

DOE'S PRODUCED WATER OPTIMIZATION INITIATIVE



NETL

NATIONAL ENERGY TECHNOLOGY LABORATORY

BACKGROUND

By 2030, oil and gas geological plays across the U.S. are expected to produce more than 60 million barrels of water per day. The majority of this water is characterized by high concentrations of total dissolved solids (TDS), exceeding 300,000 mg/L in some plays (for example, the Appalachian Formation). Even though many upstream operators strive to reuse produced water for hydraulic fracturing, disposal continues to be the leading water management practice in the U.S. However, disposal capacity is increasingly constrained in a number of areas. This reality will require the oil and gas industry to start treating (i.e., desalinating) produced water at scale in the foreseeable future.

Produced water is challenging to treat due to its high concentrations of TDS, as well as the spatial and temporal variability in production qualities and quantities. Given the variation in water produced across and within basins, oil and gas companies need to identify custom, fit-for-purpose water management, treatment and reuse approaches. Individual market participants are faced with growing complexity in contemplating capital-intensive investments in their produced water infrastructure, and they require computational decision-support tools to rapidly and quantitatively assess feasible options. At this time, few such software tools exist.

PROJECT DESCRIPTION

The National Energy Technology Laboratory (NETL), in cooperation with the Lawrence Berkeley National Laboratory (LBNL), has launched a three-year, \$5 million produced water optimization initiative to develop, demonstrate and deploy a novel optimization framework. This framework, the **Produced Water Application for Beneficial Reuse, Environmental Impact and Treatment Optimization (PARETO)**, is specifically designed for produced water management and beneficial reuse. PARETO will identify cost-effective and environmentally sustainable produced water management, treatment and reuse solutions. Specifically, the new platform will support decision-makers with: (1) coordination of produced water deliveries; (2) buildout of the produced water infrastructure; (3) selection of effective treatment technologies; (4) placement and sizing of treatment facilities; (5) identification of beneficial water reuse options; and (6) the distribution of treated produced water and/or concentrated brine for beneficial reuse. Figure 1 (below) illustrates the scope of this initiative.

The PARETO framework builds on foundational capabilities created through NETL's Institute for the Design of Advanced Energy Systems (IDAES) and DOE's National Alliance for Water Innovation (NAWI). This initiative will leverage the IDAES integrated platform, an R&D100 award-winning, open-source modeling, simulation and optimization framework, as well as the library of water treatment process models made available by NAWI. PARETO will utilize those NAWI models in an IDAES-compatible framework to create a cutting-edge produced water optimization platform that supports better and faster decision-making.

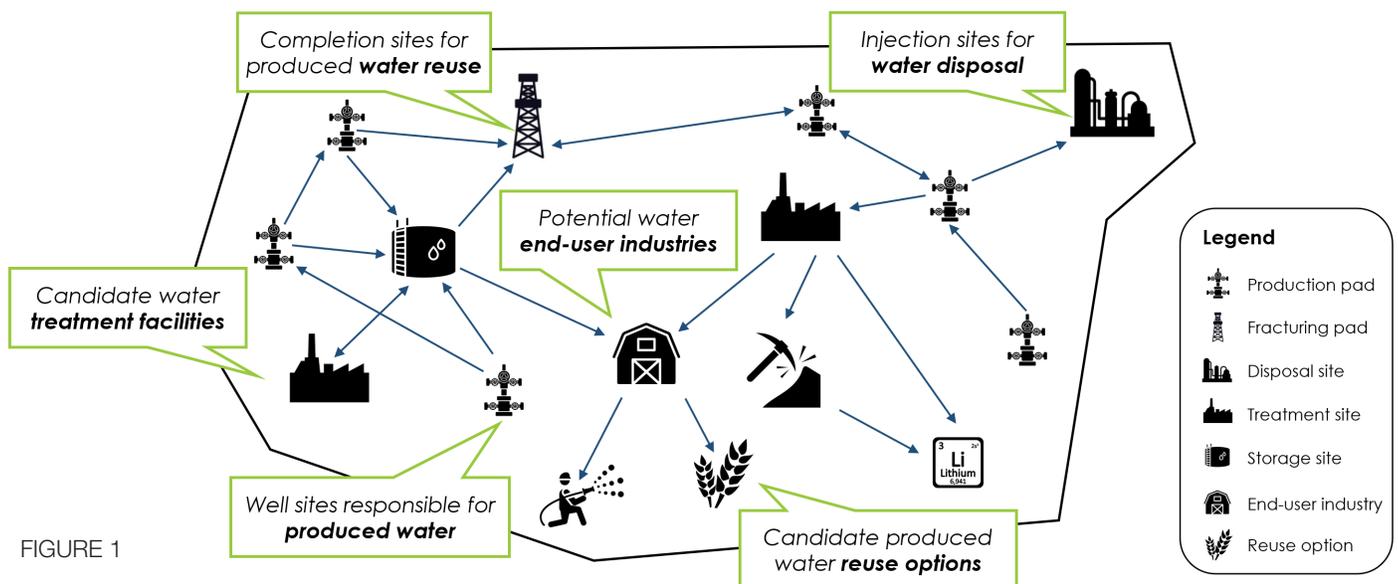


FIGURE 1

FOCUS AREAS

Initially, in execution year 2021, the modeling and optimization framework will focus on **produced water management**, i.e., capturing options for coordinating water deliveries in a given development area (i.e. disposal, reuse w/o treatment, storage). In addition, PARETO will be able to propose the buildout of additional pipelines and/or storage facilities.

By execution year 2022, the project will shift its attention towards **produced water treatment**. Research will advance to extend PARETO to explicitly consider opportunities for treating (i.e. desalinating) produced water within oil & gas development areas. Specifically, PARETO will be able to propose where treatment facilities should be located, which technologies should be considered and how the respective units should be sized.

Finally, execution year 2023 will be dedicated to **produced water beneficial reuse**. The project team will progress to extend PARETO to capture opportunities for the beneficial reuse of treated produced water and/or concentrated brines within or outside of the oil & gas industry. Specifically, PARETO will consider the demand as well as quality requirements for treated water and/or concentrated brine by potential end users. The program will determine how to best distribute and transport treated water and/or concentrated brine to prospective end users, such as farmers and mining companies.



BENEFITS

This initiative directly addresses the key Administration goals focused on investments in water and wastewater infrastructure, remediation and reduction of legacy pollution and the development of critical clean water infrastructure. The unconventional oil and gas industry will benefit from this initiative by being able to identify fit-for-purpose produced water management practices, treatment concepts and beneficial reuse opportunities for widespread adoption in plays across the U.S. In addition, this project is expected to realize a number of important environmental benefits: (1) improving the utilization of the existing water infrastructure (such as pipelines and storage facilities); (2) facilitating increased piping of produced water (as opposed to trucking); (3) reducing produced water disposal volumes; (4) decreasing freshwater consumption; and (5) identifying beneficial reuse opportunities for treated produced water inside and outside the oil and gas industry. There may also be opportunities to explore the establishment of domestic supply routes to recover critical minerals (e.g., lithium) and/or rare earth elements from produced water.

DELIVERABLES AND CAPABILITIES

The major deliverable of this project will be an open-source, optimization-based, downloadable and executable produced water decision-support application, PARETO, that can be run by upstream operators, midstream companies, technology providers, water end users, research organizations and regulators. For a given development area and a specified objective (e.g. cost minimization, maximizing re-use, etc.), the tool will provide specific and actionable recommendations including:

1. where water pipelines should be built and what size they should be,
2. where co-produced water should be delivered to (i.e. disposal, reuse, storage, treatment),
3. where to place treatment facilities, how to size them and which treatment technologies to consider (e.g. evaporators, crystallizers, reverse osmosis),
4. which beneficial reuse options are attainable (e.g. agricultural reuse, extraction of critical minerals), and
5. how to distribute treated produced water as well as concentrated brine to potential end users (e.g. mining companies, disposal facilities).

It is important to note that PARETO's objective will be entirely user-specific and can range from minimizing costs to maximizing the extraction of critical minerals to maximizing beneficial re-use of treated water outside oil and gas.

The project team will also produce detailed best practice reports and presentations based on findings derived from industry-partnered case studies and other collaborations (e.g. National Alliance for Water Innovation).





STAKEHOLDER GROUP

This initiative will place a heavy emphasis on interfacing closely with a comprehensive group of stakeholders who represent interests from across the produced water value chain. For this reason, DOE is forming an open produced water optimization stakeholder group. The intended goal is to actively engage with industrial, academic and governmental representatives who will be the ultimate users of the PARETO framework. Members of the stakeholder board will have the opportunity to regularly review progress and make recommendations to project content and emphasis, participate in training and early product testing. The stakeholders will also ensure that the project team is creating a continuous pipeline of productive end uses that bring the promise of wholistic promising water management, treatment and beneficial reuse into practical application.

The stakeholder group is expected to involve representatives from both the produced water “supply side”, i.e., upstream operators, midstream companies, technology providers and professional groups from the oil and gas industry, and the water “demand side”, i.e., water-intense industries including farming associations, mining companies and power generators. DOE also invites regulators and other governmental or nonprofit organizations to participate in the review and evaluation of the project. The ultimate goal is to assemble a truly open stakeholder group with representatives from numerous domains and different geographical plays (e.g. Permian, Marcellus, Bakken).

Organizations interested in joining the stakeholder board should contact Markus Drouven, Ph.D. for more information.

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