RESEARCH BRIEF
Start Date: August 2023 | Duration: 24 months

NAWI National Alliance for Water Innovation

Open-Source Platform for Assessing the Cost and Carbon Benefits of Flexible Desalination

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Challenge

This project aims to identify key opportunities in increasing energy flexibility of desalination plants through facility upgrades and operational flexibility. Santa Barbara's Charles E. Meyer Desalination Plant (CEMDP) is interested in decarbonizing their operations and using lower cost electricity. This may occur by coordinating water production based on the time-of-use electricity cost, minimizing peak demand charges, and more frequently participating in demand response (DR) events. It is currently unclear how to best upgrade and operate current facilities for energy flexibility in the context of temporally varying markets.

Research Approach

This project will extend process modeling capabilities beyond Water Technoeconomic Analysis Platform (WaterTAP) to analyze production scheduling at desalination plants. We will examine three synergistic mechanisms for load flexibility and energy services: 1) energy storage in MW-scale on-site batteries; 2) variable water recovery; and 3) intermittent plant shut-down. Each mechanism implies unique ramping characteristics and is constrained by component dynamics and interactions, which impact the levelized cost and carbon intensity of product water. Using measurements from the Santa Barbara CEMDP, we will demonstrate a physics-informed digital twin model of the facility and net present value (NPV) optimization workflow.

The team is comprised of WaterTAP and DISPATCHES developers and have previously demonstrated the use of relevant tools. WaterTAP is a cost optimization platform that connects physics-based water treatment process models with technoeconomic data. The Design Integration and Synthesis Platform to Advance Tightly Coupled Hybrid Energy Systems (DISPATCHES) contains workflows to design, simulate, and optimize thermochemical processes in the context of variable power supplies and grid signals.

RESEARCH PARTNERS

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This project refines estimates on the value of desalination load flexibility by extending existing capabilities for analyzing a diverse set of facilities, incorporating data-informed modeling workflows, and applying existing energy contracts from water utilities. Future work may include implementing this approach in a software application tailored for a diverse set of users.

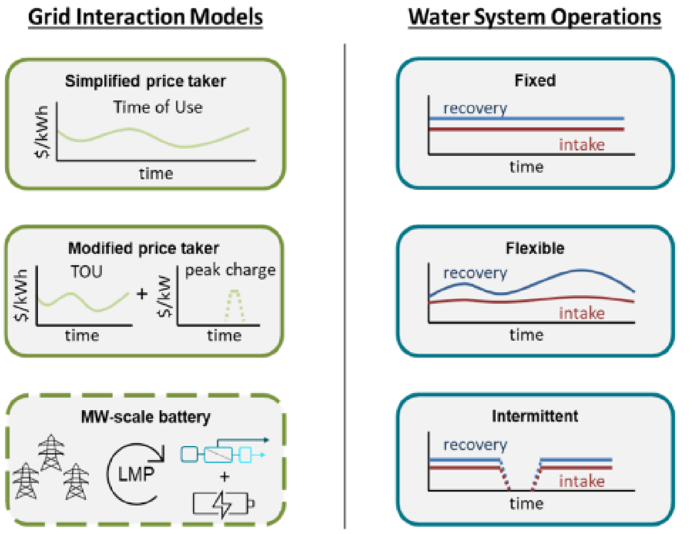

Figure 1: Modes of operation for water system (right) and energy grid interactions (left).

Impact

This project aims to provide immediate value to CEMDP while assessing the generalizability of the results nationally and implementing new capabilities for system optimization in WaterTAP. Beyond this case study, we will use the cost modeling framework to identify the most cost-effective upgrades for current facilities, create design heuristics to enhance the flexibility of new facilities, and value key improvements on process parameters such as pump and membrane ramping rates, membrane vessel burst pressure, or product water storage capacity. Further, we will identify existing national electricity markets structures in which flexible desalination processes may be best suited to.

This work was supported by the National Alliance for Water Innovation (NAWI), funded by the U.S. Department of Energy, Energy Efficiency and Renewable Energy Office, Industrial Efficiency and Decarbonization Office.

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