Los Alamos NATIONAL LABORATORY

Techno-Economic Analysis of Underground Hydrogen Storage

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Acknowledgment

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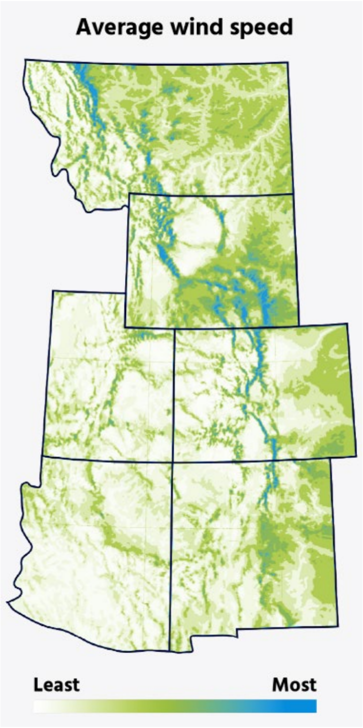
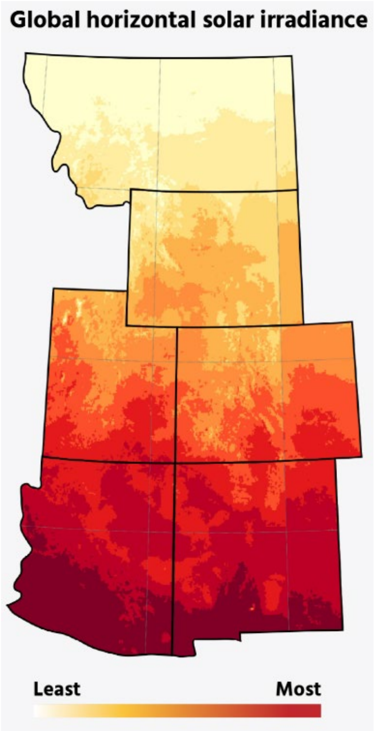
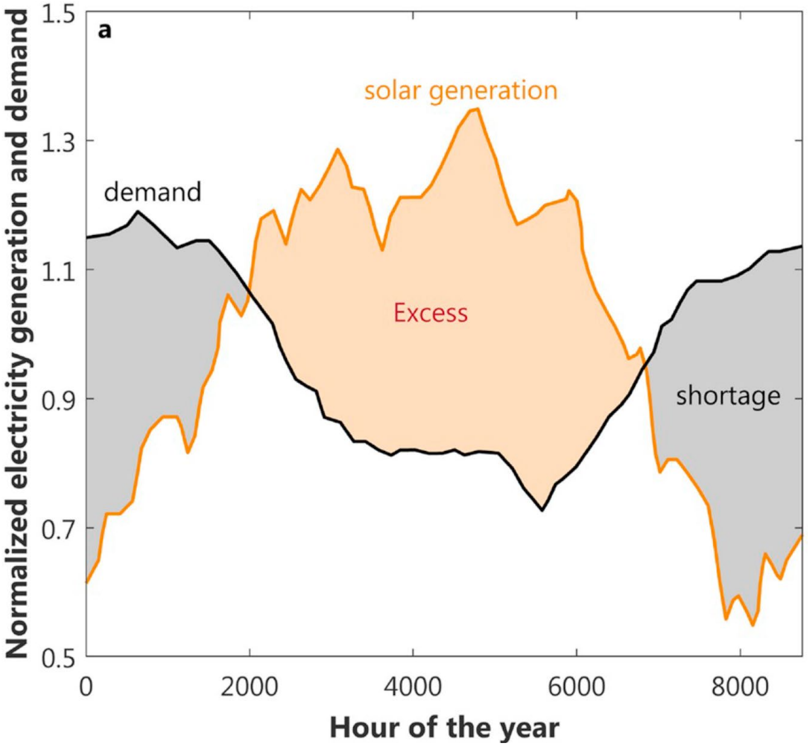
CESAM Workshop Organizer

Problem: Fluctuation in Renewable Energy Sources



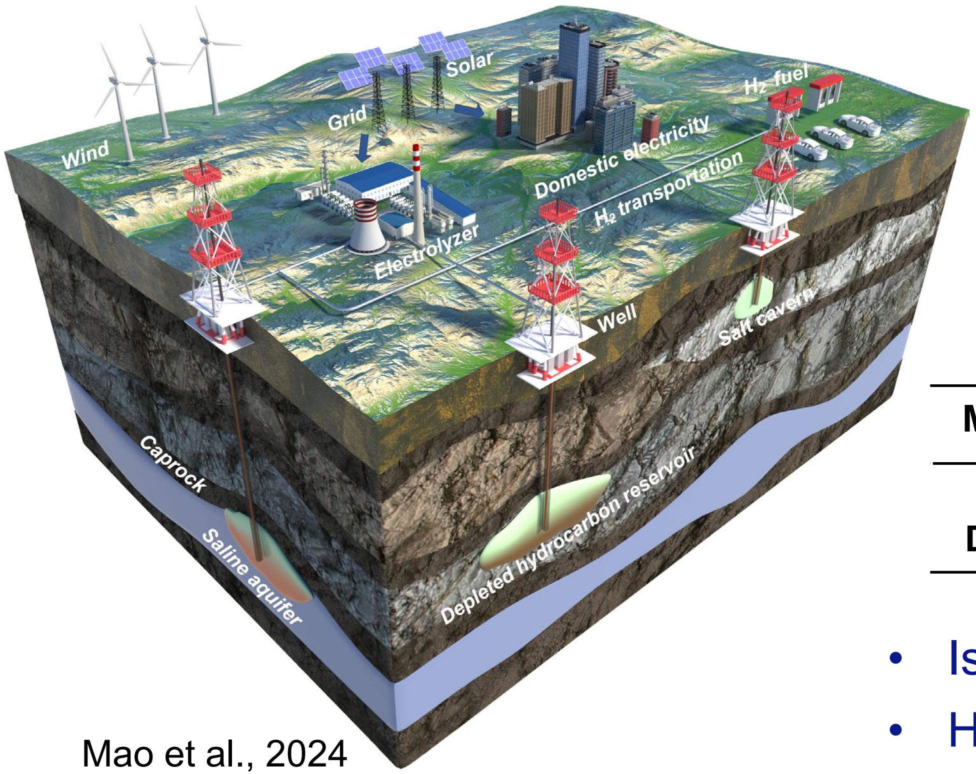


Commercial-Scale Renewable Energy Sources in NM



Significant Mismatch between Energy Supply and Energy Demand

Solution: Underground Hydrogen Storage (UHS)



Mao et al., 2024

❑ UHS Buffers Energy System

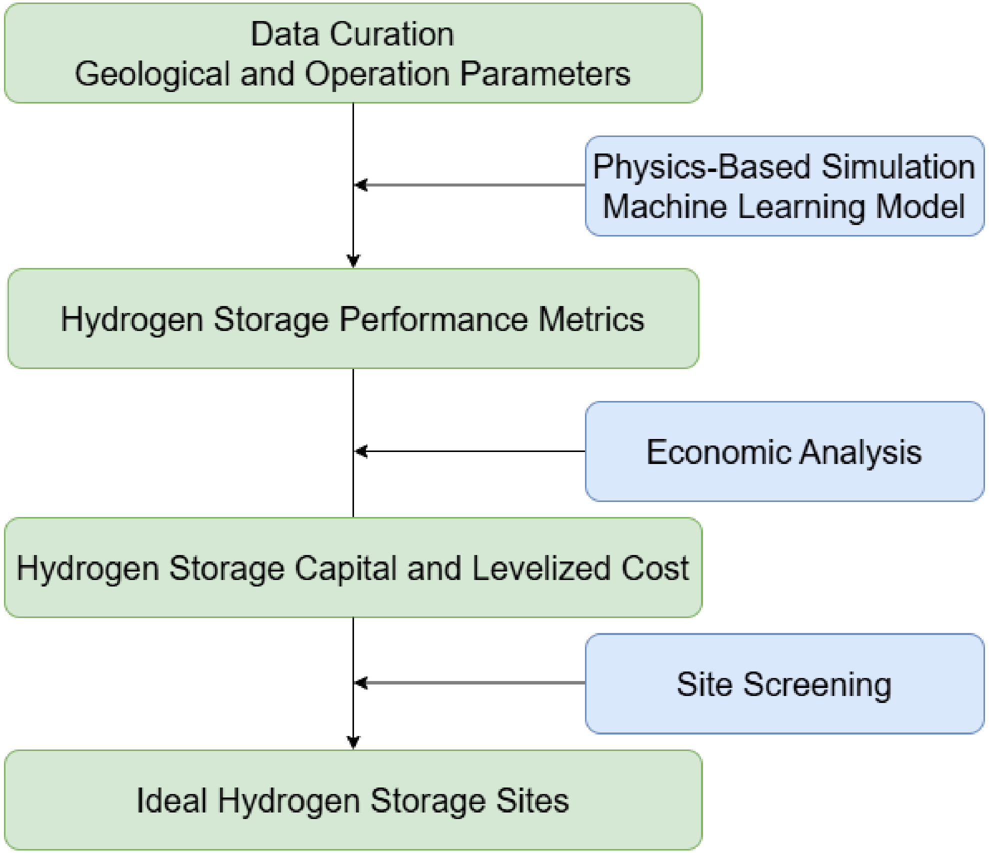
- Store H_2 during surplus
- extract H_2 during high demand

❑ UHS Stores Energy at Scale

Methods	Battery	Hydropower	UHS
Power Duration	≤ 4 hrs	≤ 12 hrs	Seasonal (Terawatt hrs)

- Is UHS economically feasible?
- How to efficiently select ideal geologic sites?

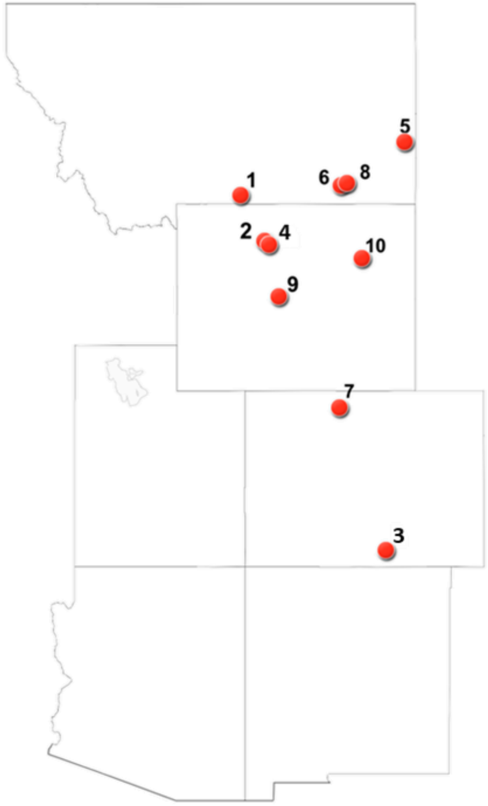
Objective: Economic Analysis and Site Screening Model



Model Advantages

- **Accurate prediction** for UHS performance based on physics-based simulation data
- **Computationally efficient** by leveraging deep learning techniques
- **Stand-alone toolset** runs on standard device
- **Applicability** for a wide range of real saline aquifers

Field Application: Site Screening in I-West Region



1. Big Horn (Tensleep)
2. Big Horn (Tensleep)
3. Raton (Entrada)
4. Big Horn (Crow Mountain)
5. Big Horn (Broom Creek)
6. Powder River (Minnelusa)
7. Piceance (Dakota)
8. Powder River (Dakota/Lakota)
9. Wind River (Muddy)
10. Powder River (Dakota)

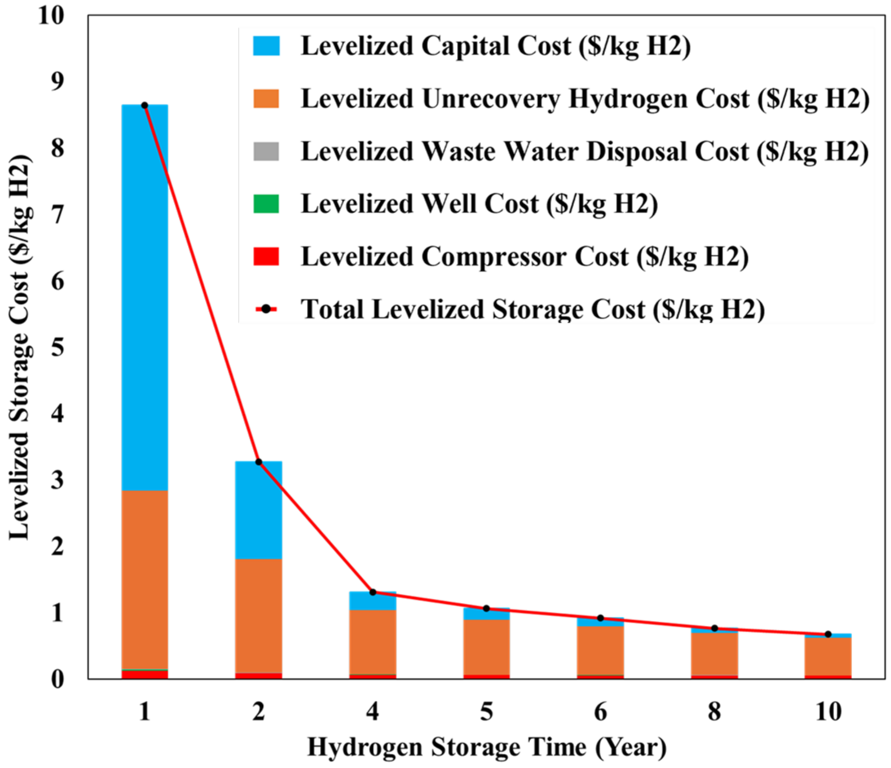
Zhao et al., 2024

Efficient field site screening in **75 saline aquifers**

Evaluating **hydrogen storage cost** over ten years of operation

Identify ideal saline aquifers with a low hydrogen storage cost

Case Study: Raton Basin in New Mexico



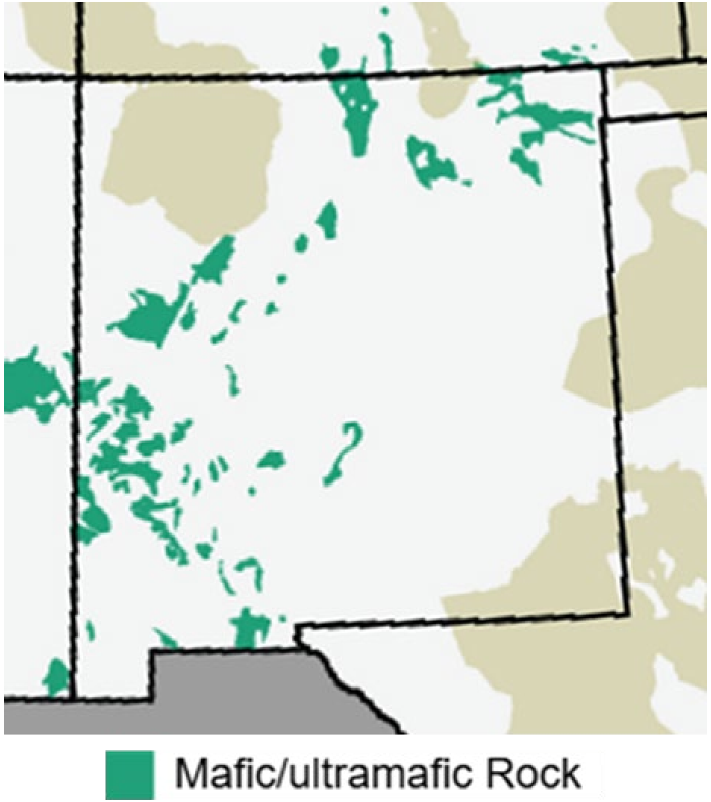
❑ **Levelized Storage Cost Overview**

- Govern by **levelized capital cost** and **unrecoverable hydrogen** at 1st year
- **Capital costs** are spread out over time, reducing their impact as operational years increase
- **Unrecoverable hydrogen** is the largest contributor to levelized cost by the end of operational

❑ **Recommendation**

- Extending storage time significantly lowers unit storage cost, indicating **longer operational life is beneficial for cost reduction**

Ongoing Work: Geologic Hydrogen Economic Analysis



U.S. Geological Survey

Geologic Hydrogen includes both naturally occurring and stimulated hydrogen generated within subsurface reservoirs through chemical reactions

❑ Production Potential

- Large deposits of mafic and ultramafic rocks in southwest New Mexico
- Potential for further discoveries near volcanic fields

❑ Geologic Hydrogen Production Cost

- Current estimation: about $1.45/kg at the wellhead
- Target cost: Less than $1/kg