TOU Water Heater Optimization

ACEEE Hot Water Forum | William Burke Ph.D.

Why are we here?

TOU | Water Heaters | Optimization

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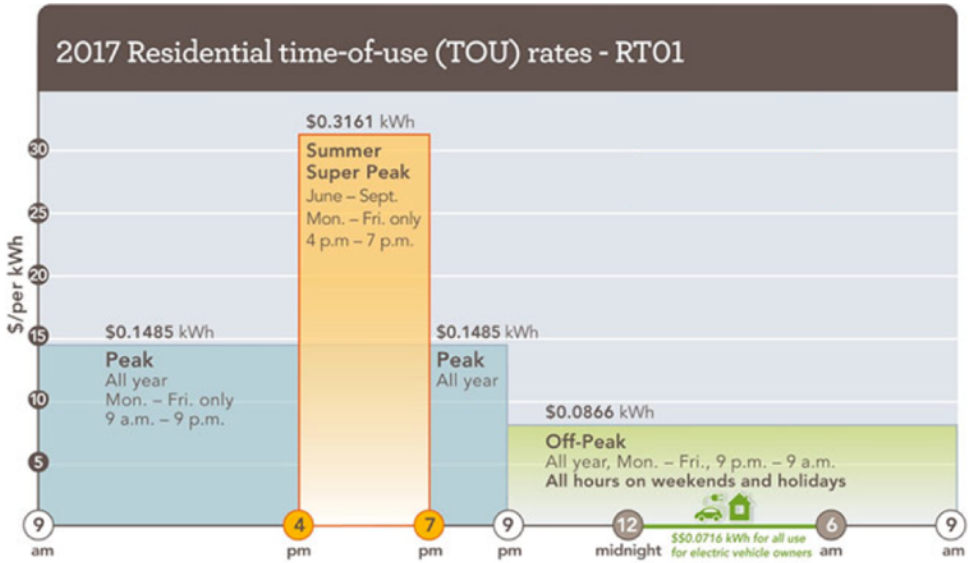
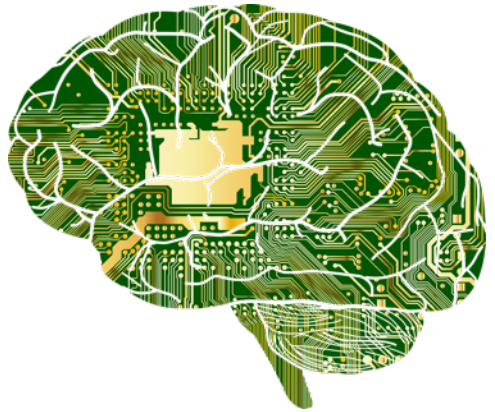
Time Of Use Pricing Optimization





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Who are we?

Virtual Peaker | Experience | Real-Time Control

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VirtualPeaker

www.virtualpeaker.io

Founded: 2014

Located: Louisville, KY

Team:

- ✓ 10+ Years Residential Energy Management.
- ✓ 5+ Years Internet of Things
- ✓ From: GE, UC Berkeley,

Our Vision:

Demand as Controllable as a Gas Turbine

Always on in the Background

Machine Learning and Real-Time Control

Minimize Peak Demand

Maximize Comfort

Engage and Delight Homeowners

Reduced Operational Costs

Customer Satisfaction

Works with Any Connected Device

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How We Do It

ENERGY DEMAND

INTEGRATION

Machine Intelligence for the Smart Grid

VirtualPeaker

Scheduling and Control
Multi-Manufacture Aggregation
Secure Web Access

Grid Optimizer

ACTION

Consumer Control

Utility Control

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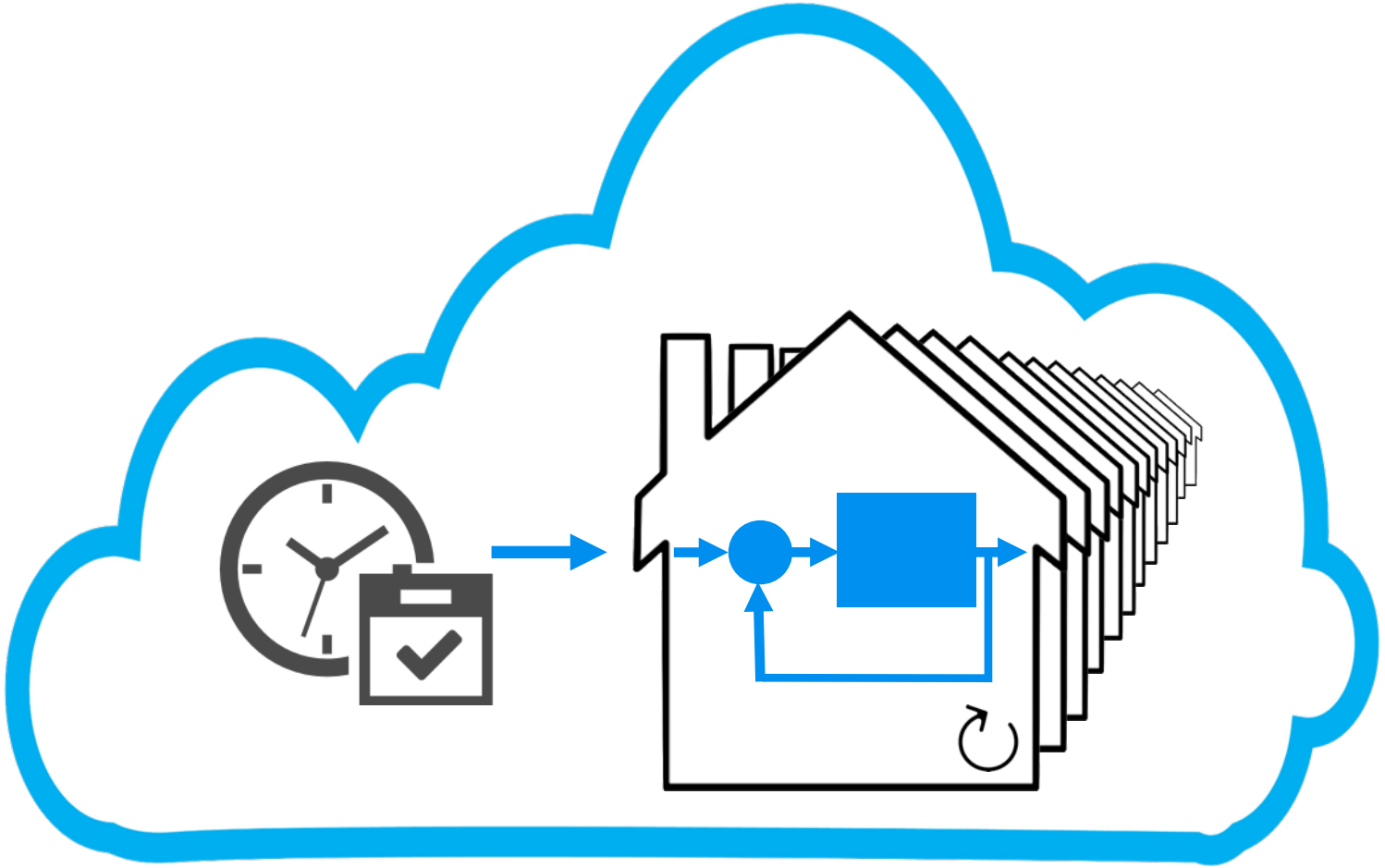
Real-Time Control



Approach

- Platoon Control
- Individual House RTC
  - Brings in New Data
  - Updates Control

Advantage

- Control Stateless Devices
- Operate Custom Algorithms

  (e.g. scheduling, learning, etc.)
- Control Devices in Coordination

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What's the project?

SMUD | GeoSpring | Virtual Peaker

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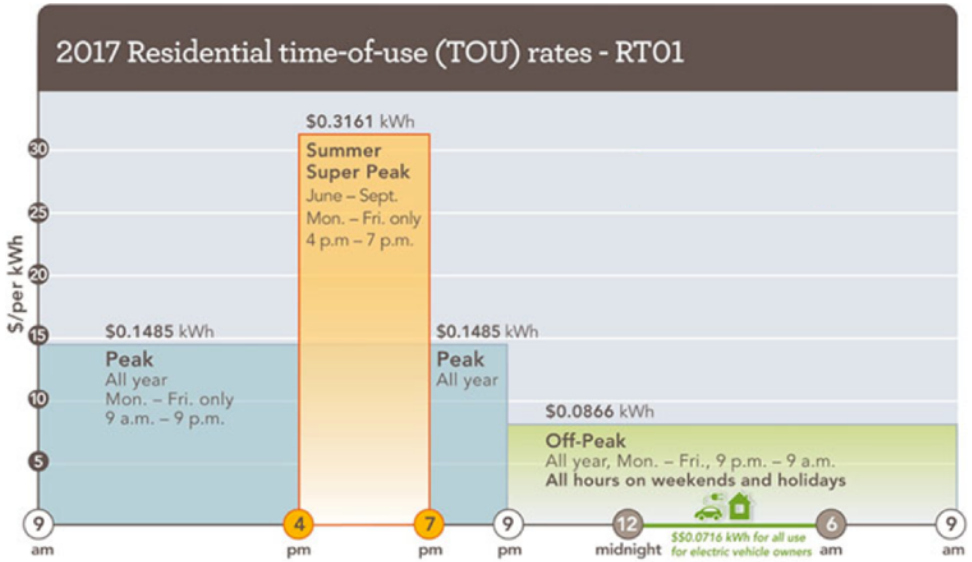
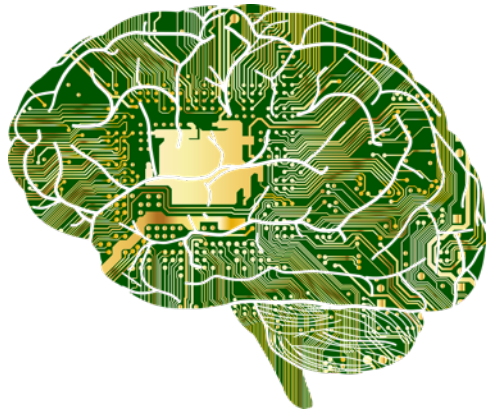
TOU Water Heater Optimization



SMUD®



VP

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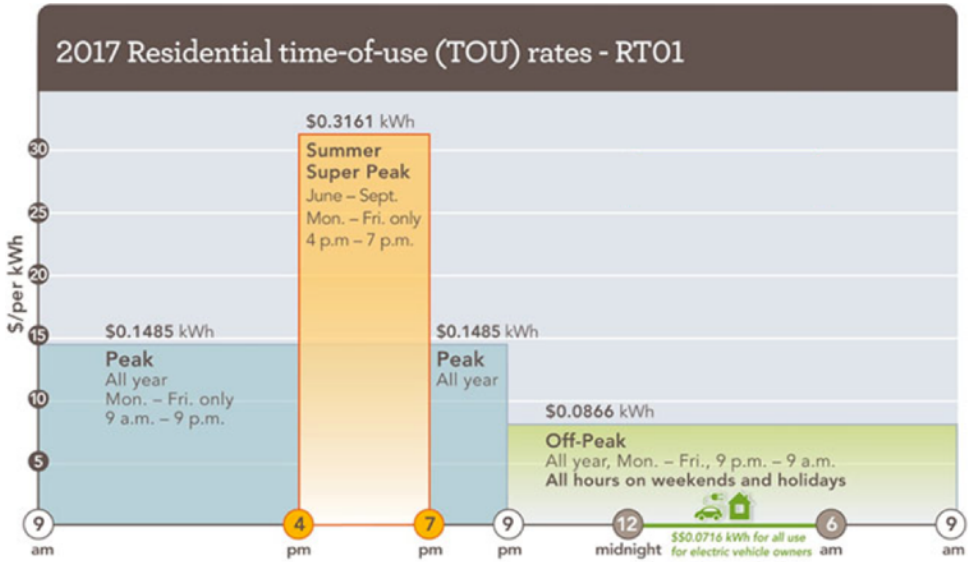
SMUD TOU Price



SMUD®

Name	Price/kWh	Time
Off-Peak	$0.0866	9pm – 9am
Peak	$0.1485	9am – 9pm
Super Peak	$0.3161	4pm-7pm Summer only

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GeoSpring Water Heater

+

- GeoSpring Hybrid Water Heater
- Thermostatic Mixing Value
- Special Control Software 160° Overtemp
- Completed Delivery
- ~2wks until Installation

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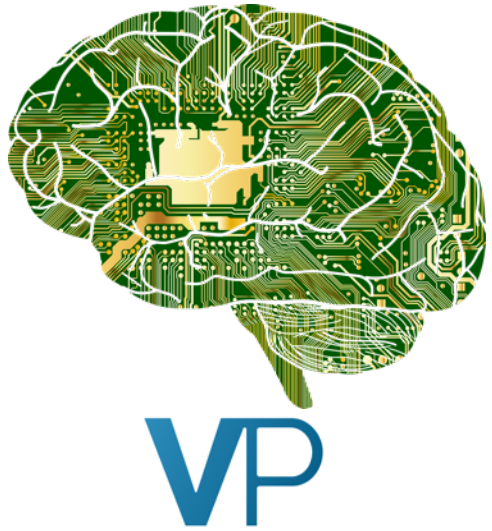
Optimization by Virtual Peaker

1. Connect with GeoSpring in the Cloud
2. Collect device behavior data
3. Apply 7-day schedule using real-time control in the cloud
4. Apply machine learning to adjust the schedule to optimal



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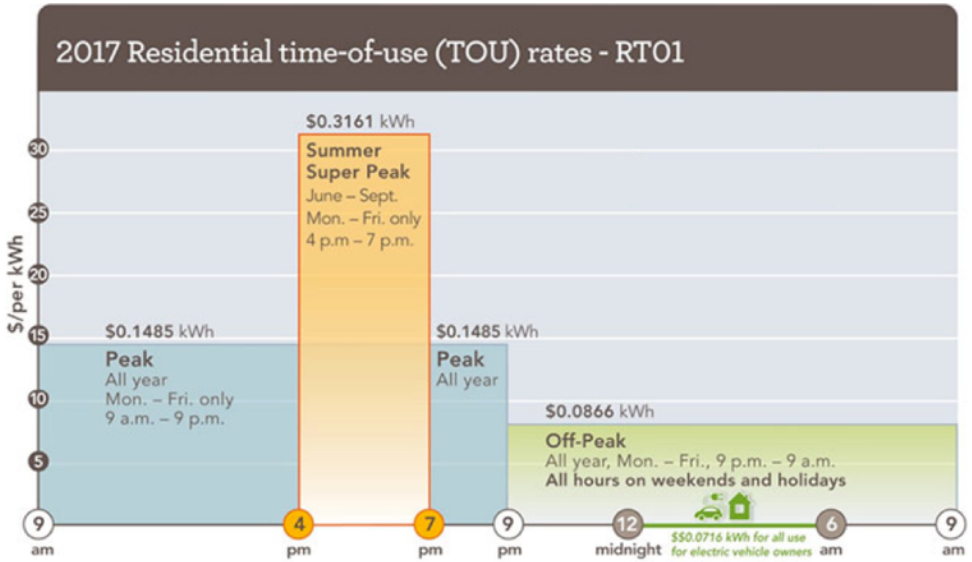
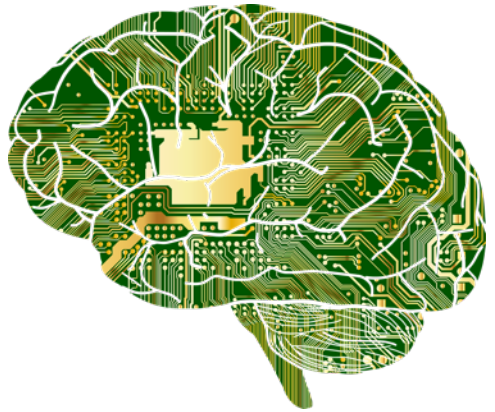
TOU Water Heater Optimization



SMUD®



VP

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How’s the Progress?

Scheduling | Simulation | Implementation

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Project Timeline

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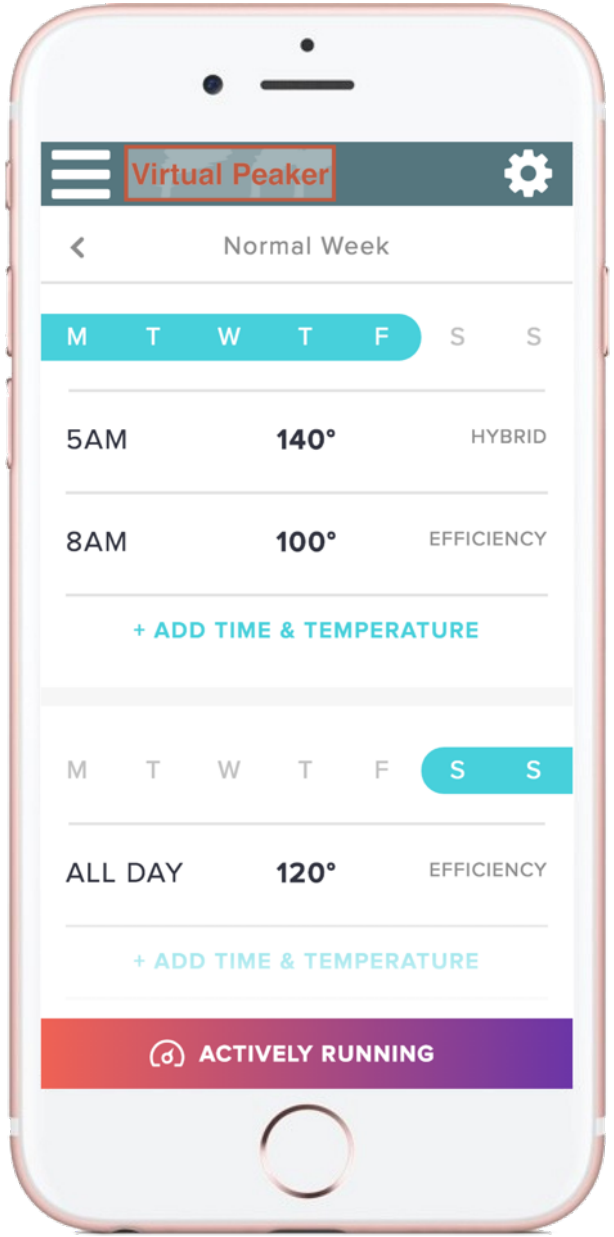
Scheduling

- No Native GeoSpring Scheduling
- VP Provides Scheduling in the Cloud
- VP Provides Homeowner App.
- *Available now!*



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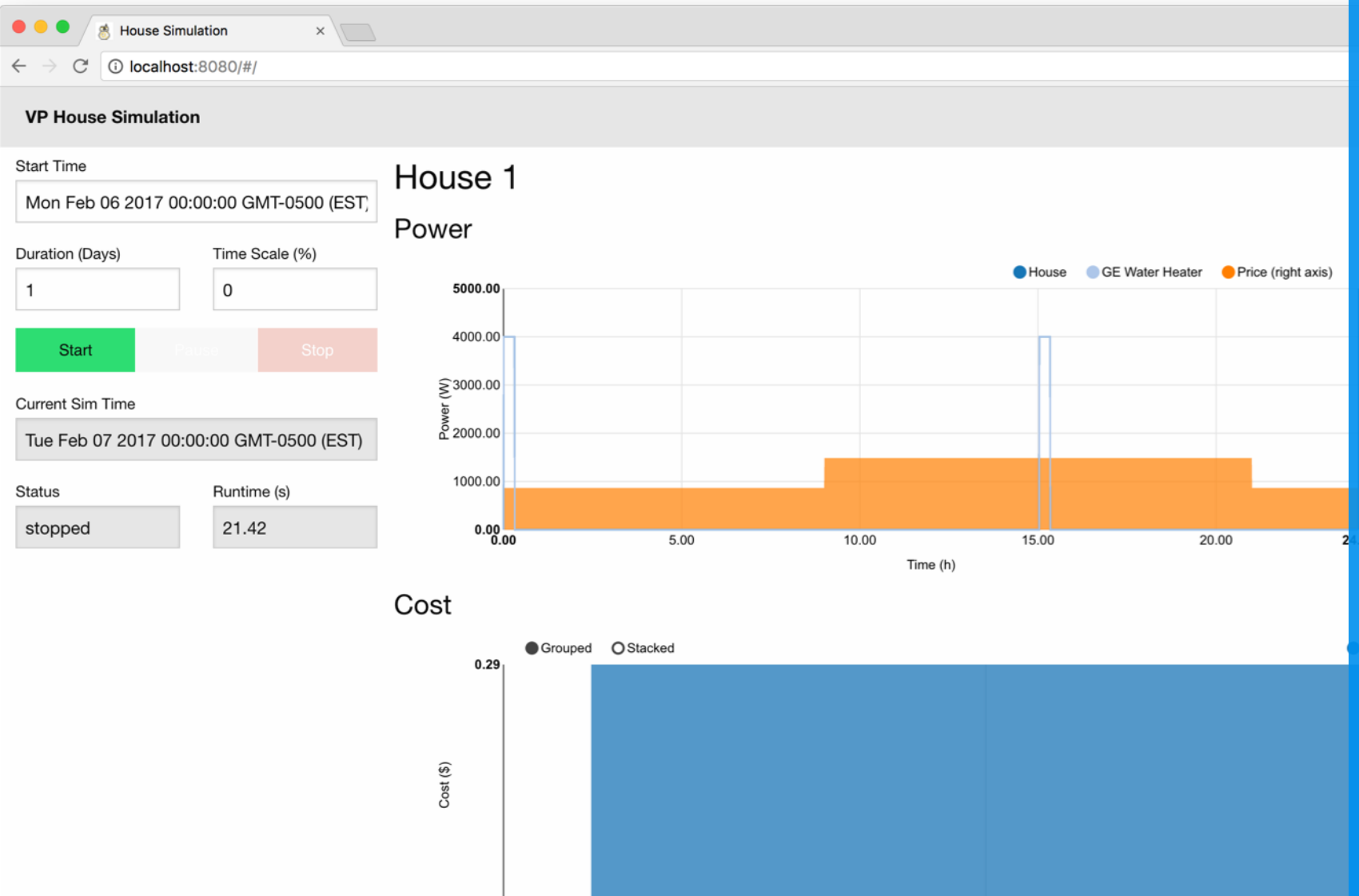
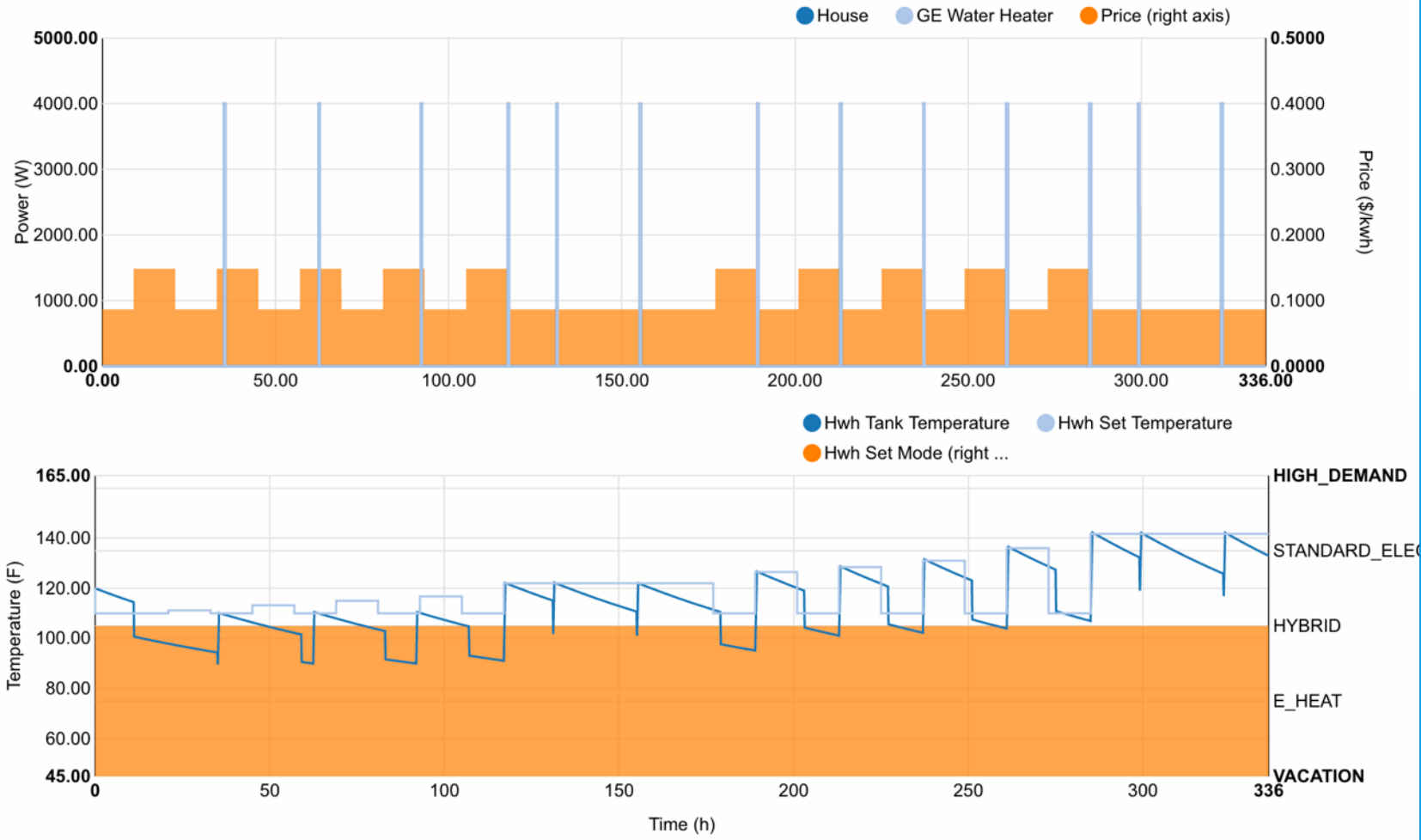
Simulation to the Rescue



SILS – Software in the Loop Simulation

- Model devices using physics based models.
- Model embedded control as accurately as possible.
- Model behavior using heuristic or statistical methods
- Apply real-time control software to software model

2-Tier Adaptation



2 Week Experiment

- TOU Price (2 tier)
- Fixed draw every day

Initial Conditions

- Flat Schedule
- Hybrid/120

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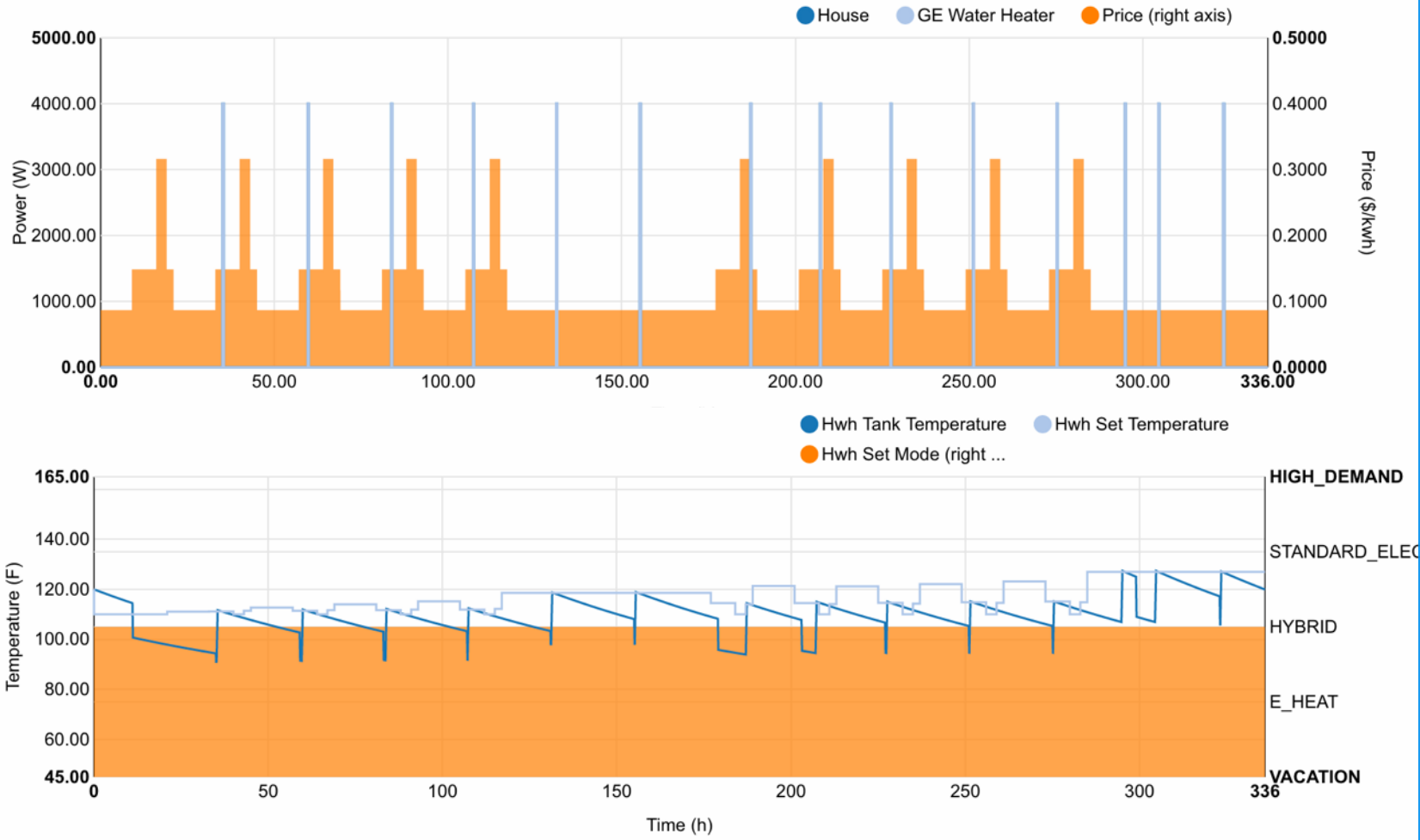
3-Tier Adaptation



2 Week Experiment

- TOU Price w/ Super Peak
- Fixed draw every day

Initial Conditions

- Flat Schedule
- Hybrid/120

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Schedule after 2 Weeks of Learning

Day	Time	Mode	Setpoint
Monday	9:00	HYBRID	110.0
Monday	21:00	HYBRID	142.7
Tuesday	9:00	HYBRID	110.0
Tuesday	21:00	HYBRID	142.4
Wednesday	9:00	HYBRID	110.0
Wednesday	21:00	HYBRID	143.0
Thursday	9:00	HYBRID	110.0
Thursday	21:00	HYBRID	145.6
Friday	9:00	HYBRID	110.0
Friday	21:00	HYBRID	141.8

Day	Time	Mode	Setpoint
Monday	9:00	HYBRID	120.8
Monday	16:00	HYBRID	110.0
Monday	19:00	HYBRID	114.8
Monday	21:00	HYBRID	126.7
Tuesday	9:00	HYBRID	115.5
Tuesday	16:00	HYBRID	110.0
Tuesday	19:00	HYBRID	114.8
Tuesday	21:00	HYBRID	126.1
Wednesday	9:00	HYBRID	115.8
Wednesday	16:00	HYBRID	110.0
Wednesday	19:00	HYBRID	114.8
Wednesday	21:00	HYBRID	126.2
Thursday	9:00	HYBRID	115.9
Thursday	16:00	HYBRID	110.0
Thursday	19:00	HYBRID	114.8
Thursday	21:00	HYBRID	126.2
Friday	9:00	HYBRID	115.9
Friday	16:00	HYBRID	110.0
Friday	19:00	HYBRID	114.8
Friday	21:00	HYBRID	126.9

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Results: Daily Average Cost

	Flat	2-Tier	3-Tier
Daily Average Cost ($)	0.1843	0.1586	0.1800
Improvement		14.0%	2.3%

- Results based on fixed daily draw during Peak ($0.1485).
- Results calculated *after only 2 weeks* of adaptation
- Results for 3-Tier Adaptation would improve with a longer test.

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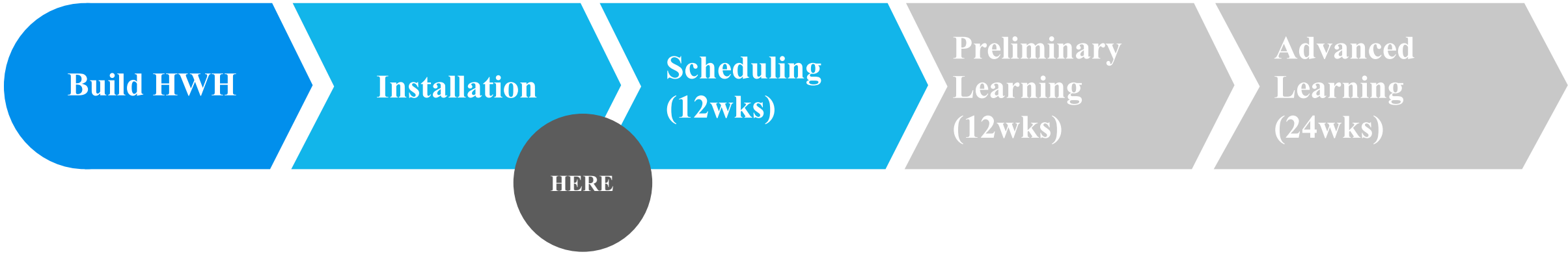
Preliminary Conclusion

- TOU Water Heater Learning and Optimization demonstrated.
- Software in the Loop Simulation shows cost improvement of 14.0%
- Implementation phase to begin within 2 weeks.



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Appendix

Partners

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Existing Partners

sonnen

SENSIBO

ecobee

aquanta

SUNVERGE

Want More?
Make a request, we are always adding...

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Virtual Peaker
Normal Week
M T W T F S S
5AM 140° HYBRID
8AM 100° EFFICIENCY
+ ADD TIME & TEMPERATURE
M T W T F S S
ALL DAY 120° EFFICIENCY
+ ADD TIME & TEMPERATURE
ACTIVELY RUNNING