Hydrogen in the Arctic

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Arctic Energy Office: A Critical Part of the DOE Mission

Department of Energy Mission:

Ensure America's security and prosperity by addressing energy, environmental and nuclear challenges through transformative science and technology solutions.

Department of Energy Goals:

- Combat the climate crisis
- Promote energy justice
- Facilitate energy transition
- Create Clean Energy union jobs

Secretary of Energy

Deputy Energy Secretary

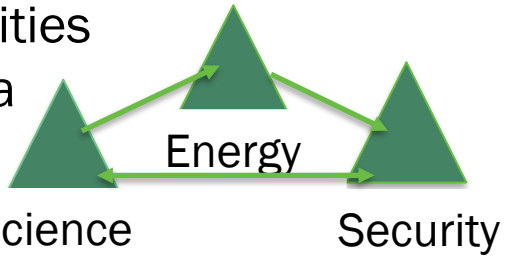
Under Secretary for Science and Innovation

Arctic Energy Office

AEO Vision:

*To bring the Arctic to the Department of Energy (DOE), and DOE to the Arctic. We collaborate in innovative ways to meet the **energy**, **science** and **security** needs of the US and its Arctic allies.*

- Headquarters offices
- National laboratories
- Interagency
- Communities
- Academia
- Industry

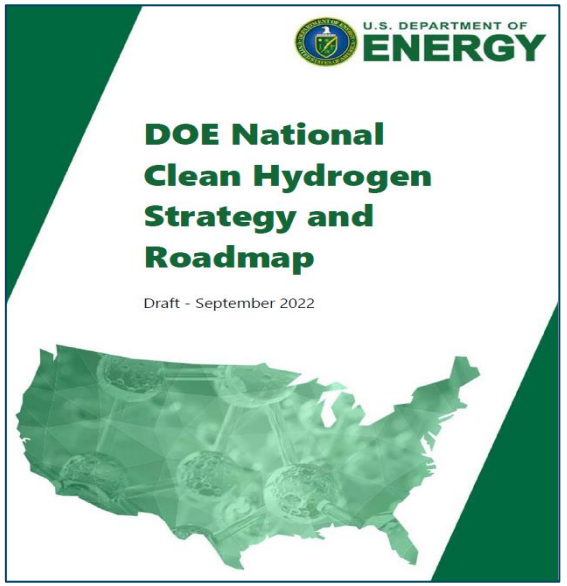


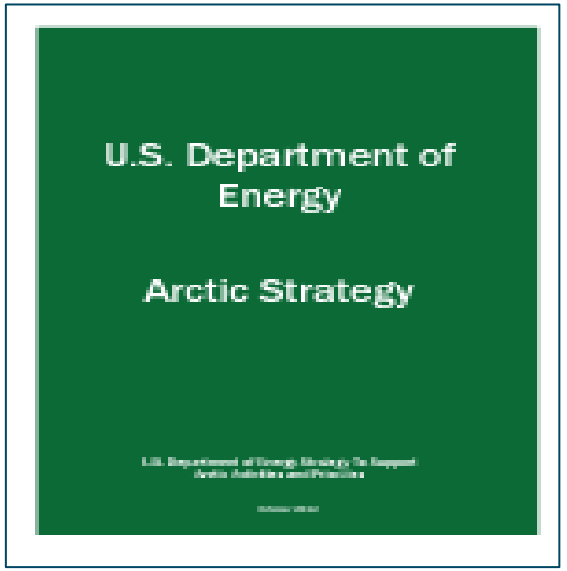
AEO's Role in Advancing Green Hydrogen

What are the economic, policy and technology drivers (and constraints) for its implementation in the Alaska context?

<u>To answer that question, AEO is:</u>

- Facilitating the Alaska State Hydrogen Energy Working Group and roadmapping process;
- Implementing the DOE Arctic Strategy;
- Working with stakeholders and other DOE offices to determine regional or scale considerations;
- Providing information about DOE Hydrogen programs & tools.





Hydrogen vs. Other Molecular Structures

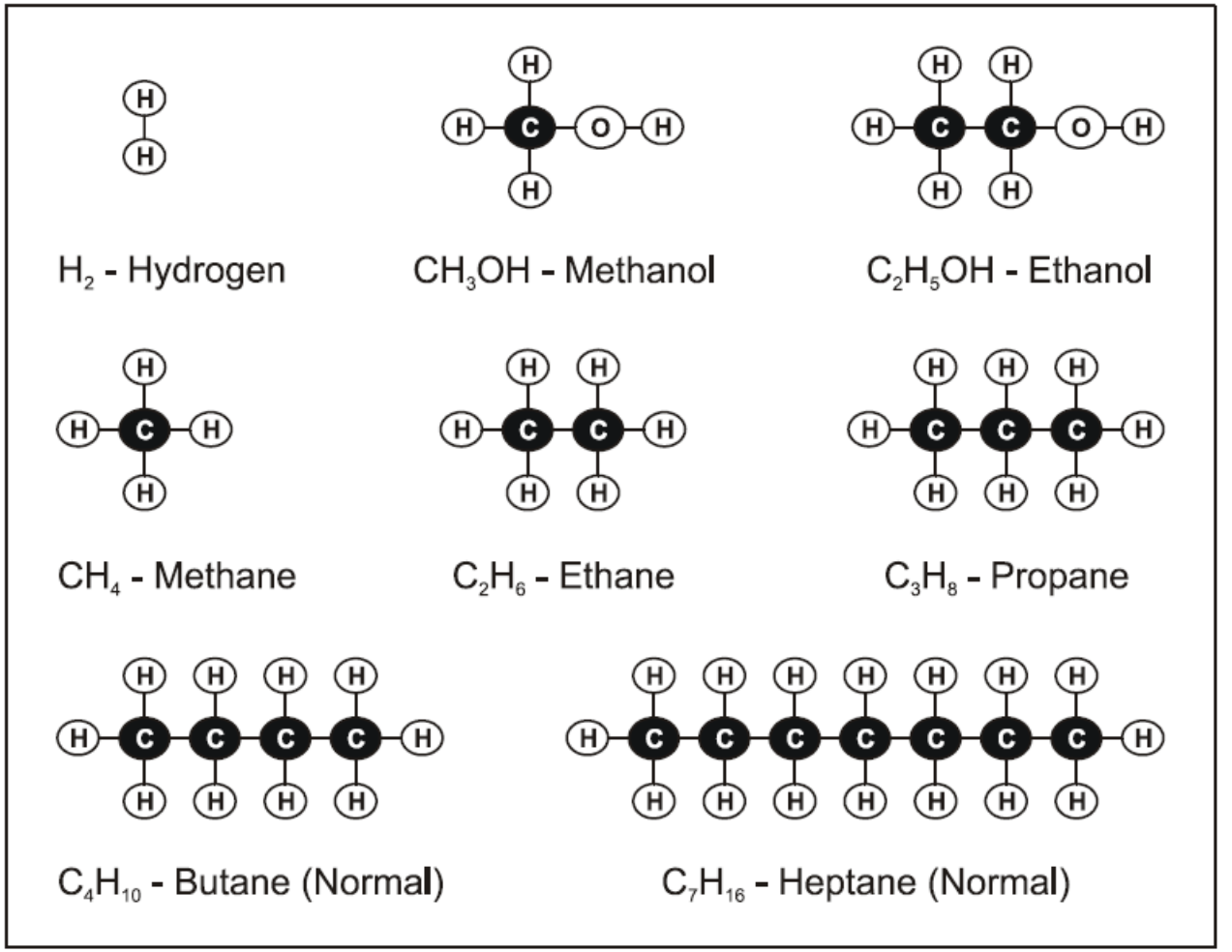
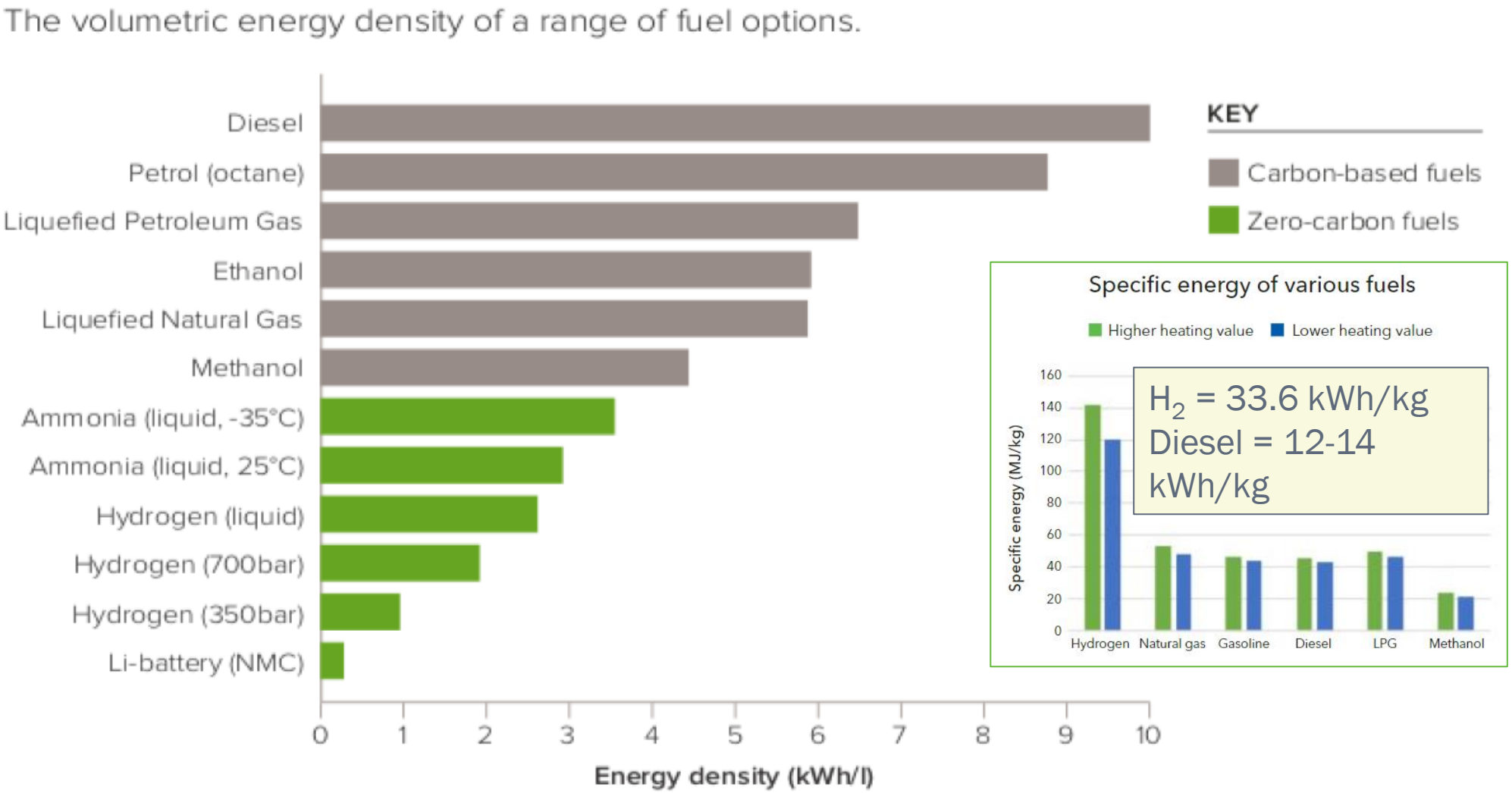


Figure 1-2 Chemical Structure of Common Fuels

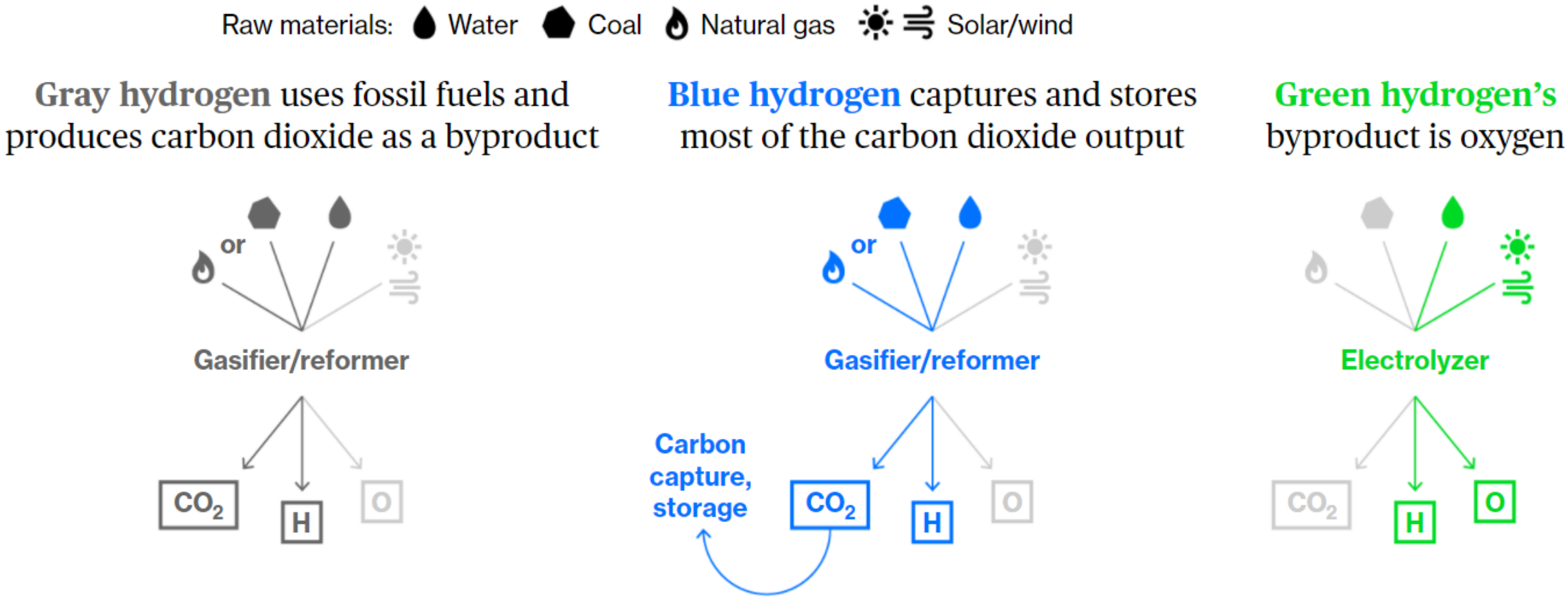
https://www1.eere.energy.gov/hydrogenandfuelcells/tech_validation/pdfs/fcm01r0.pdf

Density is Low Relative to Other Fuels, But Specific Energy is High



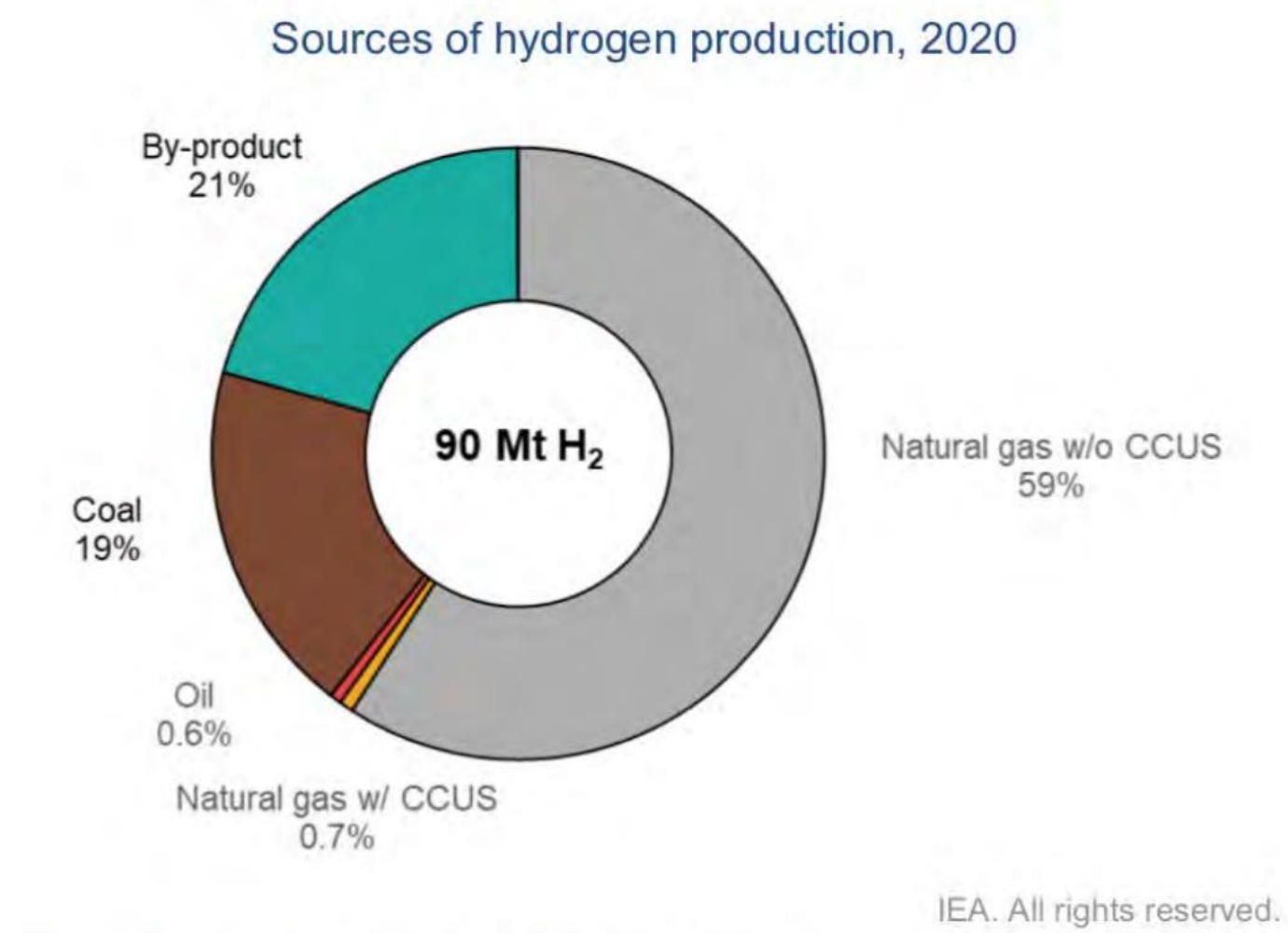
https://royalsociety.org/-/media/policy/projects/green-ammonia/green-ammonia-policy-briefing.pdf
https://www.dnvgl.com/publications/hydrogen-in-the-electricity-value-chain-141099

Hydrogen Colors (not used so much anymore)



https://www.bloomberg.com/graphics/2020-opinion-hydrogen-green-energy-revolution-challenges-risks-advantages/?sref=xfyiavTX

Mostly Gray and Brown Hydrogen Production Today



Note: CCUS = carbon capture, utilisation and storage.

https://iea.blob.core.windows.net/assets/3a2ed84c-9ea0-458c-9421-d166a9510bc0/GlobalHydrogenReview2021.pdf

The Big Picture

On February 28th, 2022, the Intergovernmental Panel on Climate Change (IPCC) released its latest report under the Sixth Assessment cycle.

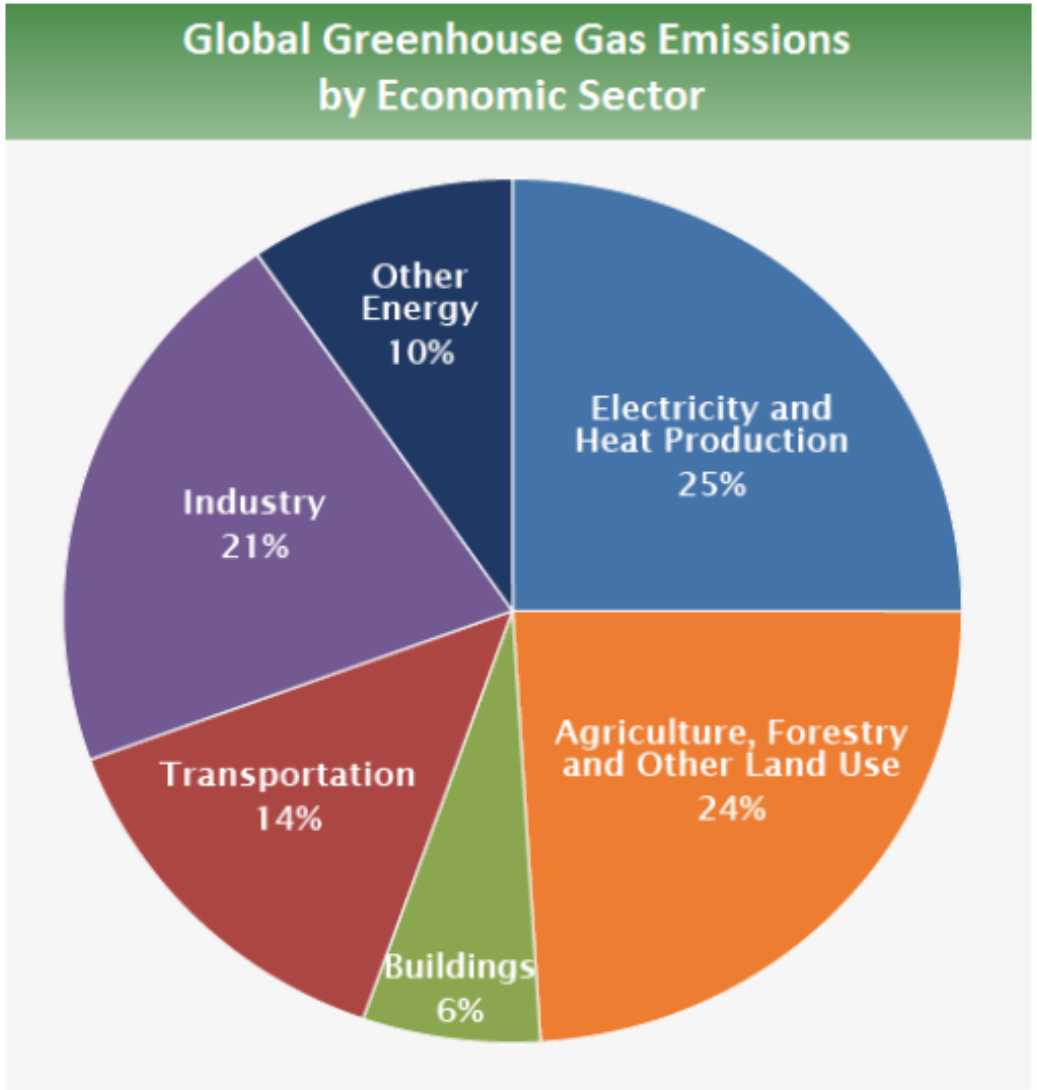
One of the key takeaways:

It is critical that we try to stay **below 1.5 degrees warming.**

If global warming exceeds 1.5°C in the coming decades or later, then many human and natural systems will face additional severe risks compared to remaining below 1.5°C.

https://www.ipcc.ch/report/ar6/wg2/

The Drivers



https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

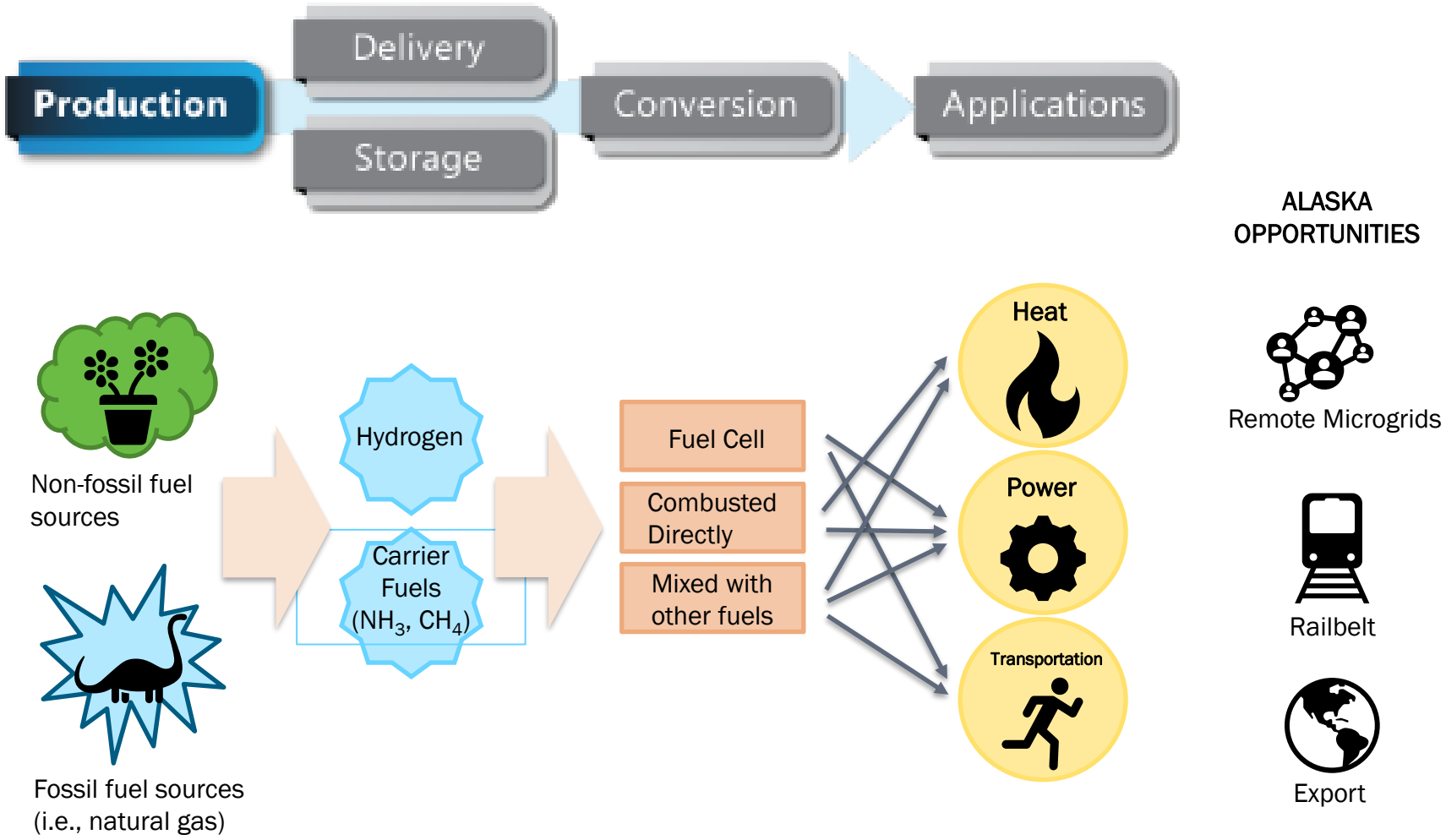
Existing and Emerging Demands for Hydrogen

	Transportation Applications	Chemicals and Industrial Applications	Stationary and Power Generation Applications	Integrated/Hybrid Energy Systems
Existing Growing Demands	• Material-Handling Equipment • Buses • Light-Duty Vehicles	• Oil Refining • Ammonia • Methanol	• Distrubuted Generation: Primary and Backup Power	• Renewable Grid Integration (with storage and other ancillary services)
Emerging Future Demands	• Medium-and Heavy-Duty Vehicles • Rail • Maritime • Aviation • Contruction Equipment	• Steel and Cement Manufacturing • Industrial Heat • Bio/Synthetic Fuels	• Reversible Fuel Cells • Hydrogen Combustion • Long-Duration Energy Storage	• Nuclear/Hydrogen Hybrids • Gas/Coal/Hydrogen Hybrids with CCUS • Hydrogen Blending

Figure 1. Existing and emerging demands for hydrogen

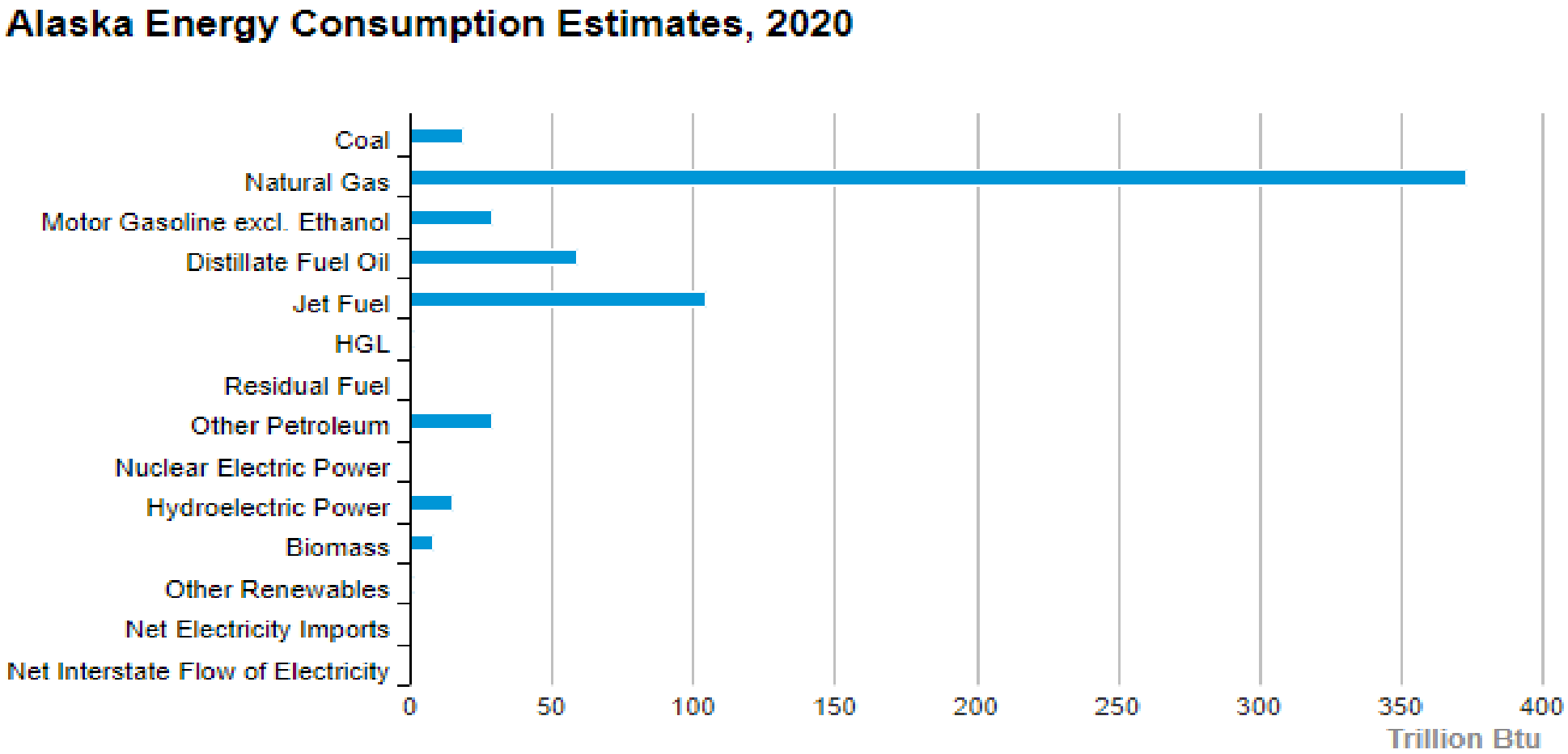
https://www.hydrogen.energy.gov/pdfs/hydrogen-program-plan2020.pdf?utm_source=Daily%20on%20Energy%20111220_11/12/2020&utm_medium=email&utm_campaign=WEX_Daily%20on%20Energy&rid=208149

Hydrogen Possibilities in Alaska



https://www.hydrogen.energy.gov/pdfs/hydrogen-program-plan-2020.pdf?utm_source=Daily%20on%20Energy%20111220_11/12/2020&utm_medium=email&utm_campaign=WEX_Daily%20on%20Energy&rid=208149

Points of Reference



https://www.eia.gov/state/print.php?sid=AK

Points of Reference

- Alaska's Railbelt has an electrical load of ~600 MW (~5 million MWh annually).
  - More than 300 million kg H_2 required to meet 100% of that load, if powered solely by hydrogen fuel cells.

- REPowerEU set a target of 10 million tonnes (= 10 billion kg) of domestic renewable hydrogen production and 10 million tonnes of renewable hydrogen imports by 2030.

  [https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A230%3AFIN&qid=1653033742483]

- China is the largest producer of hydrogen today (33 Mt – million tons = 33 billion kg), mostly from fossil fuels. Demand projected to reach 35 Mt in 2030 (~5% of Chinese energy supply) and 60 Mt in 2050.

  [https://www.csis.org/analysis/china-unveils-its-first-long-term-hydrogen-plan]

DOE Hydrogen Programs & Tools

H_2 Matchmaker

A tool to assist hydrogen suppliers, users to identify collaborators, opportunities to expand regional hydrogen hubs.

Hydrogen Shot

The first Energy Earthshot, launched 6/7/2021 aims to reduce clean hydrogen costs by 80% to **$1** per **1 kilogram** in **1 decade** ("**1 1 1**"). $47M in funding.

H_2 Twin Cities (part of the COP26, Climate Energy Ministerial)

To accelerate hydrogen deployments by pairing communities worldwide to collaborate at the city level.

H_2@Scale

To advance affordable hydrogen production, transport, storage, and use for revenue opportunities in many sectors.

H_2Hubs

DOE received 79 concept papers, using $150B of their capital + $7B of DOE funding. DOE encouraged or discouraged full applications from applicants.

Thank You!

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