Smart Water Heaters

Ashley Armstrong
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Smart Water Heaters

- Conventional electric or heat pump water heaters with additional controls;

- Allow the utility or third-party aggregator to control their energy use over the course of the day;

- Allows a fleet of water heaters to be a flexible energy-storage system, capable of increasing and decreasing the load on the grid in real-time;

- The least expensive form of energy storage available;

- Allows for load shifting, demand response, ancillary services, and responses to grid-emergency events.

Source: Podorson 2014
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
  – 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)
The Water Heater Advantage

• Grid Connected Heat Pump Water Heater (HPWH)
  – High efficiency
  – Scheduled heat from renewable energy
  – Can provide grid flexibility

• Expected Peak Demand Benefits
  – HPWH
    • 0.18 kW load reduction;
    • 1.5 kWh as storage (twice a day)
  – Electric Resistance
    • 0.35 kW load reduction;
    • 3 kWh as storage (twice a day)

Source: ACEEE March 2018-Portland General Electric
Water Heating Features

- Convenience Features
  - Remote Control
  - Alerts
    - Element Failure
    - Optional leak detect
- Energy Features
  - Vacation mode
  - Energy Smart algorithm
  - Grid connectivity ready
HPWH Controls

• Unlike battery, water storage needs to balance
  – Hot water demand
    • Customer use (draw profile)
  – Energy generation
    • Low cost energy
    • Low GHG emission
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

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

• When combined with Battery storage, ROI is improved as smaller batteries are required – NREL Dec, 2017

• Potential for $9B per year in avoided utility costs – RMI Aug, 2015

• Up to $172 per water heater per year utility benefit – Brattle Jan, 2016

• High level of consumer acceptance and grid benefits – BPA Pilot Nov, 2018
Smart Water Heater Activities

Smart Water Heating Requirements are increasing as part of decarbonization and grid-interactive building policies.............

• Technical Requirements Must be HARMONIZED!

• States are Adopting Demand Response Requirements for Water Heaters
  • Washington State (HB 1444), Oregon (proposed), .......
  • California (JA13) Title 24 Alternative Compliance Measure for New Residential Construction

• ENERGY STAR Connected Water Heater Specification and Test Procedure in development

• NEEA (Northwest Energy Efficiency Alliance) Advanced Water Heating Specification
  – Version 7.0 of Tier 3 and above includes CTA-2045 requirement
Thank You!

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