

Load Flexibility for Maine

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Load Flexibility is Essential To A Reliable Power System

1980:

- Forecast demand,
Schedule generation



2024:

Forecast generation,
Schedule demand

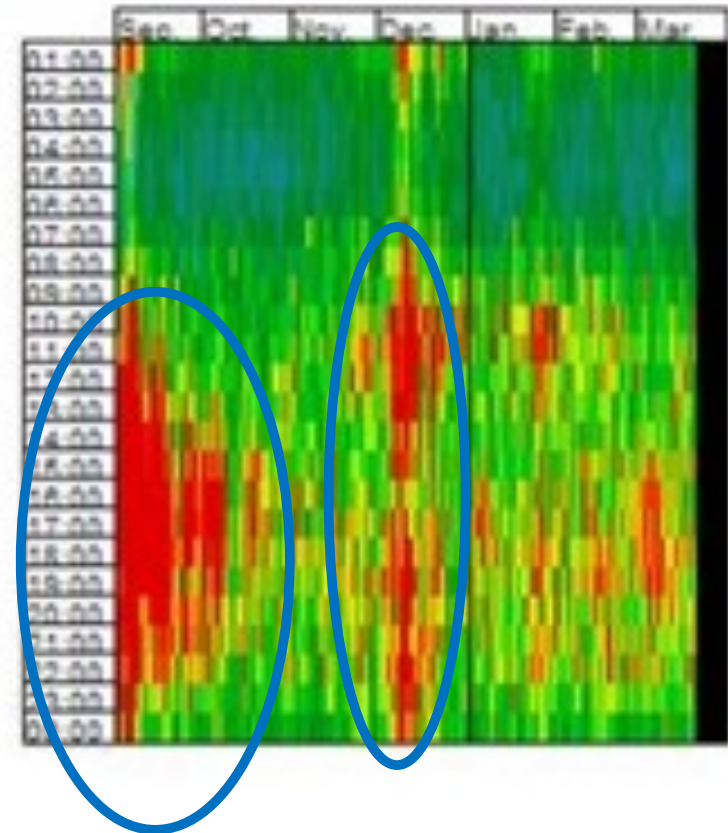


Flexibility Helps ALL Parts of the System

Locational Marginal Price - ISONE



Wholesale Generation Price Volatility



Transformer Heat Map

Teaching the “Duck” to Fly

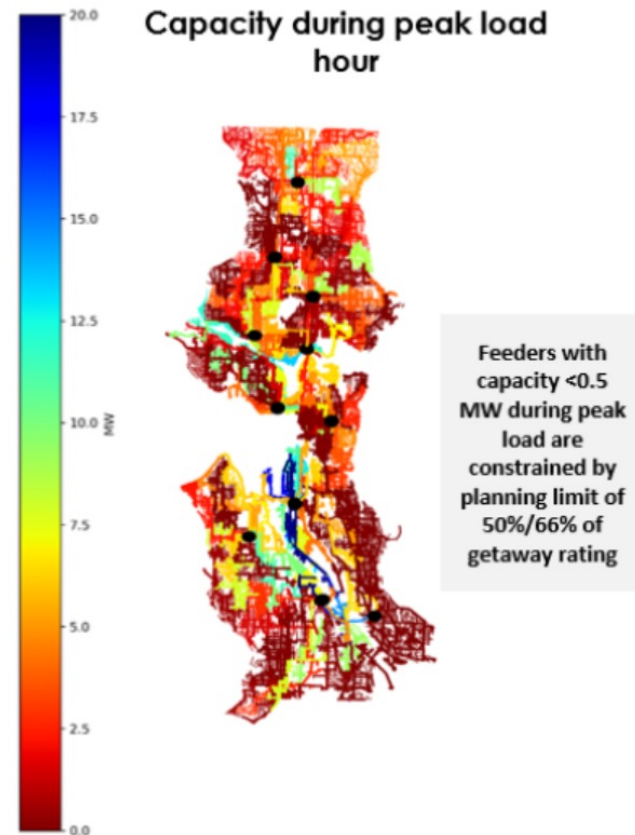
Author
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Seattle Electrification Study

- 2,000 MW utility, so same order of magnitude as Maine grid.
- Examined every distribution circuit
- Most could not handle **peak hour** load under electrification assumptions.



Many Circuits **Could** Handle Max Daily kWh

- On peak DAY, more than half of the circuits could handle the DAILY energy load, but not the maximum HOURLY load.
- On these circuits, **demand management and local storage** can avoid expensive distribution capacity upgrades.



Key Loads for Control: Water Heaters and Electric Vehicles



Local Storage Can Provide The Rest



Rate Design

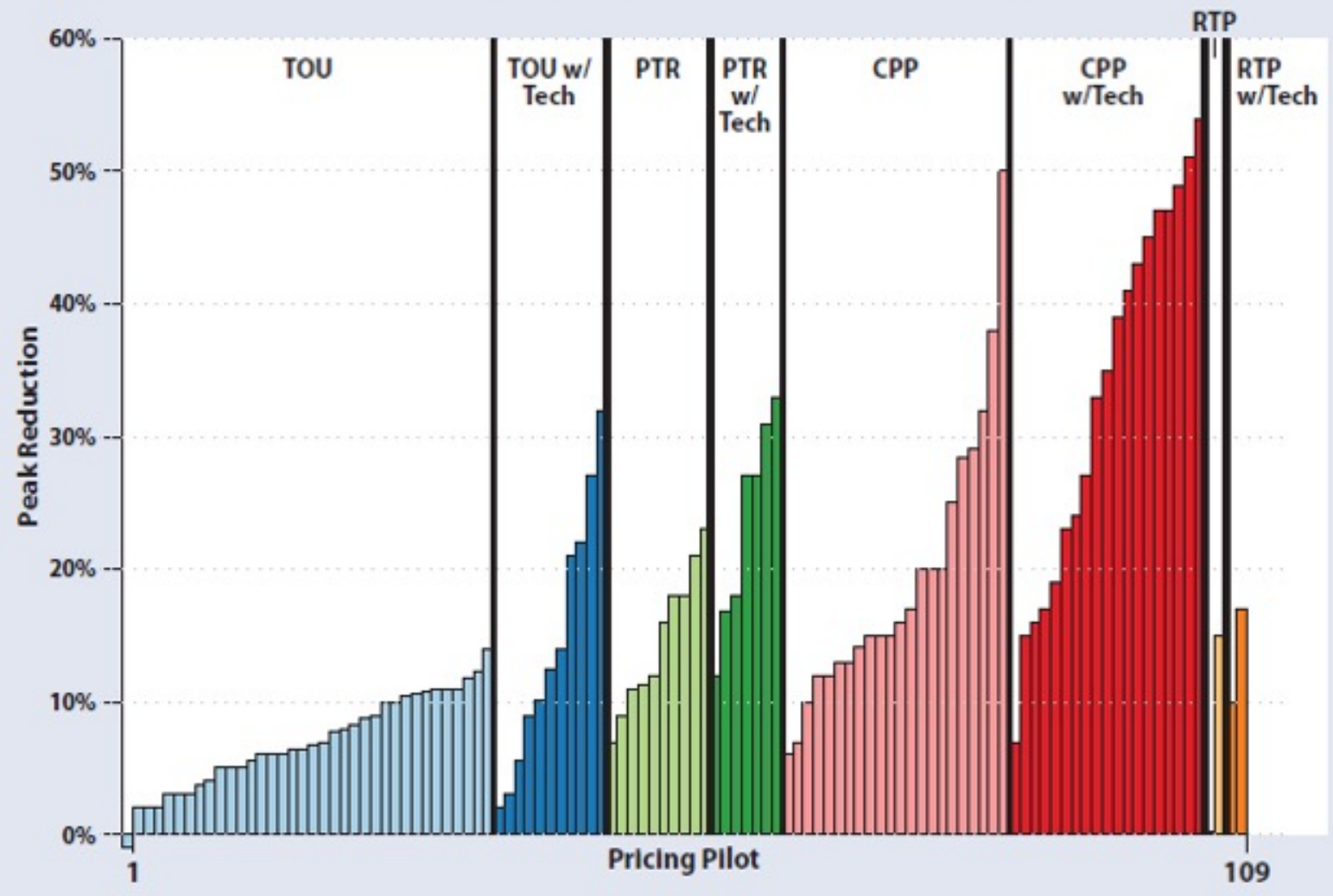
**One Necessary Element
To Incentivize Load Shaping and Storage**

What does this rate design say?



Rate design should make the choices the customer makes to minimize their **own bill** consistent with the choices they would make to minimize **system costs**.

Average Peak Reduction from Time-Varying Rate Pilots



Rate Design Is One Key Element To Facilitate Flexible Loads

- Low prices when power is cheap
- High prices when power is expensive
- Limit Demand Charge to site-specific costs

- Implement Critical Peak Pricing
or Critical Peak Rebates for key hours.

Extra Slides

Burbank TOU EV Rate

Customer Charge		\$/Month		\$ 12.07
Service Size Charge		\$/month		
Small				\$ 1.70
Medium				\$ 3.47
Large				\$ 10.38
Energy Charge \$/kWh		Delivery	Power	Total
Off-Peak		\$ 0.000	\$ 0.109	\$ 0.109
Mid-Peak		\$ 0.082	\$ 0.109	\$ 0.191
On-Peak		\$ 0.181	\$ 0.109	\$ 0.290

Hawaii Medium Commercial TOU Rate

20-160 kW Peak Demand

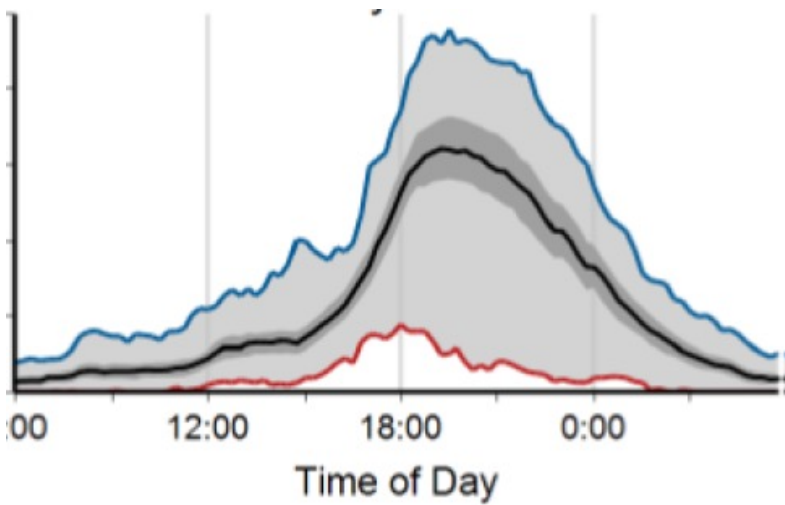
			Delivery	Power	Total
Customer Charge		\$/month	\$ 51.09		
Grid Access Charge		\$/kW/month	\$ 4.25		
Energy Charges			Delivery	Power	Total
Off-Peak	9 AM - 5 PM	\$/kWh	\$ 0.048	\$ 0.165	\$ 0.213
Mid-Peak	9 PM - 9 AM	\$/kWh	\$ 0.096	\$ 0.330	\$ 0.426
Peak	5 PM - 9 PM	\$/kWh	\$ 0.145	\$ 0.495	\$ 0.640

Electric Vehicles

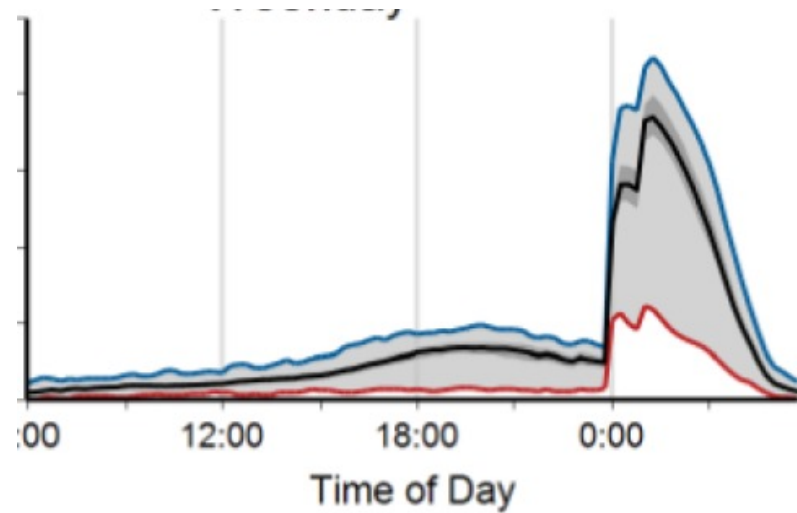
- Control when you charge to low-cost hours
- In future: use car as battery to support the grid



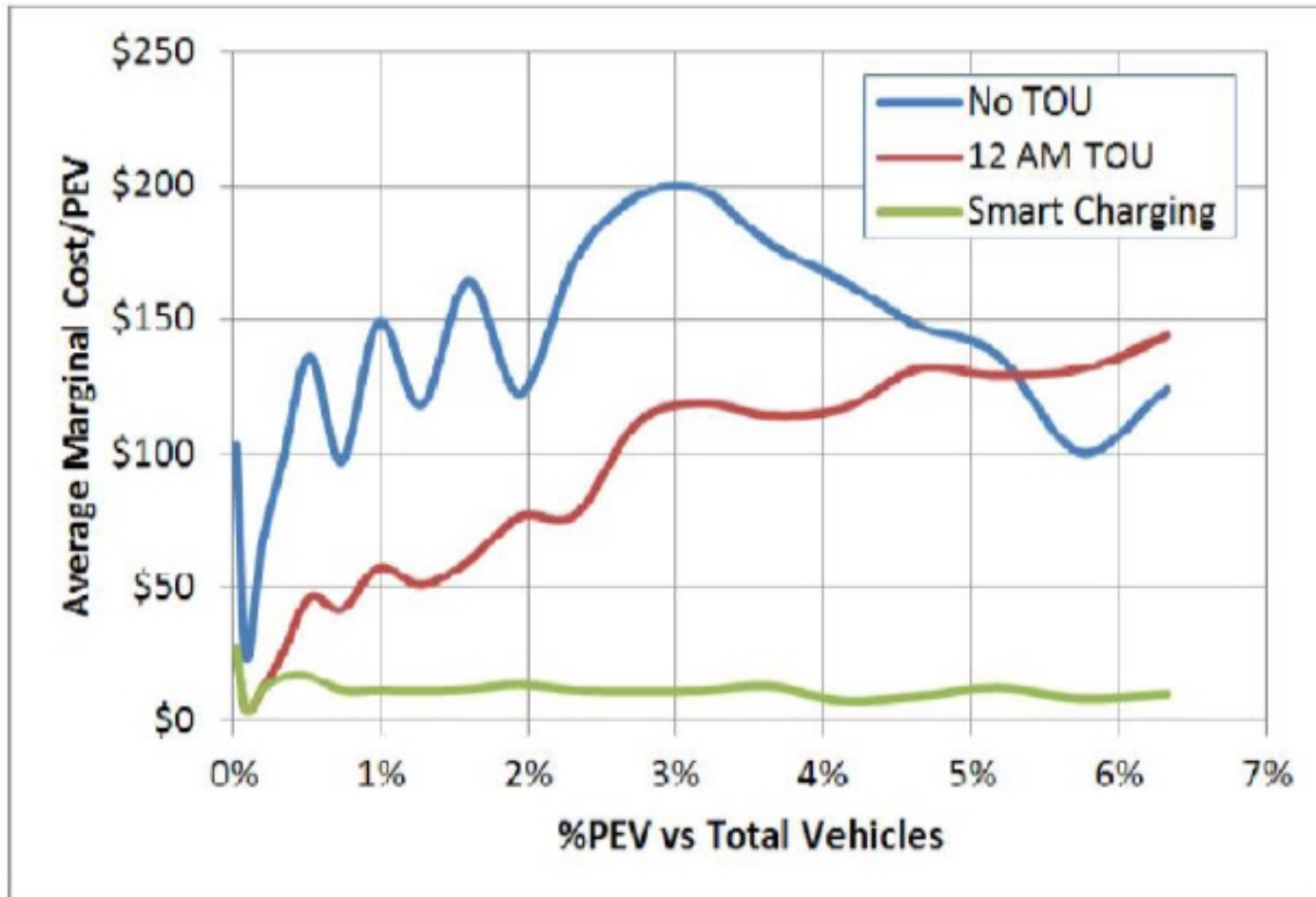
Charge When the Power is Cheap



Dallas/Ft Worth
(standard rates)



San Diego
(time-of-use rates)



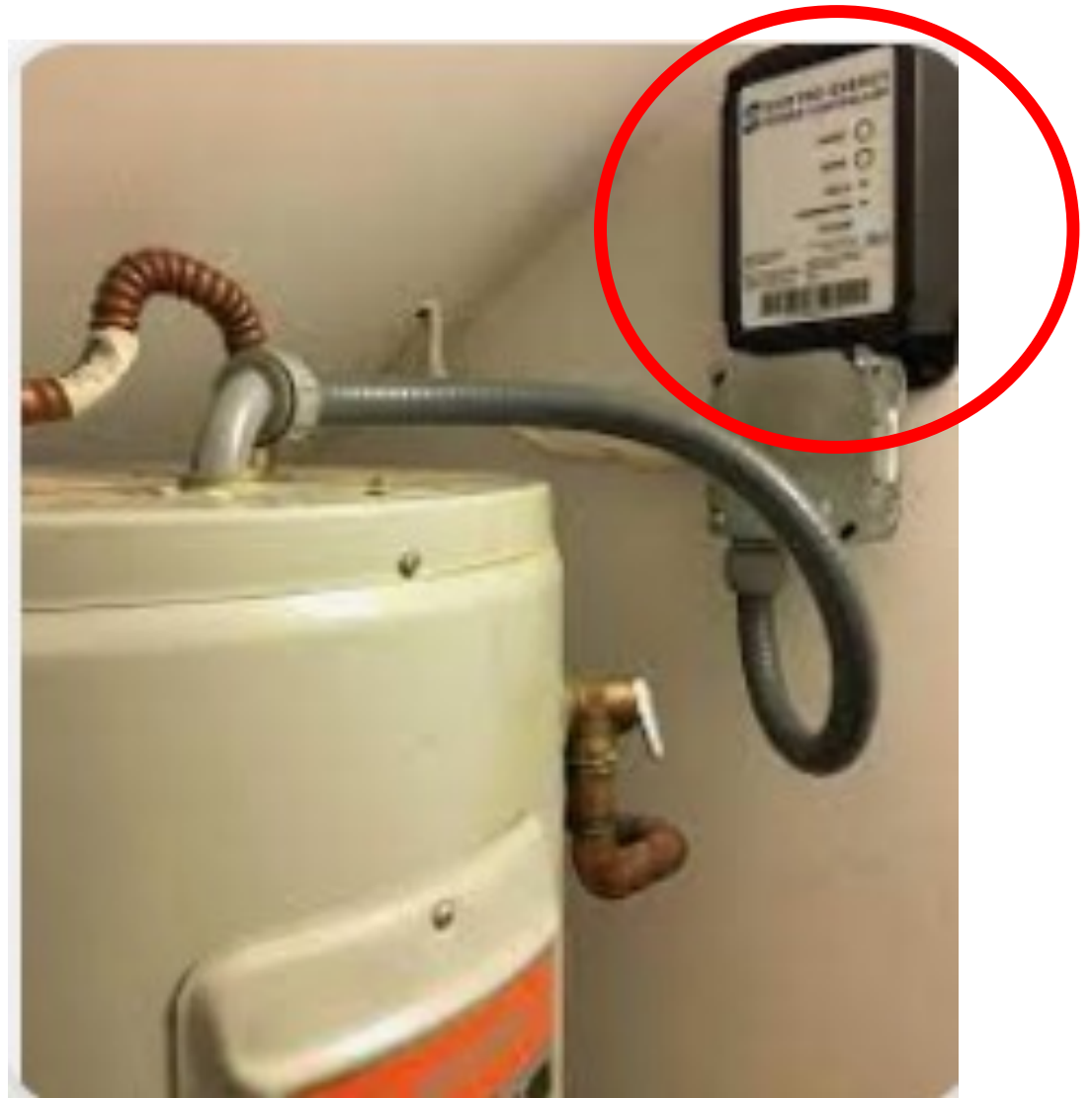
SOURCE: Berkheimer et al SAE Paper, 2014

A Water Heater is a 10 kWh Battery

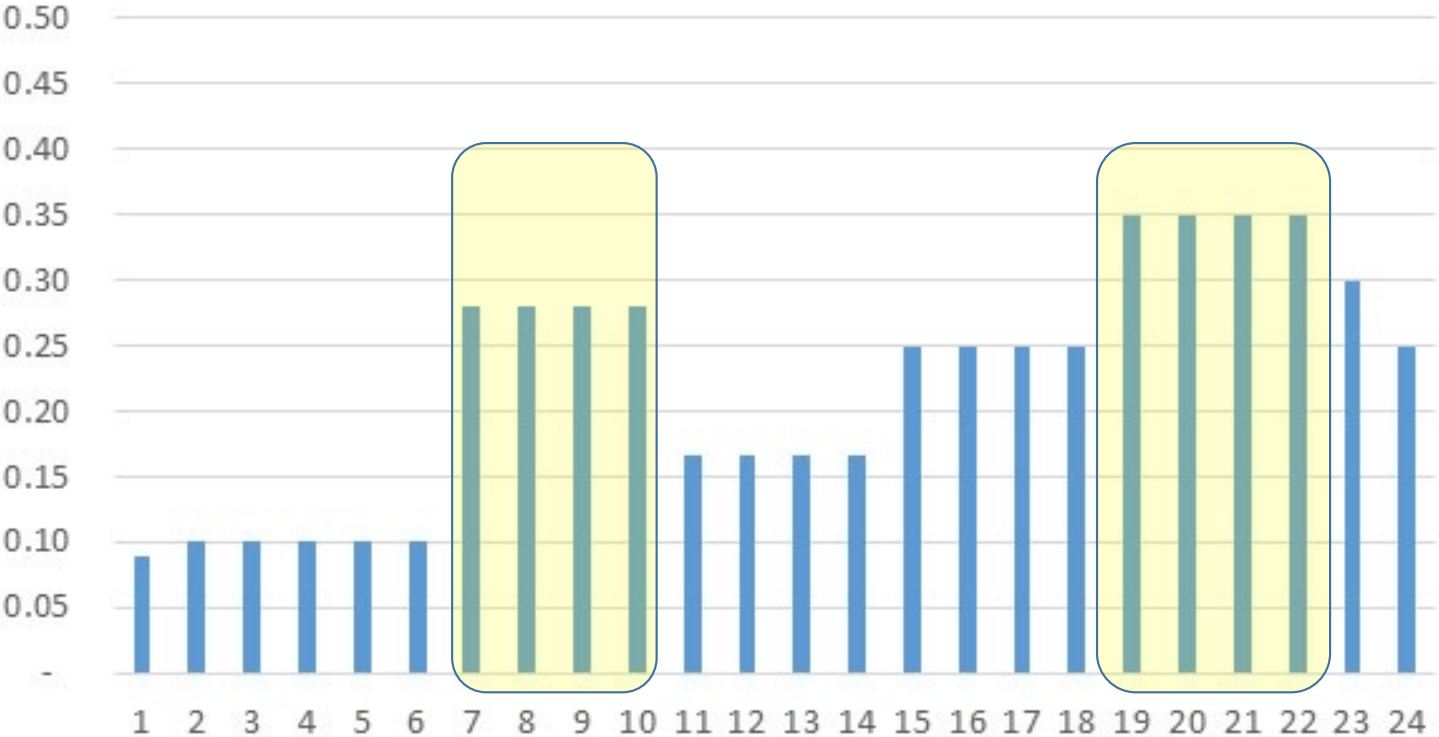
- Daily Usage:
7.5 kWh
- 52 Gallon Tank
Capacity:
10 kWh
@ 140° Max &
50° inlet water temp.



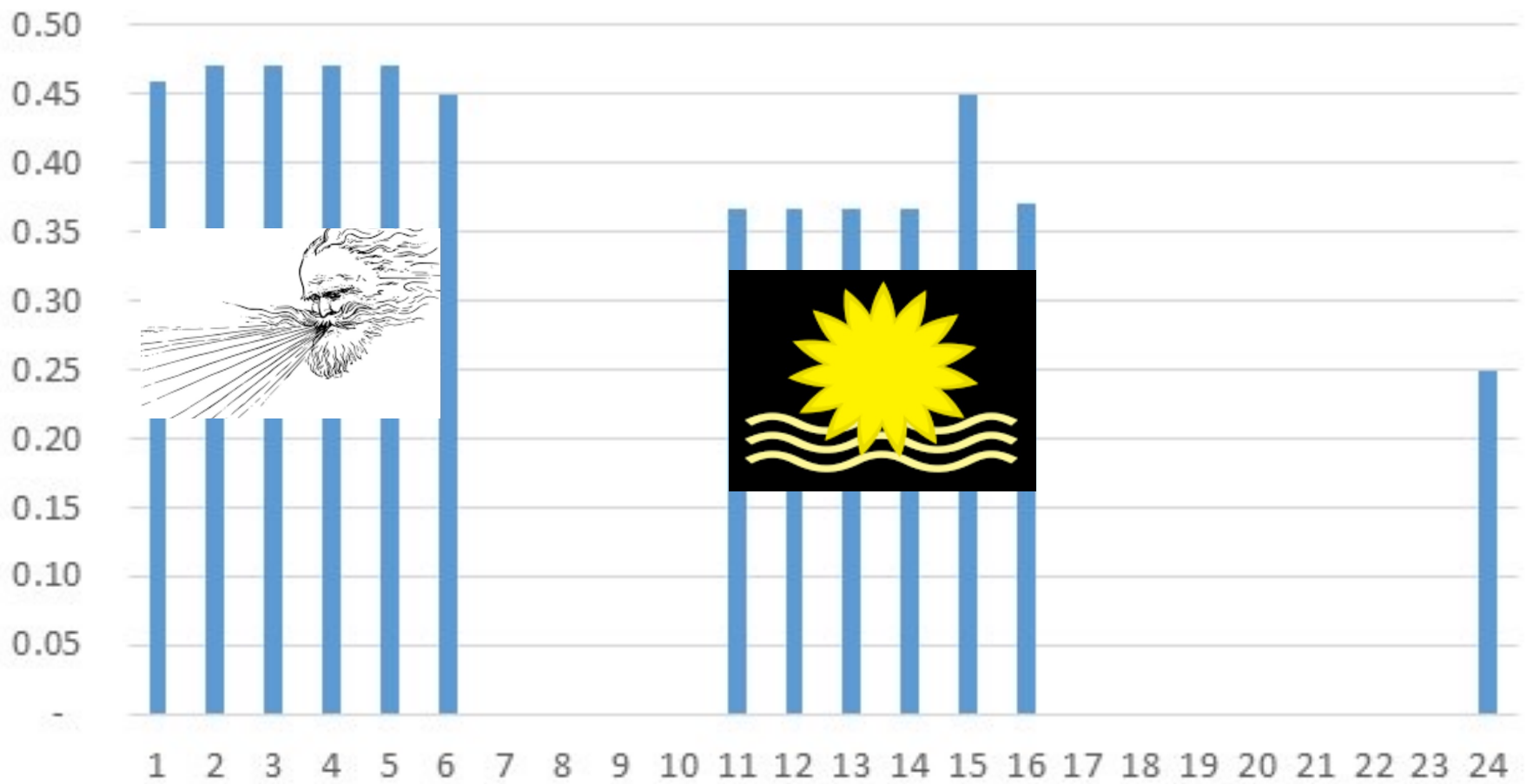
The Solution: Hot Water Heater Controls



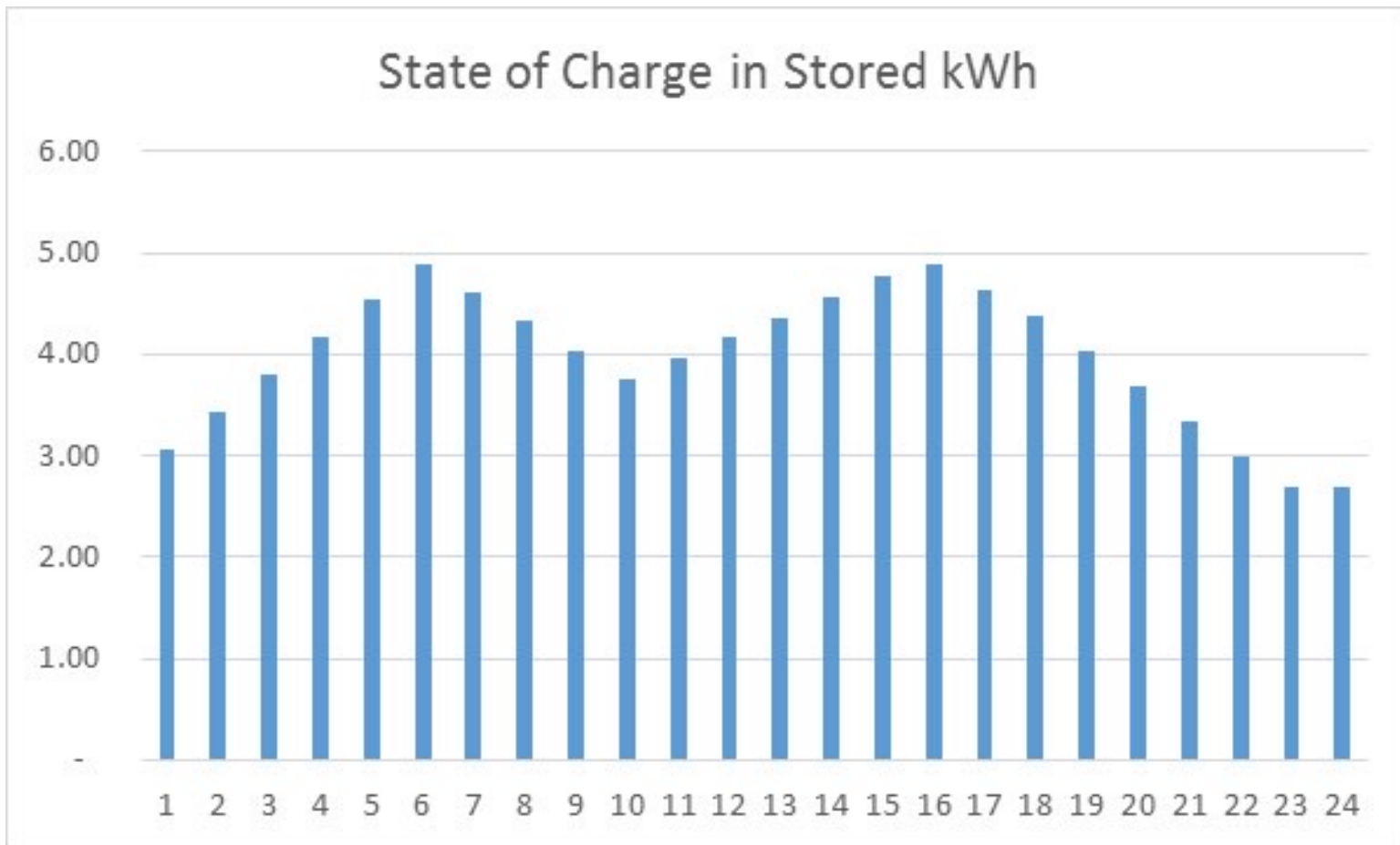
Hot Water Usage Through the Day



Hourly Controlled Charge Rate



Plenty of Hot Water When You Need It



Fort Collins Residential Rate

Combined Delivery + Power

Customer Charge		\$ 10.65
Summer Energy	Off-Peak	\$ 0.0754
	On-Peak	\$ 0.2715
Winter Energy	Off-Peak	\$ 0.0754
	On-Peak	\$ 0.2503
Tier Charge	Over 700 kWh	\$ 0.0265

Sacramento Residential Critical Peak Price

(Combined delivery + power)

- **Customer Charge:** **\$22.50**
- **Off-Peak** **\$0.115/kWh**
- **Mid-Peak** **\$0.16/kWh**
- **On-Peak** **\$0.33/kWh**
- **Critical Peak** **\$0.83/kWh**