Hydrogen Production Innovation

Holly Krutka, PhD
Executive Director
School of Energy Resources

Eugene Holubnyak
Director
SER Hydrogen Energy Research Center

Prepared for the
Joint Minerals, Business and
Economic Development Committee

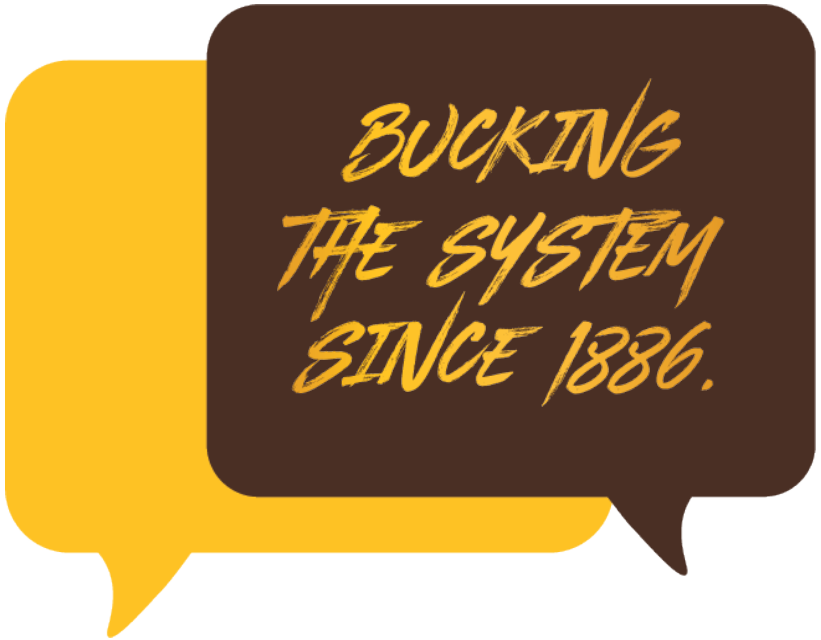
May 9, 2024

THE WORLD NEEDS MORE COWBOYS.

UNIVERSITY OF WYOMING | School of Energy Resources

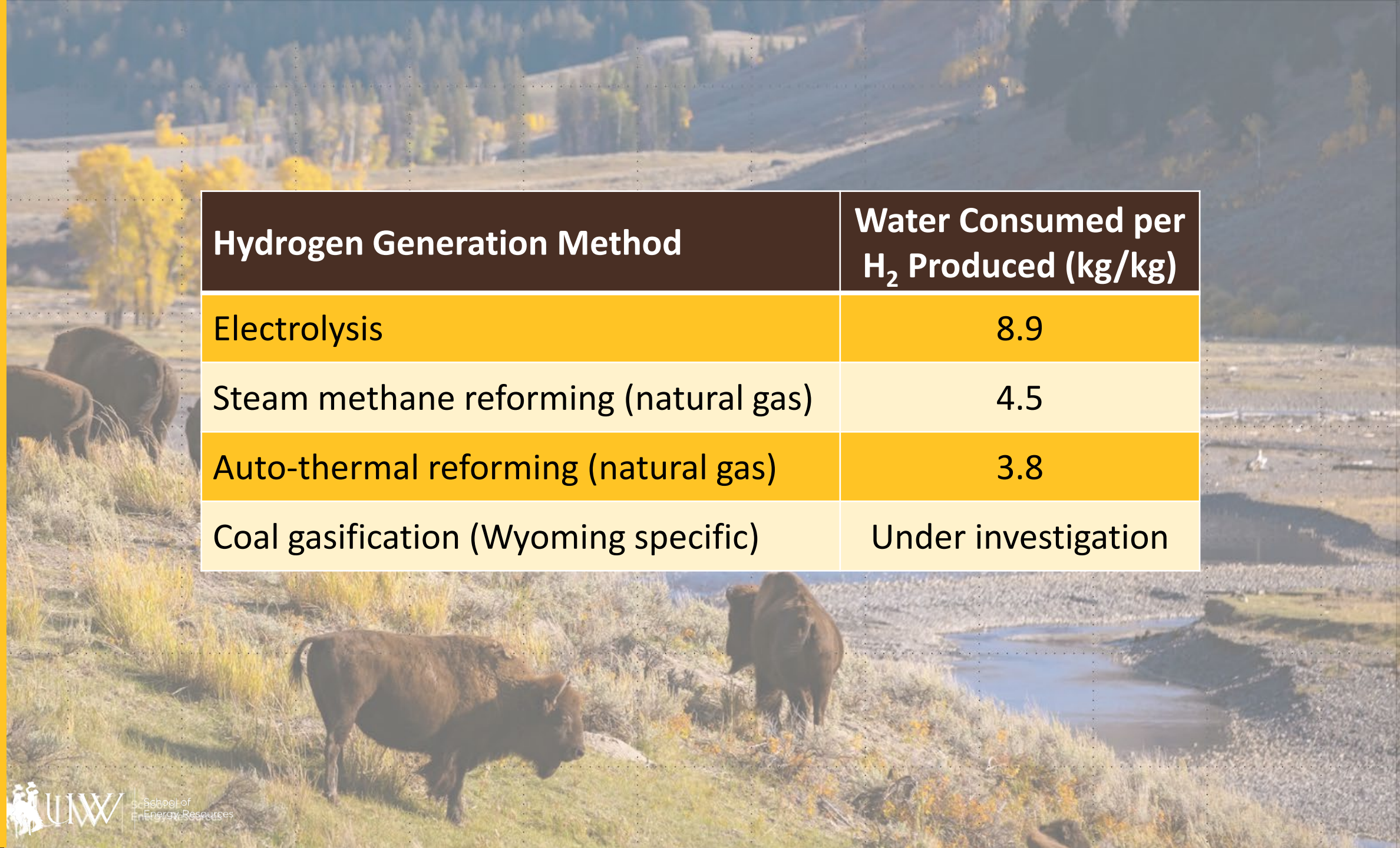
SER's Mission:

Energy-driven economic development for Wyoming



WATER NEEDED FOR H_2

Hydrogen Generation Method	Water Consumed per H_2 Produced (kg/kg)
Electrolysis	8.9
Steam methane reforming (natural gas)	4.5
Auto-thermal reforming (natural gas)	3.8
Coal gasification (Wyoming specific)	Under investigation

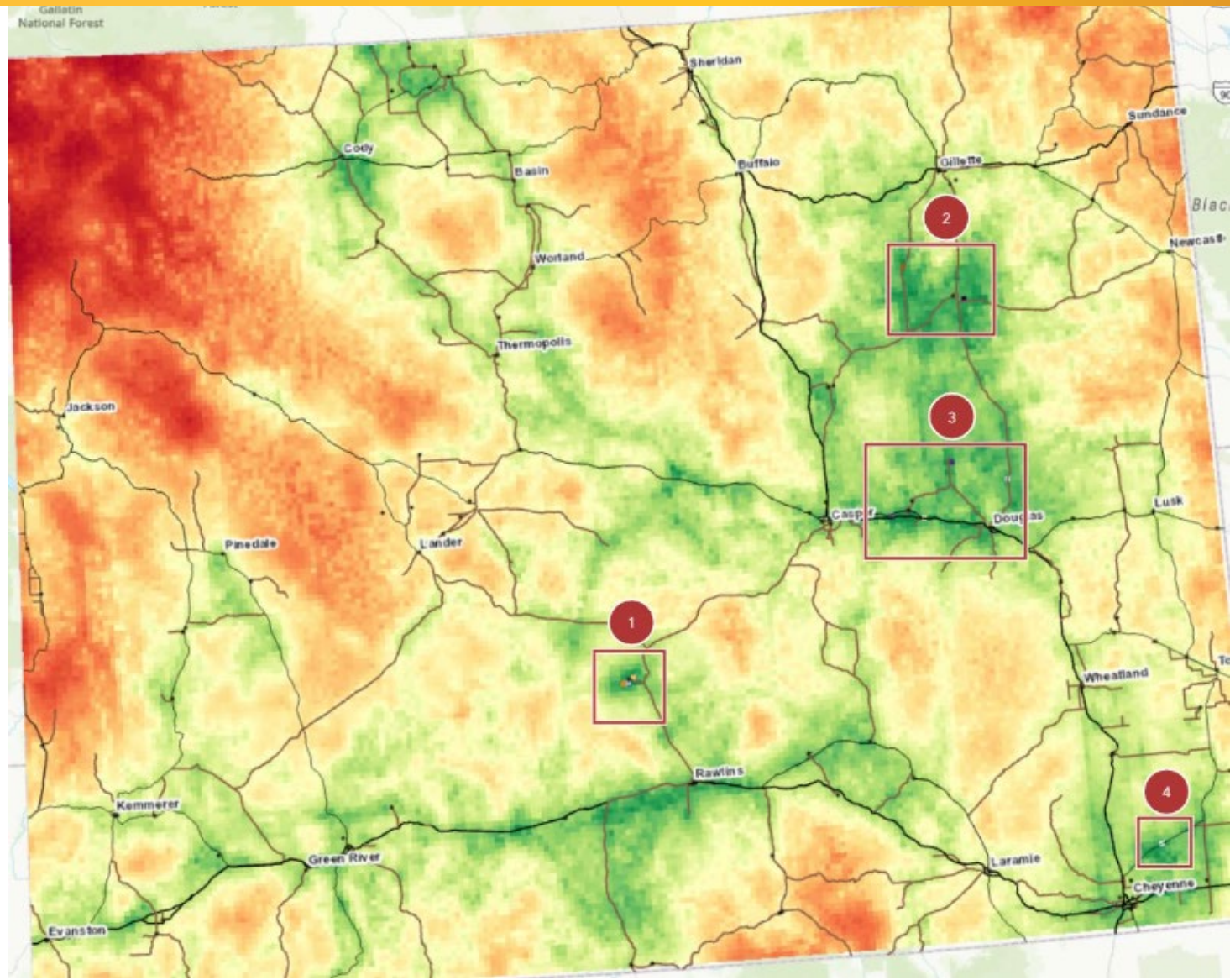


WHY H_2 IN WYOMING

- New market for Wyoming natural gas
- New market for Wyoming coal
- Approach to using stranded wind
- Draw investment to Wyoming
- Industry support and interest
- Potential use for produced water
- Industry support and engagement
- Significant potential for energy-driven economic impact

Hydrogen from Wyoming Natural Gas

- Suitability model considering no company-specific infrastructure
- This model indicates the best areas for hydrogen to be produced in WY
  - Powder River Basin
  - Greater Green River Basin
  - Denver-Julesburg Basin



Produced Water and Natural Gas to Hydrogen

- "SCWDO-SMR" process pilot to be tested in Wyoming
- Cleans produced water with advanced distillation
- Improves efficiency of steam methane reforming
- Hiring five UW students
- Total Project: $10M
  - Federal: $5 million
  - State: $2.75 million (WEA) + $550k (SER)
  - Private: $750k (EPC) + $950k (Williams)

EPC Engineering, Procurement & Construction

Wyoming Energy Authority

Department of Energy, United States of America

Los Alamos National Laboratory

UW School of Energy Resources

Williams

Produced Water Treatment is Costly for Operators

Treatment of Produced Water

- General treatment: removal oil and grease, suspended solids, bacteria and iron
- Advanced treatment: safe surface discharge; extends to the removal of salt, ammonia, and dissolved organics

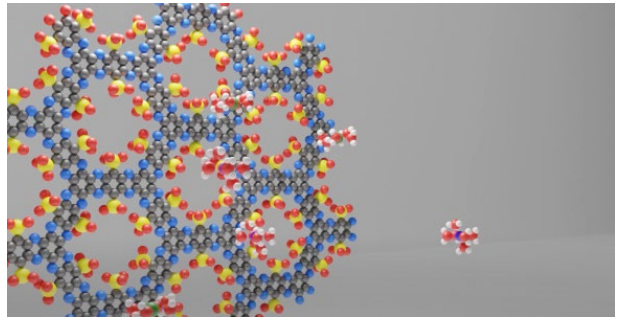
Cost Breakdown	Cost Range, $/bbl
Sourcing from ground or surface water	$0.15-0.60/bbl avg
Storage/transportation	$0.50-1.50/bbl avg $4.00-5.00/bbl long-haul
Disposal	$0.40-1.00/bbl avg
Treatment – Recycling	$0.20-0.85/bbl avg >$0.85/bbl for high chemical demand
Treatment - Advanced	$0.90-3.00/bbl membrane $2.50-9.00/bbl thermal

Source: https://www.gwpc.org/

CENTER FOR PRODUCED WATER MANAGEMENT

RESEARCH PROJECTS

Developing technologies for recovering lithium from produced waters and other brines.



Working with **Materials Modification Inc**. to develop selective membranes for lithium recovery from mixed brines.

MATERIALS MODIFICATION INC.

Working with SER researchers and Williams on a Wyoming Energy Authority sponsored project. The goal of this project is to evaluate the feasibility of producing hydrogen in Wyoming as an energy resource. CEPWM's role in this effort is to identify viable water resources, which are critical to producing hydrogen through electrolysis, and conduct treatability assessments of these waters for the purposes of producing the hydrogen.

Director

Jonathan Brandt, Professor of Civil and Architectural Engineering

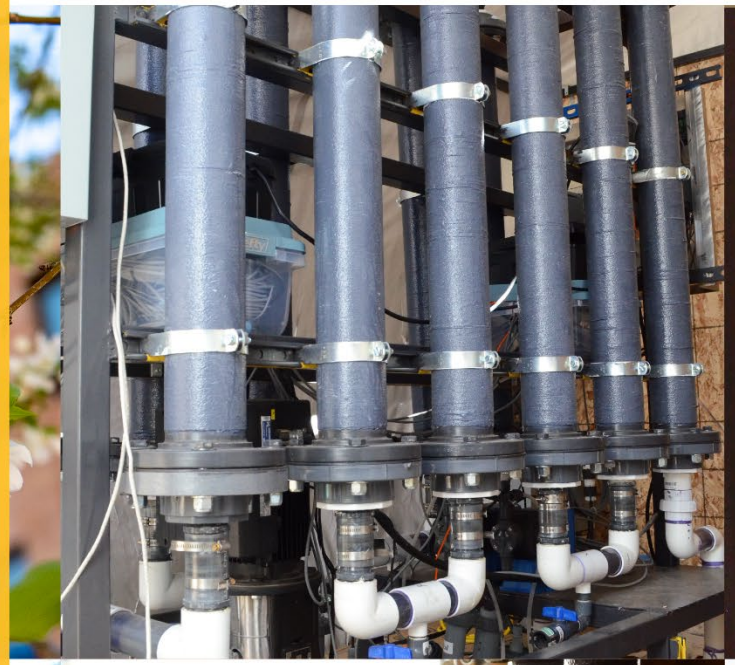
PRODUCED WATER TREATMENT | RESOURCE RECOVERY | REDUCED ENVIRONMENTAL IMPACTS

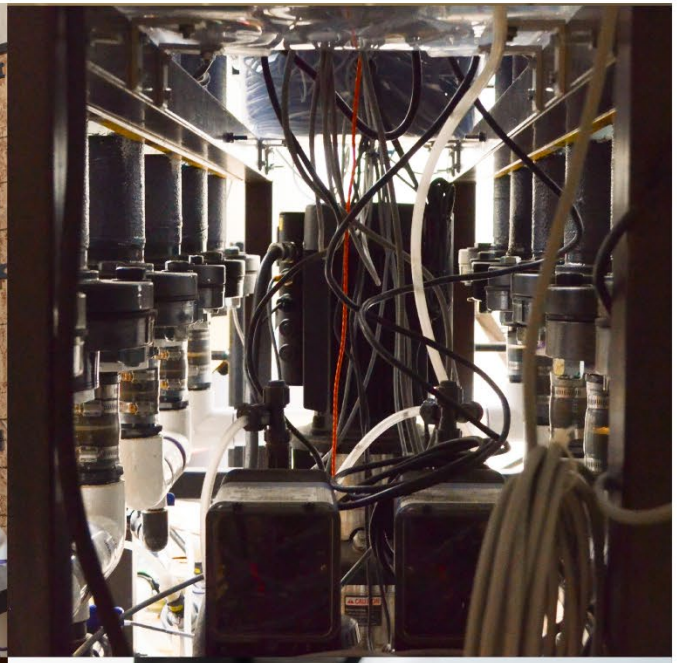
Coal Derived Membranes for Water Treatment

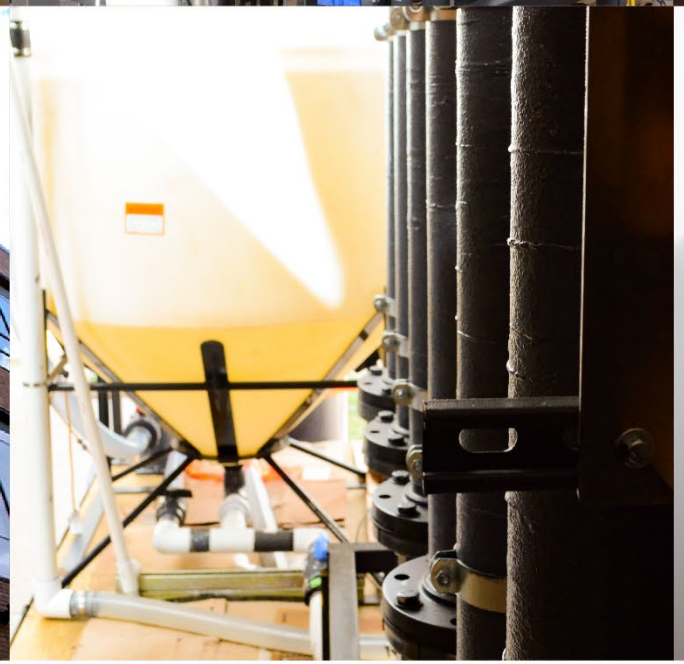
Jonathan Brant, PE, Ph.D.
UW Professor / CEPWM Director

University of Wyoming, Civil & Architectural Engineering

- Carbon Enhanced Filtration & Desalination Membranes
- Magnetic Conditioning for Reducing Membrane Specific Energy Consumption
- Reducing Membrane Fouling for Water Reuse







UW School of Energy Resources
Center of Carbon Capture and Conversion

Reference Materials

THE WORLD NEEDS MORE ADVENTUROUS SPIRIT.

H_2ERC Current Externally Funded Projects

- Desalination and Steam Methane Reforming with Williams, Los Alamos National Lab, and Engineering Procurement & Construction, LLC **(New)**
  - **$10M**, 50% cost-share, DOE NETL funded
  - **$2.75M** WY Energy Matching Fund
  - Charles Nye - PI
- Geologic Hydrogen Production, Bureau of Economic Geology – lead **(New)**
  - **$1.7M, ARPA-E,** 10% cost-share
  - Charles Nye, Co-PI
- Advancing Blue Hydrogen Production and Transport Infrastructure In Wyoming **(In progress)**
  - $650k, WY Innovation Partnership
  - Dr. Haibo Zhai - PI
- H_2Net-Zero Scenario for Wyoming – **DOE NETL ($650k) – final technical report**

SER Support of Research on Campus
Phase I: Hydrogen Make, Move, Use or Store

1. Soheil Saraji – **A Multiscale Study of Hydrogen Geochemical Reactivity and Transport for Geo-Storage in Deep Saline Aquifers** – Petroleum Engineering

2. Charlie Zhang, Selena Gerace, Muskan Kuinkel – **Economic analysis of building new pipelines vs converting existing natural gas pipelines in gaseous hydrogen transportation** – Civil and Architectural Engineering

3. Saman Aryana - **Phase Behavior of Hydrogen and Blended Gas** – Chemical Engineering

4. Kam Ng – **Experimental Investigation of the Effect of Underground Hydrogen Storage on the Hydraulic and Mechanical Properties of Rock Reservoirs** – Civil and Architectural Engineering

5. Sarah Buckhold, Michael Stoellinger, Jonathan Naughton – **Stranded Wind Energy for Hydrogen Production in the State of Wyoming** – Mechanical Engineering

6. Haibo Zhai – **Technological Learning and Resources Required for Large-Scale Blue Hydrogen Production toward Energy Earthshot Target** – Civil and Architectural Engineering

7. Minou Rabiei, Morteza Dejam, Vamegh Rasouli – **Feasibility Study of Developing Salt Caverns for Hydrogen Storage in Wyoming** – Petroleum Engineering

SER Support of Research on Campus
Phase II: Hydrogen Make, Move, Use or Store

1. Charlie Zhang, Selena Gerace, and Danish Kumar - **Developing a Smart, Safe, Sustainable, Resilient (SSSR) Hydrogen Transport Ecosystem in Wyoming** - Civil and Architectural Engineering

2. Haibo Zhai - **A Multi-Scale Computing Framework for Advancing Hydrogen Transportation Infrastructure** - Civil and Architectural Engineering

3. Saman Aryana - **Hydrogen Production through Coal Gasification – State of the Art and Future Directions** - Chemical & Biomedical Engineering

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