

# Retrofit Ready HPWH Workshop

## October 22-23, 2018, San Francisco, CA

### Executive Summary

## 0. Opening Plenary Highlights

### 0.1 Government and Utility Context

- Commissioner McAllister, CEC
  - HPWH first step in many - many analogous tech transitions to make in state - one of easiest
  - CEC - app eff standards (but with fed preemption issues), building standards, load management standards
  - AB 758, SB 350, AB 3232 - will be updated in 2019
- Commissioner Rechtschaffen, CPUC
  - SB 1477 Stern Bill allocates \$50mil/yr for new and retrofit residential incentive programs. Up, mid, and downstream education.
  - CA successful with regulatory tools in the past - PV, ZEV, batteries, LEDs
  - great business opportunities
- Kurt Karperos, ARB
  - min or eliminate combustion - near source health impacts - all sorts of heat sources and power sources
  - AB 617 better protecting disadvantaged communities from pollutants
- Heriberto (Eddie) Rosales, CEC “California WH Market”
  - Current price estimates @50 gal replacement costs: HPWH \$3,300, GSWH \$1,000. Estimated \$/gal: HPWH \$34/gal (280% higher) than GSWH: \$12/gal
  - 49% of natural gas consumption in res is water heating, 37% space heating
  - 79% (8.4 million) NG WH in 2010 RASS, new RASS underway
- Shon Richey, Southern Company, AL “National HPWH Markets”
  - Story of HPWH success, started HPWH pilots in 2009
  - Process: Internal/External trainings, plant tours, validate performance via field tests, Alabama Appliance Sales and Service offers on bill financing, tech support, market support, multi-pronged incentives
  - better to partner with heating and cooling contractors - understand upsell better (instead of plumbers)
  - HVAC training center
  - Case: AP Smart Neighborhood- 62 homes, all HPWH 28-100+ gal/day

- Martin Prado, EPRI “HPWH Barriers”
  - 10+ years, 1% market penetration “anemic sales”
  - Existing models too small for MF central boiler replacement
  - Like replacement standard industry practice
  - HPWH for thermal storage load management needs refining
- Owen Howlett, SMUD, “Electricity Provider Programs”
  - customer journey mapping – reduce steps
  - How to pass dynamic pricing to HPWHs in practice
  - Structure programs to capture the cross-interest of customers (EV, electric drier, panel upgrade, and HPWH all at once to defray costs)
  - how to increase customer desire/ perceived need for electrification
  - Vertically integrated: load-shifting opportunities in HPWH during overgeneration periods

## 0.2 Industry Context: Manufacturer, Distributor, Contractor

Jennifer West, StopWaste “Installers & Distributors Panel.”

Panelists: Scott Walker - AO Smith rep, Hunter Marquez - Ferguson Enterprises (largest HVAC distributor), Mike Woodruff - WH masters, Larry Waters - energy upgrade contractor

- How does manufacturer influence the distributor? Your role in what’s carried and trainings of installers?
  - Scott – manufacturers educate on production and installation; training at their facility or job site or with distributors
- How does the distributor select stock?
  - Heinrich - demand driven by contractor and end users; vet product with warranties, training.
- Challenges with installation - space
  - Mike - narrowing footprint for tank would be highest impact
  - Larry - can usually get around space constraints - drop pedestal, get rid of venting; biggest challenge is electricity panel, explaining to customer
- Integration with other retrofits
  - Larry - HPWH, HP, PV - decarbonization package - all 13 HPWH he’s sold have been part of upgrade package
- Training
  - Mike - went through Owen’s program; a lot is on the job get out the manual
  - Larry - training is often phone call to rep and trial by fire; manual is usually last ditch effort; use crews that are good with particular projects - new guys with people who are experienced
- Resident wants to install HPWH
  - Mike - it’s not on the truck but dealer they work with has them in stock
  - Larry - panel is less of an issue if you’re doing multiple items

- Lessons learned from tankless transition
  - Larry - shorter jump from gas tankless to HPWH than a gas tank to tankless; \$3k to install HPWH is not realistic in this market
  - Scott - homebuilders were hesitant to go gas tankless but legislation requiring upsized gas supplies, preventing, electrical supply, etc closed cost gap

Geoff Wickes, NEEA

- general public doesn't care about their water heaters, product inertia
- target market- builders, progressive installers, owner occupied homes
- programs - build relationships with contractors
- supply chain needs
  - 750k-2.25M units per year
  - seamless territories - don't change the program across boundaries
  - send incentives to manufacturers - they know how to get things sold with their distribution web/supply chain, provide training, etc building on existing relationships; can provide sales receipts that CEC wants
  - modest documentation
- only 37% planned replacement, promote - saving several hundred dollars a year
- no more pilots
- pro-deal - give installer a unit to put in their own home to champion product
- give manufacturers details of spec not how to make it happen

## 1. Program Breakout Group

### 1.1 Comprehensive Barriers to Retrofit-Ready HPWH

1. First cost\*
2. Existing conditions\* Upstream
3. Program issues\*\*
  - a. Lack of cross-selling w/other electric offerings
  - b. Lack of favorable rate design
  - c. Lack of consistent Programs across utilities
  - d. Require too much paperwork for contractor and end-user
  - e. 3 prong test barrier
4. Lack of trained installers\*\*
  - a. Installer dismissive of technology
  - b. Risks of callback/install
5. Rates\*\*\*
  - a. Customer will/may not save on bill Downstream

- b. Rates will continue to change/ go up so savings could diminish over time  
Downstream
  - c. Customer concern over rate hikes
  - d. Gas is cheap right now
- 6. Lack of preemptive, proactive sales channel\*
- 7. Emergency replacement\* Midstream
  - a. Not stocked @ distributor/ retailer – 48 hrs gas vs. 2 weeks HPWH\*
  - b. Distributors lack capital to stock a low-demand item
  - c. Contractors and customers lean toward like-replacement
- 8. Lack of broad marketing campaign / value proposition\*\*\*
  - a. Customer Value Proposition Upstream, Midstream, and Downstream
  - b. Disconnect from full electrification package (EV, PV, etc)
  - c. Disconnect from broader vision- decarbonization, public health
- 9. Customer perception
  - a. Uninterested in WH specifics
  - b. Unaware of incentive programs
- 10. Potential increased emissions w/early replacements (LCA), refrigerant emissions concern
- 11. Lack of “voice of customer” Upstream
  - a. Customers don’t think about WH until it breaks, then want easy (like) replacement
  - b. Customer journey too complex
- 12. Plumber business model Midstream
  - a. Plumbers not good advocates for electrification upsells
  - b. Prefer routine & minimal paperwork
  - c. Overquote for unfamiliar technology- HPWH
  - d. Easier to give fast low quote for like-replacement (gas especially)
- 13. Lack of “ecosystem” to support HPWH (PV adoption example of newly developed thriving ecosystem)
- 14. Requires multiple trades for install
- 15. Building offices / permit offices lack of code understanding- ability to install electric replacement for gas WH

## 1.2 HPWH Program Elements Brainstorm

1. Make it simple\*\*
  - a. Easy to choose HPWH
  - b. Streamlined, minimal paperwork for contractors and end-users
  - c. Upfront incentive savings (don’t require participant to carry debt / rebate)
2. Cohesive statewide program\*, long term program commitment
3. Focus upstream & midstream: pro-deals, equipment leasing

4. Price
  - a. Price near-equivalent to gas (worked in Maine)
  - b. Disrupt market for cost equivalency to gas
  - c. TOU- free electricity
  - d. 12-month thermal storage credit
5. Utilities facilitating HPWH purchase\*\*
  - a. On-bill financing (OBF) (works in AL)
  - b. Bulk equipment purchase
  - c. Midstream consignment program (stock inventory at distribution center so HPWH are ready for emergency replacement)
  - d. Data analytics on neighborhoods for scale & aggregate/ like pricing
6. Installation
  - a. Point of sale change out
  - b. Good quality assurance, quality control
  - c. Support trade partnerships
  - d. Consistent messaging
7. Encourage planned replacement / early replacement
  - a. Modular bundling HPWH w/other energy upgrades
  - b. Target communities based on “good” housing stock to easily install
    - i. WH in first floor garage
    - ii. Already have panel upgrades
  - c. MF is good target- 1 contact for multiple WH
8. Focus on Emergency Replacement (ER)
  - a. Propane -> HPWH good starting market
  - b. Have HPWH available on the “emergency replacement truck”
9. Smart / Tech/ IoT
  - a. Smart phone site assessment & pricing – App development
  - b. Sell tech interface- settings, app, etc. – easy and engaging controls for customer (like Nest, Ecobee), have demos at retail outlets w/ displays and data
  - c. Demand Response (or DR ready), smart appliances only
10. Quantify and include non-energy benefits (NEB)
11. Include Disadvantaged Communities (DAC)
12. Simulate market with a collection of targeted replacements

## 1.3 HPWH Program Design Priorities

### 1.3.1 Cohesive, Replicable Program

- Core features
  - Statewide consistency
  - Keep it simple for consumer

- Connects well with other programs / aligns and leverages related programs
- Minimal paperwork for contractor and consumer
- Equitable outcomes for customers across income and geography
- Effective incentive targeting / well branded
- Product needs to have controls (equipment eligibility)
- Program enrollment dependent on customers being made aware about grid-tied capabilities
- Savings by design
- Activities
  - a. Design and implement appropriate incentive stream (could include permitting & entitlements) (3<sup>rd</sup> party program?)
  - b. Work with existing workforce development groups to identify and/or train contractors/architects/engineers who can complete work -> funnel jobs to these contractors
  - c. Documentation / information feedback / performance measurement
  - d. Inspect installation
  - e. Free technical “hotline” assistance (3<sup>rd</sup> party program?)
  - f. Group purchasing
- Outputs
  - Eligible product list
  - Participating contractors, distributors, etc.
  - Engaged utilities
    - Centralized website for statewide program
  - Program administrator
  - Tracking database to inform program targeting
  - Web based app
  - Coordinated training program
  - Ad campaign
  - Coordination plan w/ PV installers
- Outcomes
  - 100% HPWH where appropriate
  - Public educated about benefits & tech of electrification (ecosystem)
  - Well-trained and registered workforce
  - HPWH stock on par (at least) w/ GWH
  - Market leads to regulatory adoption nationwide
  - All electric ready homes (panel ready)

### 1.3.2 Market Research

- Activities:
  - Consumer/trade ally segmentation

- Benchmark successful programs: VT, ME, NEEA
- 6-10 housing types
  - *SF electric, SF dual fuel, MF centralized WH, MF unitized electric, MF unitized gas*
  - *Difficulty of installation, % garage installation*
  - *Age of home*
  - *Code compliance*
- Tools: RASS survey, database tracking w/UCB, permit data -radiant labs
- Outputs: profile of attractive customers, proof of concept, roadmap
- Outcomes: evidence-based programs w/ clear priorities, feeds into program design, marketing plan, leads to trade allies

### 1.3.3 Value Proposition

- Value Propositions by group:
  - Ratepayers
    - Is it saving money?
    - Is it healthy and safe for my family
    - Is it more sustainable?
    - Does it provide better service?
  - Midstream
    - Higher profit margin
    - Differentiation / leg up on competition
  - Manufacturers
    - Higher profit margin
  - Utilities
    - Increased electricity sales, grid services/ reliability
- Activities:
  - Define tipping point for midstream backing/promoting of HPWH
  - Modify fuel substitution rules
  - Understand secondary value streams (grid services/DR)
  - Analyze context/factors driving decision to switch- rates, DR, PV, financing, first costs
- Outputs
  - Flexible tool to help understand value factors and target MEO
  - Training / certification for contractors and other midstream
  - Market characterization to drive action/ engagement from midstream and upstream
- Outcomes
  - Market reflecting a more holistic and systems level capture of HPWH value proposition for interaction with stakeholders

### 1.3.4 Workforce Training & Contractor Engagement

- Activities
  - Trainings by:
    - manufacturers when selling to distributors -> installing contractors
    - utilities (pacific energy center, BayREN, 3<sup>rd</sup> party programs)
    - unions?
    - Coordinate ongoing efforts, gov'ts stay brand agnostic
  - Audiences: union, designer, HVAC, plumbing, electrical, bldg. dept officials, distributors
  - Engage early and often
- Outcomes
  - Industry read to guide answer homeowner questions on efficiency, cost, energy bill effect, incentive, value proposition
  - Empowered building community

### 1.3.5 Marketing & Education Outreach

- Marketing to contractors/engineers/designers, consumers/HOAs/property managers, distributors, retailers, governments
- Marketing by “educators”: manufacturers, utilities, distributors, NGO’s, governments
- Focus on contractors\*: rebates, trade shows, energy center ed., value proposition, pro-deals
  - A convincing marketing outreach push to contractors is higher impact than end-users, since end users don’t have preferences other than “well priced hot water”
- All marketing needs to be preemptive and tailored to various audiences
- Consumer oriented marketing should be simple. “HPWHs Exist!” Incorporate consumer voice, segment message based on audience.
  - Goal: when buying a new WH, consumers know to ask about the HPWH option
- Retailers/ Distributors are BOTH educators and an audience. Once they are convinced, they have high impact convincing contractors.

## 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).

	<b>Space Constraint Exists?</b>	
<b>Power Constraint Exists?</b>	Yes	No
Yes	1. The Minimum Northern Climate UEF, which is potentially less than 2.6, that allows for designs that meet the space constraints and electrical constraints (i.e., potentially allows for a 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 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<sub>2</sub> 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.