Multi-Period Modeling for Solar Thermal Driven Water Treatment

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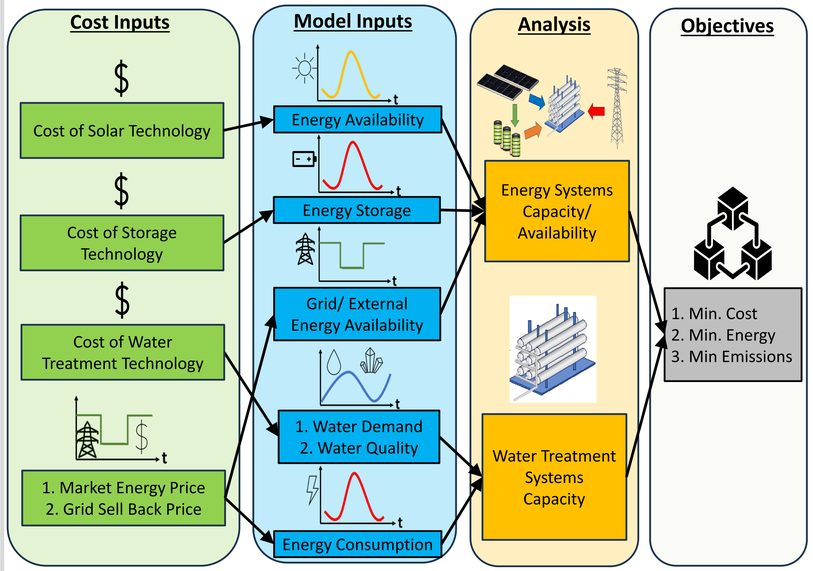
Motivation

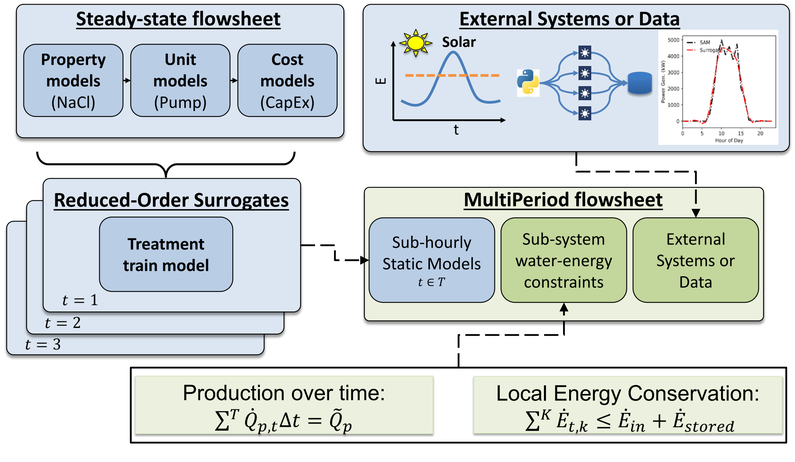
Water systems are constrained by multiscale, time-varying factors, modeled by non-linear dynamics



Multi-period modeling can simplify dynamic optimization problems and use existing steady-state models

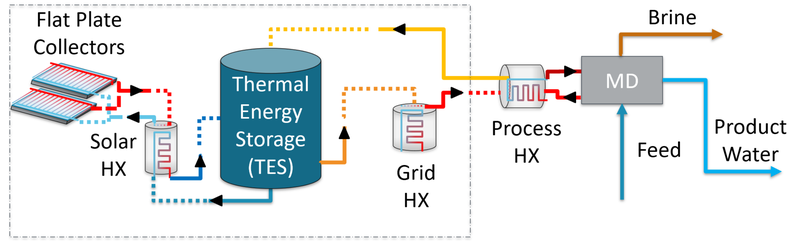
Multi-period Model Strategy

Links expressive, non-linear steady-state models over time with rate limiting constraints

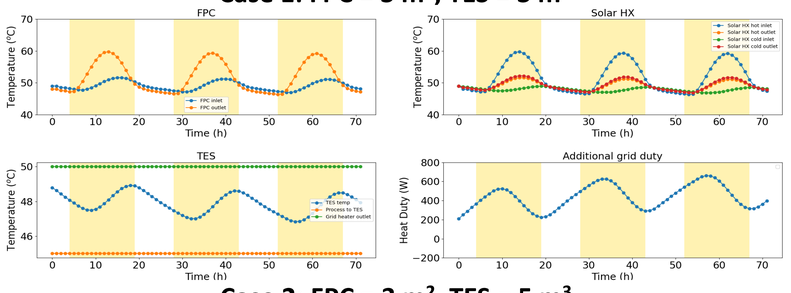


Multiperiod FPC-TES System

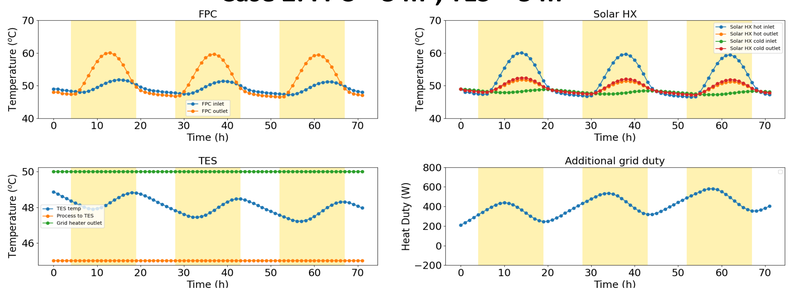
Multiperiod analysis on flat-plate collector (FPC) and thermal energy storage (TES) interaction with desalination systems responding to time-varying external inputs



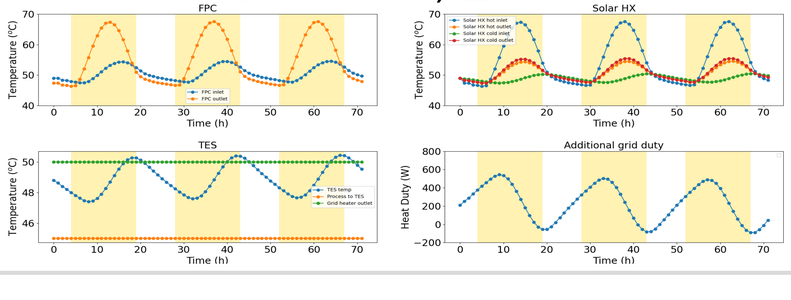
Case 1: FPC = 3 m², TES = 3 m³



Case 2: FPC = 3 m², TES = 5 m³

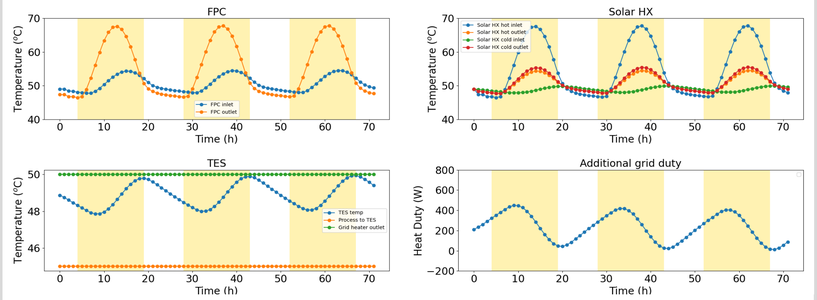


Case 3: FPC = 5 m², TES = 3 m³



Key Findings

Case 4: FPC = 5 m², TES = 5 m³



- A large TES tank decreases temperature oscillations
- FPC area should be a function of process heat required
- Negative heat duty implies a bypass line is required
- FPC area and TES can be optimized to minimize grid heat duty and minimize temperature oscillations

Remarks and Future Work

- Technologies from several DOE-funded projects were used to achieve multi-period modeling (WaterTAP, WaterTAP-REFLO, IDAES, DISPATCHES, SAM)

Future Work

- Model validation
- Optimize TES and FPC area to minimize LCOW and or grid energy consumption
- Include control logic with splitters and mixers to eliminate negative heat duty
- Simulate flow sheet with time-varying water treatment system demand/operation

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