RESEARCH BRIEF
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NAWI National Alliance for Water Innovation

Evaluating the Value of Grid-Responsive Flexible Desalination

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Challenge

As the need for desalination capacity to secure water supplies expands, the timing of their facilities' electric loads will need to be better aligned with the timing of low-carbon or renewable generation. This is to ensure the added electricity demand from desalination facilities avoid or minimize their contributions to greenhouse gas emissions, take advantage of low electricity price periods, and receive revenue for providing grid services to reduce the cost of desalinated water. Traditionally, however, desalination facilities have been designed to operate at steady-state and are subject to technical and practical constraints in their processes' ability to respond to variable renewable electricity generation. There is a need to understand how these constraints, individually and collectively, affect how well desalination facilities can respond to changing grid conditions. This effort will better enable the coupling of expanded desalination capacity with emissions-free electricity generation in a cost-effective manner.

Research Approach

This project addresses this need by leveraging three assessments. First, is the development of a dynamic process model for a desalination treatment train, using the real-time data monitoring and analytical infrastructure of a brackish water desalination plant operated by the Chino Desalter Authority (CDA) that can capture the transient dynamics of a desalination facility. Second, is a techno-economic analysis of the effect of flexible operation on potential revenue streams and cost savings for the facility, weighed against any additional operation and maintenance costs from such operation, and a comparison to the alternative of exporting dynamic capability to battery storage. Lastly, an evaluation of potential emissions reductions associated with flexible desalination. The treatment train Digital Twin (DT) will receive inputs from regional electric grid dispatch modeling to assess how operating desalination facilities in response to grid conditions affects greenhouse gas emissions associated with facility operation.

Impact

This project contributes four primary impacts. First is the development of a configurable dynamic digital twin for a desalination treatment train which captures how equipment sizing and process dynamics affect the train's electric load flexibility. Second is a deeper understanding of how desalination treatment train design affects electric load flexibility and the tradeoffs between increased capital expense and potential revenue from flexible operation. Third, an understanding of whether flexible operation of desalination facilities is an economically favorable practice and if so, how to maximize the benefit of such operation for reducing the cost of desalinated water. Fourth, an understanding of the extent to which process dynamics must be modeled. We will construct the digital twin in two different modeling platforms: SUMO and WaterTAP. SUMO is a process-based modeling platform that models true dynamics of water treatment and equipment processes requires a paid license, while WaterTAP is an open-source modeling platform used by other NAWI projects but uses quasi-steady-state modeling. This will allow us to determine the extent to which true dynamics must be modeled to capture flexible behavior of the brackish water desalination plant.

Figure 1: A photo of an RO train at Chino Desalter Authority

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