Emerging Technologies

Central Water Heating Workgroup August 4, 2020

Design Implications: Load Shifting Central Water Heating Systems

ECOTOPE

Emerging Technologies

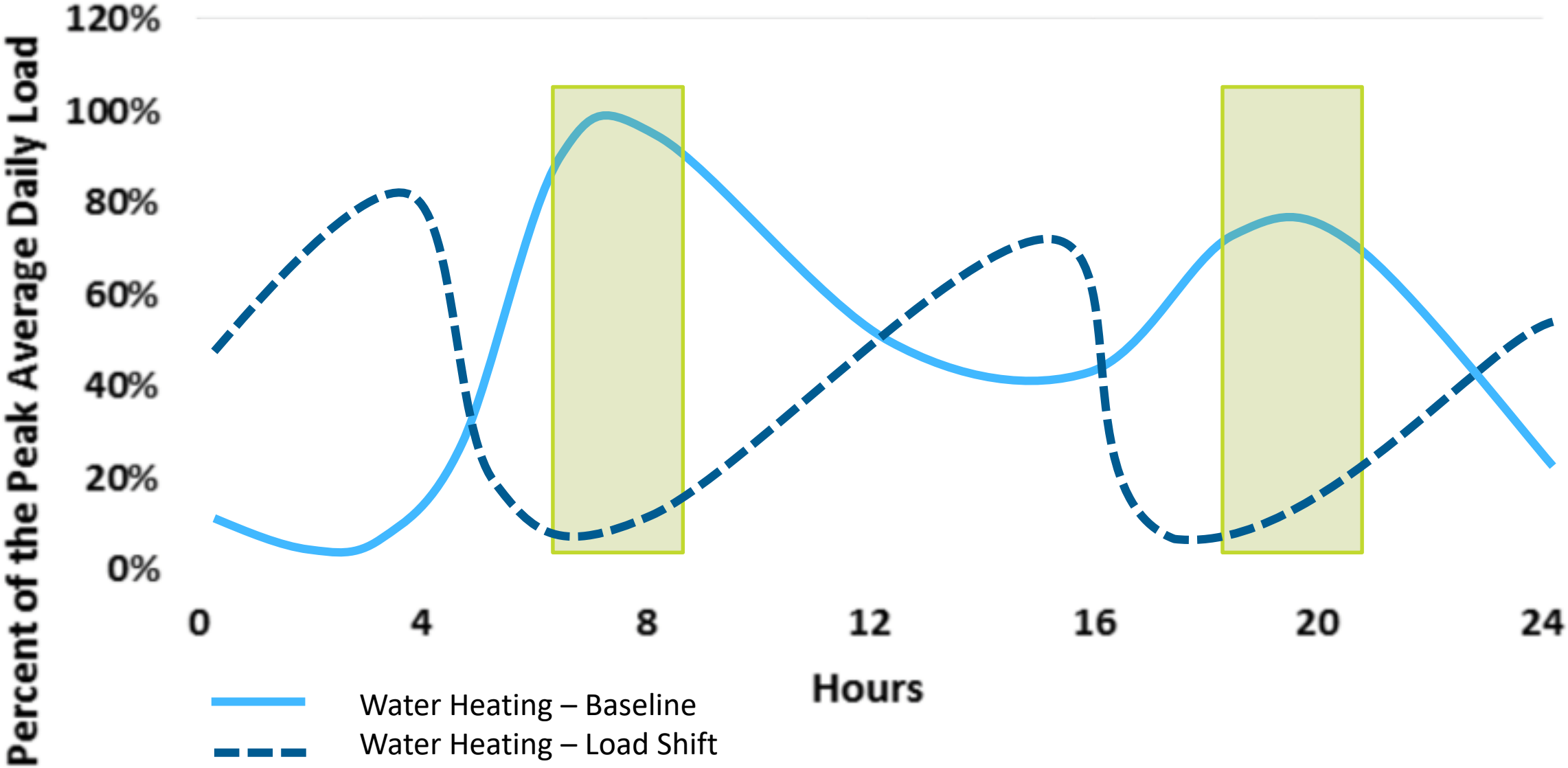
GOAL: Advance the development and adoption of HPWH Technologies faster together

- HPWH are standard practice in new construction and retrofit
- COP ~ 3
- Low-GWP refrigerants
- Plug-and-play packaged systems
- Cost-effective
- Reliable
- Ability for load shift

Agenda

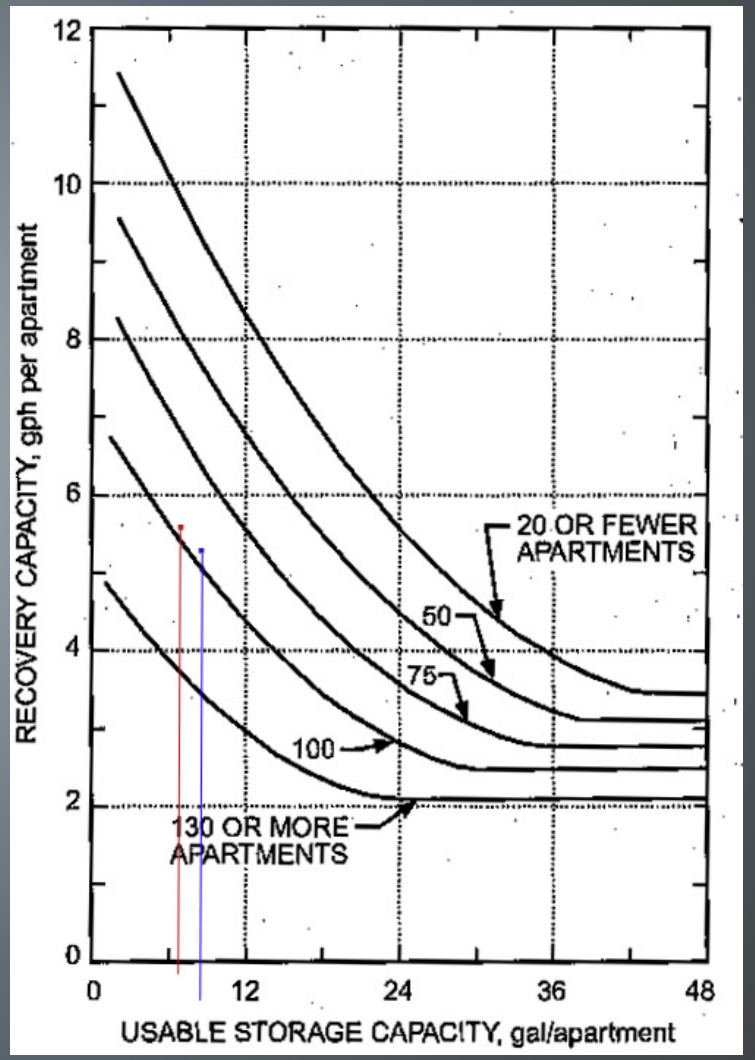
- What's New? Discussion – 15 minutes
- Introduction to Design Implications of Load Shifting
  Jonathan Heller; Ecotope – 10 minutes
- EcoSizer Central HPWH Sizing Tool
  Paul Kintner; Ecotope – 15 minutes
- QAHV – Integration of Load Shifting Capabilities – 15 minutes
  Cain White; Mitsubishi Electric
- CTA-2045 Communications for Load Shifting – 15 minutes
  Geoff Wickes; NEEA and Tristan de Frondeville; Skycentrics
- JA-13 Central HPWH Systems Update – 10 minutes
  Pierre Delforge

Managing DHW Load Shape



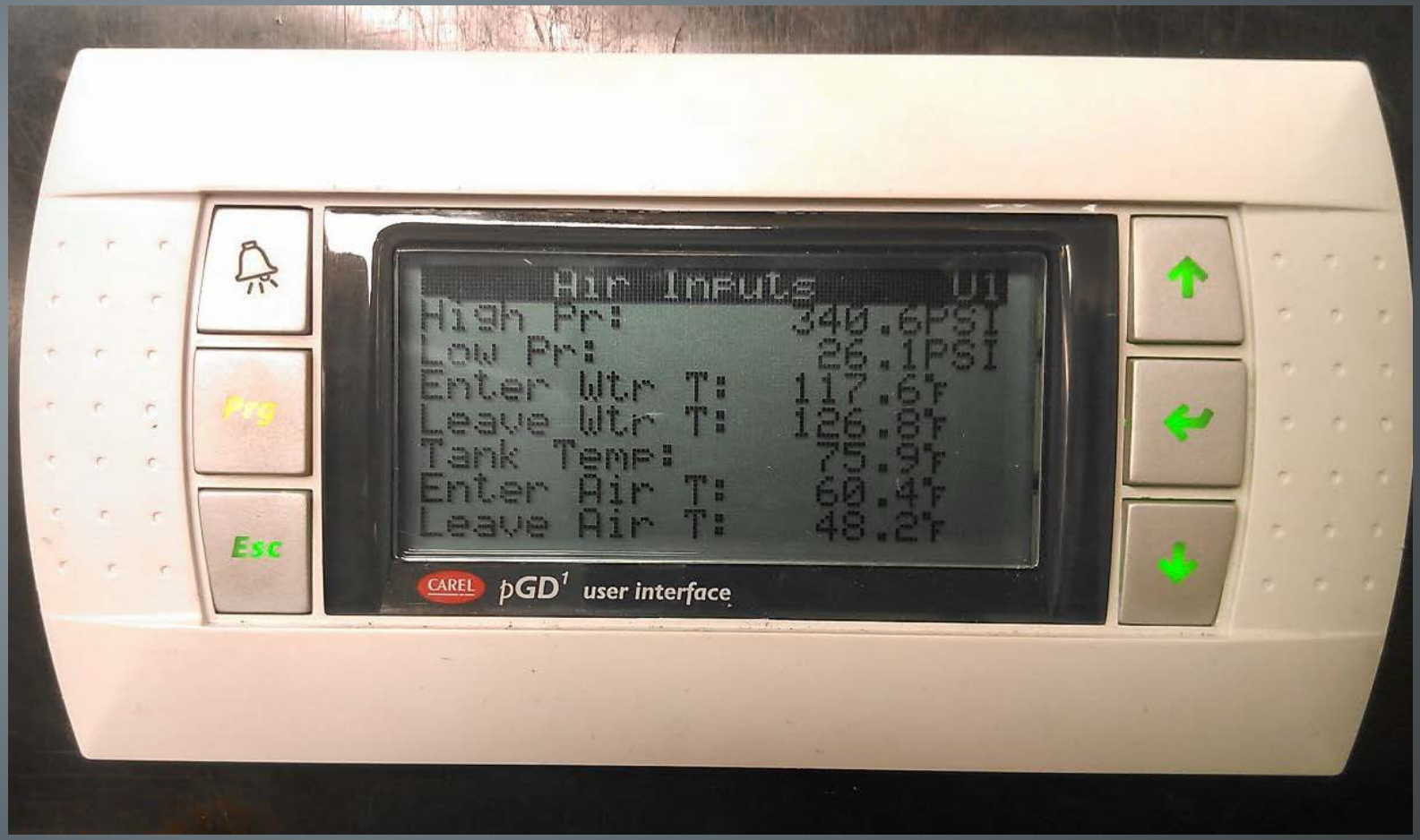
Equipment Sizing

1. Storage Volume
2. Output Capacity



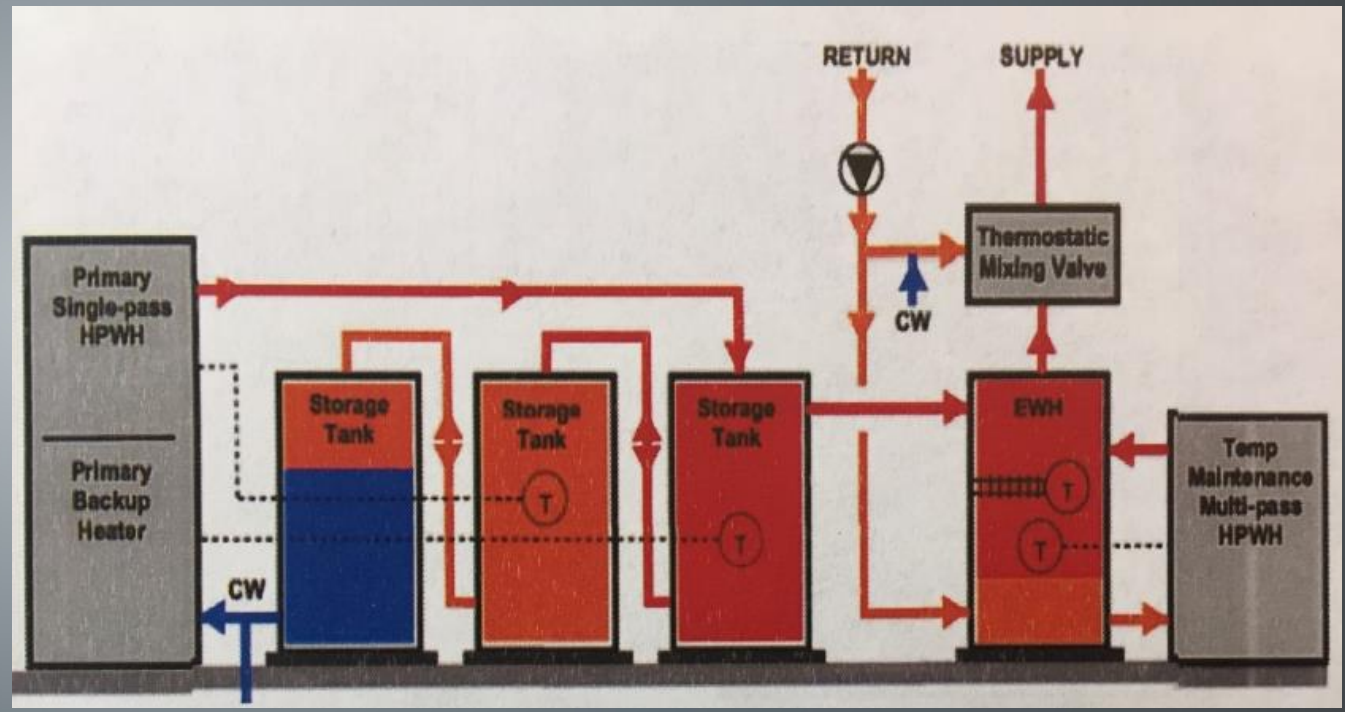
Controls and Communications

- Shift
- Shape
- Shimmy
- Shed



Sensors / Smarts

- How much hot water do we have left?
- How much hot water do we need in next period of time?



EcoSizer

A CHPWH Sizing Tool

- Paul Kintner

- Central HPWH Working Group
- August 4th, 2020

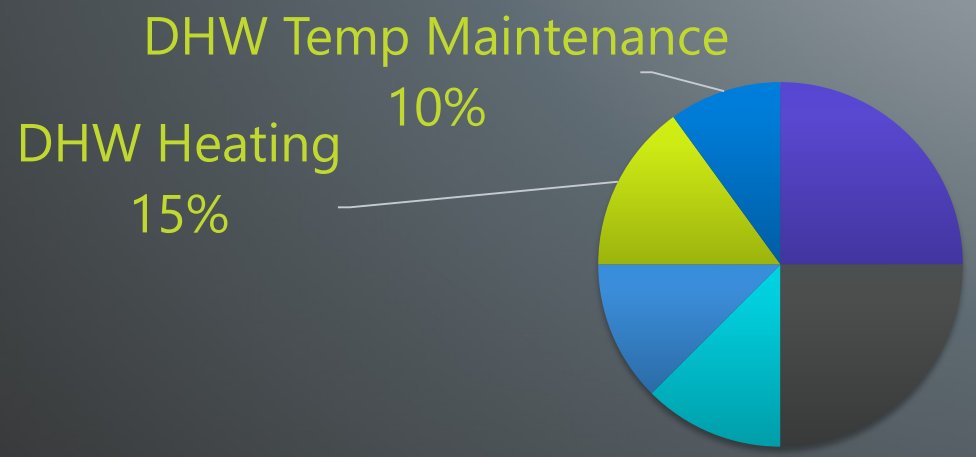
Sizing and Equipment Selection

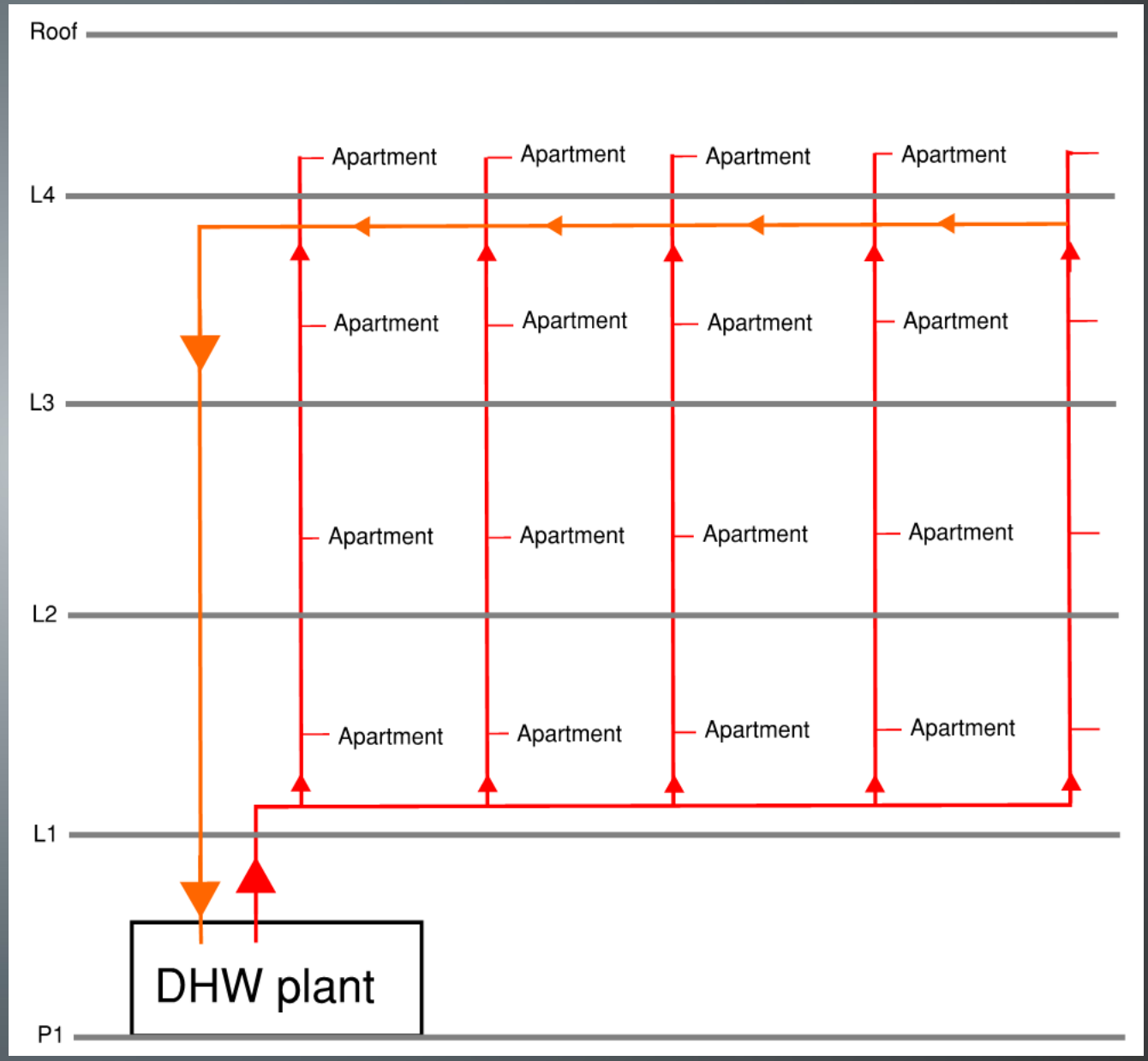
55 Tons
1,000 Gallons

5 Tons
520 Gallons

Two Separate DHW Loads

- Primary Heating:
  - Heating water for use
  - Making cold water hot
- Temperature Maintenance:
  - Reheating water due to energy losses in the distribution system
  - Keeping hot water hot

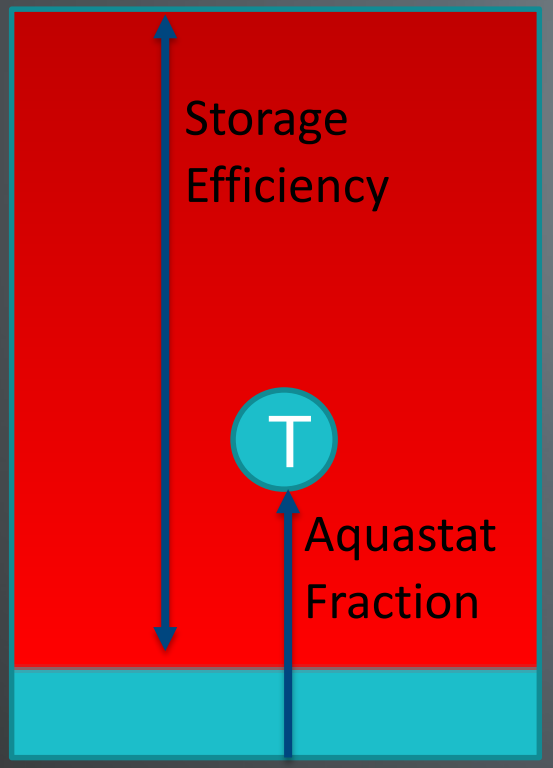


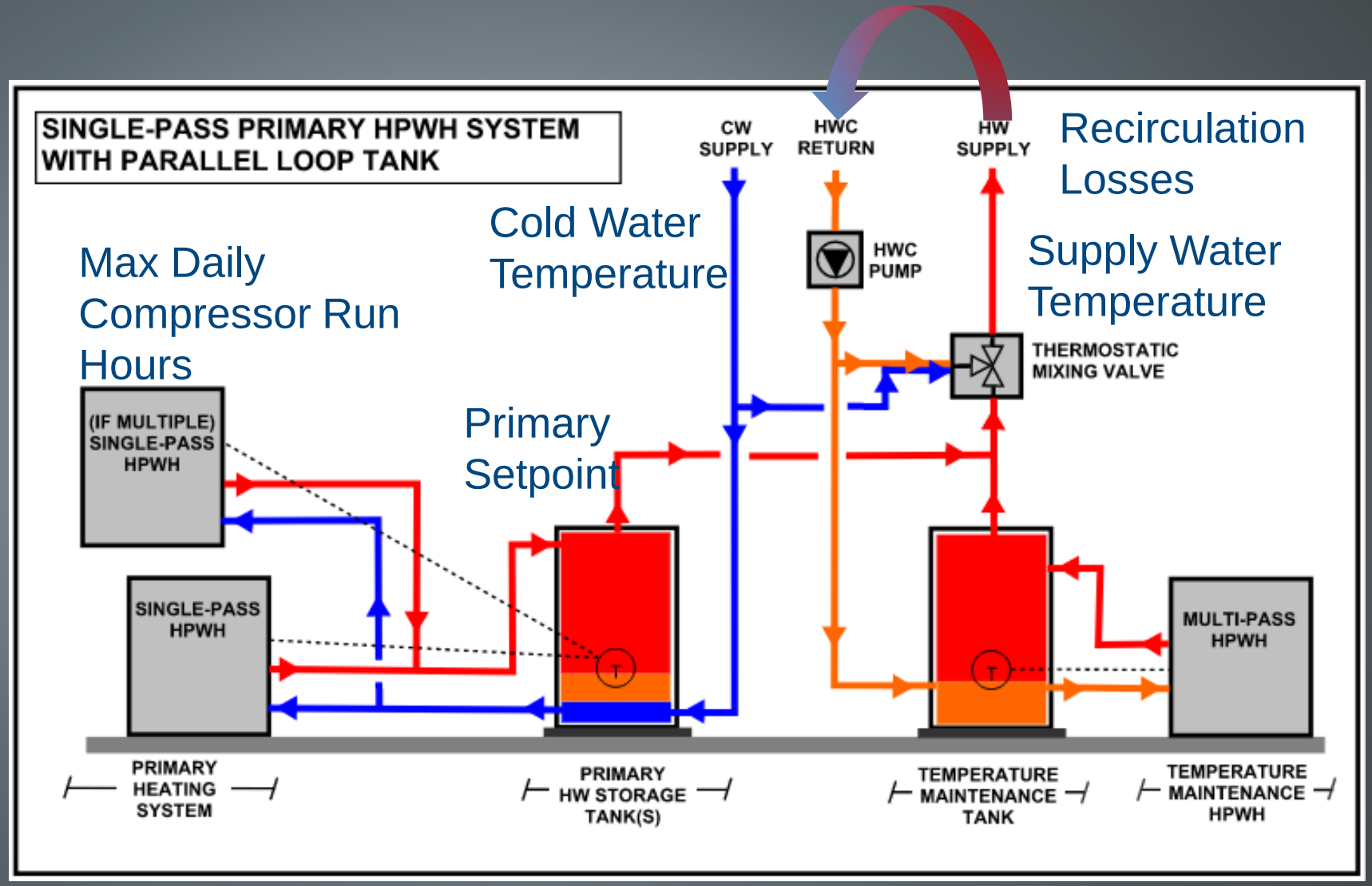


Inputs

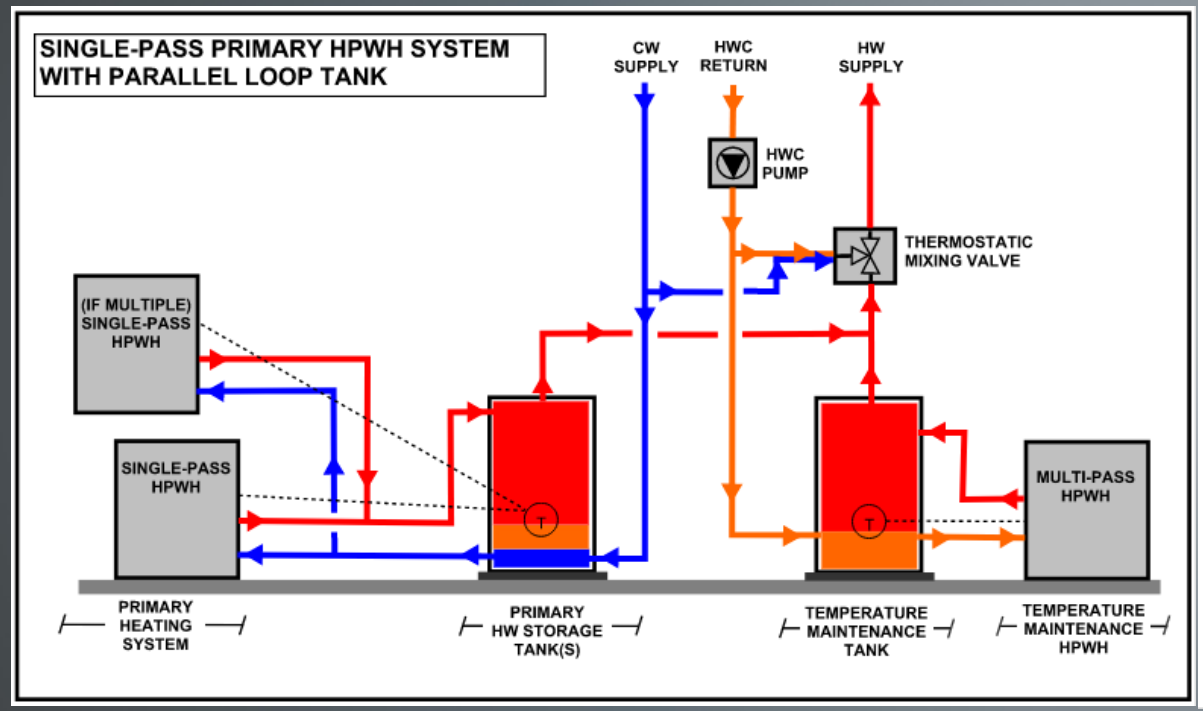
DHW Load

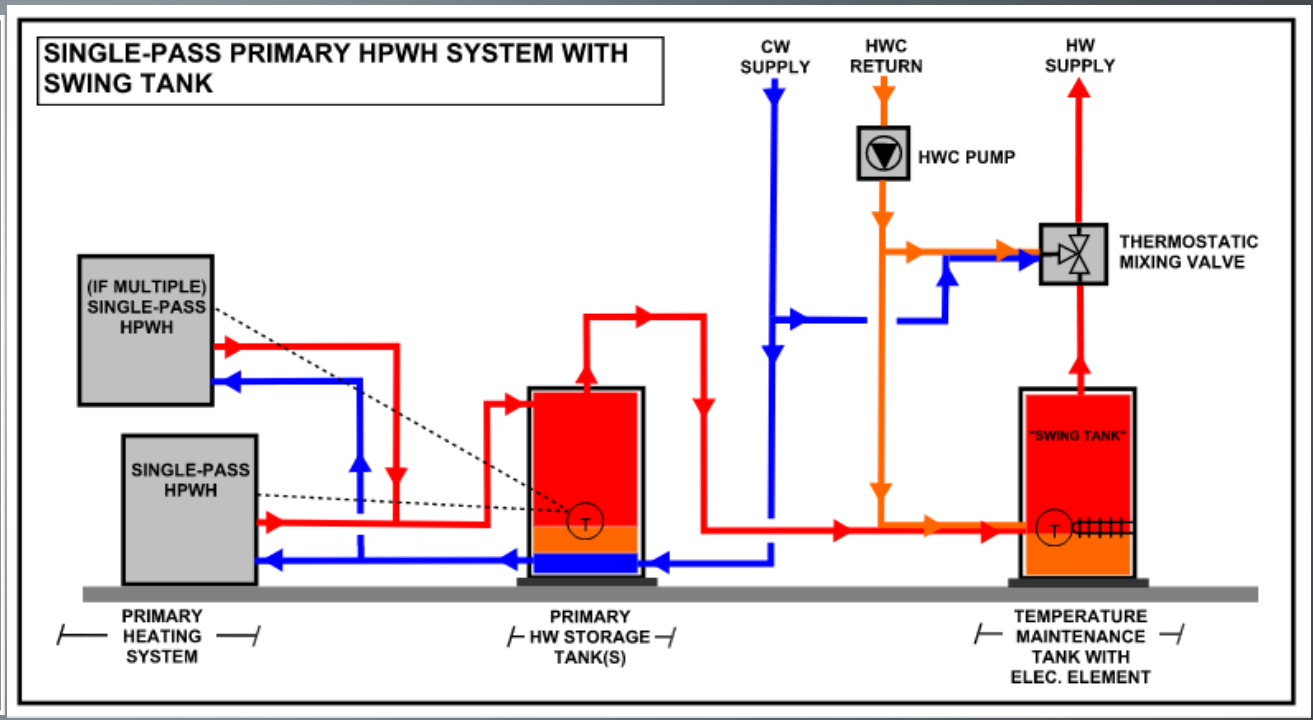
- Number of People
- Gallons per Day per Person





Schematic Selection



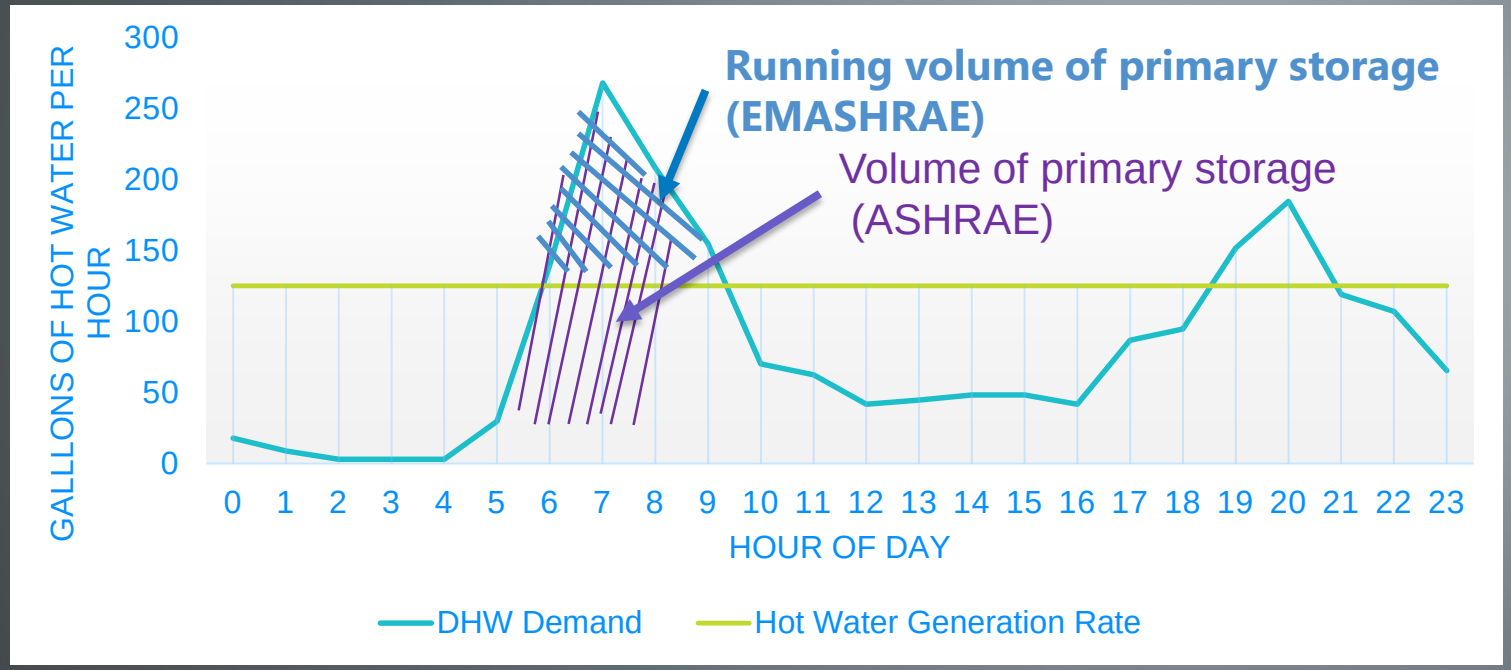


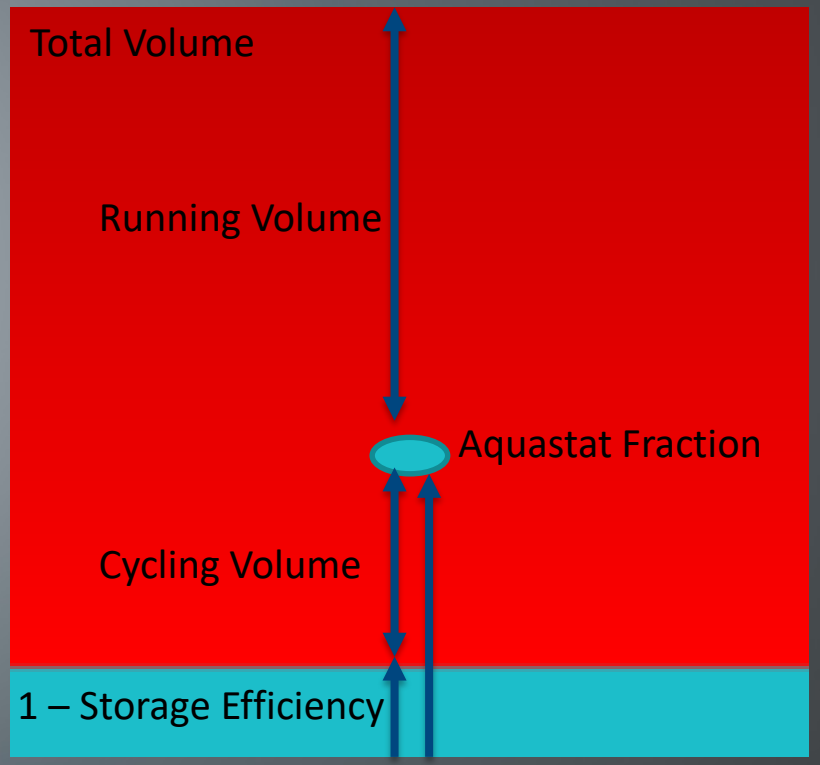
Ecotope Modified ASHRAE Methodology (EMASHRAE)

Hot Water Demand – Water used by occupants

Hot Water Generation Rate – How much hot water is produced by HPWH per hour

Load shape from 118 unit building



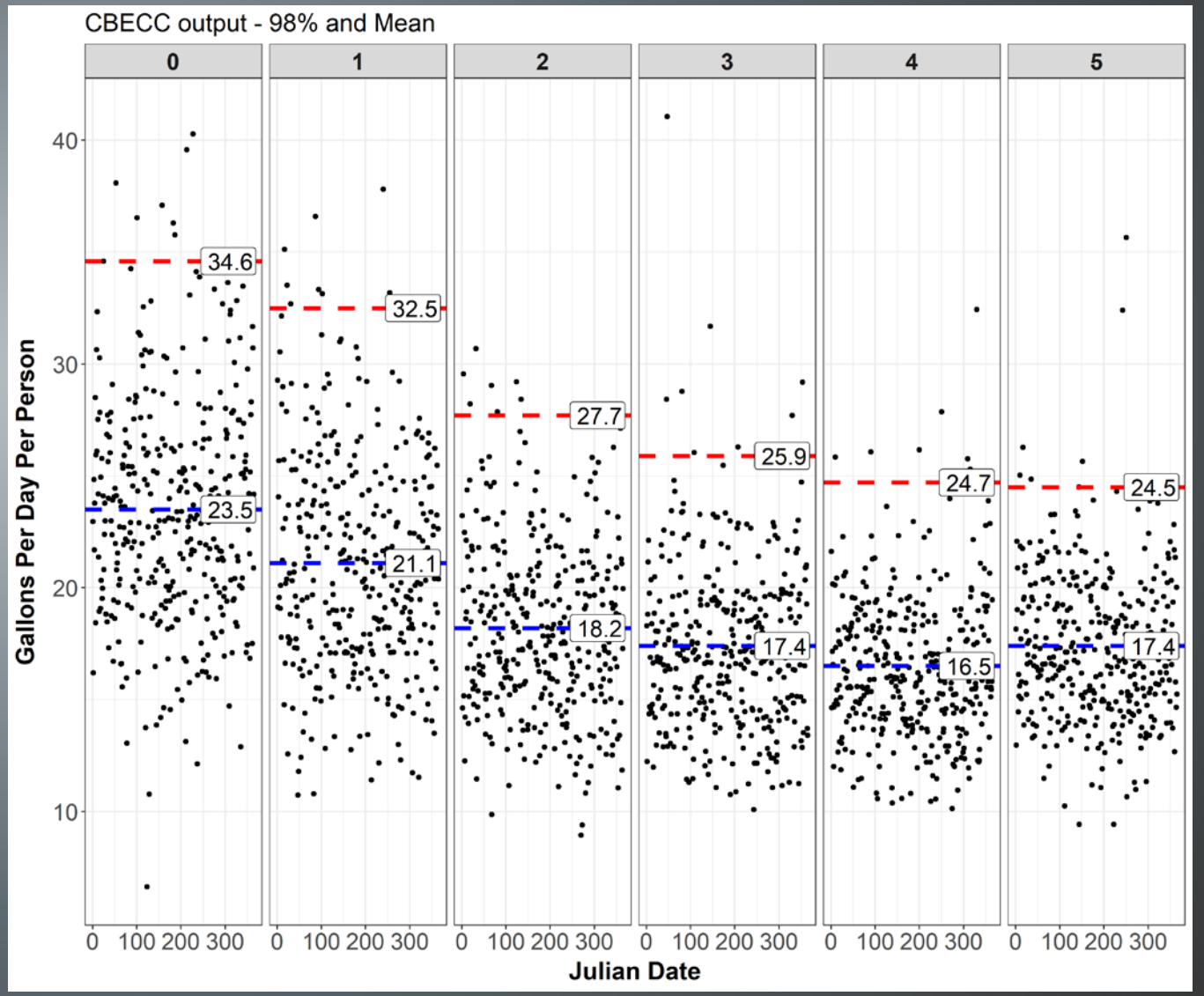


Example given has 2000 gallons per day, 100 people, HPWH sized to run 16 hours

Estimating DHW Demand

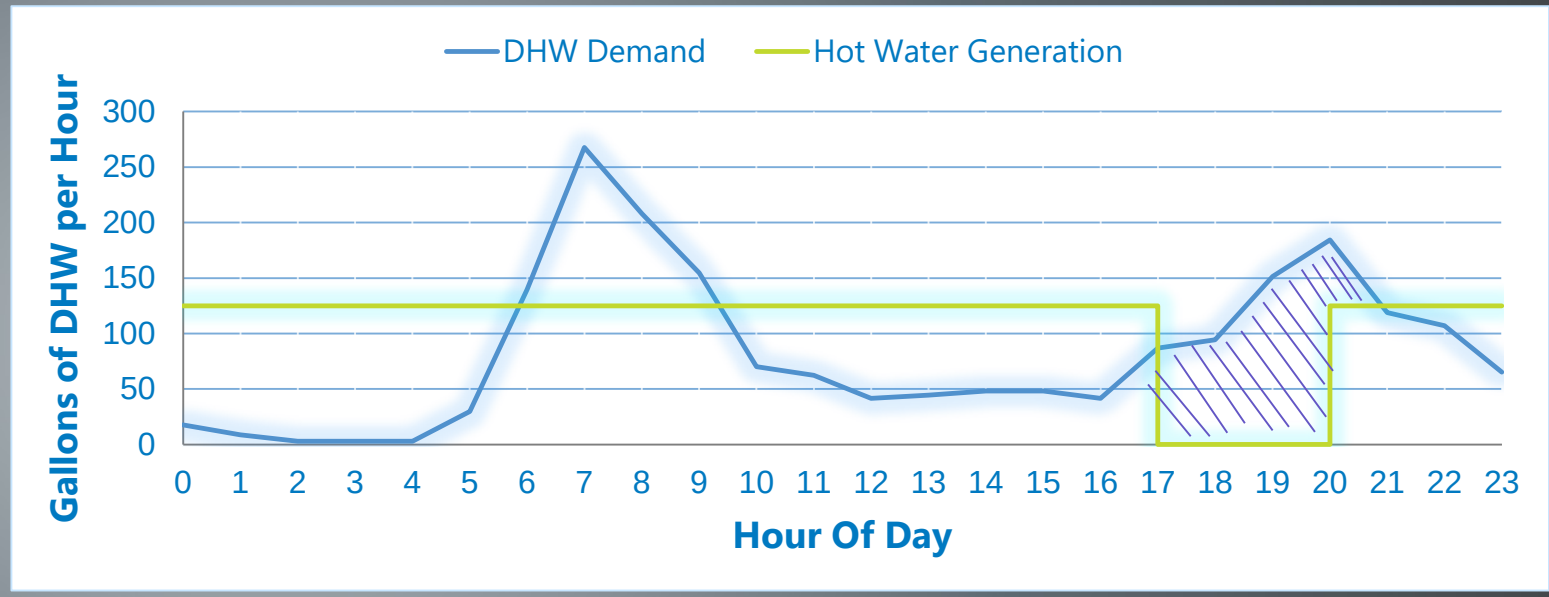
Gallons Per Person Per Day

- ASHRAE
- Ecotope M&V
- CBECC-Res



EMASHRAE – Load Shifting

- Load Shifting between 5 pm and 8 pm
- Same methodology but hot water generation rate goes to 0
  - Validates it has enough recovery for the whole after the event
- Expand storage volume, but still trades off with heating capacity
- If load shifting more hours than the HPWH is off per day going to have to increase hot water generation rate

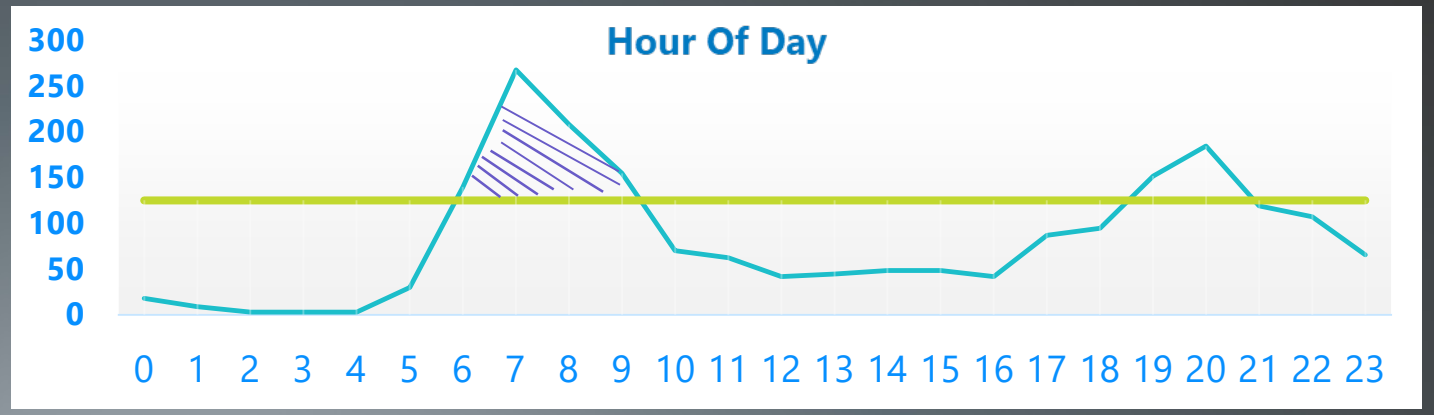


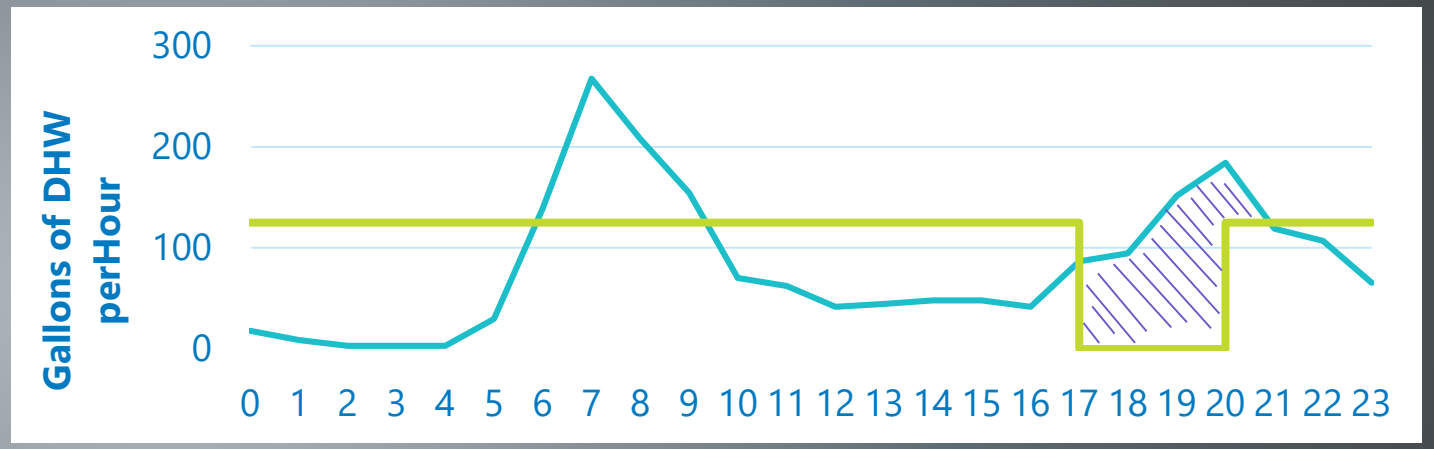
EMASHRAE – Load Shifting

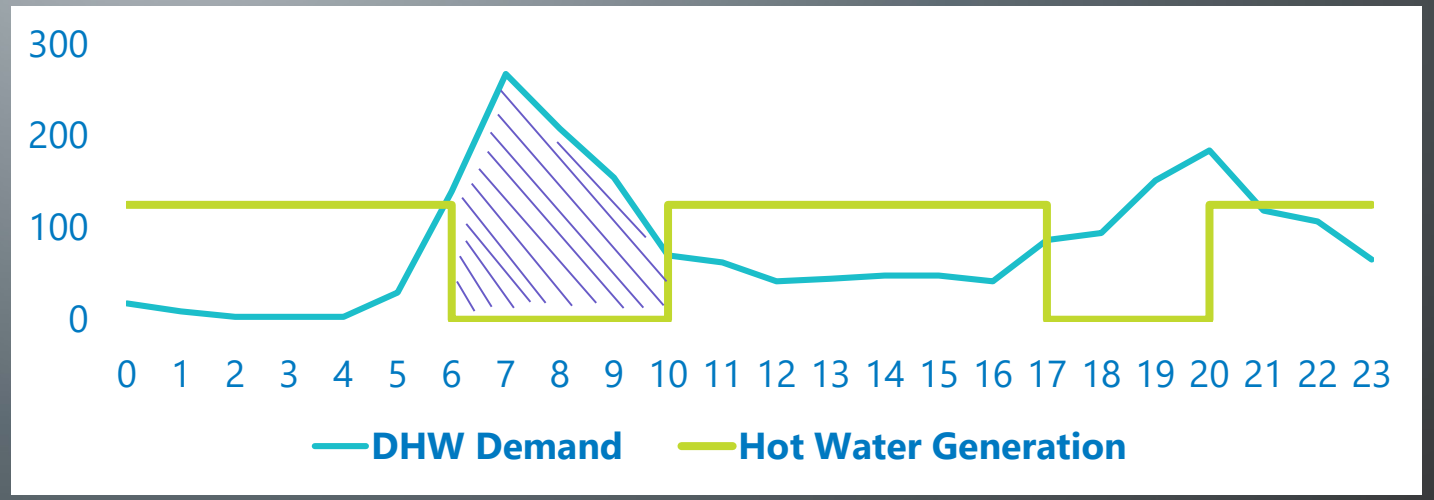
Comparison

- 100 people, 2000 gallons per day
- HPWH size to run 16 hours
- Without load shift and between 5 pm and 8 pm, and morning and evening.

Scenario	Sized Volume (Gallons)	Heating Capacity kBTU/Hr
No Load Shift	530	83
5 pm to 8 pm	700	83
6 am to 10 am and 5 pm to 8 pm	950	104







Thank You

Paul Kintner – paul@ecotope.com

ECOTOPE

Input:

2050 PARTNERS

ZYD ENERGY

Funding:

SOUTHERN CALIFORNIA EDISON®
An EDISON INTERNATIONAL® Company

SMUD®

QAHV – Case Study of Integration of Load Shifting Capabilities

Cain White

Mitsubishi Electric

Determine Utility Requirements

- **Effective design and integration requires clear established standards**
  - Time of use
  - Duration of use
  - Seasonal
  - Notice in advance of event (6, 12 or 24 hours ahead?)
  - What information does the Utility require in return?
  - How much are utilities prepared to spend to implement a solution?

- **Utilities must align on shape and structure of demand signal for equipment to respond**
  - CTA 2045 has not had significant market sales so far for Mitsubishi Electric
  - We sell equipment in all 50 states, therefore we need a repeatable solution that will work for all regions

Mitsubishi QAHV

- **2021 Product Launch**
  - Feasibility assessment complete
  - Currently undergoing UL testing
  - Application testing under way
  - Demonstration and M&V in design
    - Seattle multifamily project with Ecotope
    - CA EPIC project in San Francisco – AEA, Ecotope

- **QAHV Key Specifications**
  - CO2 Refrigerant – GWP of 1
  - 11 tons nominal
  - Capacity data to -13F ambient conditions
  - Systems operating in Europe down to -35F
  - Variable speed Mitsubishi Electric compressor
  - Variable speed pump built-in
  - Cascade control for multiple units

QAHV Capabilities

- Up to 16 QAHV units can be connected in parallel
- 40KW to 640KW system capacity
- QAHV can integrate up to 6 temperature sensors
  - Temperature sensors can determine the volume of stored hot water
- Cascade control built in – units will reduce capacity or turn off automatically
- Ability to limit the capacity of the system via utility signals
- Ability to ramp up production of hot water prior to an event
- Signals can be received from utility or consumer
  - Intending to implement a gateway device with open ADR 2.0b technology
- Successfully demonstrated load shifting with other Mitsubishi technologies
  - Utilizing CTA 2045 USNAP interface

CTA 2045 for Multi-family Overview

Geoff Wickes & Tristan de Frondeville

August 4th 2020

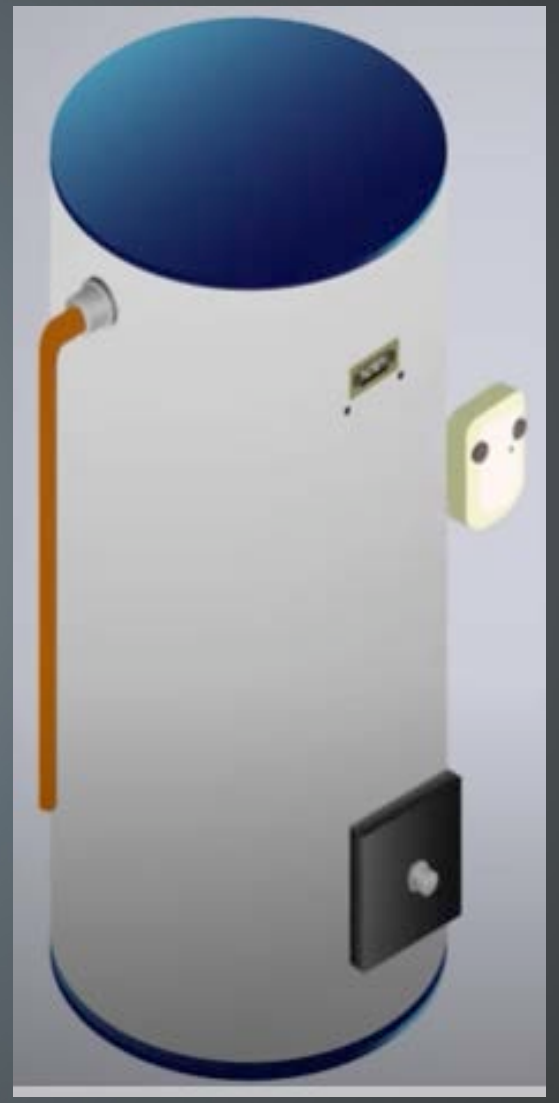
CLASSIFICATION LEVEL : PUBLIC,

CTA – 2045 Overview

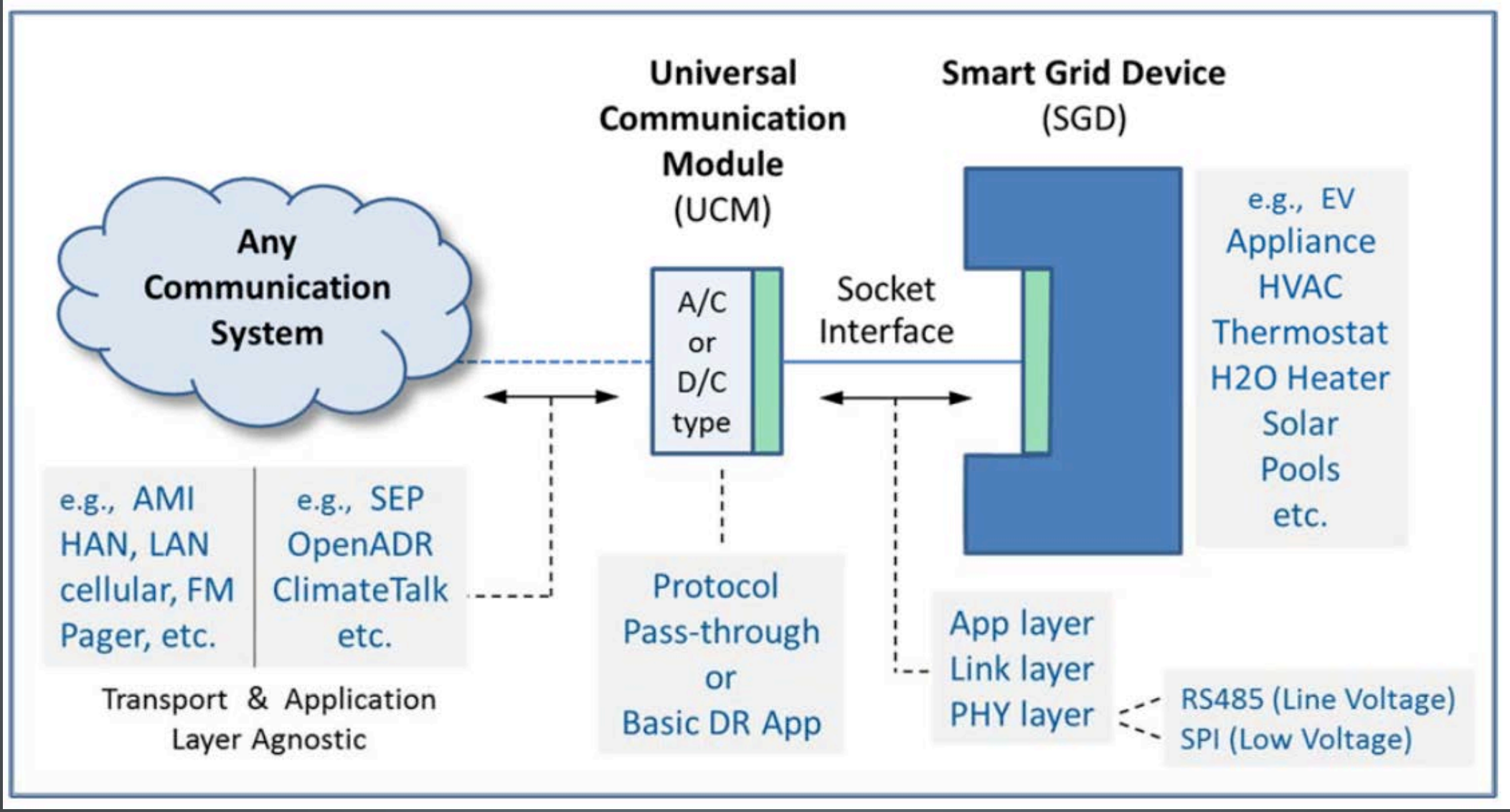
- Origins
- Overview of how 2045 works
- Current key target markets (Unitary and split residential and small multi-family)
- How to extend into central systems
- CTA 2045-B next generation
- Where should control be placed

Origins of CTA-2045

- 2013 - Utilities want a future where they can access large electric appliances in homes and small businesses at scale
- Worked with Consumer Technology Association (CTA) to encourage broad manufacturer participation and adoption
- OEMs asked utilities what kind of connection required
- Utilities answered – With variety of solutions leading to universal port
- A universal port with a modular connection was deemed the best approach



How it works

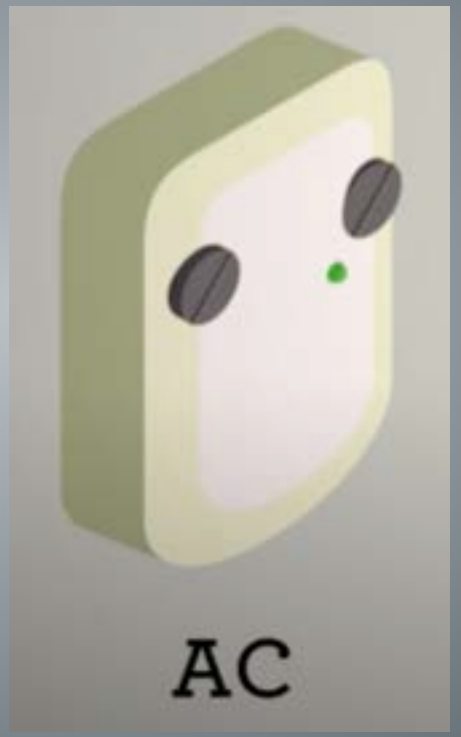


How it works (details)

- Three Levels of Shed
  - Shed
  - Critical Peak Event
  - Grid Emergency
- Two Levels of Load Up
  - Load Up
  - Advanced Load Up (Title 24, JA 13)
- Other design features
  - Customer Override/Opt Out – communicated to utility from device
  - OEM decides how their controls respond to the signals to balance customer needs
  - Modules can provide 24/7 scheduling to appliances that never had scheduling capabilities
  - Keeps the cost low at scale on the appliance (cloud and apps not required, can be provided in the module)

Current Key Target Markets

- Unitary Residential
- Split Residential
- Small Multi-family



Ideas on extending to Central Systems

- Coordinate with vendors looking to make plug and play systems
- Work with Ecotope to determine the ability of the system to shift the 3-4 hour evening peak, and 1-3 hour morning peak for seasonal TOU or daily streaming prices
- Work with vendors to determine the system response to the three levels of shed, and two levels of load up
- Work with vendors to determine the ability of the systems to report instantaneous power use and storage capacity in wH

What is coming in CTA-2045-B (Sep 2020)

- **Time of Use schedule formats –** This will help Title 24, JA 13, standard ways for utilities to post TOU schedules.
- **24 hour ahead streaming prices** – If SGD understands them great, or, module can translate to standard CTA-2045 commands.
- **Advanced Load Up –** To comply and match with Title 24 JA13 which defines and Advanced Load Up function
- **Mode control for water heaters –** To be able to change between Heat Pump only, Hybrid, etc.
- **More functionality** to control Mode, Fan speeds and other items in HVAC
- **A Test Mode** signal will be able to be sent to help with testing for certifications
- **Advance Warning/Resiliency** message can be sent to the SGD so that it can prepare for storms and outages

What is coming in CTA-2045 (Q4 2020)

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:

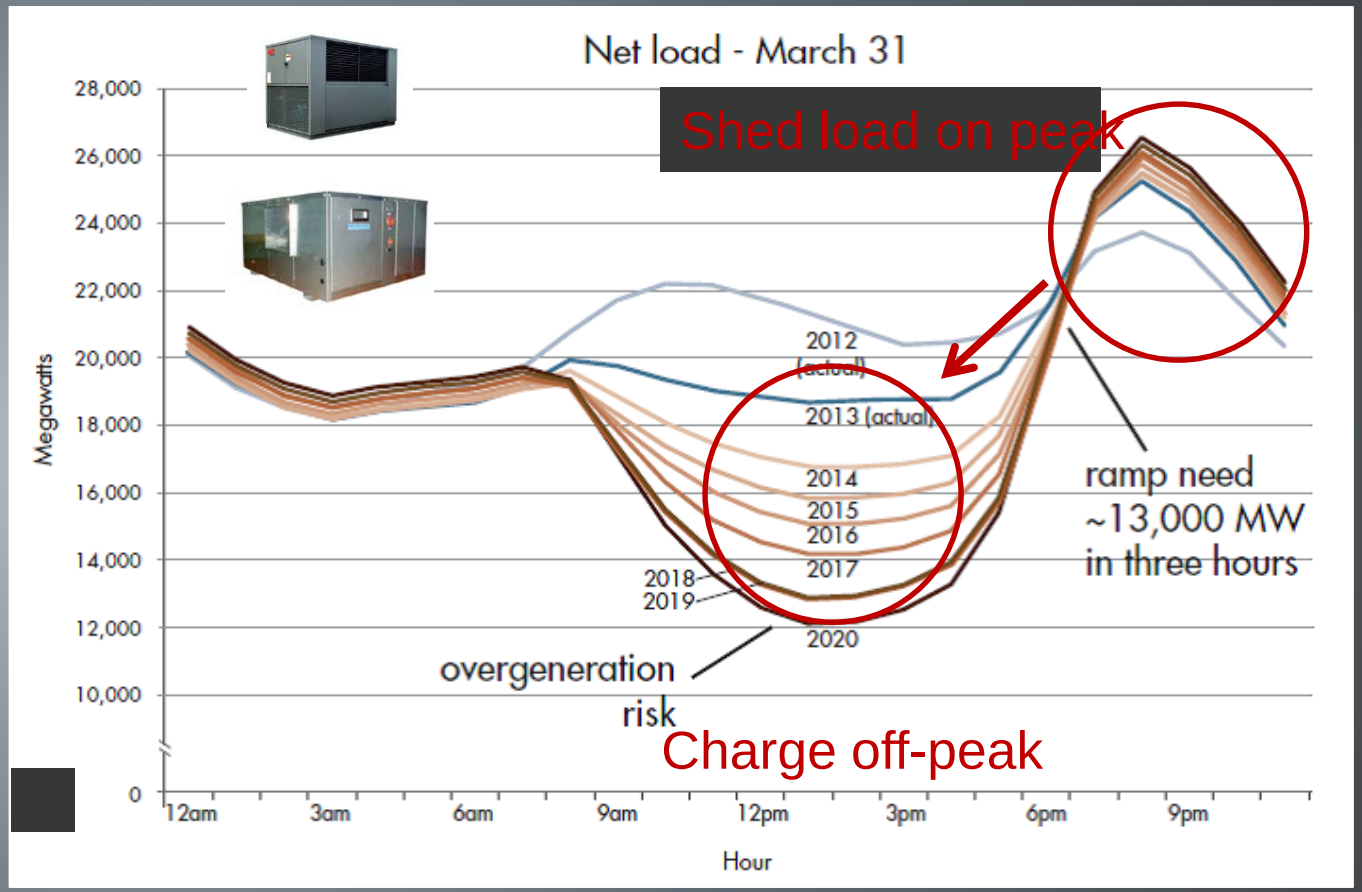
1. Send standard CTA-2045 signals
2. Update firmware
3. Manage connectivity
4. Report telemetry from the SGD
5. Report opt-outs from the SGD

CTA-2045 certification

- NEEA and OpenADR working together to develop certification methods for OEMs and Module Vendors
- OpenADR will host CTA-2045 which will help diffuse the current confusion in the market.
- Certified Product Lists will be hosted on OpenADR, CTA and NEEA websites.

JA13 for Central HPWH

- Pierre Delforge, NRDC
- Aug. 4, 2020



Objective

- Joint Appendix 13 (“JA13”), adopted by CEC on July 8, 2020
- Covers unitary residential HPWH only
- How about central HPWH?
  1. What is the current status of JA13 for central HPWH?
  2. What is the process for developing the proposed requirements?
  3. What is the timeline for input and roll-out?
  4. How can the people on the working group get involved?

JA13 in CA Title 24, 2022 Code Update

- CA 2022 building code:
  - CASE proposal mostly developed, workshops expected to start late Aug. / early Sep. Express terms by Dec. 2020, adoption mid-2021, effective Jan. 1, 2023
- Non-Res Grid Integration CASE proposal re. JA13:
  - https://title24stakeholders.com/wp-content/uploads/2019/06/NR-Grid-Integration_Draft-CASE-Report_Statewide-CASE-Team.pdf
  - Includes high-level update to JA13 to include Central HPWH (section 7.3.3), but few details, pending JA13 finalization and adoption
  - CASE proposal update in-progress
- Timeline:
  - Comment period on initial CASE proposal closed end June 2020
  - More opportunities to comment during formal proceeding **Sep.-Dec. 2020**
  - How to influence: Assess Appendix A straw proposal, get ready to submit comments and any additional proposals during first workshop comment period

Self-Generation Incentive Program (SGIP)

- Jan. 2020: CPUC decision allocates $45M for HPWH
  - Unitary + Central, Residential + Commercial
- Mar.-Jun.2020:
  - CPUC stakeholder working group and workshops
- Building Decarb Coalition (BDC) working group proposal:
  - 20% of budget for CHPWH + 15% for equity projects (incl. CHPWH) => $9-16M
  - Straw proposal to expand JA13 expansion to central and commercial (“Appendix A”)
- Timeline:
  - Sept. 2020: CPUC staff proposal
  - **Oct. 2020: Comments on staff proposal**
  - Q1’2021: CPUC Decision

Appendix A: Qualification Requirements for HPWHs – Requirements

Complement to Joint Appendix 13 (“JA13”) for commercial and central HPWH

Leverages JA13 with adjustments for commercial and central HPWH specifics

Appendix A: Qualification Requirements for HPWHs – Requirements

To qualify as a demand management heat pump water heater for the purposes of SGIP rebate eligibility, central and commercial HPWH must meet the same requirements as JA13 with the following adjustments to #2 and #4:

1. Safety Requirements
2. **Minimum Thermal Storage Requirements**
3. Control Requirements for Demand Management and Local Time-of-Use
4. **Load shifting performance requirements**
5. Non-standard mode exception
6. Local time management
7. Override and permanent disabling
8. User interface
9. Measurement and validation

2. Minimum Thermal Storage Requirements

Unitary Residential (JA13, for reference)	**Unitary Commercial**	**Central Residential**	**Central Commercial**
Comply with First Hour Rating (FHR) in 2018 Uniform Plumbing Code (UPC)	Must have a minimum hot water delivery of **300 gallons per day**	Must have a minimum **0.84 kWh** thermal storage **per person** based on design occupancy of the project described in the SGIP rebate application. The sizing calculation is based on an ambient air temperature of 67.5 F and an inlet water temperature of 58 F	Enough thermal storage to support a minimum **4 hours of compressor operation**. The sizing calculation is based on an ambient air temperature of 67.5 F and an inlet water temperature of 58 F

4. Load Shifting Requirements

For a heat pump water heating system sized per the minimum storage requirements in section 2, above, and with the set point from the point of manufacture, the System shall be able to shift:

	Unitary Residential (JA13, for reference)	**Unitary Commercial**	**Central Residential**	**Central Commercial**
Basic Load Up + Light Shed	A minimum of **0.5 kWh** of electrical energy per event	A minimum of **1 kWh** of electrical energy **per 100 gallon** storage per event	A minimum of **0.2 kWh** of electrical energy per person per event (design occupancy)	**4 hours** minimum of compressor run time at nominal rated power (same 4 hours as thermal storage requirement, not additive)
Advanced Load Up + Light Shed	A minimum of **1 kWh** of electrical energy per event, including at least **0.5 kWh** on Advanced Load Up	A minimum of **2 kWh** of electrical energy **per 100 gallon** storage per event	A minimum of **0.4 kWh** of electrical energy per person per event, including at least **0.2 kWh** on Advanced Load Up (design occupancy)	