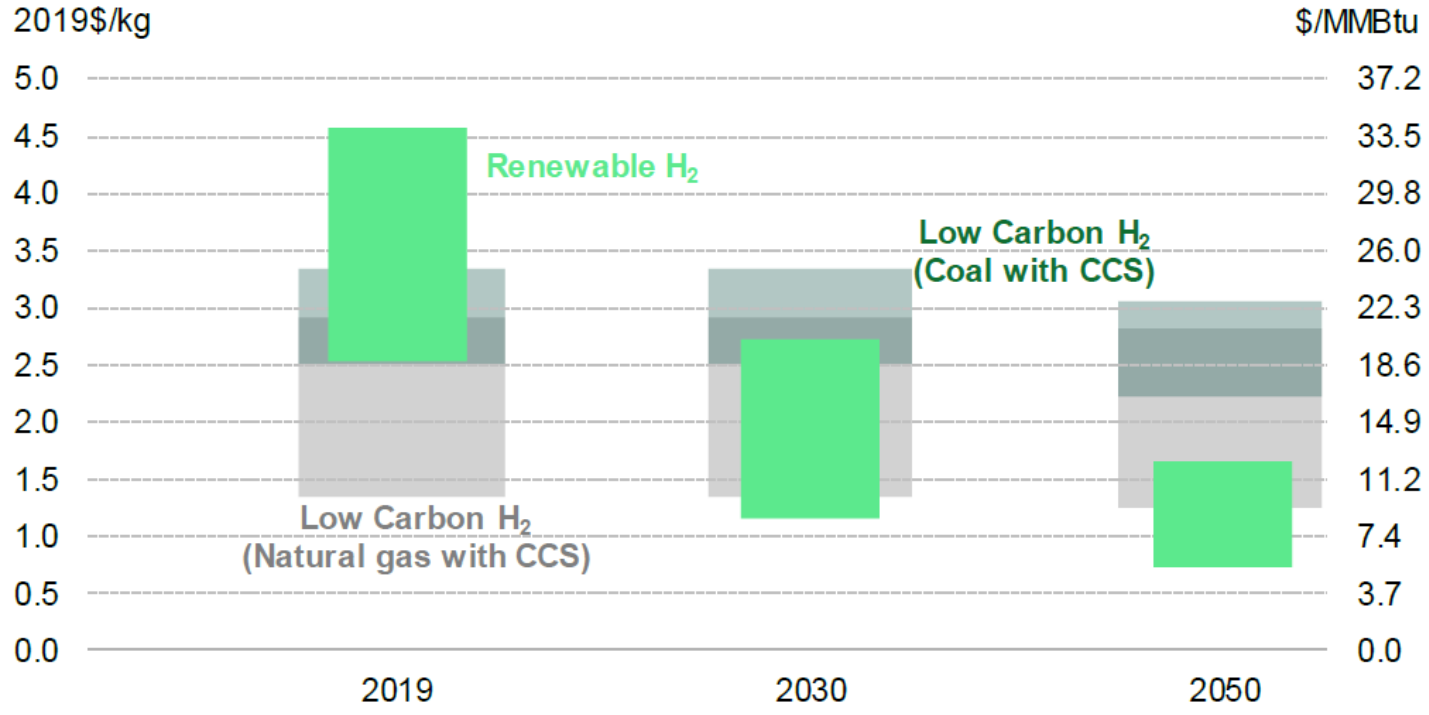
Source: Chris Reid, CEO, Ekona Power Inc. (used with permission)

Cost Forecast into 2050 (Blue vs Green)

Bloomberg NEF (March 30, 2020 Report)

- Hydrogen is projected to meet **24% of the global energy demand** by 2050.
- Hydrogen is likely to be most competitive in **large-scale local supply chains.**
- In the **decarbonisation scenario**, about 1/5th of the electricity generated in 2050 is converted to hydrogen for use in industry and transport sectors.

Figure 3: Forecast global range of levelized cost of hydrogen production from large projects



Source: BloombergNEF. Note renewable hydrogen costs based on large projects with optimistic projections for capex. Natural gas prices range from $1.1-10.3/MMBtu, coal from $30-116/t.

Price of electricity dominates electrolyzers economics

Summary

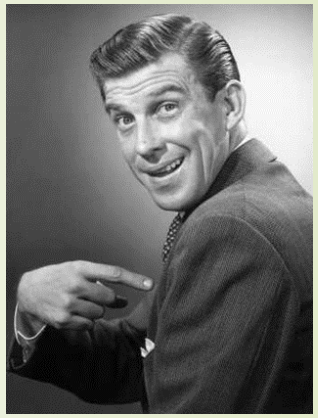
- Low-cost, scalable Green Hydrogen production is the single most important factor in accelerating the hydrogen economy.
- Focus on scaling applications and technologies that create the biggest 'improvement for-investment'
- Water splitting via thermo-chemical cycles using waste/process heat is one of the most economical methods of producing Green Hydrogen at scale.
- The clean energy technologies we will need tomorrow hinge on innovation today Technological innovations are essential in combating the impact of climate change.
- Hydrogen alone is not enough to reach zero-carbon by 2050. A more holistic approach to emissions reduction in all sectors is necessary

Concluding Thought

Our response to climate change should be:

- **I**nnovation
- **A**daptation
- **M**itigation

I A M responsible!



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