Retrofit Ready HPWH Specification Breakout Group

Breakout Question One

What barriers should be addressed in a specification for for retrofit ready heat pump water heaters?

Barriers to Retrofit Ready Heat Pumps Identified in Breakout Group that the Specification will Need to Address

- Maintenance – Ease of repairs and durability
- Warranty
- Sound
- Equipment efficiency
- Controls for load shifting
- Return water temperature with HPWH is supplying a circulation hot water distribution system
- Operating temperatures for locating the HPWH in a residential building
- Self-protection devices
- Ductability options
- "End of Life" i.e. what happens to the HPWH when it finally fails
- Condensate management
- Refrigerants (Kino? Used and California Air Resources Board)
- First hour rating / Recovery Rate
- Communication protocol for grid interaction – modes and use cases
- Cost
- Toxicity / Safety – potential of refrigerant mixing with potable water
- Target market – the HPWH tank size should be identified based on how common the tank will be installed. Manufacturers want to design a system that will reach the largest retrofit market first and then design systems that will reach smaller markets.
- Test procedures
- Split system versus packaged HPWH system
- Space –this includes the floor area needed site the HPWH, the volume of space required for the system, the height of the space and the opening into the space to be able place the system in the existing space.
- Electric resistance back-up – this should be limited
- Power supply available to the system – 110 versus 220 Volt / electrical panel capacity / existing circuit capacity
- Building codes – National Electric Code requirements / how each jurisdiction interprets the code for the installation of a HPWH

Breakout Question Two

The overriding criteria for the development of the HPWH specification was that it:

1. Focused on residential building (one- and two family and multi-family residential 3 stories and less), and
2. Addressed existing building

The specification breakout group requested that additional parameters be placed on the specification that provided a more focused market segmentation. The following parameters were added to the parameters identified in Number 1 above:

- The HPWH would assume that 110 volts was available
- The specification would focus on 30 and 40 gallon tanks
- The hot water delivery would meet the requirements per the Uniform Plumbing Code

Breakout Question Three

What technical topics should be included in a specification for retrofit ready heat pump water heaters?

- Performance
- Refrigerant specification / air and water temperature
- Electrical
- Space
- System communications and controls
- Warrantees

Note that the group agreed that the following two topics should be considered during the development of each portion of the specification:

- Cost
- Building code including plumbing and electrical

Parking Lot Topics

The following topics were placed in the "parking lot" and designated for future discussion

- Blowing agents for foam materials used in the HPWH
- Dashboard for the homeowner to help monitor the HPWH system
- How the specification can require variable speed compressors
- Performing a market segmentation study that would identify the total market of the following:
    - Houses built earlier that 1960 that typically includes detached garages
        - These garages typically either have no power or 110 volt power run to them
    - Houses built from 1970 and newer that typically included attached garages
        - There are fewer barriers for retrofit ready HPWH when installed in garage

Retrofit Heat Pump Master Specification

Section 1.0 Introduction

Section 2.0 Specification Boundaries

Meet Uniform Plumbing Code requirements

HPWH Size: Small tanks (40 and 30 Gallon)

Space (volume and area space for installing HPWH)

Section 2.1 Performance

PERFORMANCE SPECIFICATION:

The heat pump water heater must have an UEF as measure by the NEEA's Northern Climate Heat Pump Water Heater Testing (Appendix A):

	Space Constraint Exists?	
Power Constraint Exists?	Yes	No
Yes	1. The Minimum Northern Climate UEF, which is potentially less than a 2.6 Northern Climate UEF that allows for designs that meet the space constraints and electrical constraints (i.e., potentially allows for a lower first-hour less than 51).	2. The Minimum Northern Climate UEF that corresponds to a Tier 3 NEEA (2.6 UEF) when simulated at a medium draw pattern allowing for a 140 mean tank temperature.
No	3. The Minimum Northern Climate UEF that corresponds to a that corresponds to a 2.0 UEF with a mean tank temperature of 140 degrees.	4. 2.6 UEF

Set first hour rating of 51 gallons as measured by the DOE test procedure.

Northern Climate UEF of 2.6.

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Section 2.2 Refrigerants / Temperature (Air / Water)

Refrigerants

- Environmental
  - Very dynamic time for refrigerant legislation state to state
    - Hinge on CARB dates and appliance classification
    - Need: definite dates from CARB
  - Tier approach?
    - Tier 1 - Current GWP<1500 (current solution)
    - Tier 2 - GWP<750 (Mid level step if needed)
    - Tier 3 - GWP 150 (Long term solution)
  - Safety/Toxicity (Considerations for future policy for type of refrigerant that can be included in a later version of the specification)
    - Should A2L and A3 be allowed if our target installation location is a very tight closet?
    - A3 refrigerants are currently limited to 150 grams, may not be sufficient for current condenser wrap design.
  - Serviceability
    - HFC's and HFO blends
    - Transicritcal CO_2 will drive up unit cost necessitating repairable design, but there is currently severe lack technicians that can service these units.
- Operating envelope
  - Air
    - Heat pump operation
      - Ambient temperature
        - $T_{AMBIENT}$ 40°F to 120°F
        - Backup Resistance element allowed for operation above or below (Electric only mode not a selectable)
  - Water
    - Inlet
      - Inlet water minimum of 50°F per NEEA specification
    - Tank Setpoint
      - Must be capable of achieving 140°F set point

Commented [EM2]: Need to have discussion on temperature. Should 37 degrees be considered? Need to research to look at percent of construction that is located in climates that are 37 degrees.

Section 2.3 Electrical

Electric Component of Retrofit-Ready HPWH Spec

- Spec
  - 110-120 V
  - Plug and play without a dedicated circuit or panel upgrade: 5-12 A
    - NEC - continuous heating loads can take up to 80% of capacity of shared circuit

        - 5A is a worst case – 1/3 of 15 A circuit; 12 A is "best case" - 80% of 15A circuit
- Feasibility check
    - Load up to 140 F with mixing valve
        - Based on Ecotope study, this is the sweet spot between thermal capacity, standby losses, and loss of efficiency
    - With 110V, 140F, 40 gal tank, can achieve 49 gal first hour rating with compressor
        - Required by UPC for up to 2 bed, 2.5 baths or 3 bed, 1.5 baths
    - In backup resistive mode, even at 40F inlet water temperature you get a 6 gal/hr recovery rate - can recharge whole tank in 8 hours
        - Overnight for morning draws
        - During the day for evening draws - low carbon electricity from solar
- Research questions
    - Double check NEC requirement for continuous load on a shared circuit – is it 80%?
    - Double check that you can start first hour rating test with the tank at 140 F.
    - What would be required to achieve UPC first hour rating for 62 gal? (Larger homes)
    - Research: How many showers in the real world do you get from a 49 and 62 gallon first hour rating tank?
    - NEC – fixed appliances require dedicated circuit. Need to verify. Can NEC be amended at state or local level?
    - Reference NEC 210.21(B)(1) and 210.23(A)(1) Look at GFI requirements

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Section 2.4 Space

How water storage vessel must to fit through a 22" opening for installation, and must fit within a space of 24"X26"X84" (inclusive of drain pan and all plumbing connections and venting connections).
Add language for recommended serviceability

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NOTE: This space requirement is based on limited data set and anecdotal experience. We recommend gathering more field data before solidifying these numbers. We recommend crowd sourcing the info by just putting the question out to the Building Decarb Working Group Listserve.

Section 2.5 Communications / Controls

- Open Protocol at device or at cloud – non-proprietary API
- Secure API – Security is important
- Open Cloud based API -
- Integration with home controls ecobee, nest, etc.
- Wireless WIFI signals that are open for communication recommended that OEM manage the relationship with customer experience
- Enable management of ToU energy cost for consumers through a trusted energy advisor
- Don't force the all the hardware and software on the water heater
    - Minimum capability at the standard water heater for onboard controls are:
        - Tank Temperature upper & lower
        - Setpoint temperature with capability to program setbacks or time of use interaction
        - Programmable on physical unit or remote

        - on/off controls
        - Change operating mode
        -
        - Connection through USB, BLE or wifi direct connect for provisioning and commissioning
- Add on "Dongle" or enhanced hardware "connect in" option for commissioning or updates
    - One option is CTA 2045 software protocol
        - Robust set of commands
        - Communication protocols
        - Consensus based ANSI standard
        - Standardized communication plugs

Draft language to describe the intent of the controls – communication enabled

Consider minimum set of data parameters for stakeholder needs

Third party tested

Utility Integration

- Opt out/ setback 72 hrs to efficiency/demand response mode
- Price signal capable, solar response to negative price signals
- Training for installers and setup for controls
- Thermal storage capable for first hour requirement and management

Section 2.6 Warrantees

5.3 Warranty and Service. The unit shall carry a warranty of a minimum of 10 years for all system parts. The unit shall carry a warranty of a minimum of 1 year for labor from date of installation with a reasonably priced, manufacturer provided extended labor warranty.

Should delete 5 years of labor warranty based on business models

Can 1.5 years (18 month) year warranty for labor be considered?

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Background Notes for Specifications

2. Specifications Breakout Group

2.1 Barriers for Retrofit-Ready HPWHs

- Space constraints
- Sufficiency of hot water, particularly as tank size gets smaller

- Available power
- Efficiency
- Cost
- Controls
- Multiple trades required

2.2 Requirements from Manufacturers

- Manufacturers want to design a system that will reach the largest retrofit market first and then design systems that will reach smaller markets.
- The spec has to cover enough applications that it's worth the manufacturer's while to make it
    - Target market – the HPWH tank size should be identified based on how commonly it would be installed.
    - R&D budgets depend on sales volume
- Market cannot only be driven by incentives; it has to have a value proposition on its own.

2.3 Specification

The group identified many barriers to retrofit-ready heat pump water heaters, but the spec cannot address them all. After some discussion, it was decided that the spec would cover existing residential buildings (one- and two family and multi-family residential 3 stories and less). And the requirements were that the HPWH

- Operate with 110 volts
- Be a replacement for 30 and 40 gallon tanks
- Meet the hot water delivery requirements per the Uniform Plumbing Code

Section 2.3.1 Performance

The performance requirements were considered separately depending on whether or not the application is space or power constrained. In some cases it is a specification and in others it is a path to one. Ultimately all four boxes below should have a single target UEF as measured by the NEEA's Northern Climate Heat Pump Water Heater Testing (Appendix A).

	Space Constraint Exists?	
Power Constraint Exists?	Yes	No
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No	3. The Minimum Northern Climate UEF that corresponds to a 2.0 UEF with a 140° mean tank temperature.	4. 2.6 UEF

Section 2.3.2 Refrigerants

- Environmental
  - Very dynamic time for refrigerant legislation state to state
    - Hinge on CARB dates and appliance classification
    - Need: definite dates from CARB for refrigerant GWP requirements
  - Tiered approach to get products to market faster
    - Tier 1 - Current GWP<1500 (current solution)
    - Tier 2 - GWP<750 (Mid level step if needed)
    - Tier 3 - GWP <150 (Long term solution)
- Safety/Toxicity (Considerations for future policy for type of refrigerant that can be included in a later version of the specification)
  - Should A2L and A3 be allowed if our target installation location is a very tight closet?
  - A3 refrigerants are currently limited to 150 grams, may not be sufficient for current condenser wrap design.
- Serviceability
  - HFC's and HFO blends
  - Transcritical CO_2 will drive up unit cost necessitating repairable design, but there is currently severe lack technicians that can service these units.

Section 2.3.3 Temperature (Air / Water) of Operating Envelope

- Air – Heat pump operation
  - Compressor must be operable at ambient temperatures between 40° and 120°
    - Electric only mode not selectable in that range.
    - Backup resistance element can be the primary or only heat source for operation above or below that range.
- Water
  - Inlet
    - Inlet water minimum of 50°F per NEEA specification
  - Tank Setpoint
    - Must be capable of achieving 140°F set point

Section 2.3.4 Electrical

- 110-120 V
- Must be plug and play without a dedicated circuit or panel upgrade: no more than 5-12A
  - 5 A is a low possible cap – one third of a 15 A circuit
  - 12 A is the highest possible cap for a 15 A circuit
    - From NEC 210.21(B)(1) and 210.23(A)(1), continuous heating loads can take up to 80% of the capacity of a shared circuit

Section 2.3.5 Space

- Hot water storage vessel must be able to fit through a 22" opening for installation and must fit within a space of 24" x 26" x 84" (inclusive of drain pan and all plumbing connections and venting connections).
  - NOTE: This space requirement is based on limited data set and anecdotal experience. We recommend gathering more field data before solidifying these numbers. We

recommend crowd sourcing the info by just putting the question out to the Building Decarb Working Group mailing list.

- Add language for recommended serviceability

Section 2.3.6 Communications / Controls

The intent of the controls is for the water heater to be communication enabled with the utilities and/or other smart technology in the home. However, don't delay installing HPWHs until the controls are perfect.

- The controls should be translatable to CTA 2045
- Non-proprietary, secure API
- Minimum onboard controls, programmable on physical unit or remotely
    - Tank temperature – upper & lower
    - Setpoint temperature with capability to program setbacks or time of use interaction
    - On/off controls
    - Change operating mode
- Utility integration
    - Enable management of TOU energy cost for consumers through a trusted energy advisor
    - Opt out/ setback 72 hrs to efficiency/demand response mode
    - Price signal capable, solar response to negative price signals
- Integration with home controls, eg ecobee, Nest, etc.

Section 2.3.7 Warranties

The unit shall carry a warranty of a minimum of 10 years for all system parts.

The unit shall carry a warranty of a minimum of 1 year for labor from date of installation with a reasonably priced, manufacturer provided extended labor warranty.