RESEARCH BRIEF
Start Date: Feb 12 2021 | Duration: 25 months

NAWI
National Alliance for Water Innovation

Development of the Water Technology Techno-Economic Assessment Pipe Parity Platform (WaterTAP3)

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Challenge

Existing techno-economic analysis (TEA) tools for water technologies and treatment trains fail to provide a consistent, cross-sector, spatiotemporally resolved basis for evaluating the diverse suite of pipe parity metrics to inform desalination technology selection. The TEA tools that do exist are rarely open-source or able to provide transparent data and key metrics for both specific technologies and treatment train performance. As a result, there is a gap in the sector's ability to conduct technical feasibility analyses to help prioritize R&D research in desalination.

Research Approach

The Water Technoeconomic Assessment Pipe-Parity Platform (WaterTAP3) was developed under the National Alliance for Water Innovation (NAWI) to facilitate consistent technoeconomic assessments of desalination treatment trains. The WaterTAP3 is an analytically robust modeling tool that can be used to evaluate water technology cost, energy, and environmental tradeoffs across different water sources, sectors, and scales. The model simulates steady-state water treatment train performance and costs including flow and constituent mass balance across unit processes, based on source water conditions, configurations of treatment technologies, and system-level techno-economic assumptions.

Impact

WaterTAP3 can help identify trade-offs among the different system performance metrics, with insight on how particular technologies or systems promote pipe-parity. The flexibility and comprehensive scope of the tool makes it a promising solution to industry-wide water technoeconomic evaluations, leading to more informed water investment decisions and technologies. As a user-friendly, open-source platform, WaterTAP3 can be used by industry, academia, policymakers, and planners.

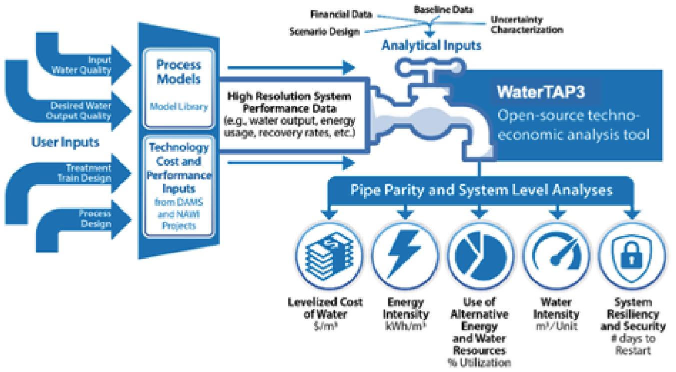

Figure 1. WaterTAP3 evaluates water technology cost, energy, and environmental tradeoffs across different water sources, sectors, and scales, with insight on how particular technologies or systems promote pipe-parity.

RESEARCH PARTNERS

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1. Miara, Ariel, Talmadge, Michael, Sitterley, Kurban, Evans, Anna, Huang, Zheng, Macknick, Jordan, McCall, James, Kurup, Parthiv, Akar, Sertac, Van Allsburg, Kurt, Stokes-Draut, Jennifer, Bartholomew, Timothy, Lee, Andrew, and Gingerich, Daniel. *WaterTAP3 (The Water Technoeconomic Assessment Pipe-Parity Platform)*. Computer Software. Link here. USDOE Office of Energy Efficiency and Renewable Energy (EERE), Energy Efficiency Office. Advanced Manufacturing Office. 08 Jun. 2021. Web. doi:10.11578/dc.20210709.1.

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Accomplishments & Findings

The WaterTAP3 project was launched at the start of the NAWI program with the immediate goal of providing a common technoeconomic analytical (TEA) framework in support of baseline studies. These studies focused on eight different water use sectors and, for each sector, a corresponding NAWI research team was tasked with conducting water treatment and reuse cost and energy analyses using the WaterTAP3 modeling tool. The model was designed to be an Excel-based tool where water treatment unit processes could be simply represented, and high-level estimates of cost and energy use could be quickly calculated. ProteusLIB was launched at the same time to develop physics-based models of key unit processes.

But early in the project, it became clear that some unit processes (such as reverse osmosis) could not be effectively rendered in the high-level WaterTAP3 environment without first developing an underlying physics-based model. This dramatically expanded the scope of the WaterTAP3 project while the urgent need for accurate TEA models for the 8 baseline studies remained on its original (tight) schedule.

After establishing the framework of the technoeconomic water treatment model in Excel (led by Michael Talmadge), the WaterTAP3 team then pivoted to rendering both existing and new unit models and functionality into Python (team member Kurban Sitterley was instrumental) and utilized progress that the ProteusLIB team made in developing a physics-based RO model.

Detailed data sets of existing treatment facilities were used to constrain unit process cost and energy models for baseline studies when available. In other cases, the WaterTAP3 team had to conduct literature reviews and seek out high quality data sets, all while developing the model, and this posed additional challenges given the tight schedule. Nevertheless, the WaterTAP3 team was able to provide the 8 baseline study groups with high-level TEA models which were important contributions to the final set of peer-reviewed publications in ES&T Engineering's March 2022 issue which featured NAWI's baseline studies and related research in a Special issue (figure 1).

Related Accomplishments

The WaterTAP3 effort and the ProteusLIB effort were merged into a single project (named WaterTAP) at an earlier than anticipated timeline. WaterTAP3 remains a valuable high-level tool for TEA and can utilized reduced order models developed and refined by WaterTAP. WaterTAP3 is also used to perform TEA for the projects funded under DOE's Wastewater Resource Recovery research program (DE-FOA-0002336) and research sponsored by DOE's Solar Energy Technology Office.

Opportunities for Further Research

WaterTAP3 is particularly effective when large numbers of simulations are needed to evaluate a large-scale issue, such as examining alternate water supply scenarios and costs for thousands of different locations across the U.S. Given that WaterTAP3 is built in Python, the potential exists to populate WaterTAP3 with both more detailed and reduced-order models produced by other research teams beyond NAWI.

Publications and Reports

All publications listed below were in a single special issue of ES&T Engineering - volume 2, Issue 3, published in March, 2021

1. Analysis of Brackish Water Desalination for Municipal Uses: Case Studies on Challenges and Opportunities, p306-322
2. Cost and Energy Metrics for Municipal Water Reuse, p489-507
3. Mine Water Use, Treatment, and Reuse in the United States: A Look at Current Industry Practices and Select Case Studies, p391-408
4. Oil and Gas Produced Water Reuse: Opportunities, Treatment Needs, and Challenges, p347-366
5. Opportunities and Challenges for Industrial Water Treatment and Reuse, p465-488
6. Opportunities for Treatment and Reuse of Agricultural Drainage in the United States, p292-305
7. Pipe Parity Analysis of Seawater Desalination in the United States: Exploring Costs, Energy, and Reliability via Case Studies and Scenarios of Emerging Technology, p434-445
8. Zero Liquid Discharge and Water Reuse in Recirculating Cooling Towers at Power Facilities: Review and Case Study Analysis, p508-525

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