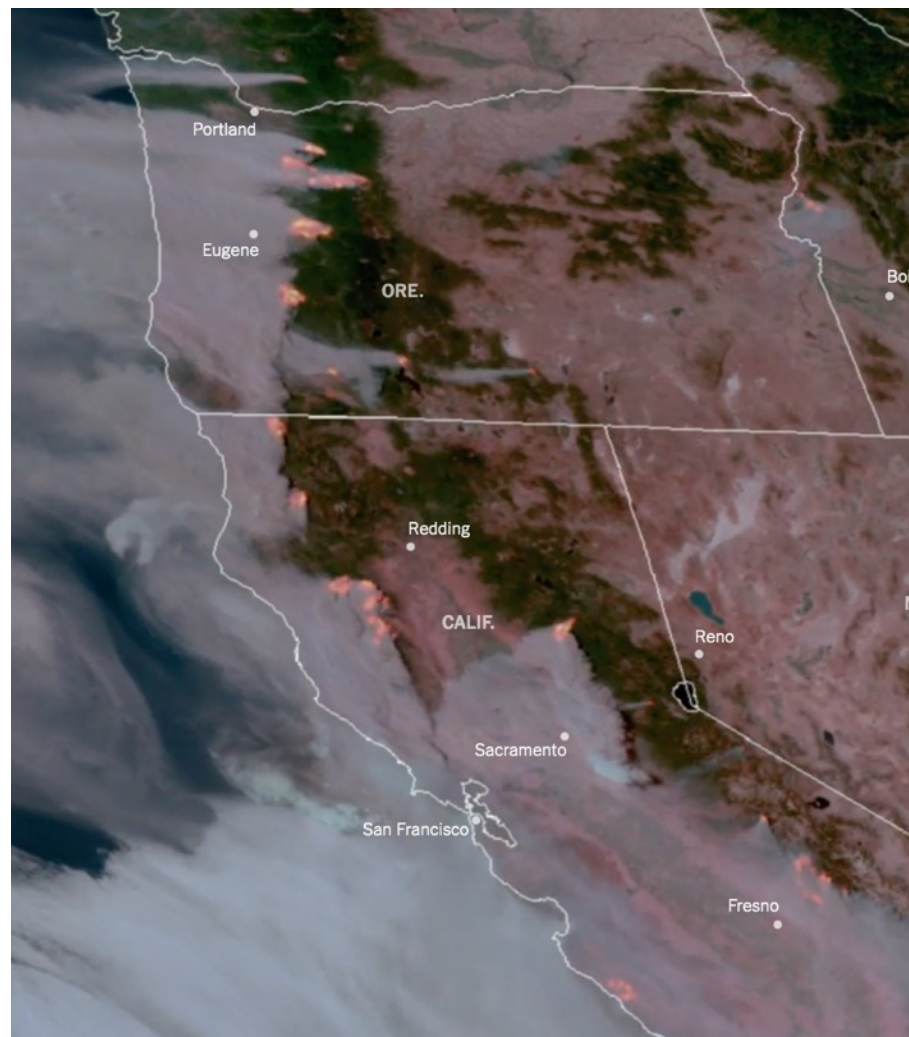


Grid problems are multiplying – solutions?

IREC Presentation – May 2022

Last year's fires mean that we need a grid that just works better

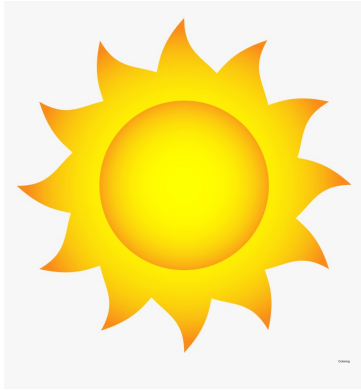
- More reliable
- More resilient
- With more renewables
- Emitting less carbon





WHAT
SHOULD
WE DO?

Connected machines that turn on and off at the right time – not the random time



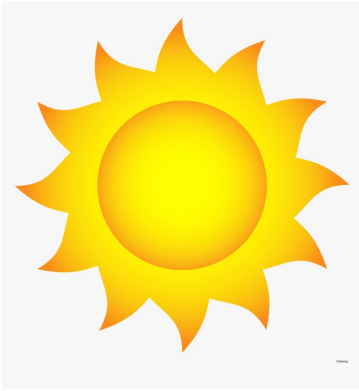
ON



OFF



With Open Standards

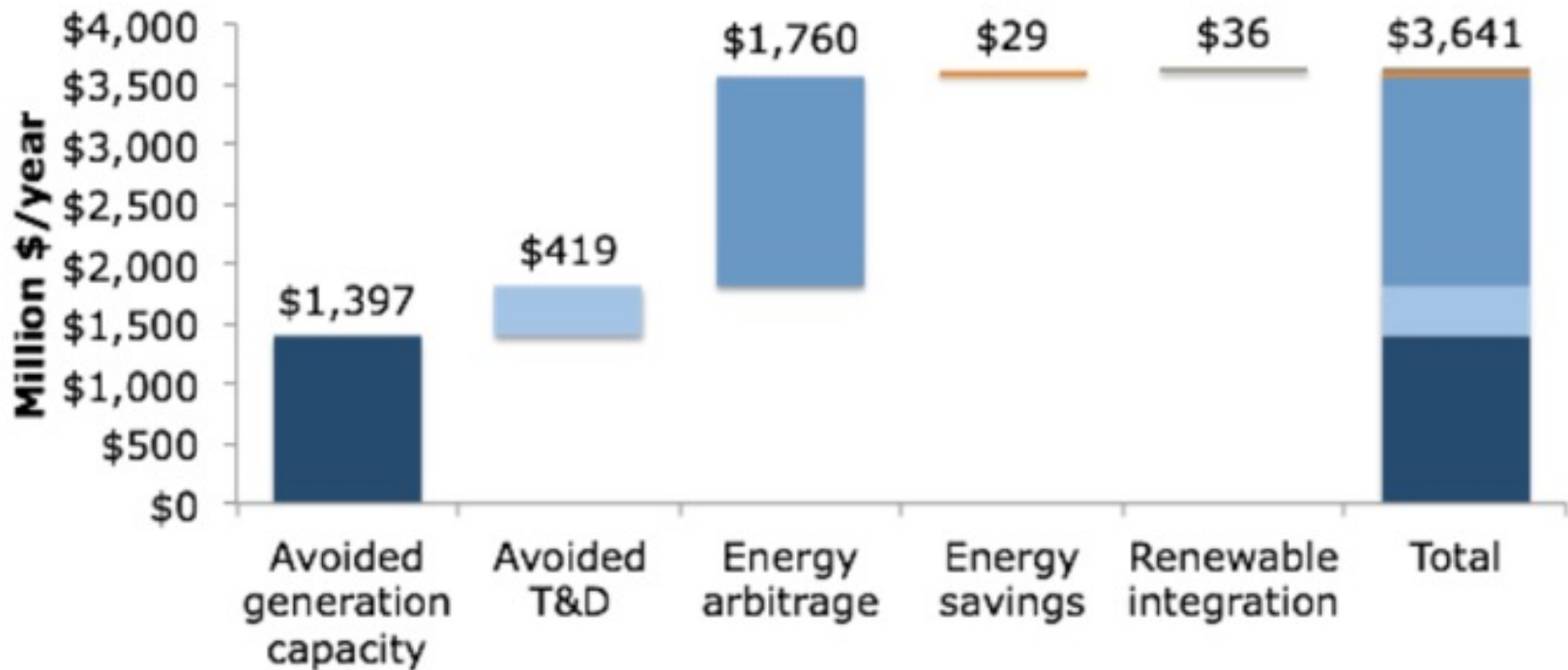


**CTA-2045-B Level 2
CERTIFIED**



What's
it
Worth?

The value of grid connected water heaters - 2018



\$3.6 billion/year in value from a grid-interactive fleet of water heaters. Source: RMI.

Based on 50M US water heaters = \$72/year/water heater, but up to \$200

Benefits to the grid (CA)



- 13M water heaters in CA
- \$10B a year in savings*
- Carbon reduction = 3.5M cars per year*
- Allows more renewables to be on the grid

Based on 13M CA water heaters = \$760 per water heater per year

* Extrapolation from “State of Charge” - Massachusetts Energy Storage Initiative Study
and

“Grid-connected Heat Pump Water Heaters:

Method to Forecast Energy Use and Extrapolate Load Shifting” – Pacific Northwest National Lab

Bonneville Power Pilot – 600 water heaters

Results: 301 MW by 2039

Market Transformation

- 5 years to ramp up
- 15 years to full replacement
- Then 15 year of operation

kW reduction

Winter AM: .33 to .47

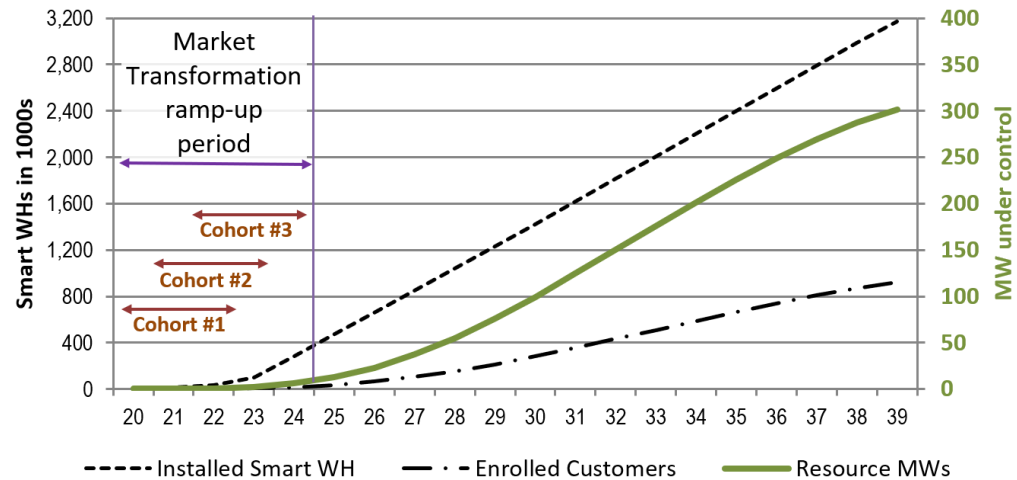
Winter PM: .27 to .44

Summer PM: .26 to .30

Economics (at 26.5% adoption)

- Regional benefit: \$230 million
- Benefit/cost ratio: 2.6

Aggregated Benefits of Market Transformation



Benefits not quantified:

- Daily energy shift
- CO₂ reduction
- Ancillary services
- Customer perception

Full report at: www.bpa.gov/goto/smartwaterheaterreport

CTA-2045 in law because of BPA study

State	Regulation	Date of Implementation	Details
WA	SB 5115 HB 1444	January 1, 2021	All new electric water heaters CTA (Heat pump 1/21, Electric resistance 1/22) 40 – 120 Gal
OR	EO 2020-04	January 1, 2022	All new electric water heaters CTA (Heat pump & Electric resistance 1/22)
Energy Star National	Connected Appliances	Pool Pumps (Pentair certified through the SkyCentrics cloud)	All Energy Star connected appliances must have OADR or CTA-2045-A or an equivalent open standard at the appliance or in the cloud.
Energy Star National	Connected Appliances	Water Heaters	Connected device specification in progress
National	AHRI 1380	2019	DR-ready Variable Capacity HVAC systems rated to 65,000 Btu/hr or less shall have CTA-2045-A or OpenADR 2.0 or both.
CA	Title 24, JA13	July 8, 2020	Requires NEEA Tier 3 v7, which requires a CTA-2045 port (New Construction)

Grid-Interactive Efficient Buildings (GEBs) could save up to \$18 billion per year in power system costs by 2030, or roughly \$100 to \$200 billion between 2020 and 2040

...but less than 2% of commercial buildings are connected!

GEBs are characterized by active, continuous, and integrated energy use

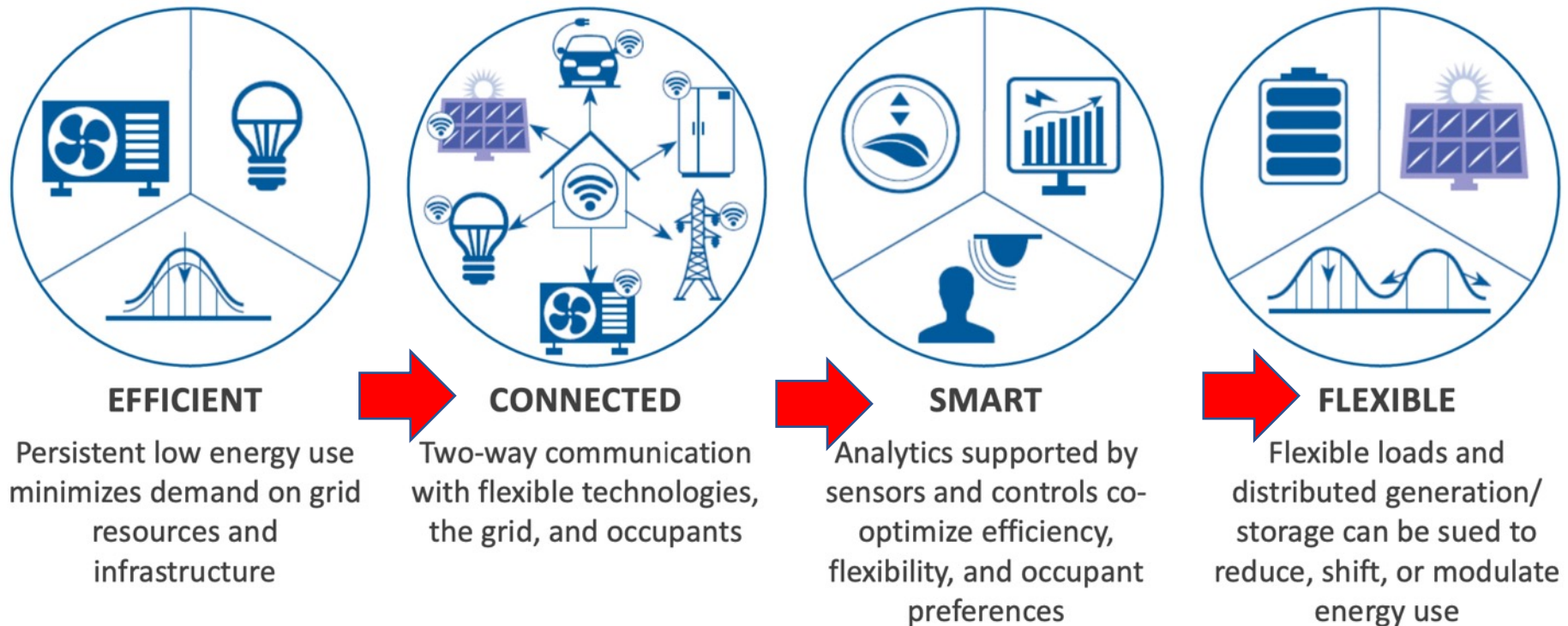


Figure source: Neukomm et al. (2019). Grid-interactive Efficient Buildings: Overview. US DOE Report.

A National Roadmap for Grid-Interactive Efficient Buildings

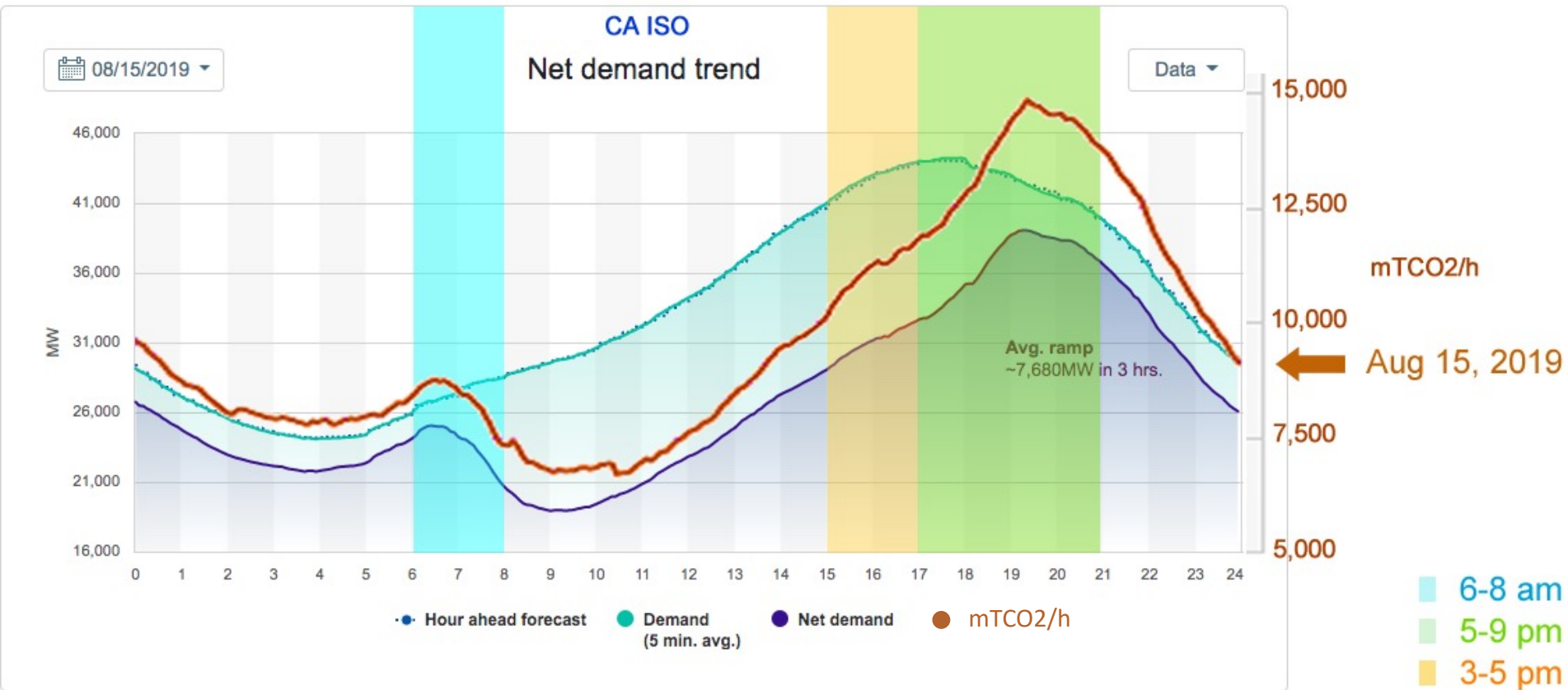
Source = A National Roadmap for Grid-Interactive Efficient Buildings - gebroadmap.lbl.gov

Why Water Heaters?

Aug' 19 CO2 mapped onto CA ISO Net Demand

Net demand (demand minus solar and wind) AS OF 15:20

This graph illustrates how the ISO meets demand while managing the quickly changing ramp rates of variable energy resources, such as solar and wind. Learn how the ISO maintains reliability while maximizing clean energy sources.

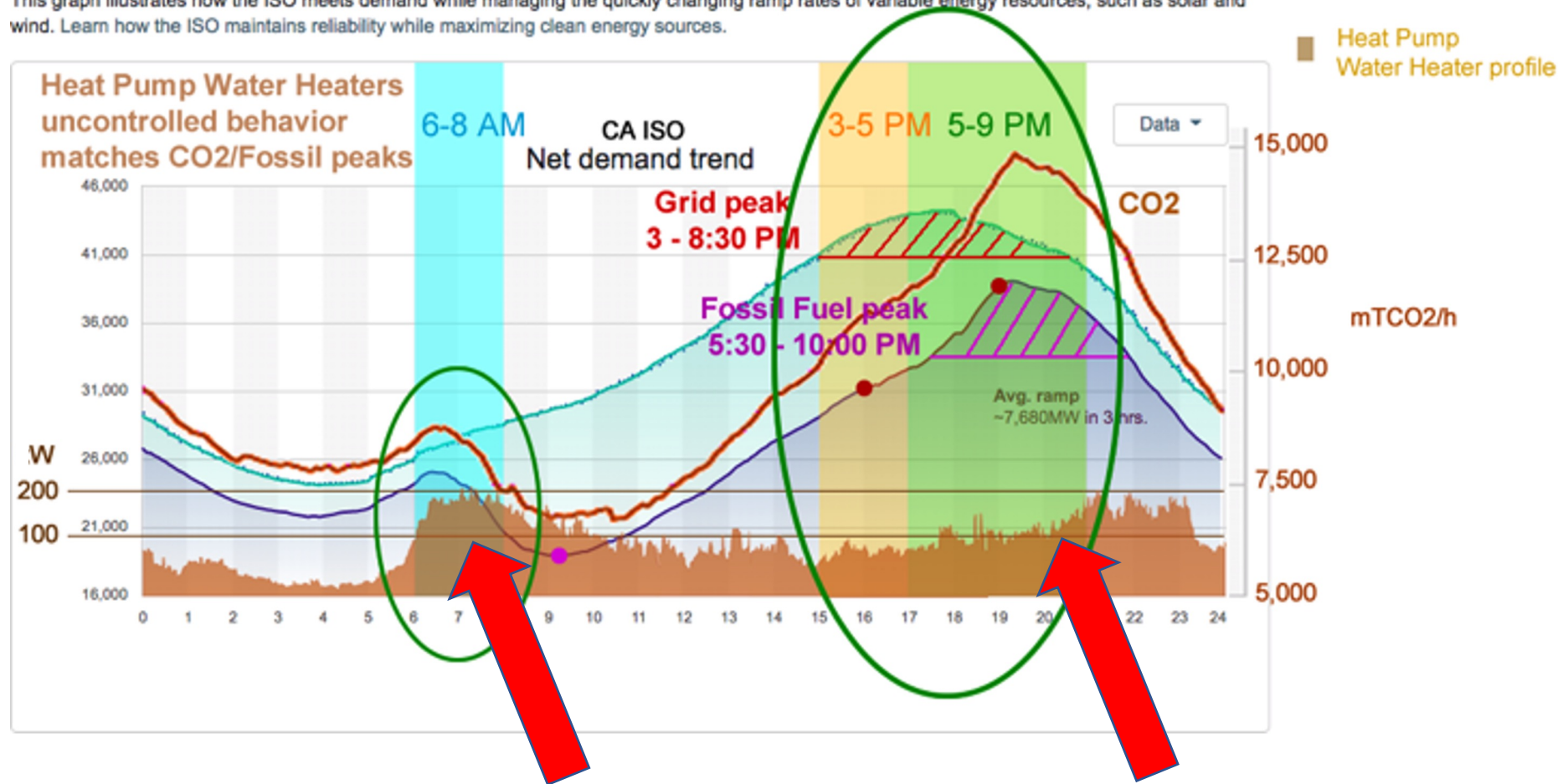


Note how the CO2 curve matches the Net Demand Curve

Business case for connected heat pumps

Net demand (demand minus solar and wind) AS OF 15:20

This graph illustrates how the ISO meets demand while managing the quickly changing ramp rates of variable energy resources, such as solar and wind. Learn how the ISO maintains reliability while maximizing clean energy sources.

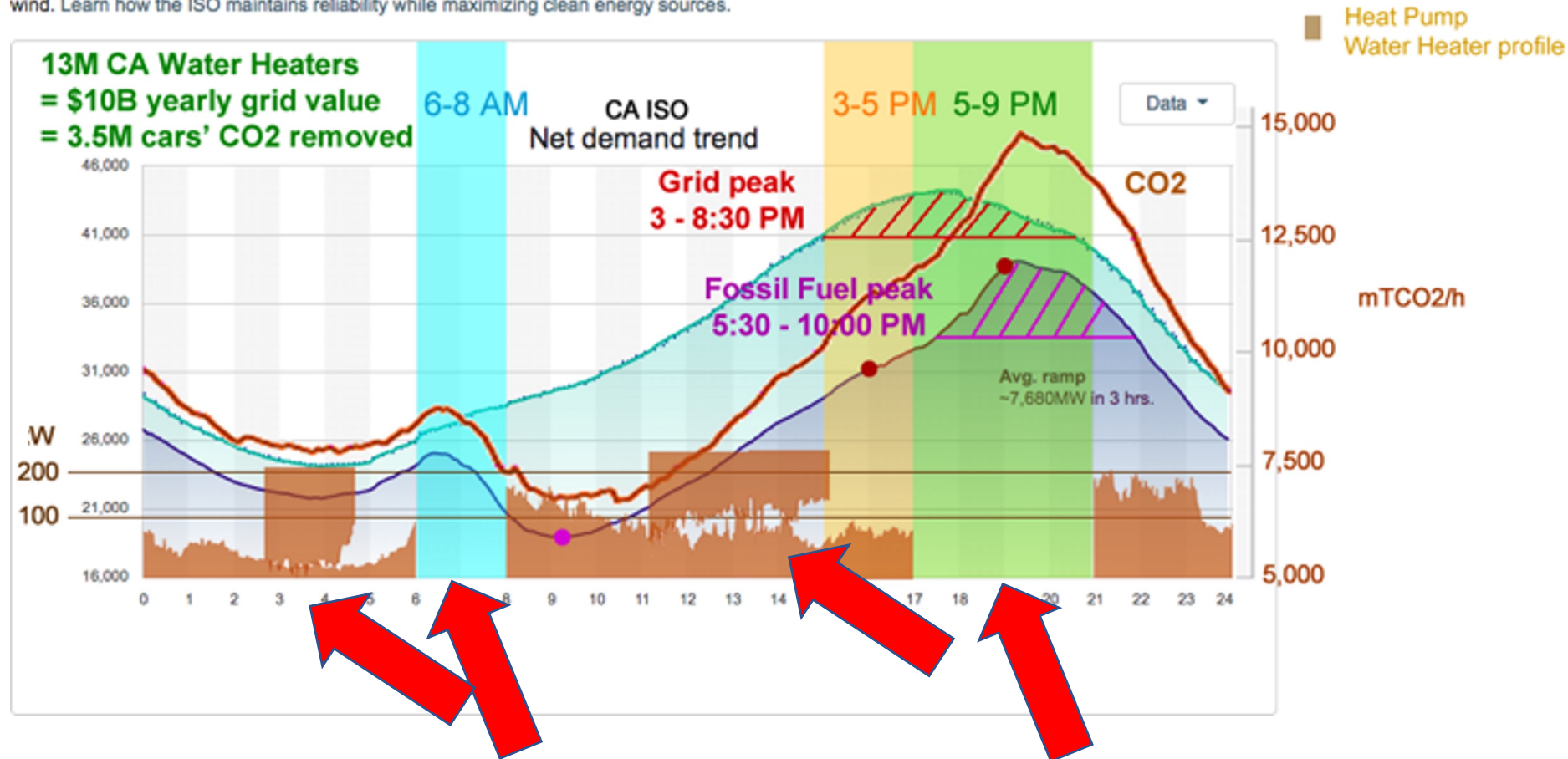


Note how the water heater peaks match the grid peaks.

Shed, Shift, Shape, and Shimmy

Net demand (demand minus solar and wind) AS OF 15:20

This graph illustrates how the ISO meets demand while managing the quickly changing ramp rates of variable energy resources, such as solar and wind. Learn how the ISO maintains reliability while maximizing clean energy sources.

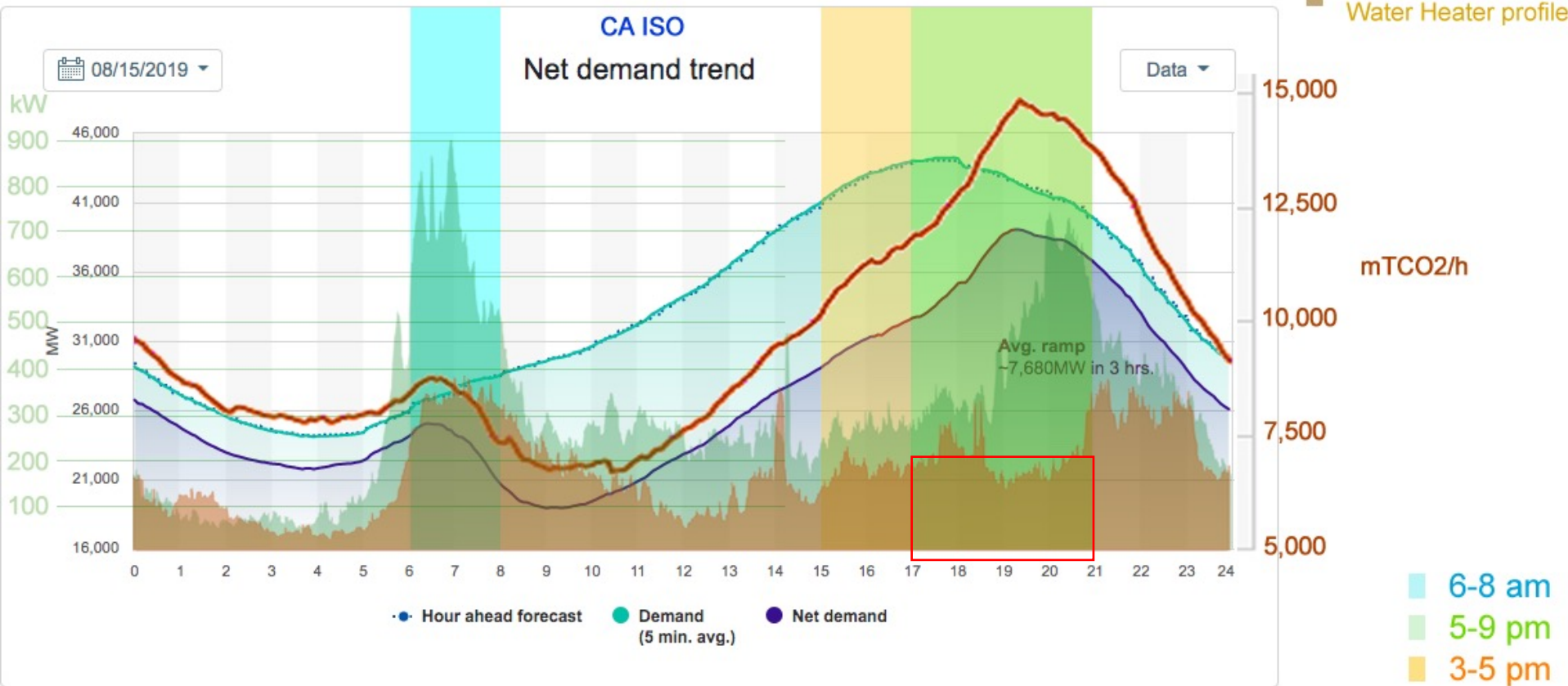


You can get almost 100% of the load shifted to a better time.

Net Demand, CO2 and water heater profiles

Net demand (demand minus solar and wind) AS OF 15:20

This graph illustrates how the ISO meets demand while managing the quickly changing ramp rates of variable energy resources, such as solar and wind. Learn how the ISO maintains reliability while maximizing clean energy sources.

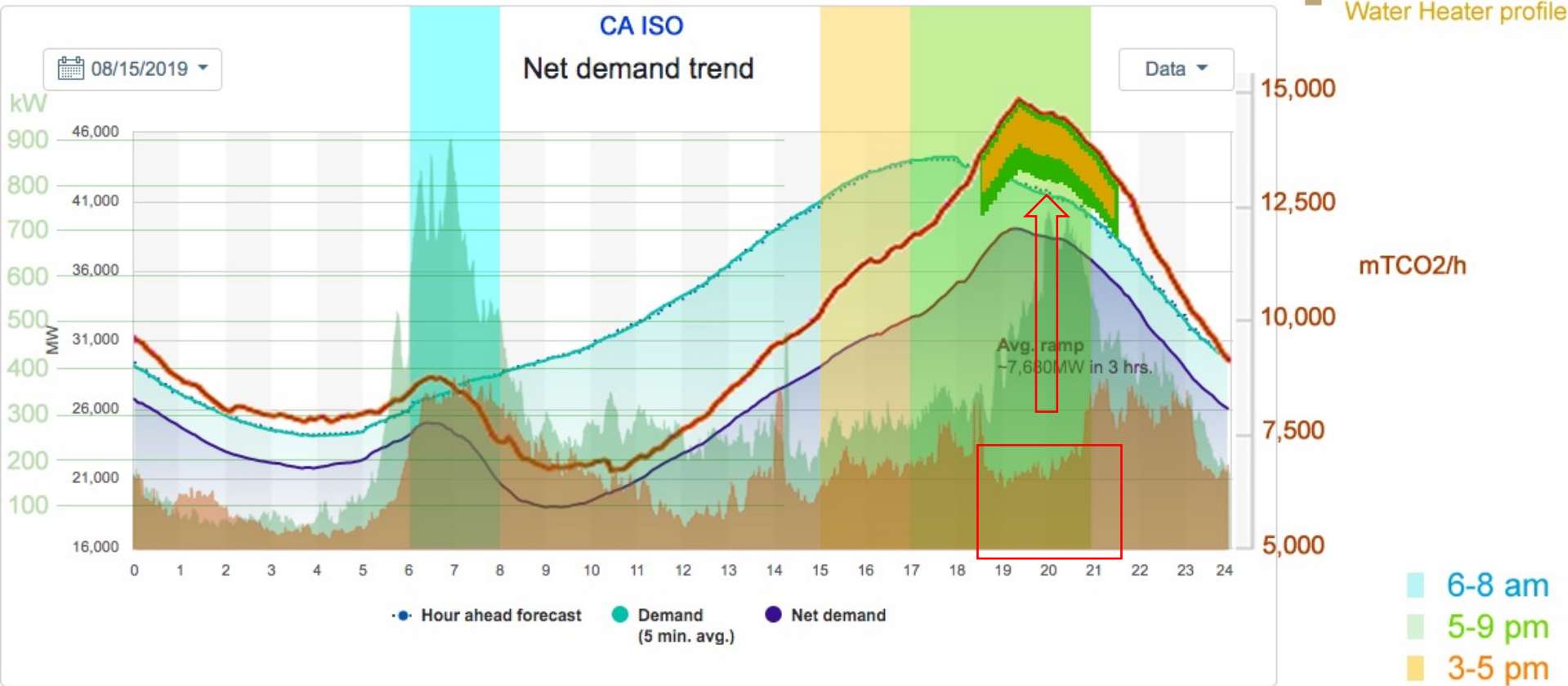


Heat Pump water heaters use about 0.8 kWh between 5-9 pm (see red box)
13M would use 2.6 GW every hour or a total of 10.4 GWh
During that time, the grid consumes about 42 GW every hour (42,000 MW)
13M water heaters would account for about 6% of the demand.

13M HP Water heaters reducing CO2 by 6%

Net demand (demand minus solar and wind) AS OF 15:20

This graph illustrates how the ISO meets demand while managing the quickly changing ramp rates of variable energy resources, such as solar and wind. Learn how the ISO maintains reliability while maximizing clean energy sources.



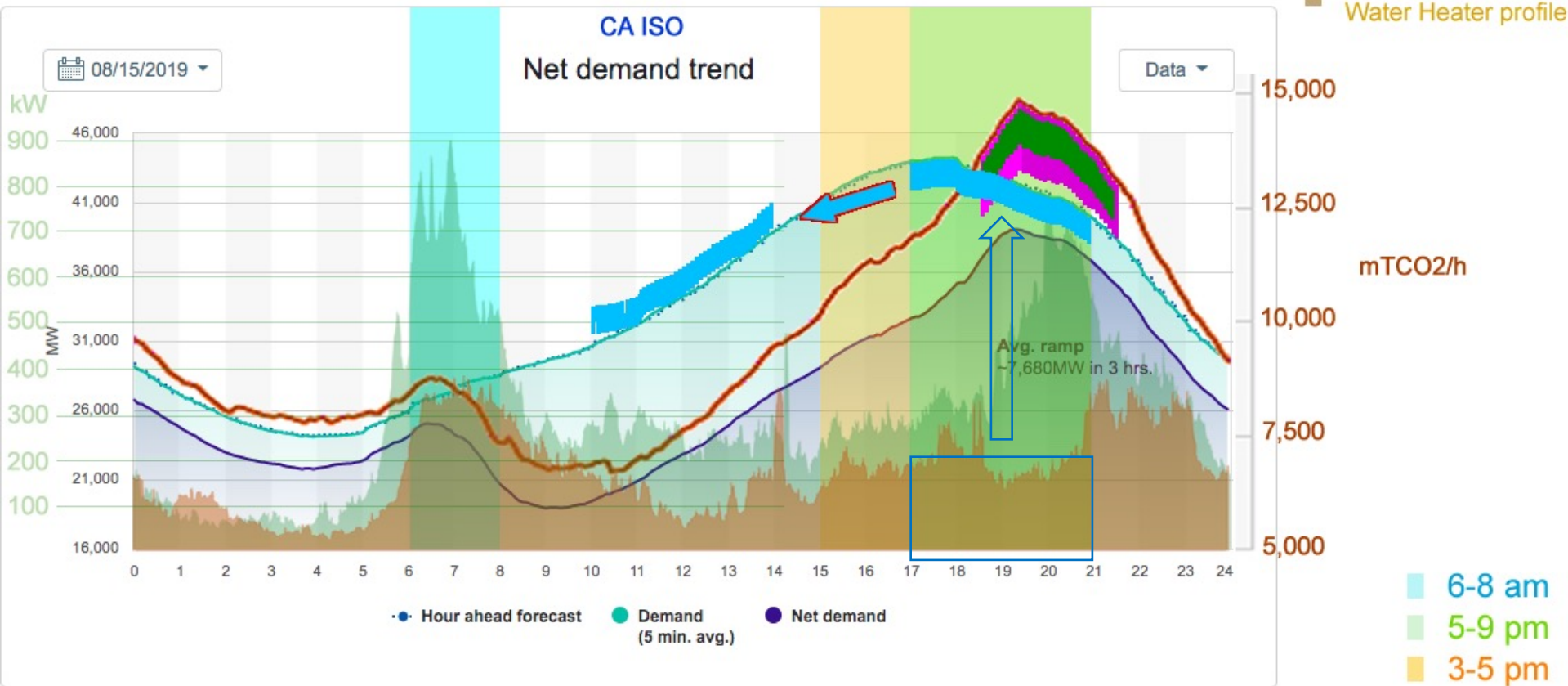
The orange is what 13M heat pump water heaters could do to reduce CO2 (6%)
The dark green area is what 13M electric resistance water heaters could do (14%)
Removing 6% of CO2 in one day is about 20,000 mTCO2 per day*

* Since 95% of CA water heaters are gas, their electrification would add to these graphs, but then time shifting them would not add to the peak.

13M HP Water heaters reducing peak by 6%

Net demand (demand minus solar and wind) AS OF 15:20

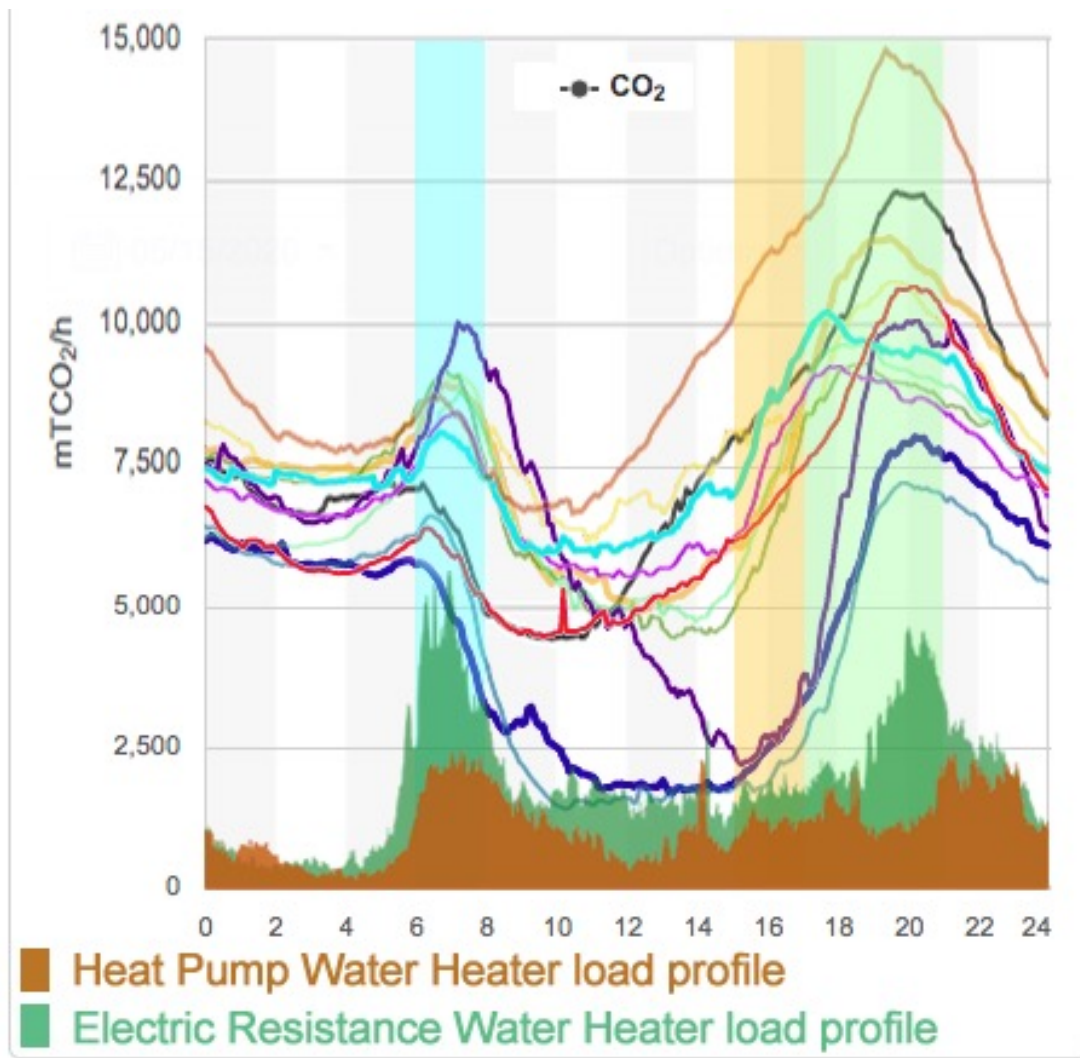
This graph illustrates how the ISO meets demand while managing the quickly changing ramp rates of variable energy resources, such as solar and wind. Learn how the ISO maintains reliability while maximizing clean energy sources.



The blue area is what could be time shifted to earlier in the day, saving 6% of peak.

* Since 95% of CA water heaters are gas, their electrification would add to these graphs, but then time shifting them would not add to the peak.

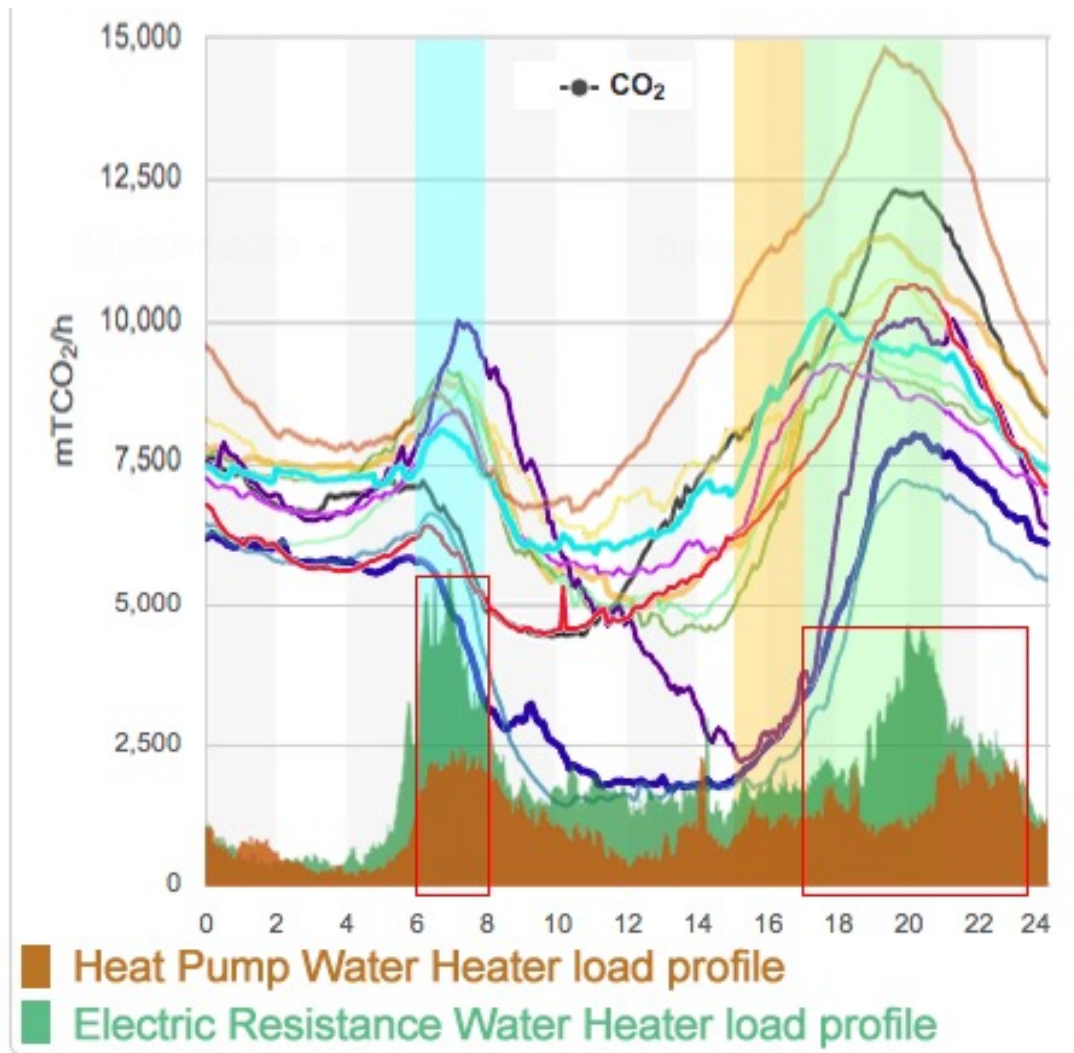
CA ISO CO2 emissions with water heaters



Jun 10, 2020
May 15, 2020
Apr 15, 2020
Mar 13, 2020
Feb 14, 2020
Jan 15, 2020
Dec 13, 2019
Nov 15, 2019
Oct 15, 2019
Sep 16, 2019
Aug 15, 2019
Jul 15, 2019

6-8 am
5-9 pm
3-5 pm

CO2 and water heaters align



Jun 10, 2020
May 15, 2020
Apr 15, 2020
Mar 13, 2020
Feb 14, 2020
Jan 15, 2020
Dec 13, 2019
Nov 15, 2019
Oct 15, 2019
Sep 16, 2019
Aug 15, 2019
Jul 15, 2019

6-8 am
5-9 pm
3-5 pm

If it is worth so much
then why aren't we
doing it?

First a quick detour
showing CTA-2045 and
OpenADR solutions

CTA-2045 **ECOPORT** appliance family



Hot Water
Heaters



Pool Pumps



PTACs



EV Chargers



Heat Pump HVAC
Mini-splits

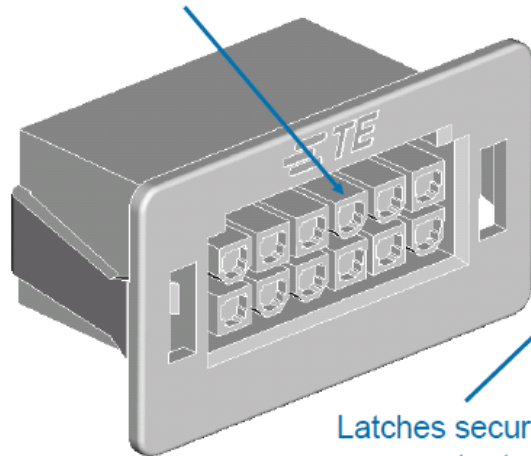


CTA-2045 Standard –
a 'USB port' for appliances

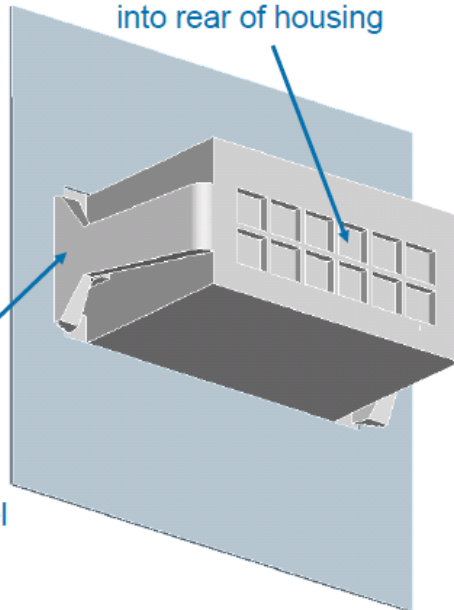
ECOPORT

AC Powered slot and module

Contacts protected from finger probe by housing silos



Crimped contacts inserted into rear of housing



Latches secure connector to panel
Width increased to prevent rocking



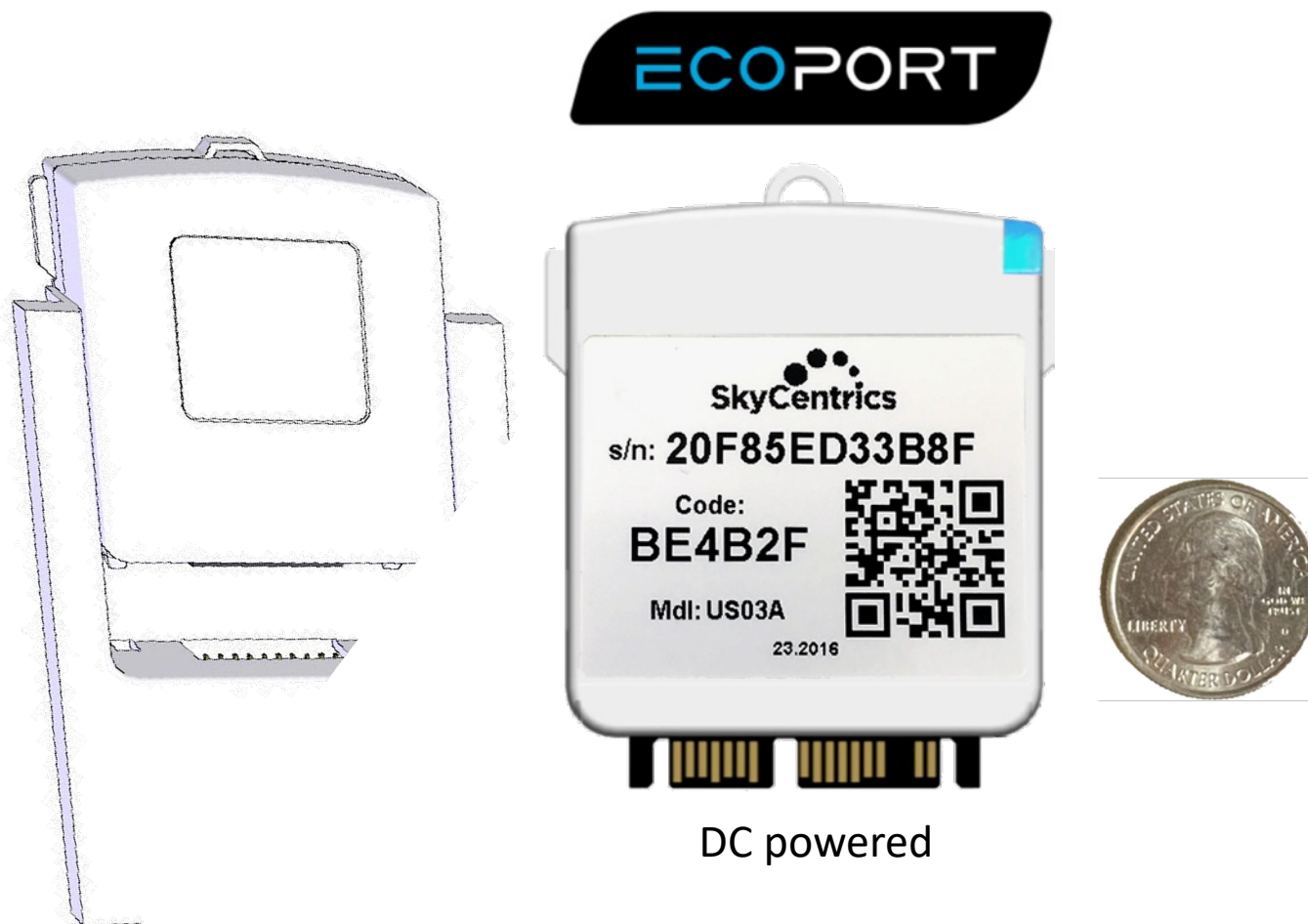
US quarter

ECOPORT



AC powered

DC Powered slot and module



CTA-2045 **ecoPORT** appliance family

SkyCentrics AC Powered USNAP module World's First UL 916 certified module

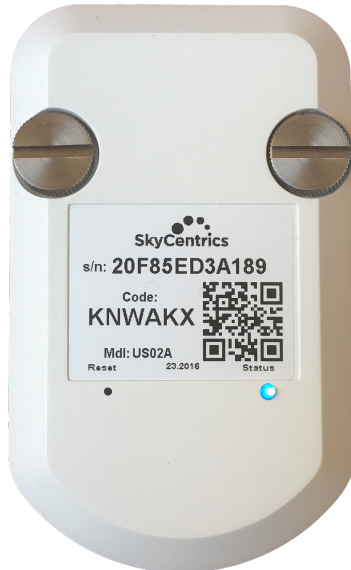


SkyCentrics DC Powered USNAP module



AO Smith – Electric Resistance Water Heater	Siemens EVSE Car Charger
AO Smith – Heat Pump Water Heater (HPWH)	Mitsubishi Mini-Splits
IslandAire PTAC HVAC units	GE Appliances – Heat Pump Water Heater
Pentair IntelliConnect Pool Pump Controllers	Bradford White – Heat Pump Water Heater
Rheem – Heat Pump Water Heater	Nyles – Water Heater (110V heat pump)
Mitsubishi AQHV – Central System HPWH	Emerson 30 Amp Water Heater Switch
Mitsubishi VRF	Emerson Thermostat

ECOPOINT communication paths available (security)



FM Radio (e-Radio)

SkySnap – OpenADR Gateway



SkySnap Features

- OpenADR
- Secure Sandbox for 3rd Party Apps
- Cal Flex Hub Flexible Load Gateway
 - New Features to be added
- Can provide on premise (local) data storage and web app access
- 2 relays
- 2 dimmers
- Modbus/Bacnet/MQTT



Installation of Rooftop Skid



Retrofit kit = both OpenADR & EcoPort

ECOPORT

openADR™ 2.0b
CERTIFIED

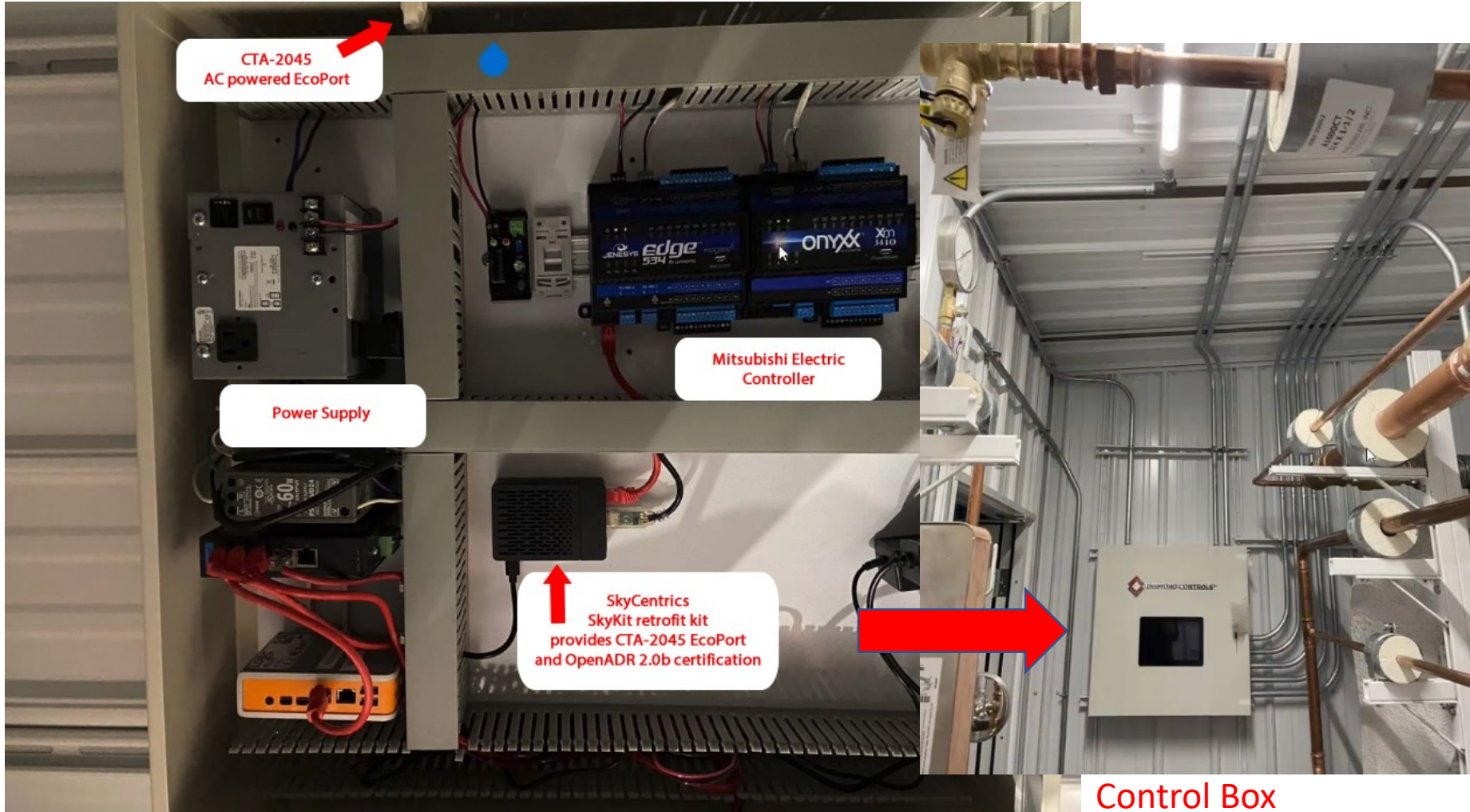
CTA-2045
AC powered EcoPort

Power Supply

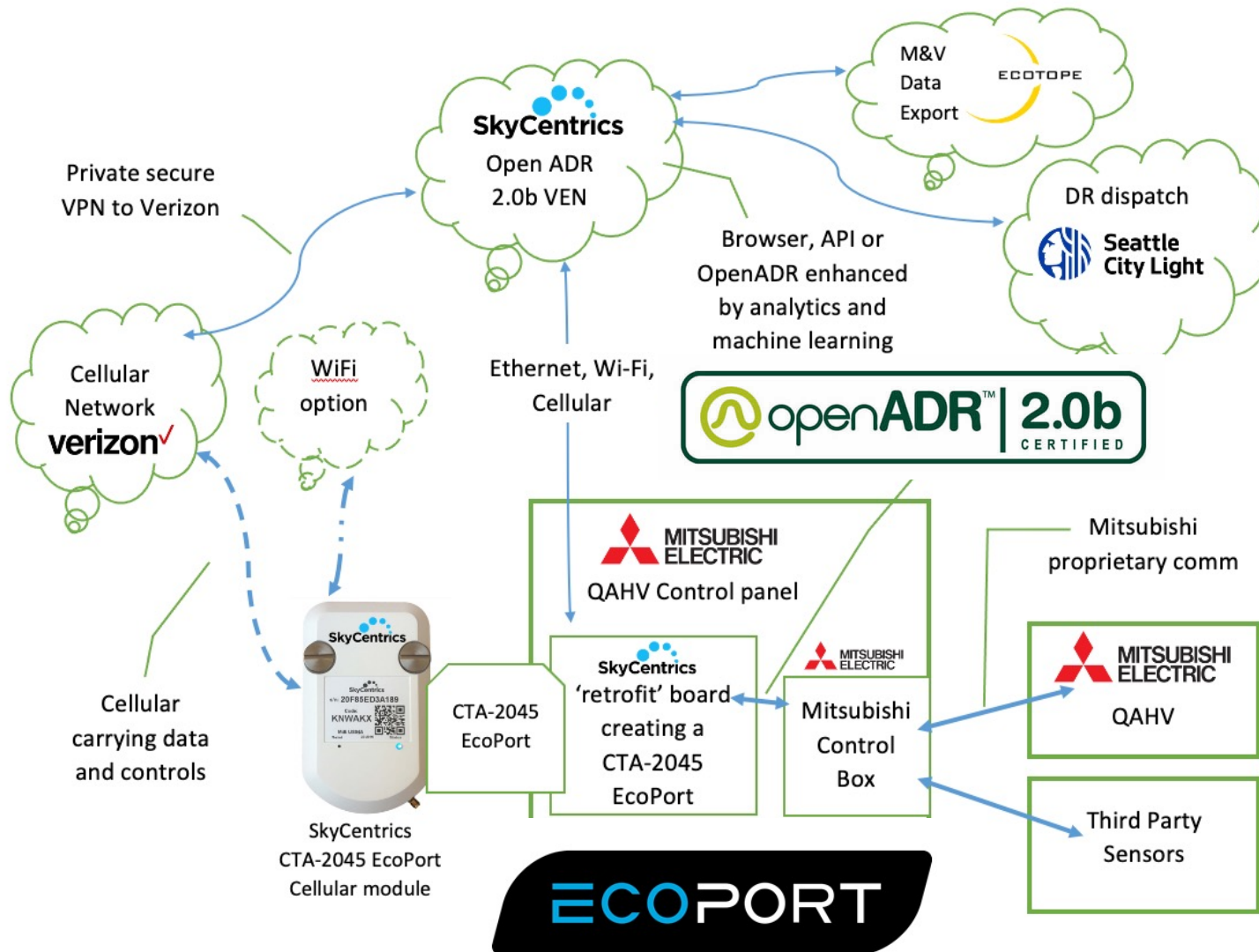
Mitsubishi Electric
Controller

SkyCentrics
SkyKit retrofit kit
provides CTA-2045 EcoPort
and OpenADR 2.0b certification

Control Box



SkyKit – OEMs get OADR & ECOPORT



The variety of grid benefits by different appliance types

CTA-2045 **ECOPORT** appliance family



Pool Pumps



EV Chargers

Load Shifting

- Stores hot water for 8 hours
- Can Load Up
- Can Advanced Load Up and store more

Load Shaping-Frequency Response

- Variable Power between 0-100%
- Frequency Response Possible –
No damage to product from rapid changes

Water Heater Event Behavior

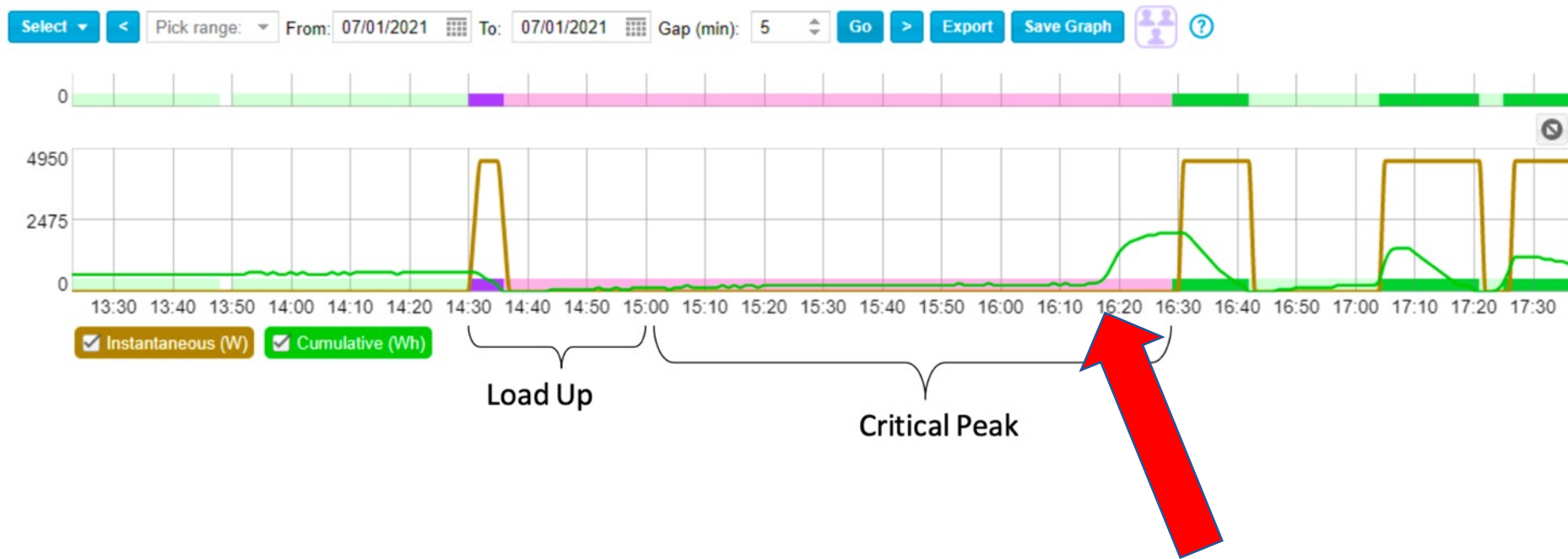
Color should be
light purple
when power is off
during load up

Zoom in on chart
LOAD SHIFTING SHOW a normal
graph



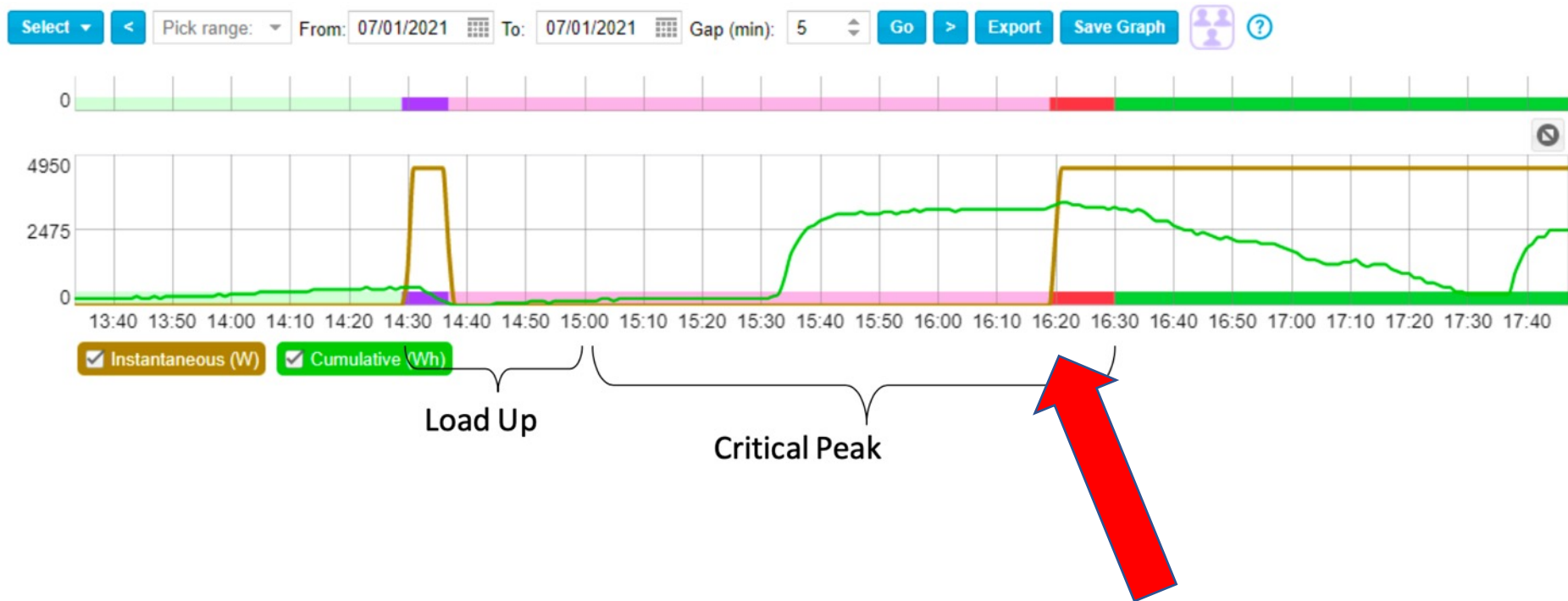
**Most common response
no power used during event**

Water Heater Event Behavior



**No power used during event
but water was drawn**

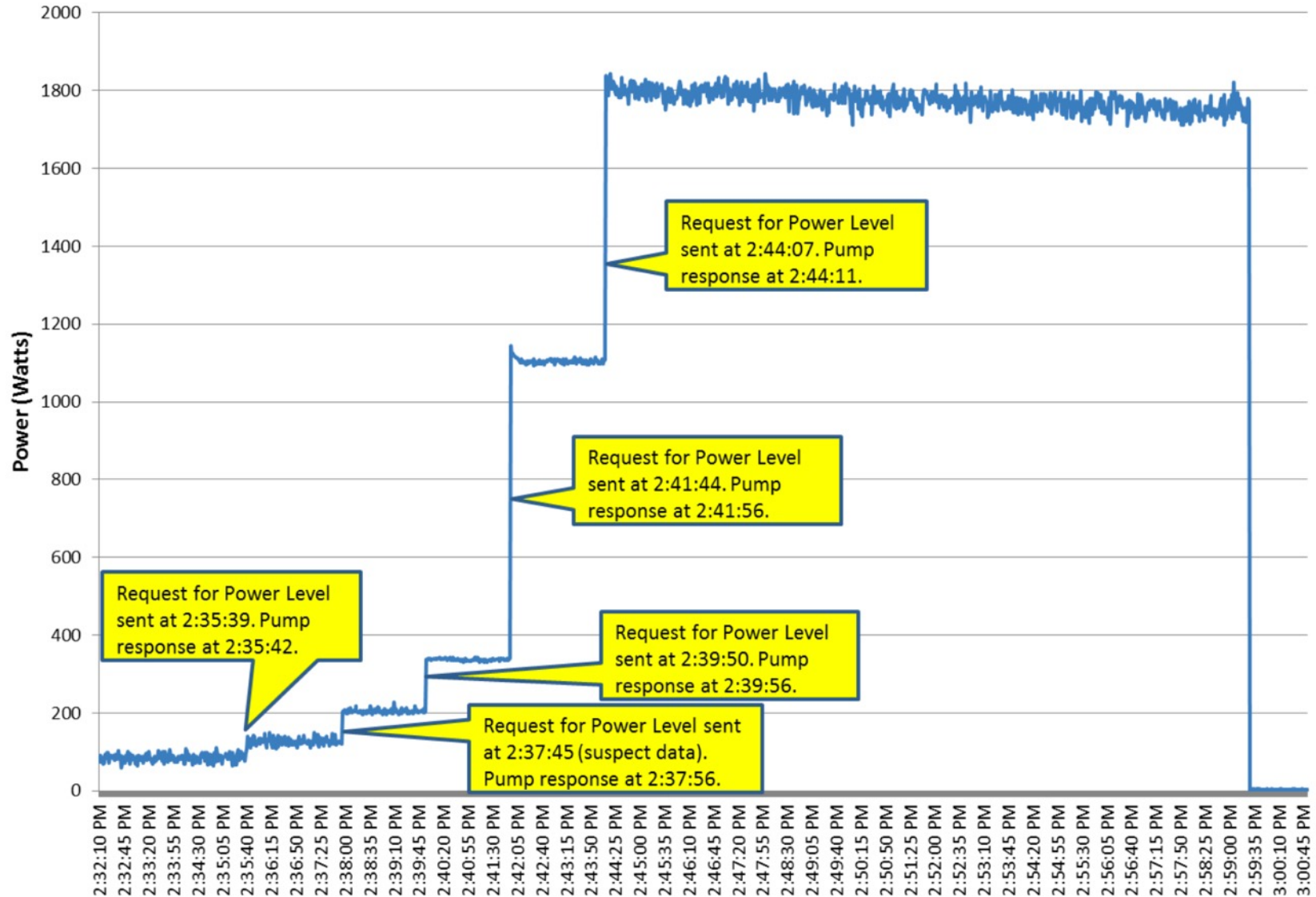
Water Heater Event Smart Behavior



**Power used near end of event
to prevent cold water event**

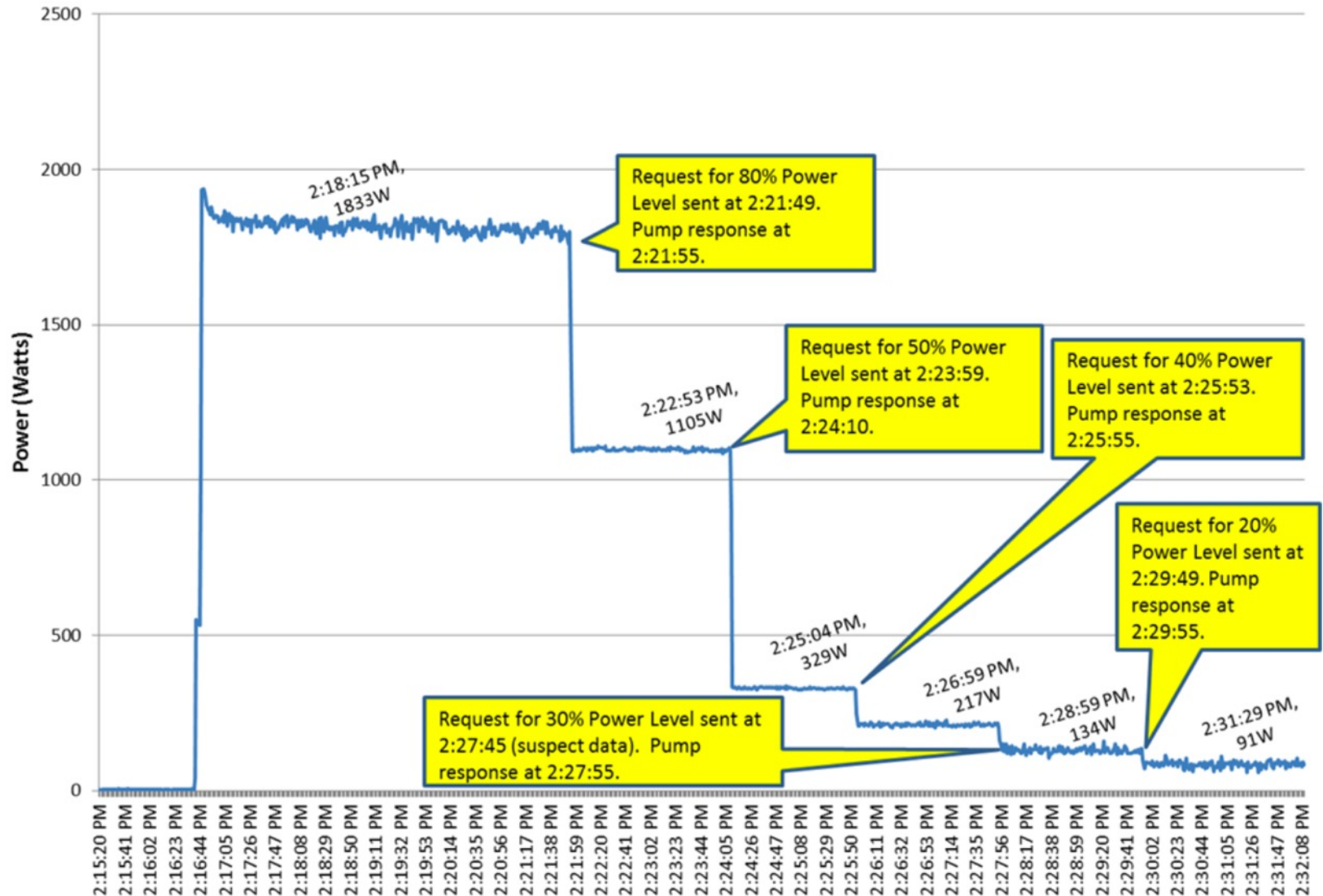
Variable Speed Pool Pump Event Behavior

EcoPort Power Level signals sent to increase the speed 0-100%

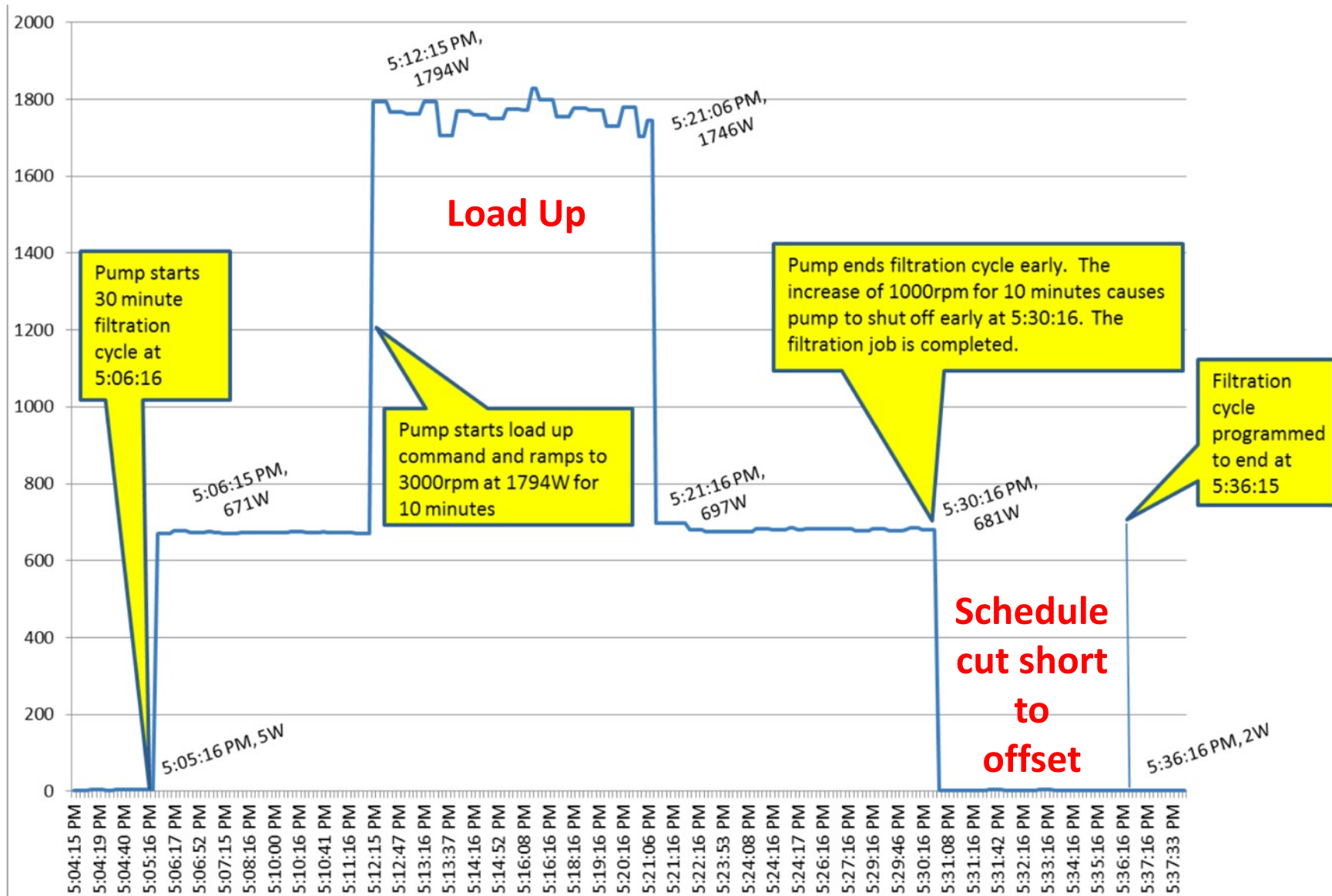


Variable Speed Pool Pump Event Behavior

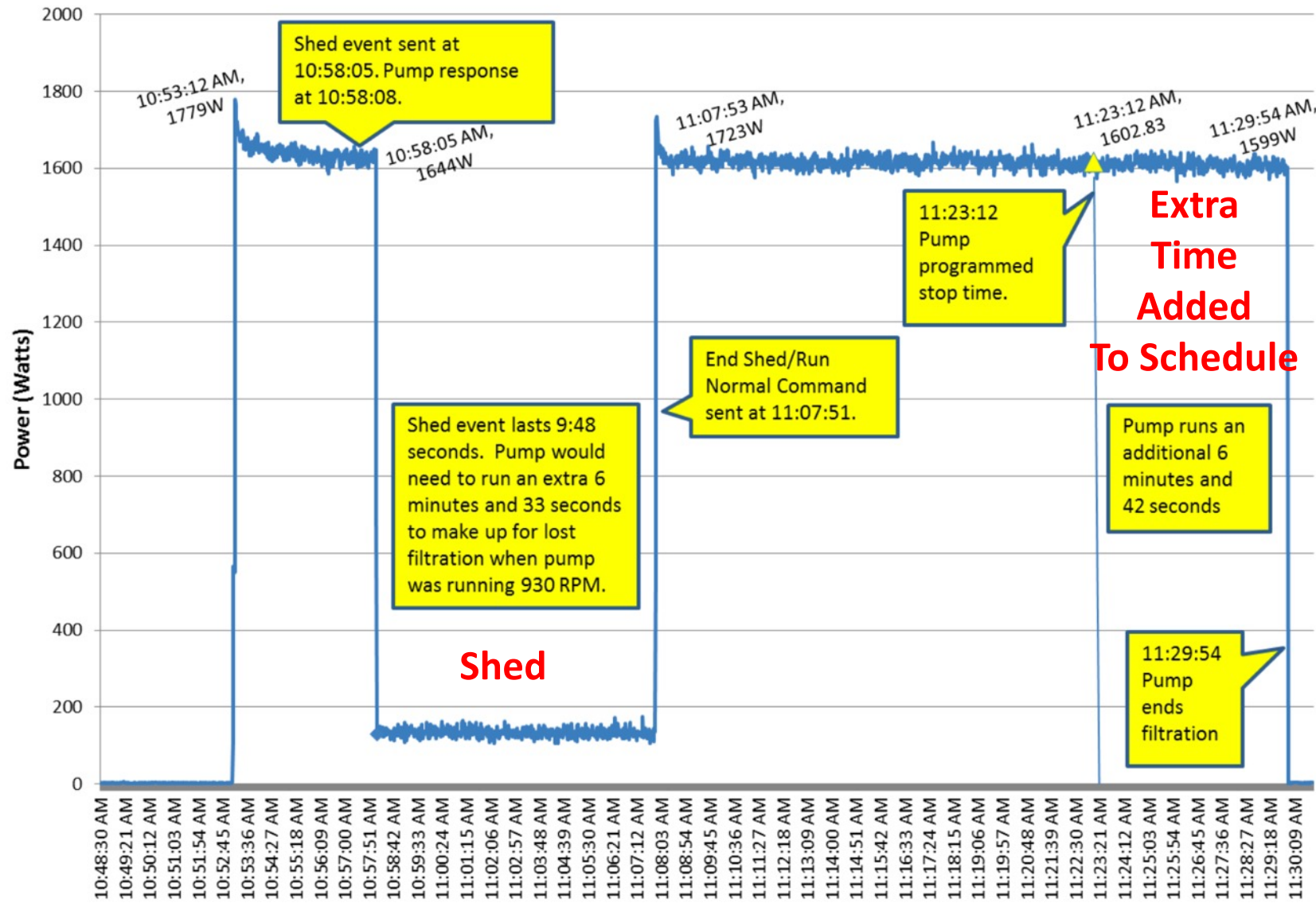
EcoPort Power Level signals sent to decrease the speed 0-100%



Pool Pump SMART Event Behavior



Pool Pump SMART Event Behavior



Navigant Cost-effectiveness of DR for Residential End-Uses

0.1 kW
per heat pump
Water heater

Table 2. Potential Unit Impacts¹¹ Based on Literature Review and End-Use Metering

Appliances	Enabling Device	DR Strategy	Phase 1 – Literature Review ¹² (kW)	Phase 2 – Baseline Study All Days (kW)	Phase 2 – Baseline Study Hottest Days (kW)	Estimated Unit Impacts ¹³ (kW)
Central Air Conditioner	Wi-Fi thermostat	Temperature setback	0.71	0.35	0.85	0.71
	Built-in	Temperature setback	0.08	0.05	0.13	0.13
Room Air Conditioner	Simple timer plug	DLC	0.06	0.05	0.11	0.11
	Wi-Fi plug	Temperature setback	0.06	0.04	0.09	0.09
Clothes Washer	Built-in	DLC	0.02	0.00	0.00	0.00
	Simple timer plug	DLC	0.02	0.00	0.00	0.00
	Wi-Fi plug	DLC	0.02	0.00	0.00	0.00
Clothes Dryer	Built-in	DLC	0.06	0.04	0.04	0.04
Dishwasher	Built-in	DLC	0.01	0.01	0.01	0.01
Refrigerator	Built-in	Deferred defrost	0.03	0.05	0.05	0.05
	Wi-Fi plug ¹⁴	DLC	0.05	0.05	0.05	0.05
	Built-in	DLC	0.20	0.13	0.14	0.14
Dehumidifier	Simple timer plug	DLC	0.17	0.08	0.10	0.10
	Wi-Fi plug	DLC	0.19	0.09	0.11	0.11
Ductless Heat Pump/Air Conditioner	Wi-Fi thermostat	Temperature setback	0.05	0.10	0.25	0.25
Heat Pump Water Heater	Built-in	DLC	0.13	0.10	0.09	0.09
	Simple timer switch	DLC	0.13	0.10	0.09	0.09
	Wi-Fi switch	DLC	0.13	0.10	0.09	0.09
Electric Resistance Water Heater	Built-in	DLC	0.27	0.17	0.16	0.16
	Simple timer switch	DLC	0.27	0.17	0.16	0.16
	Wi-Fi switch	DLC	0.27	0.17	0.16	0.16
Pool Pump	Built-in	DLC	0.58	0.46	0.61	0.61
	Wi-Fi plug ¹⁵	DLC	N/A	N/A	N/A	N/A
	Simple timer switch	DLC	0.58	0.46	0.61	0.61
	Wi-Fi switch	DLC	0.58	0.46	0.61	0.61
Battery Storage ¹⁶	Built-in No-Solar	DLC	N/A	0.86	1.37	1.37
	Built-in Solar	DLC	4.00	N/A	N/A	4.00
EVs ¹⁷	Built-in EV	DLC	0.09	N/A	N/A	0.09
(Home Charging)	Wi-Fi EVSE Controller	DLC	0.09	N/A	N/A	0.09
	OBD Dongle	DLC	0.09	N/A	N/A	0.09
	EVSE Built-In	DLC	0.09	N/A	N/A	0.09

CTA-2045 and/or OpenADR?

**CTA-2045-B Level 2
CERTIFIED**

- Hardware port (like USB)
- and utility friendly software
- Universal access through one provider

Utilities don't want to have to have a
Contract with every OEM

10 years of in the field proof it works



- Software Only
- Often allowed in the cloud
- Because expensive in devices
(SSL certificate required every year)

Good for expensive gateways that
control lots of devices

To date, mostly available in clouds and
gateways

Why Open Standards?

**CTA-2045-B Level 2
CERTIFIED**



- OEM equipment lasts 10-20 years
- Communications and technology change much more frequently
- Avoid stranded assets
- Modules can change firmware and add features much faster

Energy Star and AHRI potential 'oops'

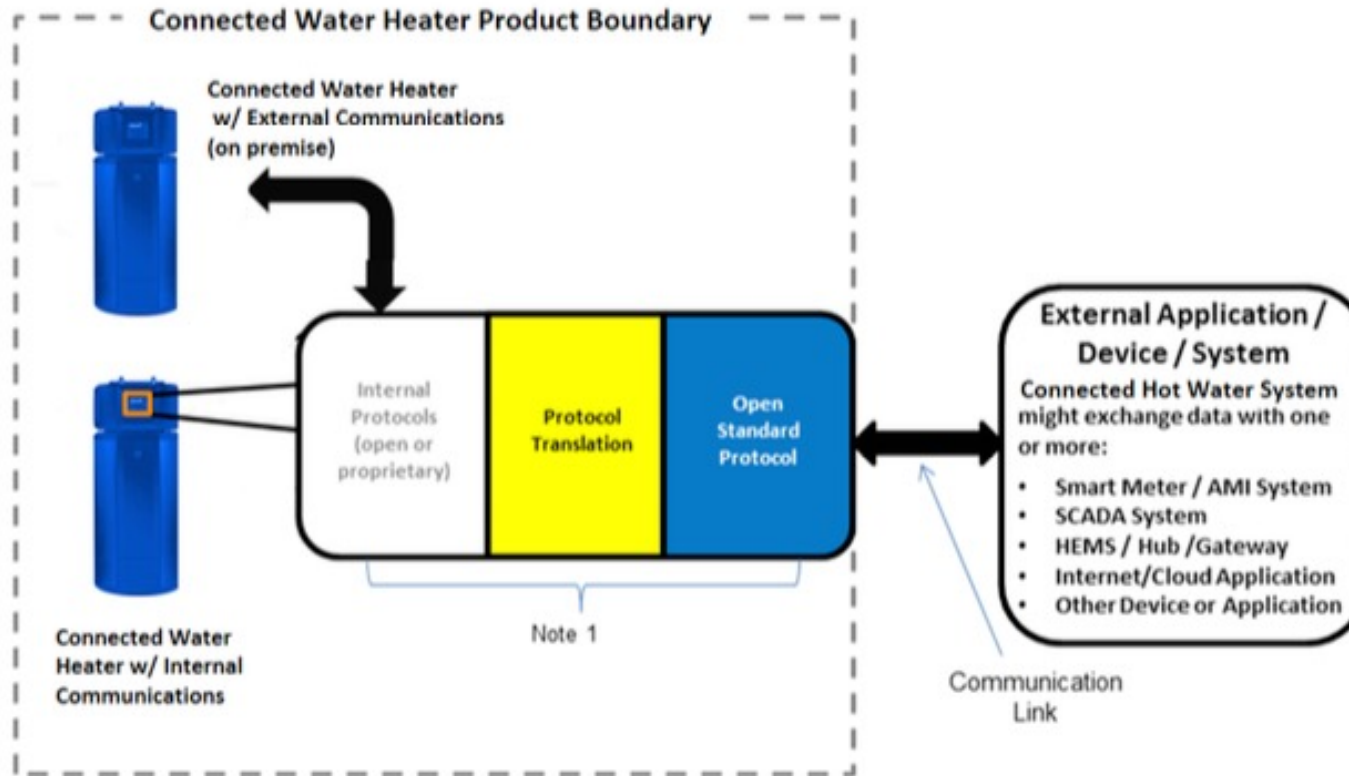
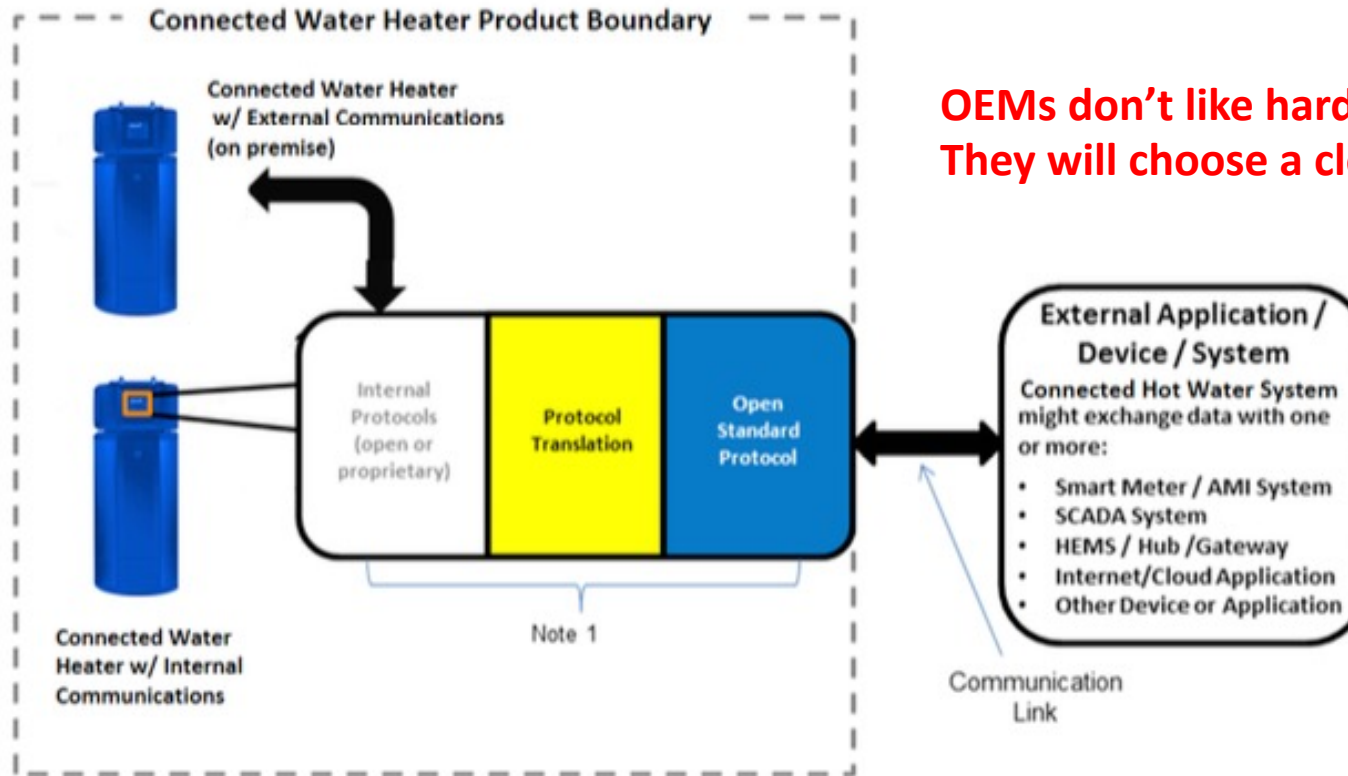


Figure 1: Connected Water Heater Product (CWHP)

Note 1: Communication device(s), link(s) and/or processing that enables Open Standards-based communication between the CWHP and external application / device / system(s). These elements, either individually or together, could be within the water heater/controller, and/or an external communication module, a hub/gateway, or in the Internet/cloud.

Energy Star and AHRI potential 'oops'

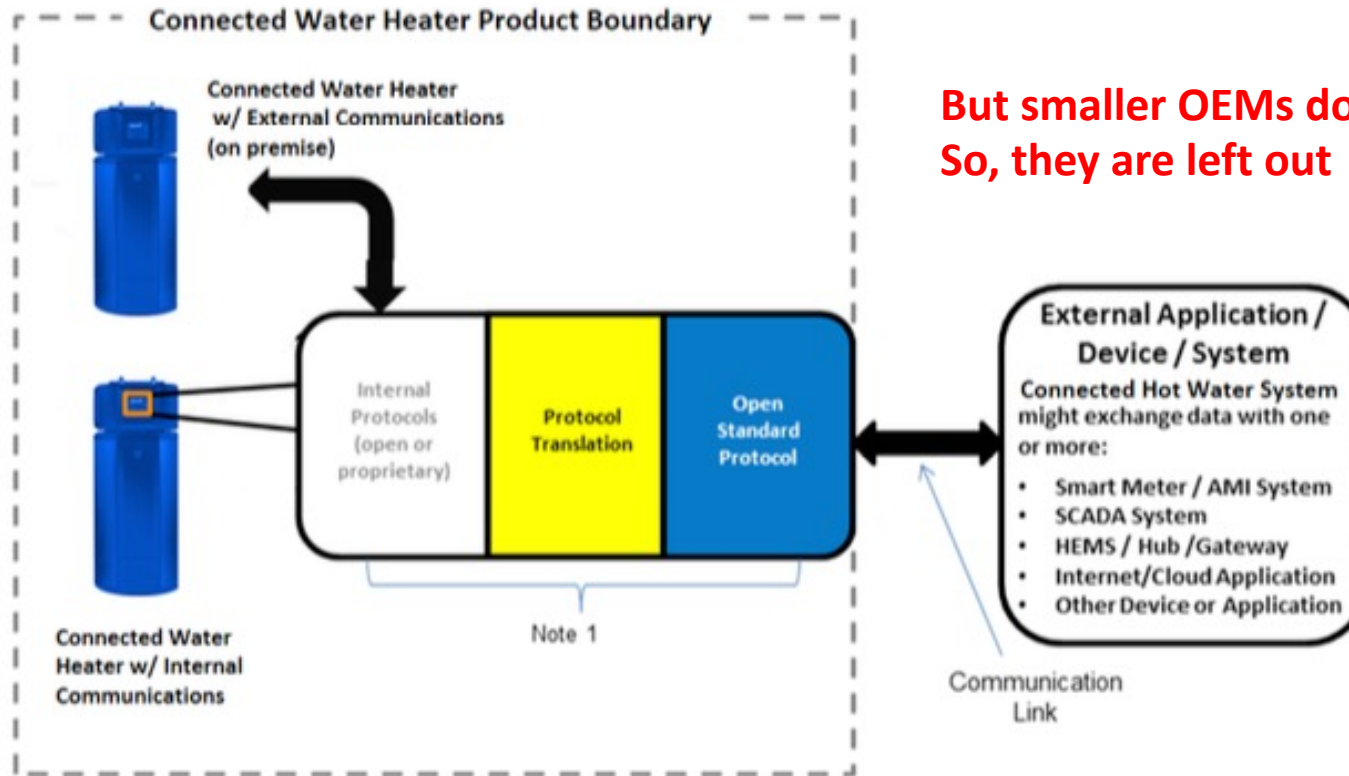


**OEMs don't like hardware changes
They will choose a cloud solution**

Figure 1: Connected Water Heater Product (CWHP)

Note 1: Communication device(s), link(s) and/or processing that enables Open Standards-based communication between the CWHP and external application / device / system(s). These elements, either individually or together, could be within the water heater/controller, and/or an external communication module, a hub/gateway, or in the Internet/cloud.

Energy Star and AHRI potential 'oops'

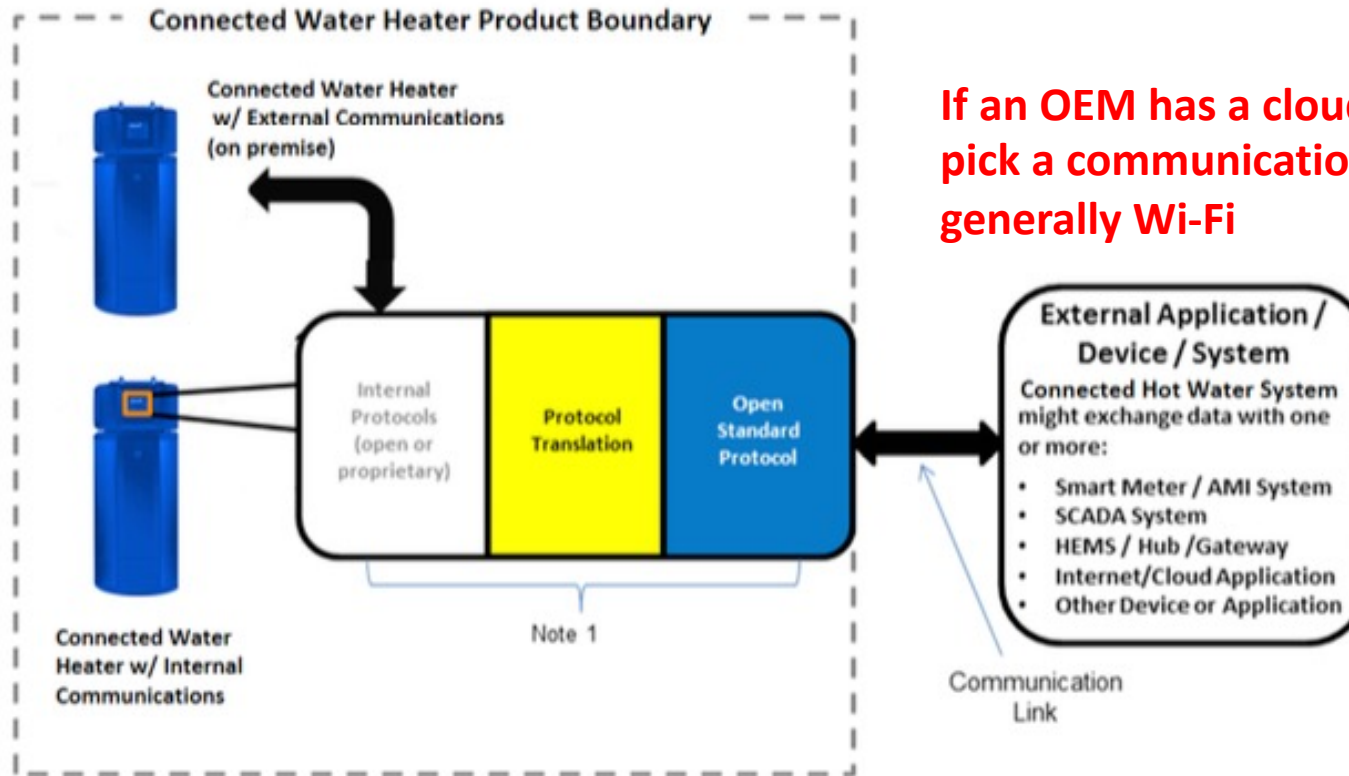


**But smaller OEMs don't have clouds
So, they are left out**

Figure 1: Connected Water Heater Product (CWHP)

Note 1: Communication device(s), link(s) and/or processing that enables Open Standards-based communication between the CWHP and external application / device / system(s). These elements, either individually or together, could be within the water heater/controller, and/or an external communication module, a hub/gateway, or in the Internet/cloud.

Energy Star and AHRI potential 'oops'



If an OEM has a cloud, he has to pick a communication path, generally Wi-Fi

Figure 1: Connected Water Heater Product (CWHP)

Note 1: Communication device(s), link(s) and/or processing that enables Open Standards-based communication between the CWHP and external application / device / system(s). These elements, either individually or together, could be within the water heater/controller, and/or an external communication module, a hub/gateway, or in the Internet/cloud.



Note 1: Communication device(s), link(s) and/or processing that enables Open Standards-based communication between the CWHF and external application / device / system(s). These elements, either individually or together, could be within the water heater/controller, and/or an external communication module, a hub/gateway, or in the Internet/cloud.

The water heater OEMs are CTA-2045!

SkyCentrics AC Powered USNAP module World's First UL 916 certified module



SkyCentrics DC Powered USNAP module



AO Smith – Electric Resistance Water Heater	Siemens EVSE Car Charger
AO Smith – Heat Pump Water Heater (HPWH)	Mitsubishi Mini-Splits
IslandAire PTAC HVAC units	GE Appliances – Heat Pump Water Heater
Pentair IntelliConnect Pool Pump Controllers	Bradford White – Heat Pump Water Heater
Rheem – Heat Pump Water Heater	Nyles – Water Heater (110V heat pump)
Mitsubishi AQHV – Central System HPWH	Emerson 30 Amp Water Heater Switch
Mitsubishi VRF	Emerson Thermostat

Shouldn't Energy Star and AHRI just get on board?

OEMs don't like states with different regulations, they prefer a national standard!

CTA-2045 guarantees communication options

OpenADR & CTA-2045 work well together

The more expensive OpenADR can be placed in the cloud, or in the CTA-2045 module.
Not recommended in the appliance.

Utilities

Need options for communication paths
May need guaranteed communication
May need OpenADR...or not.

Customers

Want to monitor and schedule their devices through easy to use apps
Choice of Manufacturers

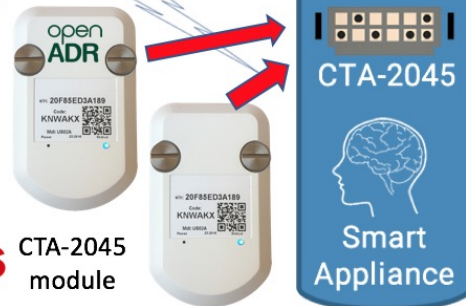
Low cost Cellular, AMI Mesh and other options are coming and may prove more reliable to utilities than customer Wi-Fi, which to date has been frustrating and costly.

OEM

Can put minimum smarts for utilities only, OR
Maximum smarts for additional features through an OEM cloud connection

\$\$\$\$ CTA-2045 module with OpenADR*

\$ CTA-2045 module



Some OEMs like IslandAire PTACs are happy to have the module vendor provide the mobile app so that they don't have to build a cloud, others like AO Smith and Rheem will have their own cloud.

*OpenADR is expensive to code, certify, and has a yearly SSL certificate cost! Put it in the module if necessary, NOT IN THE APPLIANCE

OEM communication path options for smart connected appliances

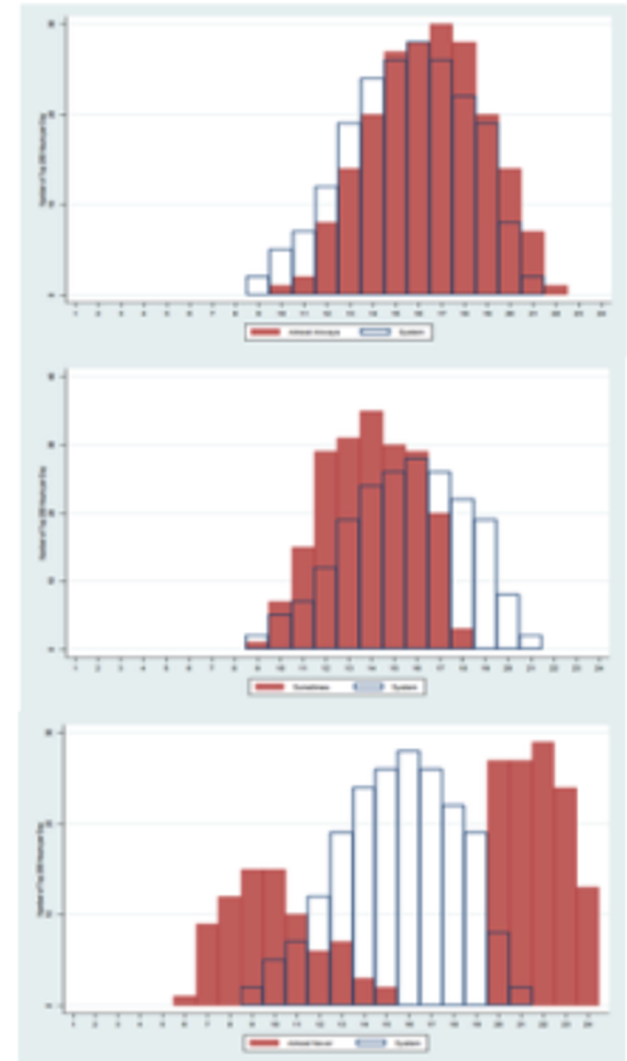
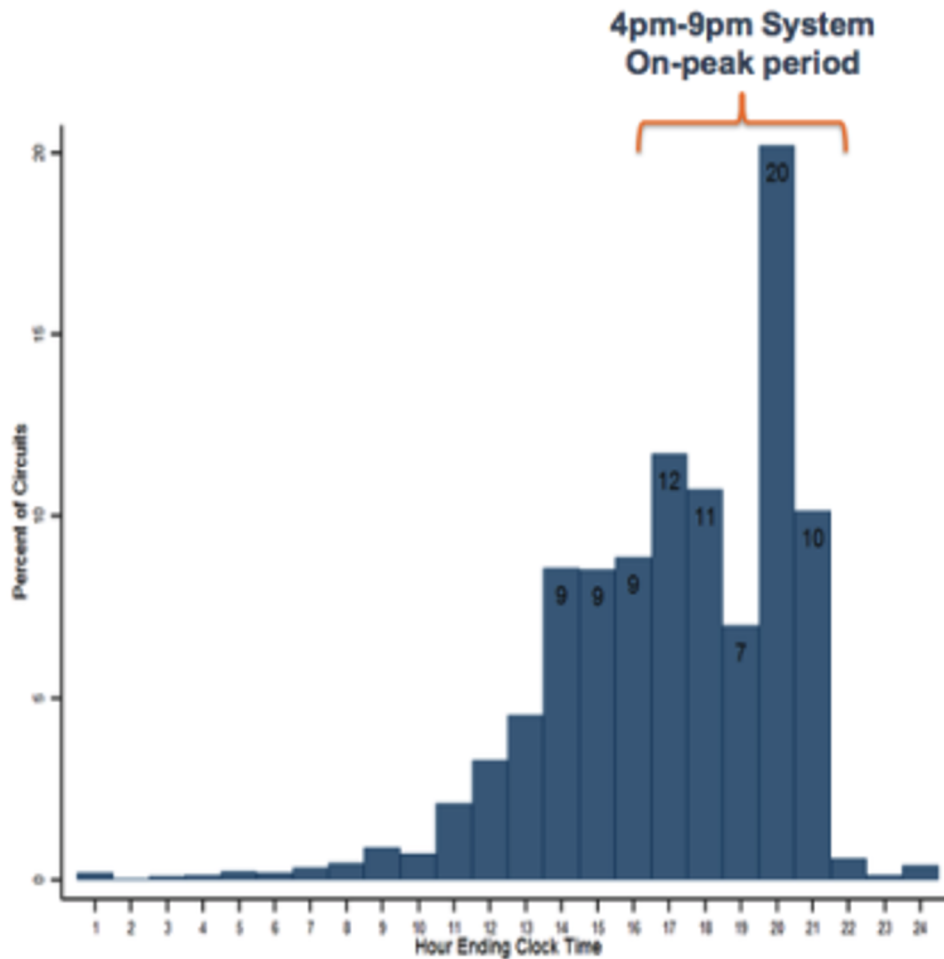
**TOU vs 24 hour ahead vs real time
6 month vs 24 hour vs microsecond response**

TOU is a blunt instrument, we need daily changes

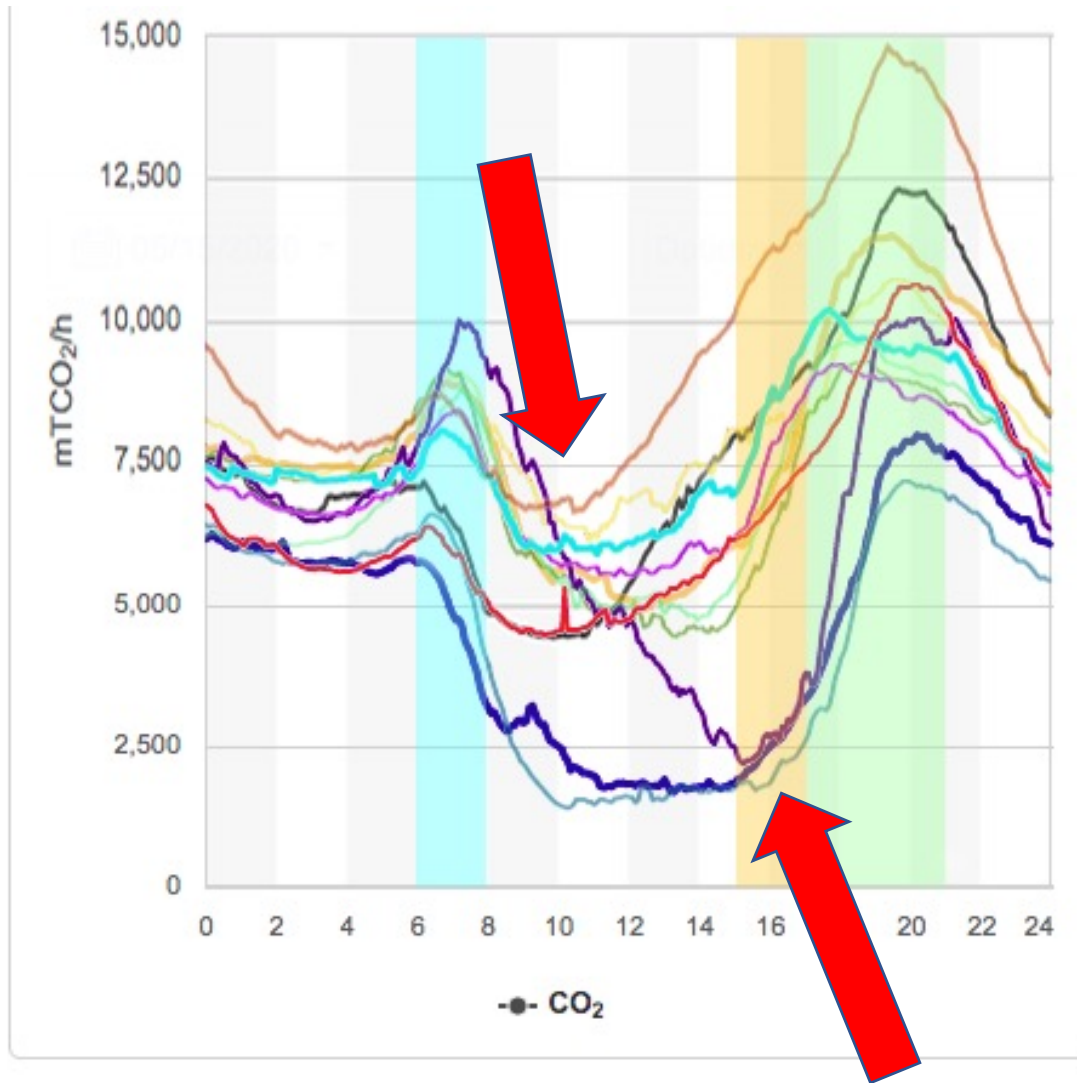
Let's not get stuck for years on TOU!

SDG&E feeder mis-alignment

The timing of circuit peaks may not align with system peak



12 months of CA ISO CO2 emissions variations



Jun 10, 2020

May 15, 2020

Apr 15, 2020

Mar 13, 2020

Feb 14, 2020

Jan 15, 2020

Dec 13, 2019

Nov 15, 2019

Oct 15, 2019

Sep 16, 2019

Aug 15, 2019

Jul 15, 2019

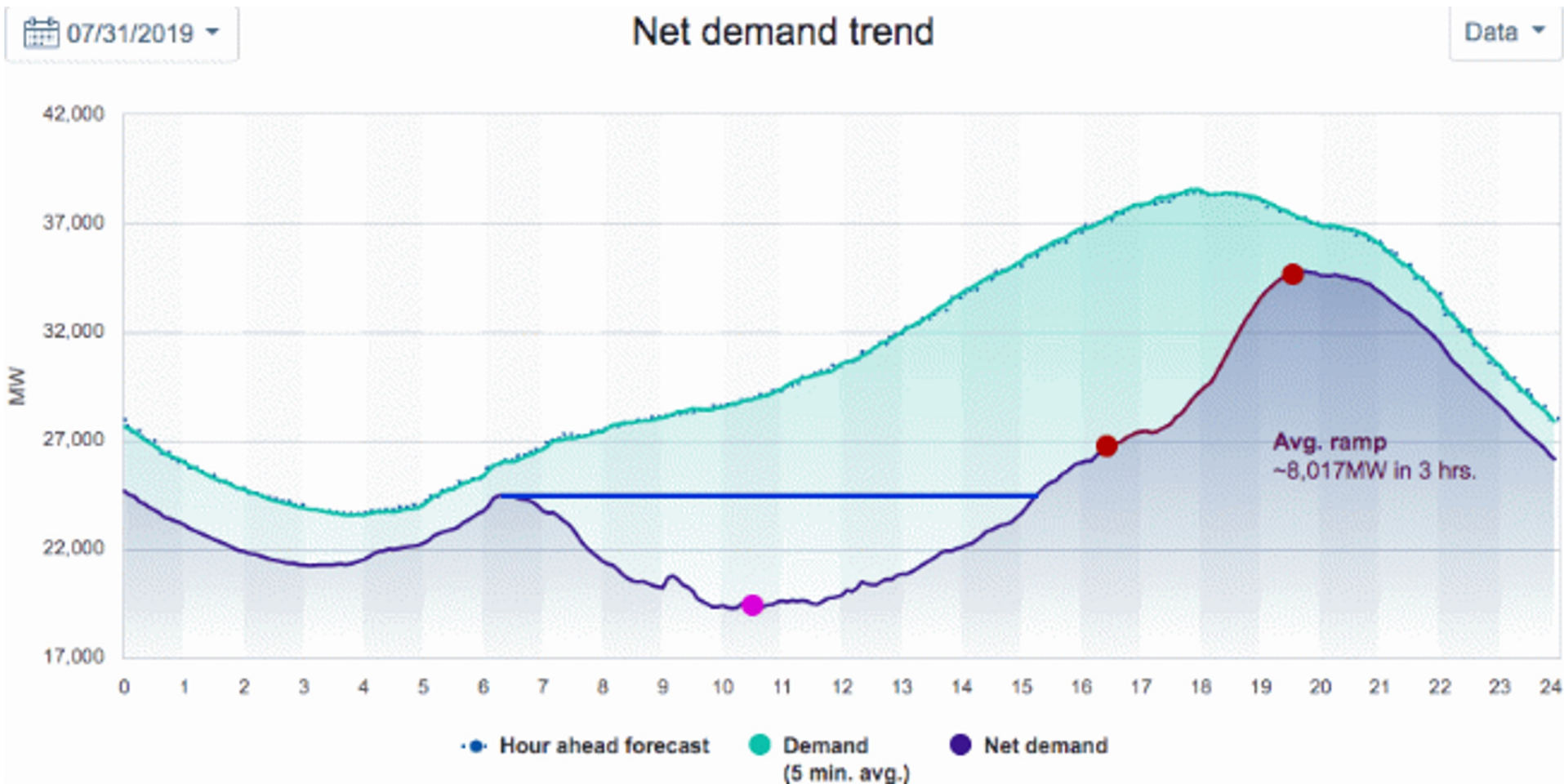
6-8 am

5-9 pm

3-5 pm

CA ISO daily variations – Time of Use is blunt

Daily schedule adjustments 2-5x more valuable than TOU
- Pierre Delforge (NRDC), Owen Howlett (SMUD)



Daily schedule changes provide 2-5x benefits to GHG and grid*

	Schedule Type	Pro-Con	Cost
	Unscheduled	EE benefits of Heat Pump only	-
	TOU – changes every 6 months	Misses daily, weekly, and monthly variability	JA13 – built in to water heater
	Daily changes	Can match daily variability	Cellular + yearly fee
	Real Time changes	Needed for the 3 months of DR or Fire season	Cellular + yearly fee x2

* SMUD Analysis

Incentives

Products in the field

Utility Programs

Status of CA incentives – Single Family

Cost	Incentive Layer	Program	Incentives For:	Potential Incentive Amount	Benefit Claim (% of Share)
Smart Controls \$400	4	ESP&IP	Smart Controls Only	\$300?	<ul style="list-style-type: none"> • Peak Demand Reduction • GHG Reduction
Labor \$700-\$1,000	3	SGIP	Equipment and Labor	\$1,700?	<ul style="list-style-type: none"> • Peak Demand Reduction • GHG Reduction
Wiring \$300-\$1,000					
Panel Upgrade \$3,000-\$4,000	2	TECH Pilot	Equipment, Labor, and Panel Upgrade	\$2,500?	<ul style="list-style-type: none"> • GHG Reduction
50G HPWH \$1,500					
	1	Energy Efficiency	Equipment	\$500?	<ul style="list-style-type: none"> • Energy Efficiency Savings • GHG Reduction

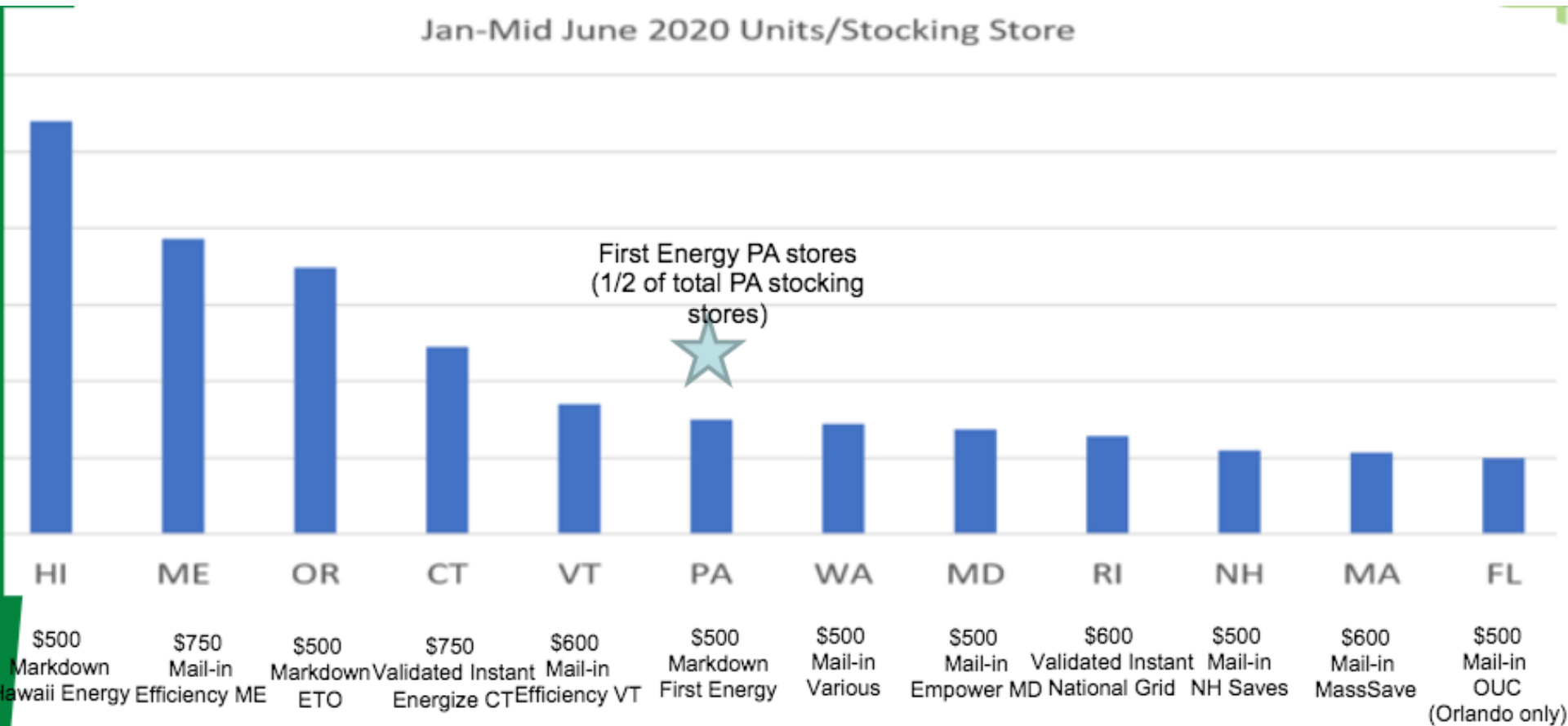
\$6,000 Total Installed Cost

Potential Incentives \leq \$5,000

Customer Installed Cost after Incentives \geq \$1,000

BayREN - Home+ - \$2,000 for the 11 Bay Area communities
 Sonoma Clean Power – adds another \$750

Comparison of Heat Pump incentives



Status of CA incentives – Multi-Family

Cost	Incentive Layer	Program	Incentives For:	Potential Incentive Amount	Benefit Claim (% of Share)
Battery \$8,000	3	ESP&IP (New Homes Energy Storage Pilot)	Battery Storage	\$7,650?	<ul style="list-style-type: none"> • Peak Demand Reduction • GHG Reduction
Smart Controls \$400		ESP&IP	HPWH Smart Controls Only	\$300?	
HPWH \$1,120 HPSH \$620 Dryer \$820 Cooking \$1,800	2	BUILD Pilot	Above EE Emissions Reductions	\$1,000?	• GHG Reduction
	1	Energy Efficiency	Above Code Equipment Efficiency	\$1,000?	• Energy Efficiency Savings
Development Costs \$1,595	0	SCE Clean Energy Homes	To Code	\$1,595?	<ul style="list-style-type: none"> • Bill Savings • GHG Reduction

\$14,355 Total Installed Cost

Potential Incentives \leq \$11,545

Customer Installed Cost After Incentives \geq \$2,810

Multi-Family is a sweet spot



Garden Style

126 apartments – 6 per building

21 buildings

Solar + Battery + 126 ECOPORT water heaters



Highrise

100 apartments

Low Income

Central System

Installation of Rooftop Skid



Commercial Equipment Now Here



Shiftable Water Heater Load = 20,000 watt-hours

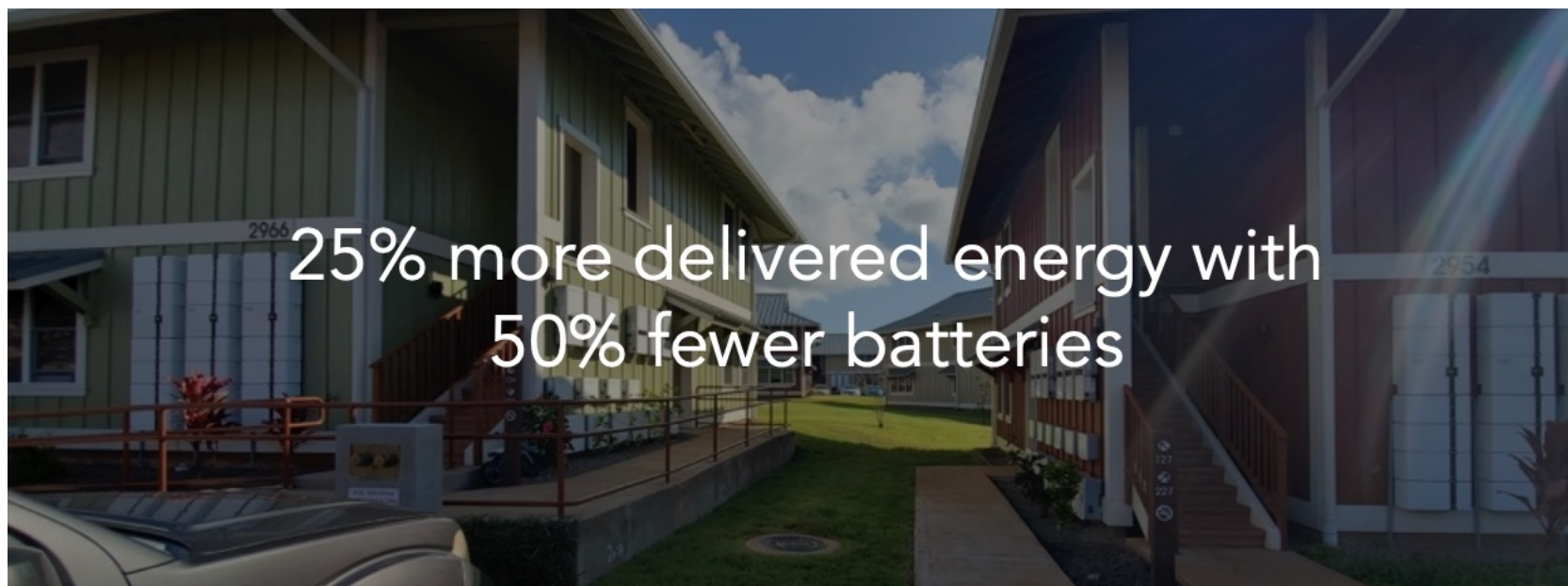
Hawaii is providing \$2,000 per water heater in **Multi-Family** developments...

...if the water heater can be
shown to be controllable
by a solar array.

That carport has a direct link to
controlling 140 water heaters.



Incentives - Hawaii



\$2,000 per water heater IF controlled by the SUN

Historically that meant solar on the roof

Here, it meant solar+batteries controlling water heaters
through CTA-2045 ECOPORT

Rapid Change Can Happen

**ONLY BY MAKING THESE MACHINES THE MOST AFFORDABLE
CAN WE SUCCEED.**



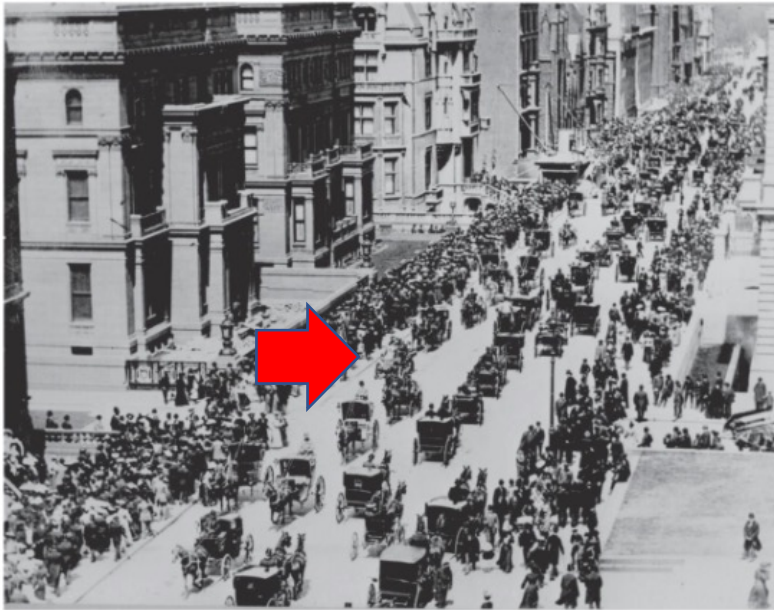
1900. 100's of horses, 1 car.



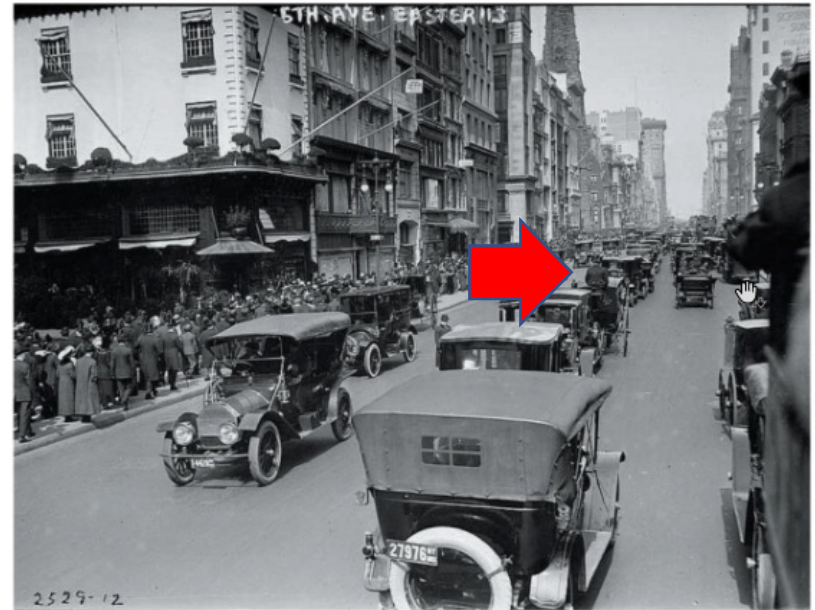
1913. 100's of cars, 1 horse.

Rapid Change Can Happen

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CAN WE SUCCEED.**



1900. 100's of horses, 1 car.



1913. 100's of cars, 1 horse.

Questions



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OpenADR 2.0b to CTA-2045 signal mapping

1. Use case #1 (basic simple level strategy):

Event	Signal Name	Signal Type	Value	Event
Event	Simple	Level	0	Load Up

Signal Name	Signal Type	Value	Duration	CTA-2045 Event
Simple	Level	0	Any	Load Up
Simple	Level	1	Any	Shed
Simple	Level	2	Any	Critical Peak
Simple	Level	3	Any	Grid Emergency

OpenADR simple levels 0-3 can be used for the basic CTA-2045 commands, however there are only 4 simple levels, while CTA-2045 and Title 24 JA13 are enabling more commands such as “Advanced Load Up”.

OADR 2.0b to CTA-2045 signal mapping

2. Use case #2 (advanced strategy with multiple signal intervals in a single event):

Event	Signal Name	Signal Type	Value	Event
Event	Simple	Level	0	Load Up
	LOAD_CONTROL	x-LoadControlLevel-Offset	0...10	Load Level

Signal Name	Signal Type	Value	Duration	Event
Simple	Level	0	Any	Standard – run normal
Simple	Level	1	Any	External Blocking
Simple	Level	2	Any	Low Price – Use more
Simple	Level	3	Any	Overcapacity – Use less

Signal Name	Signal Type	Value	Duration	Event
LOAD_CONTROL	x-LoadControlLevel-Offset	0...10	Any	Load Level

This controlled 2 relays and 2 x 0-10 V dimmers on a SkyCentrics SkySnap which were used to control a Hitach Heat Pump HVAC system.

3. Use case #3 (advanced strategy with multiple signal intervals in a single event):

Event	Signal Name	Signal Type	Value	Event
Event	Simple	Level	0	Load Up
	LOAD_CONTROL	x- <u>LoadControlLevel</u> -Offset	0...10	Load Level

Signal Name	Signal Type	Value	Duration	Event
Simple	Level	0	Any	Standard – run normal
Simple	Level	1	Any	----
Simple	Level	2	Any	Low Price – Use more
Simple	Level	3	Any	Overcapacity – Use less

Signal Name	Signal Type	Value	Duration	Event
LOAD_CONTROL	x- <u>LoadControlLevel</u> -Offset	0	Any	Load Up
LOAD_CONTROL	x- <u>LoadControlLevel</u> -Offset	1	Any	Shed
LOAD_CONTROL	x- <u>LoadControlLevel</u> -Offset	2	Any	Critical Peak
LOAD_CONTROL	x- <u>LoadControlLevel</u> -Offset	3	Any	Grid Emergency
LOAD_CONTROL	x- <u>LoadControlLevel</u> -Offset	4	Any	Advanced Load Up
LOAD_CONTROL	x- <u>LoadControlLevel</u> -Offset	5	Any	Cycling 1
LOAD_CONTROL	x- <u>LoadControlLevel</u> -Offset	6	Any	Cycling 2
...
LOAD_CONTROL	x- <u>LoadControlLevel</u> -Offset	x	Any	xxx

Here we show a method of using OpenADR to CTA-2045 in an infinitely flexible way, so that there will be no limitations.

New water heater control for Title 24 JA 13, coming with CTA-2045-B in September 2020

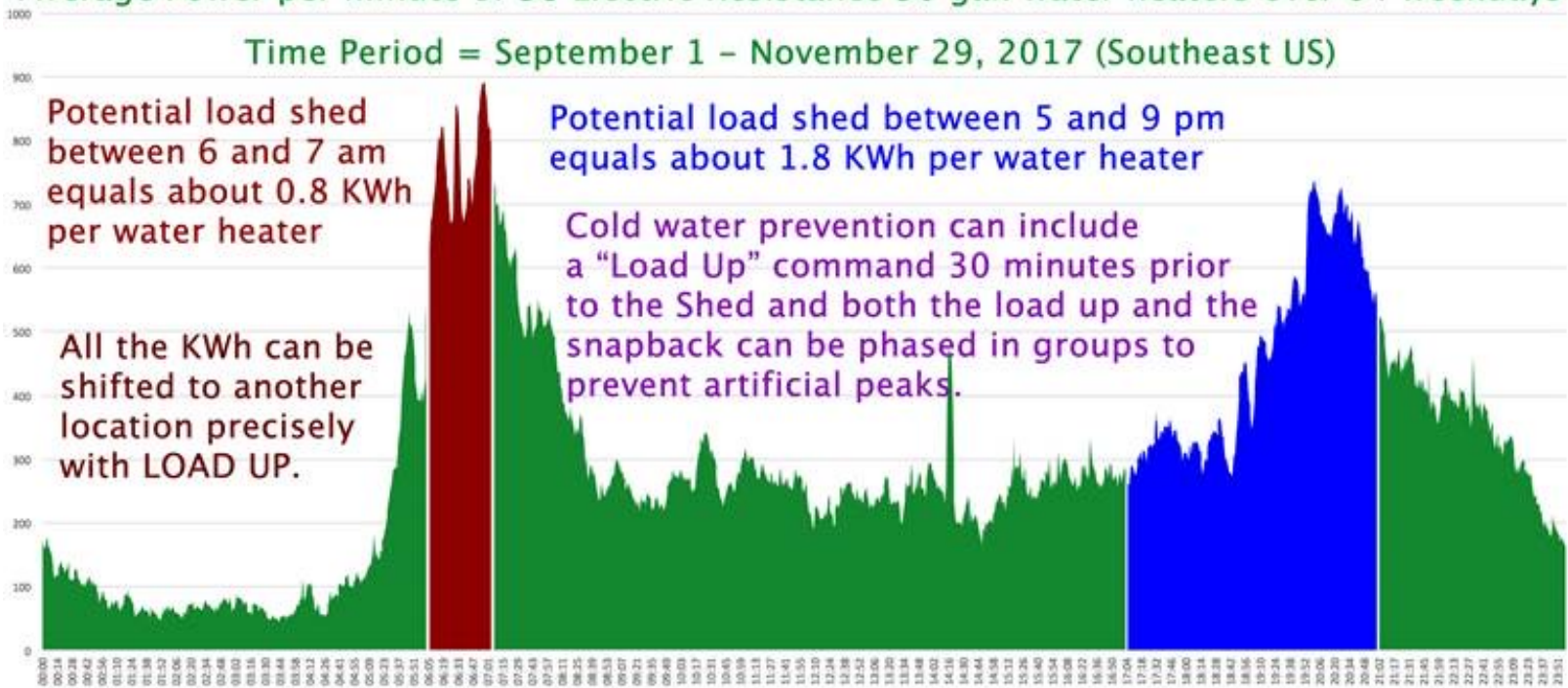
Shows the number of commands can be added to the list.



Why heat pump water heaters?

Average Power per minute of 38 Electric Resistance 50 gal. water heaters over 64 weekdays

Time Period = September 1 – November 29, 2017 (Southeast US)



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