Clean Coalition

How open-standard appliance orchestration will help proliferate renewable energy

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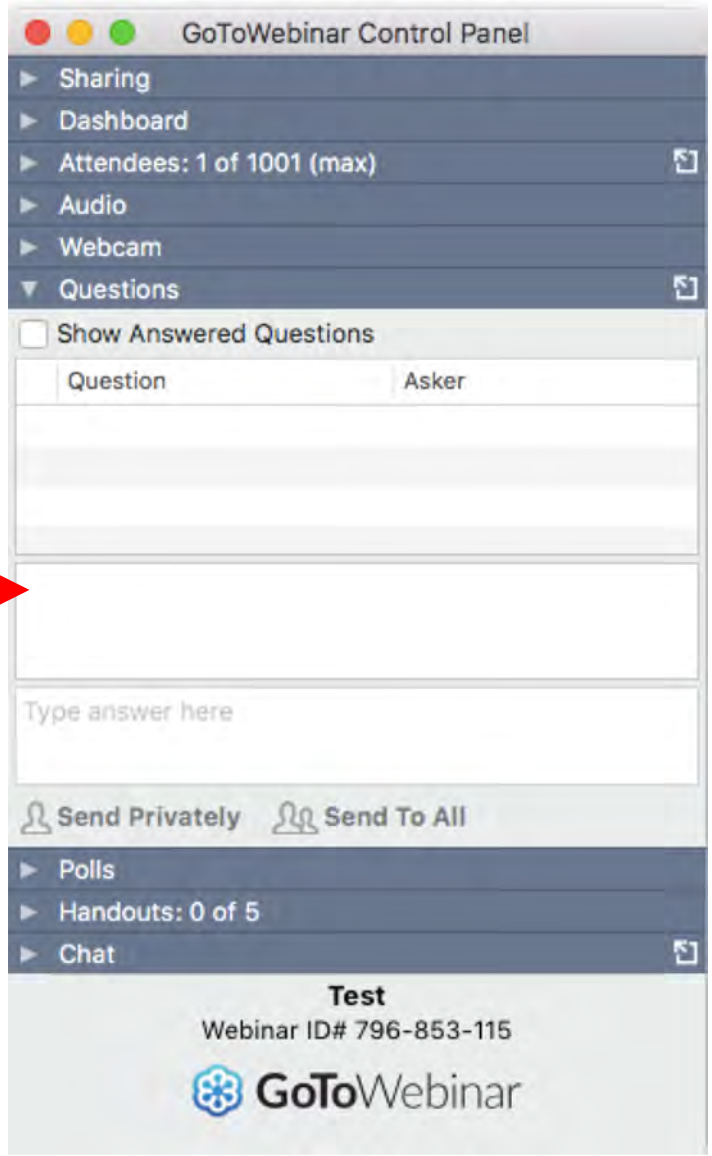


Presenters

Tristan de Frondeville

Tristan is CEO at SkyCentrics, a leader in open standards smart building solutions that include CTA-2045, OpenADR, Volttron, and Linux. He has more than 20 years experience in software and hardware engineering management, including at Apple, and SRI International. Tristan is on the Consumer Technology Association committee managing the CTA-2045 standard, as well as working with NEEA, ACEEE, Energy Star, and National Laboratories on OpenADR, Volttron, and other regulatory and policy initiatives, where his main focus is enabling buildings and electric loads to support increased renewables on the grid.

Presenters

Craig Breaden

Craig is Lead Integration Engineer at Smarter Grid Solutions, a software company that provides distributed energy resource management system *(*DERMS) solutions, with expertise in deploying DERMS at utilities in North America and the United Kingdom. He has extensive experience in power systems control, including the certification IEC 61850 Client & Server as well as emerging protocols such as OpenADR and Sunspec Modbus.

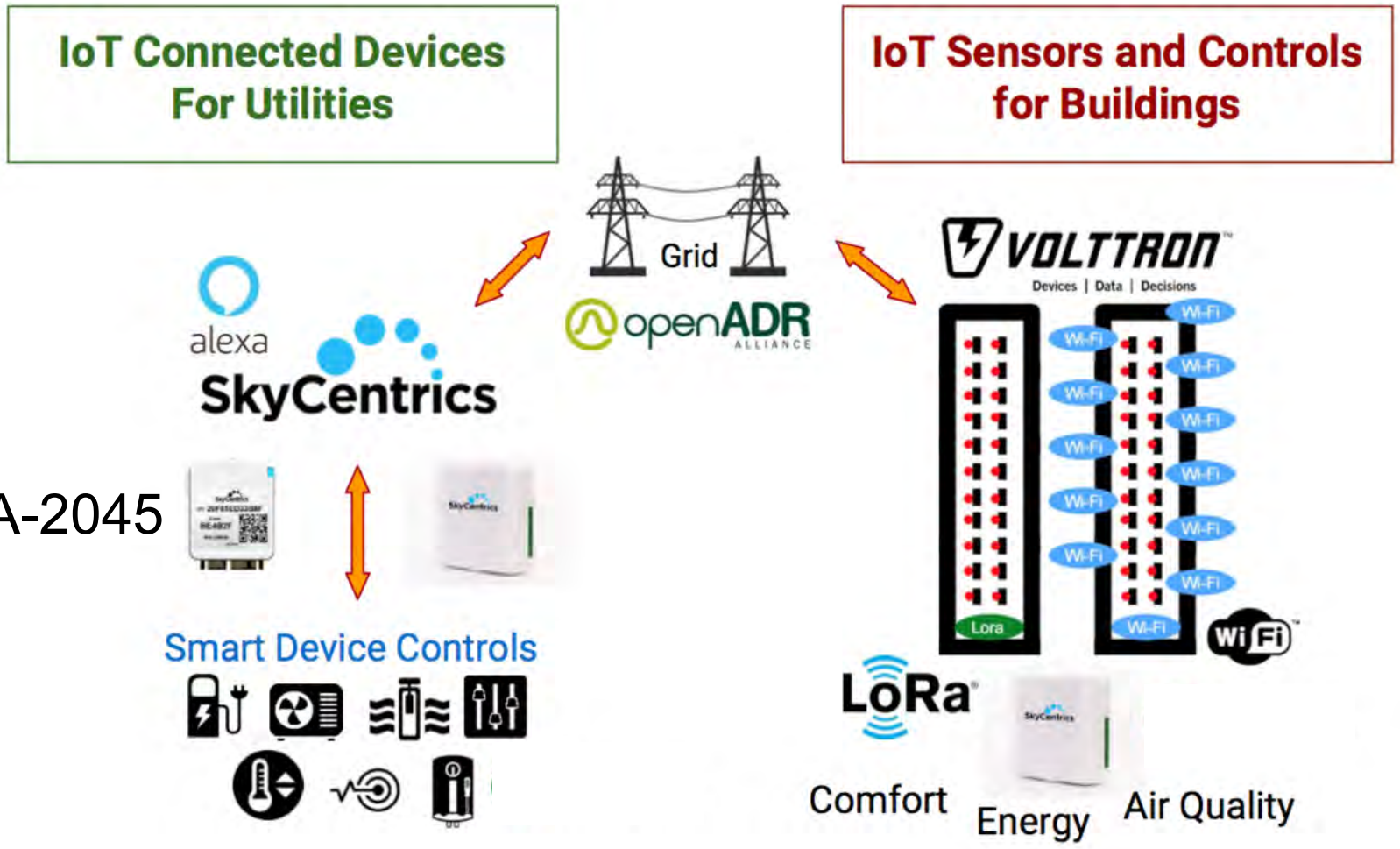
SkyCentrics

How open-standard appliance orchestration will help proliferate renewable energy

SkyCentrics

Clean Coalition Webinar – July 22, 2020

About SkyCentrics & Open Standards



SkyCentrics SkySnap w Volttron & OpenADR

- Complete solution from sensors to apps

- Scalable cloud platform w REST API
- Customer traction in utilities and commercial property
- The link between IoT and legacy BMS
- OADR gateway for utility demand response
- Fast Iteration of custom I/O boards

VOLTTRON™

openADR ALLIANCE

SkyCentrics Rapid OpenADR certification

SkyCentrics' DREAM scalable cloud DRMS platform and OADR 2.0b VEN combine with its CTA-2045 devices, the open standard for connected devices, to control appliances from AO Smith, Pentair, Mitsubishi, Islandaire, and Emerson. Open standards give utilities control for Demand Response and Ancillary Services without fear of stranded assets, and web and mobile apps allow customers to monitor, control, and schedule their appliances. SkyCentrics' CTA-2045 modules communicate through Wi-Fi, cellular and soon Lora, and can store Time-of-Use and 30 days of DR event schedules and provide real-time (<5s interval) data on device status. Meanwhile, the SkyCentrics cloud can send DR signals to over 1M devices in less than 1 second.

Manufacturer websites listing CTA-2045 capable products and appliances:

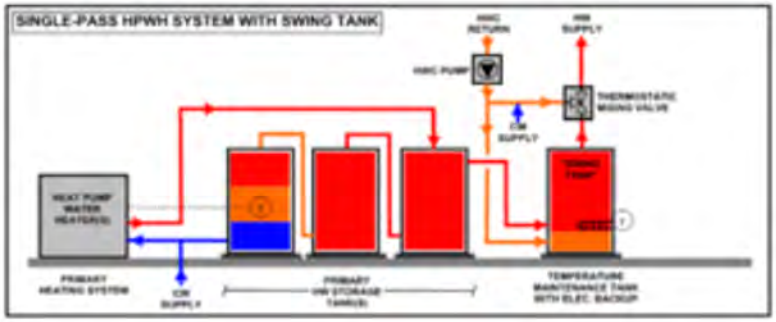
(Note) The appliances are ONLY OADR 2.0b capable when connected to the SkyCentrics CTA-2045 Cloud.

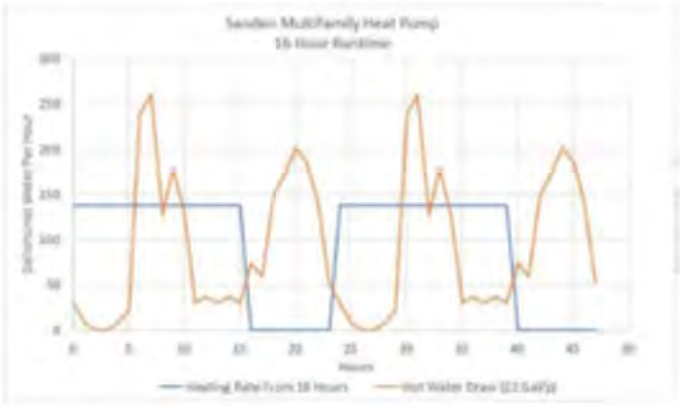
Water Heaters – A.O. Smith

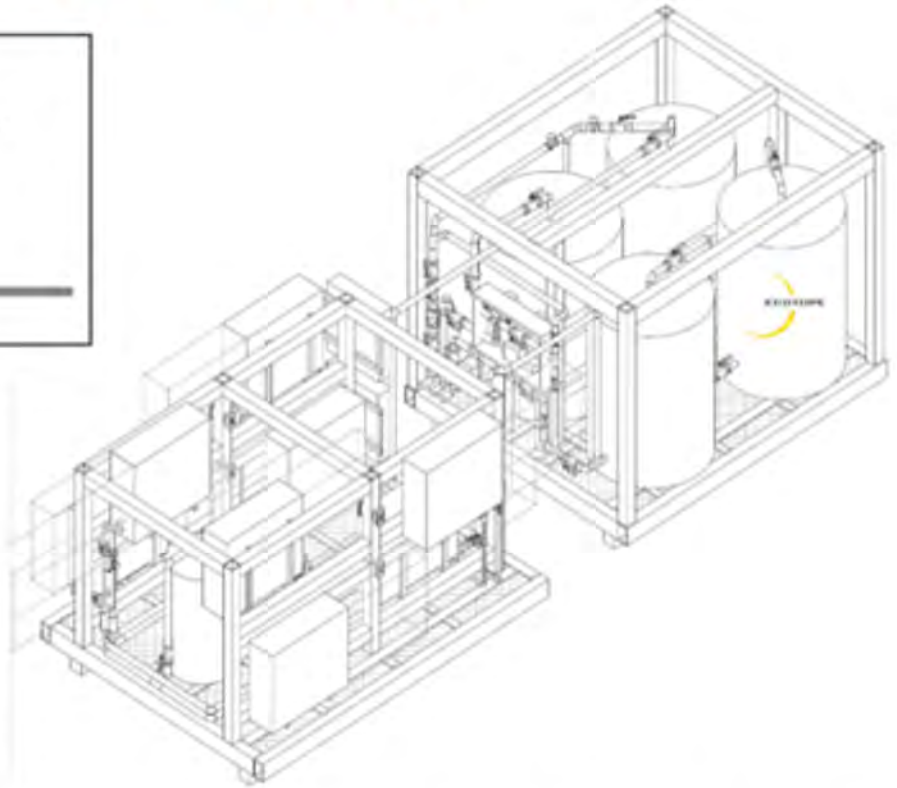
Pool Pumps and Heaters – Pentair

SkyCentrics working on Multi-Family DR

Prefab Plug and Play Skid for Rooftops







- Culmination of focused effort around the Techology Innovation Model with Sanden plug and play solution.

100 Person, Load Shift Capable, Plug and Play Sanden Skid for Menlo Park Apartment Projects (840 units)

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.

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

CTA-2045 Standard

AC powered

Consumer Technology Association™

SkyCentrics

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

DC powered

openADR™

CTA-2045 appliance family

Hot Water Heaters

Pool Pumps

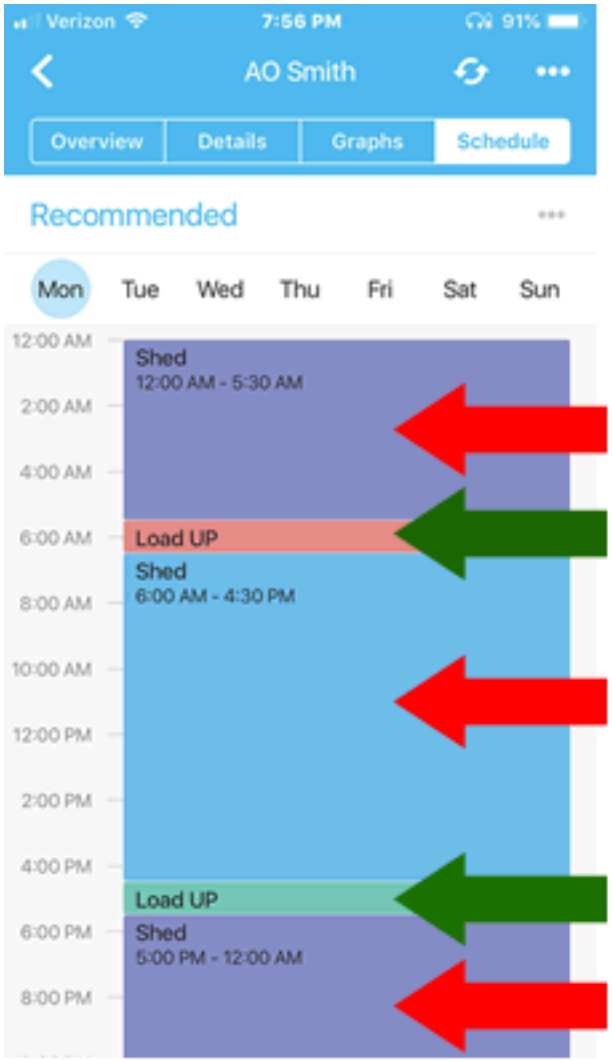
PTACs

EV Chargers

Heat Pump HVAC Mini-splits

Cold water prevention ‘smarts’

Everyday savings schedule



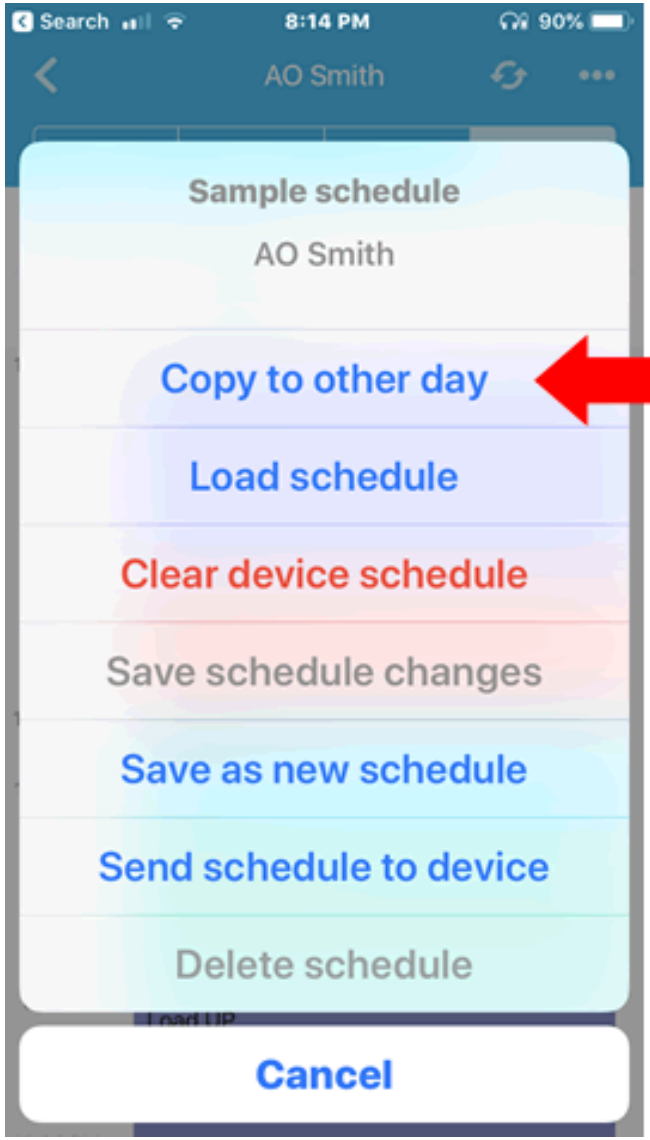
12 - 5:30 AM - Shed
Save energy at night when you don't need hot water.

5:30 - 6:00 AM - Load Up
Fully heats your tank for morning showers.

6:00 AM - 4:30 PM - Shed
Save energy during the day while you are not home.

4:30 - 5:00 PM - Load Up
Fully heats your tank to get ready for the evening.

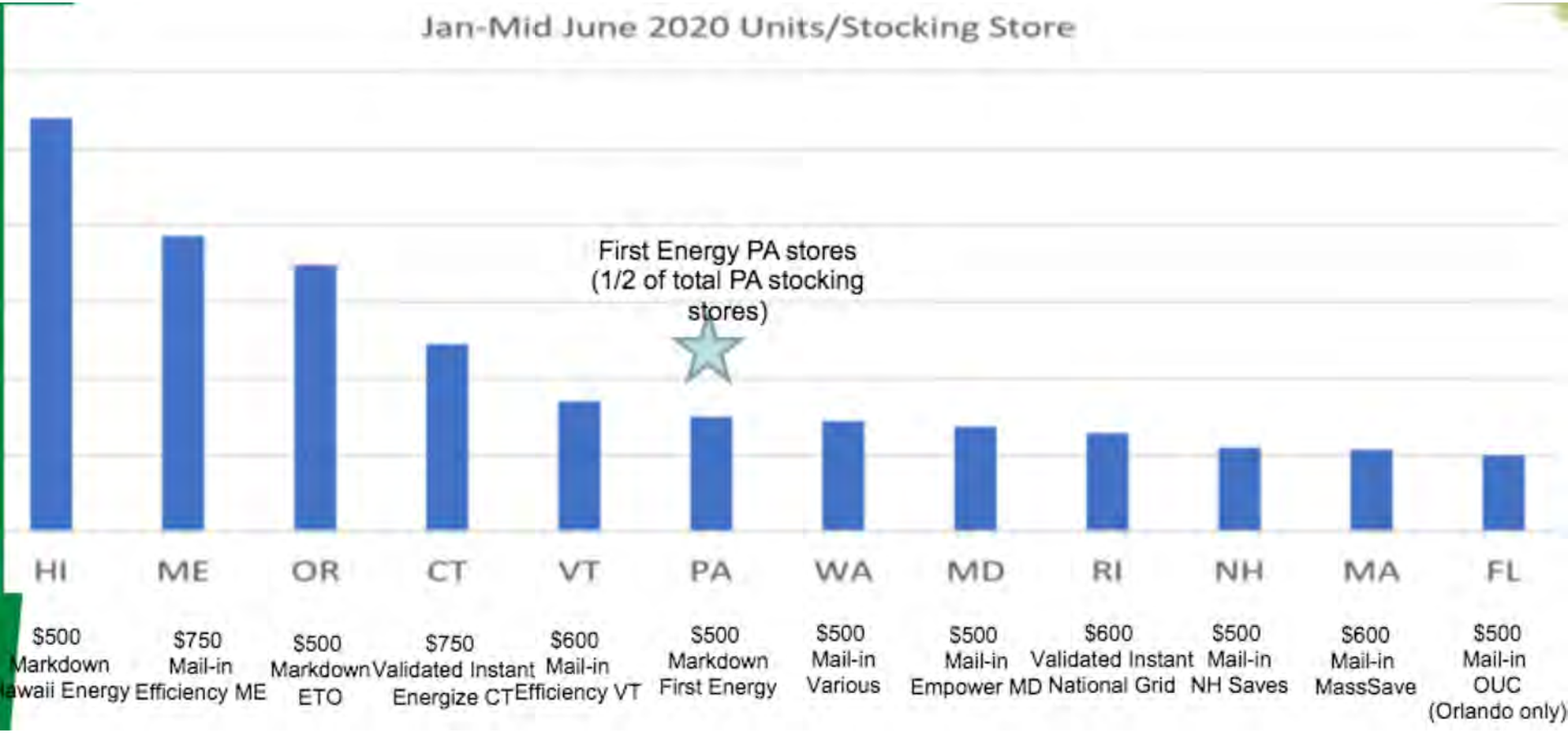
5:00 PM - 12 - Shed
Save energy at night when you don't need hot water.



Status of CTA-2045 regulations

State	Regulation	Date of Implementation	Details
WA	SB 5115 HB 1444	January 1, 2021	**All new electric water heaters sold in WA state** must have a CTA-2045-A port or equivalent. (Heat pump 1/21, Electric resistance 1/22)
OR	EO 2020-04	January 1, 2022	**All new electric water heaters sold in OR state** must have a CTA-2045-A port or equivalent. (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	Due to the developments in CA below, there is a good chance that Energy Star will move to requiring CTA-2045-A at the appliance in the next 12 to 24 months.
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 OADR to water heaters either in the cloud or at the device on new construction or large retrofit – Requires NEEA Tier 3 v7, which requires a CTA-2045 port.

Comparison of Heat Pump incentives



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?	• Peak Demand Reduction • GHG Reduction
Labor $700-$1,000	3	SGIP	Equipment and Labor	$1,700?	• Peak Demand Reduction • GHG Reduction
Wiring $300-$1,000	2	TECH Pilot	Equipment, Labor, and Panel Upgrade	$2,500?	• GHG Reduction
Panel Upgrade $3,000-$4,000					
50G HPWH $1,500	1	Energy Efficiency	Equipment	$500?	• Energy Efficiency Savings • GHG Reduction

$6,000 Total Installed Cost

Potential Incentives <= $5,000

Customer Installed Cost after Incentives >= $1,000

BayREN - Home+ - $2,000 for the 11 Bay Area communities

Sonoma Clean Power – adds another $750

Status of CA incentives – Multi-Family

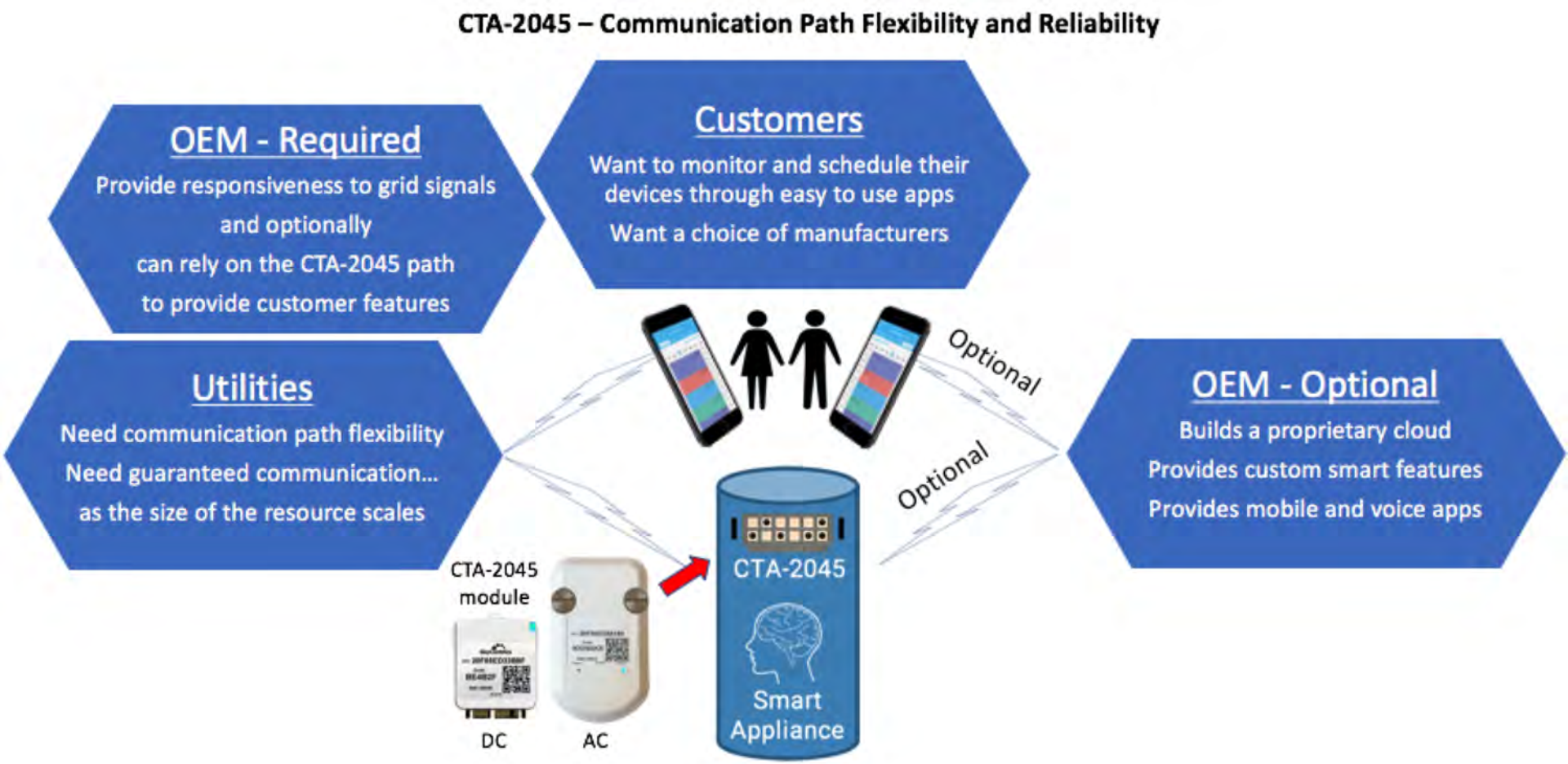
Cost	Incentive Layer	Program	Incentives For:	Potential Incentive Amount	Benefit Claim (% of Share)
Battery $8,000	3	ESP&IP (New Homes Energy Storage Pilot)	Battery Storage	$7,650?	• Peak Demand Reduction • GHG Reduction
Smart Controls $400		ESP&IP	HPWH Smart Controls Only	$300?	
HPWH $1,120 HPSH $620 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?	• Bill Savings • GHG Reduction

$14,355 Total Installed Cost

Potential Incentives <= $11,545

Customer Installed Cost After Incentives >= $2,810

CTA-2045 guarantees communication options



10-20 year appliance life

We need flexible, modular communications to future proof the connectivity to the appliance.

Wi Fi

BLE

4G LTE

ZigBee

LoRa

openADR ALLIANCE

or NOT!

Now is the time for a low cost cellular module

$20 - $36 per year
per water heater

Wi Fi™ → 4G LTE

…and then even smart meter modules

Itron

Landis+Gyr
manage energy better

Everyone talks about storage

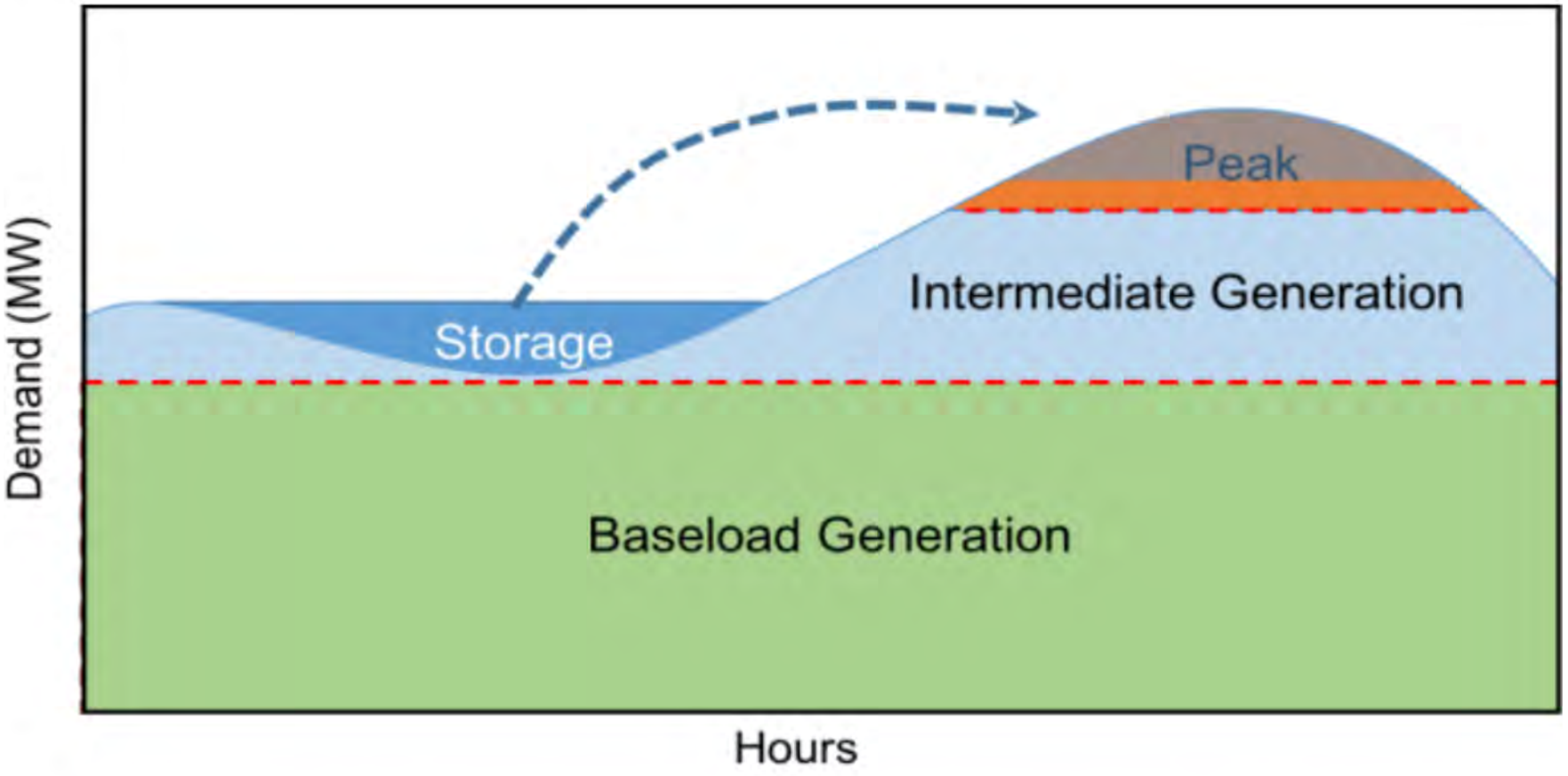
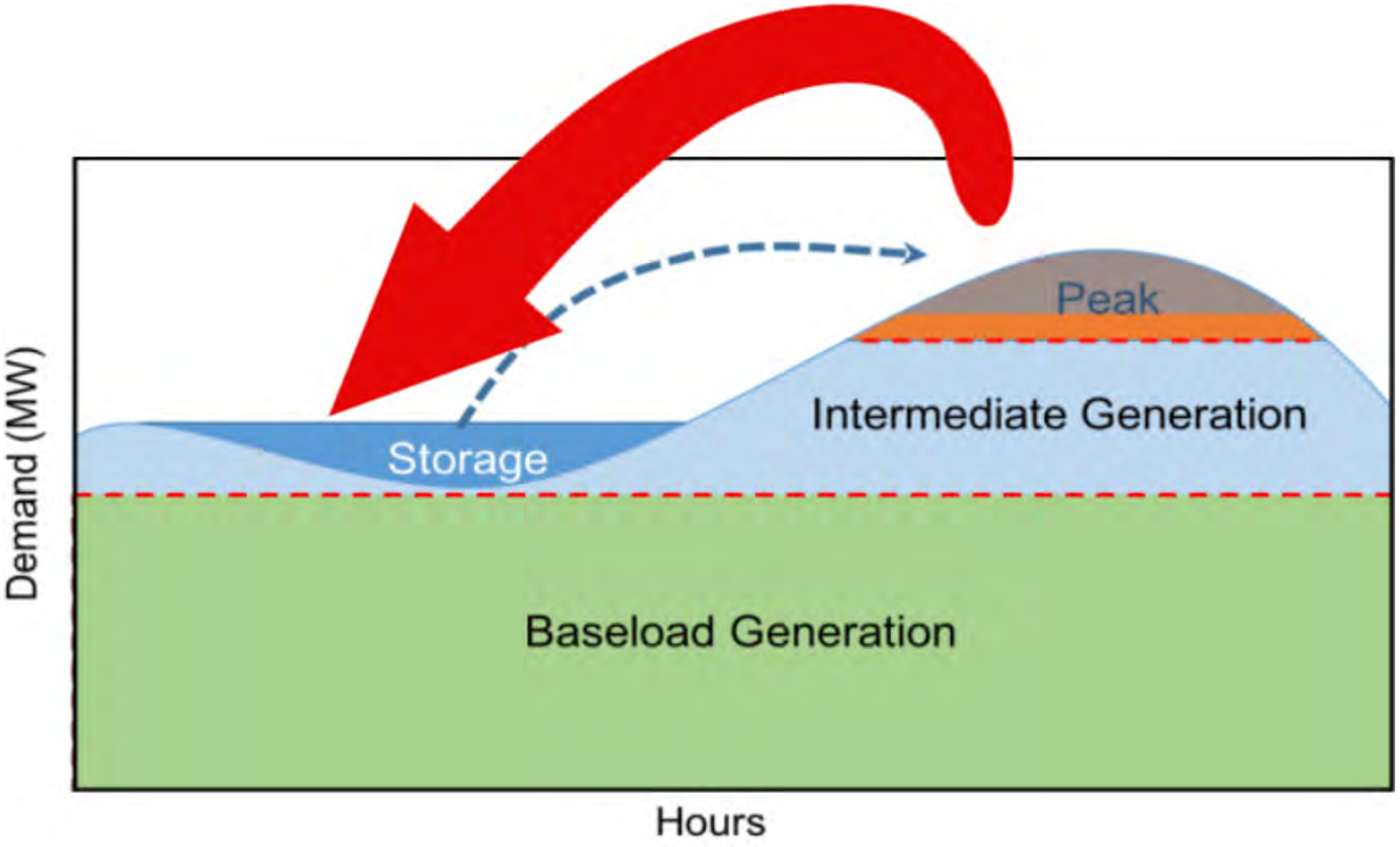


Figure 3: Energy storage can use off peak energy during times of high demand

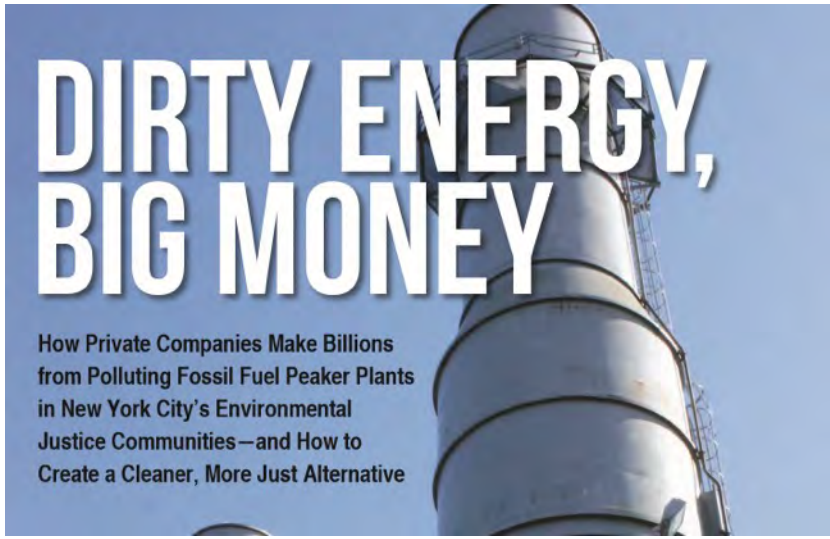
Demand Management is half the cost*



* Heat Pump Water Heater Demand Flexibility Study – Preliminary Results – NRDC & Ecotope

Why we need grid connected water heaters

- Standard solution: low-cost peaking plant at $800/kW.
- 300 MW plant to meet peak demand 1st cost: ~$240 million
- Tough to justify resource that runs only a few hours per year



Choices:

1. Build plant,
2. Short term solution in wholesale market, or
3. Meet peak with demand response

How Heat Pump Water Heaters help the grid

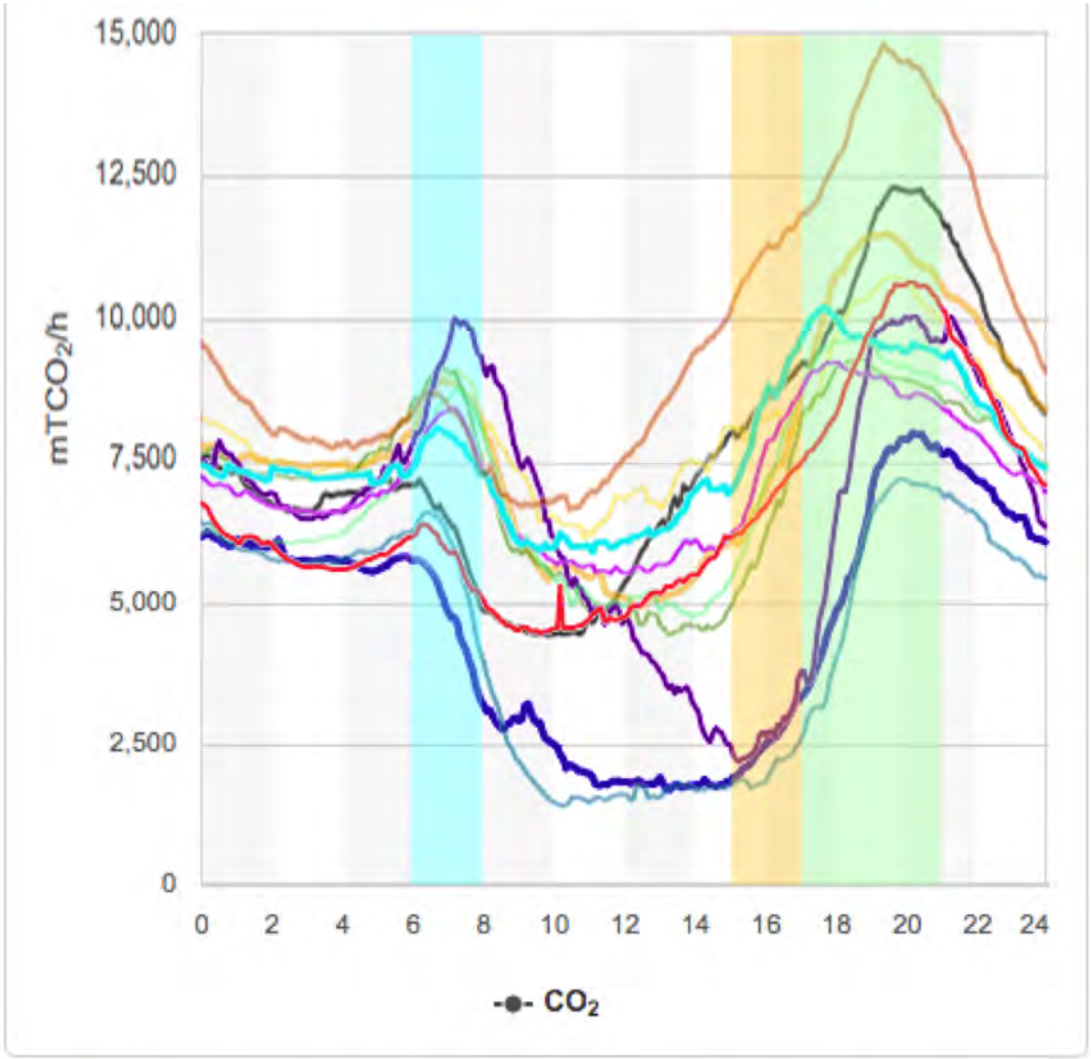
If they can come on at the ‘right time’…

instead of the ’random time’,

then schedulable and manageable
heat pump water heaters are worth
$9-20B annually to the CA grid…

and they can reduce the CA grid emissions
by over 6% per year!

12 months of CA ISO CO2 emissions



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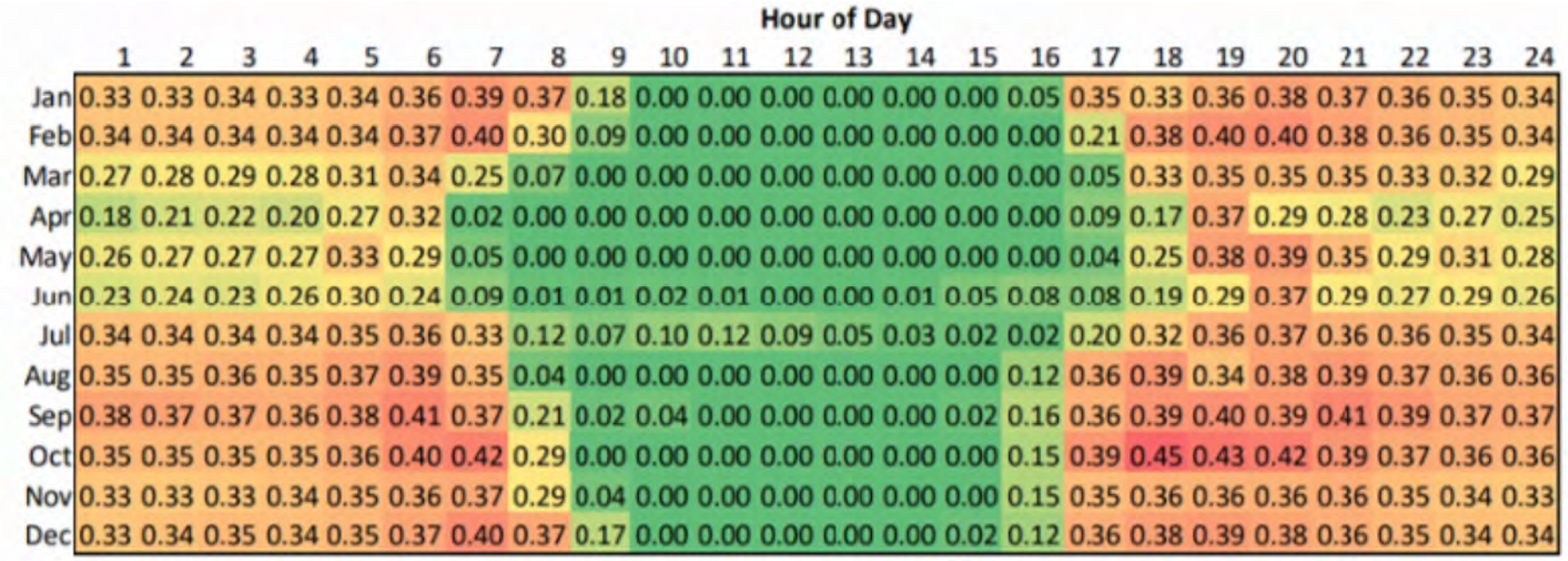
6-8 am
5-9 pm
3-5 pm

http://www.caiso.com/TodaysOutlook/Pages/Emissions.aspx

12 months of CA assumed marginal CO2 emissions*



	Hour of Day																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	0.33	0.33	0.34	0.33	0.34	0.36	0.39	0.37	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.35	0.33	0.36	0.38	0.37	0.36	0.35	0.34
Feb	0.34	0.34	0.34	0.34	0.34	0.37	0.40	0.30	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.38	0.40	0.40	0.38	0.36	0.35	0.34
Mar	0.27	0.28	0.29	0.28	0.31	0.34	0.25	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.33	0.35	0.35	0.35	0.33	0.32	0.29
Apr	0.18	0.21	0.22	0.20	0.27	0.32	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.17	0.37	0.29	0.28	0.23	0.27	0.25
May	0.26	0.27	0.27	0.27	0.33	0.29	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.25	0.38	0.39	0.35	0.29	0.31	0.28
Jun	0.23	0.24	0.23	0.26	0.30	0.24	0.09	0.01	0.01	0.02	0.01	0.00	0.00	0.01	0.05	0.08	0.08	0.19	0.29	0.37	0.29	0.27	0.29	0.26
Jul	0.34	0.34	0.34	0.34	0.35	0.36	0.33	0.12	0.07	0.10	0.12	0.09	0.05	0.03	0.02	0.02	0.20	0.32	0.36	0.37	0.36	0.36	0.35	0.34
Aug	0.35	0.35	0.36	0.35	0.37	0.39	0.35	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.36	0.39	0.34	0.38	0.39	0.37	0.36	0.36
Sep	0.38	0.37	0.37	0.36	0.38	0.41	0.37	0.21	0.02	0.04	0.00	0.00	0.00	0.00	0.02	0.16	0.36	0.39	0.40	0.39	0.41	0.39	0.37	0.37
Oct	0.35	0.35	0.35	0.35	0.36	0.40	0.42	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.39	0.45	0.43	0.42	0.39	0.37	0.36	0.36
Nov	0.33	0.33	0.33	0.34	0.35	0.36	0.37	0.29	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.35	0.36	0.36	0.36	0.36	0.35	0.34	0.33
Dec	0.33	0.34	0.35	0.34	0.35	0.37	0.40	0.37	0.17	0.00	0.00	0.00	0.00	0.00	0.02	0.12	0.36	0.38	0.39	0.38	0.36	0.35	0.34	0.34

Figure 8-1 Heat map of the assumed marginal emissions rate (metric tons of $CO_{2,eq}$/MWh), averaged by month and hour in 2030.

* Energy & Environmental Economics (E3), 2019. Residential Building Electrification in California Consumer economics, greenhouse gases and grid impacts.

Hourly Marginal Costs (2024 PG&E) – Annual Average*

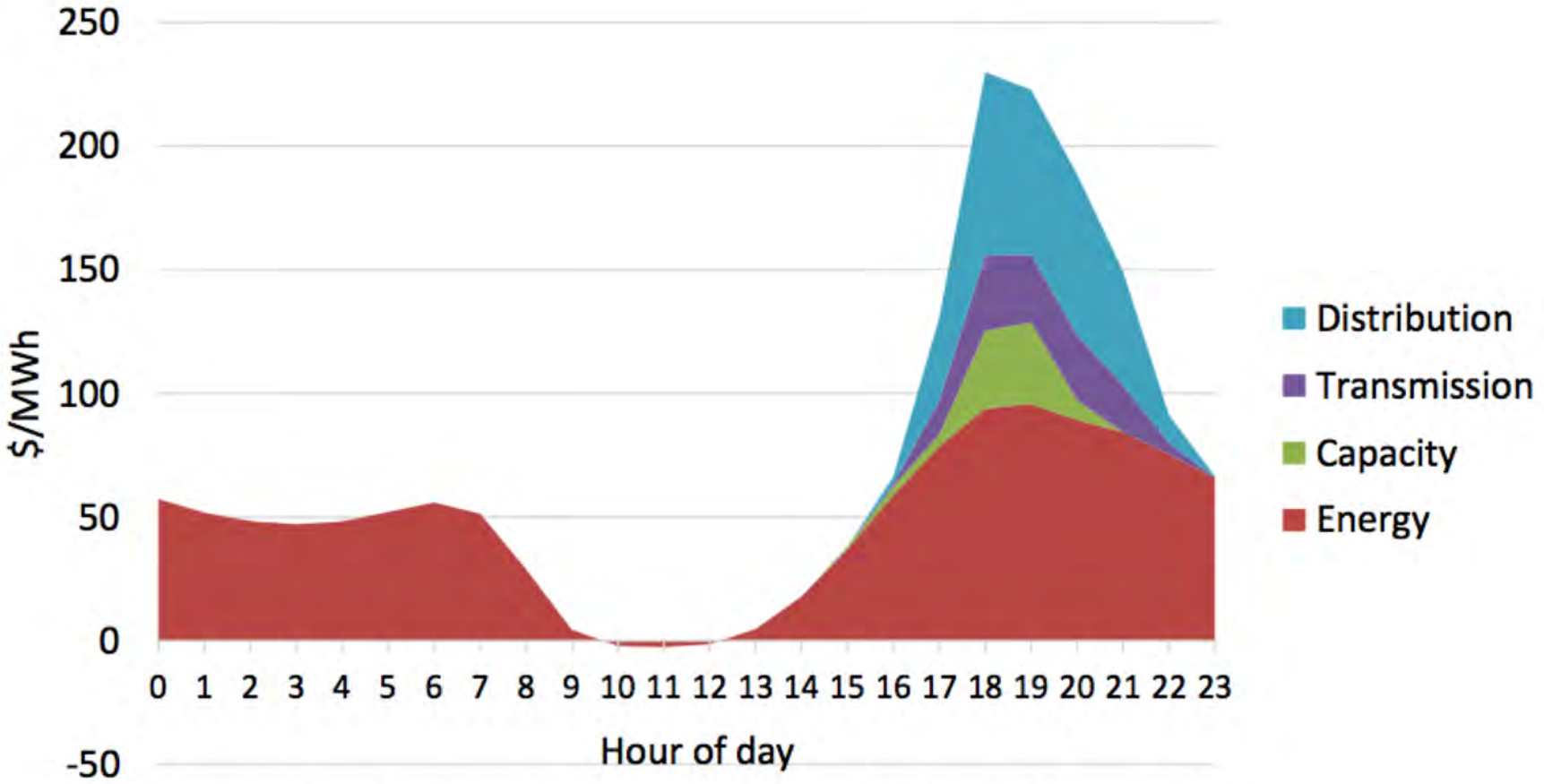


Chart shows annual average of hourly values for simplicity.
Price schedule has 8760 hourly values for entire year.

* Heat Pump Water Heater Demand Flexibility Study – Preliminary Results – NRDC & Ecotope

SMUD analysis on value of controlled HPWH*

Viewing Karen Janowitz'...

Central Water Heater Control Taxonomy

	Load control signal	Value to utility / society	Value to customer	Implementation issues
Load controlled directly by the utility or third-party implementers	Real time prices and/or marginal GHG signal from the utility	$$$ if utility ignores comfort... $$ if it doesn't	Depends on how much the utility passes through...	Third-party control perhaps most likely, to minimize cost and direct complaints to utility Hard to implement before occupancy
Load controlled by the device itself using onboard logic	Pre-published time-of-use rates from the utility	$	$$	Less expensive to implement Load could be highly mismatched with GHGs, for intermittent utilities

See: Ecotope, 2018, *Heat Pump Water Heat[illegible] ling Study*

* Ecotope, 2018, Heat Pump Water Heater Electric Load Shifting: A Modeling Study

SMUD analysis on value of controlled HPWH*

Operational savings depend on what controls optimize for:

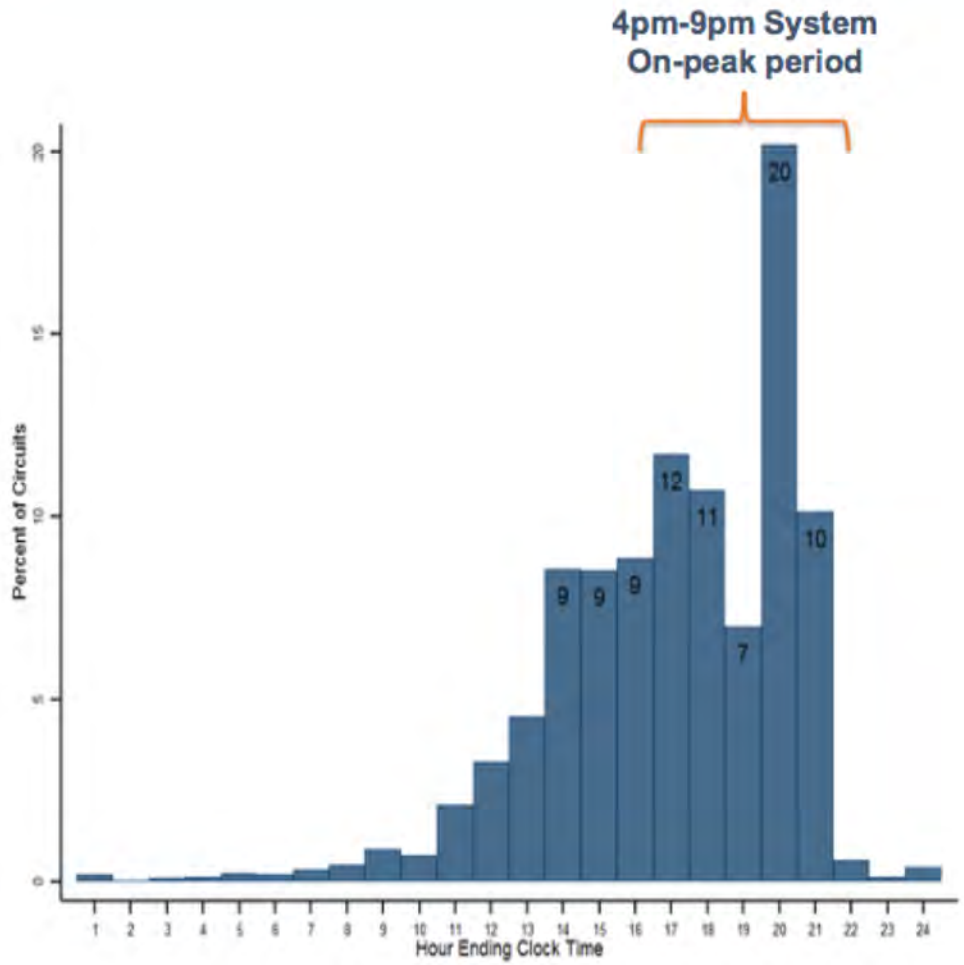
	Customer bill savings	Utility marginal cost savings
Optimizing for customer costs (TOU)	-15% to -20%	-35%
Optimizing for grid marginal costs	0% to +5%	-60%

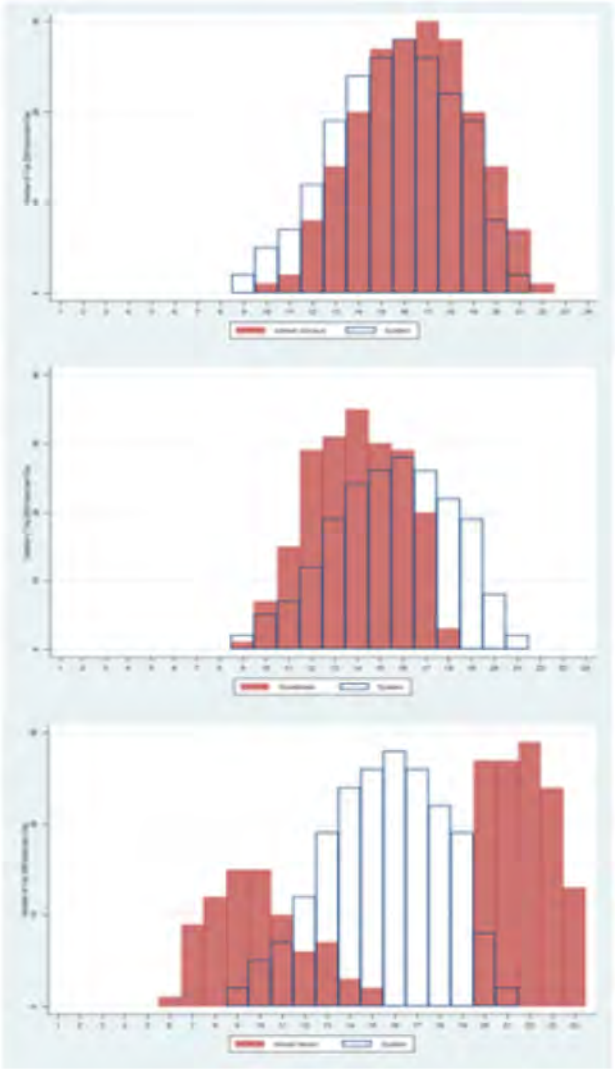
- Optimizing for customer bills yields significant cost savings for both customers and grid/society
- Optimizing for grid marginal costs can **potentially increase customer bills**.
  - Would requires different mechanism to compensate customers, e.g. free or discounted water heater, annual cash payment, etc…

* Ecotope, 2018, Heat Pump Water Heater Electric Load Shifting: A Modeling Study

SDG&E comparison of circuit & system peaks

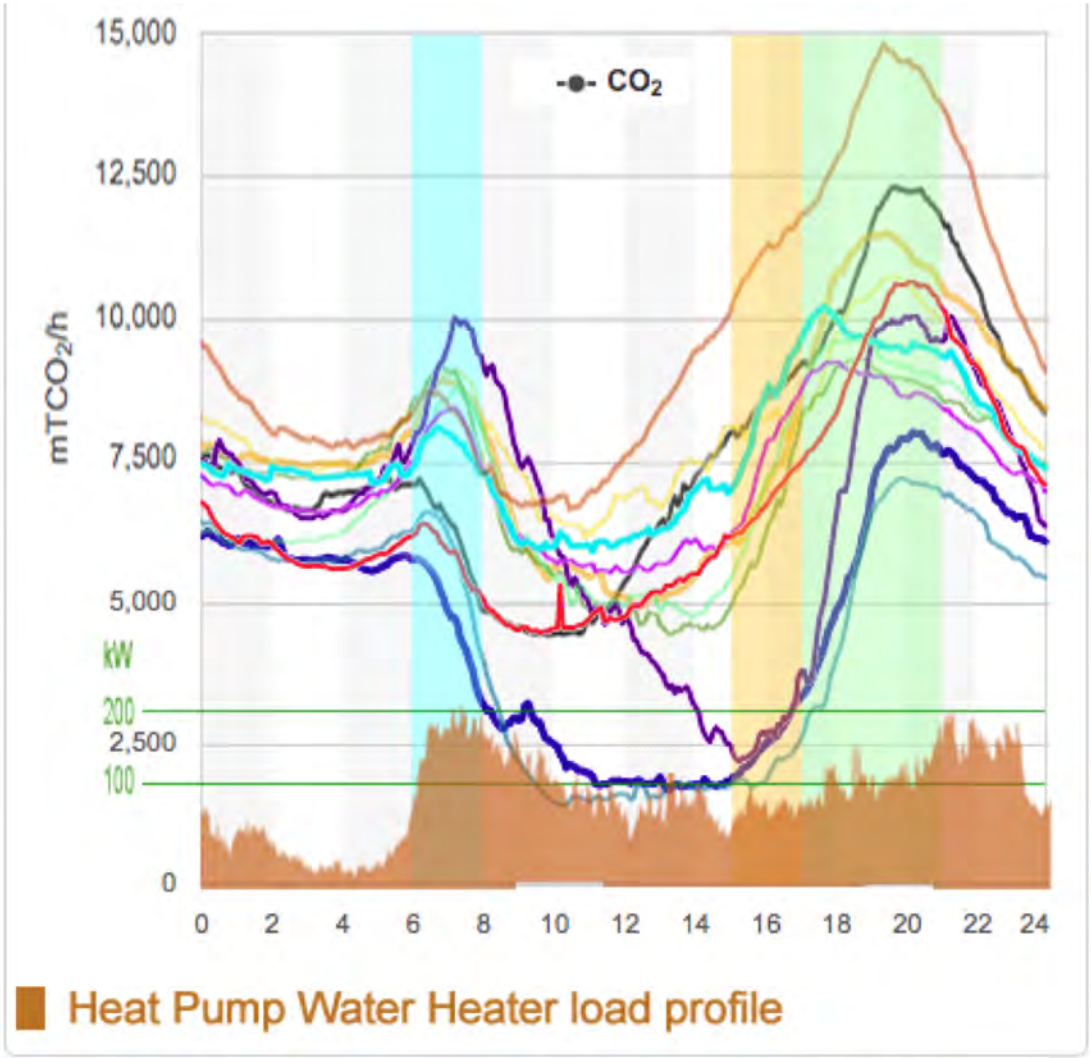
The timing of circuit peaks may not align with system peak





* Load Management Workshop - SDG&E - Power Your Drive - An Hourly Dynamic Rate Design.pdf

CA ISO CO2 emissions with water heater profile*



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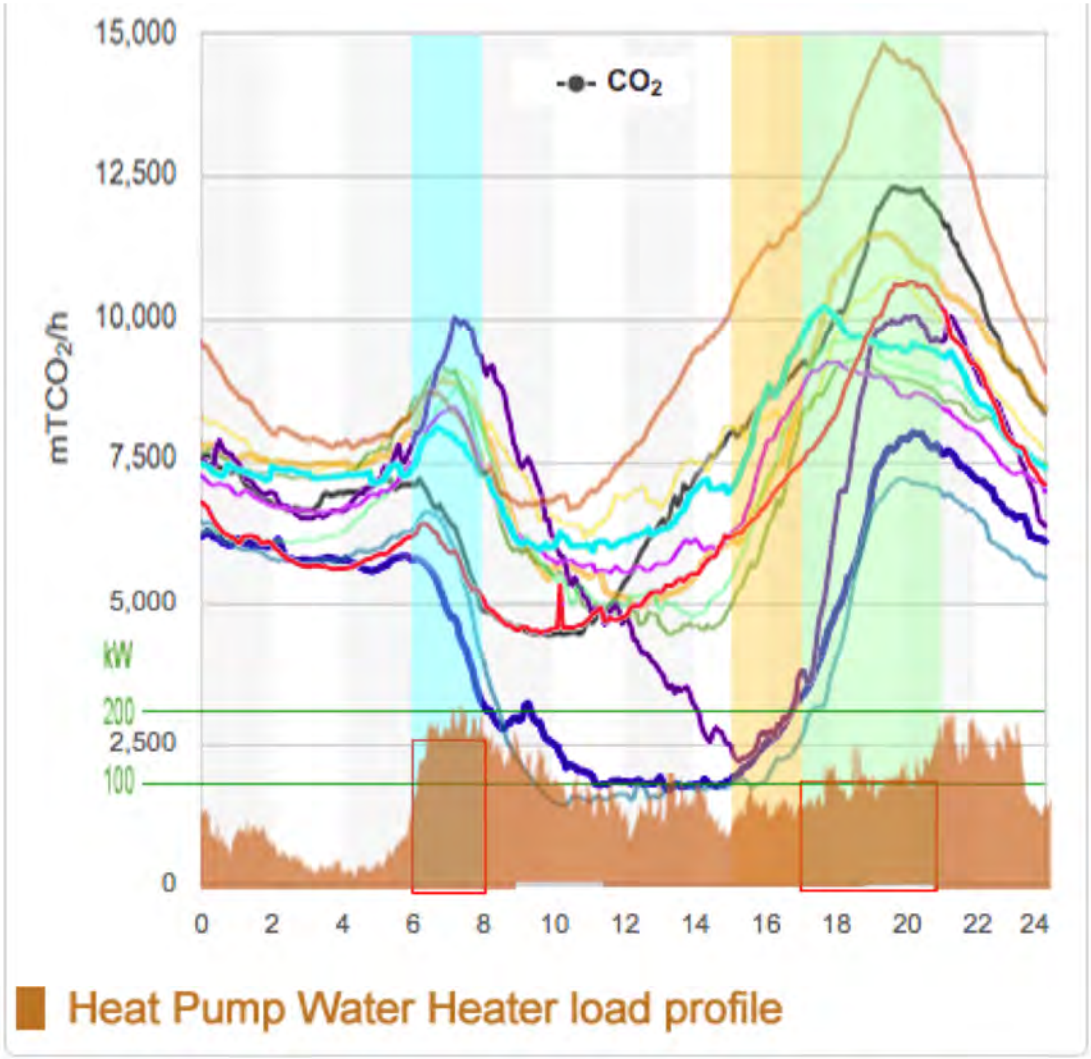
6-8 am
5-9 pm
3-5 pm

http://www.caiso.com/TodaysOutlook/Pages/Emissions.aspx

* Gurlaskie Session 7A Heat Pump Water Heater Duke Energy – ACEEE Hot Water Forum 2016 – Orange overlay of SkyCentrics data (see slides 28-30)
Also corroborated in the Navigant report titled “Cost-Effectiveness-of-DR-for-Residential-End-Uses-Final-Report-2019-04-18” (Table 2 – pg 6 [slide 31])

CO2 and water heaters align (red rectangles)



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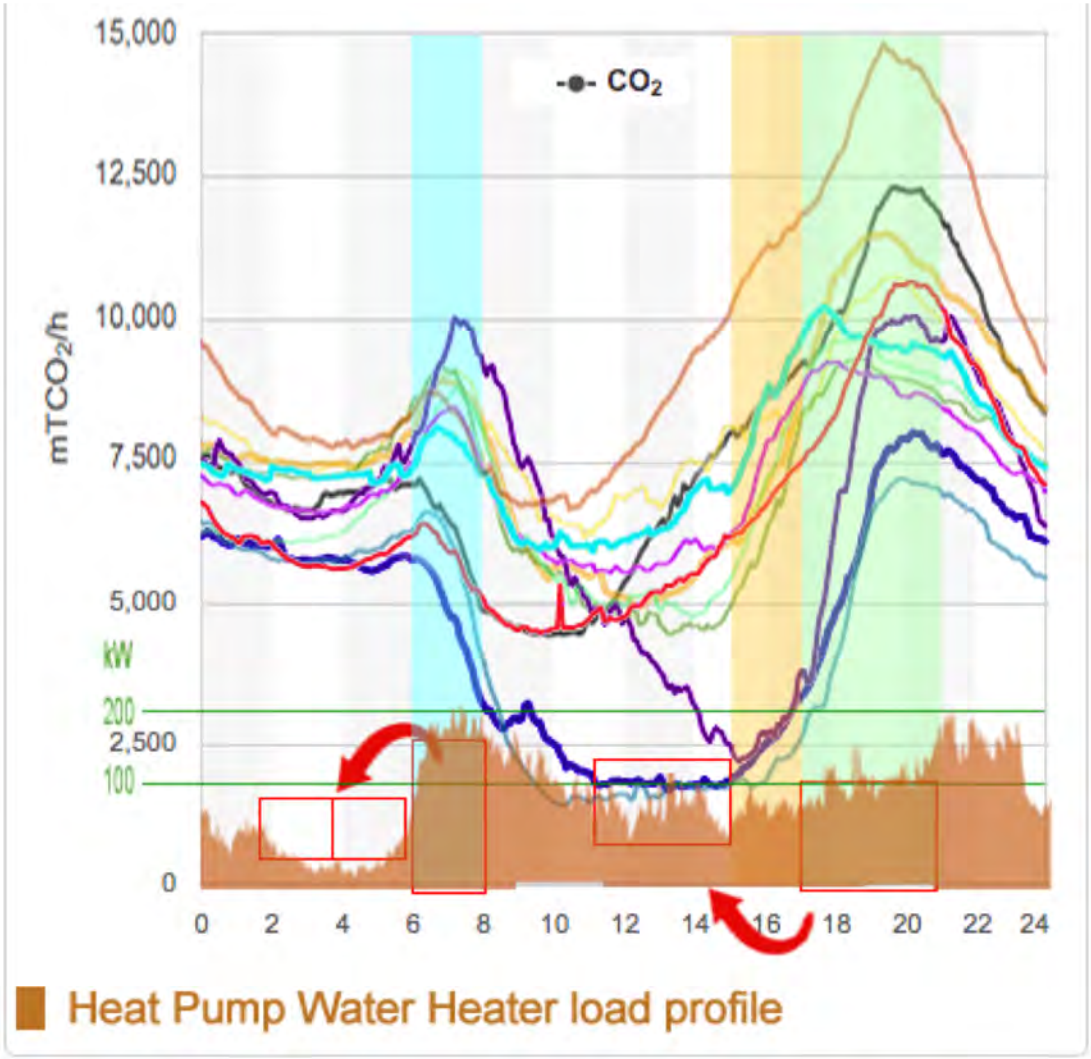
Water Heaters can shift to lower CO2 times



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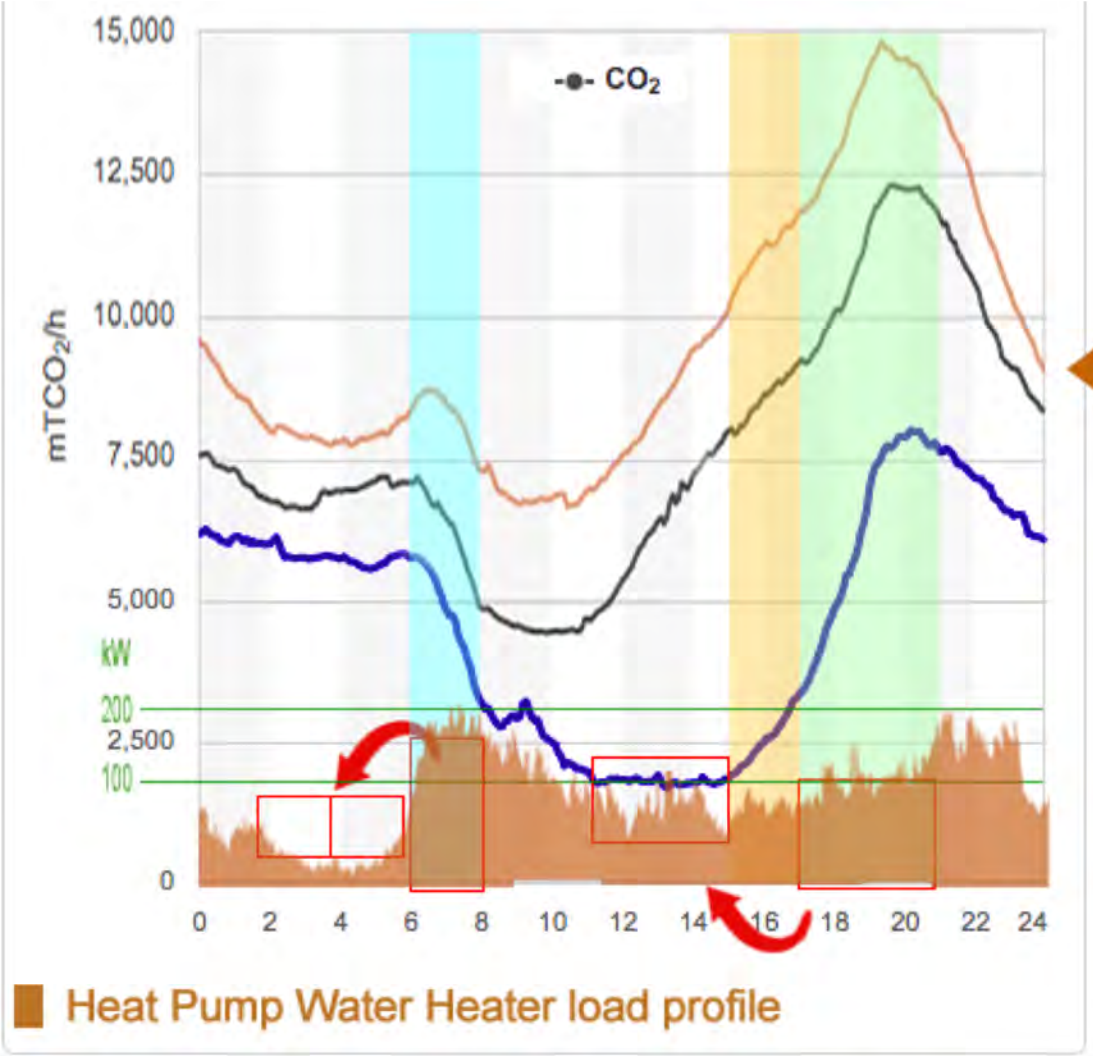
Peak CO2 month of August



Jun 10, 2020

May 15, 2020

Aug 15, 2019

6-8 am

5-9 pm

3-5 pm

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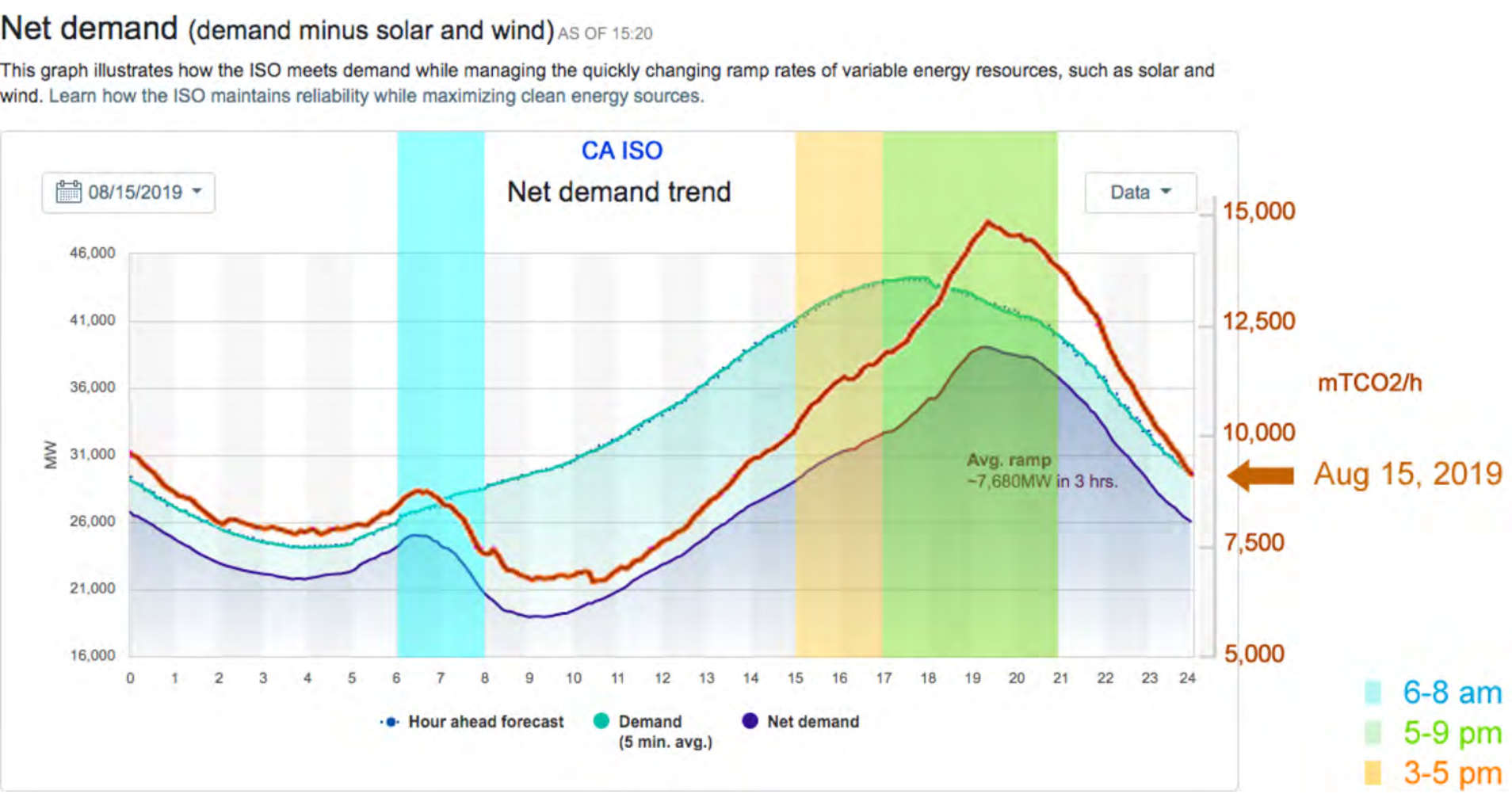
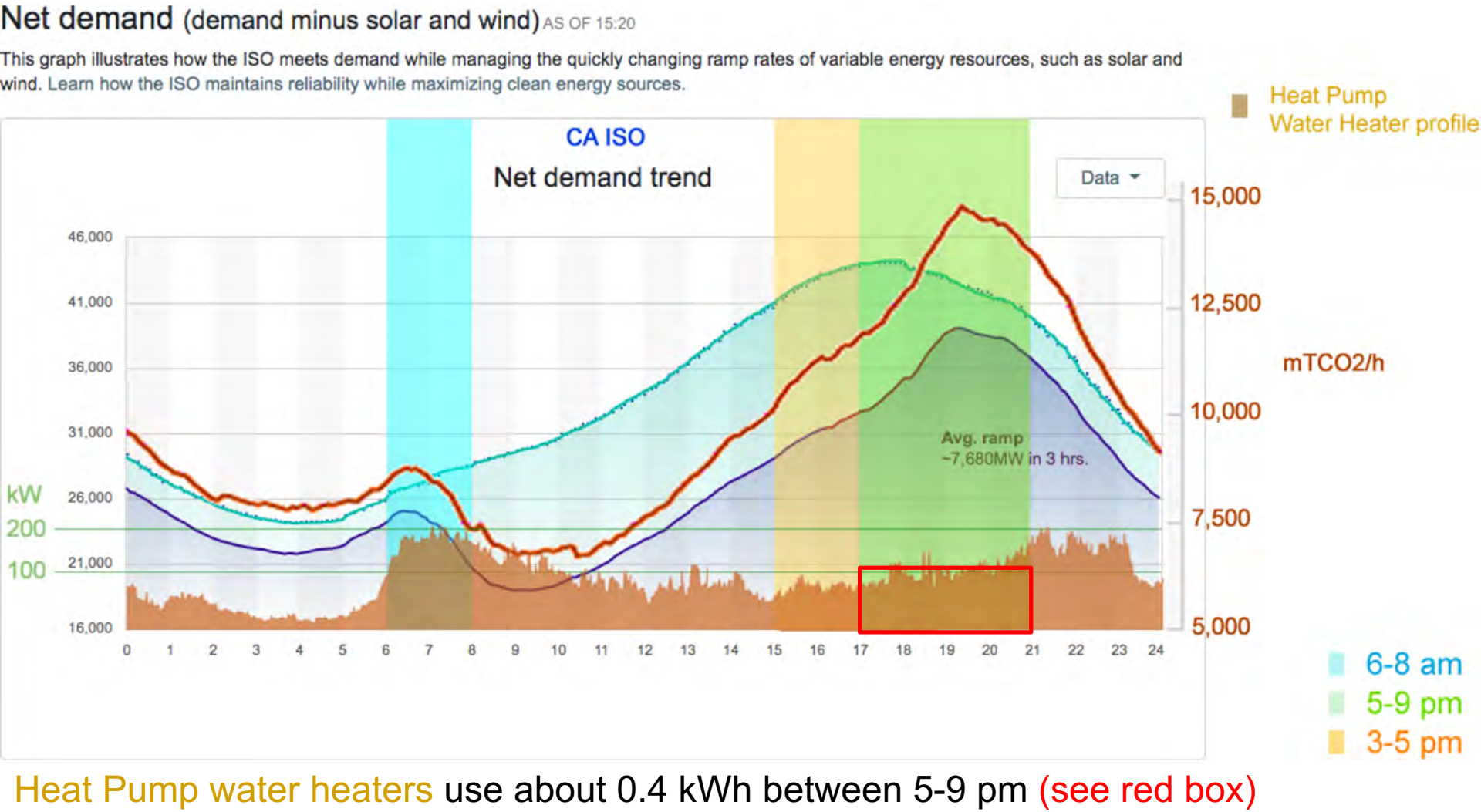
Aug' 19 CO2 mapped onto CA ISO Net Demand



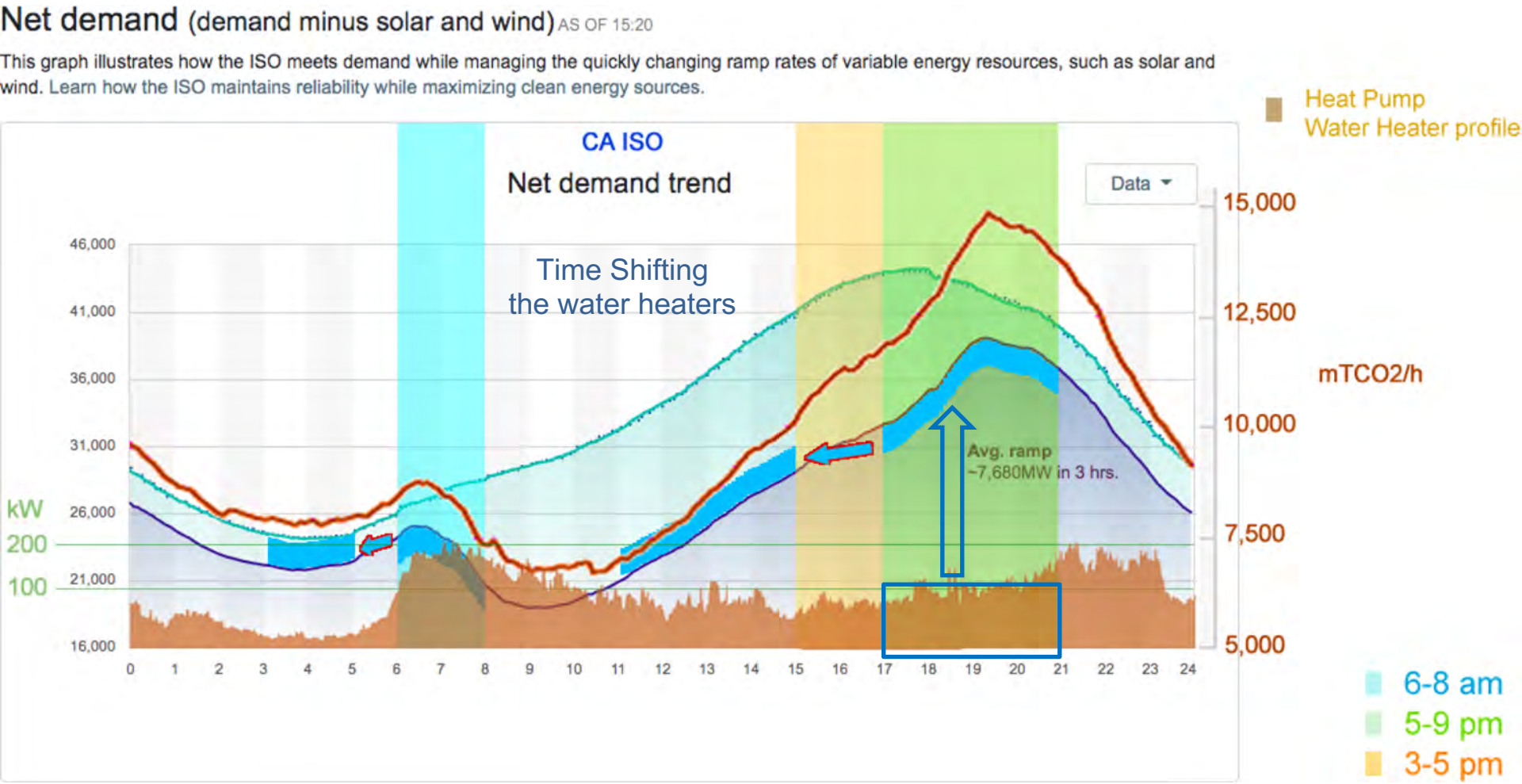
Note how the CO2 curve matches the Net Demand Curve

Net Demand, CO2 and water heater profiles



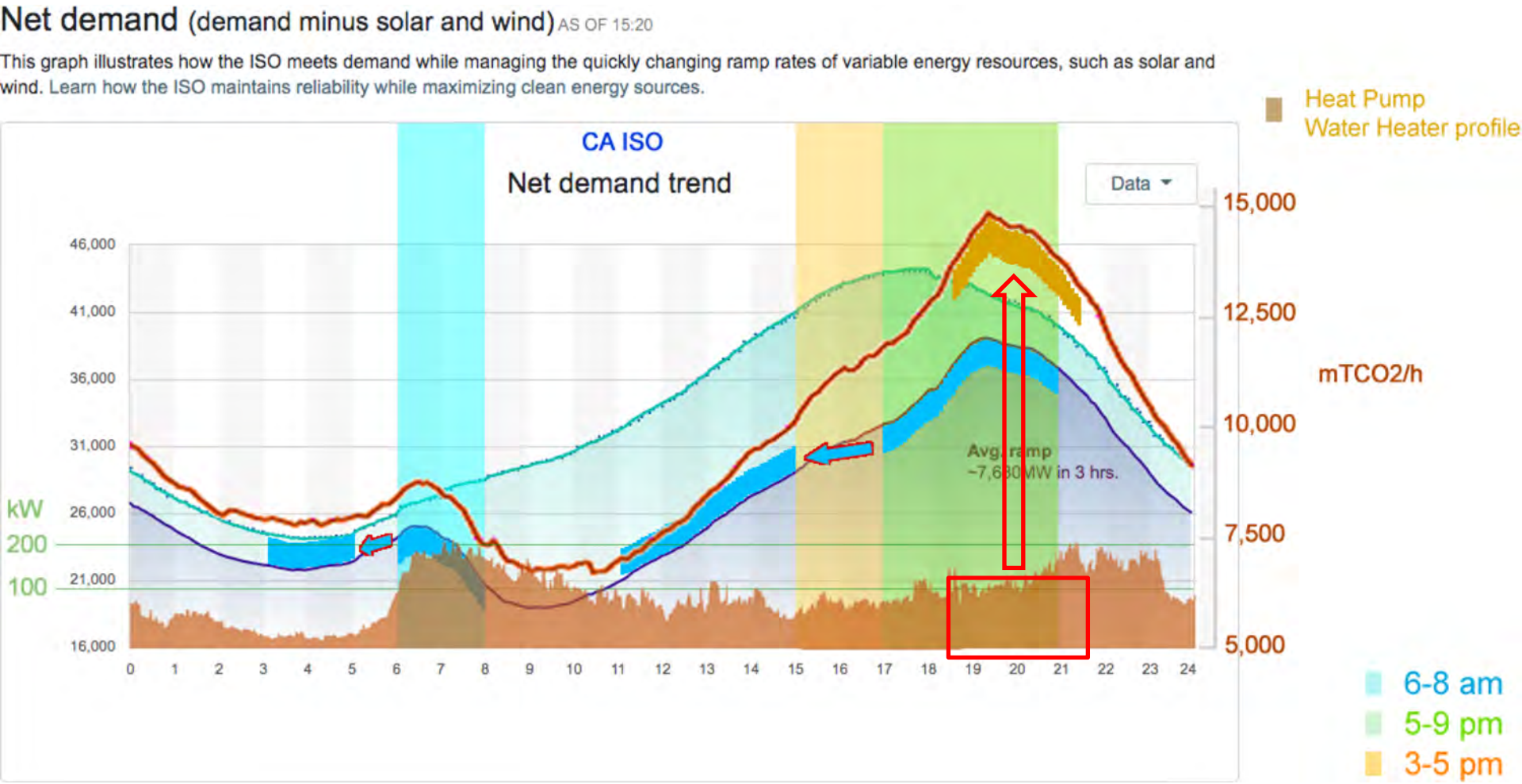
Heat Pump water heaters use about 0.4 kWh between 5-9 pm (see red box)
13M would use 1.3 GW every hour or a total of 4.2 GWh
During that time, the net demand on the grid is about 38 GW every hour (38,000 MW)
13M water heaters would account for 3.3% of the net demand (first add the 1.3 + 38 GW).

13M HP Water heaters reducing peak by 3.3%



The blue area is what could be time shifted to earlier in the day,
saving 3.3% of peak in August when net demand is at its highest (38 GW),
about 4.5% in the winter peak (since net demand is between 25-30 GW),
And up to 5% in the spring (March-May, when net demand is between 23-25 GW).

13M HP Water heaters reducing CO2 by 3.3%

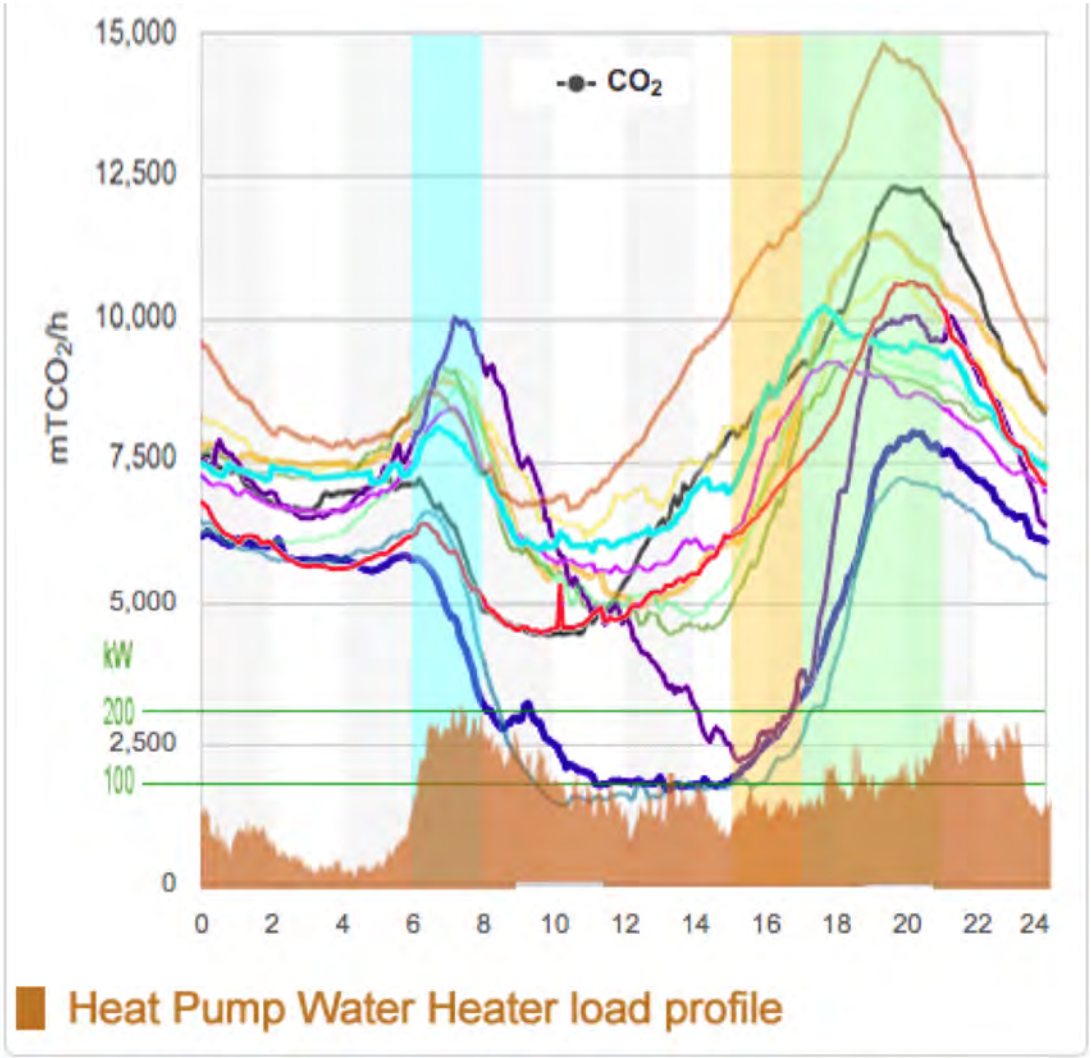


The orange area represents a reduction of 3.3% of CO2 that could be expected to be reduced because of the 3.3% reduction in peak demand shown.

And we would be reducing the peak net demand by 3-5% every day of the year

* 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 heater profile*



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

http://www.caiso.com/TodaysOutlook/Pages/Emissions.aspx

* Gurlaskie Session 7A Heat Pump Water Heater Duke Energy – ACEEE Hot Water Forum 2016 – Orange overlay of SkyCentrics data (see slides 28-30)
Also corroborated in the Navigant report titled “Cost-Effectiveness-of-DR-for-Residential-End-Uses-Final-Report-2019-04-18” (Table 2 – pg 6 [slide 31])

Interpreting the value of water heaters to grid

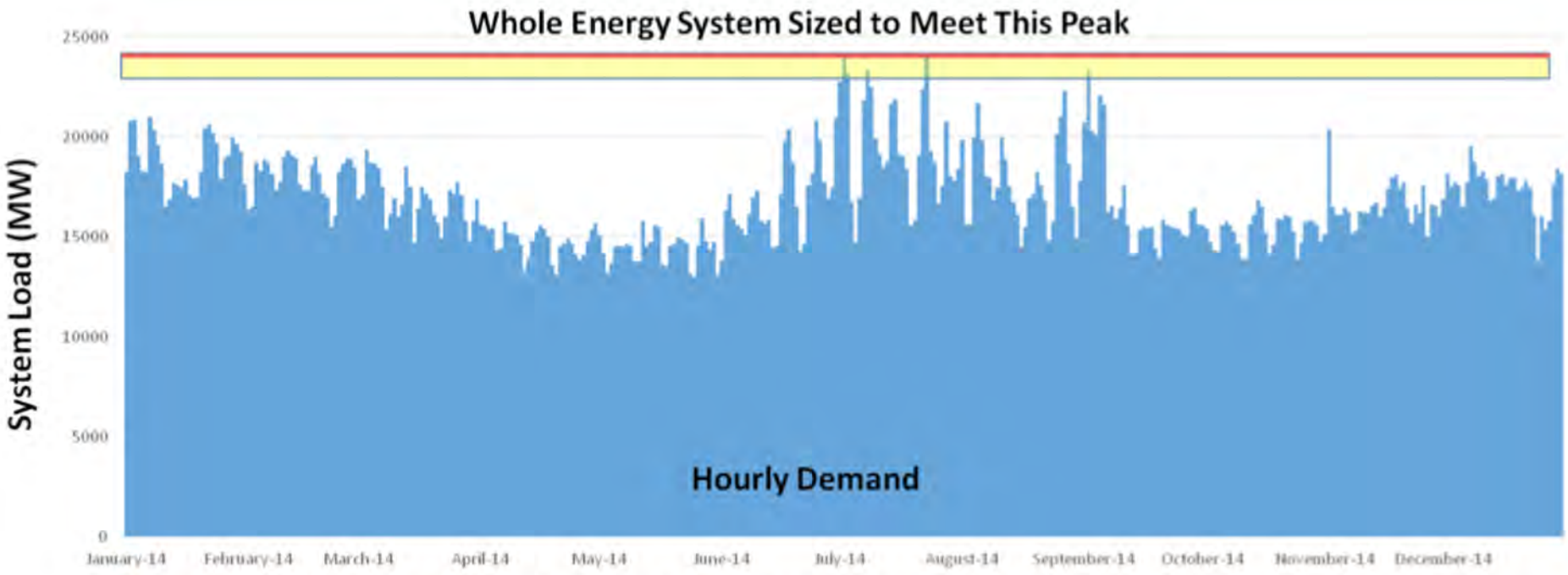


Figure 2: The whole electricity system is sized to meet peak demand

"Over the last three years from 2013 – 2015 on average, the top 1% most expensive hours accounted for 8% ($680 million) of Massachusetts ratepayers' annual spend on electricity. The top 10% of hours during these years, on average, accounted for 40% of annual electricity spend, over $3B [per year]."

- State of Charge - Massachusetts Energy Storage Initiative Study

Detailed Value of Water Heaters to grid

CA annual spend is about 5x MA

If the numbers are similar, then:

The top 1% most expensive hours would account for 5 x $680M = $3.4B

The top 10% of hours would account for 5 x $3B = $15B

13M managed heat pump water heaters could shave 3.3% off of the peak every day.

Using the 1% number, we get a value of 3.3 x $3.4B = $11B annually

Using the 10% number, we get a value of 6 x ($15B/10) = $5B annually

The only problem is CA's water heaters are gas.
Let's get busy making them electric!

Why the native CTA-2045 port is critical

With this value to the grid, at a scale of 13M water heaters, we need 'bombproof and secure' communications. Customer Wi-Fi has been shown to have large amounts of devices 'dropping off.'

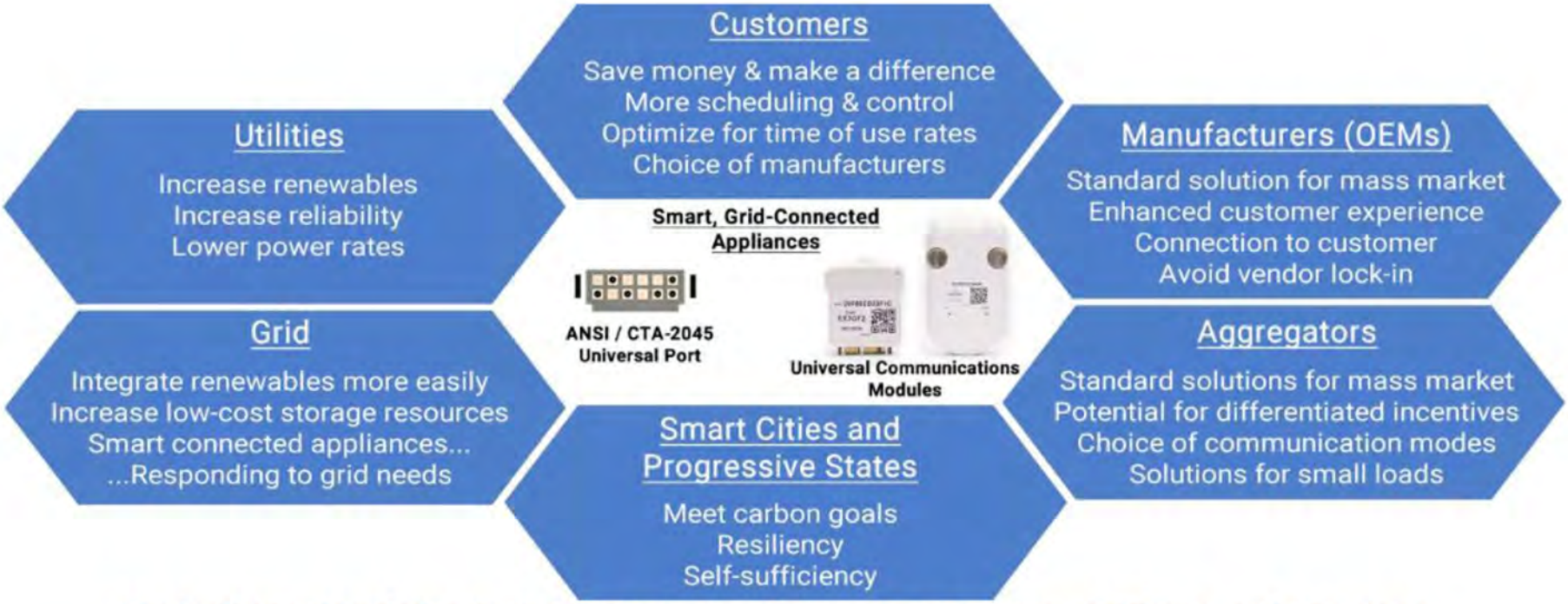
Low cost cellular, AMI mesh and other communication paths are coming to be available. With a CTA-2045 port, the appliance can be retrofitted to these communications at any time. Is there any other way to guarantee this 'future proof' flexibility?

If manufacturers choose to have their own communications to their appliance (some have, some have not), the CPU that they use to enable their own communications can easily add the CTA-2045 functionality.

States such as WA and OR have agreed to mandate the port. As more states come online, the marketing dollars can combine into one common message.

"Look for CTA-2045 inside"

The value to the stakeholders



Market Map: Market actors and their specific needs, value propositions, and use cases

More About Open Standards

- CTA-2045, OpenADR and Heat Pump Water Heater studies https://skycentrics.com/studies/
- CTA-2045 Water Heater Demand Response (SkyCentrics) https://www.youtube.com/watch?v=baPmqPgQhDE
- AO Smith SkyCentrics CTA-2045 hardware install - https://www.youtube.com/watch?v=-oLVHxGaZAM
- AO Smith SkyCentrics CTA-2045 connect Wi-Fi - https://www.youtube.com/watch?v=B_Yy_zLR17w
- EPRI CEA-2045 Field Demonstration Project (EPRI) https://www.youtube.com/watch?v=BHMssq6_R94
- Alexa voice control of PTAC (SkyCentrics) https://youtu.be/YSQaxz2tzUM
- Water heaters, as sexy as a Tesla? (Rocky Mountain Institute) https://www.rmi.org/news/water-heaters-sexy-tesla/
- Economic Sizing of Batteries for the Smart Home (NREL) https://www.nrel.gov/docs/fy18osti/70684.pdf
- Email me at info@skycentrics.com for the white paper on OpenADR and CTA-2045

Questions

Tristan@skycentrics.com

415.962.1505

Clean Coalition Presentation

Craig Breaden, Lead Integration Engineer
Smarter Grid Solutions
July 2020

Who are Smarter Grid Solutions?

Global software company with European Head-Quarters

Multi-use case DERMS interfacing to the grid and market unlocks the true value of DER

Implementing and managing 1.5 GW of DER, with near-term projects to reach 3 GW

Flexible technology means ability for partners to create unique propositions / IP

Continuous R&D on top of foundational platform ensures continued market leadership

World-class reference customers operationally using our technology

Breadth and depth of team covering the technical and commercial aspects of the market

Flexible architecture to configure and scale deployments relevant to customer requirements

Our purpose is to develop and deliver the most flexible and scalable DER management software platform that enables energy companies to create and implement solutions for the transition to net zero carbon emissions.

smarter grid solutions

Track record and engagement in the most advanced markets

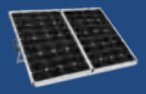
smarter grid solutions

Track record of DER types

BATTERIES:

- SHETLAND MICROGRID — Scottish & Southern Electricity Networks
- RAIN — TEP Tucson Electric Power
- ENTERPRISE DERMS — UK Power Networks
- MYRES HILL — LOTTE CHEMICAL
- ENTERPRISE DERMS — hydro one
- RESILIENT ZONES — NORTHERN POWERGRID
- ENERGY AS A SERVICE — sse

PV:



- EASE & IGP — SOUTHERN CALIFORNIA EDISON
- ISLE OF WIGHT — Scottish & Southern Electricity Networks
- RAIN — TEP Tucson Electric Power
- ENTERPRISE LICENCE — WESTERN POWER DISTRIBUTION
- FICS — AVANGRID
- ENTERPRISE DERMS — UK Power Networks
- ENERGISE
- FLEXIBLE PLUG & PLAY — UK Power Networks

WIND:

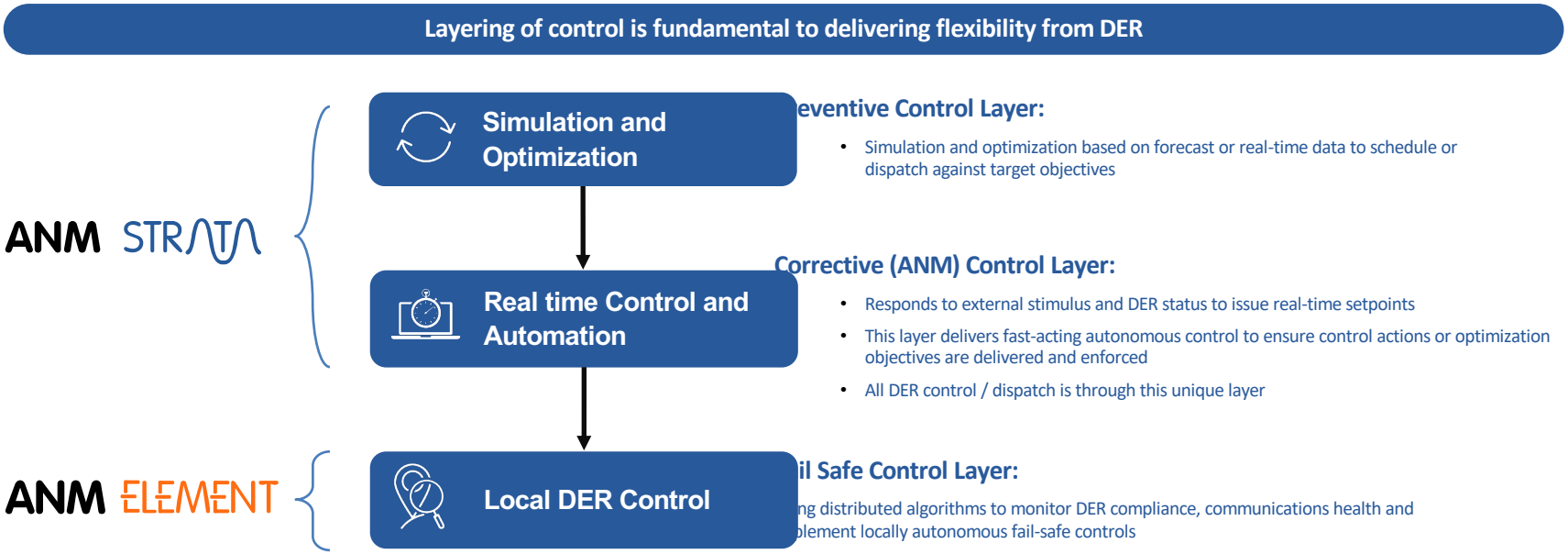
- ORKNEY ANM — Scottish & Southern Electricity Networks
- ENERA — ewenetz
- ARC — SP ENERGY NETWORKS
- CORBY/BRIDGWATER — WESTERN POWER DISTRIBUTION
- WESTERN ISLES — Scottish & Southern Electricity Networks
- FLM — SP ENERGY NETWORKS
- FLEXIBLE PLUG & PLAY — UK Power Networks

LOAD:

- LOW CARBON LONDON — UK Power Networks
- OPTIMISED — LAING O'ROURKE
- MICROGRID RESILIENCY — NREL
- RAIN — TEP Tucson Electric Power
- ENTERPRISE DERMS — hydro one
- RESILIENT ZONES — NORTHERN POWERGRID
- SHETLAND MICROGRID — Scottish & Southern Electricity Networks
- ENERGY AS A SERVICE — sse

smarter grid solutions

Our philosophy is a layered approach to control



Track record of Use Cases

GRID MANAGEMENT	ORKNEY ANM	ENERA	ARC	CORBY/BRIDGWATER	WESTERN ISLES	FICS	ENTERPRISE DERMS
FLEXIBILITY SERVICES	EASE	LOW CARBON LONDON	RAIN	ENTERPRISE LICENCE	ENTERPRISE DERMS		
MICROGRIDS	HYDRO QUEBEC	IGP	MICROGRID RESILIENCY	SHETLAND MICROGRID	RESILIENT ZONES		
NON-WIRES ALTERNATIVES	ENERGISE	RESILIENT ZONES	ENTERPRISE DERMS	REV DEMO			
STACKED REVENUES*	NYISO	OPTIMISED	MYRES HILL	ENERGY AS A SERVICE			

List of current SGS projects

* Stacked revenues are where more than one value stream or market is being accessed by the same resource

Case Study – Tucson Electric Power (TEP)

Creating a Virtual Power Plant From Multiple Device Types

smarter grid solutions

Tucson Electric Power

Problem

In collaboration with EPRI, our customer sought to demonstrate the technologies and processes to handle mass consumer take up of PV and other consumer level DER. The DERMS was required to demonstrate connectivity and control of all consumer types of residential DER (PV, storage, EVs) connected via a range of protocols and standards.

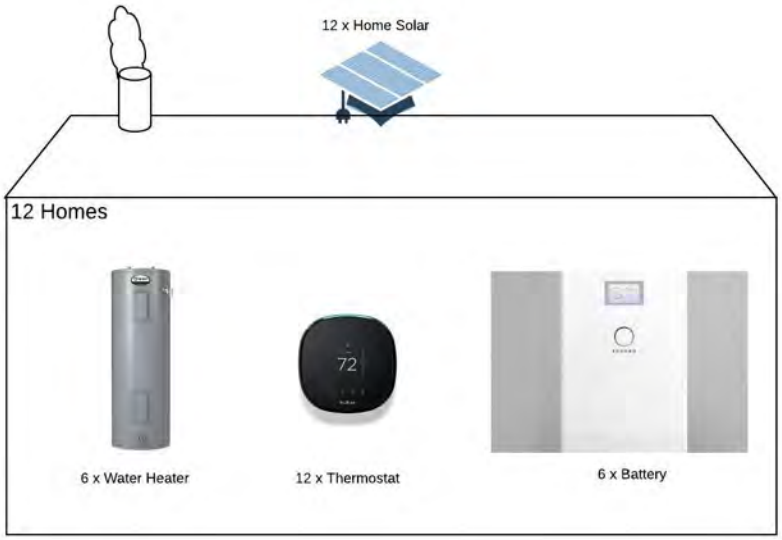
Solution

ANM Strata was deployed in a private cloud architecture to integrate PV using Sunspec Modbus, and Sonnen Batteries and EV charging using OpenADR.

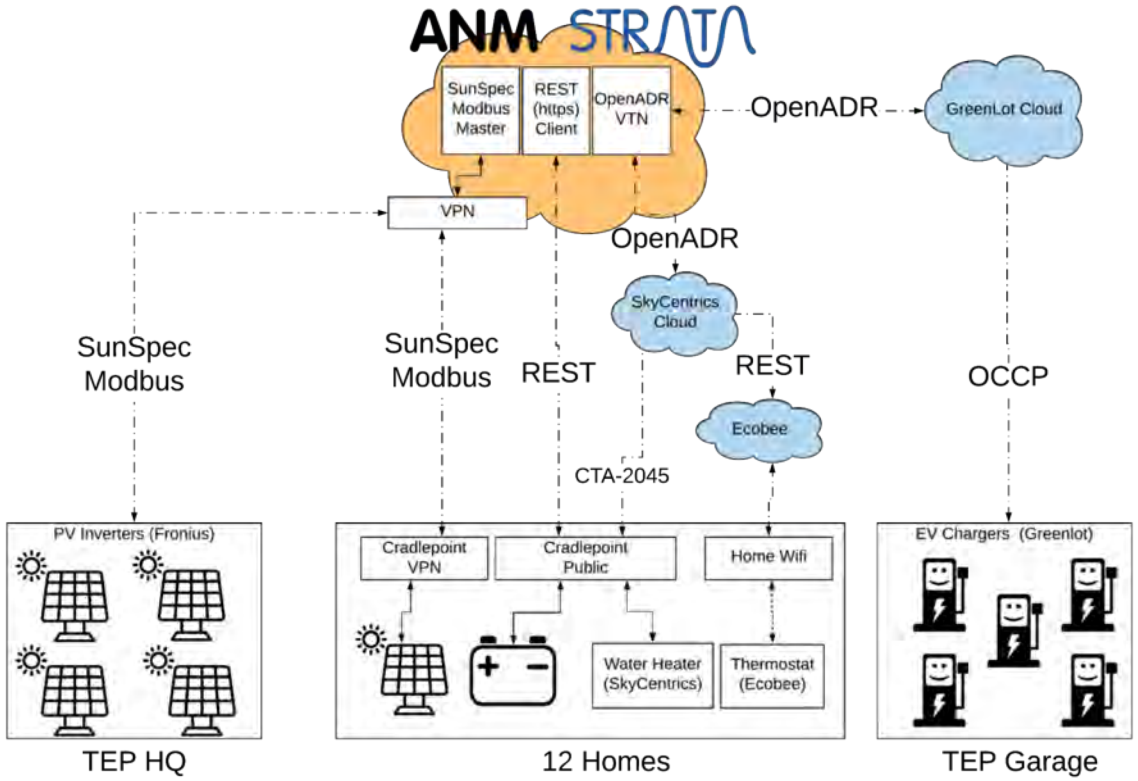
Result

Successfully demonstrated the integration of all DER devices and the process to scale up to 400,000 customers.

Tucson Electric Power



Tucson Electric Power



Protocol Intro – Open & Proprietary

- SunSpec - Industry Standard for Solar
  - Data Model built on Modbus
  - Centralised controller sends commands to Inverters
- OpenADR – Industry Standard for Demand Side Resources
  - Virtual Top Node (VTN) generates events
  - Virtual End Node (VEN) polls/retrieves the event
- Proprietary API
  - REST calls (e.g. ${URL}/api/v1/setpoint/charge/${setp

SunSpec Modbus

- Plug & Play(*-ish*)
- Reasonably simple configuration
- Provide an IP Address and it will scan the device, pulling back the relevant information
- Scales well
- Behaviors subject to firmware versions

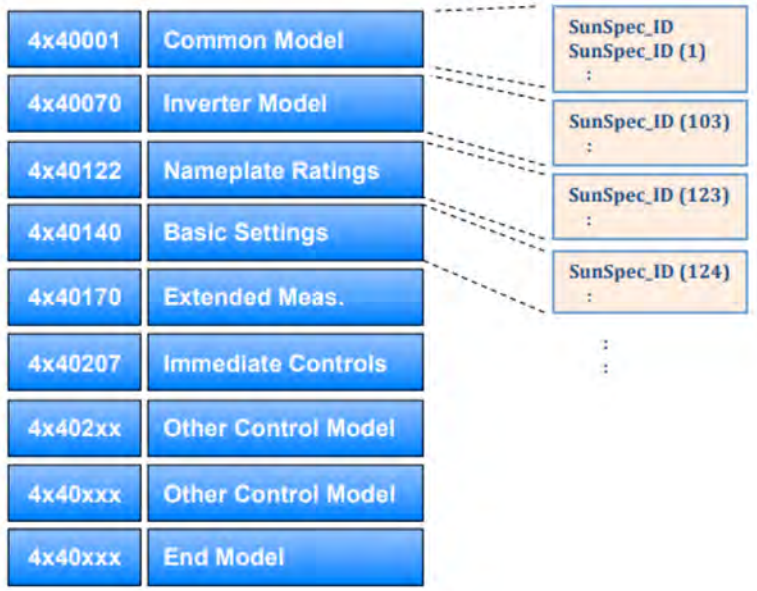


Figure 1: Chained Inverter Control Models

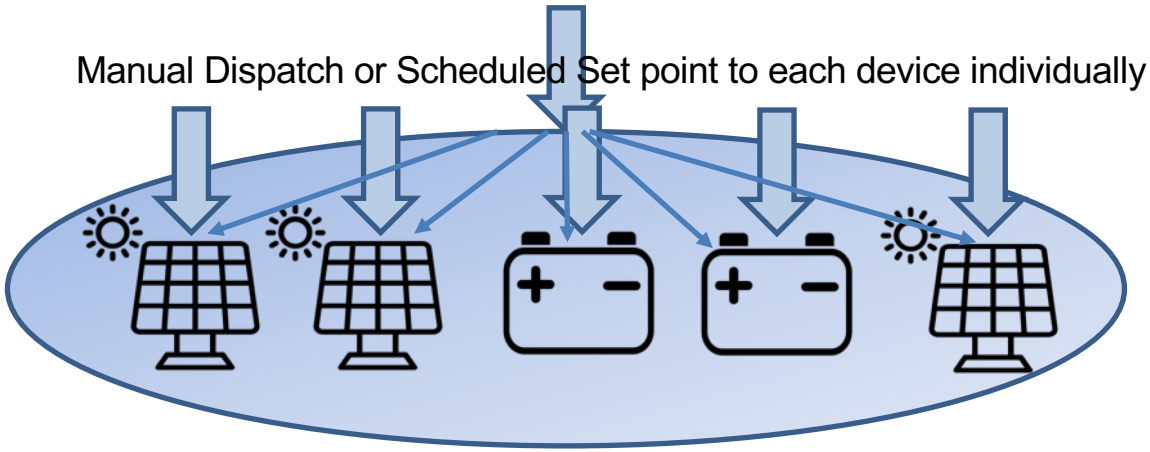
OpenADR

- Simple Level Mappings
- Flexible Integration: ‘ResourceID’ vs ‘MarketContext’
- Requires interpretation of the standard and co-ordination with vendors

Sonnen Batteries

- Proprietary API
- Easy to control:
  - *Send Setpoint*
  - *Set Mode*
- Not a scalable solution
  - *Unique per vendor*

Aggregation & Grouping



Device Harmonization

- Multiple dispatchable level for all devices
- Single operator action
- Heterogenous grouping:
  - *By home*
  - *By feeder*
  - *By commercial agreement*
  - *Etc.*

Project Takeaways

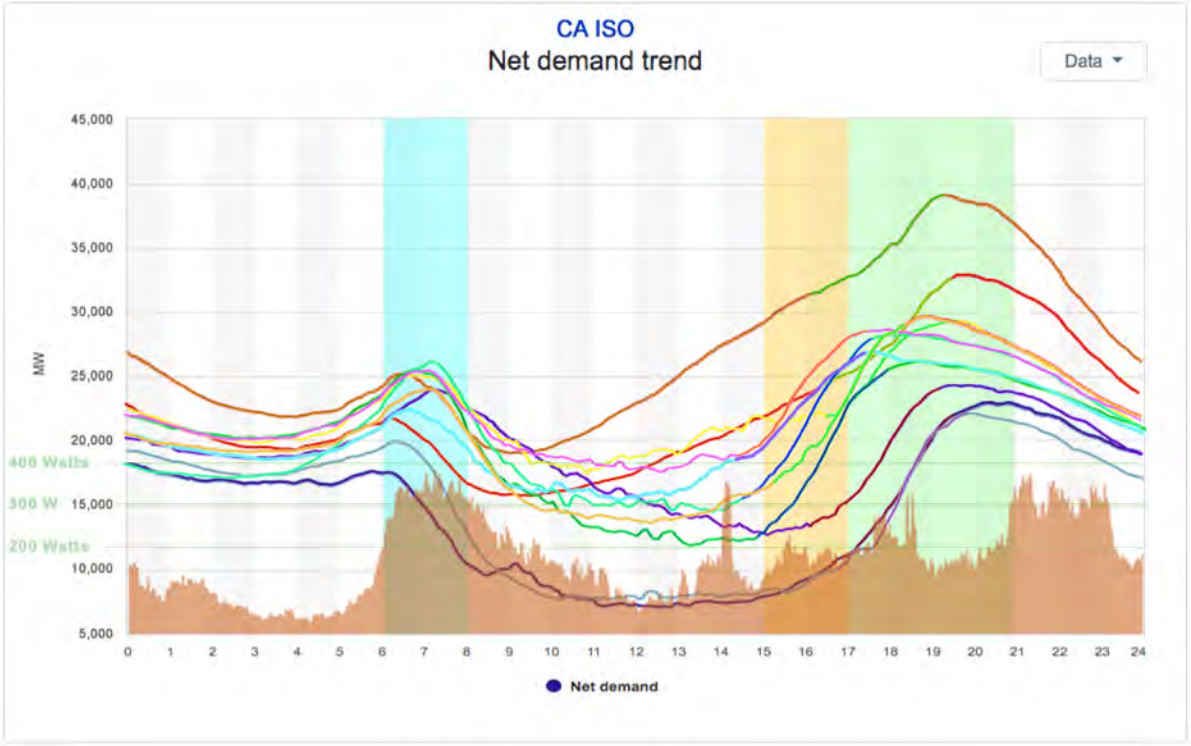
- DERMS can reduce complexity for an operator
- Standardization goes a way to scaling these types of deployments
- Standardization is not exclusively ‘Interoperability’ or ‘Plug & Play’
- Collaborate with vendors early:
  - *Align expectations*
  - *Set out the rules of the game*
  - *Frequently test*
- Learning Reports: https://www.epri.com/research/products/000000003002017454

Contact Details

- Craig Breaden – cbreaden@smartergridsolutions.com

Backup slides

CA ISO Net Demand 12 month graphs

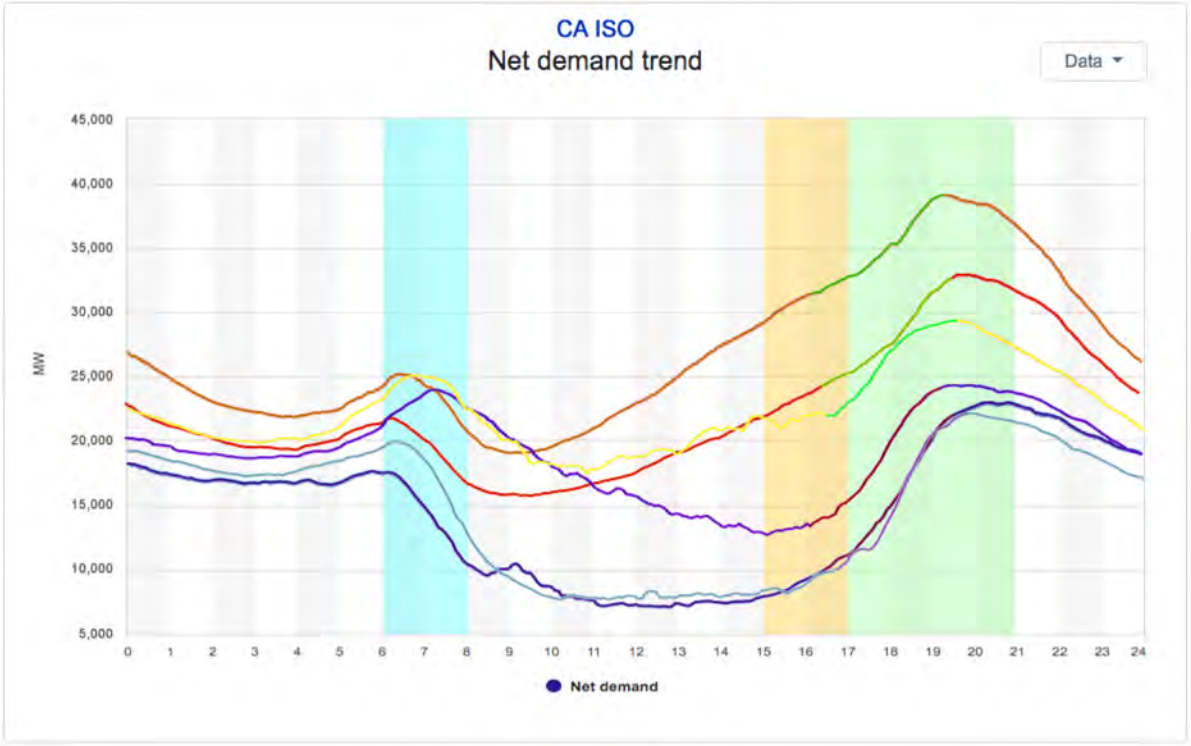


	Ramps	
Jun 10, 2020	08,838 MW	4:20 - 7:20
May 15, 2020	11,978 MW	4:30 - 7:30
Apr 15, 2020	11,816 MW	4:50 - 7:50
Mar 13, 2020	10,695 MW	4:15 - 7:15
Feb 14, 2020	12,765 MW	2:50 - 5:50
Jan 15, 2020	12,067 MW	2:30 - 5:30
Dec 13, 2019	09,598 MW	2:30 - 5:30
Nov 15, 2019	08,172 MW	2:20 - 5:20
Oct 15, 2019	12,102 MW	3:20 - 6:20
Sep 16, 2019	07,405 MW	4:30 - 7:30
Aug 15, 2019	07,680 MW	4:10 - 7:10
Jul 15, 2019	08,311 MW	4:30 - 7:30

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

Note that August is the largest peak net demand by a substantial amount

CA ISO Net Demand 12 month graphs



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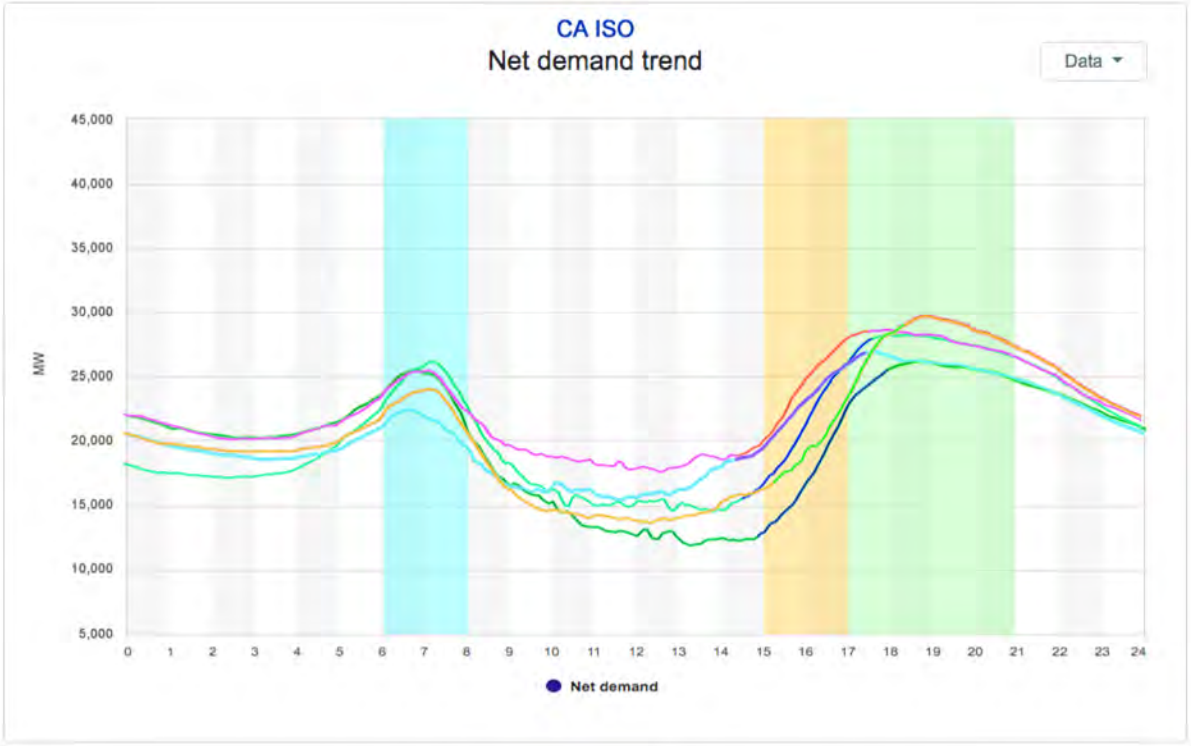
Jul 15, 2019	08,311 MW	4:30 - 7:30

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

Note that July, August and September are the high peak net demand months in CA 28-39 GW

Spring months (Mar-Apr-May) are the low peak net demand months in CA 22-25 GW

CA ISO Net Demand 12 month graphs



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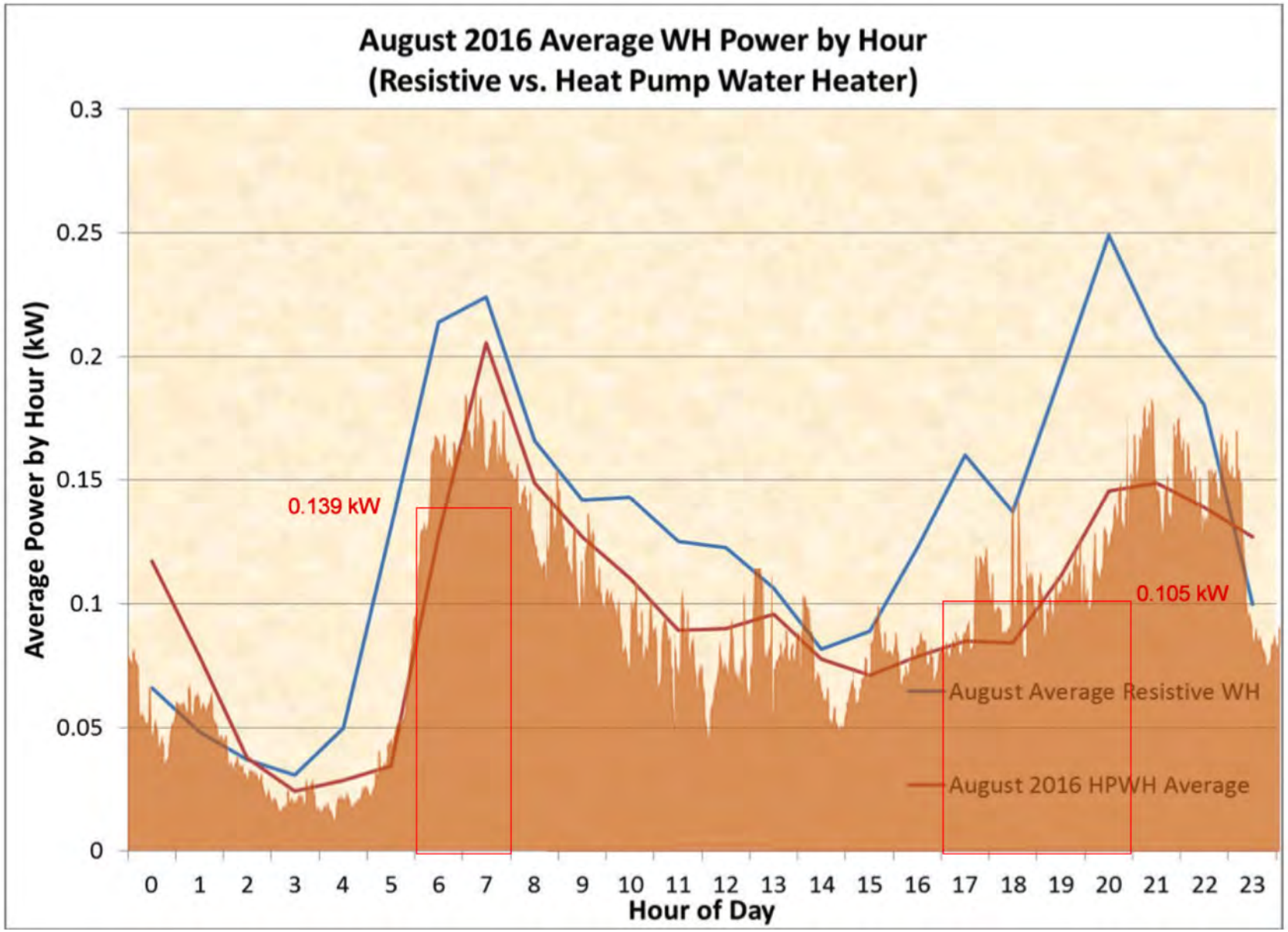
Nov 15, 2019	08,172 MW	2:20 - 5:20
Oct 15, 2019	12,102 MW	3:20 - 6:20

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

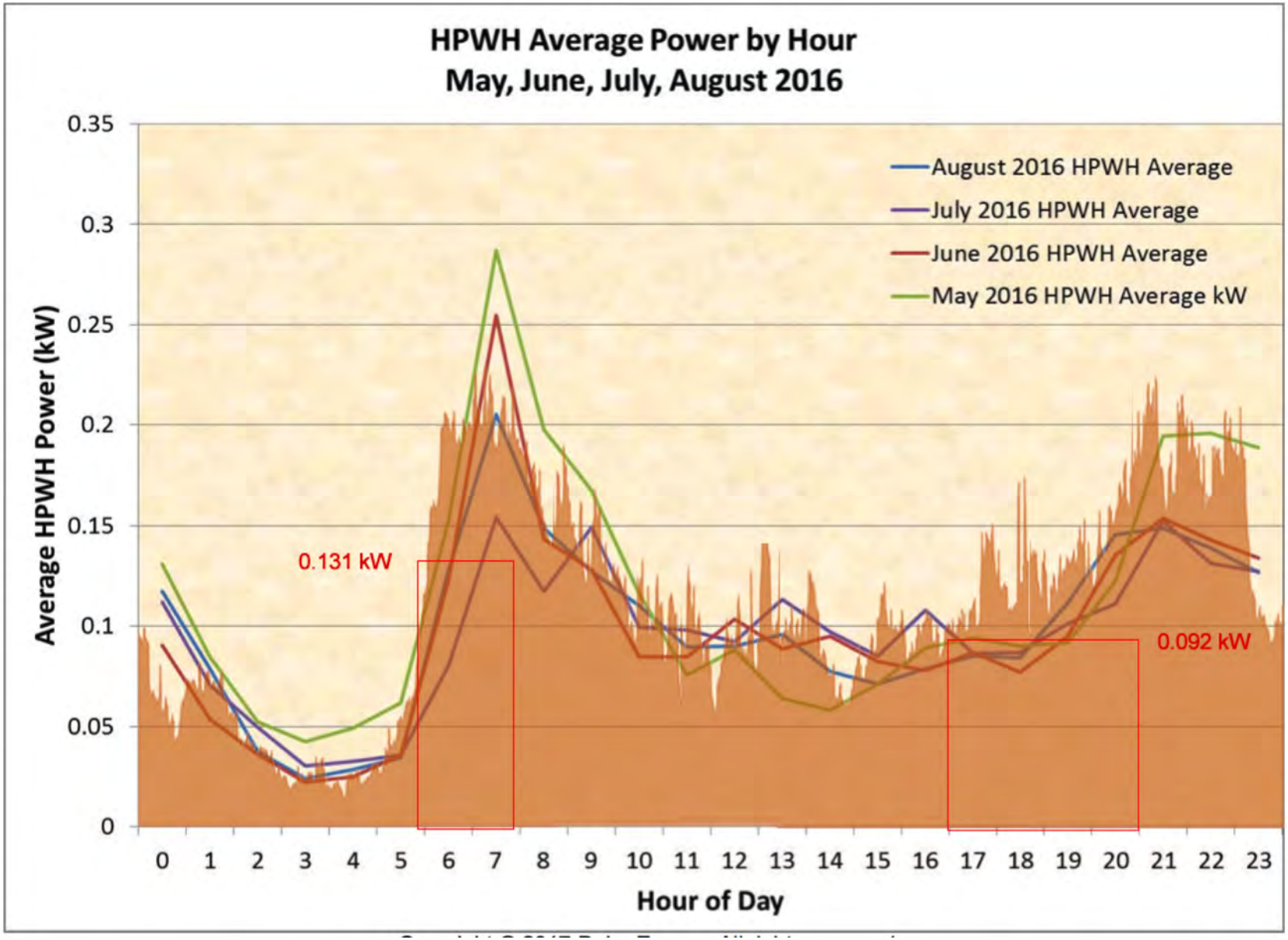
Note that Winter is the average peak net demand 25-30 GW

Duke Energy Data* on HWPW - 1



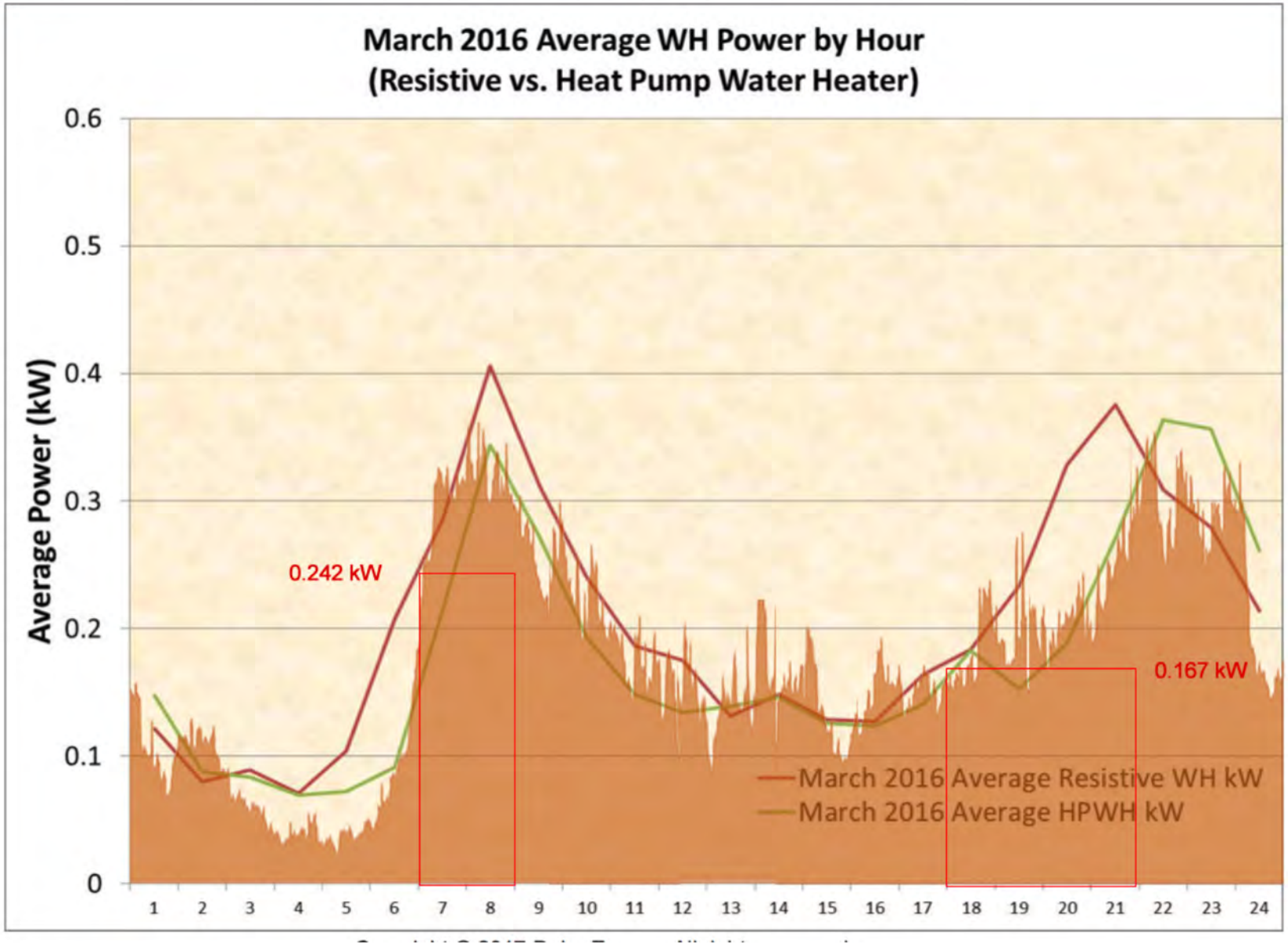
* Gurlaskie Session 7A Heat Pump Water Heater Duke Energy – ACEEE Hot Water Forum 2016 – Orange overlay of SkyCentrics Data

Duke Energy Data* on HWPW - 2



* Gurlaskie Session 7A Heat Pump Water Heater Duke Energy – ACEEE Hot Water Forum 2016 – Orange overlay of SkyCentrics data

Duke Energy Data* on HWPW - 3



* Gurlaskie Session 7A Heat Pump Water Heater Duke Energy – ACEEE Hot Water Forum 2016 – Orange overlay of SkyCentrics data

Navigant Cost-effectiveness of DR for Residential End-Uses

0.1 kW
per heat pump
Water heater

Table 2. Potential Unit Impacts[11] 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
Room Air Conditioner	Built-in	Temperature setback	0.08	0.05	0.13	0.13
	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
Dehumidifier	Built-in	DLC	0.20	0.13	0.14	0.14
	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

Items coming in CTA-2045-B

1. **Time of Use schedule formats** will be defined in coordination with all stakeholders. The CTA-2045 module can accept these 'potentially long term' schedules (at the very least match up with JA 13 requirements) and translate them either to the 24 hour ahead pricing or just standard CTA-2045 commands (Typically Load Up, Shed, CPE, Grid Emergency).
2. **Module to the SGD, 24 hour ahead pricing or just standard CTA-2045 commands during 24 hours.**
3. **Advanced Load Up –** To comply and match with Title 24 JA13 which defines and Advanced Load Up function to load up more than the normal Load Up.
4. **Mode control for water heaters –** To be able to change between Heat Pump only, Hybrid, etc.
5. More functionality to control Mode, Fan speeds and other items in HVAC systems.
6. A Test Mode signal will be able to be sent to help with testing for certifications
7. Advance Warning/Resiliency message can be sent to the SGD so that it can prepare for storms and outages.

Items coming in CTA-2045.4

Module can communicate via TCP/IP with the outside world either locally to a HEMS or to a third party cloud

The module vendor generally communicates to the module to:

1. Send standard CTA-2045 signals
2. Update firmware
3. Manage connectivity
4. Report telemetry from the SGD
5. Report opt-outs from the SGD

Modules compliant with 2045.4 will be able to communicate via TCP/IP with the outside world either locally to a HEMS or to a third party cloud.

Current CTA-2045.1,2,3 standards in place

CTA-2045.1

Allows module to update firmware on appliance

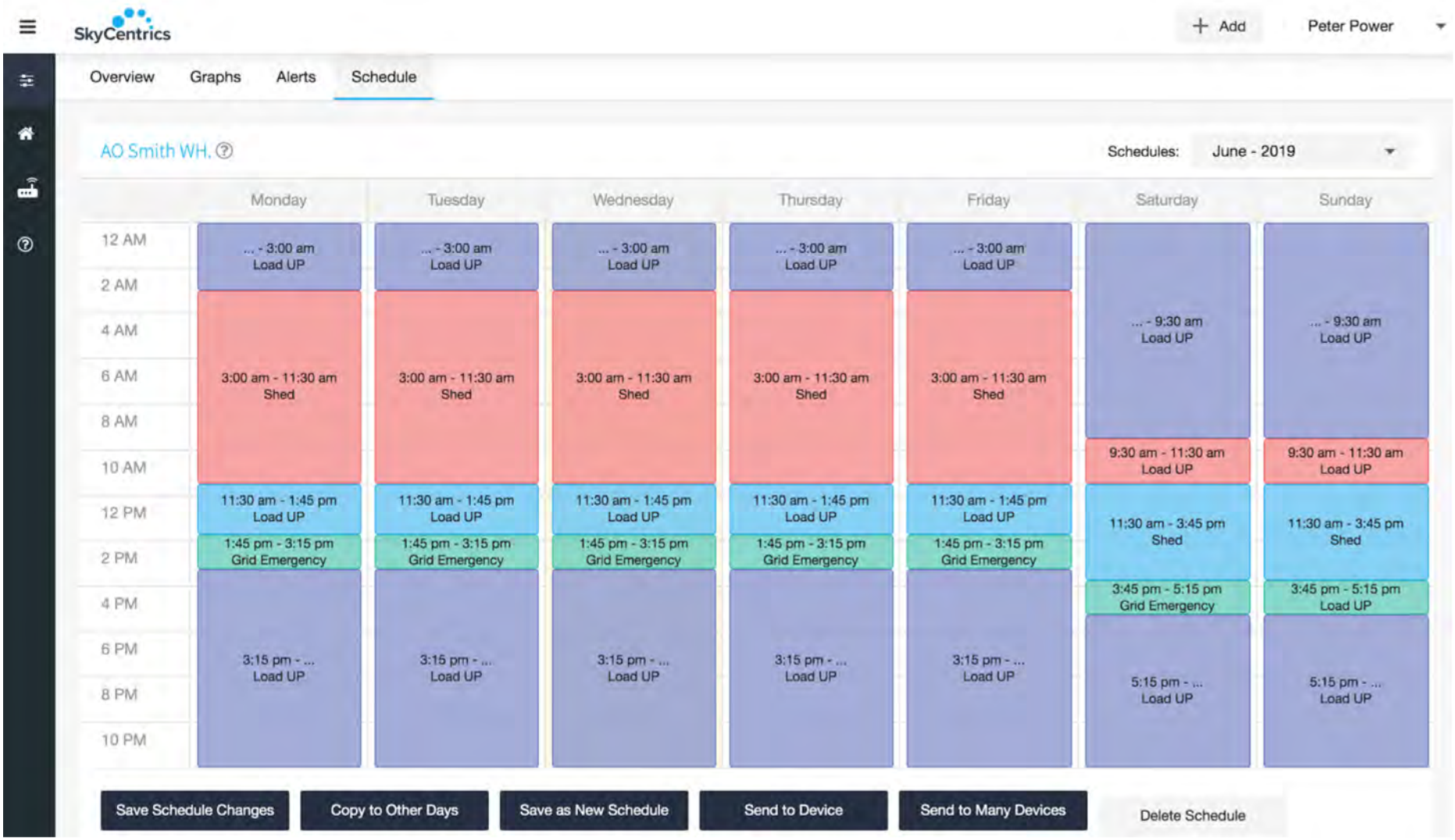
CTA-2045.2

Allows communication of electricity prices to a display

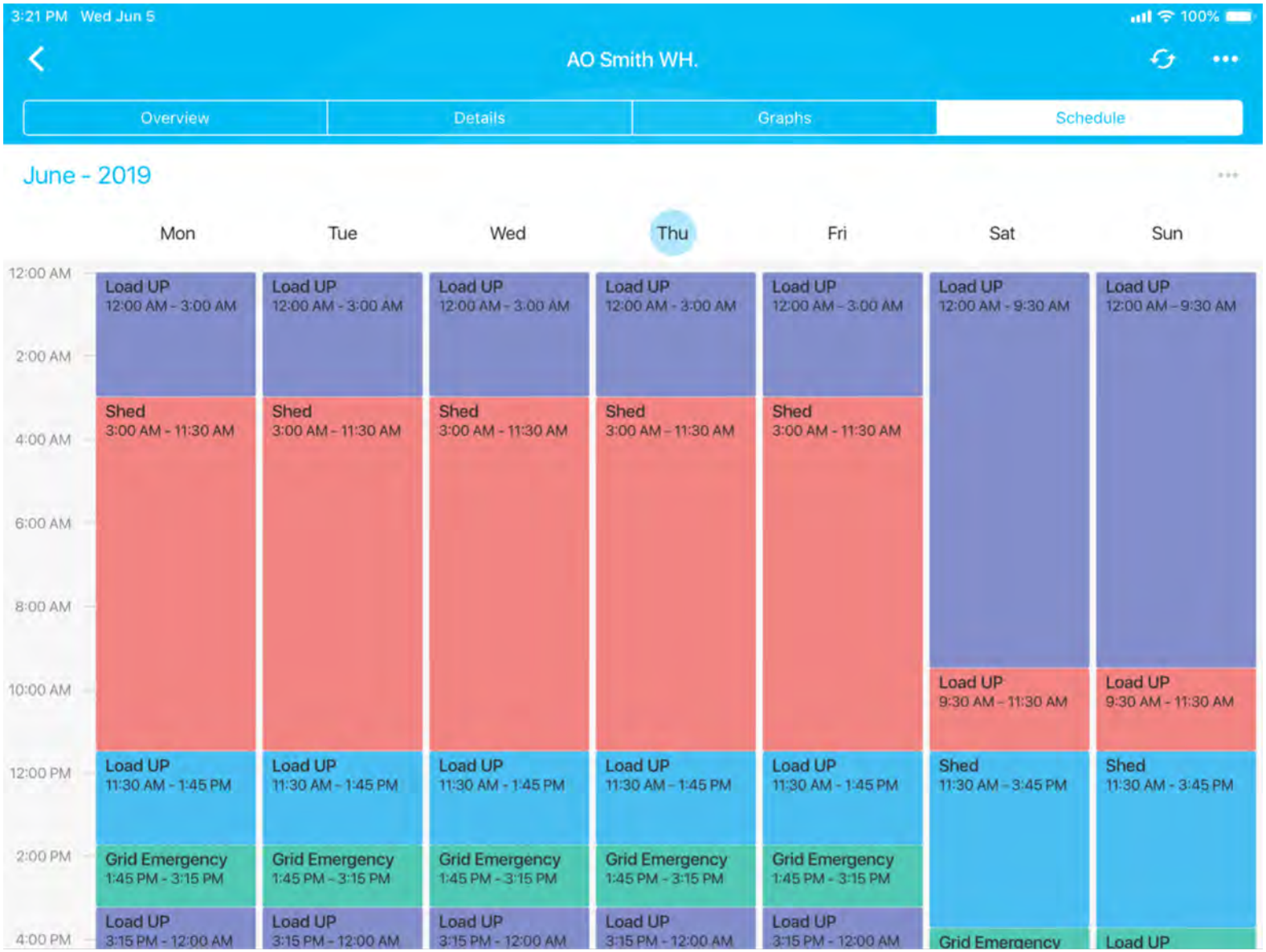
CTA-2045.3

Detailed thermostat commands

Scheduler - web



Scheduler - mobile

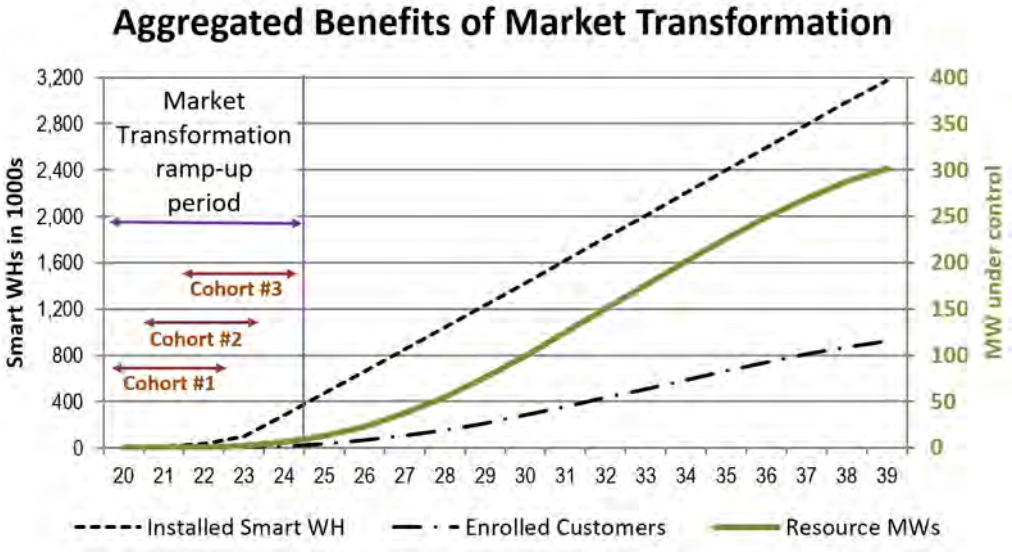


Bonneville Power Pilot – 600 water heaters

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)

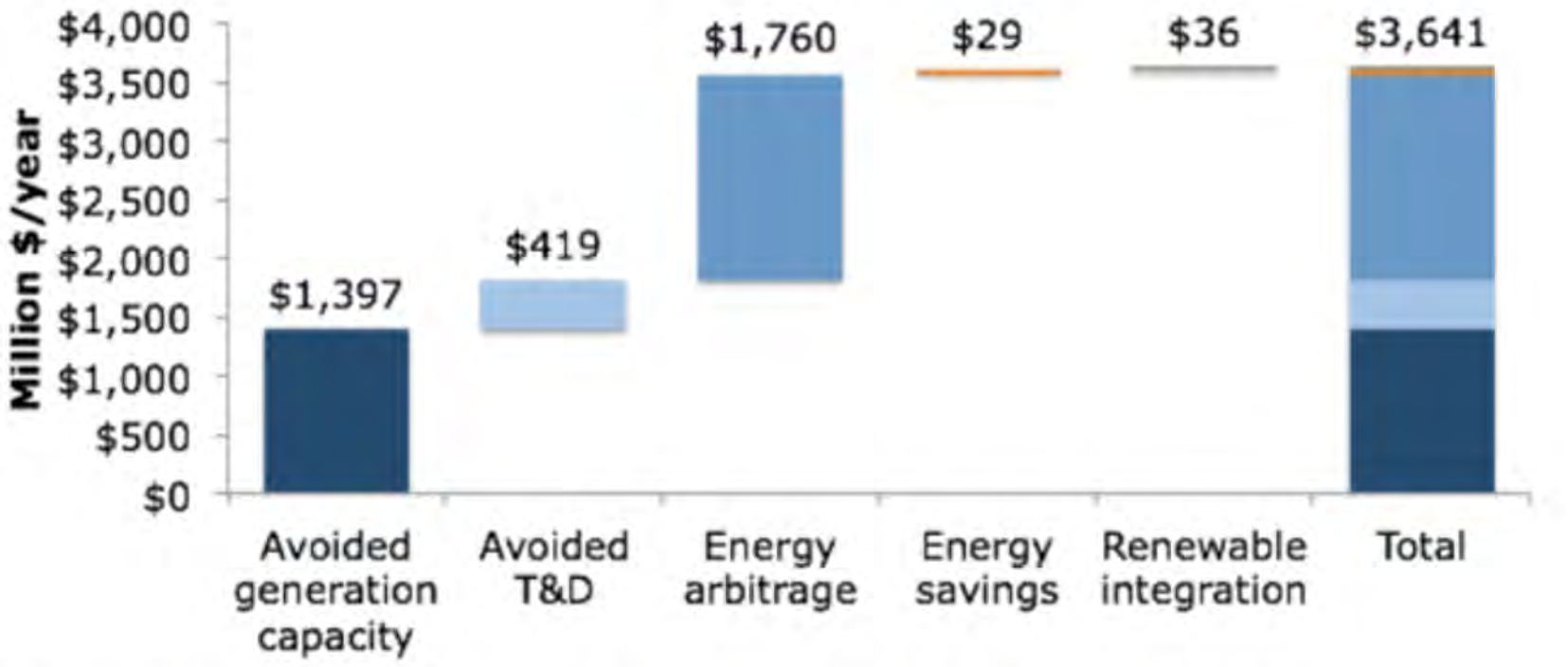
- Regional benefit: $230 million
- Benefit/cost ratio: 2.6

Benefits not quantified:

- Daily energy shift
- CO_2 reduction
- Ancillary services
- Customer perception

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

The value of grid connected water heaters



$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