Project PARETO – DOE’s Produced Water Optimization Initiative

NETL Resource Sustainability Project Review Meeting

Pittsburgh, PA
Introduction & Motivation: Oil & Gas Produced Water

The U.S. oil & gas industry faces many challenges related to produced water management, necessitating the development of optimized strategies to ensure the sustainable and responsible production of hydrocarbons.

Rise in unconventional oil and gas production - hydraulic fracturing

Increasing stress on fresh water resources

Rise in produced water volume

Seismic Response Area (SRA) & Disposal constraints

Timing-volume discrepancies for frac demand versus produced water (Limited recycling)
Project Premise & Goals

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, …).
PARETO’s Core Capabilities

The PARETO model suite approaches:

The **Operational Model**, enhancing daily operations with existing infrastructure insights

The **Strategic Model**, projecting infrastructure buildouts for long-term strategic development.
PARETO 101: How does it work?

1. Plug in Data
   - Existing infrastructure
   - Expansion opportunities
   - Produced water forecasts
   - Cost assumptions
   - ...

2. Select your ...
   a) Preferred Objective(s)
      - Minimize LOE (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)
      - ...

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

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

PARETO immediately visualizes the solution and stores results.

PARETO does not just calculate, predict or simulate possible scenarios; the program makes specific recommendations on how to improve water management strategies.
What Else? University Collaborations!

The team has established close collaborations with several universities:

- **Carnegie Mellon University**: Larry Biegler & Sakshi Naik
- **Georgia Tech**: Nick Sahinidis & Yijiang Li
- **Carnegie Mellon University**: Carl Laird & Arsh Bhatia
- **NM State University**: 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” works closely with academic partners across the nation.
### What Else? Industrial Collaborations!

The team continues to collaborate with several industrial partners:

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<tr>
<th>Basin</th>
<th>Segment</th>
<th>Case Study Focus</th>
<th>PARETO Model</th>
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<tbody>
<tr>
<td>Appalachian</td>
<td>Upstream</td>
<td>Truck routing, storage placement/sizing, treatment/disposal cost sensitivities</td>
<td>PARETO\textsuperscript{ops}</td>
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<tr>
<td>Permian</td>
<td>Upstream</td>
<td>Capacity expansion (injection, pipelines, storage), third party constraints</td>
<td>PARETO\textsuperscript{strategy}</td>
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<tr>
<td>Permian</td>
<td>Midstream</td>
<td>Water management, desalination integration, beneficial reuse</td>
<td>PARETO\textsuperscript{strategy}</td>
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<tr>
<td>Appalachian</td>
<td>Midstream</td>
<td>Water “hubs”, produced water sharing, storage management</td>
<td>PARETO\textsuperscript{exchange}</td>
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PARETO has been developed with and tested by several industrial partners.
PARETO features and extensions

1. Beneficial reuse
2. Resource recovery
3. Treatment and desalination modeling
4. Hydraulic analysis
5. Seismic risk analysis
6. Environmental KPI measures
7. Water sharing
PARETO delivers cross-project adaptability, offering optimal reuse solutions and feasibility analysis that eliminates the necessity of initiating analysis from scratch for each project—saving substantial time and financial resources across various sectors.
PARETO Beneficial Reuse

PARETO adapts to varied reuse challenges and enhances beneficial reuse realization through what-if scenario analysis and integrated strategies, effectively illustrating what "realistic success" could look like.
PARETO Resource Recovery

PARETO resource recovery solution:
- Tracks concentration across the networks
- Sets concentration thresholds
- Analyses cutoff-concentration vs. mineable volume trade-off
- Determines break-even concentration point

PARETO empowers resource recovery within the produced water network through a meticulous analysis of key factors including cut-off concentration, extraction efficiency, logistics optimization, and precise, material-specific cost management.

Optimum cut-off concentration - Mineable volume trade-off analysis

PARETO treatment models are adeptly designed to address water quality demands for diverse applications, offering user-specific detail levels to balance treatment intensity and cost.
PARETO Hydraulics Module

PARETO hydraulic module:
- Consider elevation changes and frictional losses
- Track pressure across the network nodes
- Identify pumping needs
- Sets maximum allowable operation pressure

\[ Q = \text{volumetric flow (m}^3/\text{s}), \ P = \text{pressure (Pa)}, \ z = \text{elevation (m)}, \ L = \text{Length of pipeline (m)}, \ d = \text{pipeline diameter (m)} \]

PARETO hydraulic modules ensures hydraulic feasibility for network solutions while co-optimizing water management and pressure regulation costs.
PARETO's seismic risk module informs injection strategies, providing trade-off analysis between cost optimum and distributed injection, integrating SRA and enhanced risk avoidance policies.
PARETO Environmental and Env. Justice Measures

PARETO Environmental and Environmental Justice KPIs Categories:

- **Air pollutant metrics**
  - Greenhouse gas emissions
  - (CO2 equivalents), NH3, NOx, SO2, and PM2.5

- **Trucking activity**
  - Total volume of water trucked
  - Total hours of trucking

- **Environmental Exposure in Disadvantaged Communities (DAC)**
  - Air pollutants exposed to DAC
  - Infrastructure built across DAC

PARETO now allows for reporting on environmental and environmental justice measures, which could inform ESG impact.
PARETO's UI offers a code-free gateway to its prowess, presenting results in vibrant and impactful visuals.
What Else can PARETO do? Water Sharing!

A custom-built online portal for produced water sharing

- Collaboration between DOE-NETL & GWPC
- A web portal that functions like a matchmaker
- Simple and user-friendly submission forms
  - “I have water”
  - “I need water”
- Organizes PW “matches” in a dashboard
  - Users can accept or decline matches
- Emphasis on minimal data inputs
2024 Outlook

PARETO - Water Optimization Initiative

User Support and Education
- Institute a support workflow
- Foster partner communication
- Curate educational resources
- Develop case studies

Framework Support and maintenance
- Refine and maintain PARETO framework

Water Exchange
- Deploy Water Exchange platform
- Expand Water Exchange platform capabilities
- Develop demonstration cases (via industrial collaborations)
The team has developed a PARETO Training Workshop: Learn how to

- **Install** PARETO software.
- **Input data** into PARETO.
- **Run** PARETO optimization.
- **Develop** a variety of complex network scenarios.
- **Analyze, interpret, and compare** results.

- Additional sessions are planned for the future (possibly virtually).
- Video tutorials have also been developed and should be publicly available soon.
The PARETO Team

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Thank You!

To request a follow-up meeting or demo, please contact pareto-support@lbl.gov

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