
GEOLOGIC H₂ – A NEW FRONTIER?

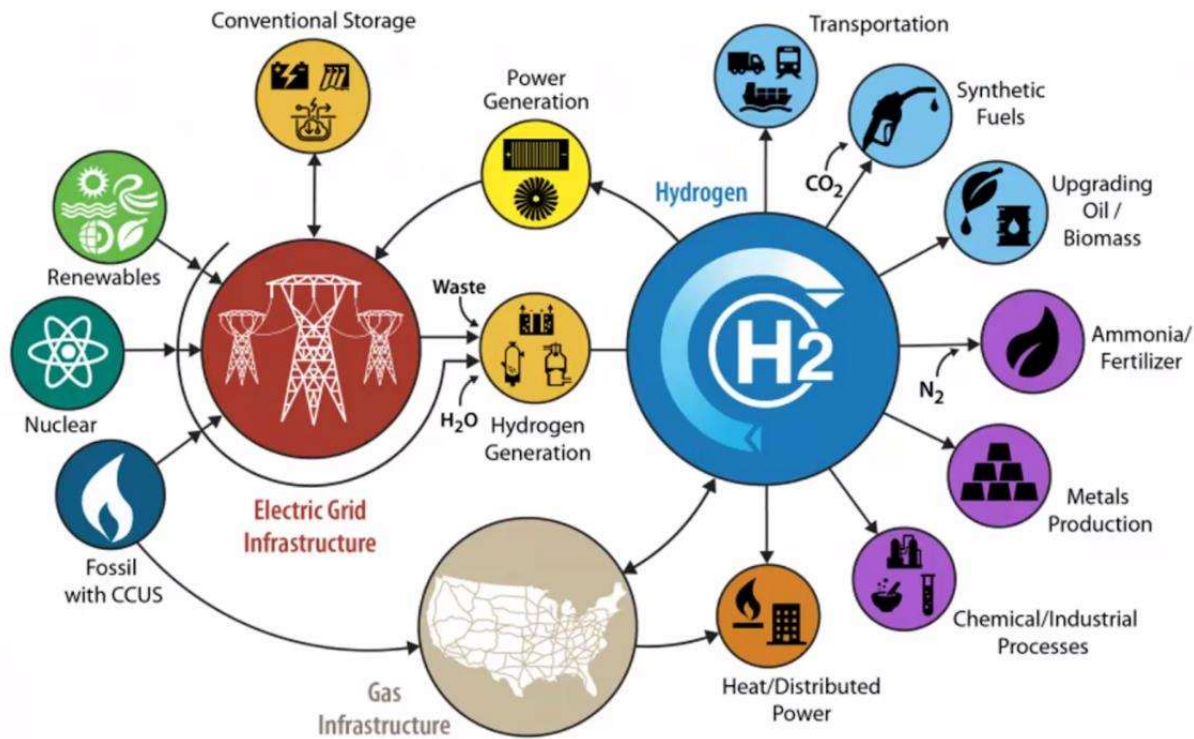
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April 17, 2024



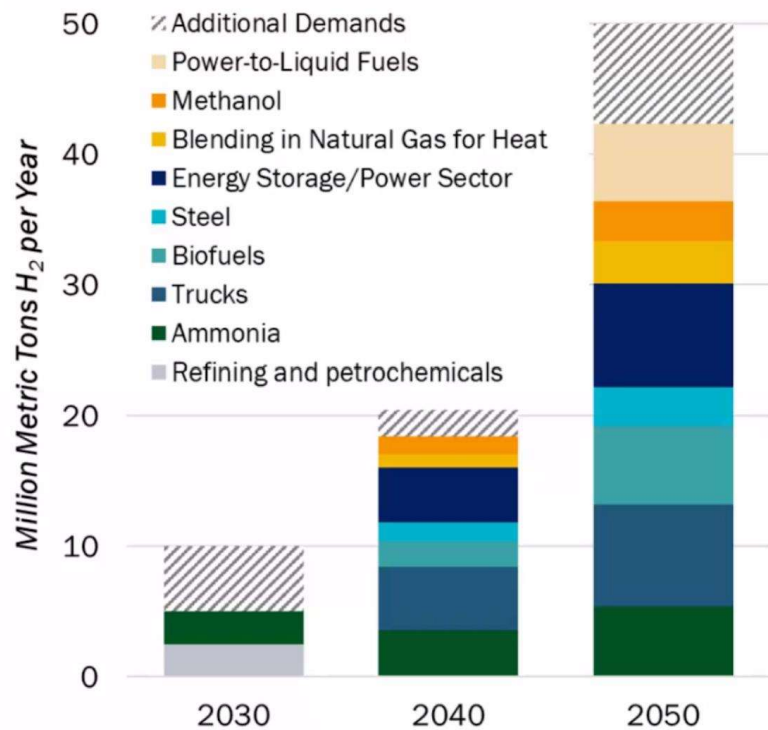
<https://www.forbes.com/sites/alanohnsman/2023/06/26/forget-oil-new-wildcatters-are-drilling-for-limitless-geologic-hydrogen/?sh=5ff43da761c8>

CLEAN HYDROGEN PLAYS ROLE IN DECARBONIZATION



<https://www.hydrogen.energy.gov/library/roadmaps-vision/clean-hydrogen-strategy-roadmap>

THE U.S. NATIONAL HYDROGEN STRATEGY AND ROADMAP



- 10 million metric tons of demand by 2030
- 50 million metric tons of demand by 2050
- Up to 10% economy-wide emissions reductions
- Strategic deployments of clean fuels and products in Sustainable Aviation Fuels, Ammonia/Methanol, and Power-to-Liquid Fuels
- **Challenges:** Clean H2 cost; renewable energy usage; Infrastructure needs.

WHAT IS GEOLOGIC / NATURAL H₂?

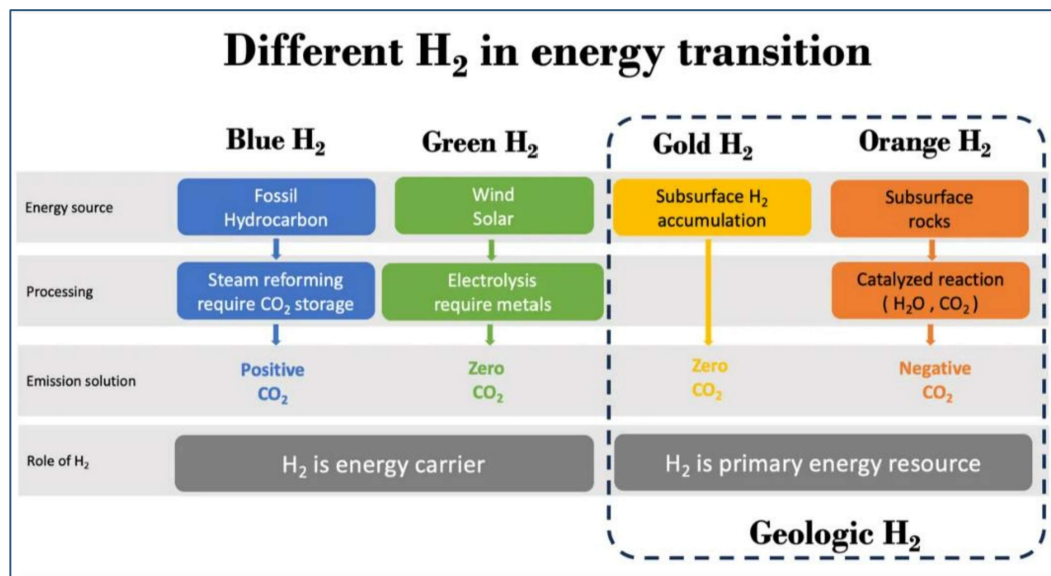
(definition is evolving)

- “Geologic hydrogen consists of continuously-generated, naturally-occurring (accumulating) subsurface hydrogen deposits, formed by reactions between rock in the Earth’s subsurface and water. “
- “The resource could be harnessed when it degases on the earth’s surface or when extracted with boreholes with or without subsurface in-situ stimulation.”
- “The Earth continuously produces natural hydrogen through chemical reactions that are mainly related to oxidation of ferrous iron minerals. It is renewable if we control the rate of extraction to the rate of generation.”



Picture of the continuously burning gas seep at Chimaera, near Antalya, Turkey. The gas contains 7.5–11.3% H₂.

UNLOCK GEOLOGIC HYDROGEN – TWO POTENTIAL PATHWAYS ?



<https://geophysics.mines.edu/geoh2/>

Pathway 1 - White/Gold H₂

- Looking for accumulations.
- H₂ production via conventional technology.
- Economic volume?

Pathway 2 – Orange H₂

- Looking for source rocks.
- H₂ generation and production via subsurface stimulation including catalyzed reaction.
- Commercial production rate? Well counts? Environmental Impact?

ARPA-E GEOLOGIC H2 EXPLORATORY RESEARCH PROGRAM (\$20MLN)

Production of Geologic Hydrogen Through Stimulated Mineralogical Processes

Stimulation and generation:

- Methods to enhance, control, and sustain serpentinization or other relevant processes for the generation of hydrogen,
- Experimental data to show that the technology meets the overall Geologic H2 and Category 1-specific performance targets

Modeling and Characterization

- Predicting and evaluating the yield and scale of stimulation methods
- methods to monitor, characterize, and confirm stimulation production

Subsurface Engineering for Hydrogen Reservoir Management

Economic Extraction and Subsurface Engineering

- Hydrogen containment and production
- Extraction and transport
- Downhole gas separations

Modeling and Characterization

- Identification of targeted reservoirs
- Characterization of source rocks
- Monitor stimulated hydrogen production
- Reservoir Management methodologies

Risk Management

- Leakage/Greenhouse Gas Effects
- Subsurface Contamination
- Seismicity (Volume Expansion, etc.)
- Biological Effects



QUESTIONS REMAIN TO BE ANSWERED

- **Formation and Accumulation Mechanisms:** How is geologic hydrogen formed, and what geological processes contribute to its accumulations?
- **Extraction Technologies:** What innovative wells and production technologies can be developed for the efficient extraction of geologic hydrogen from the subsurface?
- **Environmental Impact:** What are the environmental implications of extracting and utilizing geologic hydrogen on a large scale?
- **Economic Viability:** What is the economic feasibility of geologic hydrogen production?
- **Safety Considerations:** What safety measures and protocols are required for the extraction, storage, and utilization of geologic hydrogen?
- **Policy and Regulatory Frameworks:** What policies and regulations are needed to support the responsible development of geologic hydrogen resources?
- **Long-Term Impact:** How might the widespread adoption of geologic hydrogen impact global energy dynamics, geopolitical relations, and the overall transition to a sustainable energy future?