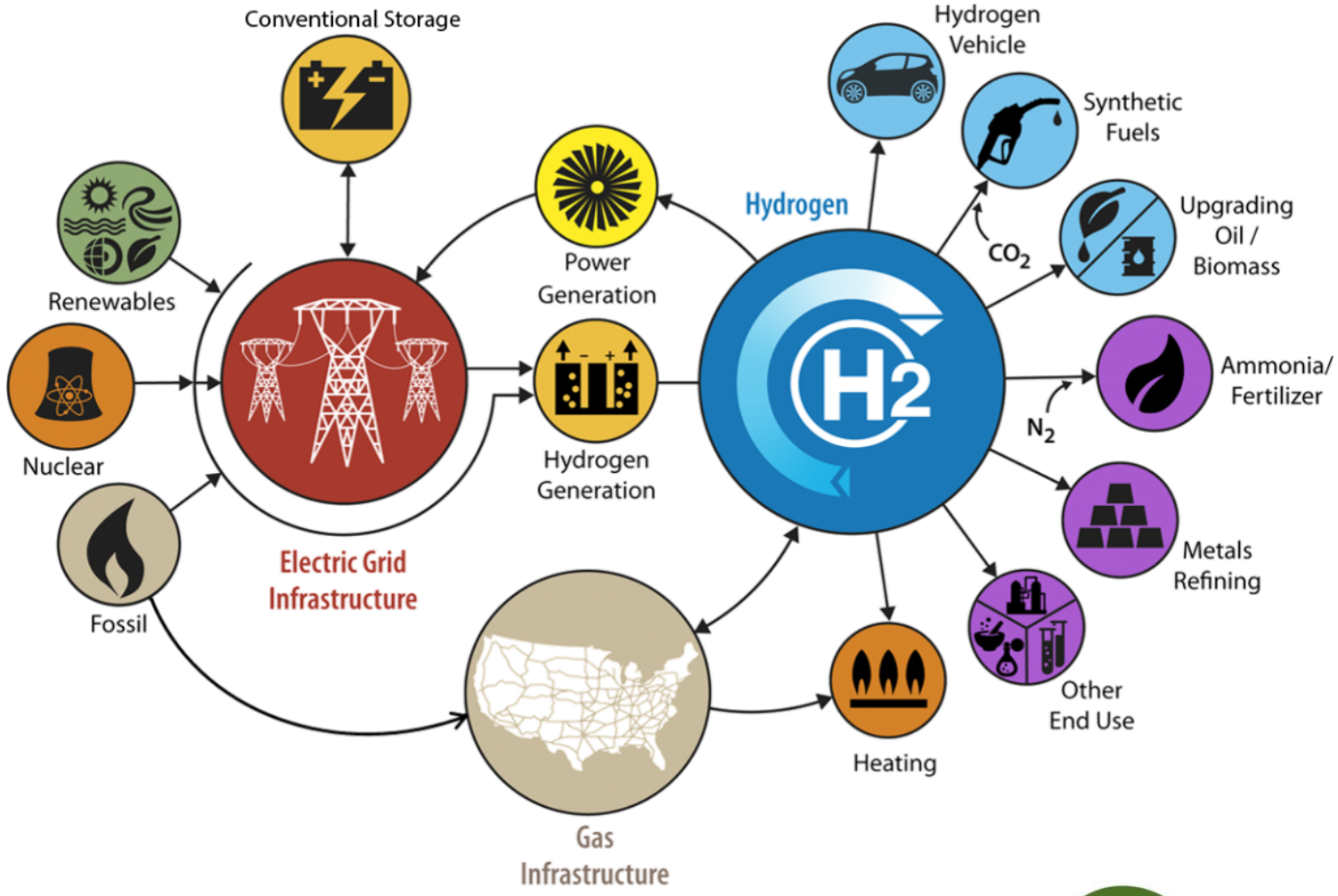
Oregon Department of **ENERGY**

ODOE RH2 Study
Stakeholder Workshop #1

Rebecca Smith
November 16, 2021



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Meeting Agenda

- Administrative information
- Renewable hydrogen study – requirements, timeline, etc.
- Hydrogen 101
- Discussion

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How this meeting will be facilitated

- **Panelists and Participants**
  - Panelists: ODOE Staff
  - Participants: There is time reserved at the end of the agenda for discussion, and you can send questions through chat throughout the meeting.
- **Community Agreements:** Designed to foster inclusive and respectful meeting today
  - Be present and ready to learn
  - Be respectful to others
  - Learning happens outside of our comfort zones
  - Listen to learn and not to respond
  - Thank you for being flexible and patient around any technology needs or changes
  - If you need something at this meeting, ask for it!
    - Technical issues or questions: Contact **Linda Ross** in the chat

Meeting Logistics

- **Logistics**
  - Note that we'll be recording this meeting and will post it online for reference
  - Please introduce yourself in the chat – name, affiliation, and a sentence about why you're interested in the study
  - Please feel free to use the chat to ask questions, ODOE staff will be monitoring the chat
  - We have set aside the final hour of the meeting for discussion
  - When we get to the discussion portion of the meeting, please use the "raise hand" function to indicate interest in asking a question or making a comment

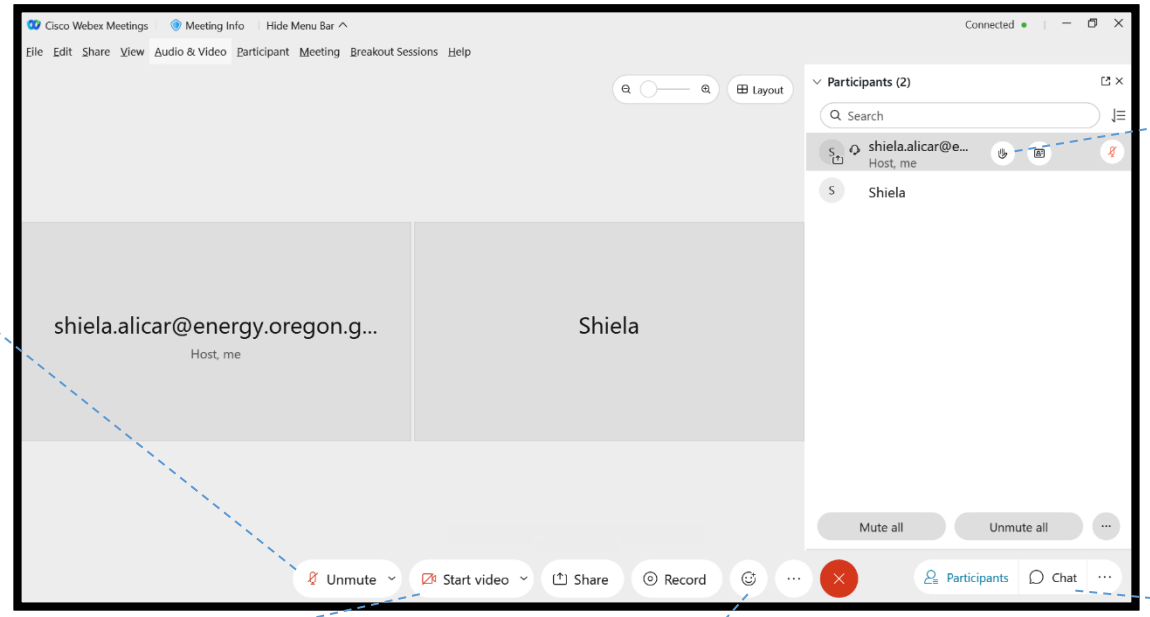
- **Next up – a few instructions on how to use WebEx to participate in this meeting**

Welcome to WebEx!

Audio Options

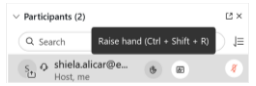
Mute — *Microphone On*

Unmute — *Microphone Off*



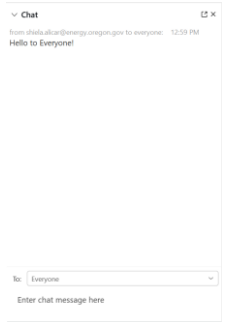
Second Raise Hand Option

You can also click on the hand next to your name in the Participant list to raise your hand.



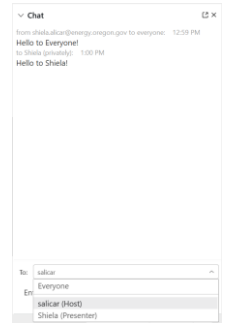
Click on Lower hand when you are done.

Chat



You can chat to Everyone in the meeting.

You can send a private message to the Host or Presenter (or all Panelists when there is a Panel).

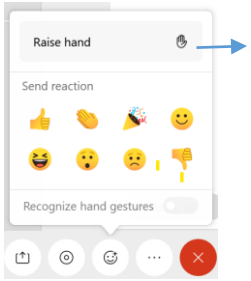


Video Options

Stop video — *Webcam On*

Start video — *Webcam Off*

Reactions



Click to Raise your hand.

Click on Lower hand when you are done.

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Leading Oregon to a safe, equitable, clean, and sustainable energy future.

Our Mission

The Oregon Department of Energy helps Oregonians make informed decisions and maintain a resilient and affordable energy system. We advance solutions to shape an equitable clean energy transition, protect the environment and public health, and responsibly balance energy needs and impacts for current and future generations.

What We Do

On behalf of Oregonians across the state, the Oregon Department of Energy achieves its mission by providing:

- A Central Repository of Energy Data, Information, and Analysis
- A Venue for Problem-Solving Oregon's Energy Challenges
- Energy Education and Technical Assistance
- Regulation and Oversight
- Energy Programs and Activities

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The SB 333 Renewable Hydrogen Study

SB 333

Study goal: Provide legislators and stakeholders with a better understanding of the benefits of and barriers to production and consumption of RH2 in Oregon. The study will also consider the trade offs associated with RH2, including safety, efficiency, cost, water usage, etc.

For the purposes of the study, **"renewable hydrogen"** means hydrogen gas derived from energy sources that do not emit greenhouse gases.

H2 = hydrogen

RH2 = renewable hydrogen

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Study Requirements Per SB 333 (2021)

- High-level analysis of how RH2 may support existing renewable energy and greenhouse gas reduction policies and goals in Oregon.
- Identification of the total H2 volume currently used annually in Oregon.
- Identification of potential applications of RH2 in Oregon by 2030.
- Assessment of potential for coupling renewable electricity generation and RH2 production to increase resiliency or provide flexible loads.
- Discussion of forecasted costs of RH2 and how they might affect adoption of RH2 in Oregon.
- Identification of technological, policy, commercial, and economic barriers to adoption of RH2 in Oregon.

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Technical Advisory Committee (TAC)

Comprised of technical experts from the public and non-profit sectors to provide feedback on data sources, assumptions for analysis and findings.

- Pacific Northwest National Lab
- Oregon Dept. of Transportation
- Oregon State University
- Portland State University
- NW Power and Conservation Council (NPCC)
- NW Energy Efficiency Alliance (NEEA)
- *Stanford University (invited)*
- *Lawrence Livermore National Lab (invited)*
- *US DOE (invited)*

Experts on call:

- National Renewable Energy Lab
- JCDREAM

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Study Timeline

	2021	2022		
TASKS	**Q3**	**Q1**	**Q2**	**Q3**
Research and analysis				
Stakeholder Engagement	Workshop #1 Nov 16 TAC mtg TBD Nov	Workshop #2 TAC mtg	Workshop #3 TAC mtg	
Report drafting				
Report to Legislature				Sept 15

TAC Meetings
- Introduction to study
- Initial findings
- Final findings

Stakeholder Workshops
- Introduction to study, H2 101, study feedback
- Initial findings
- Final findings

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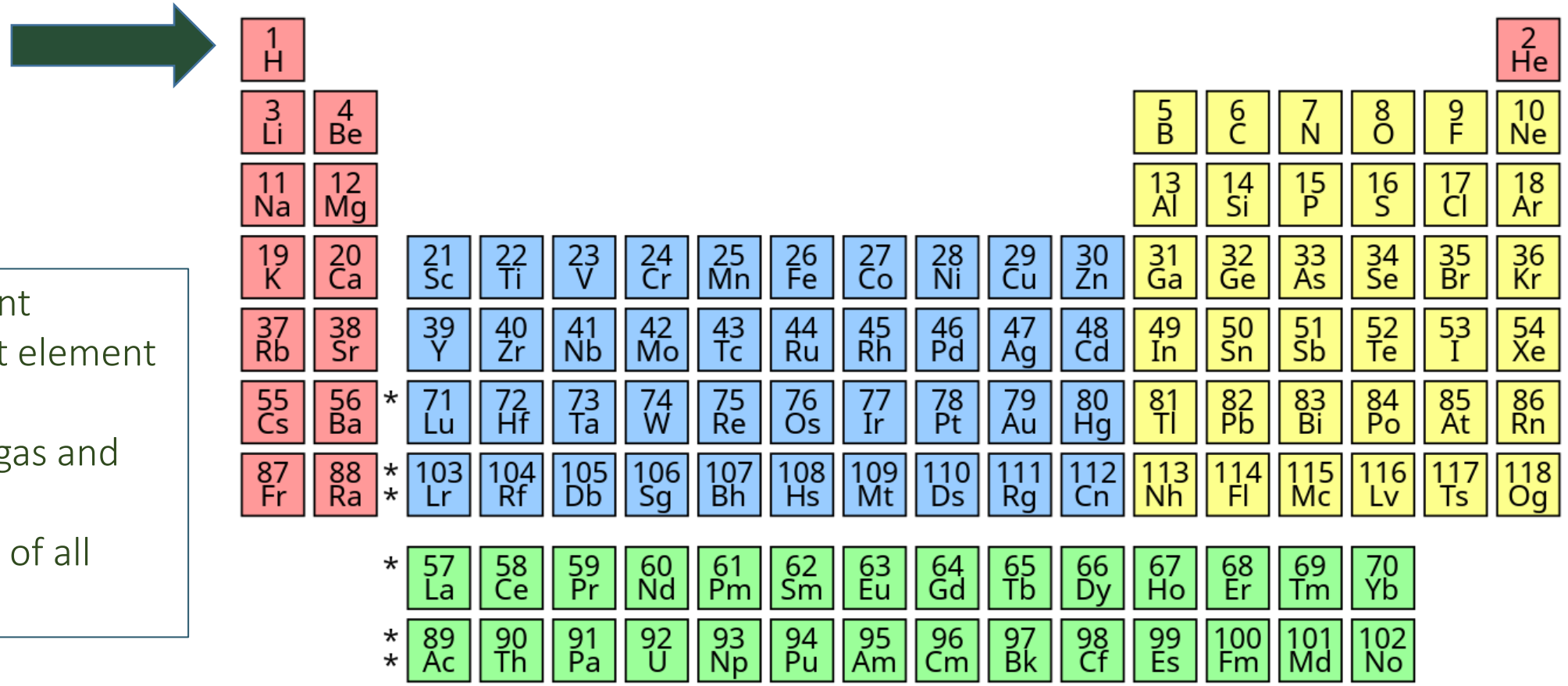
Hydrogen 101

Yaquina Head Lighthouse, Newport, Oregon

What is Hydrogen?

- Lightest element
- Most abundant element in universe
- States include gas and liquid
- Lowest density of all gases



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Energy Sources and Energy Carriers

Energy **sources** are the original resource from which an energy **carrier** is produced

Energy sources

- Fossil fuels
- Solar radiation
- Nuclear
- Wind
- Biomass
- Falling water

Energy carriers

- Fossil fuels
- Electricity
- Hydrogen
- Mechanical work
- Heat

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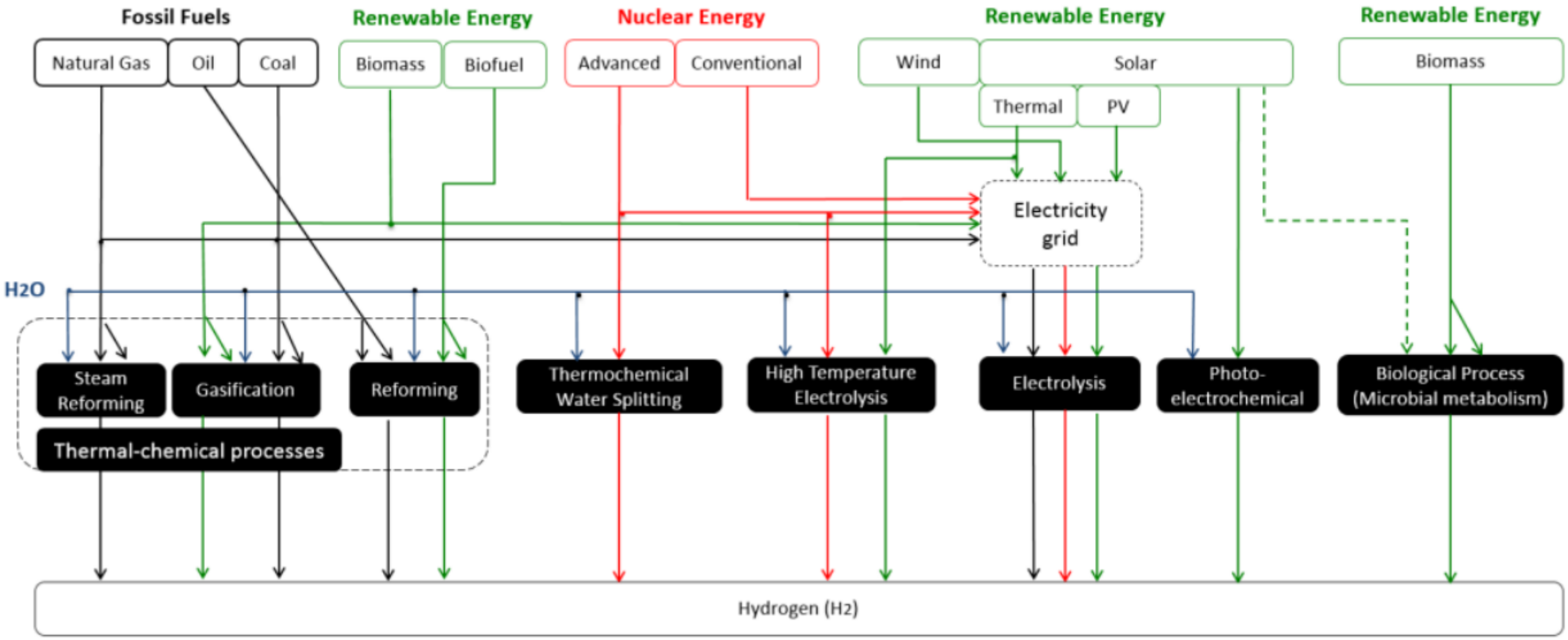
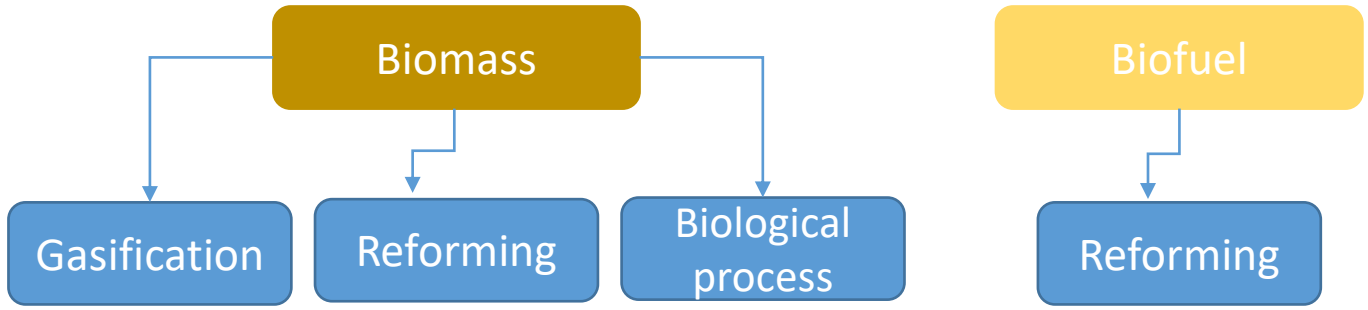
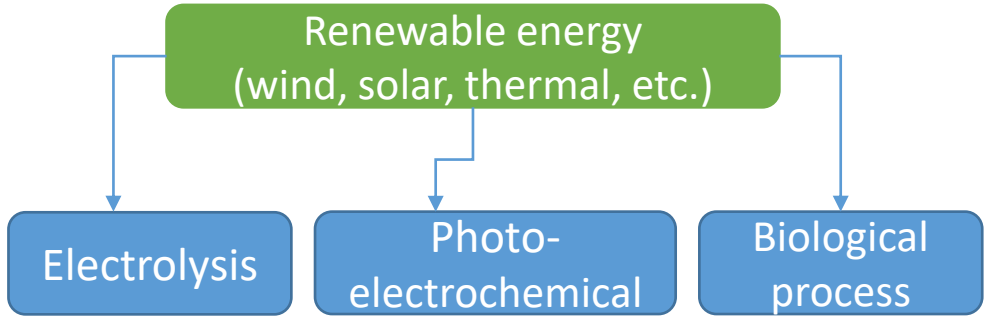
Pathways for Converting Energy Sources to H2



Renewable Pathways for RH2





Reforming: Steam reformation uses high-temperature steam with a catalyst to produce hydrogen from a source of methane, such as natural gas, biogas, ethanol, etc. Very established process.

Gasification: Process involving heat, steam, and oxygen to convert biomass to hydrogen and other products. Very established process.

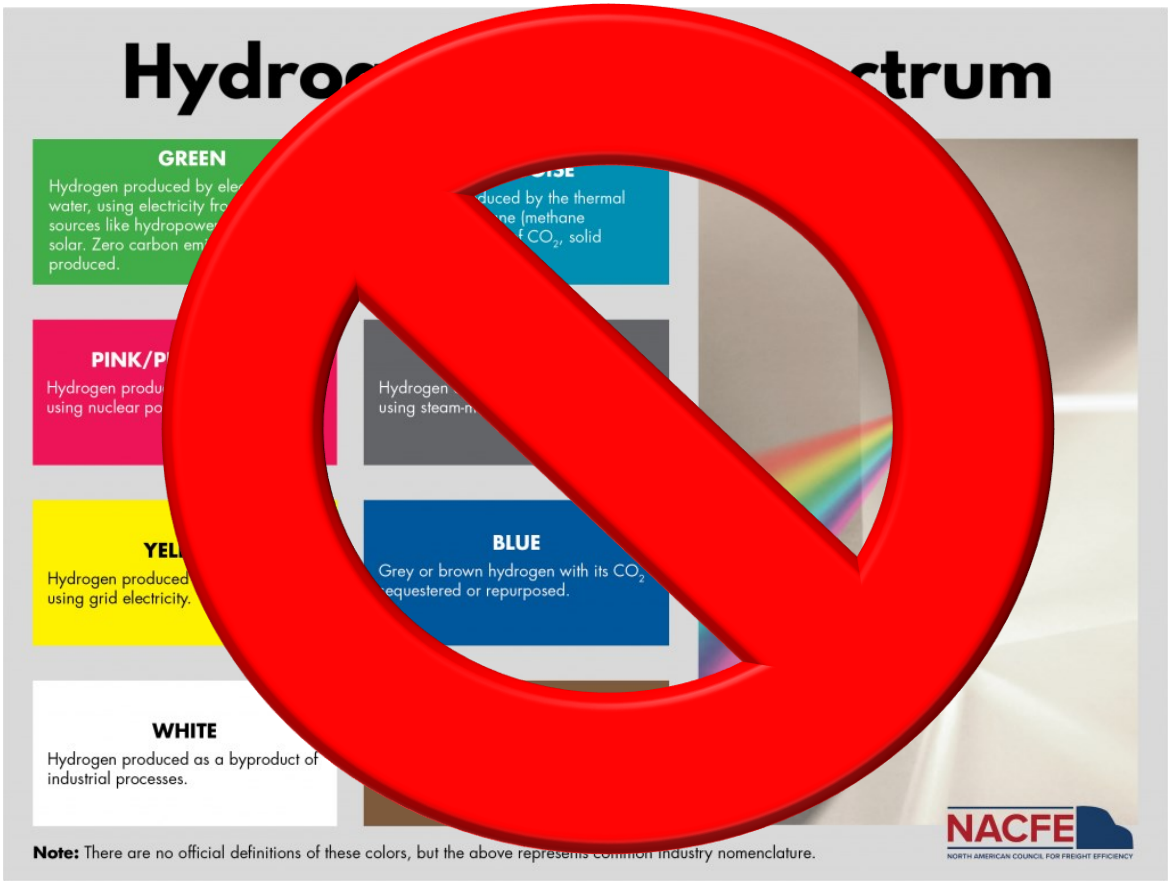
Biological processes: These can include fermentation of biomass to produce RH2 as a byproduct. Emerging process.

Photo-electrochemical: Using sunlight to directly split water into hydrogen and oxygen. Emerging process.

Electrolysis: Renewable electricity is used to split water into hydrogen and oxygen using an electrolyzer. Very established process.

Defining Renewable Hydrogen

- Recent infrastructure bill passed in August defines “clean hydrogen” as hydrogen “produced with a carbon intensity equal to or less than 2 kilograms of carbon-dioxide equivalent produced at the site of production per kilogram of hydrogen produced.”
  - Bill asks EPA and DOE to develop an initial standard for the carbon intensity of clean hydrogen production.



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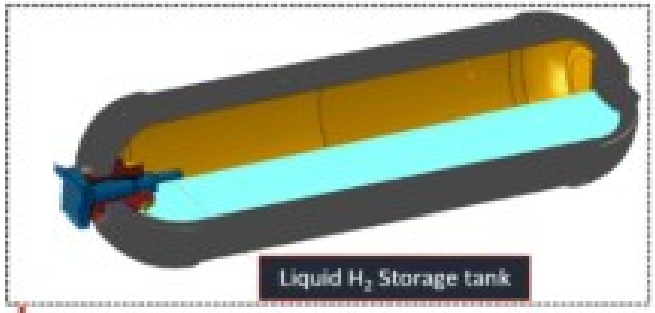
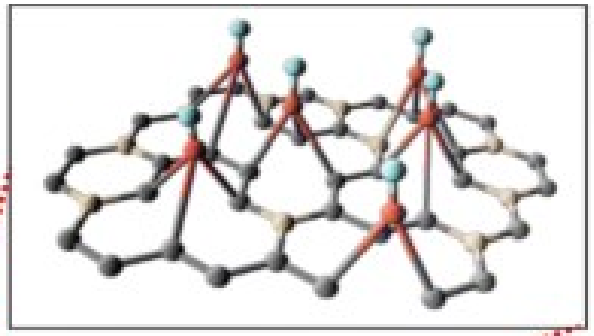
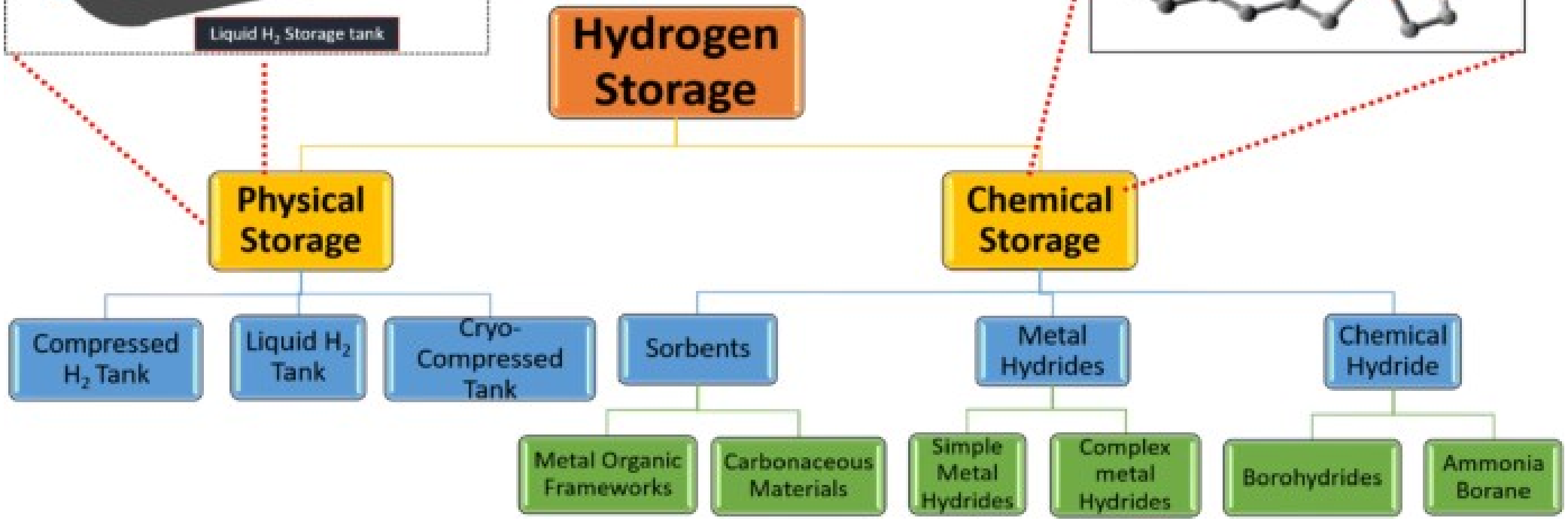
Hydrogen Storage

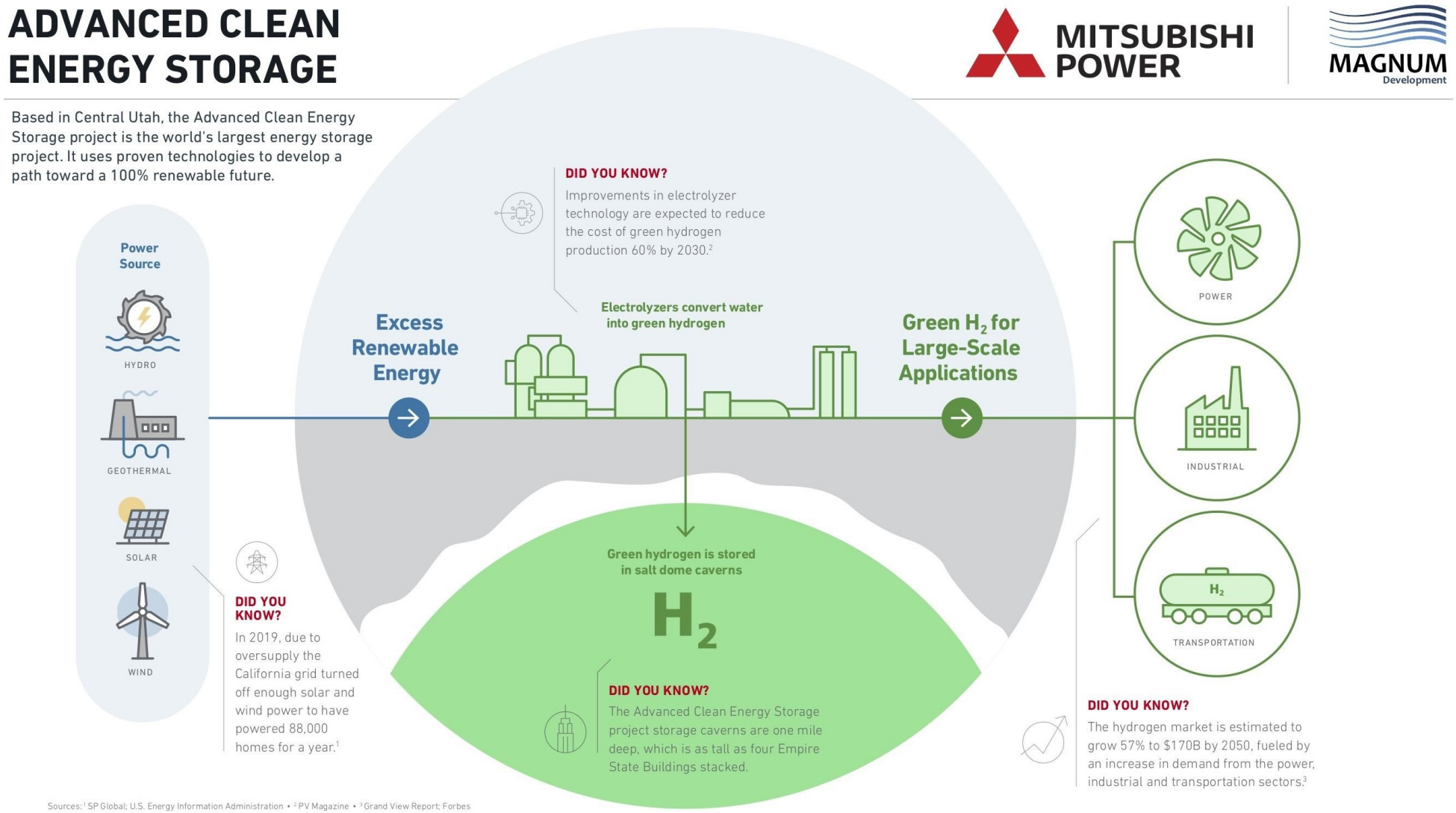
H2 storage can be physical or chemical







Geologic Storage of Compressed H2



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H2 Distribution

- Natural gas distribution and transmission pipelines
  - Can blend H2 into natural gas pipelines possibly up to 15-20% by volume
- High-pressure tube trailers via truck, railcar, ship, or barge
  - Expensive, used for shorter distances (less than 200 miles)
- Liquefied hydrogen tankers via truck, railcar ship, or barge
  - Also expensive, but more efficient for longer distances

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Common Concerns with H2 and RH2

- Safety
- Efficiency
- Costs
- Potential to prolong use of fossil fuels
- NOx emissions from combustion
- Water use

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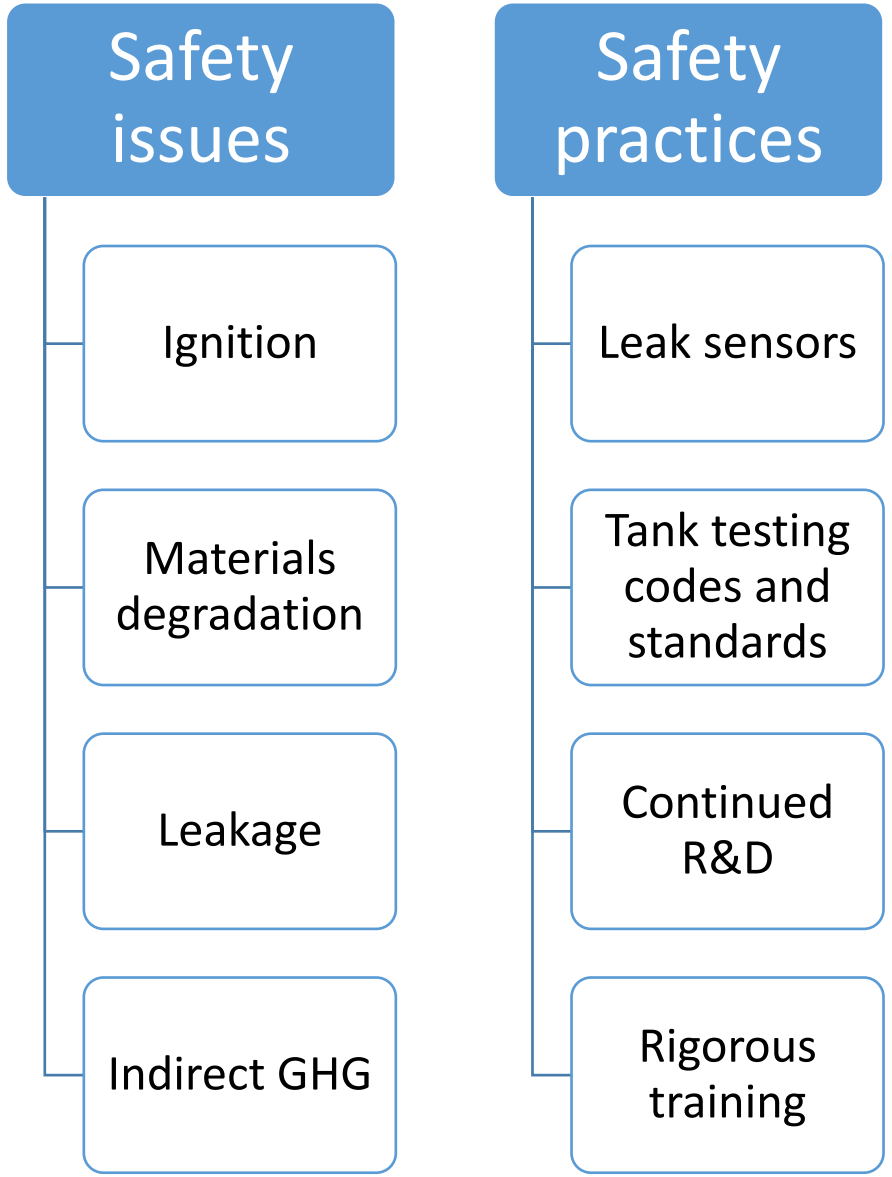
Safe Use of Hydrogen

H2 vs other fuels

Pros

- H2 is non-toxic
- H2 disperses rapidly
- H2 needs more oxygen to explode



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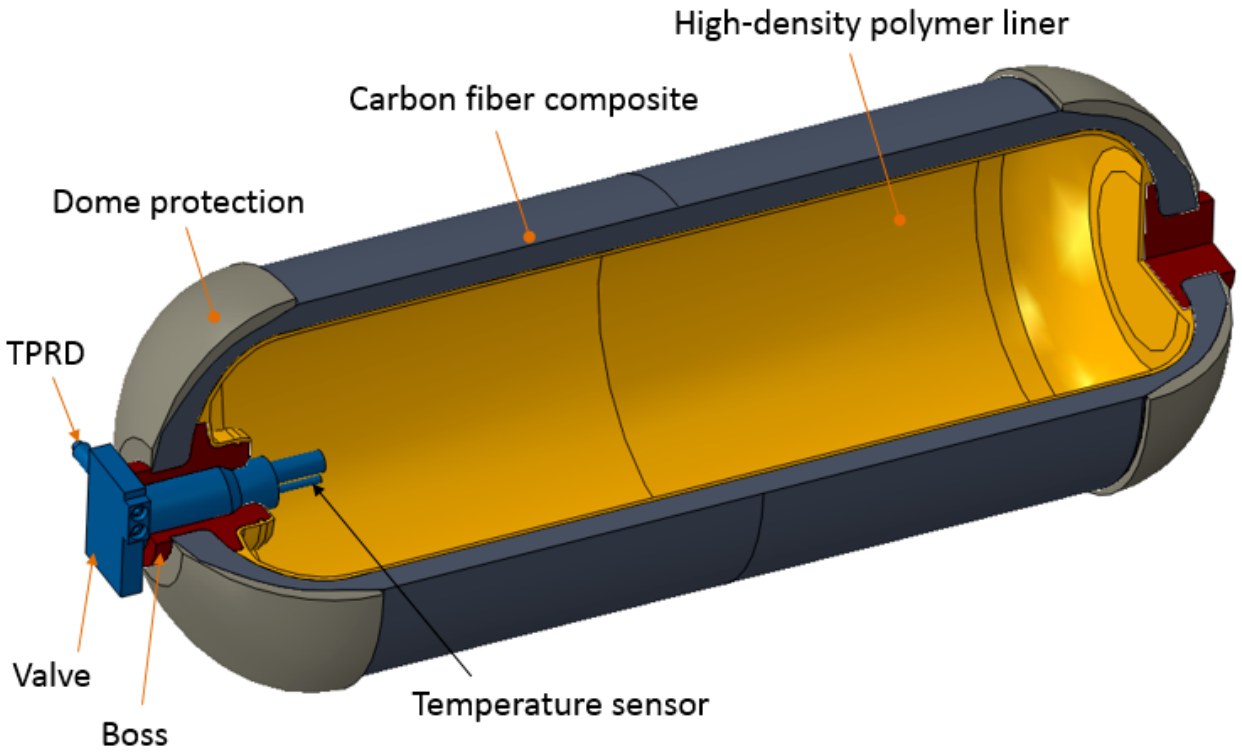
Safe Use of Hydrogen

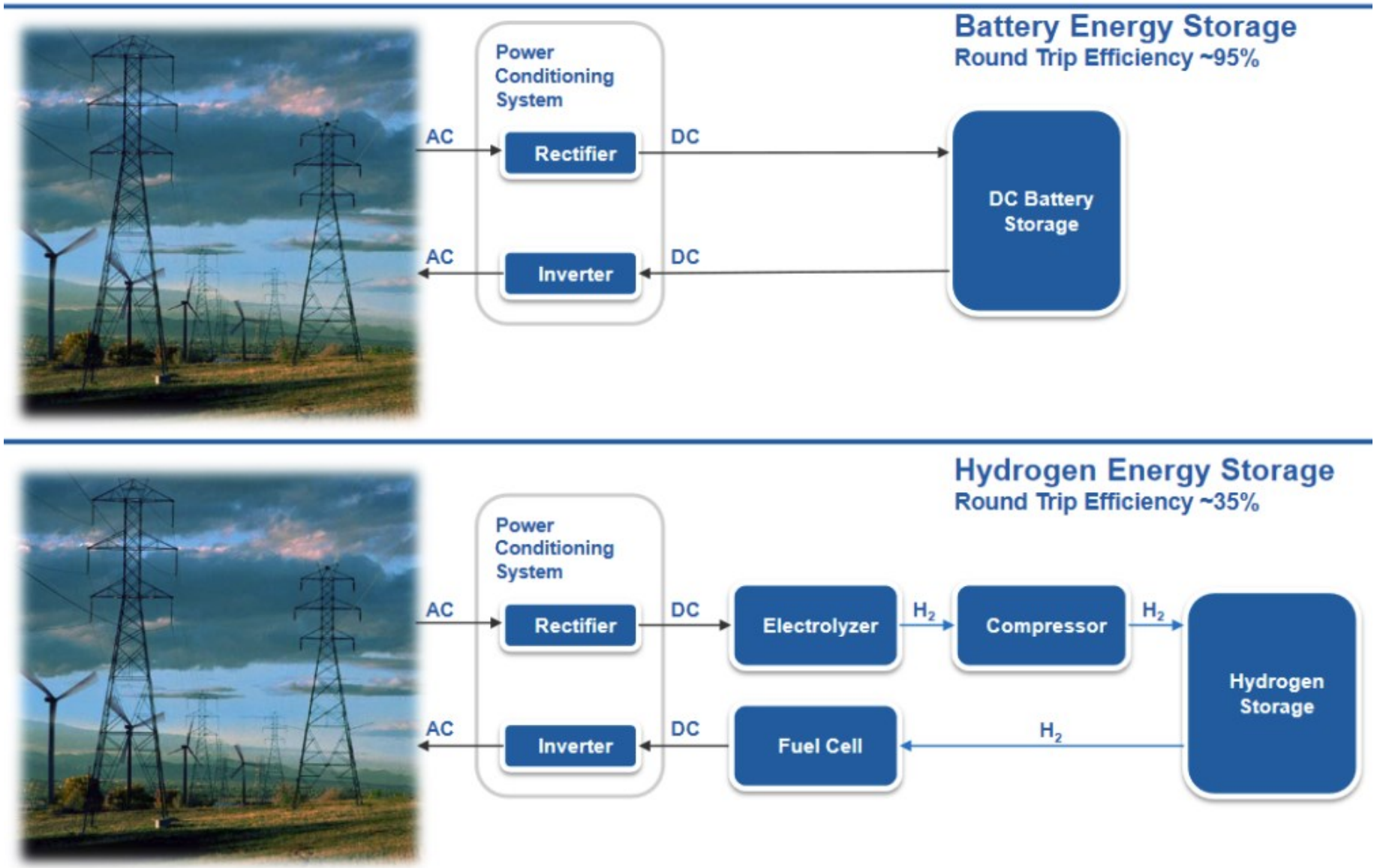


TPRD = Thermally Activated Pressure Relief Device

Source: H. S. Roh and R. K. Ahluwalia, Argonne National Laboratory (ANL), U.S.

Safety issues	Safety practices
Ignition	Leak sensors
Materials degradation	Tank testing codes and standards
Leakage	Continued R&D
Indirect GHG	Rigorous training

Efficiencies of Renewable H2 Pathways



Source: NREL

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Why the Interest in RH2?

- Hard-to-decarbonize sectors
- Need for flexible resources on the grid
- Long-duration energy storage
- Transportation where electricity doesn't work

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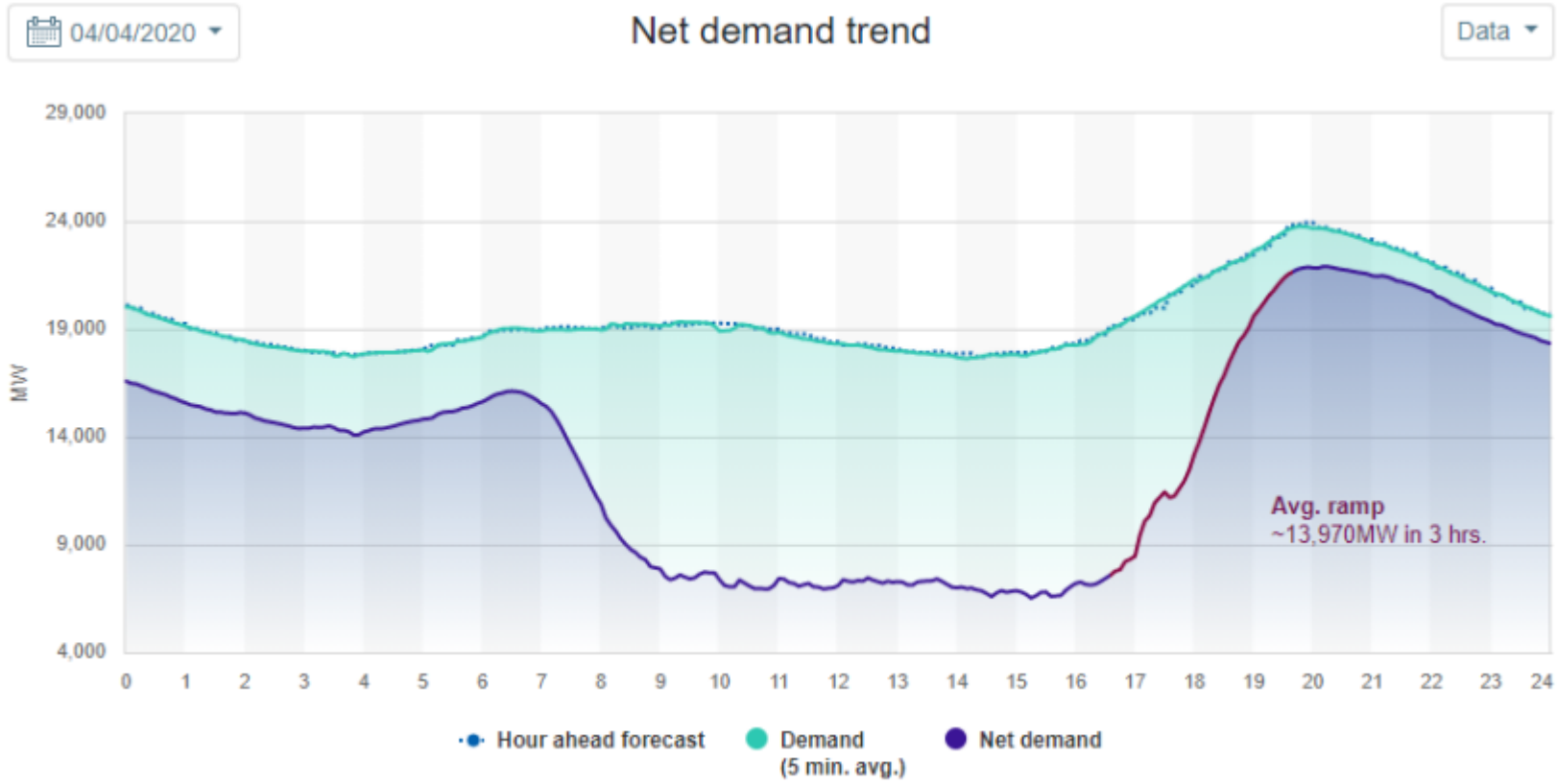
Resource Adequacy and Peak Demand

Resource Adequacy (or RA) is the term that grid planners and utilities use to refer to the evaluation of whether adequate generating capacity will be available to meet forecasted demand over the next several years (typically from one to five years).[i]



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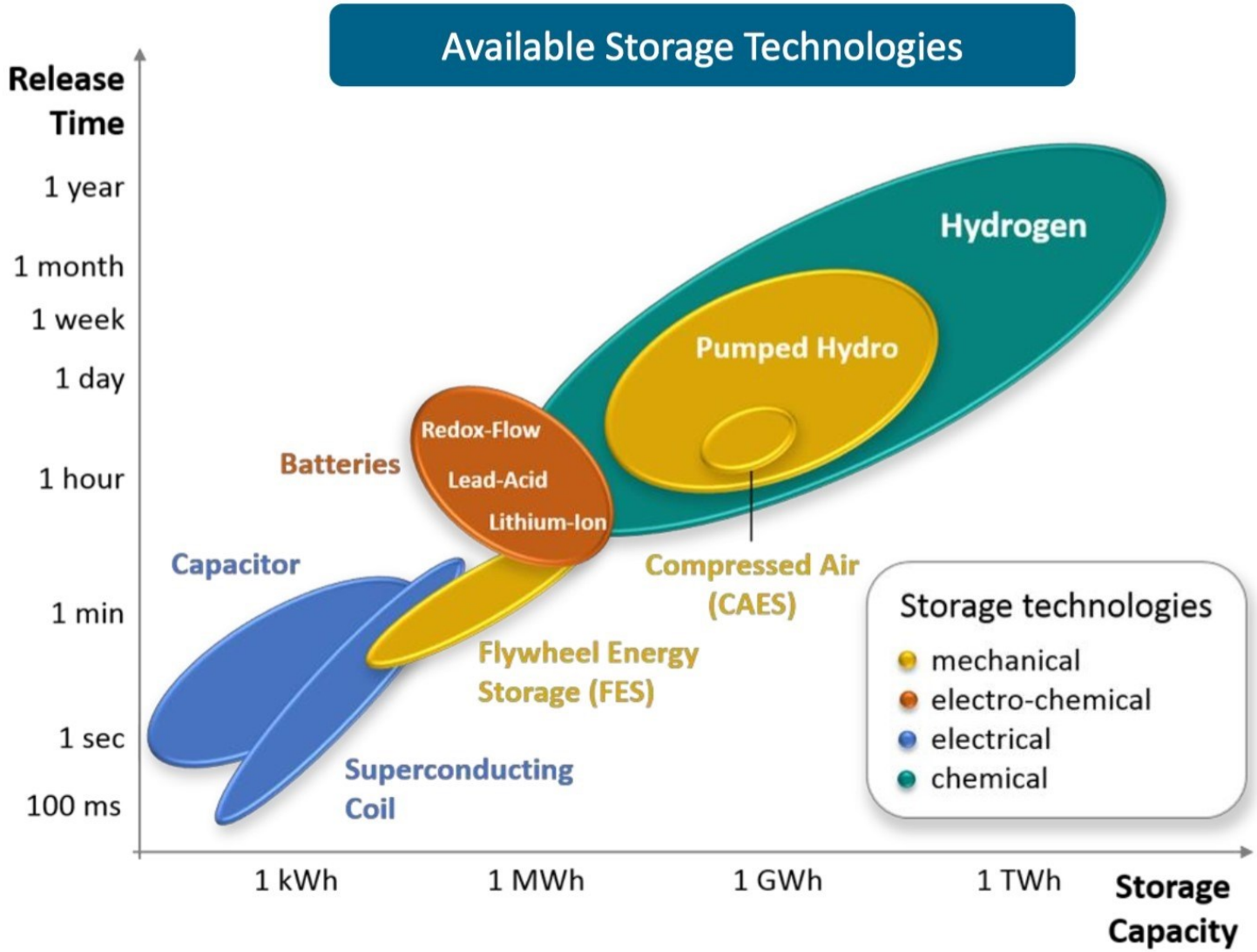
Long-Duration Energy Storage

For long-duration energy storage, NREL finds that hydropower, compressed air, and hydrogen are the most viable options.



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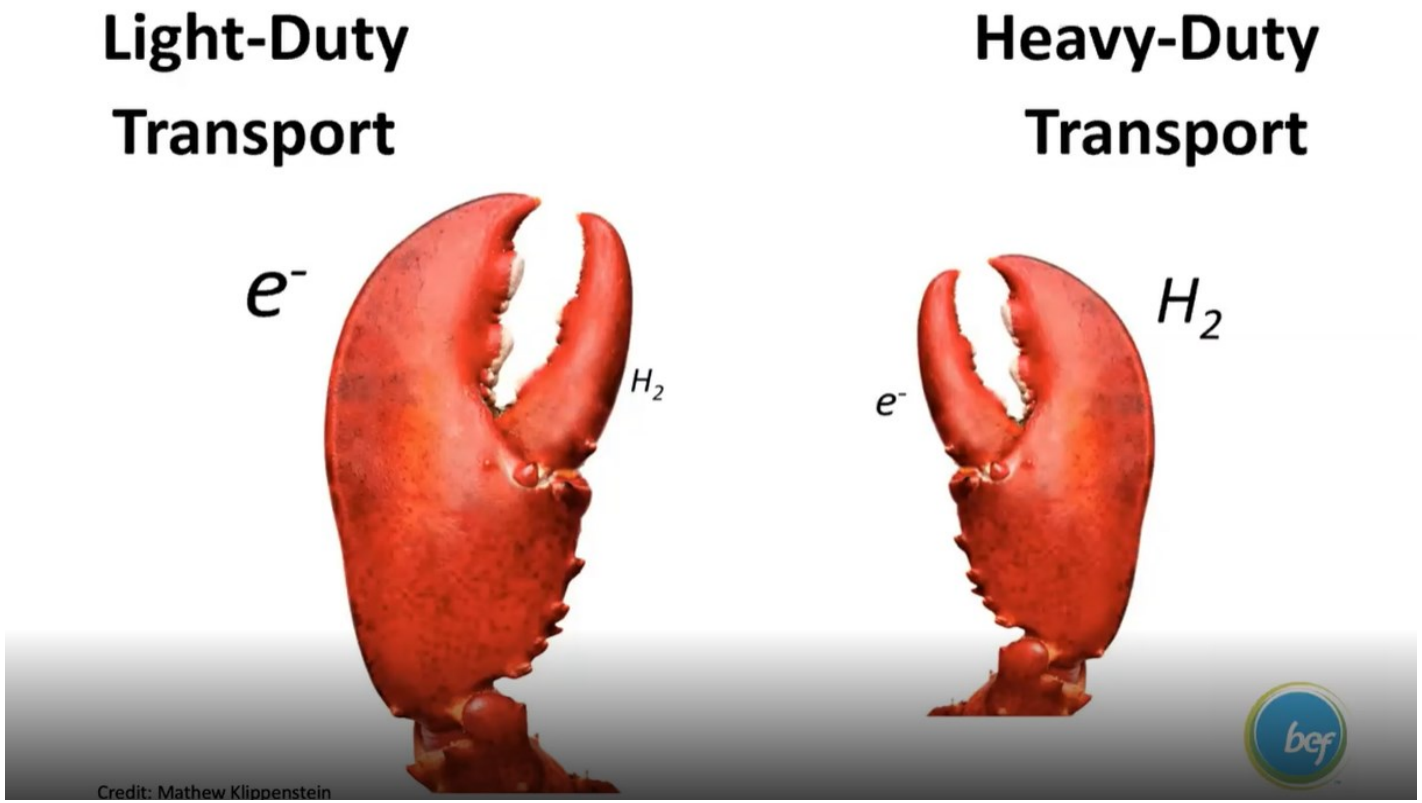
Transportation



Source: Bonneville Environmental Foundation

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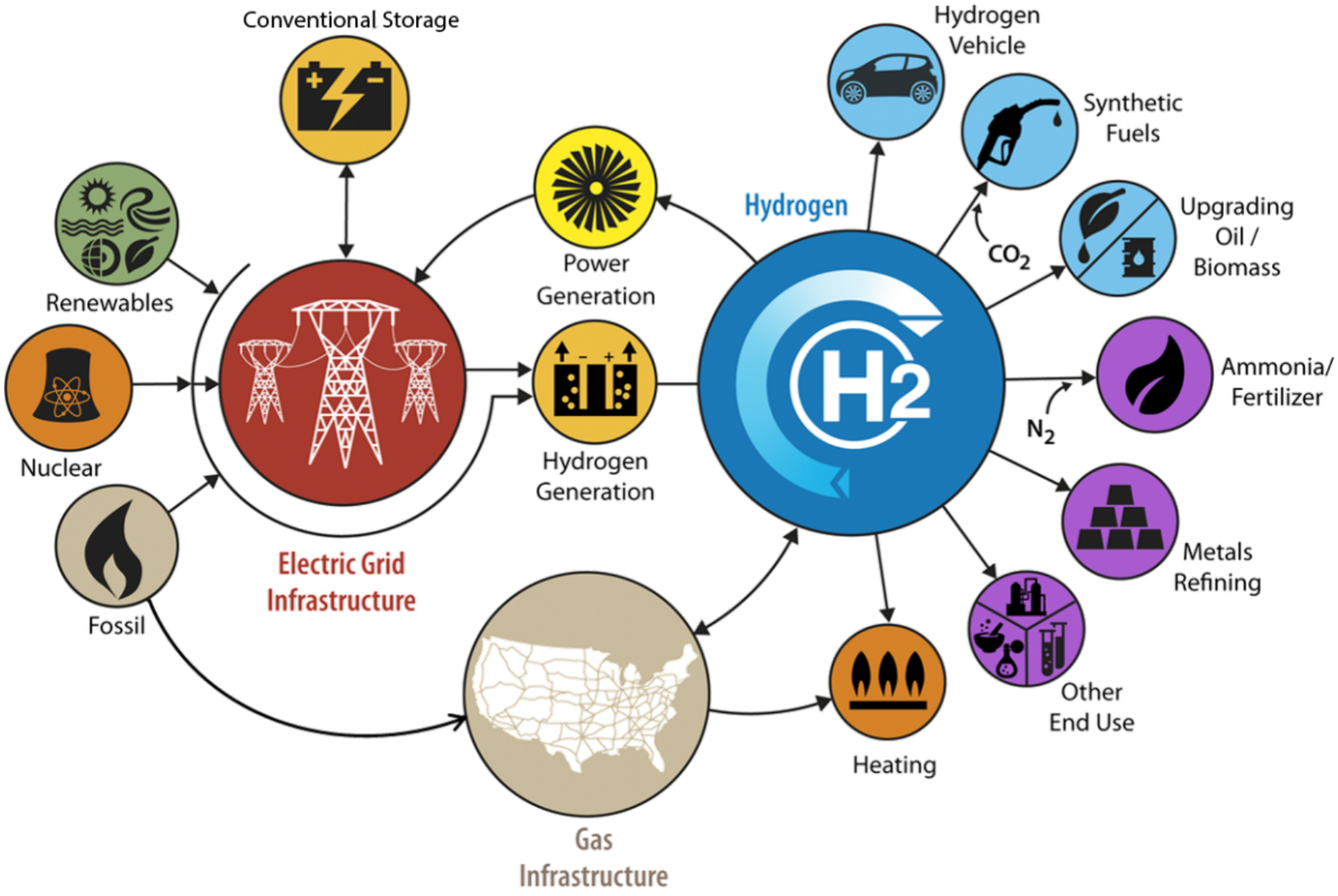
Potential Roles for RH2



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What's Happening with RH2 Today?

- Globally
  - Country H2 strategies and goals for deployed MW of electrolyzer capacity
  - Blending into NG pipelines
  - Pairing with offshore wind
- North America
  - BC RH2 strategy
  - Existing and announced projects
  - US DOE Hydrogen Shot program
  - Infrastructure bill
- PNW
  - Douglas County PUD
  - Potential projects in OR – Coos Bay, Klamath Falls, Eugene, etc.

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Questions and comments about the study?
Trillium Lake, Mt. Hood