SMART WATER HEATERS
Thermal Storage and Demand Response
A. O. Smith

- Established 1874 (147 years)
- Manufacturing Water heaters for over 80 years
- Multiple Brands
A. O. Smith

Leading Market Share in the U.S. Water Heater Market Segment

1. AOS actual shipments and AOS estimates of competitors’ shipments
2. Commercial water heater segment as defined by AHRI, total 2020 commercial units as reported by AHRI = 221,000 units
Water Heater Market

• Approx. 100M residential water heaters
• Approx. 50M residential electric water heaters
• Approx. 8.5M residential heaters installed each year
• Typical resistive electric heater 4,500 watt elements
• Average life expectancy 12 years
How a Water Heater Works

• Heat Top
• Then Heat Bottom

• Dead Band – Lower tank temp drop
• Limit relay contact arcing
• Allows for long life of thermostats
How a Water Heater Works

- **Non-simultaneous operation: elements not ON at same time**
  - **Cold tank**: 1) Tank is new/repaired
  - **Upper element ON**: 2) Heating starts
  - **Lower element ON**: 3) Upper part of tank heated
  - **Both elements OFF**: 4) Tank fully heated
  - **Lower element ON**: 5) Stand-by: keeps tank warm
  - **Cycle repeats**: 6) Bath is run-Cold enters

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Smart Water Heater Flexible Load Opportunity

• Assume 4M electric water heater per year
• Assume 4.5 kW load per water heater
• 4M year X 4.5kW = 18 GW year
• 12 years X 18 GW = 216,000 MW
Standard vs. Smart

Upper Thermostat

Electronic Thermostat

CTA-2045 Port

Lower Thermostat

Lower Temp Sensor

CTA-2045 UCM
Smart Water Heater

• Cold Water Prevention
• Multiple levels of Curtailment
• Increased Energy Storage
• Energy Storage Capacity reported in Watt Hours
• Simple installation - no truck roll
• Modular communication – Future Proof
Smart Demand Response

- Peak Shaving
- Valley Filling
- Renewable Integration
- RPS Benefits
- ToU Value
- Load Balancing
- Energy Storage
- Beneficial Electrification
- De-Carbonization
CTA- 2045 Universal Communication Port
CTA-2045 Adoption

• Oregon
  – Electric storage water heaters to require CTA-2045 port as of Jan 1, 2022

• Washington HB1444
  – HPWHs January 1, 2021 must have a CTA-2045 communication port, other electric storage water heaters >+40 gallons Jan 1, 2022

• State of California Title 24 – JA 13
  – 2020 HPWH DR
    • Must accept OpenADR or CTA-2045 DR Signals
Simple Installation
Traditional DR vs. SMART Load Management

Options
- ON
- OFF

- Shed Load
- Shift Load
- Add Load
- Advanced Load Up
- Price Controlled
- Current State on – off
- State of charge in watt/hrs
- Renewable Integration
A.O. Smith SMART water heaters

- Consumer comfort – cold water prevention
- Increased Energy Storage with Load Up or ALU
- Self Preservation – prevents over control from utility
- More robust relays to support Load Up and ALU
- Low cost solution – no expensive truck roll for DR
- More grid benefits i.e. Load Balancing, ToU
CTA-2045 Commands

• Run Normal
• Shed (reduces volume of hot water a little)
• Critical peak (reduces volume of hot water significantly)
• Grid Emergency (effectively turns water heater off)
• Load Up – Heats up entire tank and holds temp (reduced dead band)
• Advance Load Up – Requires mix valve – Increases tank temp and holds.
Why Water Heaters? Load-Up & Shed

Source: 38 residential electric resistance water heaters average daily consumption over 64 week days
Energy Storage - Load Shifting

- Energy Star DR test procedure for 50 gallon HPWH
- Energy storage via Load Up after shed approx. 750 W/hr
- Energy storage via Advanced Load Up after shed 1,500 W/hr
- Resistive electric approx. 2 – 3 X that of HPWH
Smart Product Resistive Electric
Smart Load Management

• More Low cost, low carbon generation can be harvested by shifting load improving renewable generation asset ROI

• Increased renewable generation capacity is obtained by simply shifting load to maximize renewable capacity with no additional cost of generation or transmission.

• Consumers and utilities benefit from low-cost off-peak carbon reduced generation
Cost of Energy
QUESTIONS?