

# Project PARETO – DOE's Produced Water Optimization Initiative

PSE+ Stakeholder Summit

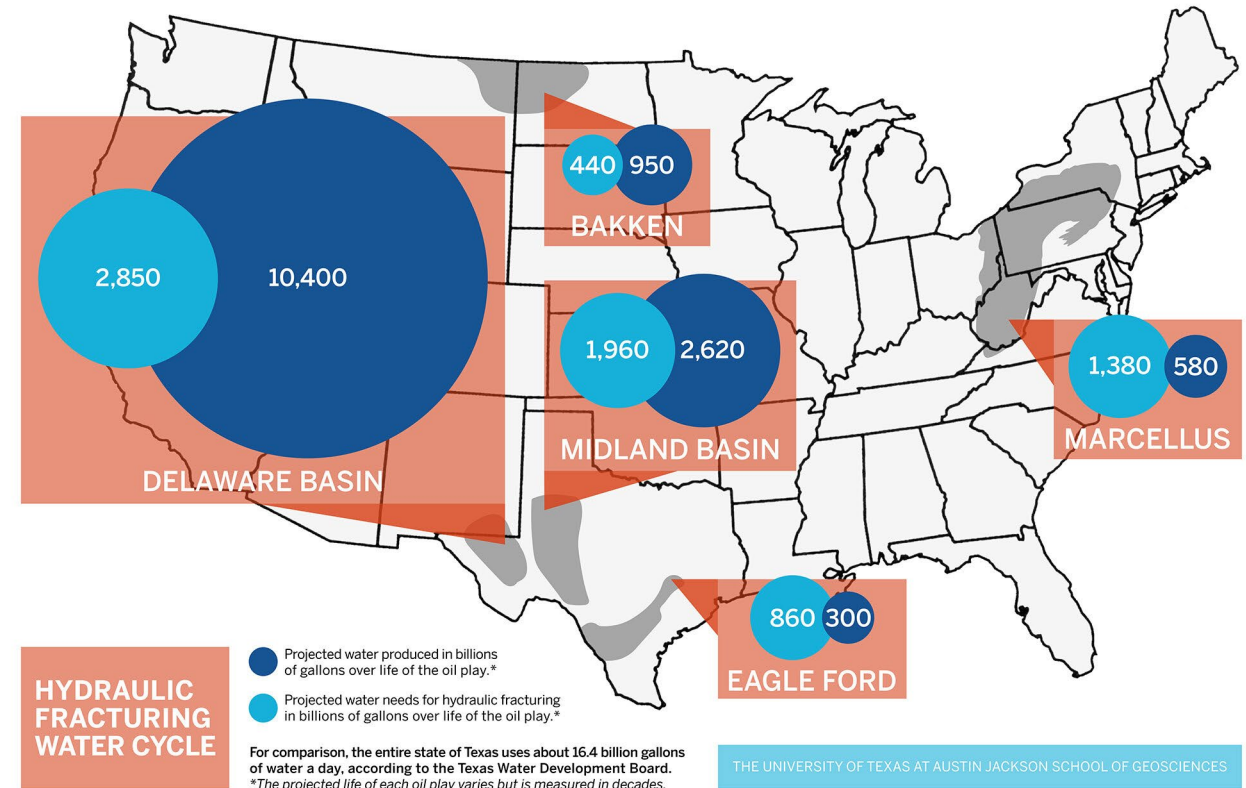


October 2023



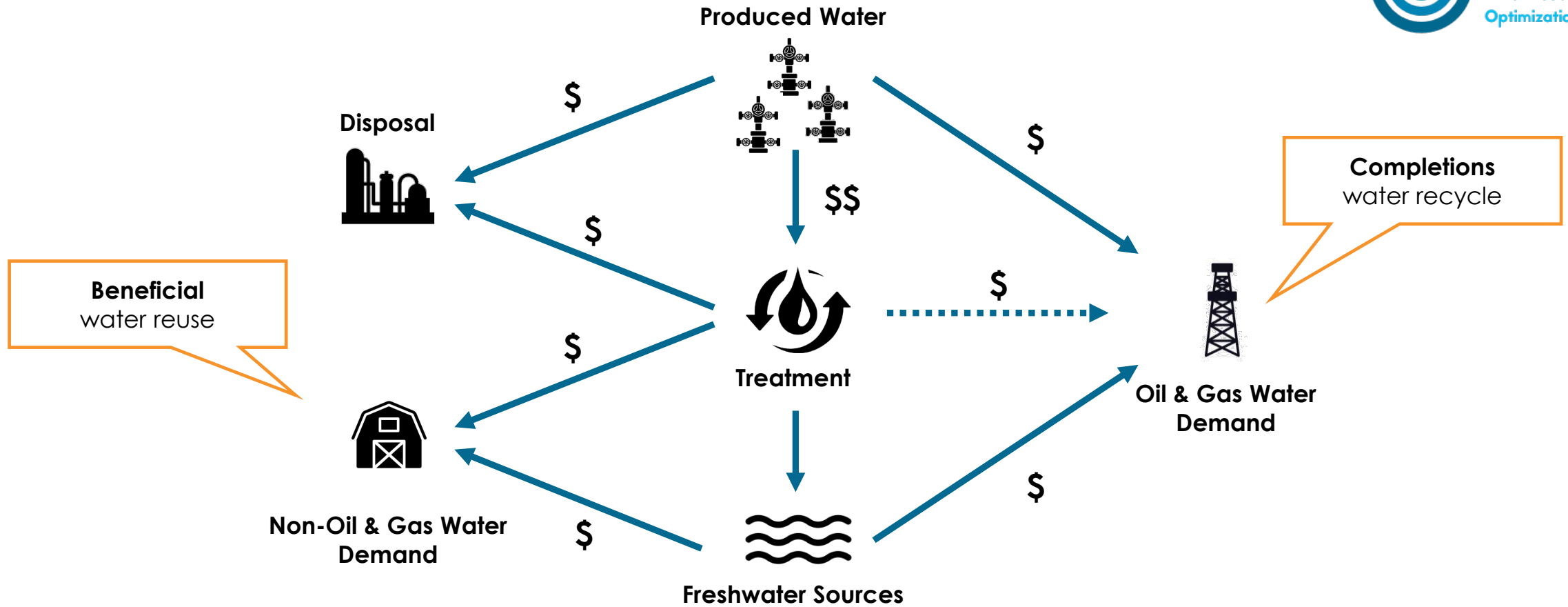
# Refresher: Oil & Gas Produced Water

- **Well-known:** oil & gas development requires water (e.g., >1 MM bbl per well)
- Water is used to drill wells and to fracture oil-/gas-bearing formations
- **Less-known:** water is co-produced as oil & gas is recovered from the reservoir
- So-called “**produced water**” is a waste byproduct to upstream operators
- The amount of co-produced water varies significantly basin-by-basin



**The U.S. oil & gas industry produces more water than it consumes.**

# Refresher: Produced Water Management Options



**Recognition: produced water management can be optimized using computational decision-support tools.**

# Refresher: Project Premise & Goals



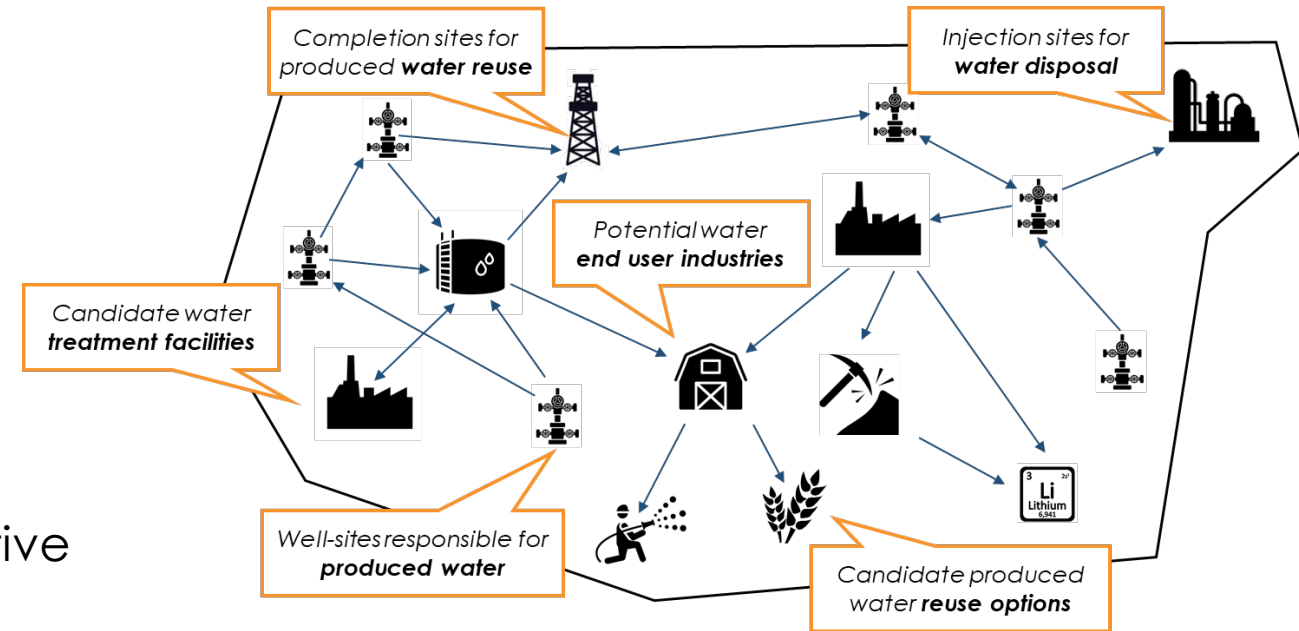
More info?  
Talk to **Markus!**



**Premise: Develop a free and trusted software program (“PARETO”) to help organizations transport, treat, store, inject and/or reuse produced water from onshore oil & gas operations.**

PARETO helps with:

- 1) produced water **management** (2021 focus)  
→ infrastructure buildout, fluid flow optimization
  - 2) produced water **treatment** (2022 focus)  
→ systems integration of treatment solutions
  - 3) produced water **beneficial reuse** (2023 focus)  
→ evaluation of beneficial water reuse options
- Views produced water from “systems” perspective
  - Addresses “macro” vs. “micro” challenges



PARETO is meant to become a trusted **decision-support tool for the extended produced water community (i.e., upstream operators, midstream/service companies, regulators, ...).**

# Refresher: How does PARETO work?



More info?  
Talk to **Markus!**



PARETO builds a digital twin of YOUR system and determines the best possible solution for YOU

Use pre-built spreadsheet templates or connect to database

## 1. Plug in Data

- Existing infrastructure
- Expansion opportunities
- Produced water forecasts
- Cost assumptions
- ...



## 2. Select your ...

### a) Preferred Objective(s)

- Minimize costs (upstream)
- Maximize profits (midstream)
- Facilitate reuse (regulator)
- ...

### b) Applicable Constraints

- Logistics (e.g., flow balances)
- Engineering (e.g., equipment sizing)
- Business (e.g., cash flow)
- ...



PARETO immediately visualizes the solution and stores results

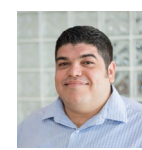
## 3. Get Recommendations

- Suggested fluid flow
- Proposed infrastructure buildout
- Environmental performance
- Anticipated economics or KPIs
- ...



**PARETO does not just calculate, predict or simulate possible scenarios; the program makes specific recommendations on how to improve your PW management strategy.**

# Refresher: PARETO's Core Capabilities



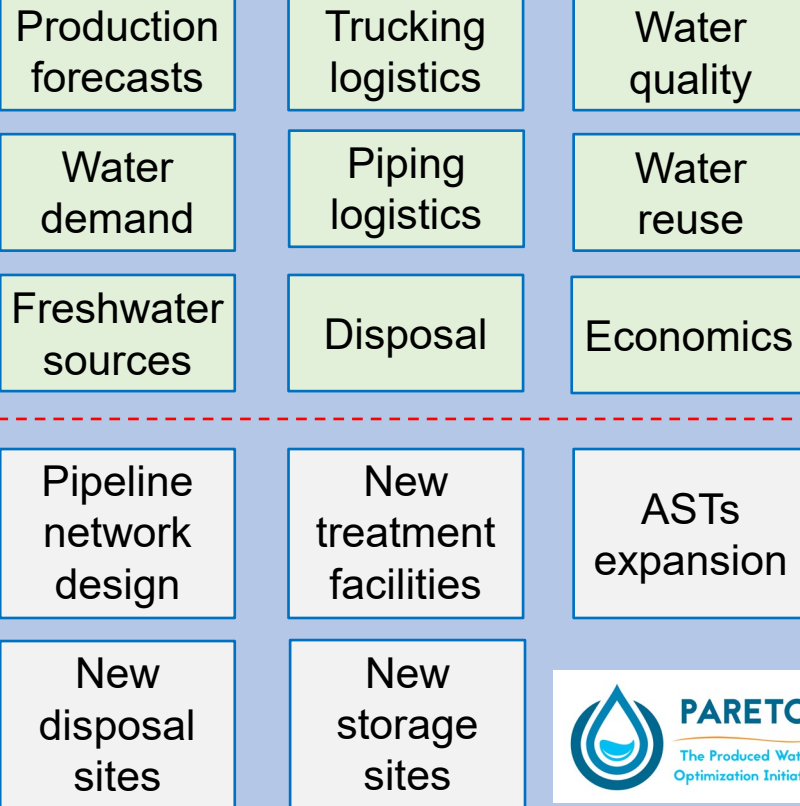
More info?  
Talk to Miguel!



## Model Library & Core Capabilities

### Strategic Model

### Operational Model



Integration with Other Platforms



- Easy access of a broad range of open-source and commercial solvers
- Availability of cutting-edge optimization techniques



- First-principle modeling of water treatment technologies
- Technology screening
- Techno-economic analysis
- Machine learning tools

Capabilities and Applications

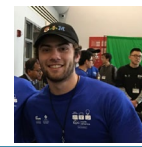
### Examples of Advanced Capabilities

- Multi-objective optimization: economics vs water reuse
- Risk management
  - Simulate network disruptions
- Optimization under uncertainty
  - Water availability, water demands

### Applications

- Benchmark of current practices
- Revise operation plans/policies
- Detailed investment strategies
- Assessment of beneficial reuse: mineral extraction, irrigation, etc.
- Water quality (MILP or MINLP)

# Tomorrow: A “Live” Demo of PARETO



More info?  
Talk to **Mike!**

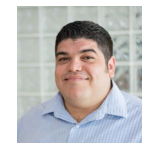


The screenshot shows the PARETO software interface. At the top, there is a menu bar with 'File', 'Edit', 'View', 'Window', and 'Help'. Below the menu bar, the 'PARETO' logo is on the left, and a 'Scenario' dropdown menu is set to 'SRA'. On the right, there is a 'VIEW SCENARIO LIST' link. The main interface has three tabs: 'Data Input', 'Optimization Setup' (which is active), and 'Model Results'. The 'Optimization Setup' window is open, showing the following settings:

- Objective Selection:**  Minimize Cost,  Maximize Reuse,  Maximize Profits
- Solver:** CBC (Free)
- Maximum Runtime:** 900 sec
- Optimality Gap:** 0 %
- Water Quality:** False
- Advanced User Options:** (dropdown menu)

An 'OPTIMIZE →' button is located at the bottom right of the settings window. At the bottom left of the main interface, there is a '← BACK' button, and at the bottom right, there is another 'OPTIMIZE →' button.

# PARETO for University Collaborations



More info?  
Talk to **Miguel!**



The team has established close **collaborations** with several universities:

**Carnegie Mellon University**

**Georgia Tech**

**Carnegie Mellon University**

**NEW**  
**NM STATE UNIVERSITY**

**Research PI**

Larry Biegler & Sakshi Naik

Nick Sahinidis & Yijiang Li

Carl Laird & Arsh Bhatia

Pei Xu & Laura Capper

**Research Focus**

Incorporation of rigorous **desalination** models into PARETO (e.g., MVC, OARO)

Consideration of **hydraulic** effects across PW pipeline networks (e.g., MAOP)

**REE/CM recovery** from produced water systems (e.g., Lithium)

Develop a PARETO utility on **induced seismicity** and SRA actions

**“Project PARETO” has continuously been enhanced by our academic partners.**







# PARETO for Industrial Collaborations



More info?  
Talk to **Karen!**



The team continues to **collaborate** with several industrial partners:

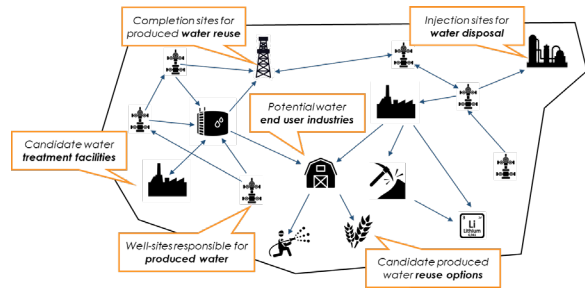
	 <b>OLYMPUS ENERGY</b>	 <b>ConocoPhillips</b>	 <b>ARIS WATER</b>	 <b>equitrans</b> Midstream <span style="color: red; font-weight: bold; font-size: 1.2em;">NEW</span>
<b>Basin</b>	Appalachian	Permian	Permian	Appalachian
<b>Segment</b>	Upstream	Upstream	Midstream	Midstream
<b>Case Study Focus</b>	Truck routing, storage placement/sizing, treatment/disposal cost sensitivities	Capacity expansion (injection, pipelines, storage), third party constraints	Water management, desalination integration, beneficial reuse	Water “hubs”, produced water sharing, storage management
<b>PARETO Model</b>	PARETO <sup>Ops</sup>	PARETO <sup>Strategy</sup>	PARETO <sup>Strategy</sup>	PARETO <sup>Exchange</sup>

**PARETO has been developed with and tested by several industrial partners.**

# PARETO the Produced Water (PW) R&D Platform

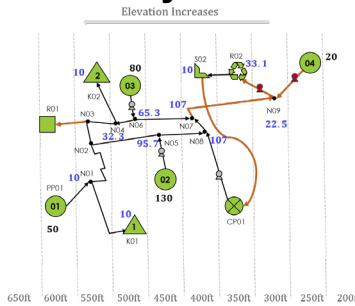


## PW Logistics



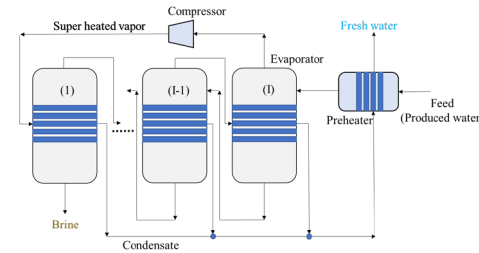
Optimize the design and operation of produced water systems

## PW Hydraulics



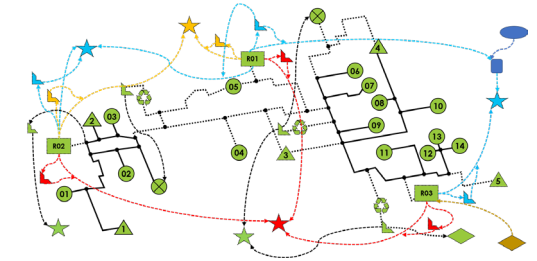
Pressure management optimization across interconnected pipeline systems

## PW Treatment



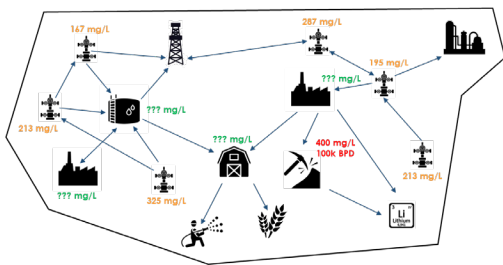
Transform produced water from a waste into a resource via desalination

## PW Beneficial Reuse



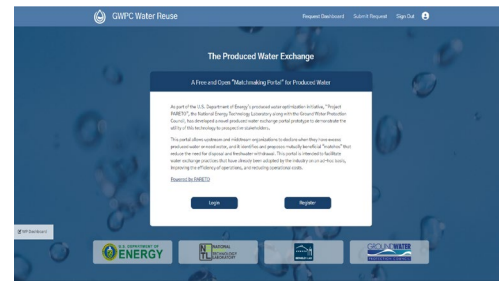
Determine infrastructure/strategies to enable beneficial reuse of treated brine

## REE/CM Recovery from PW



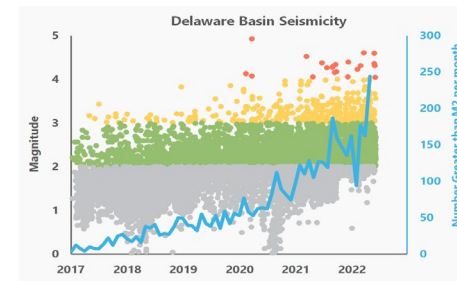
Screening tool to explore opportunities for REE/CM recovery from produced water

## PW Exchange Platform



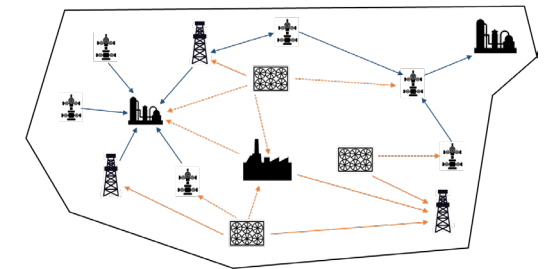
Facilitate water produced water sharing among multiple organizations

## PW Seismicity Response



Determine rapid response strategies for dispersed (i.e., multimodal) injection

## CO<sub>2</sub> Storage in PW



Repurpose existing infrastructure to store carbonated brine in the subsurface

# What's the Perspective for "Project PARETO"?



- Reminder: PARETO is **free and open-source**
  - Released under a permissive [3-clause BSD license](#)
  - Minimal restrictions on the use and distribution of the software
- Individuals & organizations may **use, modify, extract and/or commercialize the framework "as is"**
- PARETO can serve as a foundation for other **supply chain, logistics and network optimization applications**
  - CO<sub>2</sub> transport, REE/CM supply chains, etc.

Download PARETO here:

<https://www.project-pareto.org/>

- PARETO GUI for Windows
- PARETO GUI for Mac
- PARETO code repository
- PARETO documentation
- PARETO examples
- Regular support "**office hours**"
- Workshops coming in **Q4 2023**

**We are confident that PARETO will serve as a valuable resource to the produced water and other energy systems communities.**

# The PARETO Team



## **NETL:**

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