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Projects: Dynamic Behavior of Hybrid PV-CSP Plants
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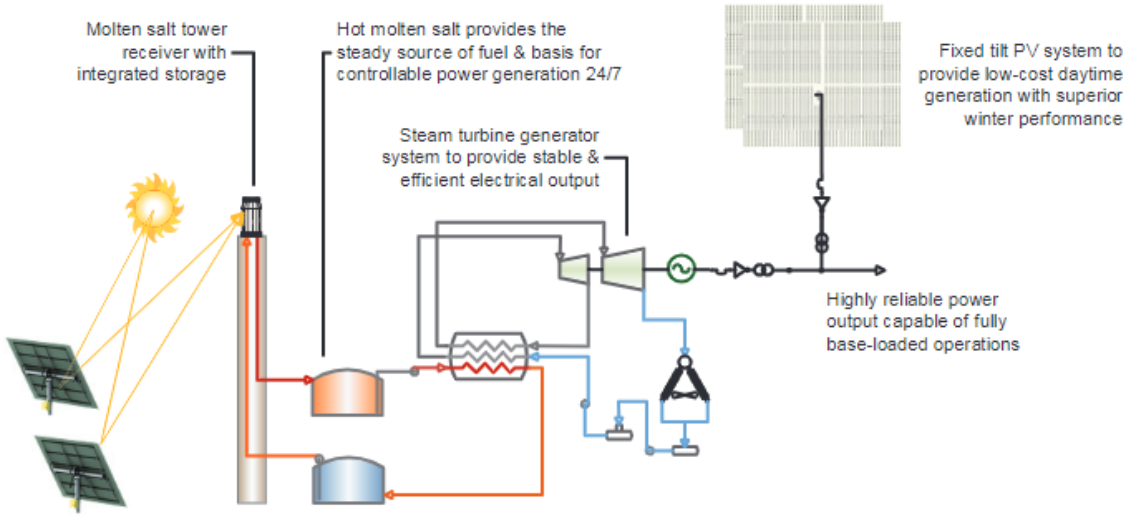
SCL
ENERGY SYSTEMS OPTIMIZATION LAB

Background

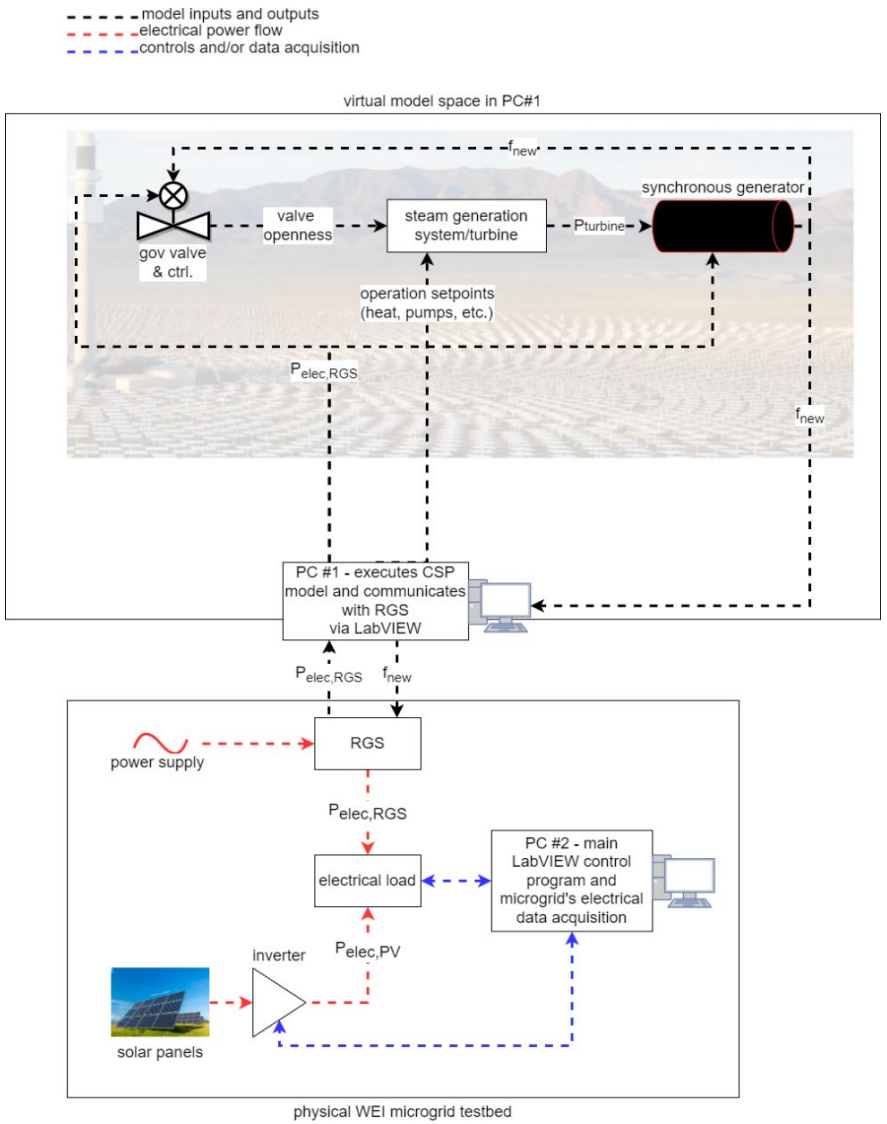
- Hybrid solar parks combine photovoltaic (PV) and concentrating solar power (CSP) to offer a low-cost, dispatchable renewable energy solution for grid decarbonization

- Hybrid plant challenges include:
  - dealing with response lag due to the CSP's thermal inertia
  - deciding if/when PV curtailment is necessary
  - load-following transitions
  - optimizing plant management to mitigate component degradation

- ESOL's Power Hardware in the Loop (PHiL) testbed integrates transient CSP models with physical PV hardware, thereby enabling study of hybrid system behavior



A hybrid PV-CSP concept layout from "High-capacity factor CSP-PV hybrid systems" by Green et al.

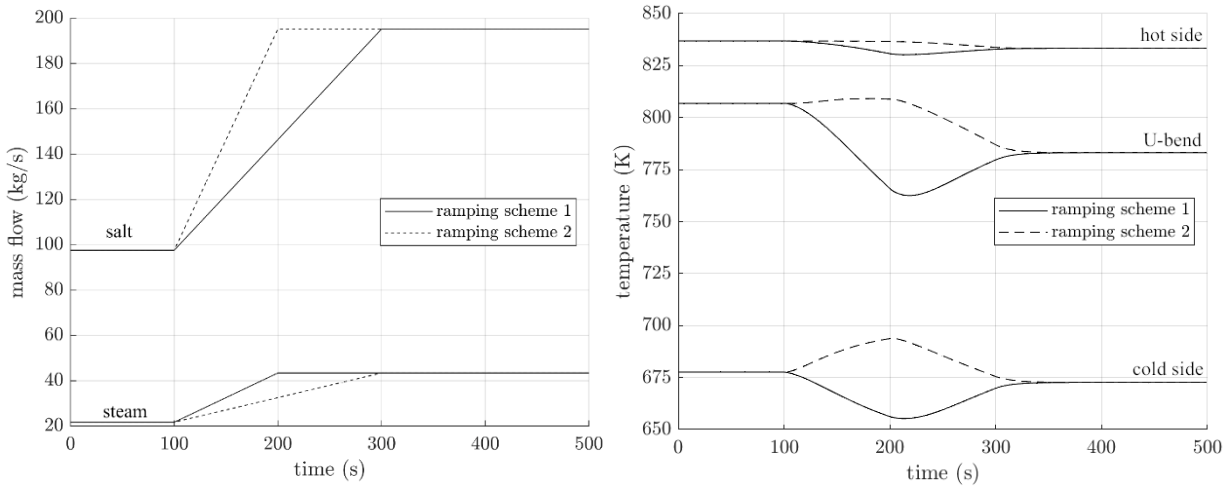


PHiL layout showing data and power flow between transient models and physical PV hardware in the WEI High Bay Lab

Project Goals

1. transient modeling for power-tower CSP

- Develop dynamic models for primary power block's salt-steam heat exchangers
- Predict temperature responses/mass flow responses at locations of interest during load-changes (see figure for example)
- Integrate models into an overall system model and quantify cumulative system lag due to thermal inertia



superheater simulation results comparing two mass flow rate ramping schemes' (left) effect on tube bundle metal temperature response at three different locations (right)

2. Investigate hybrid plant dynamics using PHiL testbed

- Capture hybrid system behavior during various events including: cloud cover (see figure for example), load-following, ancillary services, etc.

- Develop control strategies to optimize use of thermal energy storage and reduce load-following error/lag

PHiL testbed timeseries data from a cloudy day shows potential effects of cloud cover on hybrid plant operation