COLORADO HYDROGEN NETWORK

www.colorado-hydrogen.org

Monthly Meeting
21 October 2025

Agenda

- Coming Events
  - Saoradh Hydrogen Mountain Retreat, Boulder
  - Hydrogen Tech Expo, Hamburg
  - FlyingHY, Online
  - CREA Energy Innovations Summit, Westminster
  - ClimateCon!, Denver (Feb 2026)
  - RE+ Charge H2, Seattle
  - Drilling for Hydrogen (May 2026)
- “Capstone” project, University of Colorado
- Tech-Talk
  - Direct solar-to-hydrogen vs electrolysis-from-solar
  - Stationary energy storage – Battery vs hydrogen
  - Drilling technology for hydrogen & geothermal

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Coming Event

Attendees		
AFRY	Electric Hydrogen	Nikkiso CEIG
Agami Zero, Inc.	Electric Power Research Institute (EPRI)	North America Orion Steel
Alternative Fuels & Hydrogen Caterpillar	Energy Capital Ventures	NREL
American Honda Motor Co.	Energy Systems	OCA Ventures
Ammobia Inc.	Energy Transfer	OMC Hydrogen
Apricus Capital Partners	ENGIE North America	OneH2
Attorney General State of Colorado	Foley Hoag LLP	P2X AFRY
B&W	Graphitic Energy	Pickwick Capital Partners
BayoTech	Gulf Coast Energy Catalysts	Ramboll
Blaze Energy Technologies	H Cycle, LLC	RASEI
Bosch LLC	Hestia Energy	Renewable & Sustainable Energy Institute U of Colo
CapCO2 Solutions	Hydrogen Fuel Cell Partnership	Robert Bosch LLC
Carbon Solutions	**HyReveal**	Stanford University
Gold Hydrogen (now Eclipse Energy)	Hyroad Energy	Sumitomo Corporation of Americas
CHARGE/PNWH2	HySource	**SunHydrogen**
Claire Technologies	HyVizion Advisory	The Pape Group
Climate Adaptive Infrastructure	Independence Hydrogen	**Toyota Tsusho**
Colorado Cleantech	Japan Hydrogen Forum / Mitsui & Co.	True Green Capital
Colorado Frontier Consulting/SEP	LSB Industries	Uniper Global Commodities North America
Colorado Hydrogen Network	Methylennium Energy Corp.	United States Hydrogen Alliance
Colorado Innovation Center Fortescue	Mitsubishi Corporation (Americas)	University of Colorado
Critical Chemicals Company LLC	Modern Hydrogen	US Hycamite
Davis Graham & Stubbs LLP	**Toyota Motor North America**	West Virginia Methanol
EdgeCloudLink	**New Day Hydrogen**	Xcel Energy
	New Energy Management	

SAORADH™ ENTERPRISE PARTNERS

- Presented by Saoradh (SEP)
  - Second annual event
  - Boulder Oct 30-31
- Learning, collaborating, networking
- CHN invited to lead Geologic H_2 Panel

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Coming Events

Hydrogen Technology Expo Europe
October 21-23 Hamburg Messe, Germany
Register at: www.hydrogen-worldexpo.com

FLYING HY Conference
Hydrogen Aviation Event
November 5, 9:00 AM to 1:00 PM CST, Virtual On Zoom
Register at: www.hysky.org

Coming Events

Colorado Rural Electric Association (CREA)
Energy Innovations Summit
Westin Westminster Hotel
10600 Westminster Blvd, Westminster,
November 3, 8:00 to 4:30 MST
Info and registration: crea.coop

Brian will be moderating a panel discussion

ClimateCon!

ClimateCon! Denver
February 2, **2026**
3000 Lawrence St, Denver
Info and registration: climatecon.world
Earlybird rate for the first 50 applicants

Brian will be moderating a panel discussion

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Coming Events

RE+ Charge H2
November 19-20
Seattle Convention Center
Register at: re-plus.events/charge-h2
Earlybird rate till Oct 3

Engage with leaders and discuss the key issues affecting the growth and development of emerging Hydrogen Hubs in the United States

- Building the global hydrogen economy
- H2 Hubs – Status, Growth and National Strategy
- Sustainable fuels for maritime and aviation
- Building the workforce for the Hydrogen Hubs
- Microgrids, Data Center, Bitcoin and AI-Powered Energy Systems.

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Coming Events

More info when it becomes available

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“Capstone Project” Presentation

- The Capstone Project is a required collaborative project completed in partnership with a public, private, or non-profit organization
  - University of Colorado (CU) Environmental Degree
    - Masters of the Environment
  - Partnership with NREL
- NREL – Genevieve Saur, Sr. Research Engineering Analyst - Hydrogen Systems
- Students
  - Olivia Robinson
  - Peyton Furr
  - Cass Mendoza
  - Shefali Praveen Chandra

See the recording of the meeting on the CHN channel on YouTube here for this presentation.

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Announcements

Podcast

- Brian was the guest on a recent podcast "Green Giants – Titans of Renewable Energy"
  - October 10th episode
- Encouraging everyone to listen to either
  - Audio podcast version or
  - Video YouTube version
- Why listen?
  - Summarizes
    - Renewable energy & what's needed to deploy it
    - Misconceptions about renewable energy
    - Great source to refer to hydrogen skeptics or novices

GreenGiantsPodcast

GreenGiantsYouTube

Association of Geological Hydrogen

Website: ageoh2.org

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Gold Hydrogen is now Eclipse Energy

GOLD H_2

goldhydrogen.com

ECLIPSE ENERGY

eclipseenergy.co

Generating hydrogen in old oil reservoirs using microbes

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Tech-Talk

- Direct solar-to-hydrogen vs electrolysis-from-solar
- Stationary energy storage – Battery vs hydrogen
- Drilling technology for hydrogen & geothermal

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In the News

Sun Hydrogen announces the deployment of a **solar-to-hydrogen** pilot system with the University of Texas at Austin

Peak Energy announced the grid deployment of its **sodium iron pyrophosphate battery** (NFPP) – the first ever megawatt-hour, utility-scale battery storage system

Quaise Engineering sets new milestone with **non-contact drill** by boring 387 feet through solid granite

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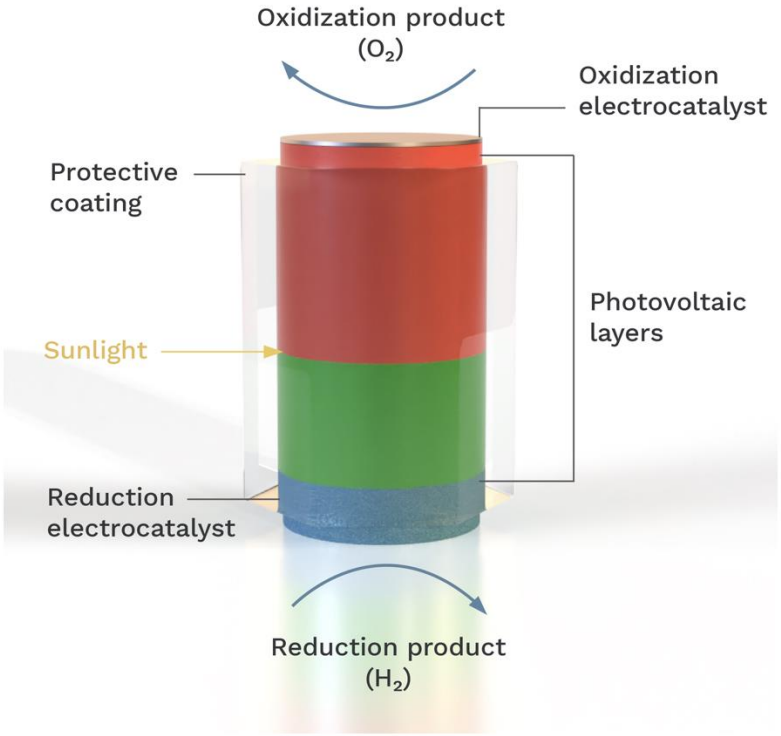
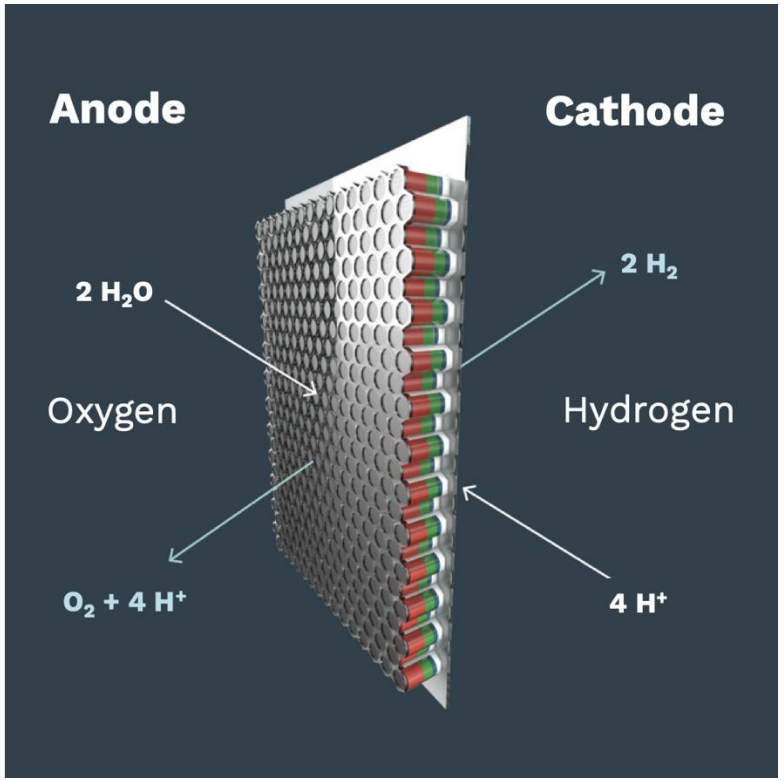
SunHydrogen

Solar panel to convert water and sunlight directly to hydrogen and oxygen





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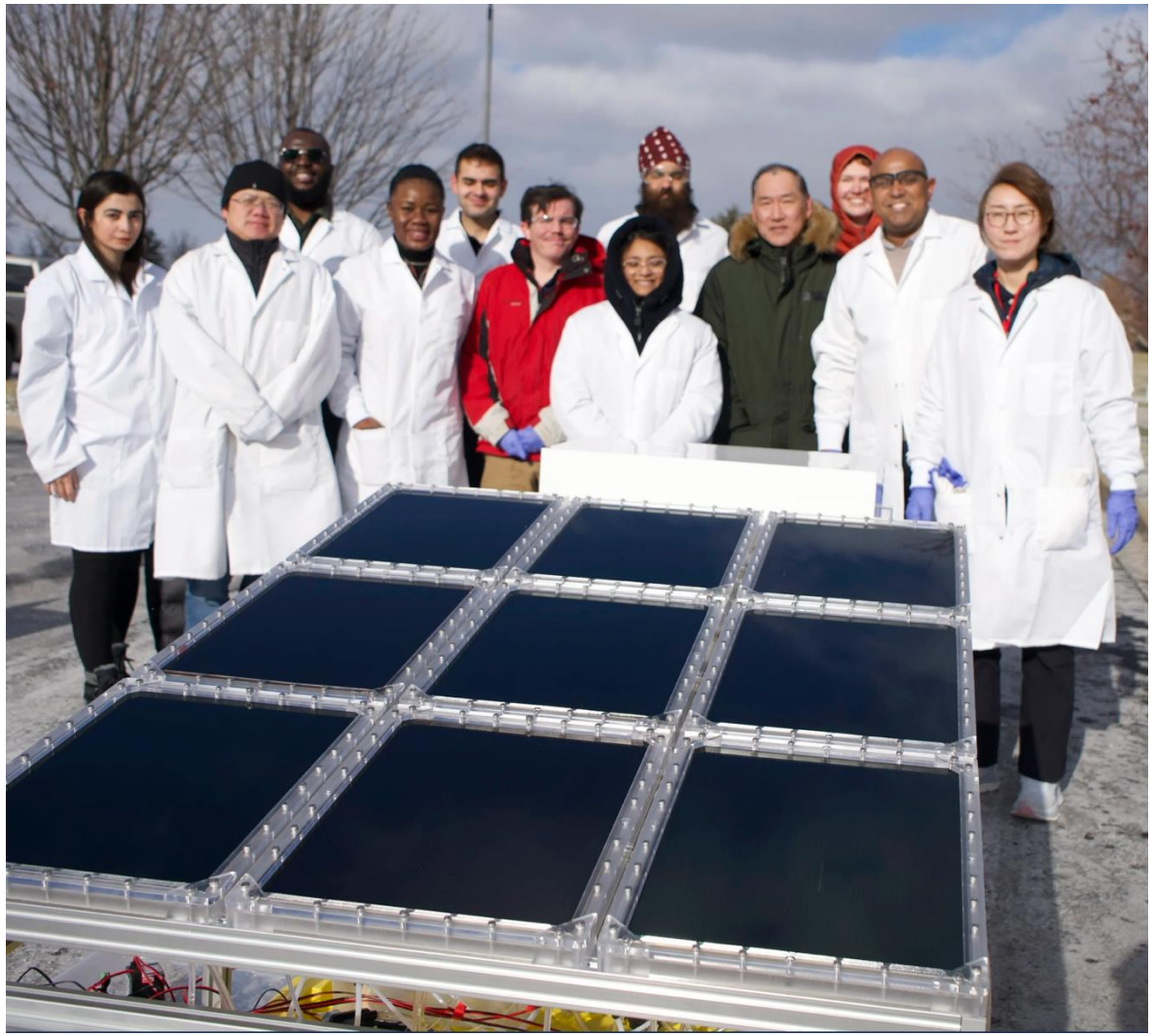
Freezing Issue

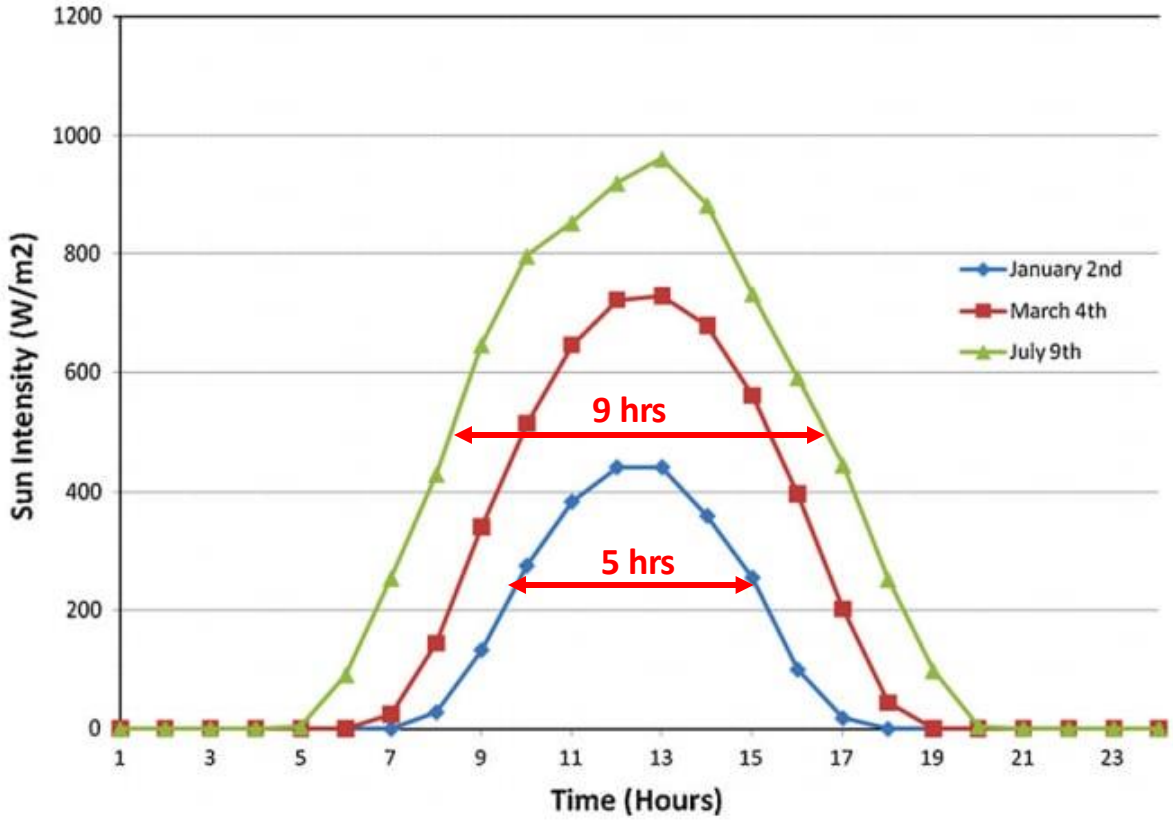
- December 11, 2024 demonstrated hydrogen production in subfreezing temperatures
  - Outdoors at the SunHydrogen laboratory in Coralville, Iowa



Land Required for direct solar-to-hydrogen

Energy per area (kg H_2):
Panels produce 0.0104 kg per sq-meter per hour
Assume 7 hours per day 365 days per year avg
Therefore, average daily out output per m^2 = 0.0728 kg
(7 x 0.0104)
200 kg per day Fuel Station Example:
200 kg per day requires 200 ÷ 0.0728 = 2,747 m^2 = ½ acre

Take-away:
Area required is too large for most on-site generation
Therefore, **hydrogen will have to be transported**



Is it cheaper to move the energy as electricity instead of as hydrogen?

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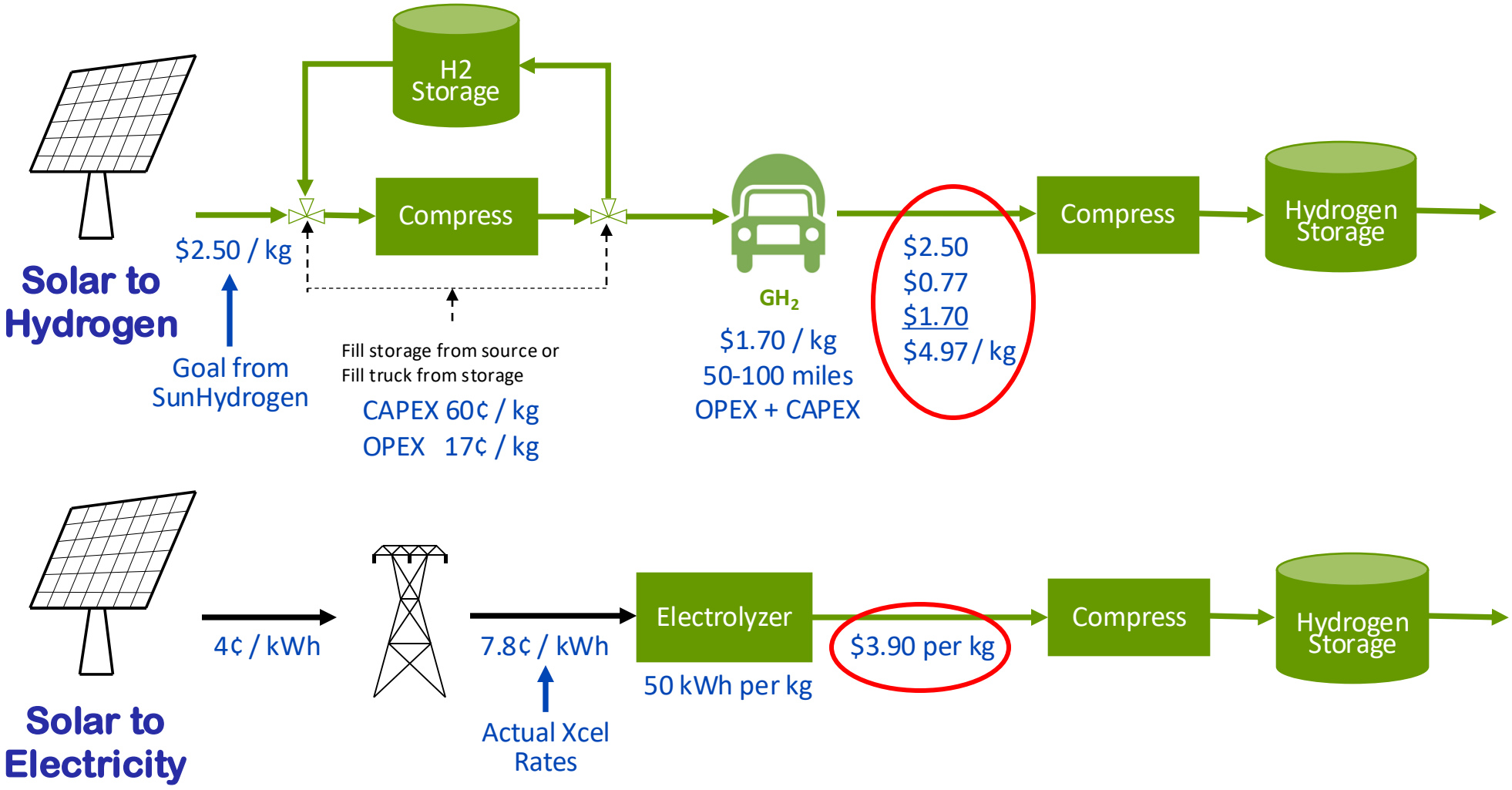
Solar-to-Hydrogen vs Solar-to-Electrolysis



The business case for solar-to-hydrogen fails if the hydrogen needs transport

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Stationary Energy Storage

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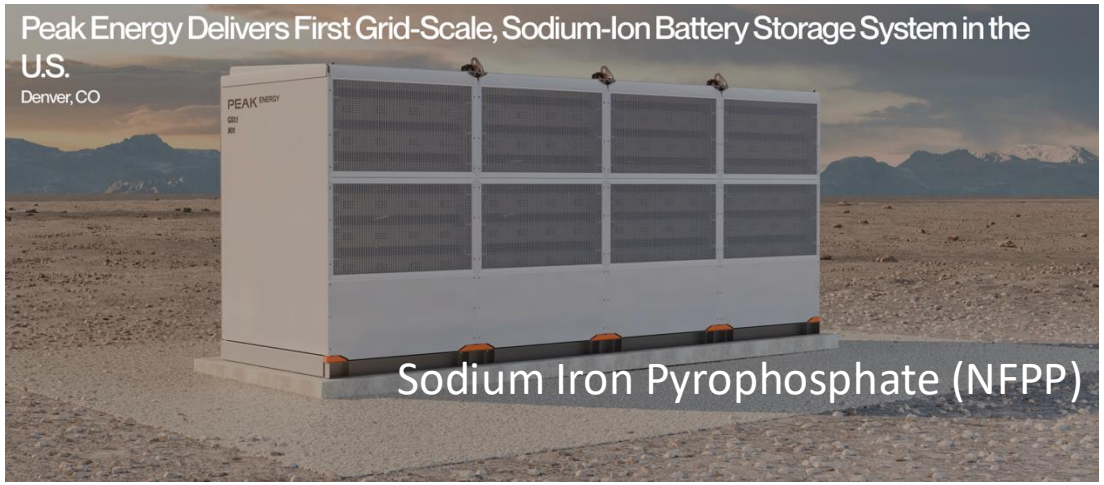
Stationary Energy Storage

Battery Energy Storage



Hydrogen Energy Storage

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Sodium Iron Pyrophosphate (NFPP) Batteries

- A type of sodium-ion battery that uses a stable crystal structure for its cathode material
  - Suitable for grid energy storage
- Advantages
  - High safety resisting thermal-runaway
  - Wide operating temperature range −20 to +45 °C (-4 to +113 °F)
  - Thousands of discharge cycles
  - Ability to be fully discharged without damage
  - Using abundant sodium and iron leads to lower manufacturing costs
- Disadvantages
  - Shorter lifespan than lithium-ion.

Iron-Air Batteries

- Discharge
  - Oxygen from the air reacts with iron pellets in a water-based electrolyte to generate an electric current
  - The iron is oxidized to iron hydroxide and then to iron oxide (rust), releasing electrons that flow through a circuit to power devices
- Charge
  - An external electrical current reverses the process, converting the iron oxide back into metallic iron and regenerating oxygen at the cathode.

Iron-Air Batteries (cont)

- Advantages
  - Cost – Significantly cheaper than lithium-ion batteries (10%)
  - Safety – No risk of thermal runaway and do not use heavy metals
  - Long duration – They can store energy for up to 100 hours or more
  - Lifespan – 10,000 charge/discharge cycles lasting 30 years or more
- Disadvantages
  - Low C-rating – Cannot discharge energy as quickly as lithium-ion batteries, making them less suitable for applications that require rapid power delivery
  - Efficiency – Low energy efficiency, partly due to hydrogen evolution and issues with the air electrode, though new designs aim to improve this
  - Early technology – Early versions had a short cycle life, though recent improvements and nanotechnology are enhancing performance
  - Operating range – 0 to 40 °C (32 to 104 °F).

Hydrogen Energy Storage

- Advantages
  - Wide operating temperature range
  - Extremely long storage time (indefinitely)
- Disadvantages
  - High CAPEX cost for electrolyzer-fuel cell, compressor, and tanks.

Comparison of the Three Types

- Cost difference including Balance of Plant (BOP)
  - NFPP $150 - $300 per kWh
  - Lithium-ion $150 - $300 per kWh
  - Iron-air $20-$25 per kWh
  - Hydrogen $300 - $1,000
- Round-trip efficiency (energy out ÷ energy in)
  - NFPP 80%
  - Lithium-ion 70 – 80%
  - Iron-air 50%
  - Hydrogen 50%

The choice is probably between NFPP or Lithium-Ion depending on circumstances

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Unlocking Geothermal Energy

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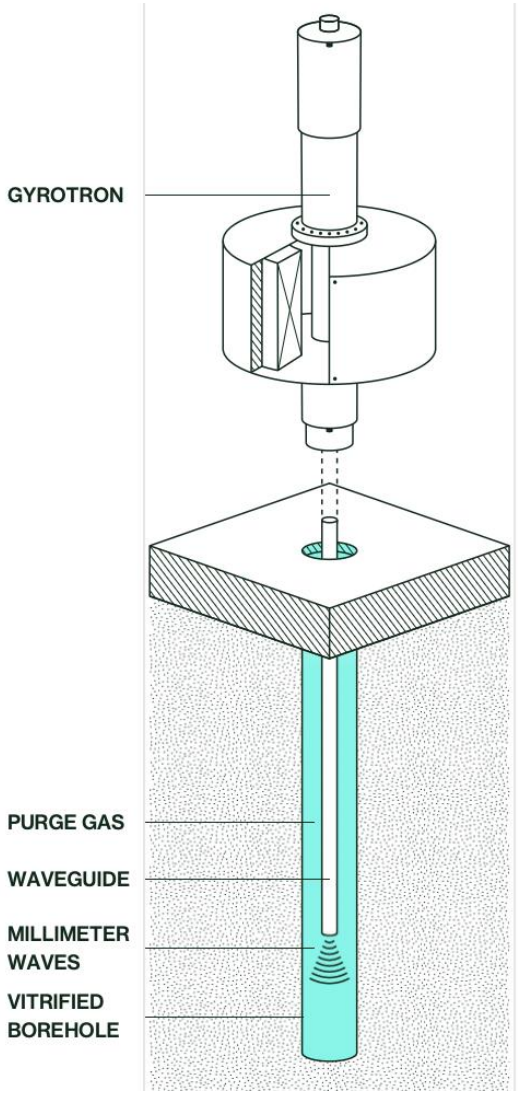
Quaise Energy

A radical new approach to ultra-deep drilling:

- First using conventional rotary drilling to get to basement rock
- Next switch to high-power millimeter waves to reach unprecedented depths

Gyrotron drilling vaporizes boreholes through rock and provides access to deep geothermal heat



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Quaise Milestone

his technology could unlock access to superhot, deep geothermal energy.

Quaise recently conducted a test at a granite quarry in Marble Falls, Texas, showed the company's ability to vaporize rock using high-frequency electromagnetic waves, drilling 387 feet (118 meters) into solid granite without any physical contact

Technology has possible use for Natural Hydrogen drilling.

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HydrogenNowCast

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Podcast