

A Digital Twin for an Advanced Water Purification System in Pilot-scale

Clean Water SoCal Water Quality Committee meeting

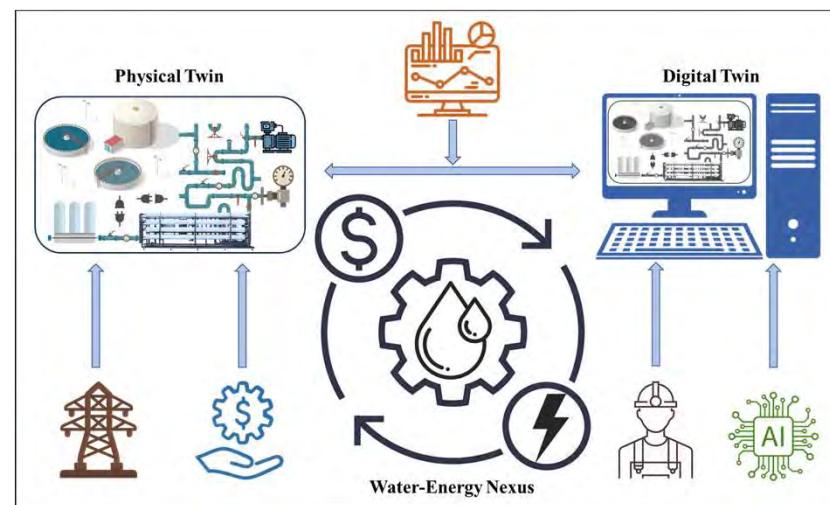
Smarter Clean Water: Digital Twins Discussion

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Delivering a better world



Agenda

- Introduction to Digital Twin
- Application of Digital Twin in the Water Systems
- Case Study (Advanced Water Purification Digital Twin)
- Using Digital Twin to Maximize Process Efficiency
- Open Discussion (Q&A)



Introduction to Digital Twin

Delivering a better world

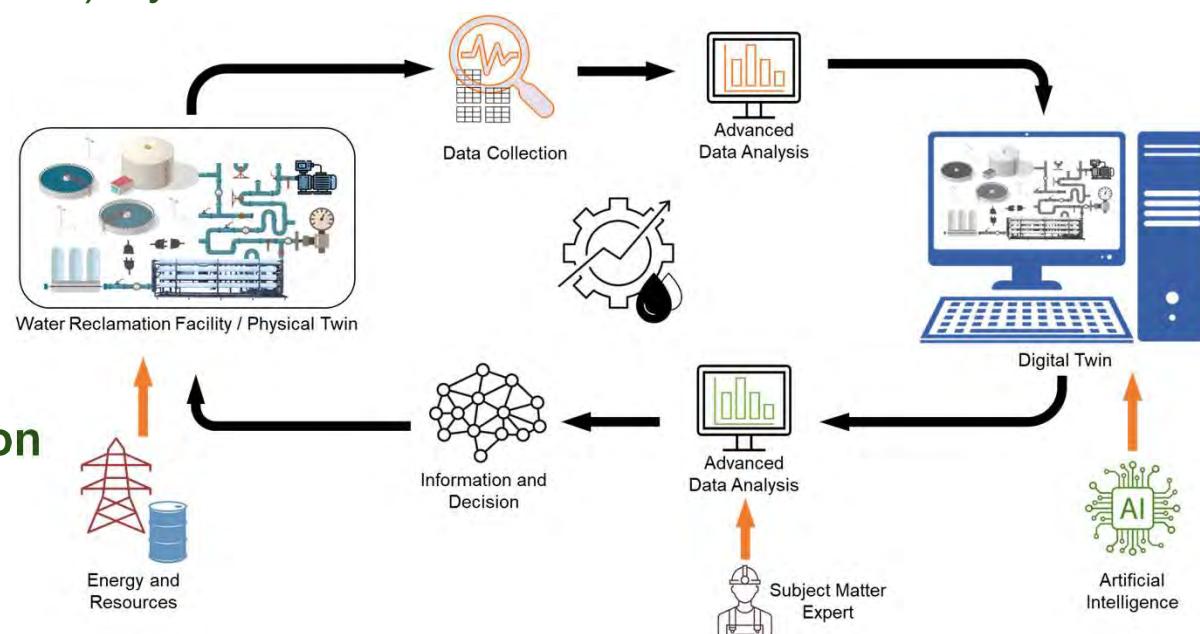
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WHAT IS A DIGITAL TWIN?

- **Definition:** A virtual representation of an operating physical entity (e.g., a treatment train or a treatment plant), synchronized at a specified frequency and fidelity.

- **Components:**

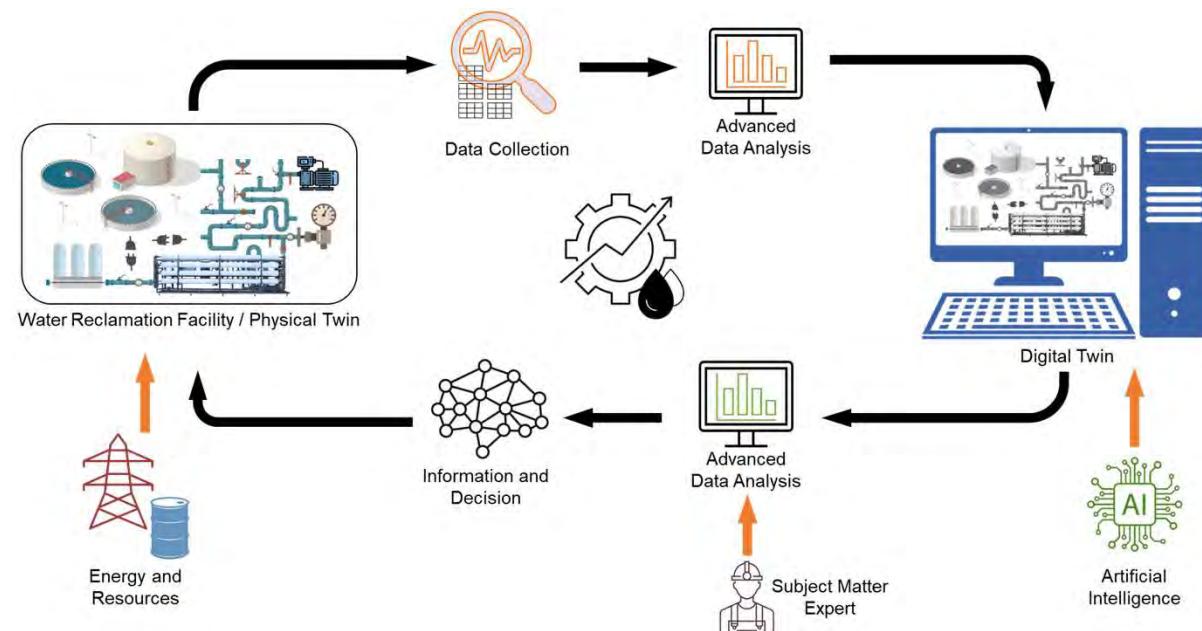
- ✓ Physical Entity (Physical Twin)
- ✓ **High-Fidelity Simulator**
- ✓ Physical Sensors
- ✓ Soft Sensors
- ✓ **Physical-to-Virtual Connection**
- ✓ Advanced Data Analysis
- ✓ Interaction and Service



WHY DIGITAL TWIN?

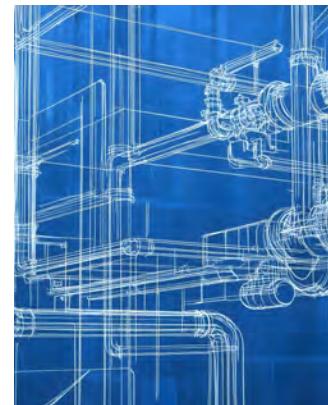
- A Digital Twin can provide a wide range of applications, including:

- ✓ Monitoring
- ✓ Optimizing
- ✓ Autocalibrating
- ✓ Forecasting
- ✓ Sensitivity Analysis
- ✓ Wrapper (Safety)



Application of Digital Twin in the Water Systems

ROLE OF DIGITAL TOOLS IN POTABLE REUSE APPLICATIONS



Early Warning Systems starting from the Wastewater Collection System

Advanced Treatment Critical Control Points (CCPs) and Log Removal Values (LRVs)

Cost-effective Purified Water Production (OPEX optimization)

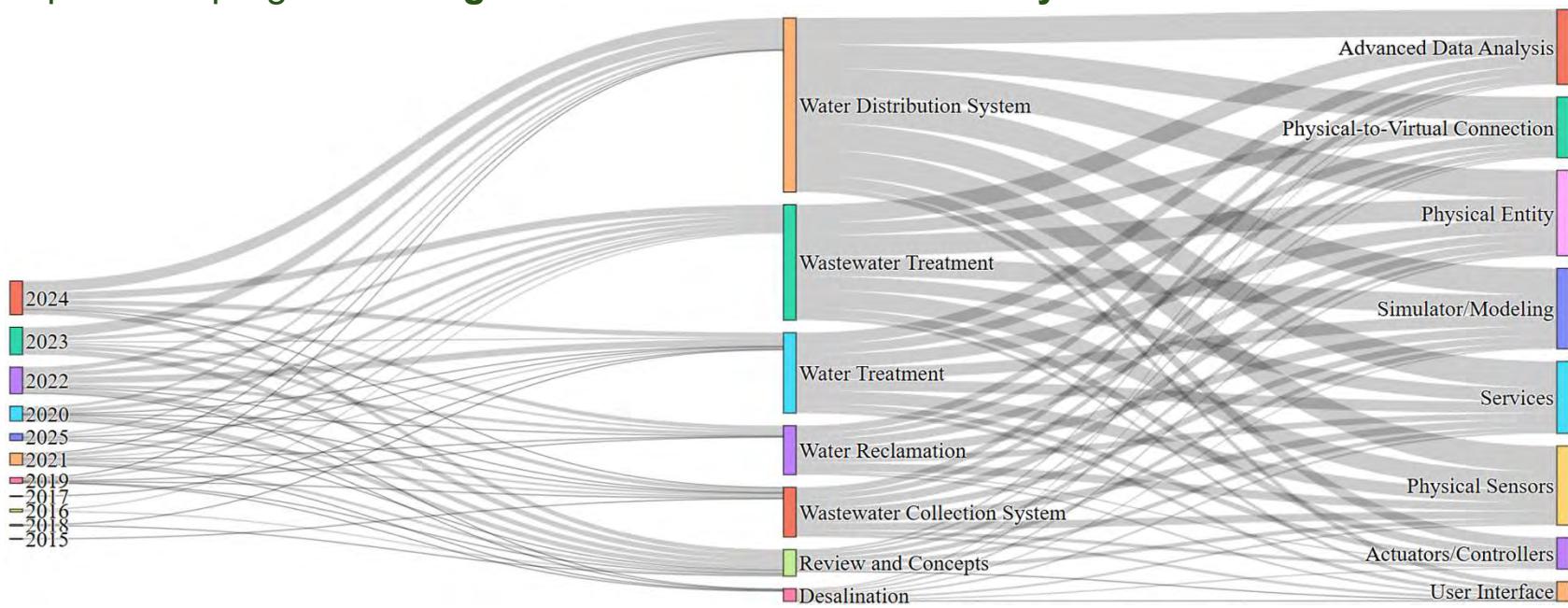
Finished Water Quality Monitoring

Water Quality/ROC Discharge Compliance

Incorporation of Purified Water in the Existing Water Distribution System

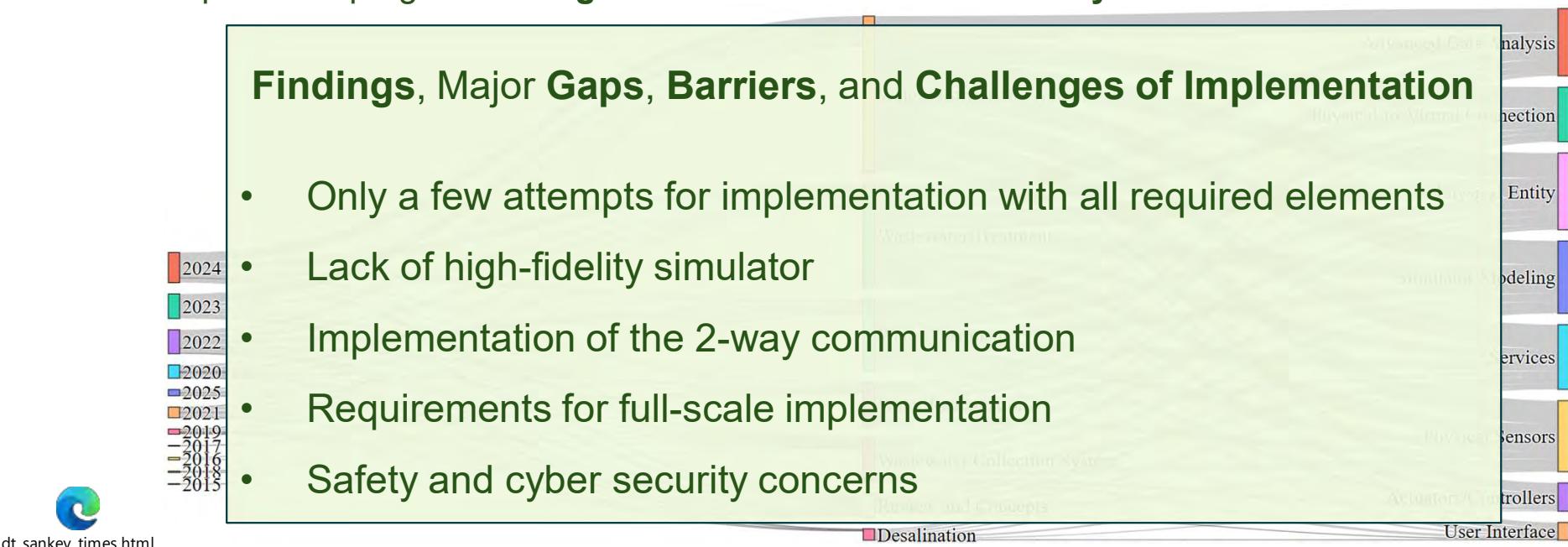
DIGITAL TWIN IN THE WATER INDUSTRY

- Reviewed over **150 studies and reports** on application of DT in the water sector, world-wide
- Up-to-date progress on **Digital Works in the Water Industry**



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Case Study

(Digital Twin Pilot Project for an Advanced Water Purification System)

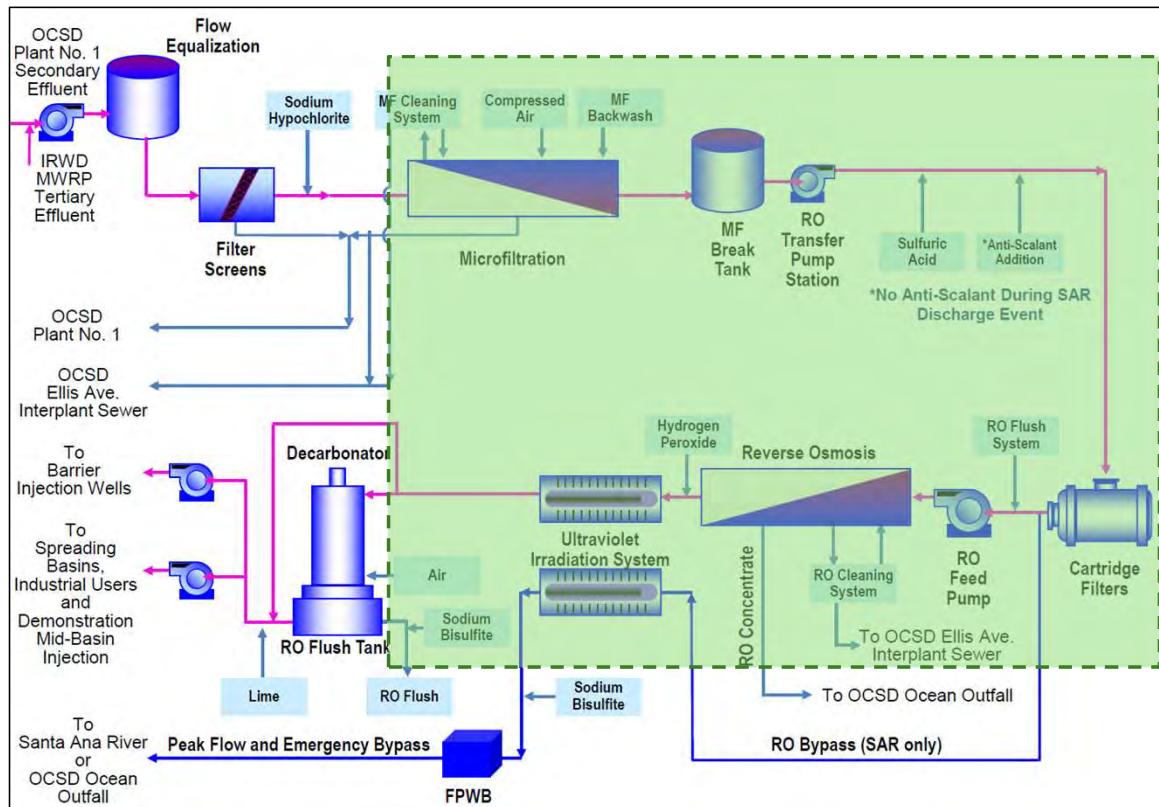
ADVANCED WATER PURIFICATION TRAIN DIGITAL TWIN AT OCWD

- **Orange County Water District (OCWD)**
 - The world's largest water purification system for Indirect Potable Reuse (IPR)
 - Operating Capacity: 130 MGD
- **Goals of Digital Twin Pilot Project**
 1. **Full-scale implementation of a DT in the water sector (Water Reuse)**
 - Identify and assess the higher-level barriers and challenges of implementation in Full-scale
 2. Evaluate the developed DT performance in **Process Optimization and Energy Cost saving**
 - **Primary goal is to reduce the energy cost per unit water produced (\$/MG)**

DIGITAL TWIN IN OCWD (PROJECT TEAM/SPONSORS)



OCWD TREATMENT PROCESSES



Treatment Process Flow at OCWD

Microfiltration/Ultrafiltration



Cartridge Filter



Reverse Osmosis

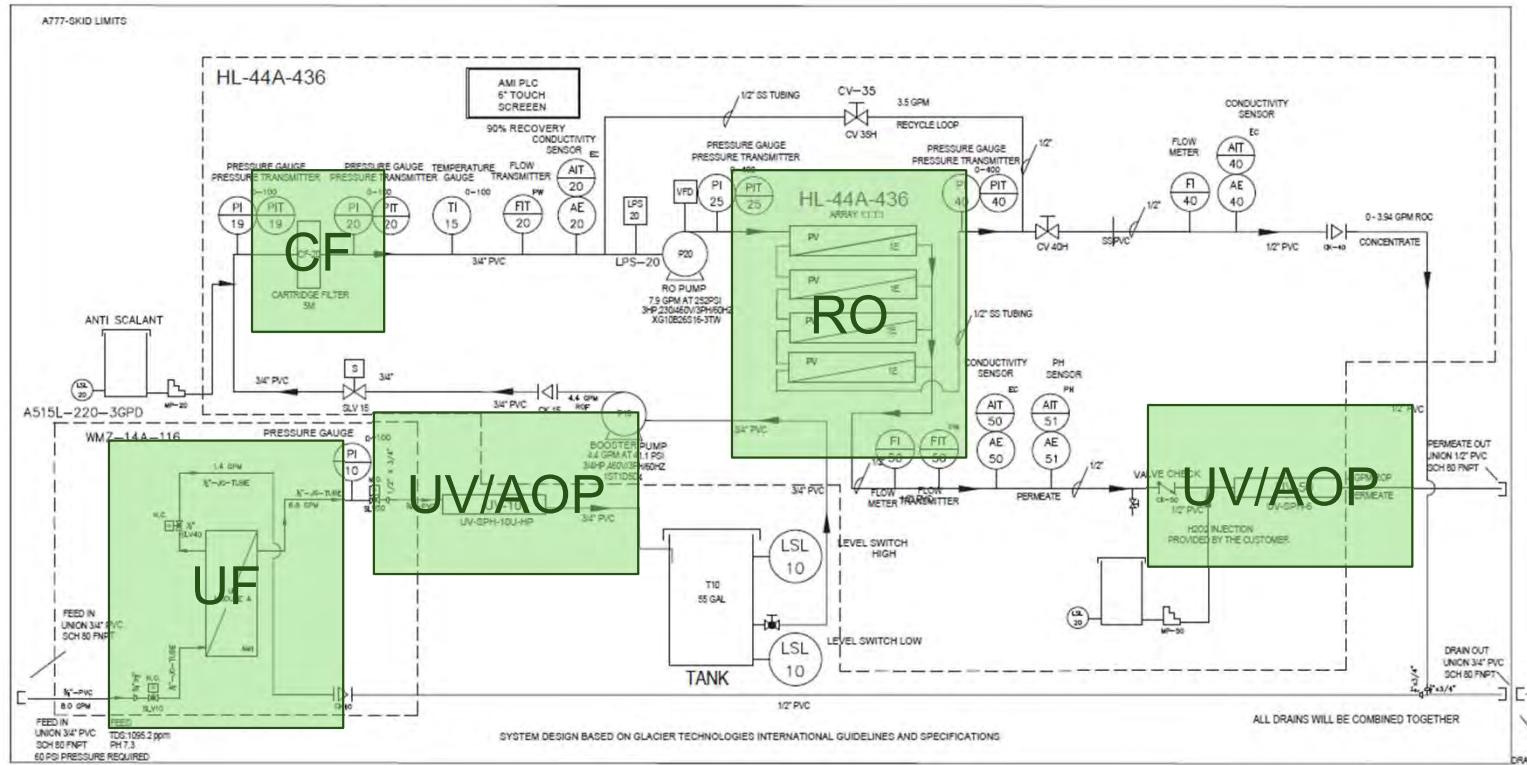


UV/AOP



Decarbonator

DIGITAL TWIN PILOT TREATMENT PROCESSES



Treatment Process for the Designed DT Pilot

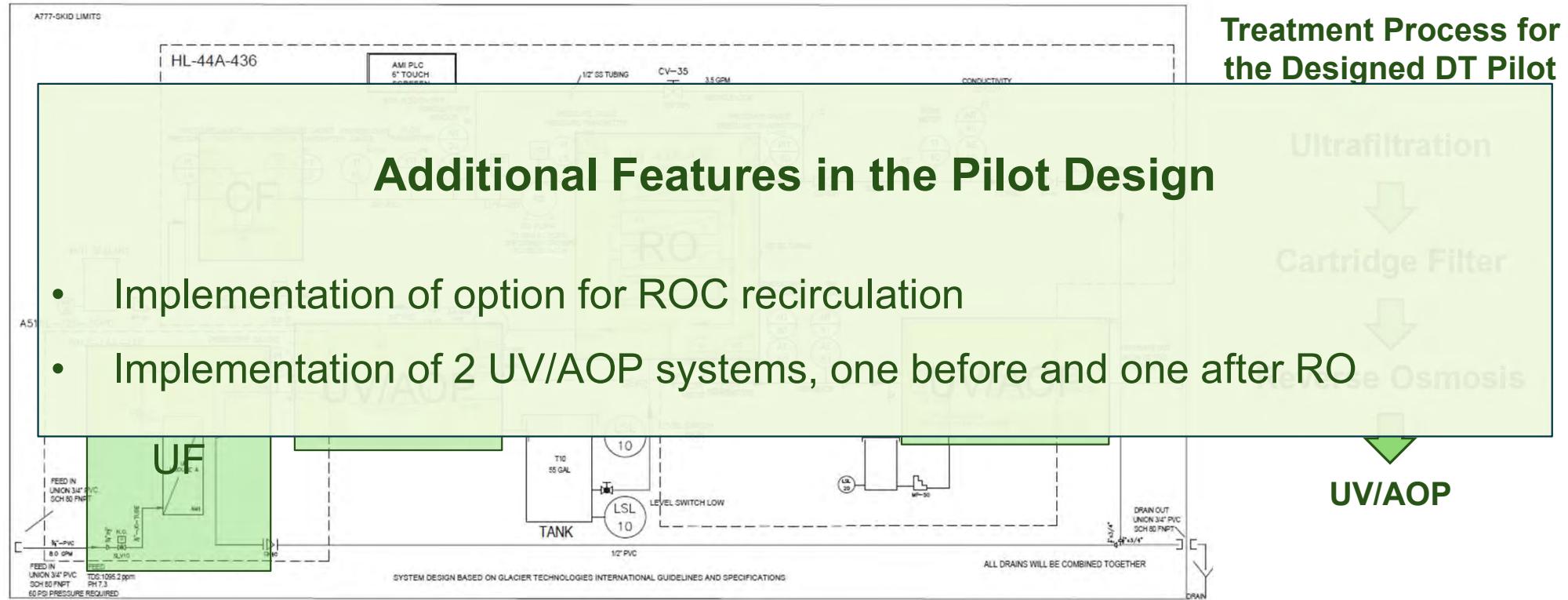
Ultrafiltration

Cartridge Filter

Reverse Osmosis

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DIGITAL TWIN PILOT TREATMENT PROCESSES

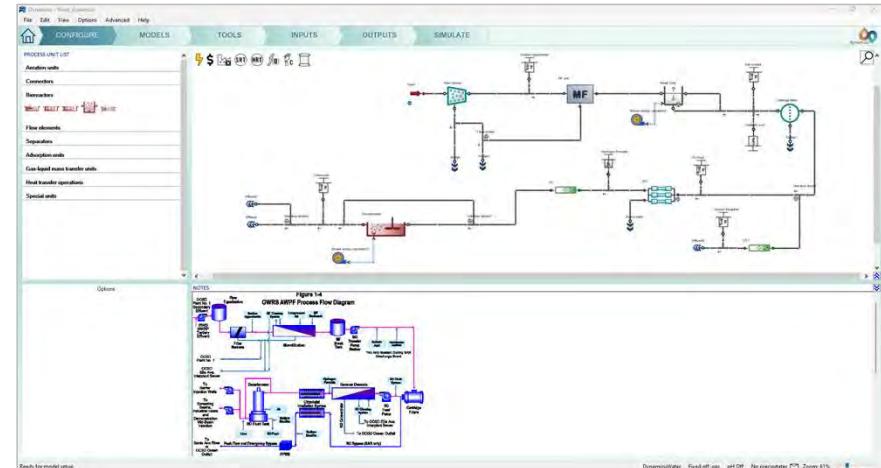
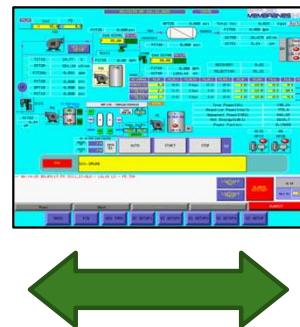


PHYSICAL-DIGITAL TWINS CONNECTIVITY



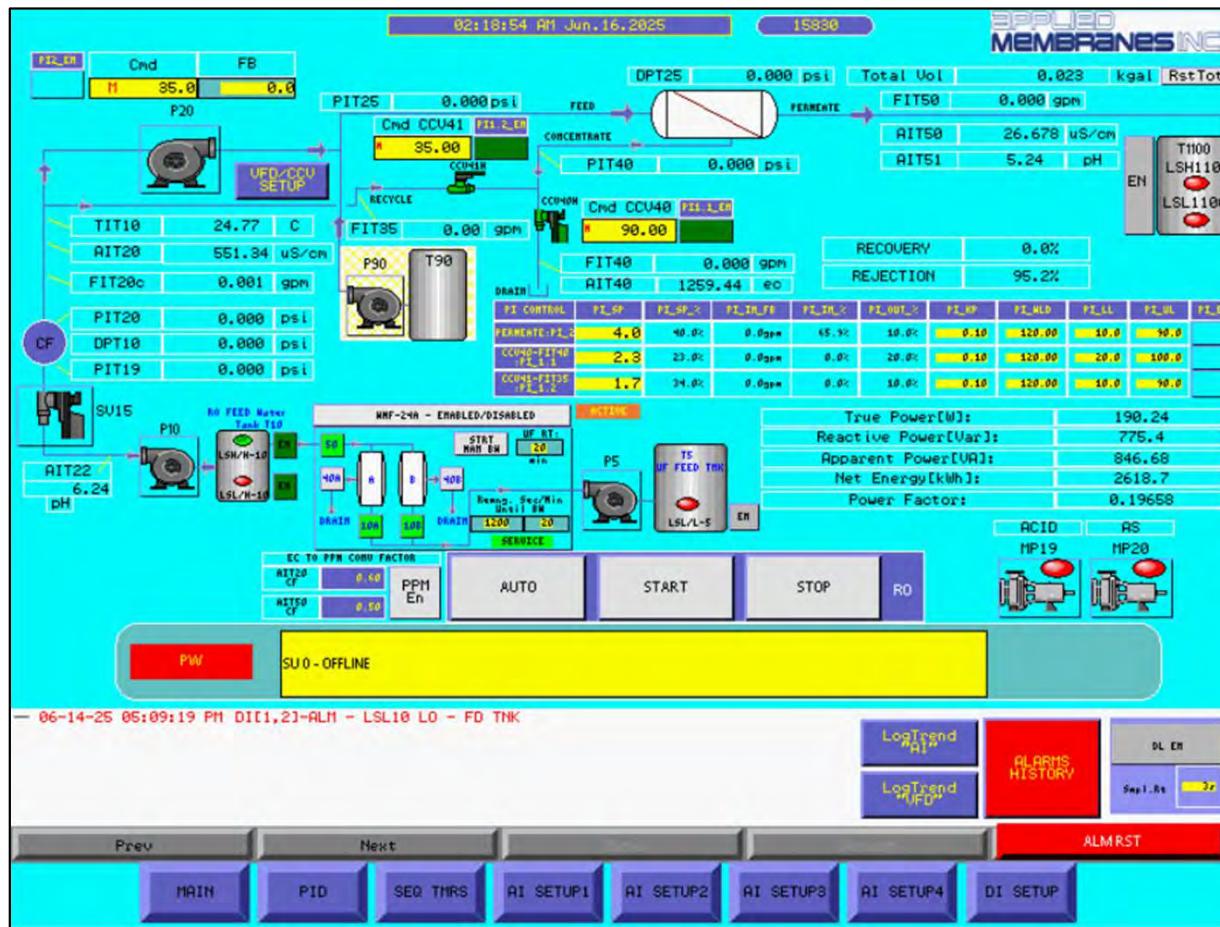
Physical Pilot at OCWD

Human-Machine
Interface (HMI)

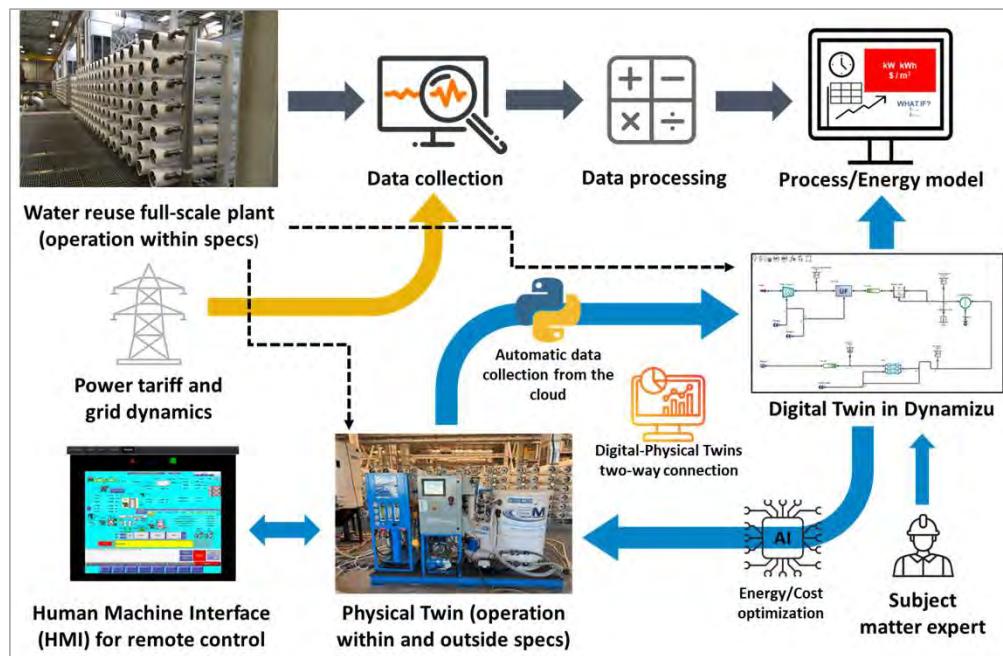


High-Fidelity Process Simulator
(SUMO/Dynamizu by Dynamita)

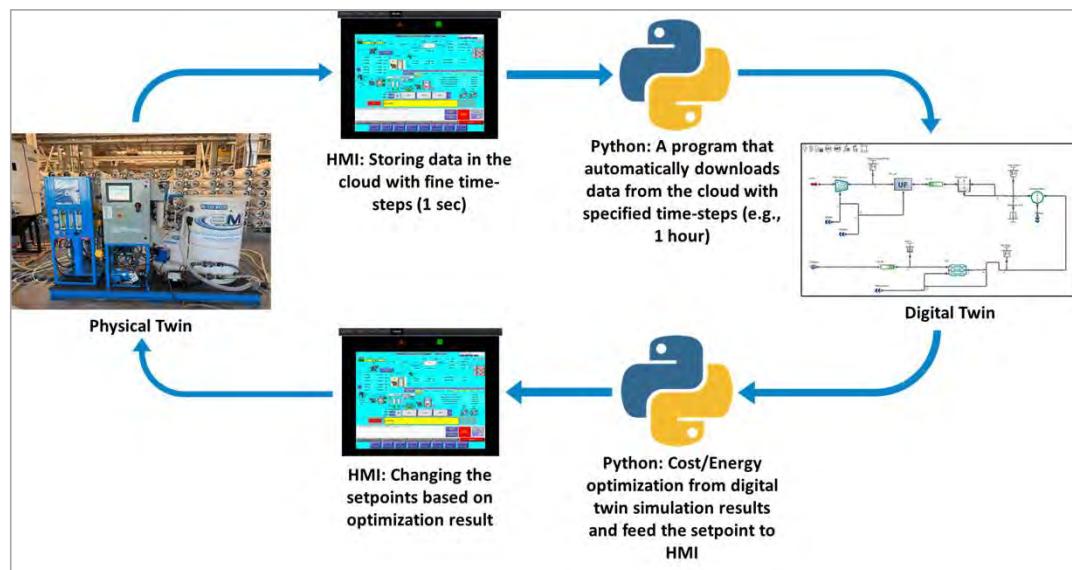
DIGITAL TWIN PILOT'S HUMAN-MACHINE INTERFACE (HMI)



IMPLEMENTATION OF 2-WAY COMMUNICATION FOR THE PHYSICAL-DIGITAL TWINS

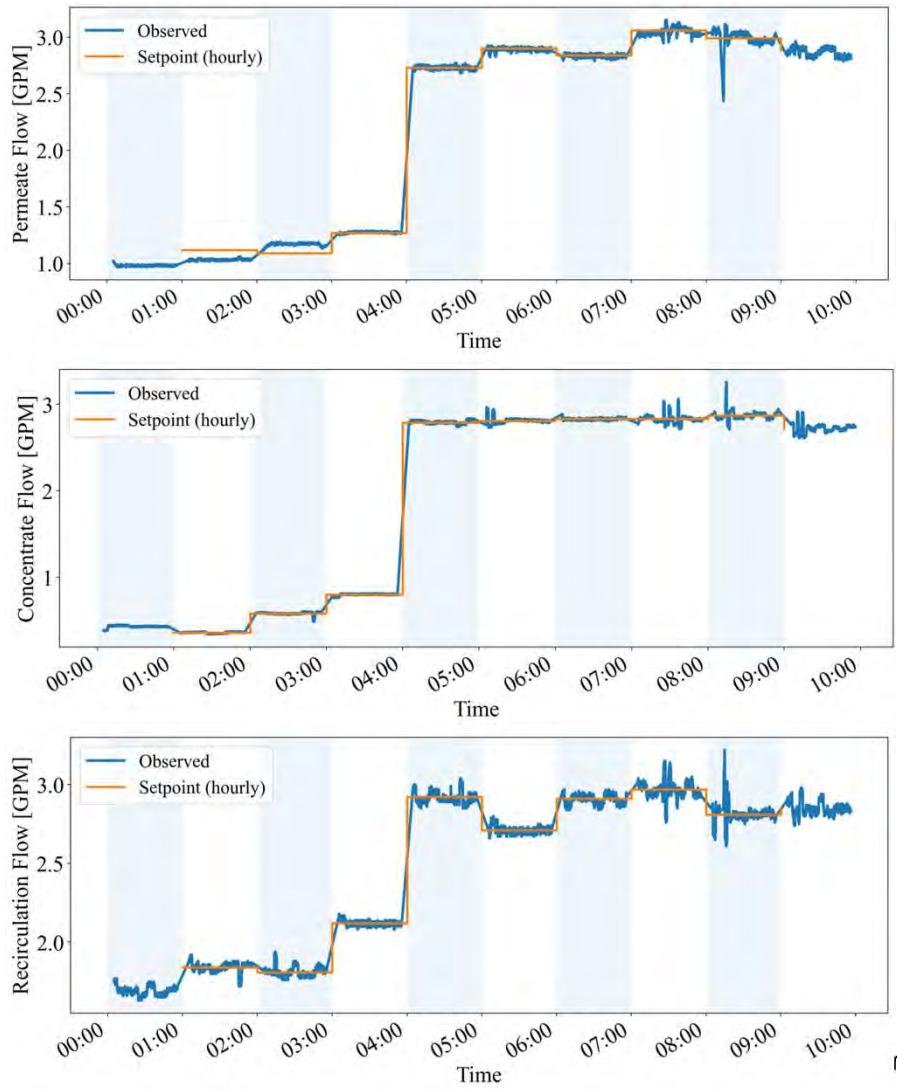
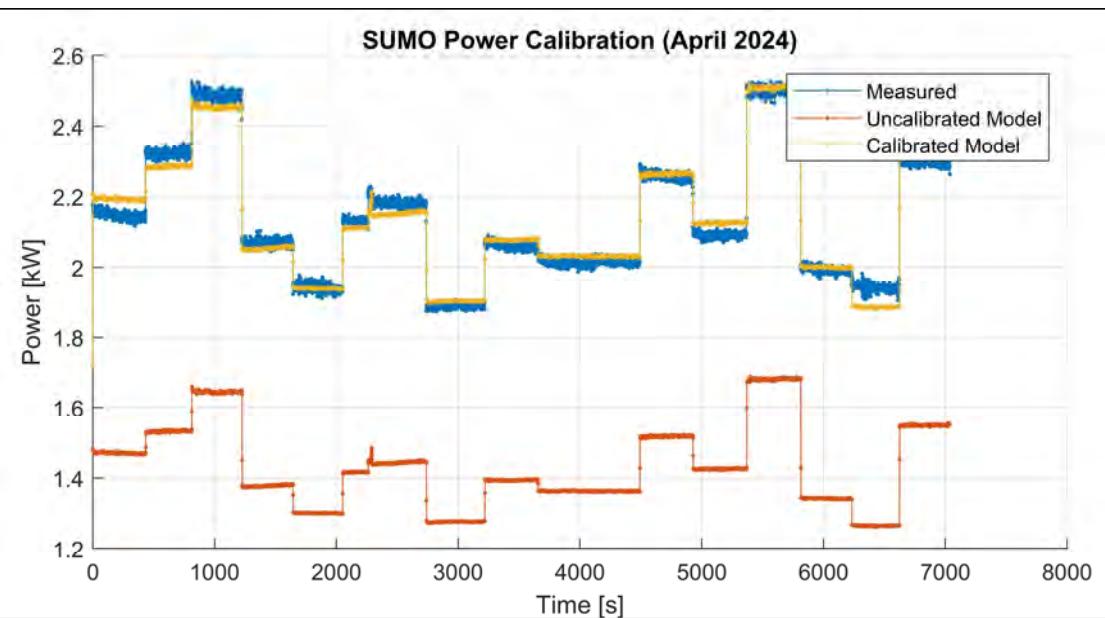


Implementation of Automated Process Control for the Physical-Digital Twins



Implementation of Data Communication between the Physical-Digital Twins

DIGITAL TWIN CALIBRATION



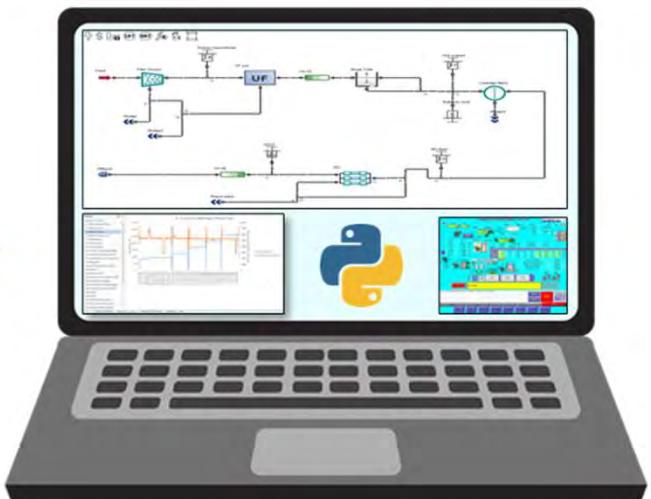
The digital twin is calibrated

- Autonomously
- Using experimental data from the physical twin
- By adjusting the equipment specifications in the simulator

IMPLEMENTATION OF THE PHYSICAL-DIGITAL TWINS



Advanced Treatment Train Pilot at OCWD



Advanced Treatment Train Pilot's
Digital Twin at UC Irvine

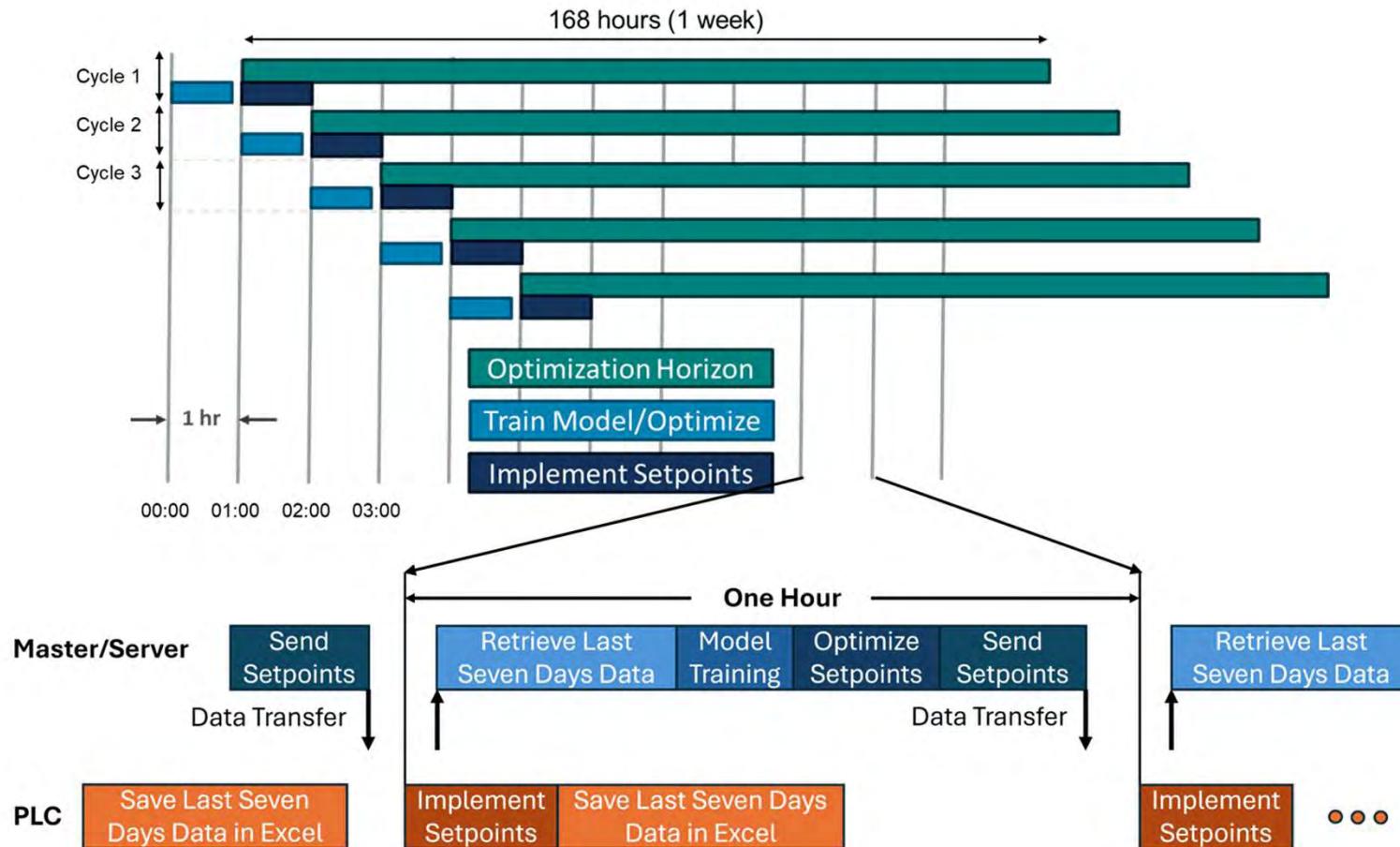


Using Digital Twin to Maximize Process Efficiency

Delivering a better world

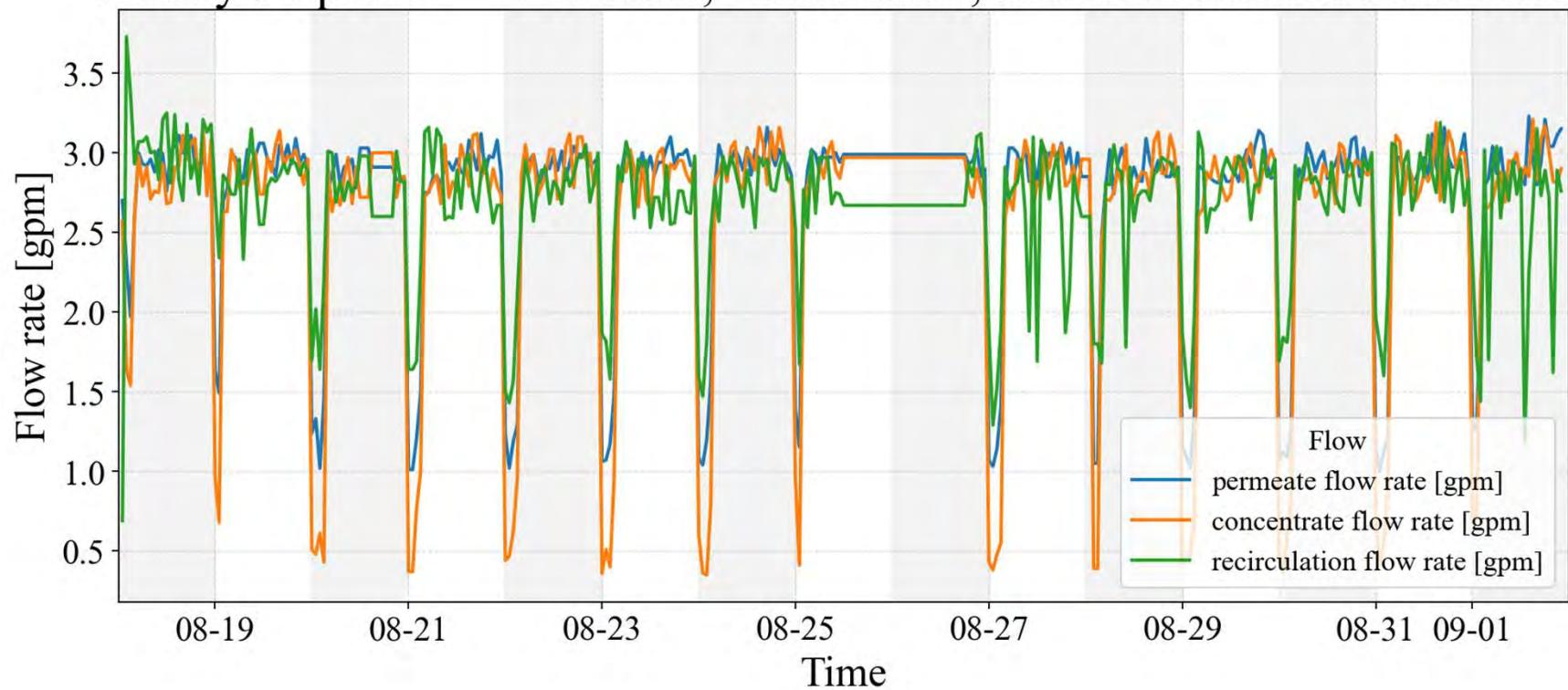
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MODEL PREDICTIVE CONTROL SCHEME TO IMPLEMENT THE OPTIMIZER

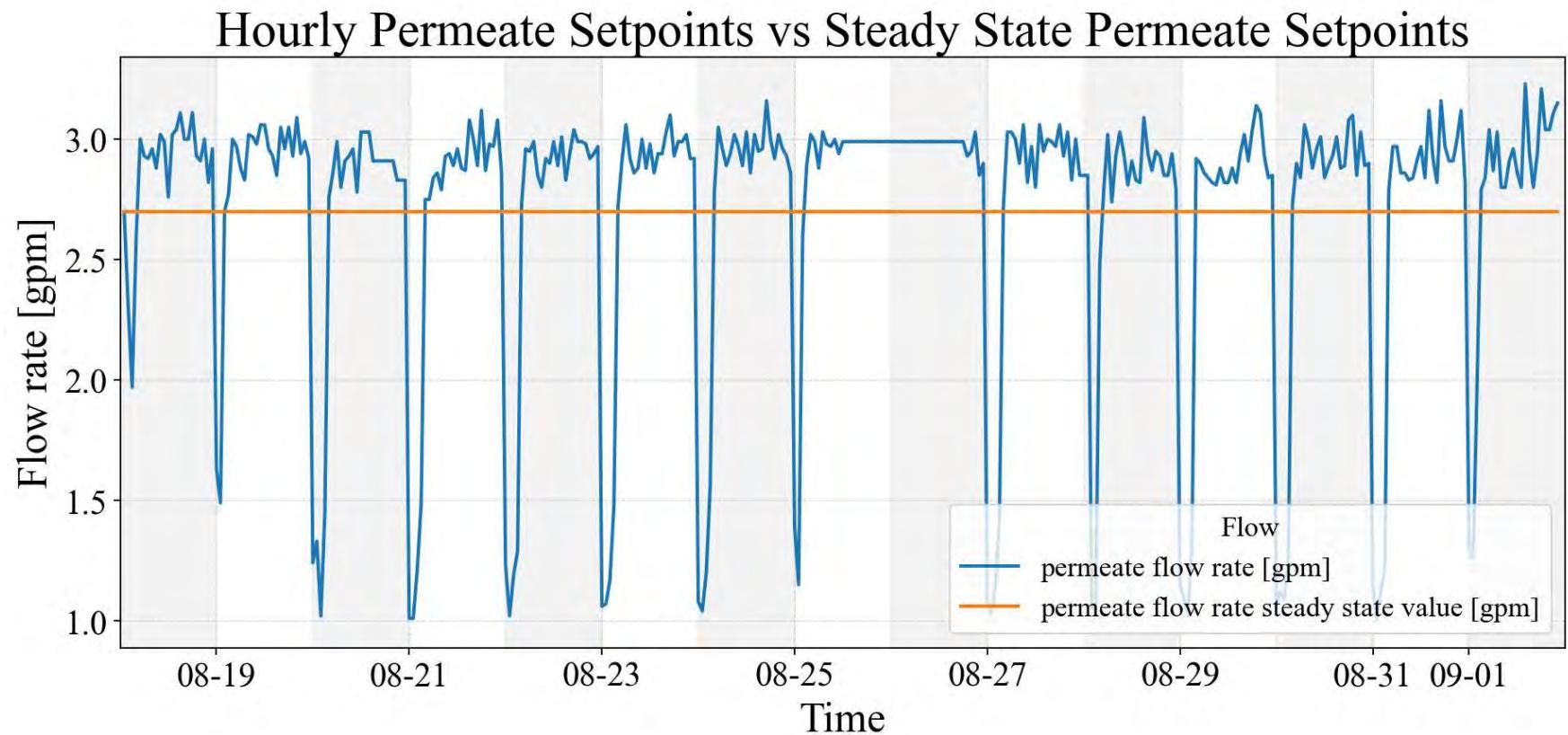


PRELIMINARY OPTIMIZATION RESULTS

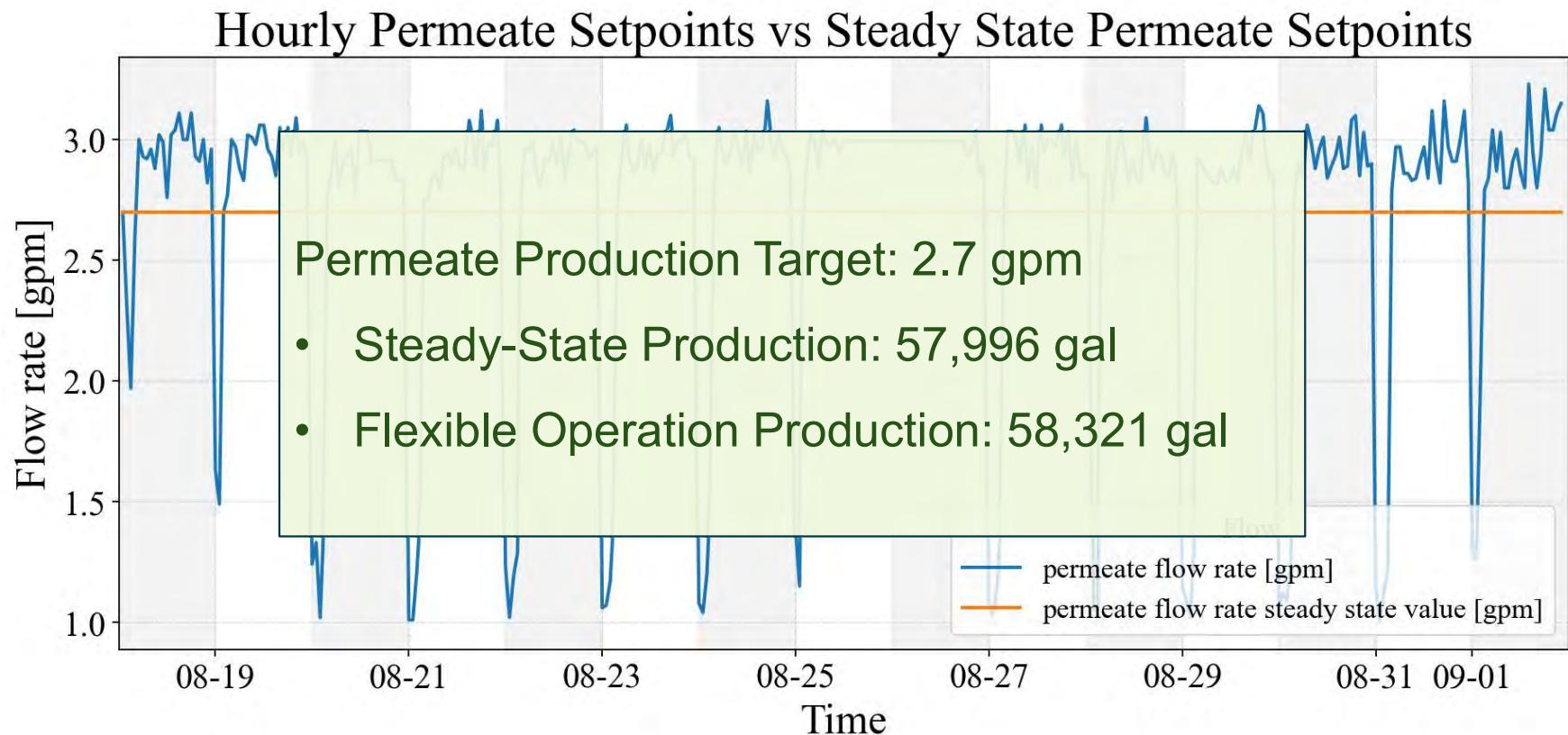
Hourly Setpoints — Permeate, Concentrate, and Recirculation Flow Rates



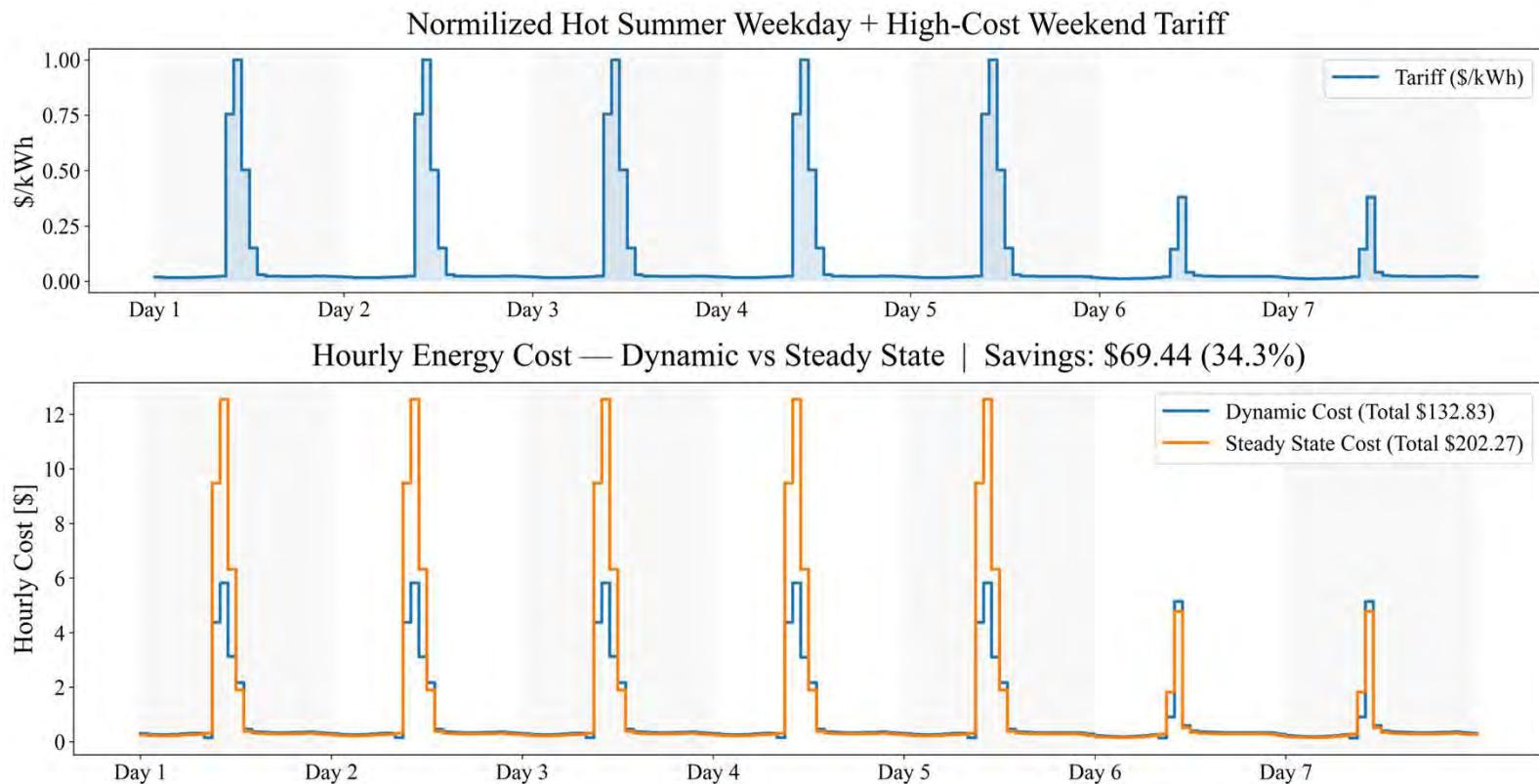
PRELIMINARY OPTIMIZATION RESULTS



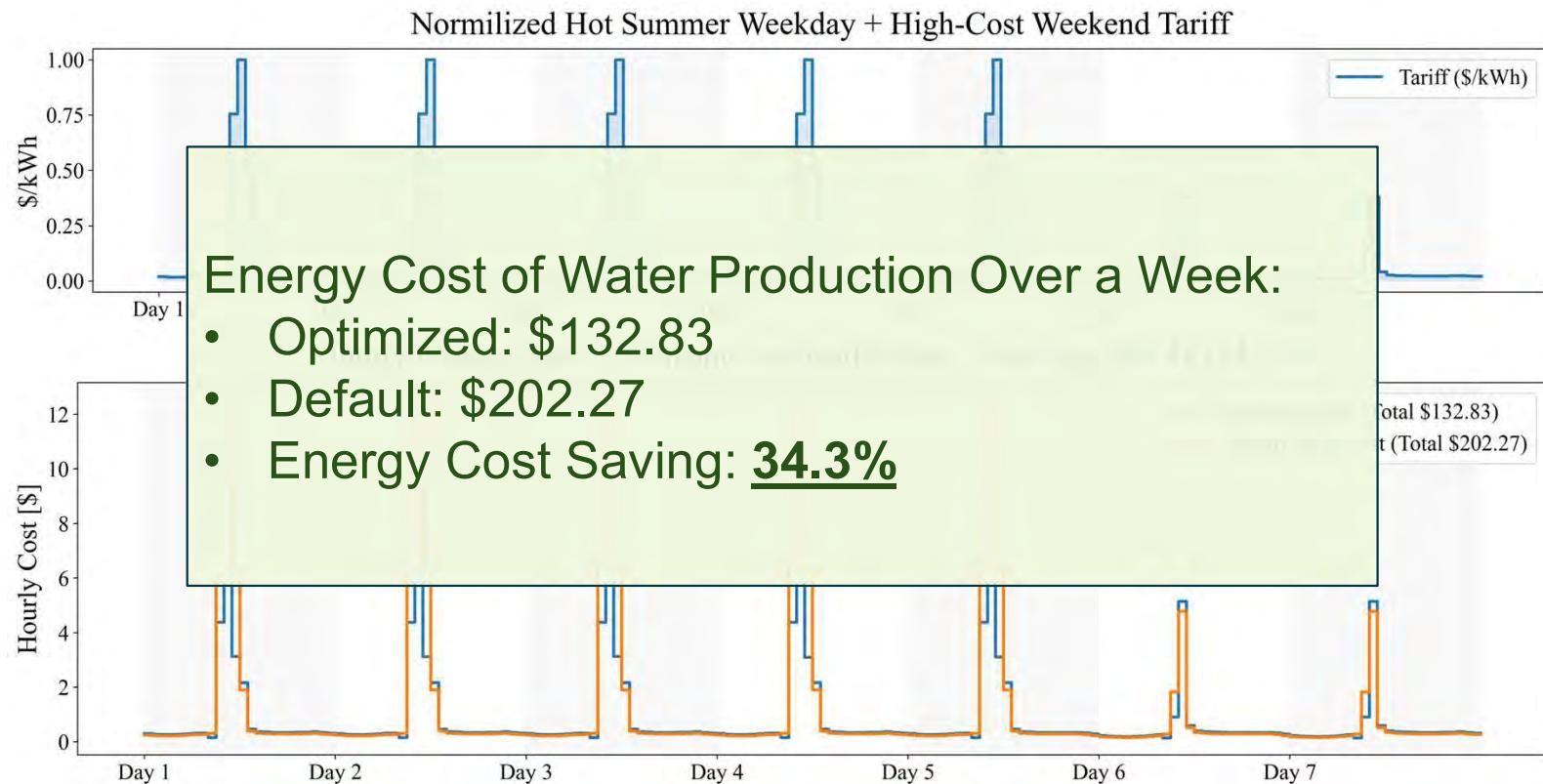
PRELIMINARY OPTIMIZATION RESULTS



PRELIMINARY OPTIMIZATION RESULTS



PRELIMINARY OPTIMIZATION RESULTS





Thank you.

Questions?

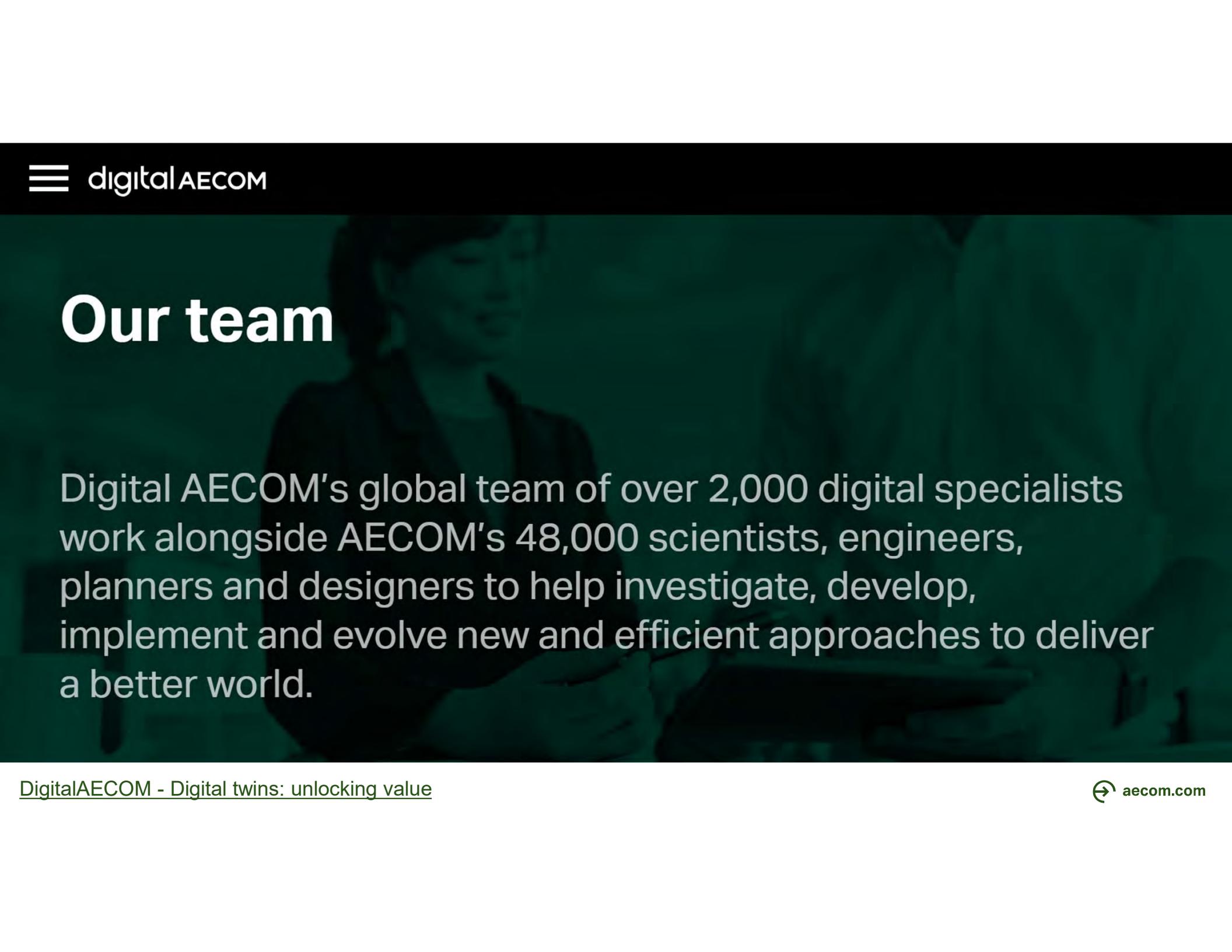
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Our team

A dark, semi-transparent background image of a person wearing a virtual reality headset and holding a controller, representing the theme of digital twins.

Digital AECOM's global team of over 2,000 digital specialists work alongside AECOM's 48,000 scientists, engineers, planners and designers to help investigate, develop, implement and evolve new and efficient approaches to deliver a better world.