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Dynamic Setpoint Control of Electric Hot Water Heater Tanks for Increased Integration of Solar Photovoltaic System

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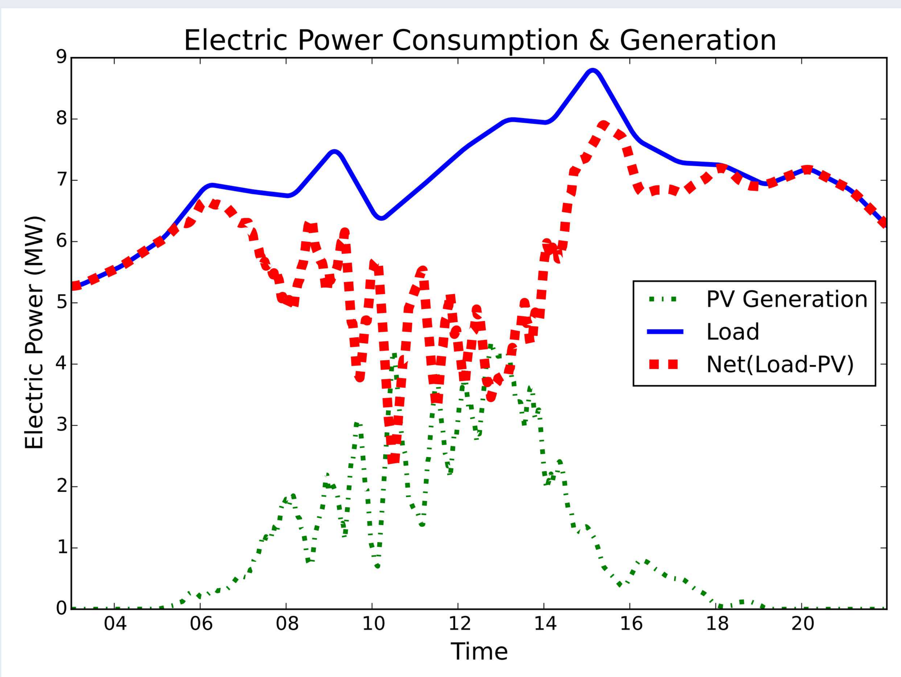
Objectives

Improve the integration of solar PV on the electric grid:

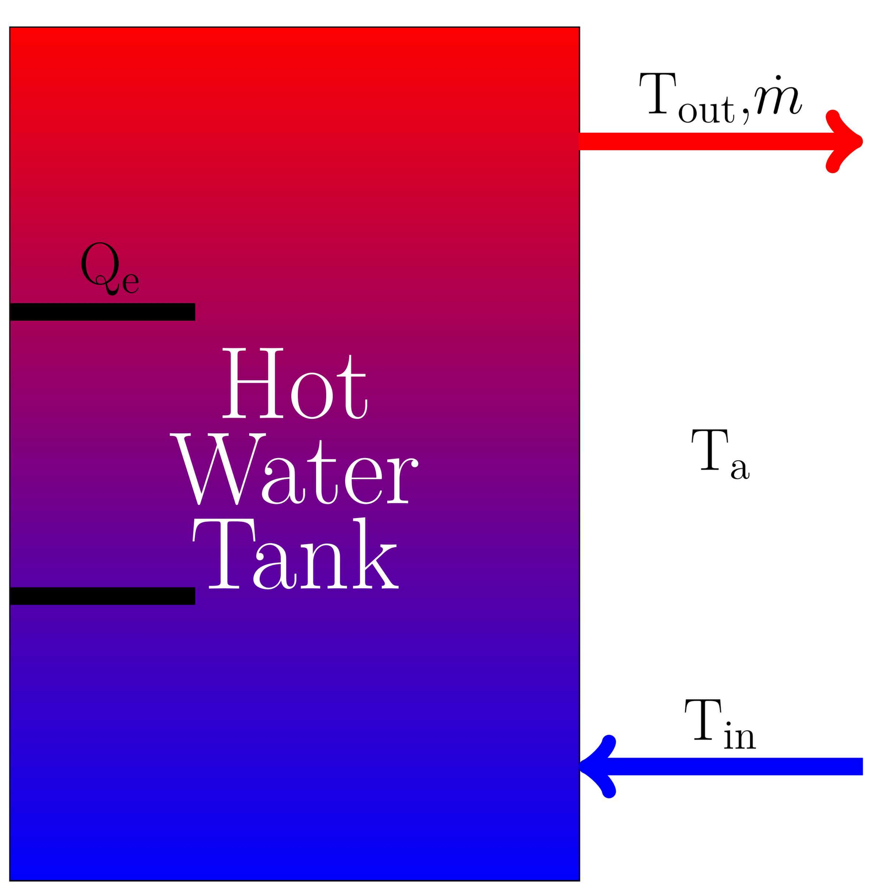
- Reduce excessive net load increase
- Smooth solar variability



Can the control of electric water heaters (EWH) tanks be synchronized with the sun to improve grid operations?

Methodology

The experiment combined EWH models with actual demand and PV data from a feeder that supports 2,900 homes. The EWH were modeled using a state space approach that considered the thermal stratification in the hot water tank [1].



The simulated tanks were presented with realistic hot water draw profiles that were developed based on statistical evaluations [2].

Dynamic Setpoint Control

The setpoint temperature (T_{sp}) is the reference temperature that is compared with the actual water temperature to determine the control of the heating element inside the EWH tanks. Typical operations have a static setpoint. The present work used a dynamic setpoint

$$T_{sp} = 12(E_e)^3 + 45 \quad (1)$$

that controlled the EWHs based on the solar irradiance (E_e).

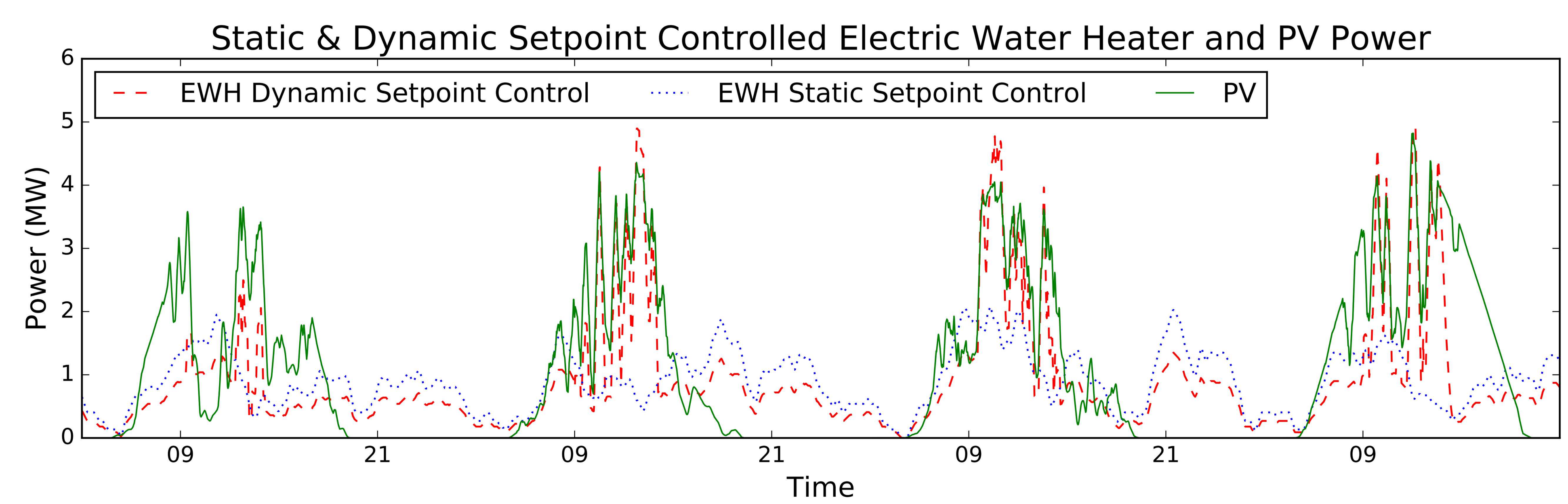
Experiment

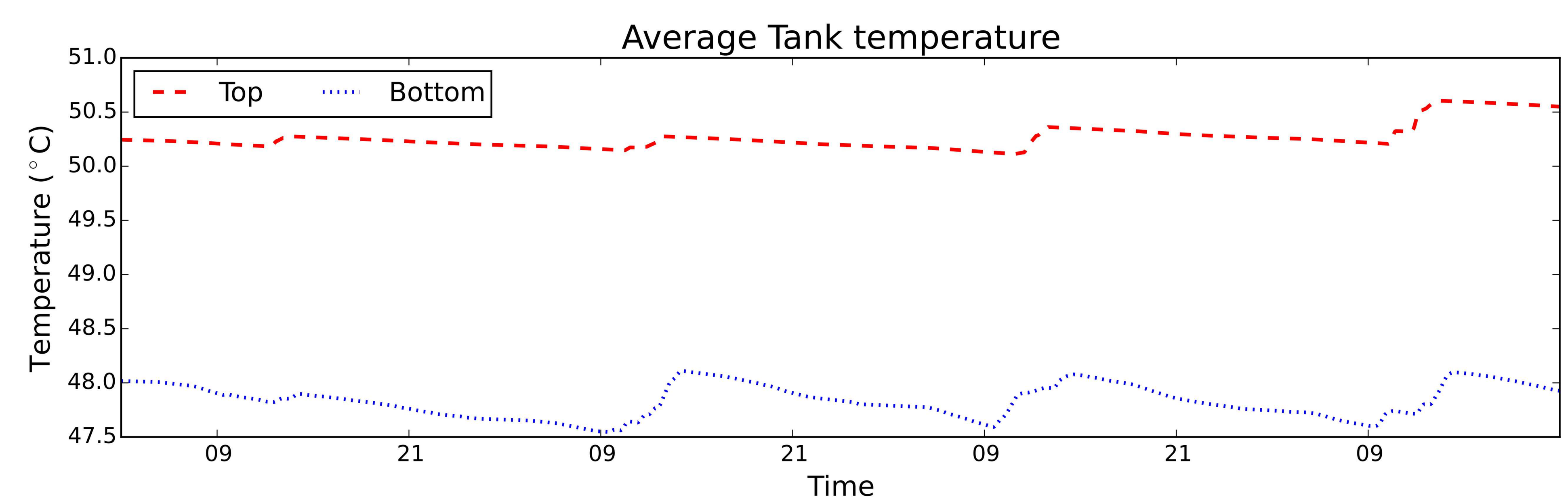
The experiment simulated three different scenarios that varied the number of EWHs controlled by the proposed setpoint control.

Table: Control scenario tests

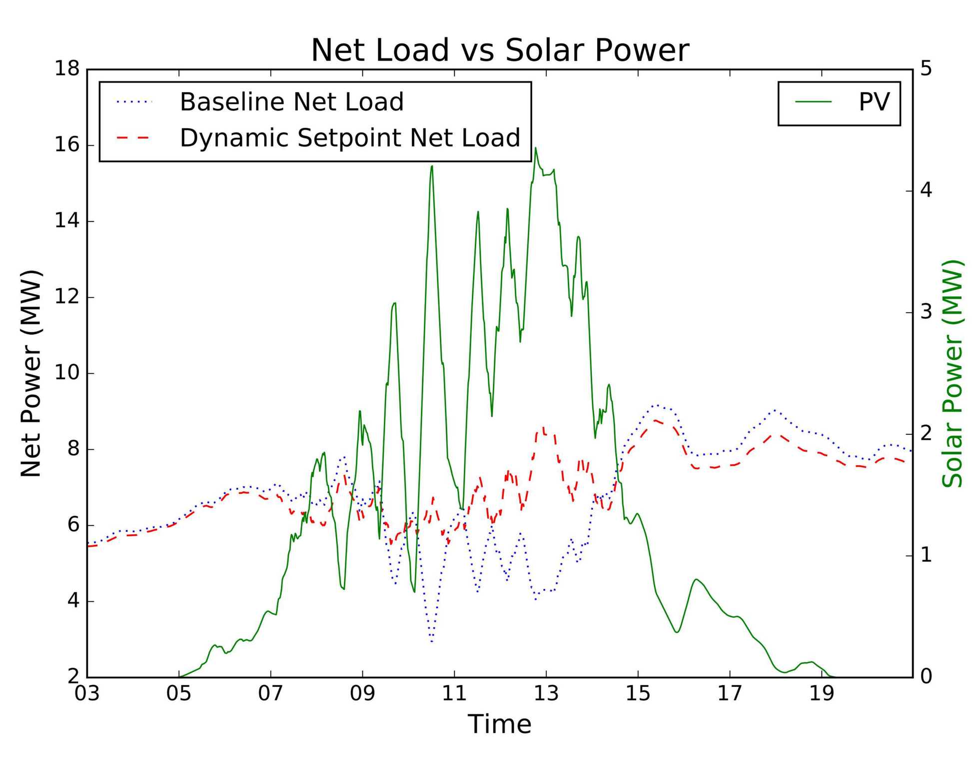
Name	Number	
	Static(49°C)	Dynamic
Baseline	2,900	0
Solar Control A	1,933	967
Solar Control B	967	1,933

EWH Demand & PV Results

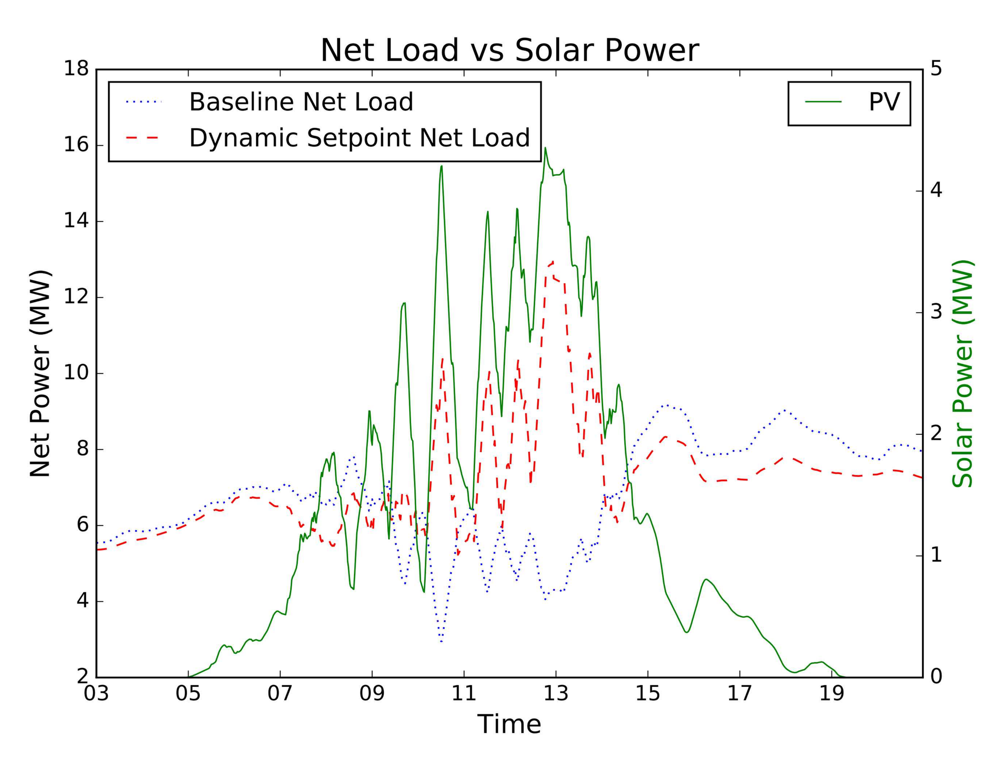




Solar Control Scenario A



Solar Control Scenario B



Conclusion

The dynamic setpoint control was able to synchronize the EWHs with the PV generation. The simulation showed that the end of day increase in demand caused by the decrease in solar generation was reduced. The EWHs were able to smooth the net load variability slightly and with further controls that matched the magnitudes could provide more.

References

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[2] B. Hendron, J. Burch, and G. Barker, "Tool for Generating Realistic Residential Hot Water Event Schedules: Preprint," *ResearchGate*, 2010. [Online]. Available: https://www.researchgate.net/publication/239883840_Tool_for_Generating_Realistic_Residential_Hot_Water_Event_Schedules_Preprint

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