



ENERGY STAR[®]
Products Partner Meeting

Load Shifting with ENERGY STAR Connected Water Heaters

ENERGY STAR Products Partner Meeting

October 28th, 2020



Today's Panel



Abigail Daken

U.S. Environmental Protection Agency

Pierre Delforge

Natural Resources Defense Council

Ashley Armstrong

A.O. Smith Corporation

Tony Koch

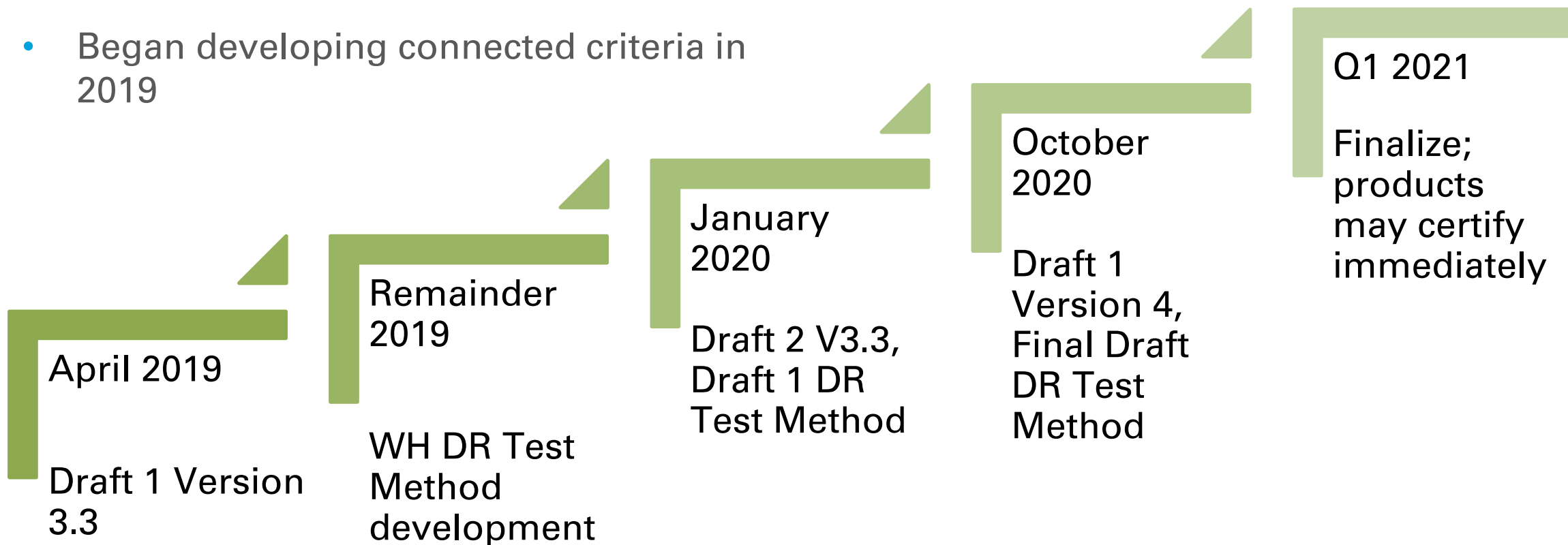
Bonneville Power Administration



SAVE TODAY. SAVE TOMORROW.
SAVE FOR GOOD.

Status and Timeline

- Began developing connected criteria in 2019



- By Q3 2020, clear a revision was needed, at least for HPWH



ENERGY STAR[®]
Products Partner Meeting

Contact Information

Abigail Daken

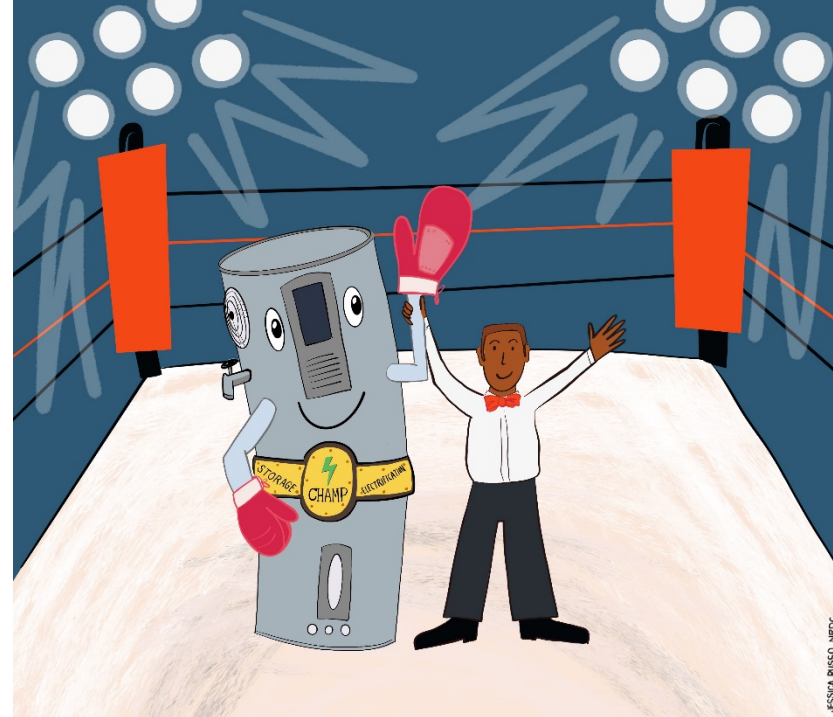
Daken.Abigail@epa.gov

202-343-9375

For more information on the ENERGY STAR Version 4.0 Water Heaters specification, visit the [ENERGY STAR Water Heaters partner page](#).

Policy Drivers for Demand Flexible Water Heaters

Pierre Delforge
NRDC
Oct. 28, 2020

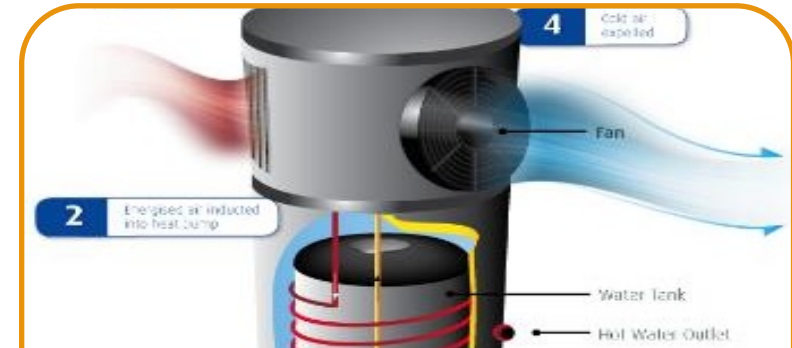


From DR to DF



Demand Response

- Primarily Commercial and Industrial
- Emergency: a few times per year
- Opt-in, limited participation



Demand Flexibility

- All sectors including residential
- Daily, or even twice daily storage cycling
- Opt-out, most customers participate

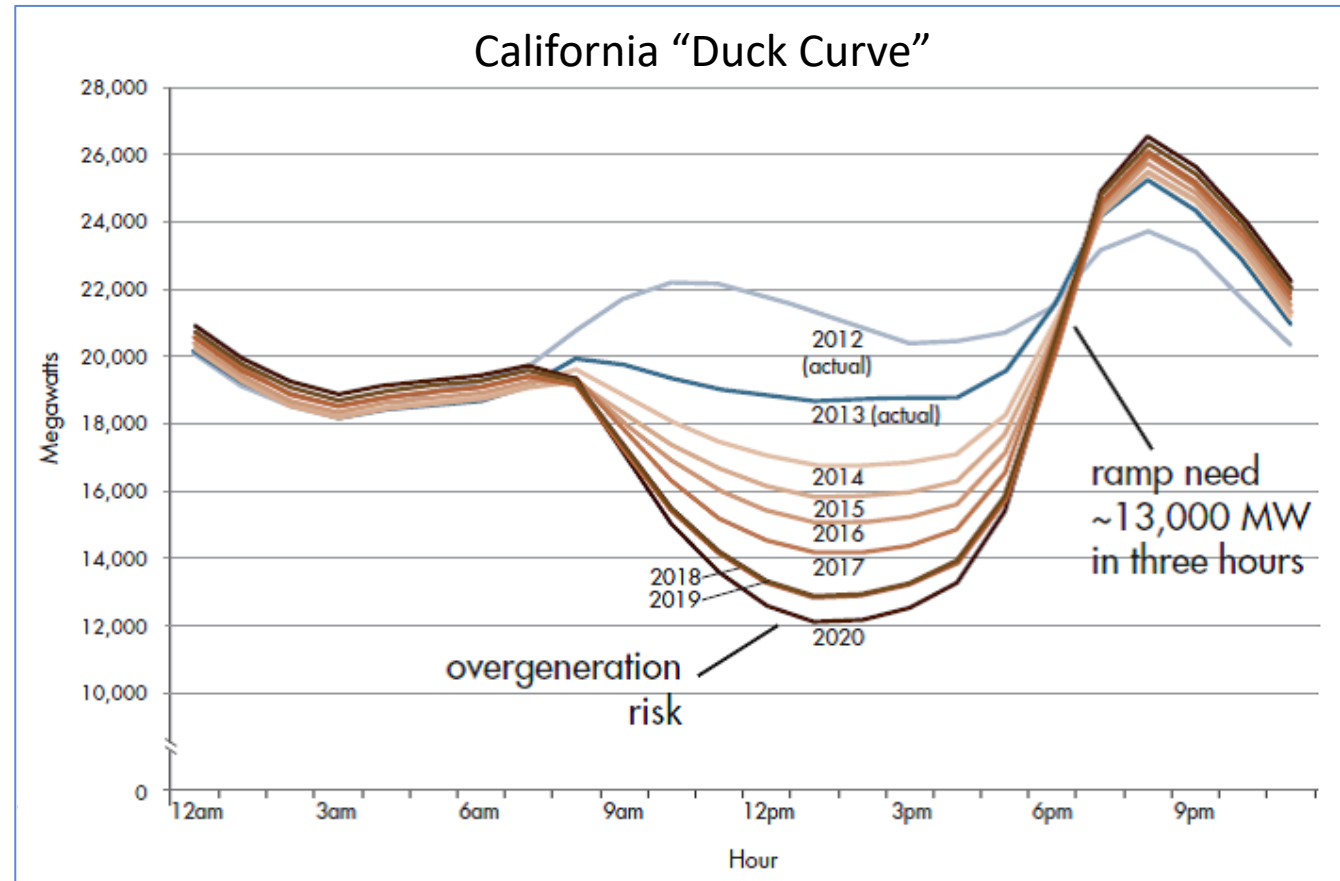
The grid is cleaning up, fast



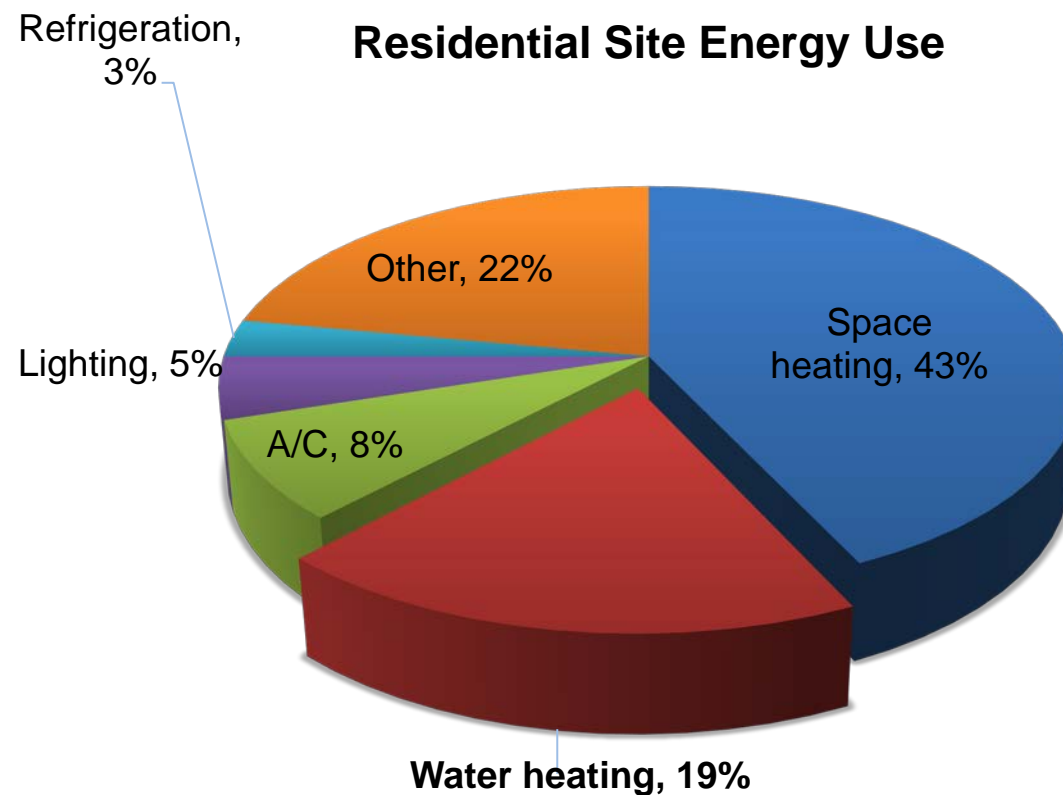
- 13 states, districts and territories¹
- 13 of 30 largest publicly-traded U.S. utilities²
- 200 cities and counties
- 111 million U.S. residents representing 34 percent of the population

1. GTM: Tracking Progress on 100% Clean Energy Targets
2. S&P Global: Path to net zero: Cracks appearing in natural gas' role as bridge fuel

Demand flexibility (and storage) critical to achieve 100% clean electricity affordably

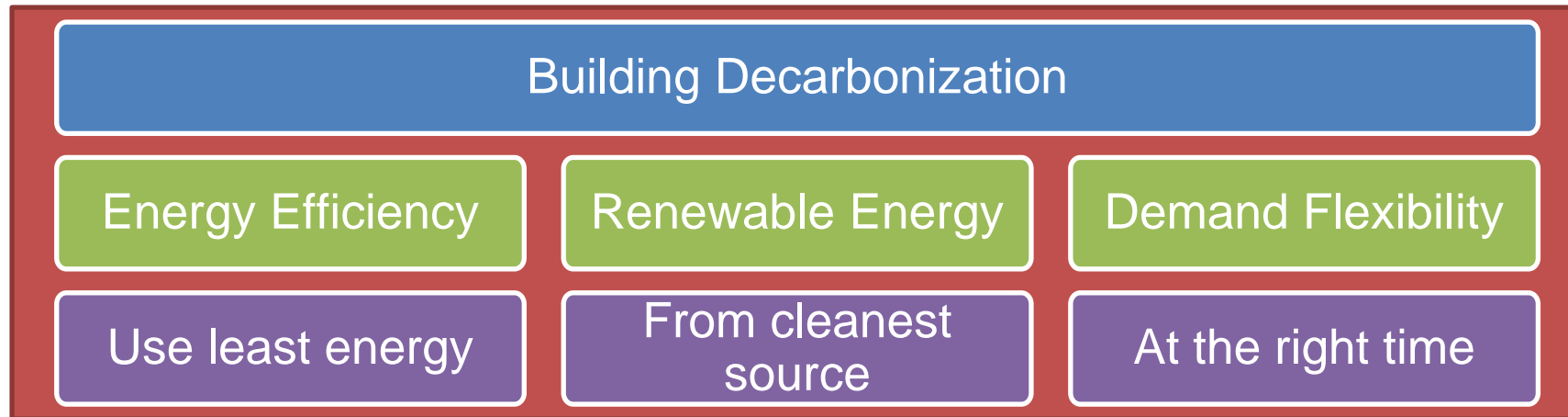


Why Water Heating? - Second largest energy use in homes



<https://www.eia.gov/energyexplained/use-of-energy/homes.php>

Why Heat Pump Water Heaters?

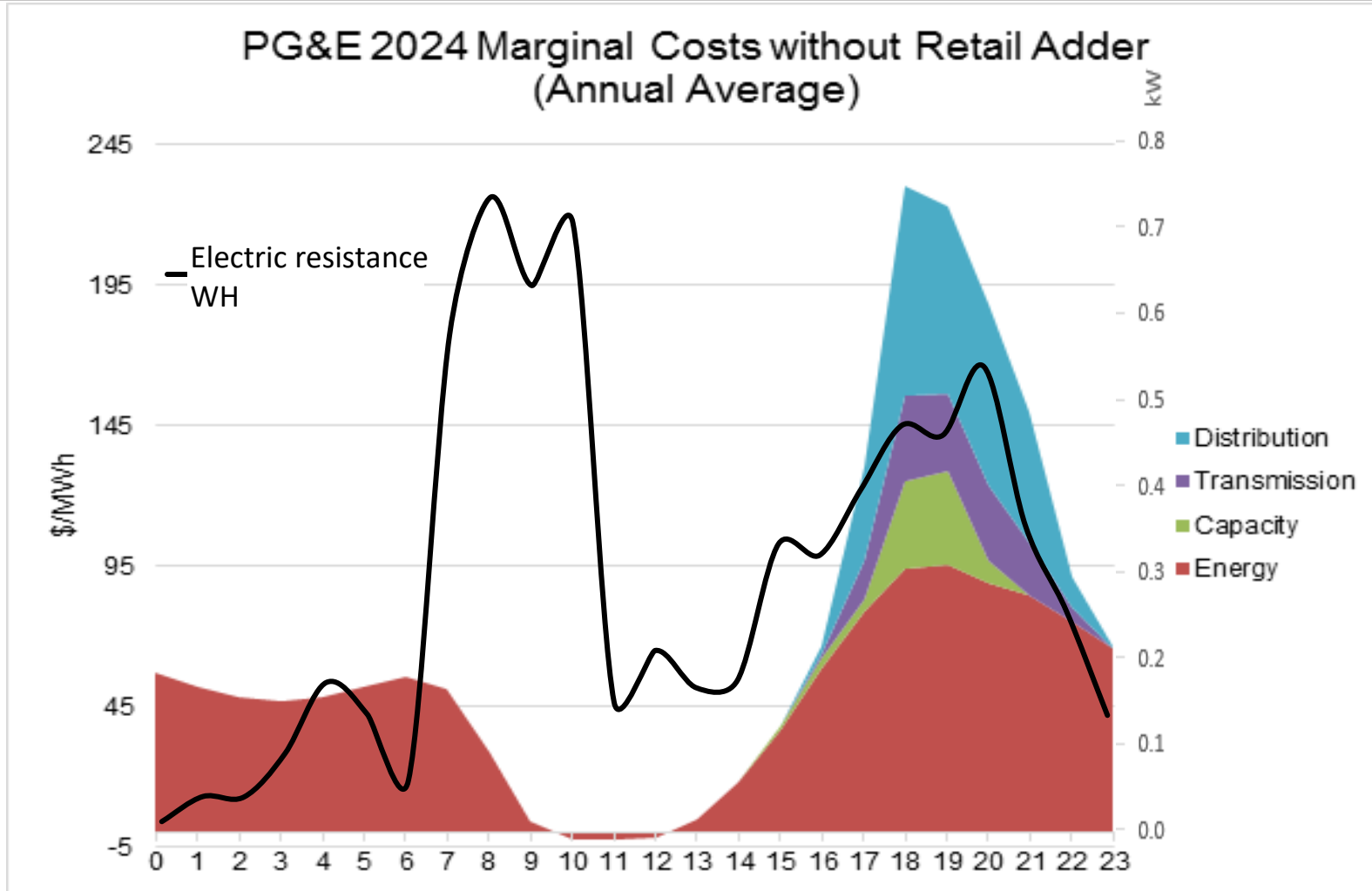


✓ 300% efficient

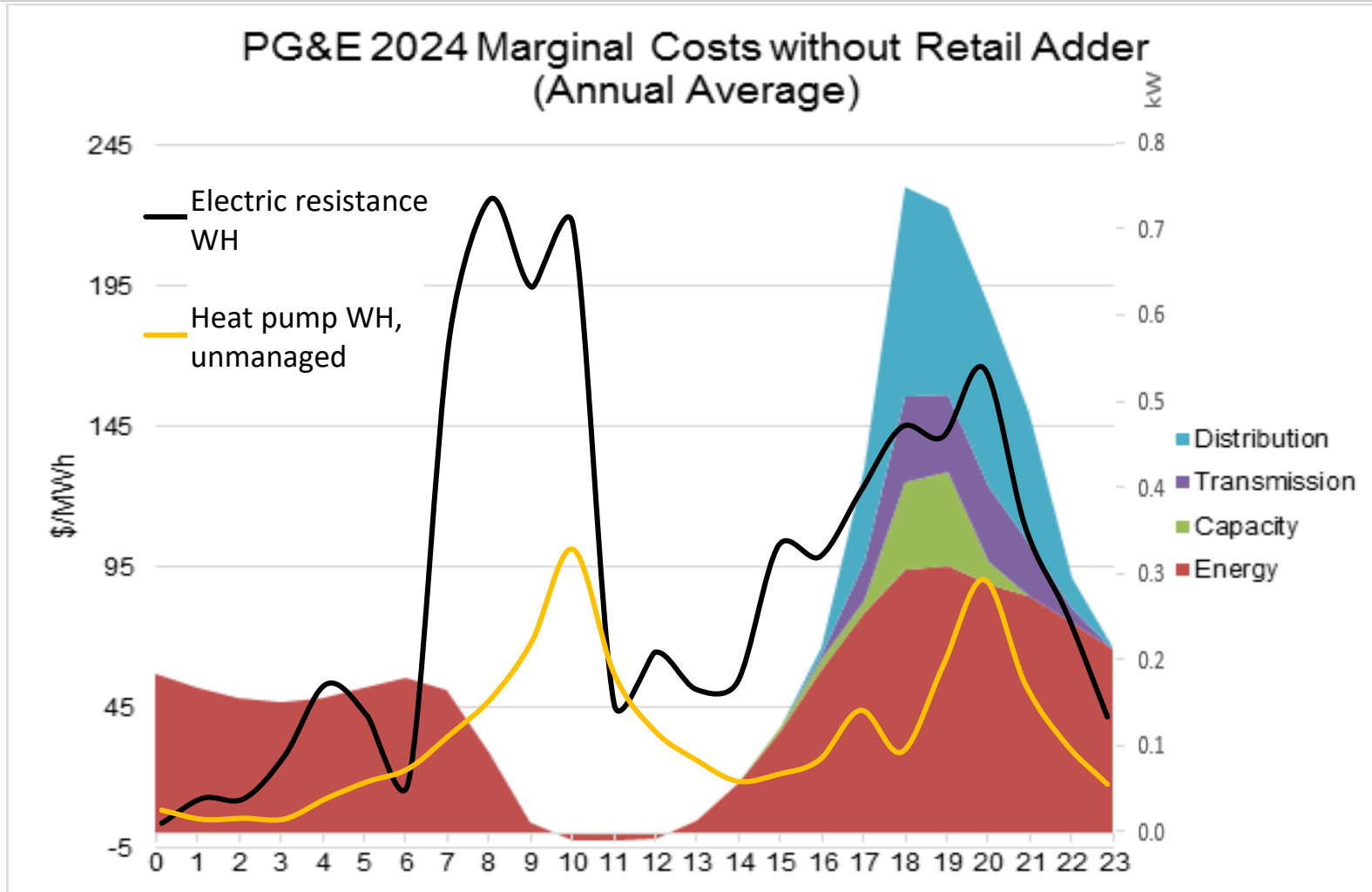
✓ electric

✓ built-in storage

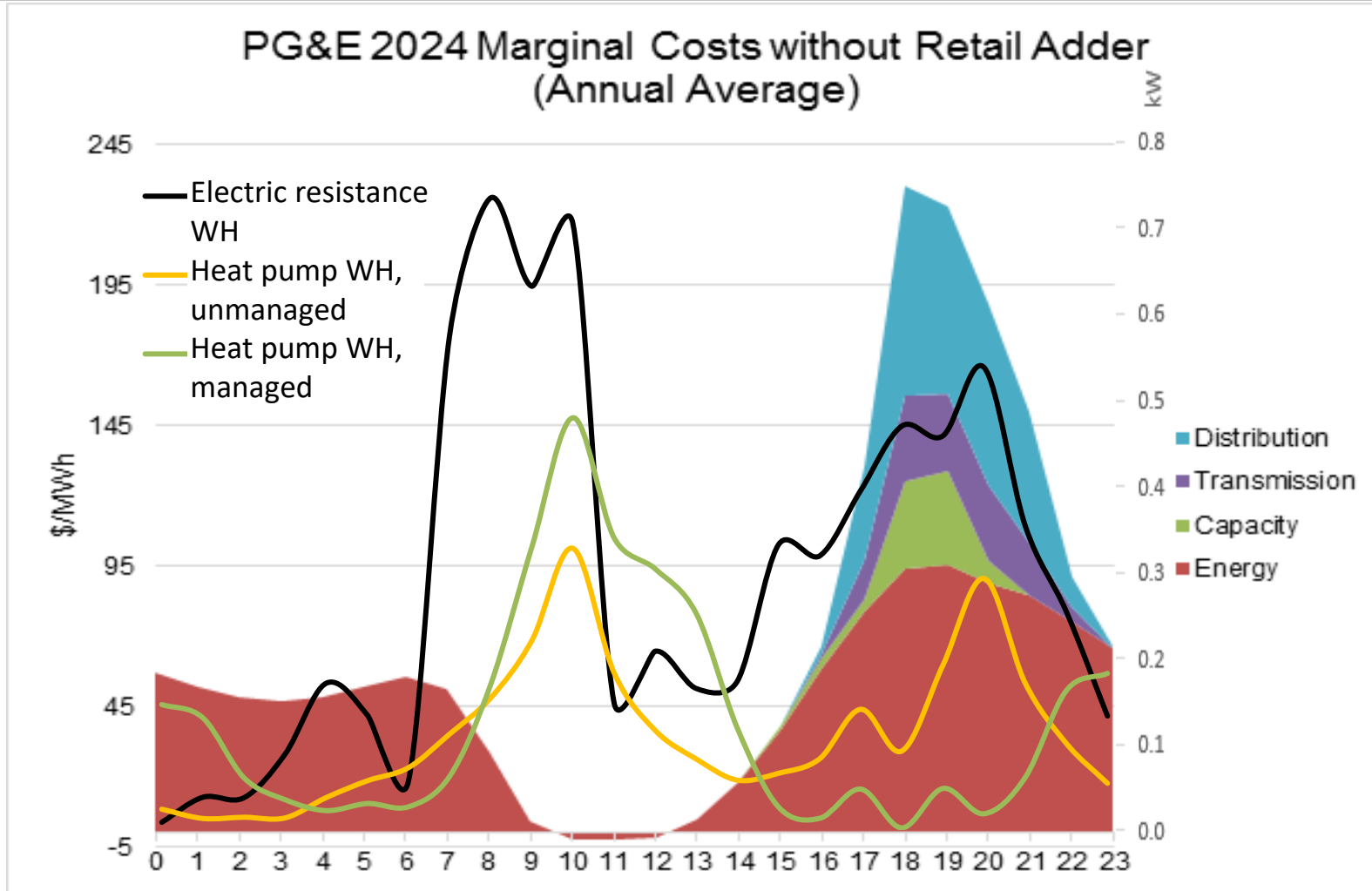
Electric Resistance Water Heater Load Shape vs. Utility Marginal Costs



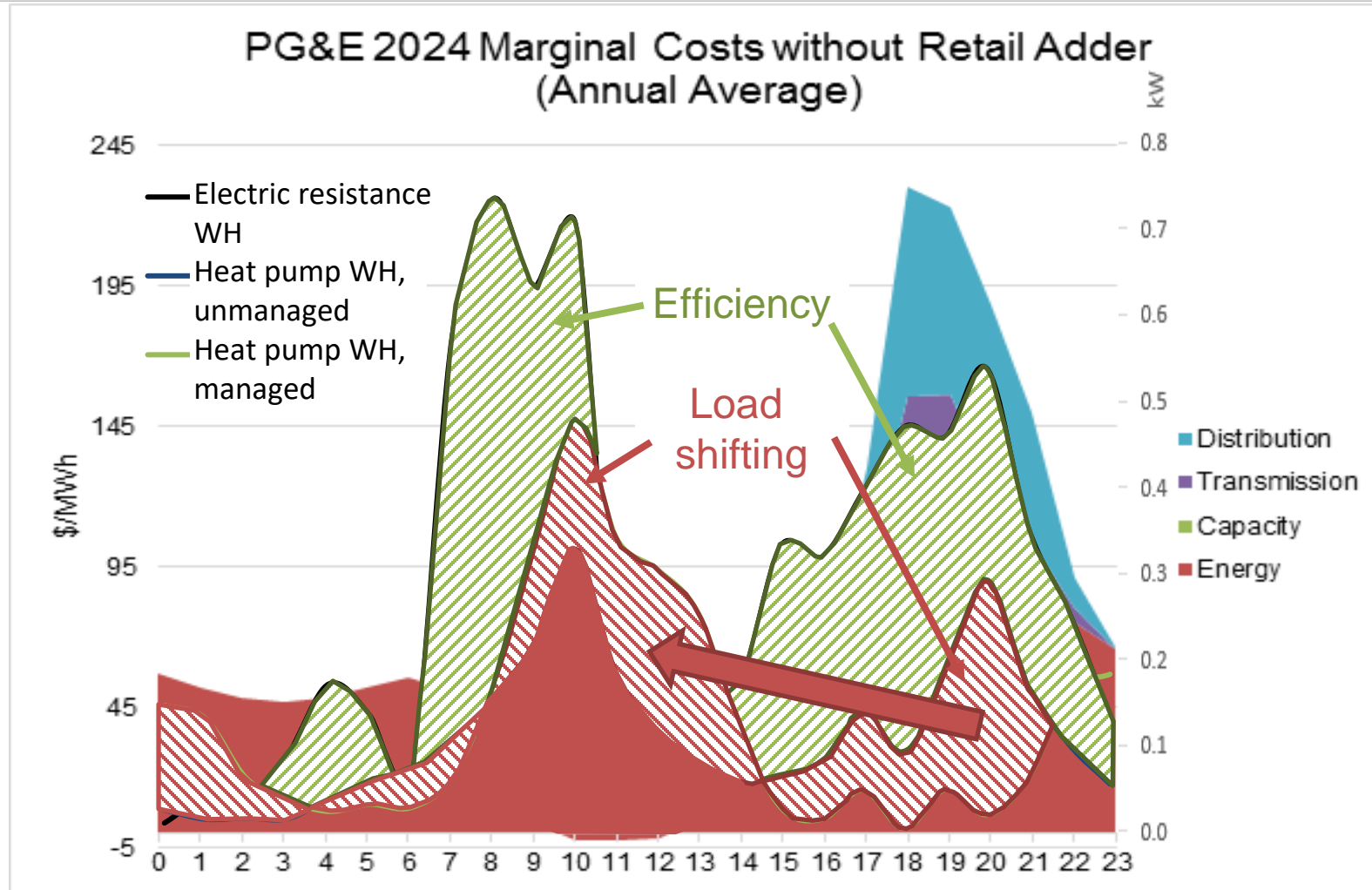
+ Uncontrolled HPWH



+ Controlled HPWH



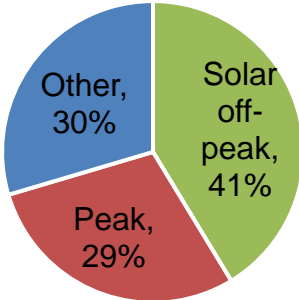
Most of the peak reduction value comes from EE, but significant additional load shifting value



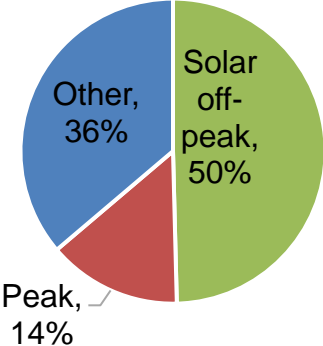
HPWH naturally shift load without controls

Controls add significant grid and customer value

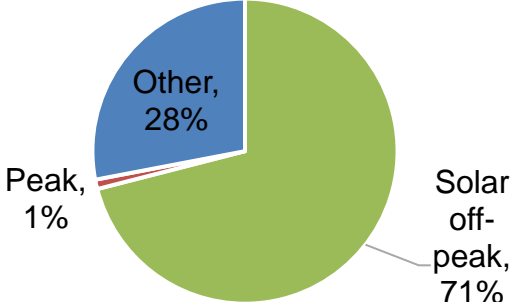
Hot Water Draws



HPWH
No Load Shifting



HPWH
With Load Shifting



Off-Peak Solar: 8 am – 3 pm (excluding afternoon ramp > 3 pm)
Peak: 5 pm – 9 pm



Joint Appendix 13: HPWH Demand Management Requirements

Requires capability to do BOTH:

1. Non-connected time-of-use-based (TOU) load-shifting; AND
2. Grid-connected load shifting



TOU Control

- Load shifting by default (opt-out), designed for mass adoption
- Initial grid connectivity for TOU setup and occasional updates
- Permanent grid connectivity not required
- Makes HPWH “TOU-Smart”



Grid-Connected

- Opt-in, where available
- Price or dispatch grid signals
- Enables higher temperature storage
- Higher grid value
- Fails over to TOU control

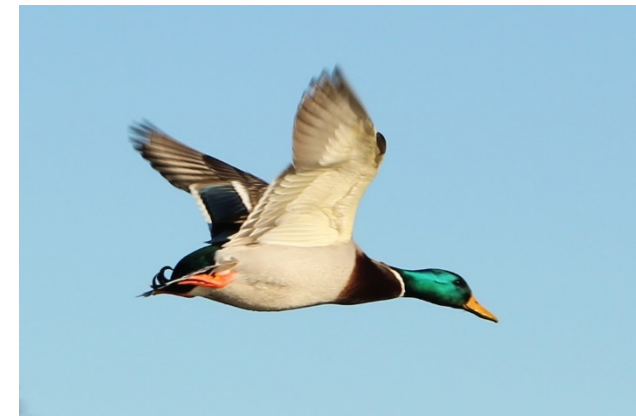
HPWH Demand Flexibility Standards

WA law (+ OR pending)	NEEA AWHs (Advanced Water Heating Specification)	CA JA13 (Title 24 Joint Appendix 13)	ENERGY STAR V3.3 Connected Criteria (Draft 2)
CTA-2045	CTA-2045	CTA-2045	CTA-2045 or OpenADR
	JA13	HPWH Only	HP and gas WH
		TOU + connected	Connected only
	Test method	Self-declaration	Test method
		Performance requirements (FHR, demand shifting)	More restrictive FHR, Same demand shifting reqts

Water Heating as a Clean Energy, Zero-Emission Solution

HPWH Demand Flexibility:

1. Electrify water heating without peak load
2. Reduce user bills
3. Help transition to 100% carbon-free grid faster and cheaper
4. Policy and technology moving fast
5. Significant market experimentation, poised to scale starting 2021





Thank you!

Pierre Delforge

pdelforge@nrdc.org





Smart Water Heaters

Ashley Armstrong
ENERGY STAR
Partner Meeting
10.16.20

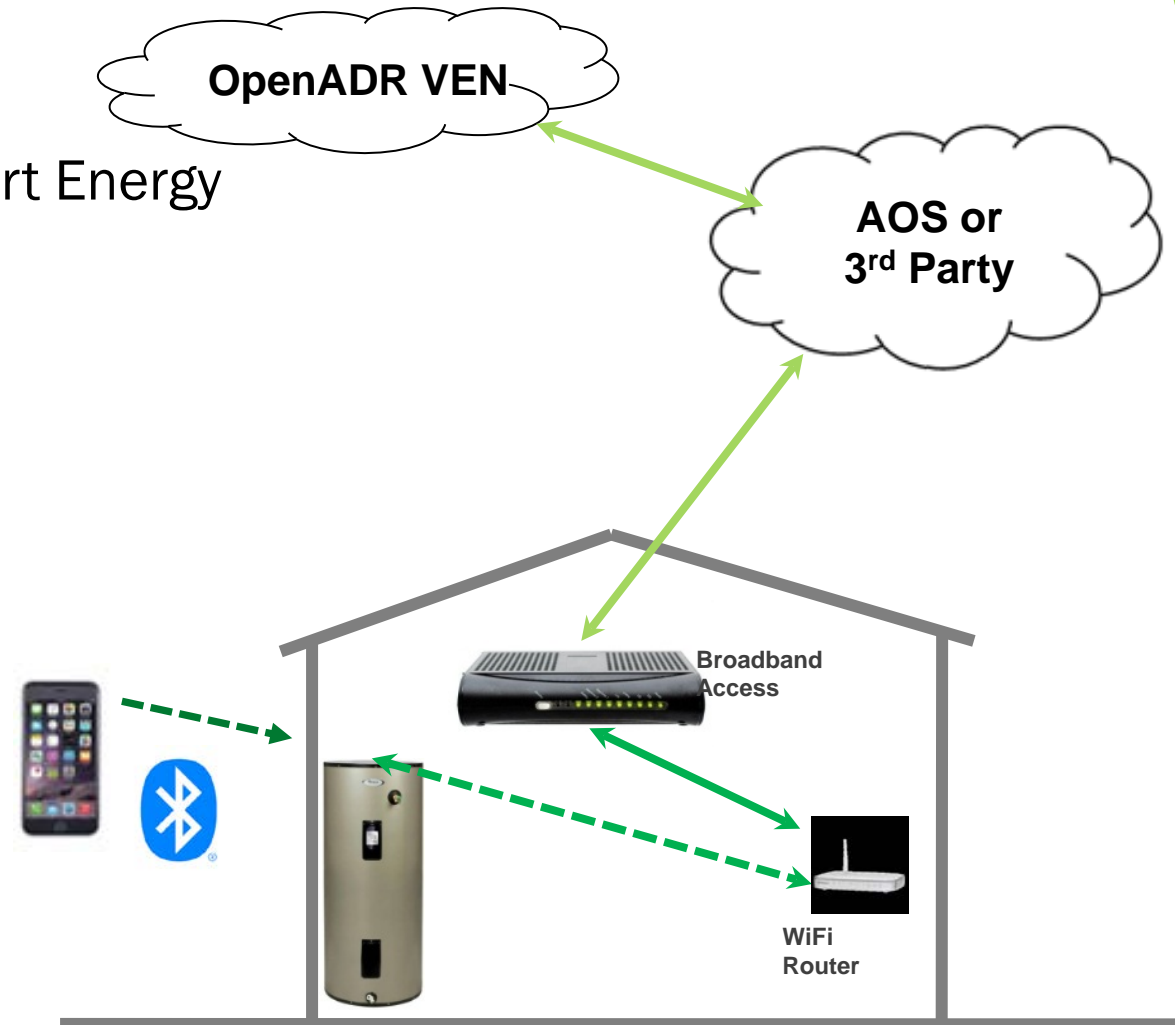
The Water Heater Advantage

- Low Interruption Annoyance
 - In comparison to most other appliances, lower likelihood that consumer will notice water heater is turned off unless cold water event
- Time Adjustable Power Usage
 - Re-heating of a tank can be done in off peak time
 - Load balancing
 - Reduces the need for spinning reserves
- Energy Storage Device
 - Possibility of loading up the tank (with the addition of a temperature limiting device)
 - Accommodates alternate power generation (renewables)



Layers for Connectivity

- CTA-2045 Connection to 3rd Party
 - Supports OpenADR, Climate Talk, Smart Energy Profile
- OpenADR via A.O. Smith Wi-Fi/BT
 - AO Smith Virtual End Node (VEN)
 - OpenADR to CTA-2045 commands
- Time-of-Use Pricing
 - Local pricing schedule
 - No connectivity required
 - Thermal management based on price



Basic Demand Response Control

- Shed Load / Critical Peak
 - Turn off until energy in tank too low to satisfy customer
- Load-up
 - Top-off heater to set temperature
- Grid Emergency
 - Heater off



BPA CTA-2045 Water Heater Demonstration

- 2 Primary Objectives
 - **Run DR Events:** Recruit and install communications on residential CTA-2045-equipped water heaters, followed by running a set of demand response events from winter through summer season.
 - **Create a market transformation plan and a business case to justify the cost:** The project was initiated because BPA anticipated if market transformation caused every water heater purchased in the next 15 years to be a CTA-2045-equipped water heater, then BPA could create a large cost-effective demand response resource that could be used on a daily basis.

CTA-2045 Water Heater Demonstration Report

Including

A Business Case for CTA-2045 Market Transformation

BPA Technology Innovation Project 336

November 9, 2018

BPA Technology Innovation Project 336

	Winter – AM		Winter – PM	
WH Type	ER	HP	ER	HP
Power Shaved (W)	325	200	320	150
Energy Shifted (Wh)	650 (2hr)	400 (2hr)	640 (2hr)	300 (2hr)

	Summer – AM		Summer – PM	
WH Type	ER	HP	ER	HP
Power Shaved (W)	330	125	325	85
Energy Shifted (Wh)	1325 (4hr)	450 (3.6hr)	1310 (4hr)	341 (4hr)

“Load Shifting Using Storage Water Heaters in the Pacific Northwest” – PNNL & BPA

A. O. Smith's HPWH with iCOMM Smart Connectivity

- Wi-Fi and Bluetooth capable
- Includes Leak Sensor and Reporting
- Free A. O. Smith app
 - Control temperature and mode
 - Monitor water heater status
 - Fault and Maintenance notifications
- California Title 24 – JA13 Compliant
 - Easily load utility Time of Use rates
 - Demand Response: OpenADR 2.0b VEN certified
- Factory Installed
 - Also available as an accessory kit. Backwards compatible on all series 130 heat pumps.

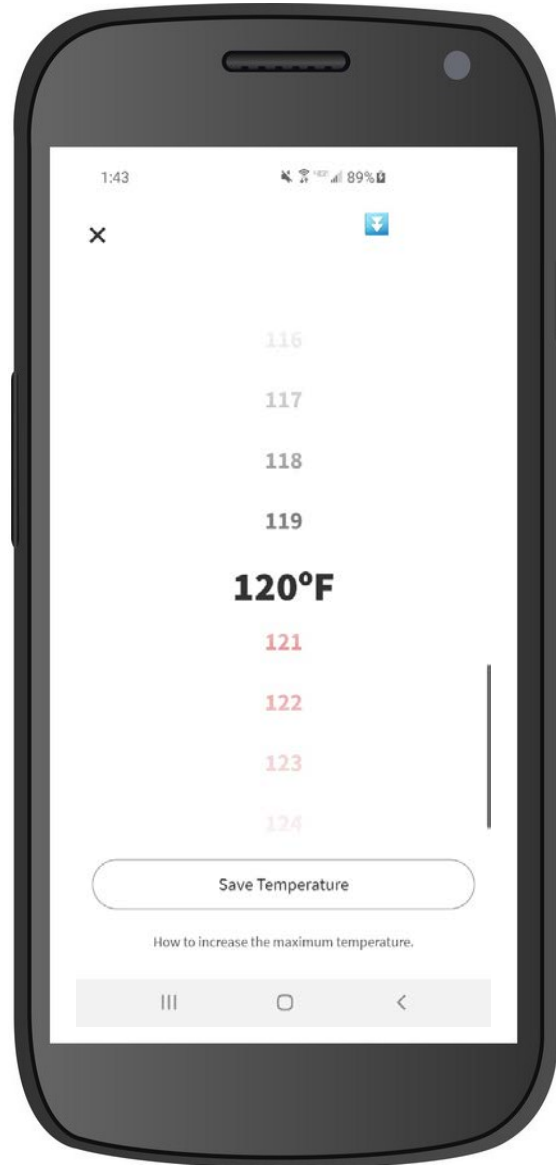
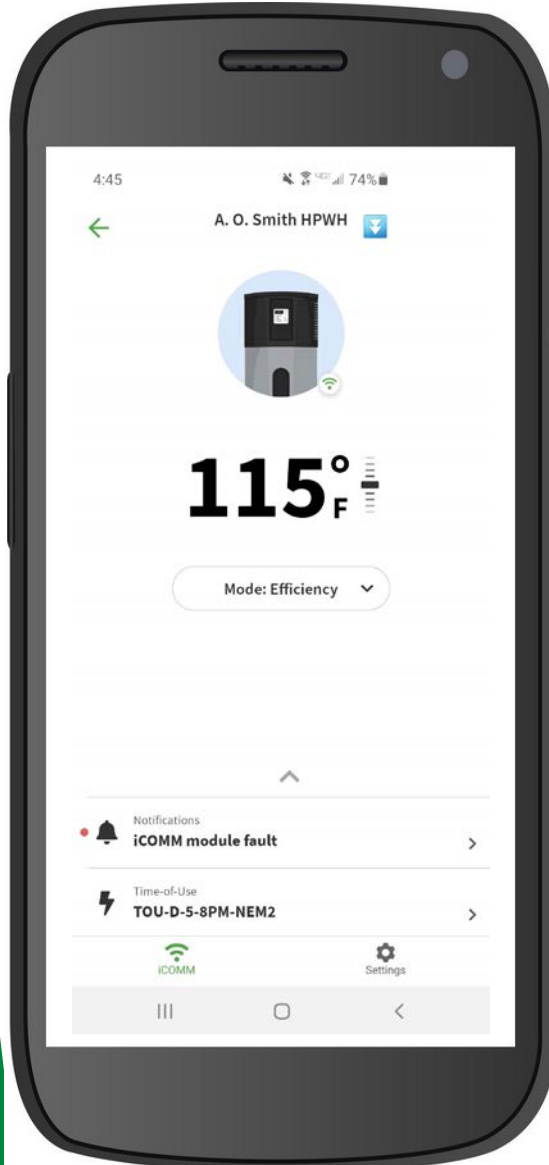


Module and
Leak sensor

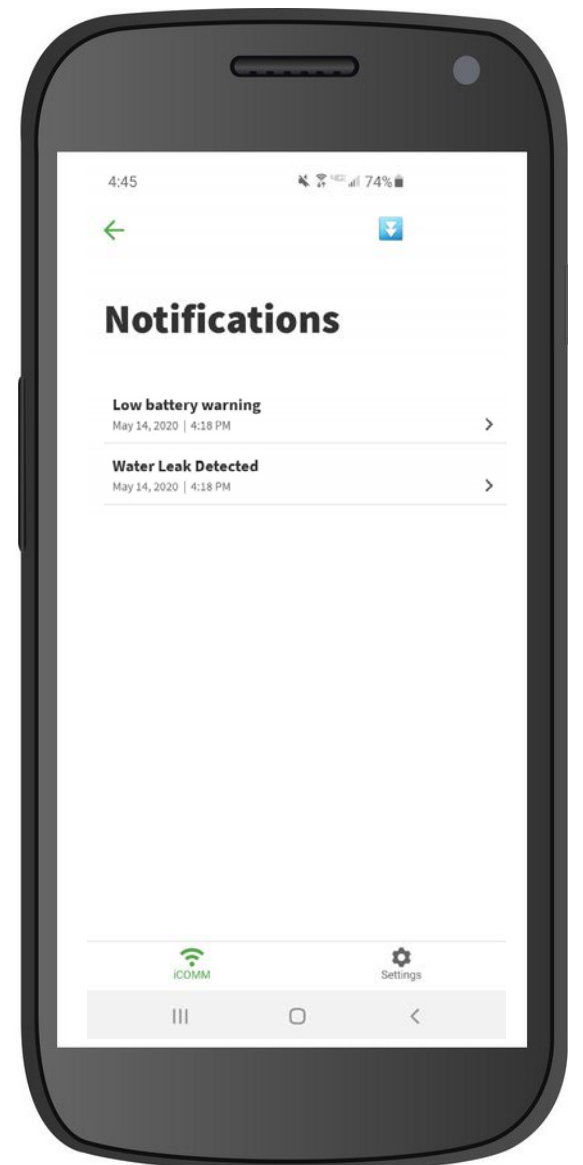
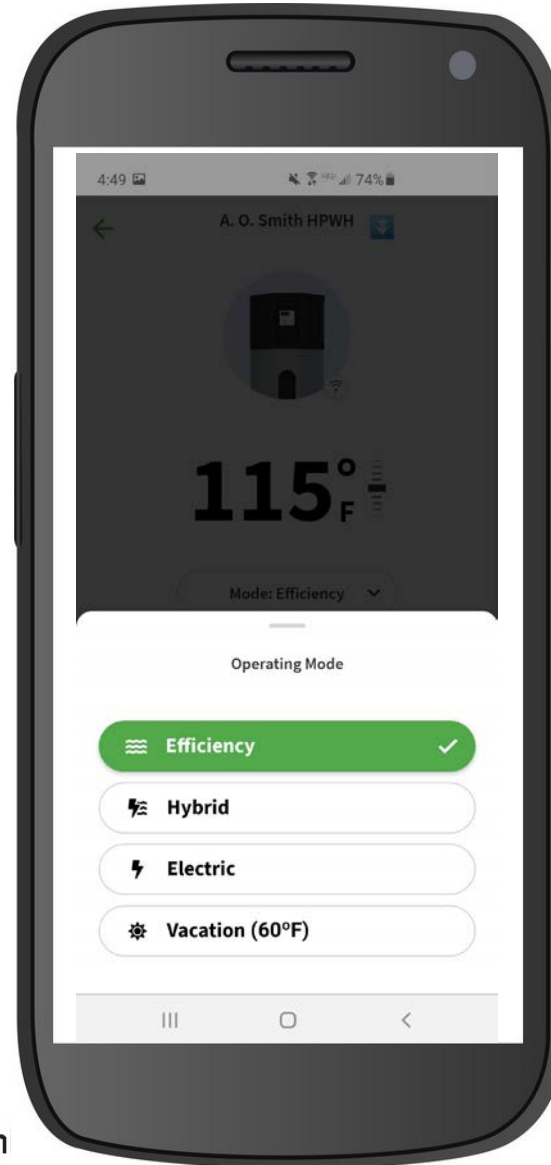


Available factory
installed

IoT Controls



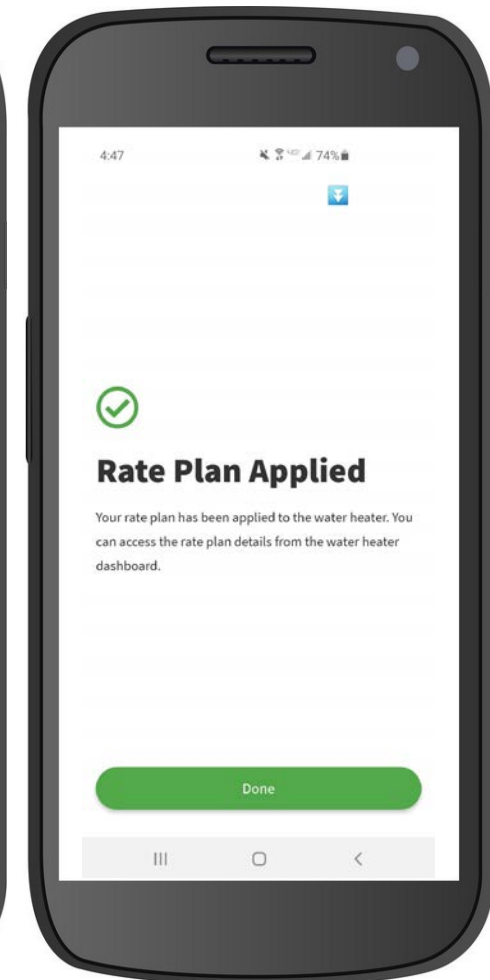
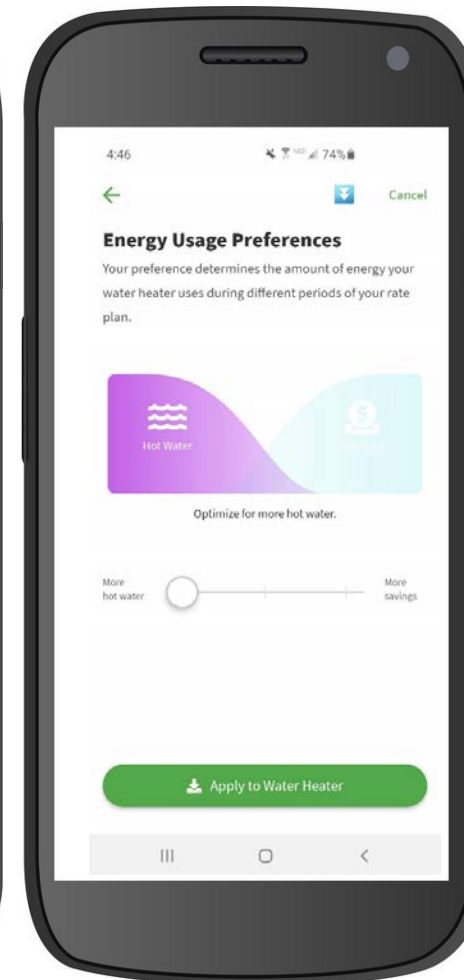
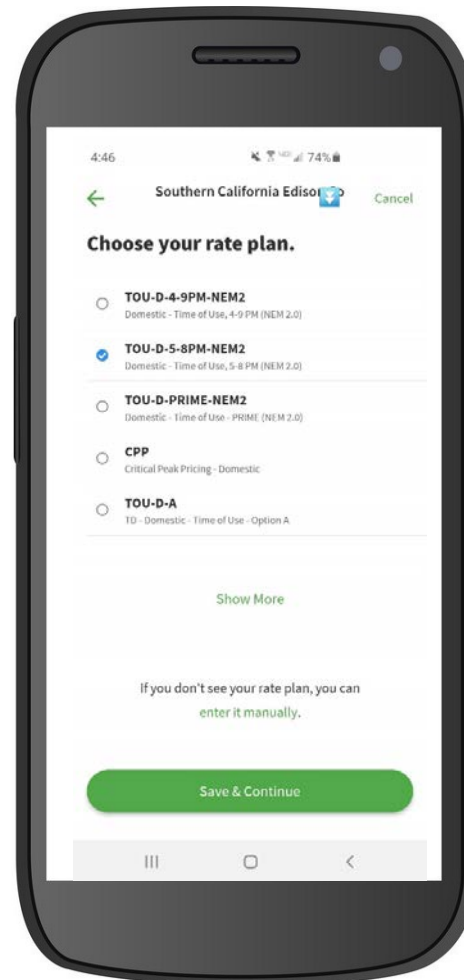
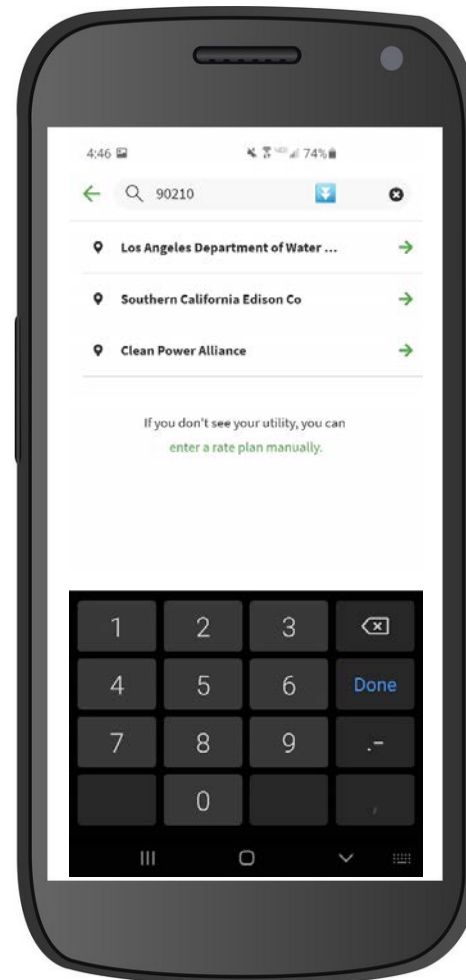
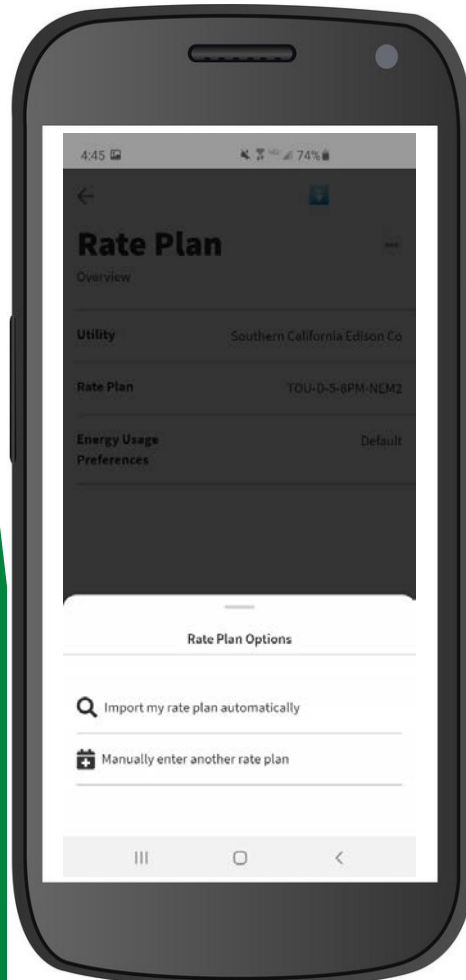
n



Utility Time of Use Rates



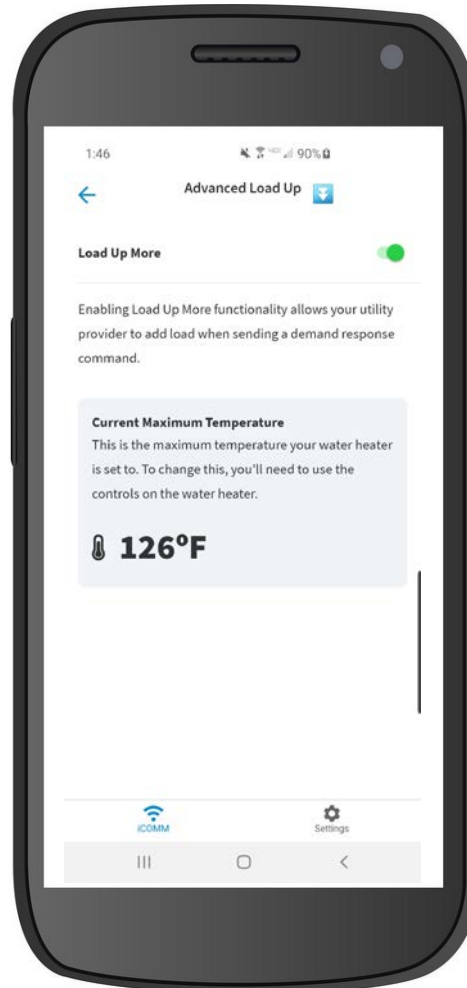
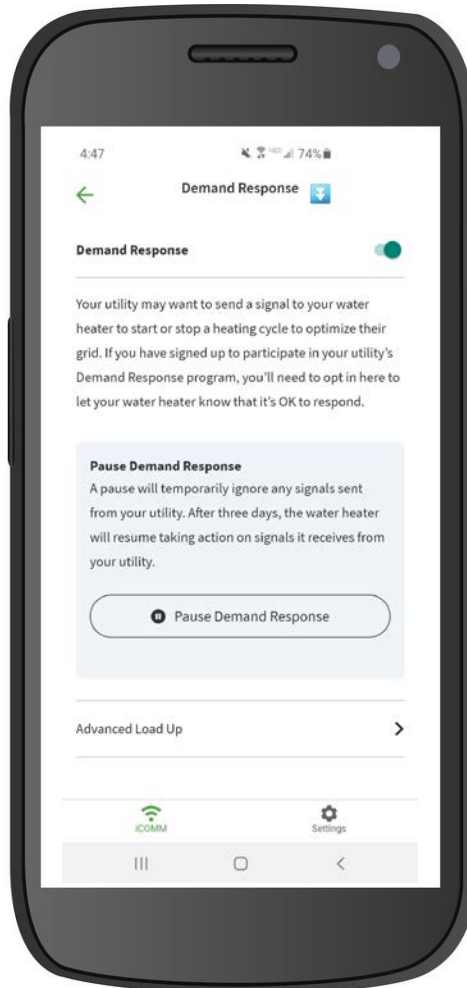
- Easily load ToU rates by utility name or zip code



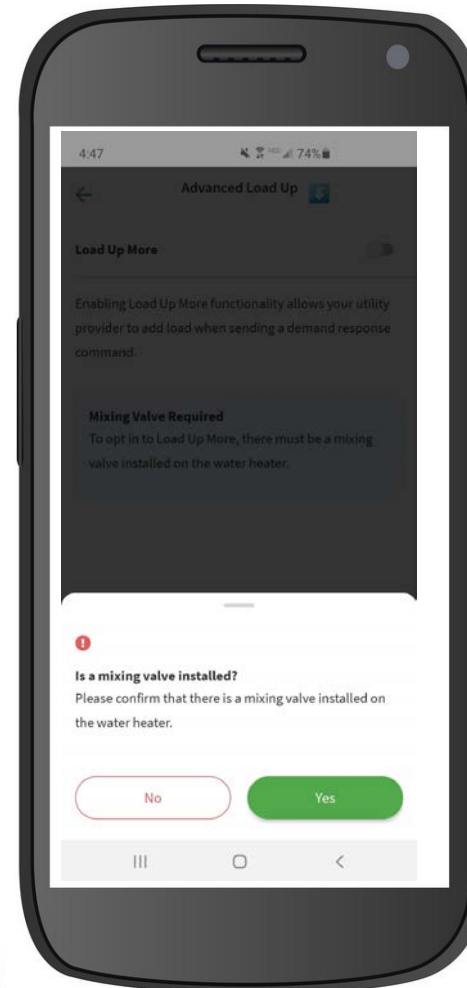
Utility Demand Response



- OpenADR 2.0b VEN certified



smith



Smart Water Heaters – Utility Polling

- The utilities have four ways to control the electric demand: Shape (TOU), Shift (surplus renewables), Shed (curtail peaks) and Shimmy (dynamically adjust).
- Shed and Shimmy require utilities to query the water heater state-of-charge (amount of kWh it can absorb), so the amount of energy that can be controlled without adversely effecting hot water delivery is known.
- Dynamically adjusting the load requires frequent polling of the heater state and better control of the grid.
- Polling the water heater state every 5 min results in about 100,000 requests per year per heater which cost about \$2.50 to \$5 per year (or \$25 to \$50 over the life of the water heater assuming a 10-year life).
- A balance must be struck between frequently polling the water heater to get information about the state and the costs.

Smart Water Heaters – What's Needed?

- Move to Sustained Large Scale Deployments
- Stick to Uniform National Standard(s) – CTA 2045 preferred
- Avoid Custom One-off DR Integrations
- Make it Worth Consumers' Effort to Participate in the Program
 - Properly Structured Incentives and Rate Tiers
- Ratepayer Satisfaction with the Program is Critical
 - Minimal no Hot Water Events and Show the Savings Realized

Thank You!



Ashley A. Armstrong
Director, Regulatory and Technology Policy
A. O. Smith Corporation
aaarmstrong@aosmith.com

Energy Star Connected Heat Pump Water Heaters



Tony Koch, PE, CEM
Mechanical Engineer
Energy Efficiency
Bonneville Power Administration
October 28, 2020

OLD School DR (on/off) with Water Heaters

We don't want this

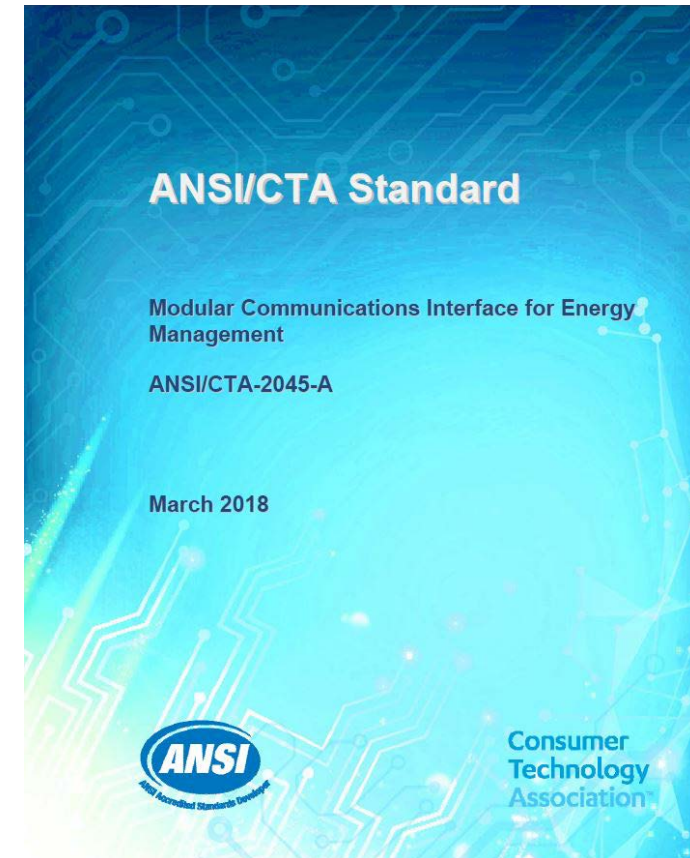
- 240V switch (pictured in the red circles)
- About \$400 installed. Can lead to stranded investment
- Requires a permit, an electrician, a truck roll, customer inconvenience
- Cycling voltage to a HPWH is not good for the electronics inside the unit
- Higher risk of customer possibly running out of hot water



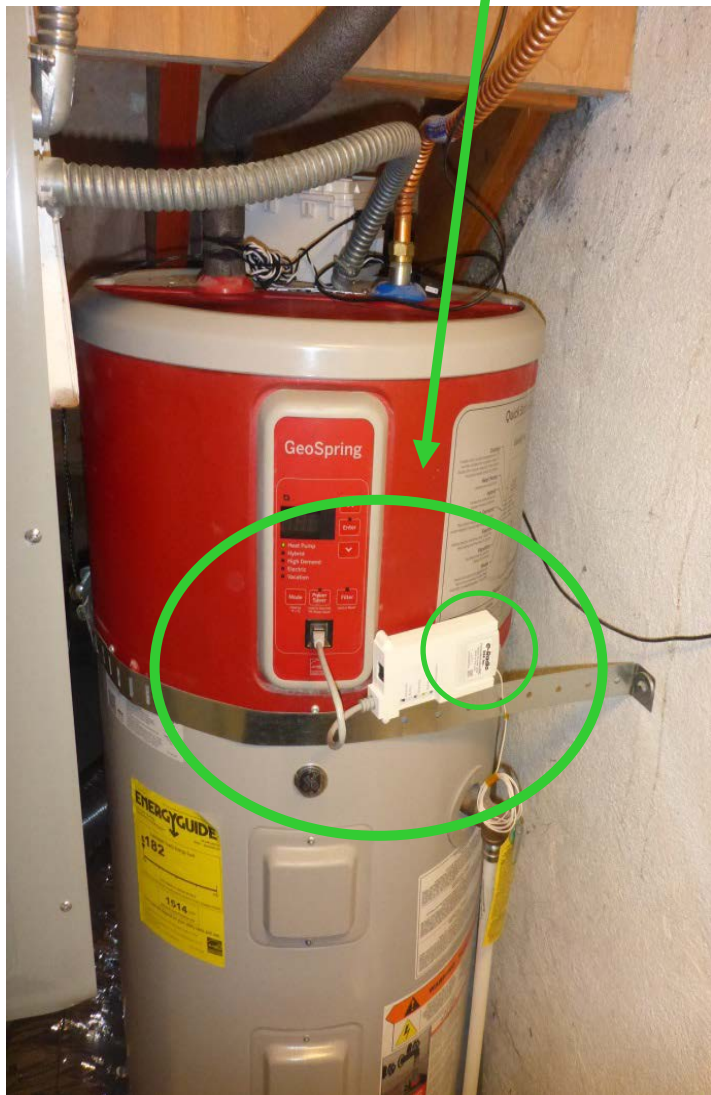
Introducing “the solution” CTA-2045

A modular, open source, demand response (DR) specific communications port and command language

- Consumer Technology Association (CTA) published the standard in 2013 and was updated in 2018, another update is expected Oct 2020
- The standard is now ANSI approved and used internationally
- Two form factors:
DC (3V) and AC (240V)



Examples of DC and AC forms Heat-Pump Water Heaters



Advantages of a Standard Socket = Lower Cost !

- Common standard sockets today
 - 120V electrical outlet
 - USB port (in various form factors: mini, micro, standard)

- Tomorrow's standard appliance socket
 - **CTA-2045**
 - Standard Physical Socket
 - Standard format for data packets
 - Standard initial exchange of information



Value for Water Heater Manufacturers and Utilities

- **Manufacturers** can build one communications port for the entire national market, not multiple versions by region or utility program
- **Utilities** can choose whatever communication network they want
 - AMI, cell, proprietary radio, FM radio, and any future technologies
- Open standard means lower cost at large scale
 - Anticipated reduction for site install cost: \$400 to \$40 (or less at volume)
 - Customer installed module (lower overall cost, and customer is in control)
- Use the same communications module on multiple appliances
 - Mitsubishi HVAC heat pumps, for example

Differences between CTA-2045 and OpenADR

In its current draft: Energy Star Connected HPWH spec allows CTA-2045 port or OpenADR

CTA-2045 and OpenADR are not equivalent standards, but can be complimentary

OpenADR

- Does not specify a physical port thus the connection typically requires internet to the tank, most likely customer WiFi (long term connection issues)
- May require robust IT security firmware in the OEM control board. This is a significant IT burden on the OEM,

or

- OEM cloud connection requiring a utility or 3rd party agreement with OEM (challenging to scale)

Synergy between CTA-2045 and OpenADR

CTA-2045 port can be used to host an OpenADR communication to the tank via the module

- This places the OpenADR IT burden on the 2045 module not tank OEM
- Module manufacturers are experts in embedding what-ever technology is requested by the module purchaser (typically the servicing utility)

CTA-2045 port at the appliance allows maximum flexibility

Contact

Tony Koch, PE, CEM
Mechanical Engineer
Energy Efficiency
Bonneville Power Administration

jakoch@bpa.gov

206.818.0191