



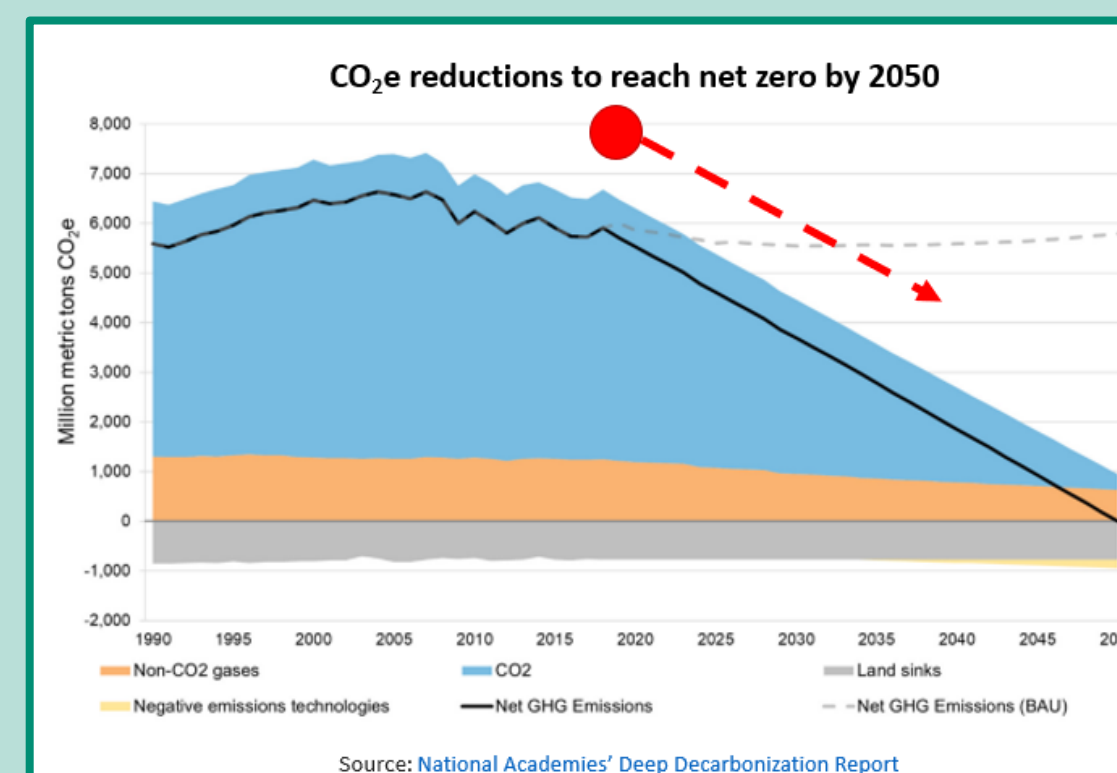
What is Water's Role in a Carbon-Neutral Future?

Thushara Gunda, Stephen Ferencz, Priya Hora, Kailey Wulfert, Stephanie Kuzio
Sandia National Labs, Albuquerque, NM

Motivation:

- Climate change is well-recognized as a threat to national and global security.
- Many nations have committed to steep emissions reductions by mid-century.
- Water resources are expected to be at the forefront of climate impacts, with demand-supply gap expected to be up to 40% by 2030.
- Emerging carbon-neutral technologies could impact already stressed water resources or create new vulnerabilities.

We are at the *cusp of potentially rapid, large scale* implementation of decarbonization technologies (see Figure to right). However, there has been a *distinct gap* in discussion about the role of water in transitioning to a low-carbon future.



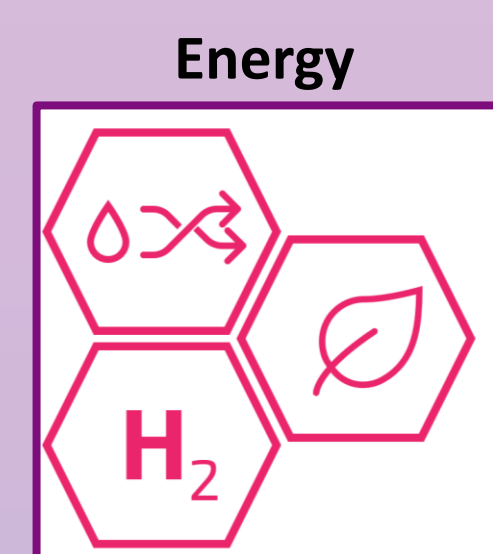
Historical carbon sources and sinks for the United States and future reductions in sources needed to achieve net-zero by 2050. (Source National Academy of Sciences)

Approach:

Sandia hosted a three-day webinar in early April 2022 to gather a variety of expert perspectives and kickstart the conversation around the importance of water in achieving a *sustainable* net-zero future.

The webinar highlighted the possible ways that water can support or influence strategies for addressing emissions activities across energy, industrial, and carbon management sectors.

Webinar Themes



- Hydrogen
- Algal biofuels
- Water for balancing renewables



- Concrete
- Shipping
- Mining critical minerals

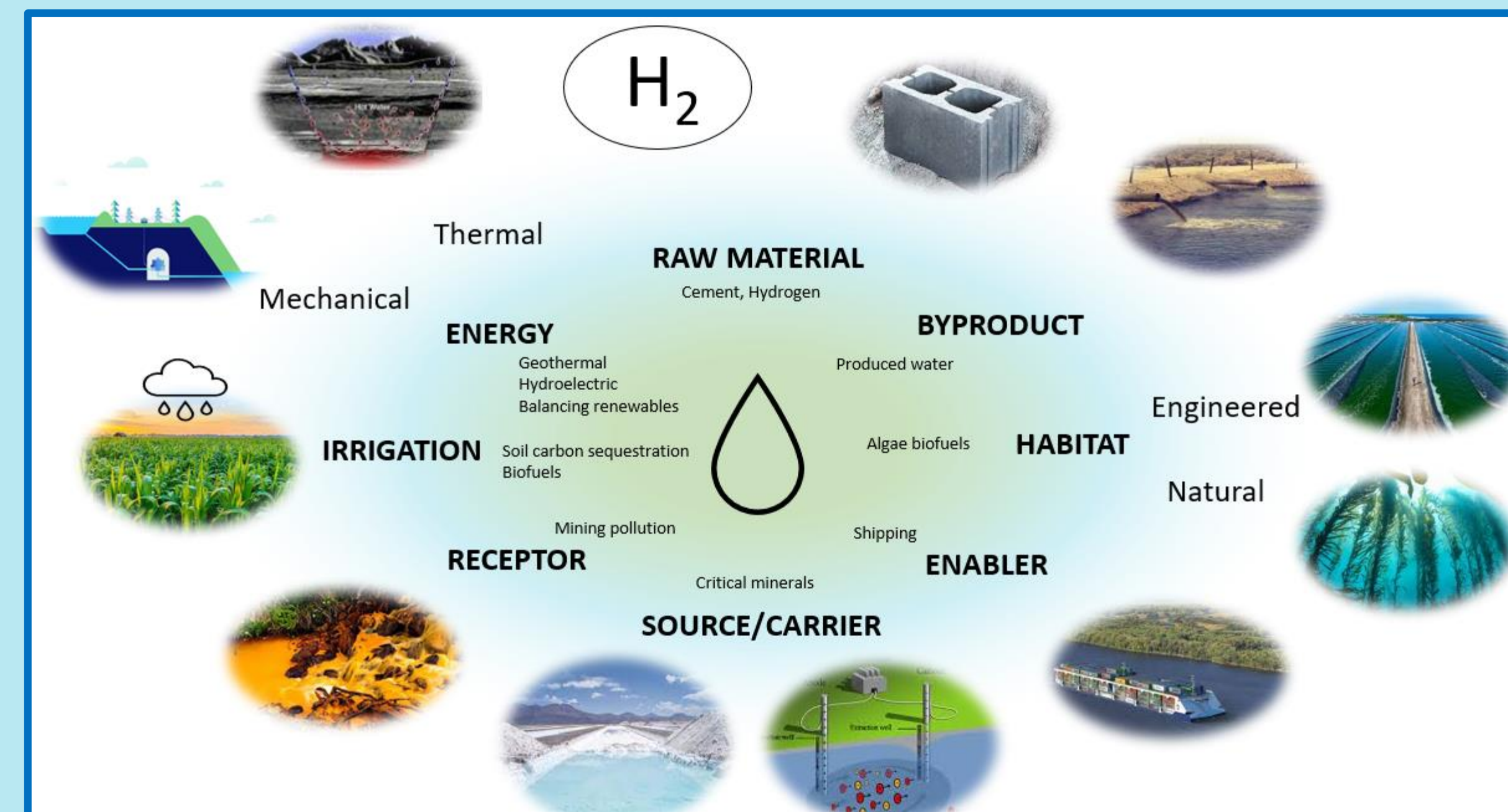
Carbon Management/Sequestration



- Direct air capture (DAC)
- Geothermal with DAC
- Soil carbon sequestration

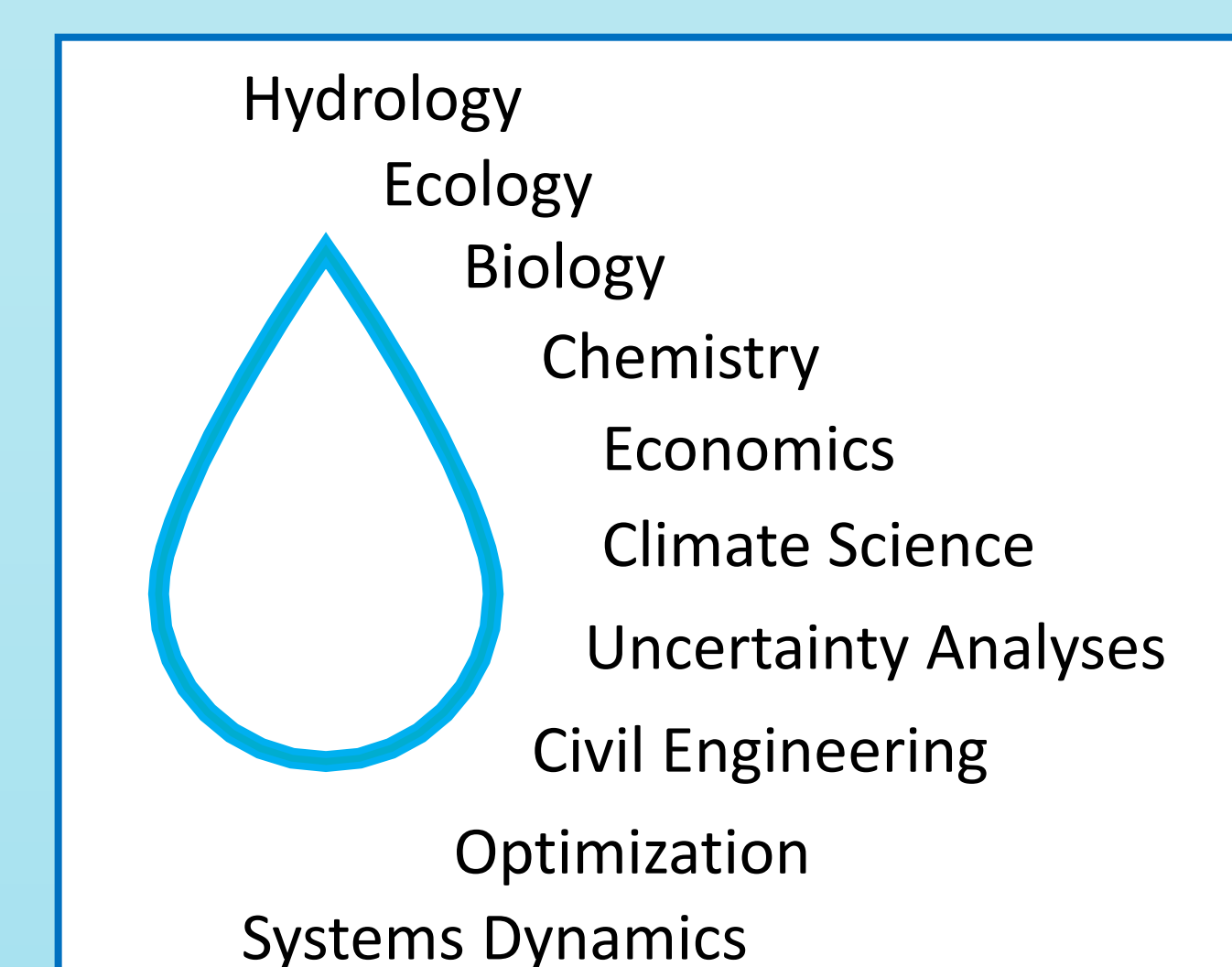
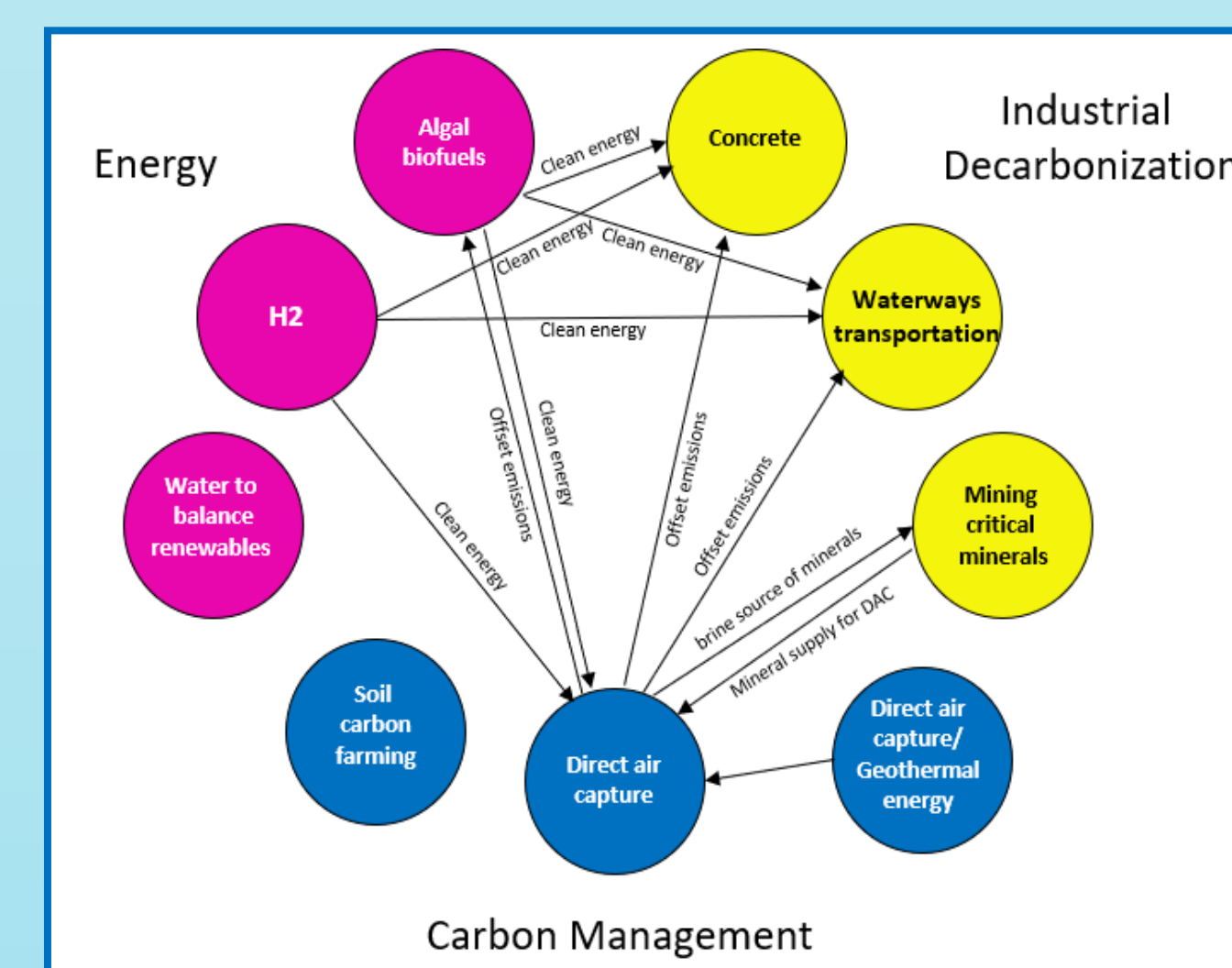
Findings:

The Many Roles Water Plays



One of the main themes and key takeaways from the Webinar was the wide variety of ways that water is critical to decarbonization efforts across industry, energy, and carbon management/sequestration. The role water plays is in bold and the sector/activity associated with each role is shown in smaller, non-bolded text.

- Water is much more than just a 'raw material' for decarbonization efforts
- There are many research needs across sectors (energy, industry, carbon management) to enable implementation at scale *with* the confidence of long-term resiliency, while minimizing environmental impacts and advancing justice priorities (full list in Webinar White Paper, see Want to Learn More section for link)
- The energy-water-carbon nexus highly interdisciplinary. The best solutions will not be discovered in traditional disciplinary silos (bottom right Figure)
- There are many synergies/connections between sectoral decarbonization approaches (bottom left figure).
- Given the *deep uncertainty* of future system states (climate, technology maturity, and market conditions), a systems perspective is needed to fully understand the capabilities, requirements, and performance at the energy-water-carbon nexus.



Research Questions:

The presentations and discussions during the Webinar generated many research questions. Below are five examples.

Energy, Carbon Management: How is uncertainty (price, availability) of assumptions captured in water calculations?

Energy: Can we characterize and identify which geological reservoirs are best suited for long-term sequestration, geothermal energy, or a combination of both?

Energy, Industrial Decarb: What type of infrastructure is needed to support integration of desalination with hydrogen production?

Cross-cutting: How do assumptions in costs and prices impact market feasibility analyses of these technologies?

Cross-cutting: How would water-energy nexus priorities and challenges (both technical and economic, such as financing) vary for urban vs. rural utilities?

Key Takeaways:

A unifying theme was the acknowledgement that we need to better understand and properly plan decarbonization with the view of water as a limited resource, and to consider how shifts in water availability due to climate change could directly or indirectly affect decarbonization efforts.

Top Opportunities/Needs Identified:

- Regionality (ex. energy potential, water resources)
- Data (sectoral water use, observational data, databases to enable analysis)
- Decision-making under uncertainty
- Systems thinking and analysis

Want to Learn More?!

Where: <https://energy.sandia.gov/watersrole>

What you'll find: Recorded sessions for all three days of the webinar and synthesis white paper report.