Technological Advancements for Growing Wyoming's Water Resources

Jonathan Brant,
Professor & Director CEPWM

CENTER OF EXCELLENCE
IN PRODUCED WATER MANAGEMENT

UNIVERSITY OF WYOMING

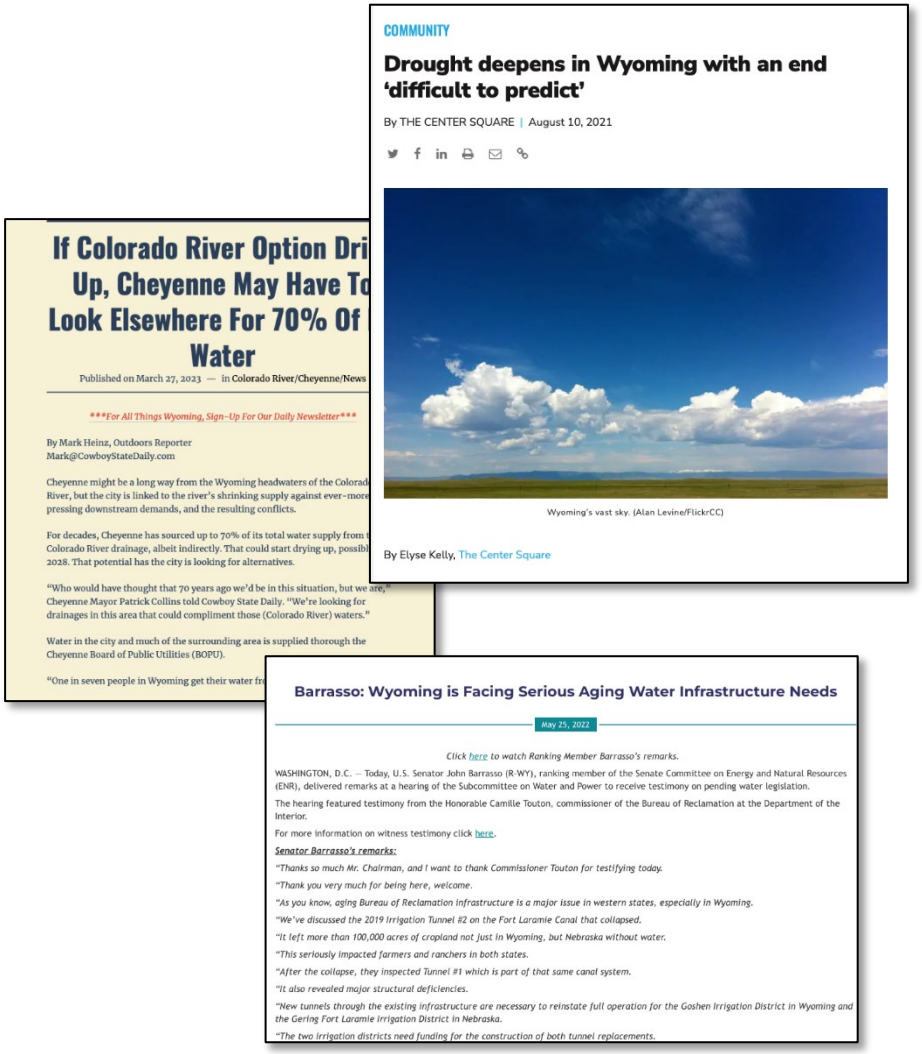
CEPWM Vision & Mission

- **VISION & MISSION:** R&D focused on synergies available to promote the management of PWs to maximize the utilization of water & other resources.
- **GOAL:** Reduce PW handling & disposal costs, permitting issues, improve environmental stewardship, & waste disposal volumes during resource extraction & utilization.
- **MOTIVATION:** The need for research and development of technologies and approaches for reducing the economic & environmental burdens of produced water management; thus promoting industrial partnerships within the Center.

www.cepwm.com

Motivation & History

- Importance of **water** to **Wyoming** is obvious with growing stresses driving need for innovation
- Oil and gas development is inexorably linked to water
  - Producers & consumers
- External pressures driving industry to innovate their water management practices
  - Fluctuating commodity prices
  - Environmental & reinjection regulations
  - Water acquisition & disposal costs
- Innovations in industrial water treatment translate to innovations in the municipal sector
  - Desalination processes
  - Water recycling & resource extraction



COMMUNITY

Drought deepens in Wyoming with an end 'difficult to predict'

By THE CENTER SQUARE | August 10, 2021

Wyoming's vast sky. (Alan Levine/FlickrCC)

By Elyse Kelly, The Center Square

If Colorado River Option Dri… Up, Cheyenne May Have To… Look Elsewhere For 70% Of… Water

Published on March 27, 2023 — in Colorado River/Cheyenne/News

****For All Things Wyoming, Sign-Up For Our Daily Newsletter****

By Mark Heinz, Outdoors Reporter
Mark@CowboyStateDaily.com

Cheyenne might be a long way from the Wyoming headwaters of the Colorad… River, but the city is linked to the river's shrinking supply against ever-more… pressing downstream demands, and the resulting conflicts.

For decades, Cheyenne has sourced up to 70% of its total water supply from t… Colorado River drainage, albeit indirectly. That could start drying up, possibl… 2028. That potential has the city is looking for alternatives.

"Who would have thought that 70 years ago we'd be in this situation, but we are," Cheyenne Mayor Patrick Collins told Cowboy State Daily. "We're looking for drainages in this area that could compliment those (Colorado River) waters."

Water in the city and much of the surrounding area is supplied thorough the Cheyenne Board of Public Utilities (BOPU).

"One in seven people in Wyoming get their water fr…

Barrasso: Wyoming is Facing Serious Aging Water Infrastructure Needs

May 25, 2022

Click here to watch Ranking Member Barrasso's remarks.

WASHINGTON, D.C. – Today, U.S. Senator John Barrasso (R-WY), ranking member of the Senate Committee on Energy and Natural Resources (ENR), delivered remarks at a hearing of the Subcommittee on Water and Power to receive testimony on pending water legislation.

The hearing featured testimony from the Honorable Camille Touton, commissioner of the Bureau of Reclamation at the Department of the Interior.

For more information on witness testimony click here.

Senator Barrasso's remarks:

"Thanks so much Mr. Chairman, and I want to thank Commissioner Touton for testifying today.

"Thank you very much for being here, welcome.

"As you know, aging Bureau of Reclamation infrastructure is a major issue in western states, especially in Wyoming.

"We've discussed the 2019 Irrigation Tunnel #2 on the Fort Laramie Canal that collapsed.

"It left more than 100,000 acres of cropland not just in Wyoming, but Nebraska without water.

"This seriously impacted farmers and ranchers in both states.

"After the collapse, they inspected Tunnel #1 which is part of that same canal system.

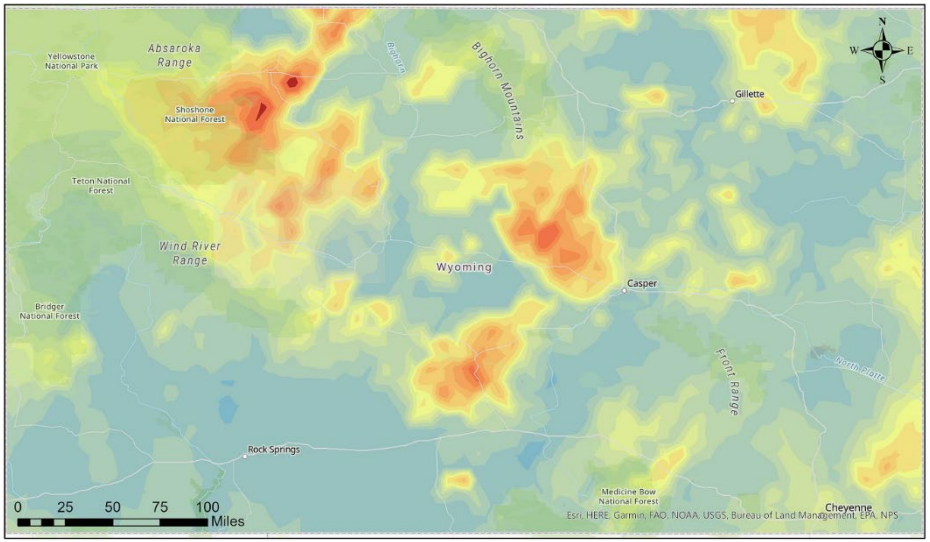
"It also revealed major structural deficiencies.

"New tunnels through the existing infrastructure are necessary to reinstate full operation for the Goshen Irrigation District in Wyoming and the Gering Fort Laramie Irrigation District in Nebraska.

"The two irrigation districts need funding for the construction of both tunnel replacements.

PW Challenges & Opportunities

- **Produced water** – all water returned to surface via a well borehole
  - Sum(fracturing fluids, formation water)
  - 21 billion bbl/yr in U.S. (1M wells)
    - 5:1 to 8:1 water:oil
- WQ is highly variable
  - Salts, minerals, metals, O&G, radionuclides, and organics
- Challenge is treating the water below current disposal prices **OR** making treatment a revenue generating exercise



BBLS OF WATER PRODUCED PER WELL PER YEAR, 2020

00.0-500.0	10,000.0-15,000.0	30,000.0-40,000.0	80,000.0-100,000.0
500.0-2,500.0	15,000.0-20,000.0	40,000.0-50,000.0	100,000.0-150,000.0
2,500.0-5,000.0	20,000.0-25,000.0	50,000.0-60,000.0	150,000.0-200,000.0
5,000.0-10,000.0	25,000.0-30,000.0	60,000.0-80,000.0	NoData

Produced water can be a valuable resource & a benefit to Wyoming's economy!

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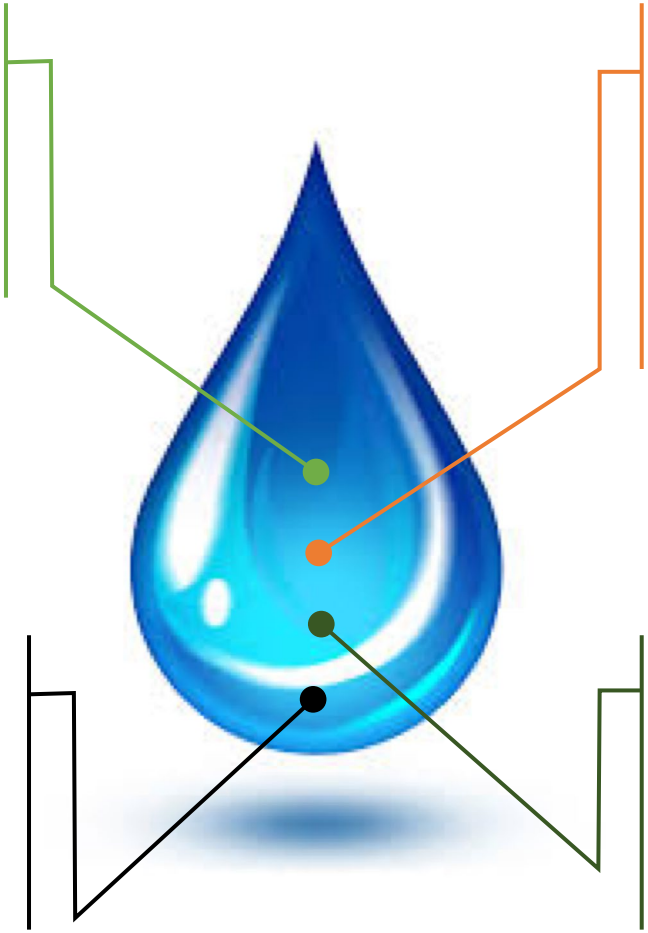
Produced Water as a Resource?

Precious Metals –

- Lithium, iodine and uranium
- Rare earth elements (REEs)

Water – 2.4 BG/day

- Irrigation & livestock watering
- Land reclamation
- Stream augmentation
- Blue hydrogen (H_2)



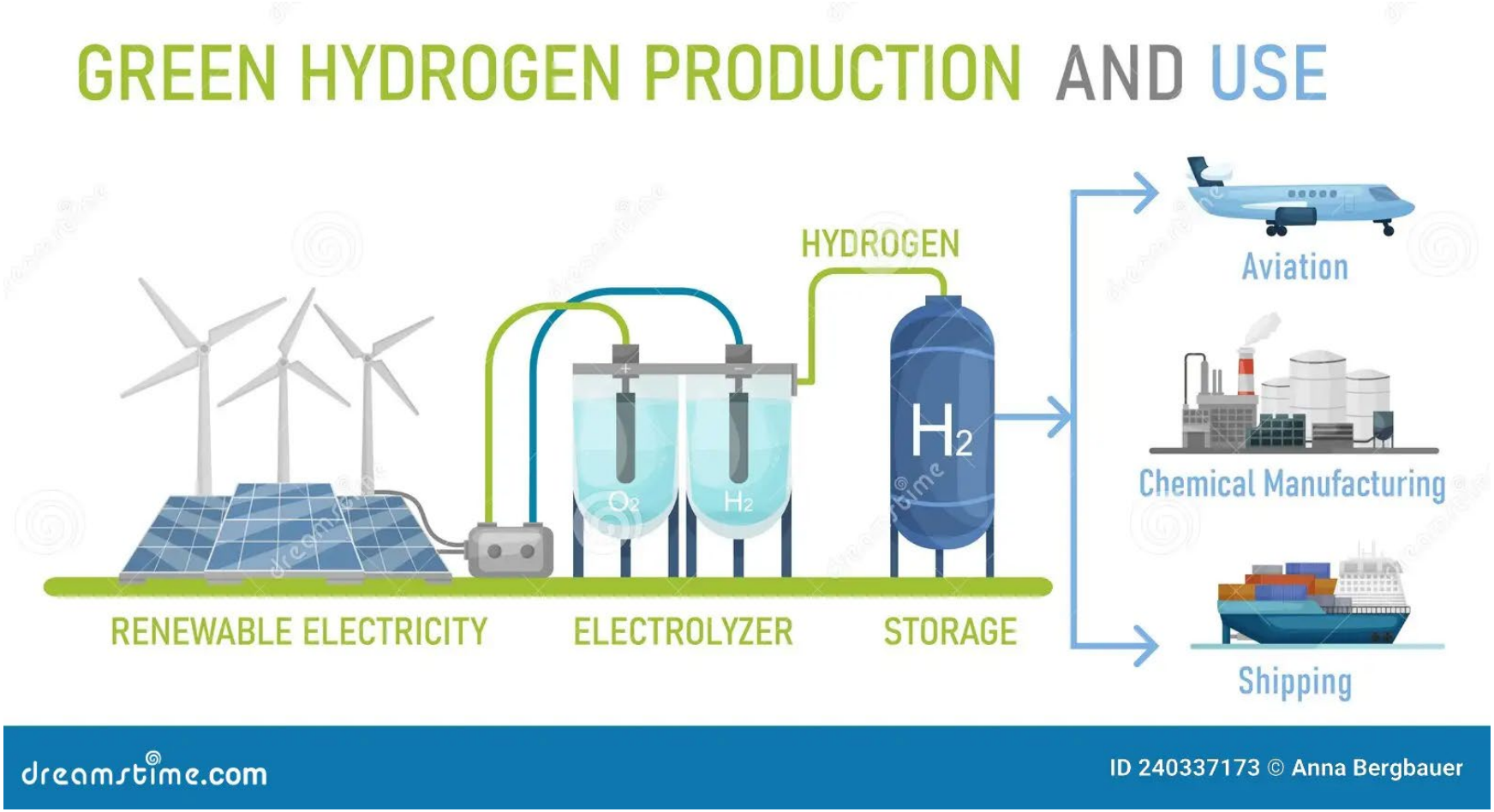
Other –

- Hydrocarbon recovery, $$
- Methanol + other additives for reuse
- Energy production (heat & chemical potential)

Minerals –

- NaOH production from $NaHCO_3$ w/ membrane electrolysis
- Na, K, Mg, and Ca

Produced Water as a Resource?



Availability of renewable energy makes Wyoming very attractive for green H_2 production ***BUT WATER*** *is needed –* ***produced water*** *can serve as a near limitless supply.*

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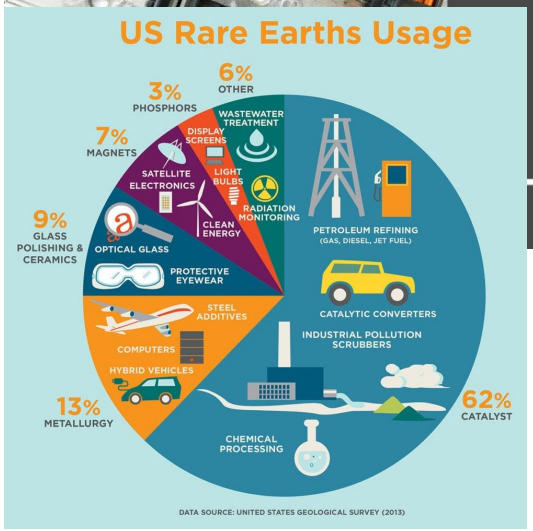
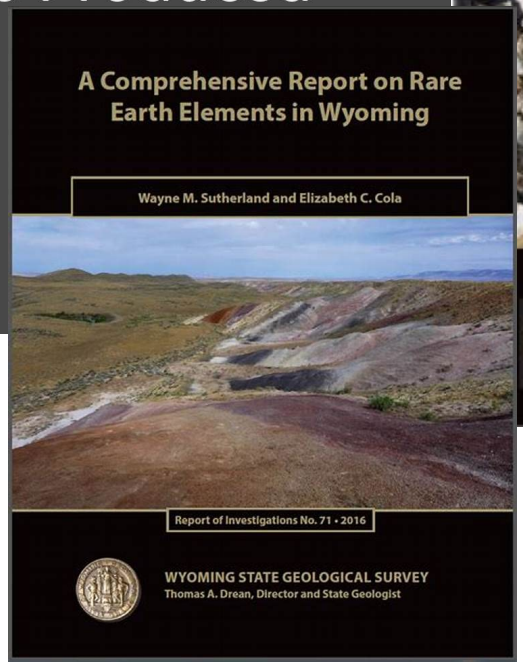
Produced Water as a Resource?

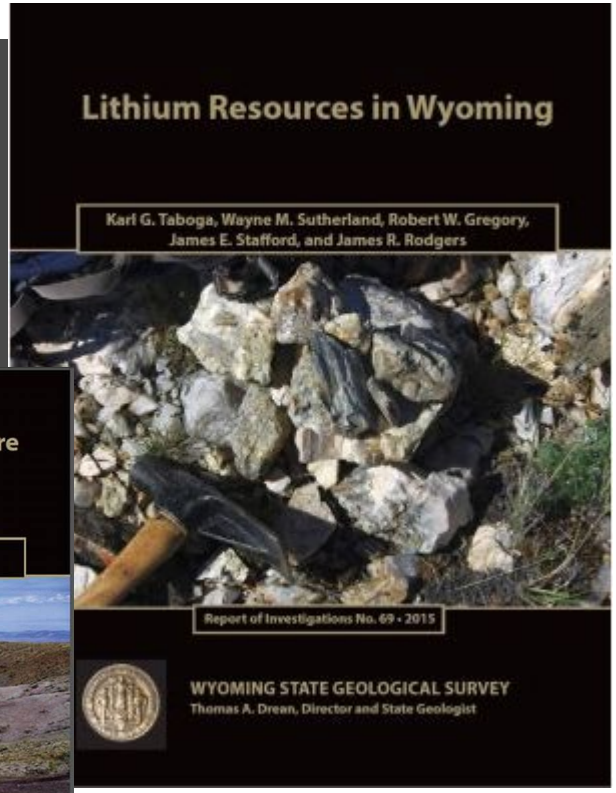
The Energy Law Blog

Lithium Extraction May Soon Turn Produced Water Into Produced Profits

Liskow







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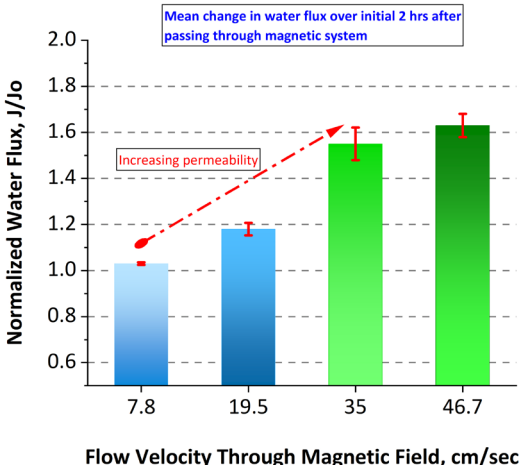
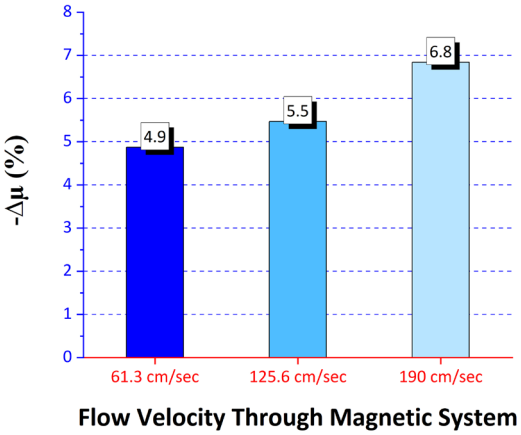
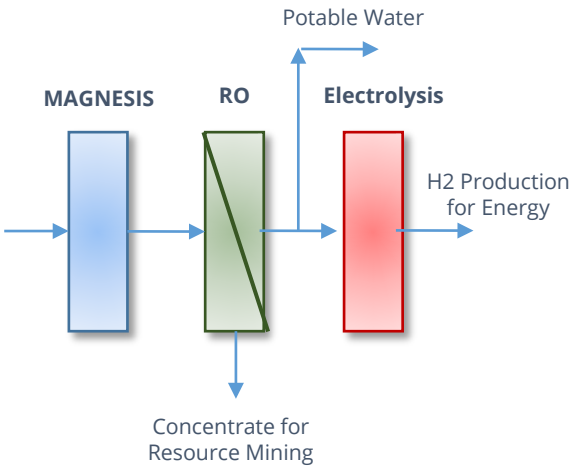
Net Zero Desalination

- Desalination largely done using membrane-based processes (NF, RO)
- Specific energy consumption (kWh/gal) hinders widespread adoption
  - Big hurdle for small communities
  - Contributes to “high” PW costs
- CEPWM developing magnetic devices for reducing energy consumption
  - Spin-off company formed in 2022 – ***Wyoming Water Innovations, LLC***







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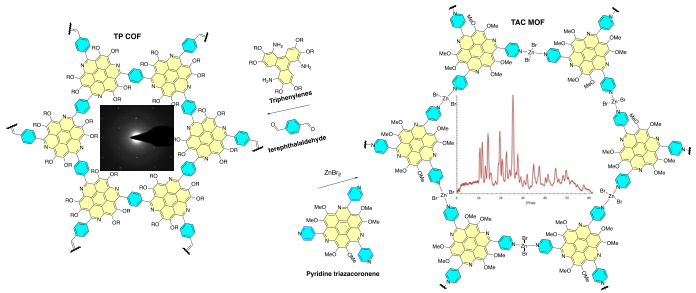
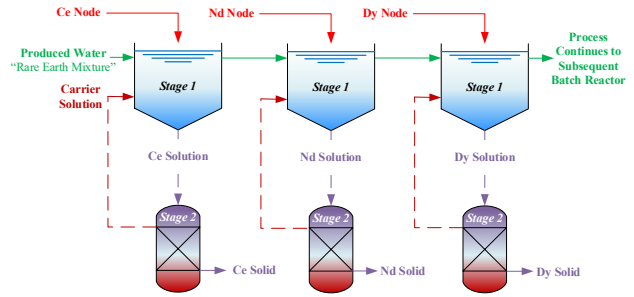
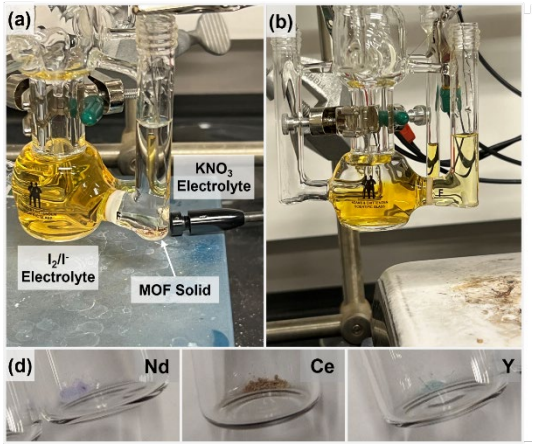
Selective Materials for Li/REE Extraction

- Multiple efforts aimed at developing materials for selective element recovery from brines
  - Solvents for Li recovery – collaboration with Materials Modification Inc. (Phase II SBIR)
  - Membranes + other materials for Li & REE recovery – DOE/NSF
- Collaborations between engineering & chemistry
  - Drs. Hoberg, Parkinson, Hill, & Brant
  - Chemistry directs COF/MOF synthesis
  - Engineering directs process design & membrane synthesis







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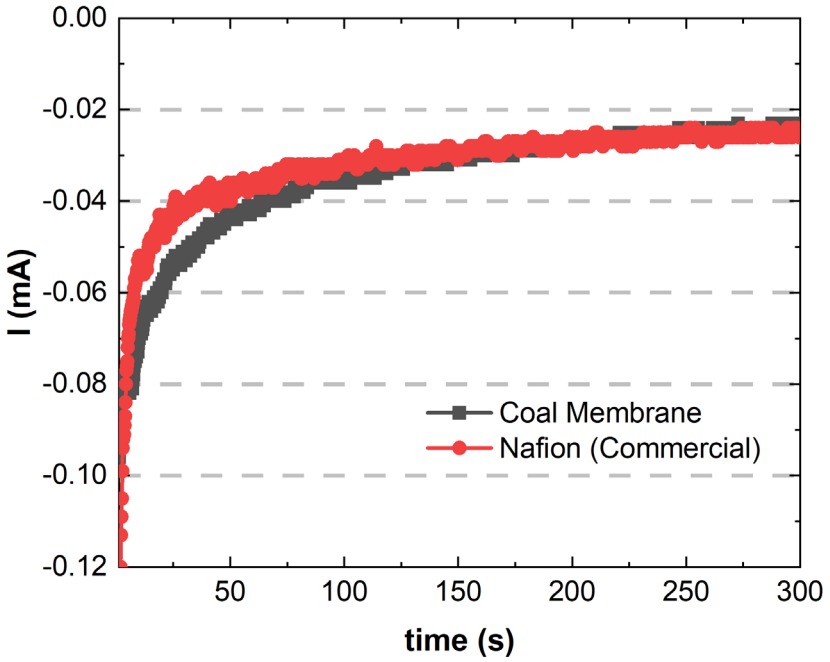
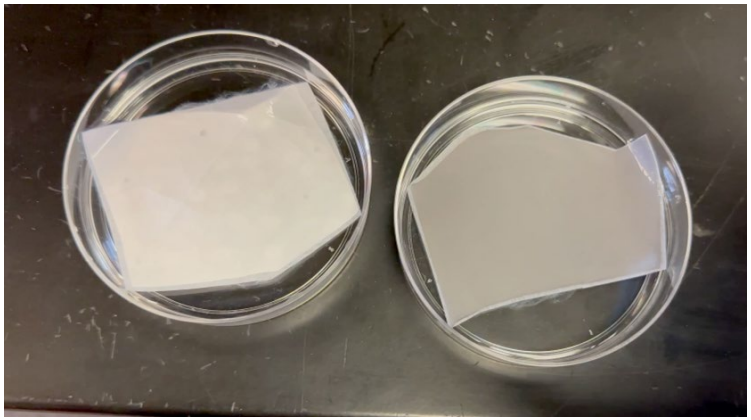
2D Carbon Composite Membranes

Membrane Properties	Theory
Enhanced tensile strength (stronger fiber)	• sp carbon-carbon/other atom linkages • increase in bond energy
Increase in ion transport rate/efficiency	• form of carbon (sp) network that allow electron and charged particles (ions in this case) to move through with aligned patterns • carbon-carbon tunnels that promote small ion (in terms of hydrated diameter) transport capability
Ion selectivity	• Gibbs-Donnan Effect coupled with dielectric exclusion • Surface charge of carbon membrane is high due to increase in the bond energy • Increase in surface charge promotes Gibbs-Donnan effect & dielectric exclusion





Development of proton exchange membranes (PEM) for H_2 production & ion selective (Li, REEs) membranes

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Hydrocarbon Recovery from PWs

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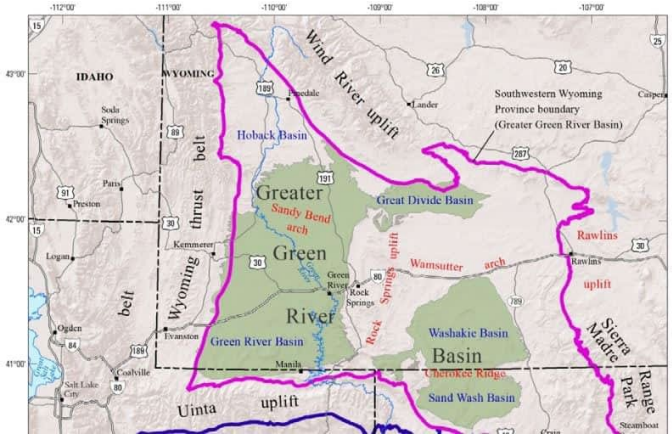
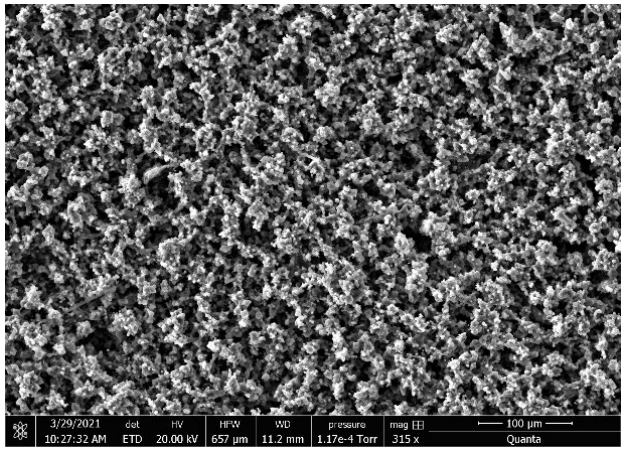
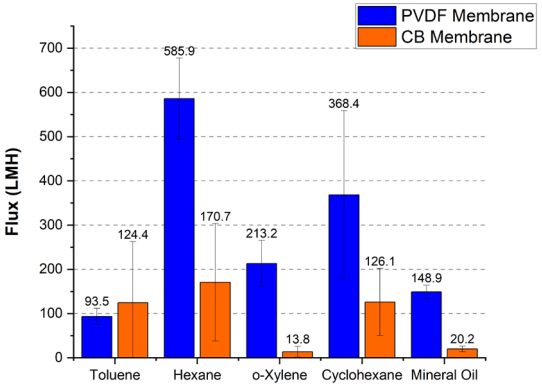
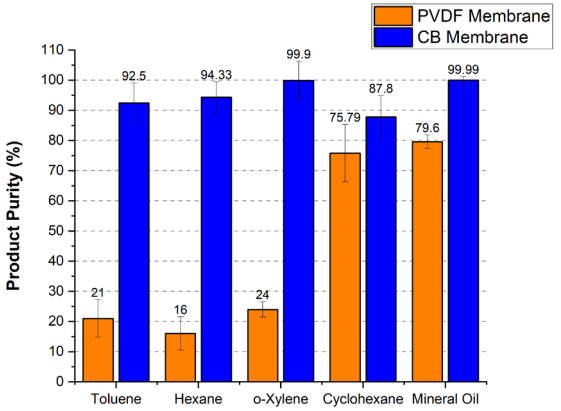
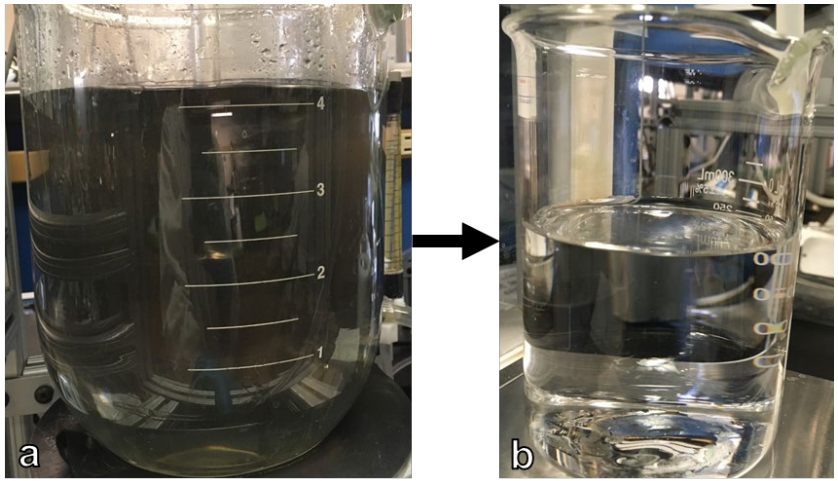




Nano-Carbon Black + PVDF-HFP







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Questions?

Jonathan Brant

University of Wyoming
Dept. Civil & Architectural Engr.
1000 E. University Avenue
Laramie, WY 82071

Phone: (307) 766 – 5446
Email: jbrant1@uwyo.edu

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