Emerging Technologies

Central HPWH Work Group

June 30, 2022

Emerging Technologies

AGENDA

- Welcome
- What's New/Roundtable Discussion
- Policy Updates (Scott Denniston, New Buildings Institute)
- DOE BTO Update (Tony Bouza, Building Technologies Office, Department of Energy)
- Programs Development (Seth McKinney, Ecotope)
- Qualified Products List Update (Jon Heller, Ecotope and Geoff Wickes, NEEA)
- Load Shift Study Results (Scott Spielman, Ecotope)
- Workgroups – Keshmira (Bonneville Power Administration)

What's New?

- Any updates from other Members? Manufacturers?
- Hot topics?
- New Introductions?

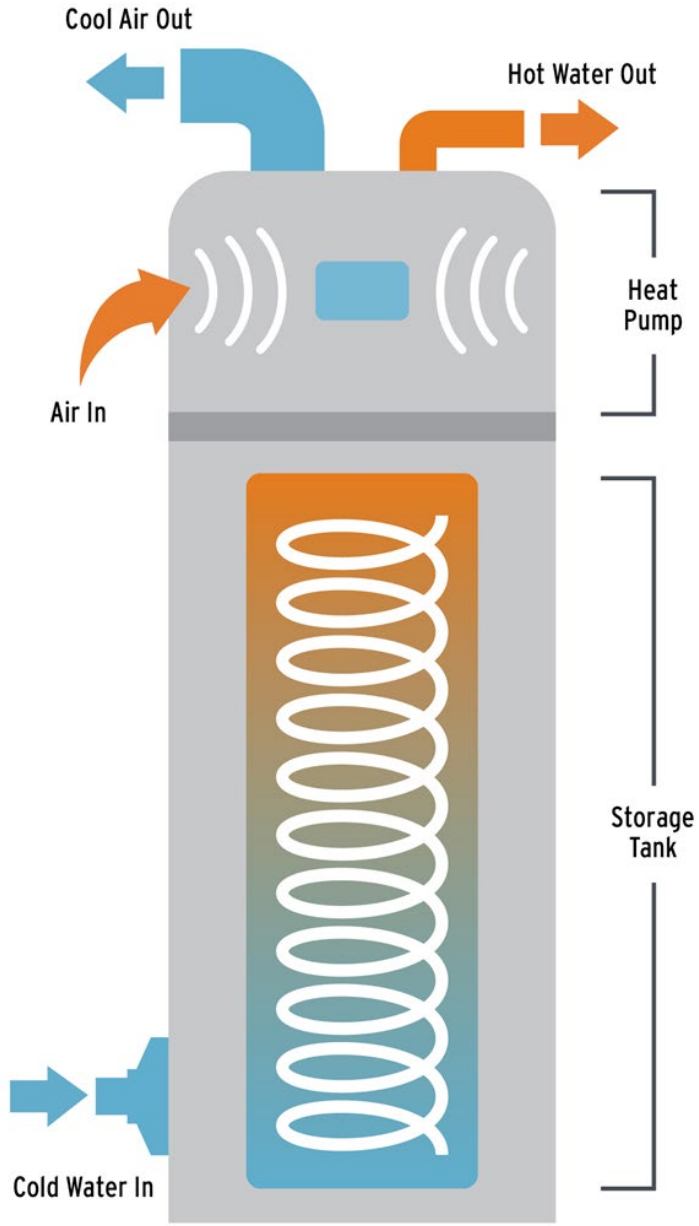
Policy

Sean Denniston
Senior Project Manager
New Buildings Institute

AWHI
ADVANCED WATER HEATING INITIATIVE™

National Policy Landscape

- Mandatory HPWHs
- HPWH Incentivization Policies
- Grid Integration
- Electrification



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Mandatory HPWHs

2021 WSEC

- **Commercial:** SHW must be 50% HPWH
- **Residential:** Mandatory HPWH for Single-Family under consideration

Mandatory HPWHs

DENVER
ENERGIZE DENVER

- **Existing Buildings:** Storage and instantaneous water heater replacements must be HPWHs (in most cases) after 2024
- **Denver Energy Code (Commercial):** Prohibition on gas and resistance storage and instantaneous water heaters in new construction (in most cases) under consideration

HPWH Incentivization – Fuel Normalization

WASHINGTON STATE ENERGY CODE - RESIDENTIAL
2018 EDITION

TABLE R406.2
FUEL NORMALIZATION CREDITS

System Type	Description of Primary Heating Source	Credits	
		All Other	Group R-2
1	Combustion heating equipment meeting minimum federal efficiency standards for the equipment listed in Table C403.3.2(4) or C403.3.2(5)	0	0
2	For an initial heating system using a heat pump that meets federal standards for the equipment listed in Table C403.3.2(1)C or C403.3.2(2) **or** Air to water heat pump units that are configured to provide both heating and cooling and are rated in accordance with AHRI 550/590	1.0	1.0
3	For heating system based on electric resistance only (either forced air or Zonal)	-1.0	-1.0
4	For heating system based on electric resistance with a ductless mini-split heat pump system in accordance with Section R403.7.1 including the exception	0.5	N/A
5	All other heating systems	-1	-0.5

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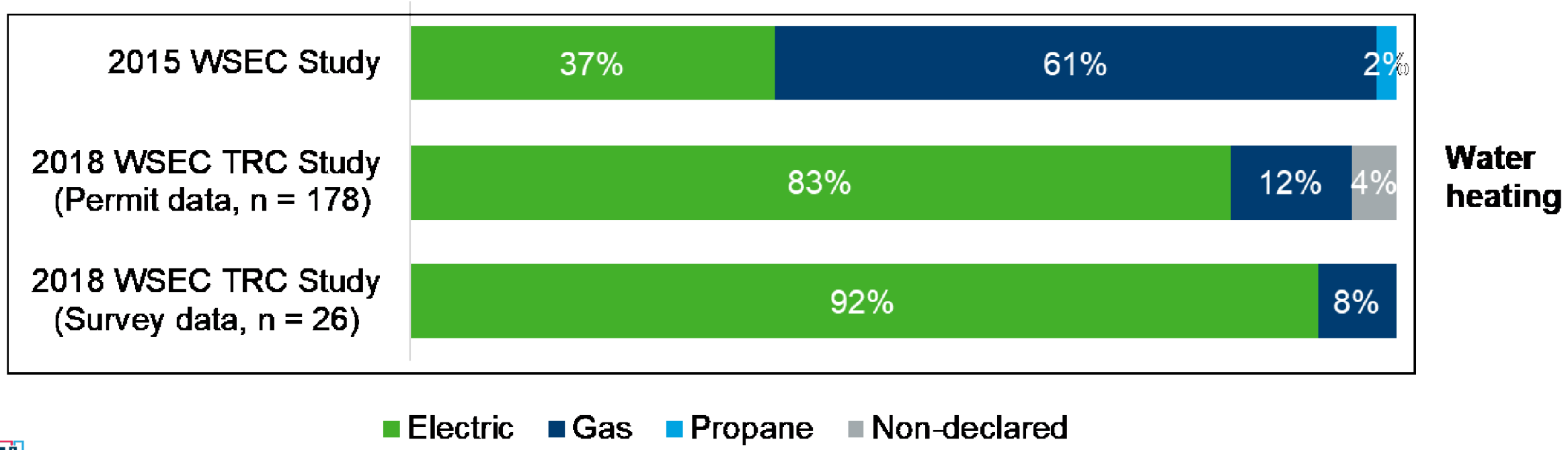
HPWH Incentivization – Fuel Normalization

May 26, 2022

Washington Residential
Post-Code Market
Research Report



HPWH Incentivization – Different Energy Metrics

BSR/ASHRAE/IES Addendum ch
to ANSI/ASHRAE/IES Standard 90.1-2019

Advisory Public Review Draft

Proposed Addendum ch to

Standard 90.1-2019, Energy Standard

for Buildings Except Low-Rise

Residential Buildings

Advisory Public Review (February 2022)
(Draft Shows Proposed Changes to Current Standard)

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HPWH Incentivization – BPSs

Building Performance Standards

Building use	Emissions standard ($kgCO_2e/SF/yr.$)					
	2025 - 2029	2030-2034	2035-2039	2040-2044	2045-2049	2050-
Assembly	7.8	4.6	3.3	2.1	1.1	0
College/ University	10.2	5.3	3.8	2.5	1.2	0
Education	3.9	2.4	1.8	1.2	0.6	0
Food Sales & Service	17.4	10.9	8.0	5.4	2.7	0
Healthcare	15.4	10.0	7.4	4.9	2.4	0
Lodging	5.8	3.7	2.7	1.8	0.9	0
Manufacturing/ Industrial	23.9	15.3	10.9	6.7	3.2	0
Multifamily housing	4.1	2.4	1.8	1.1	0.6	0
Office	5.3	3.2	2.4	1.6	0.8	0
Retail	7.1	3.4	2.4	1.5	0.7	0
Services	7.5	4.5	3.3	2.2	1.1	0
Storage	5.4	2.8	1.8	1.0	0.4	0
Technology/Science	19.2	11.1	7.8	5.1	2.5	0

CO_2 Targets for Boston BPS

Grid Integration

- Grid Flexibility/Integration in codes
- Renewable Portfolio Standards / Grid Decarbonization Requirements

Photo: AO Smith

Grid Integration - Controls

- Requirements in CA, NY, OR, WA
- Proposal moving through IECC-2024
- Congressional bill allowing DR to be added to WH appliance standards

Photo: AO Smith

Grid Integration – RPS & Decarbonization

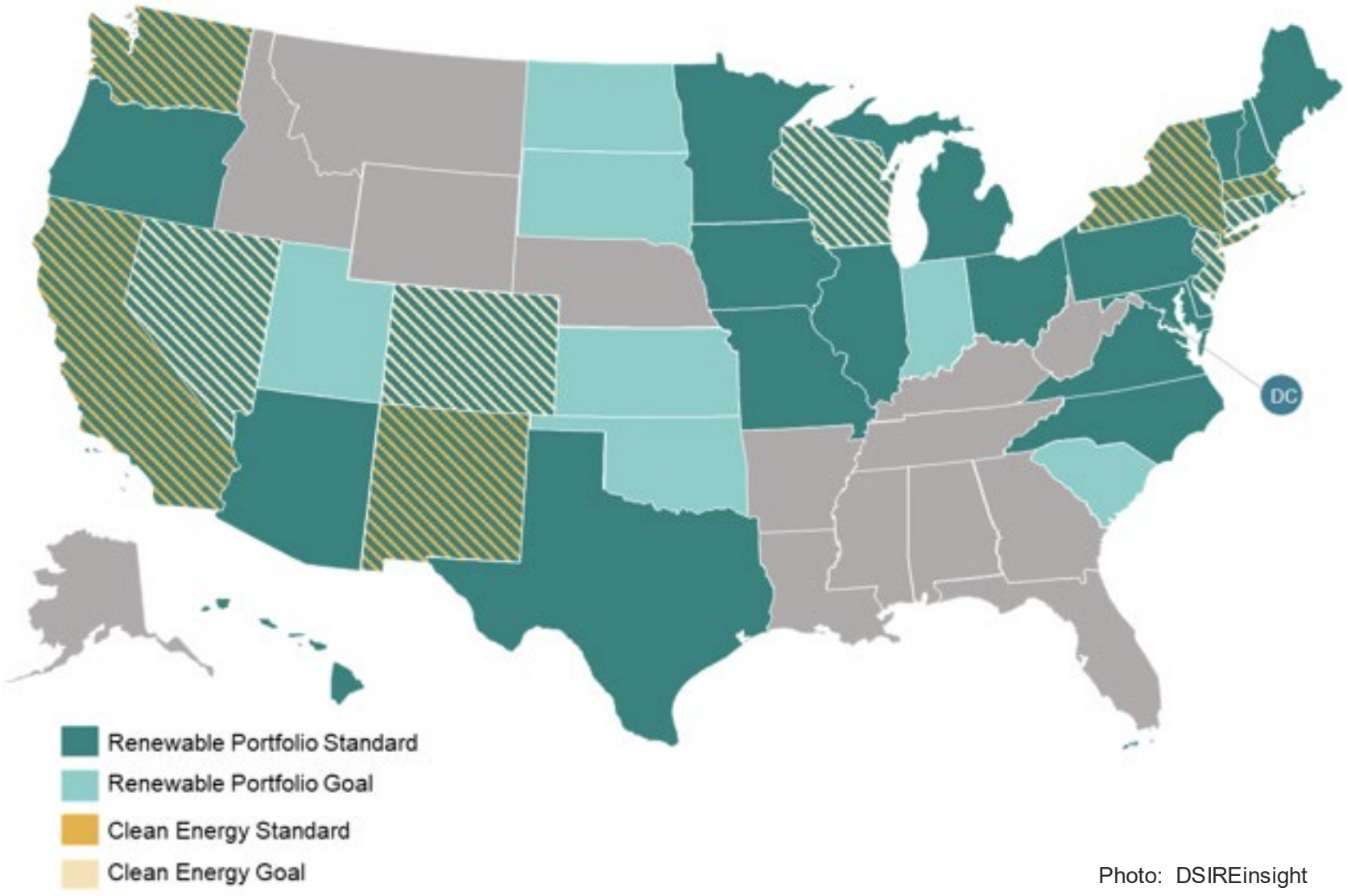

Photo: DSIREinsight

Photo: AO Smith

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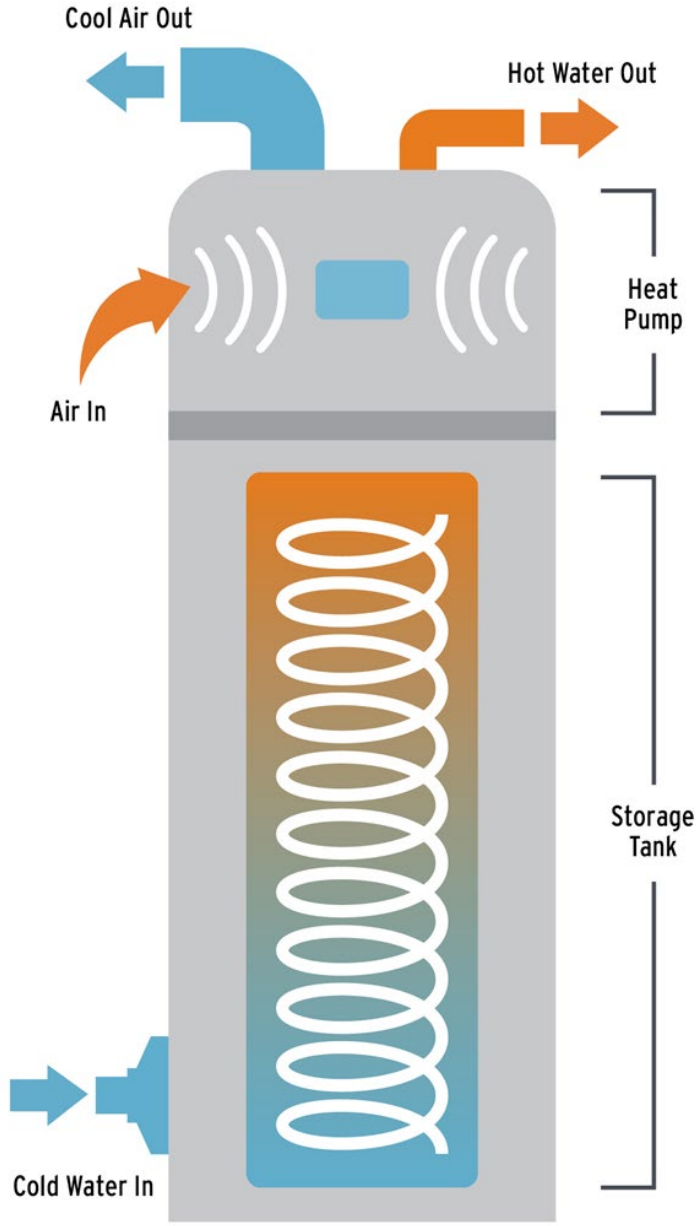
Electrification

Electrification Codes

San Jose Electrification Reach Code adoption announcement (Photo: San Jose Inside)

HPWH Policy Barriers

- Energy Cost metric combined with gas baseline systems in energy modeling
- Blunt cost effectiveness tests and cheap natural gas
- Fuel switching prohibitions in incentive programs
- Gas Ban .. bans



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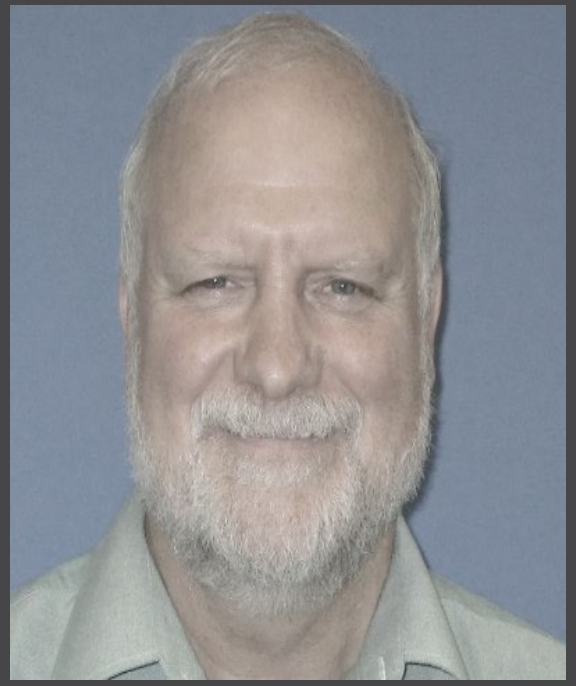
DOE Updates

+ Tony Bouza
+ Technology Manager, Department of Energy Building Technologies Office

Programs Development

Seth McKinney,
Policy & Programs Manager
Ecotope

Jack Zeiger,
Energy Conservation Engineer
Tacoma Power



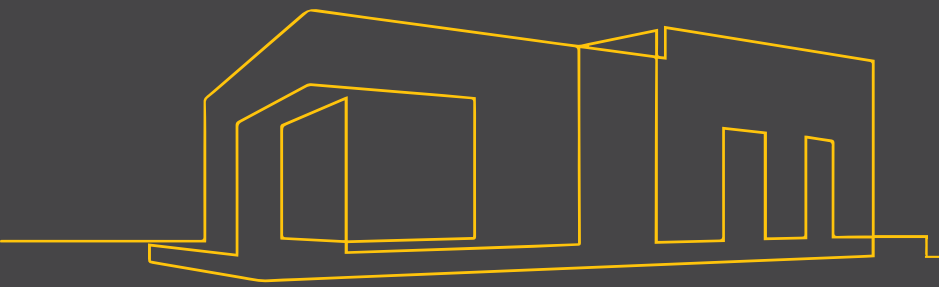
TACOMA POWER CHPWH PROGRAM

9/23/2022

Overview

+APPA Grant

- + Support a new, simplified utility prescriptive program for CHPWHs
- + Develop/improve tools to deliver reliable savings and high customer value
- + Accelerate the deployment of high-performance CHPWHs in the multifamily sector



PROBLEM

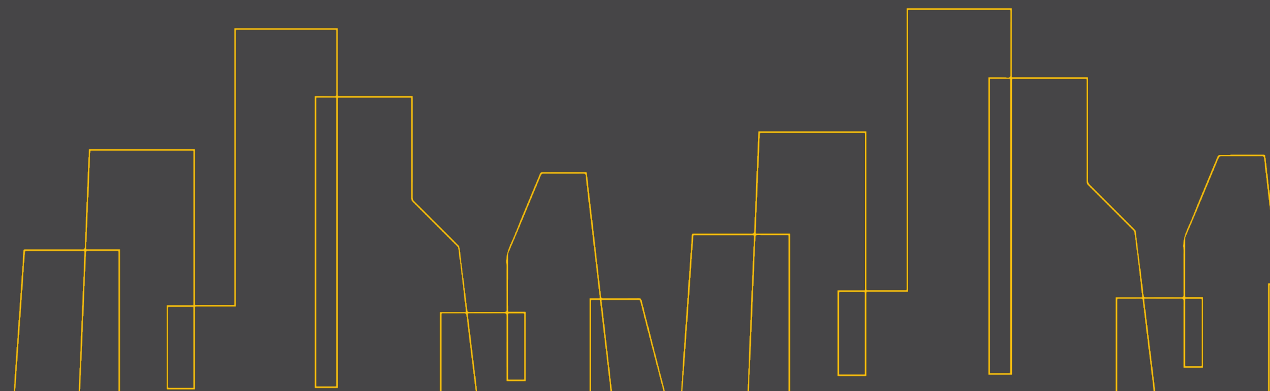
+ Market currently relies on custom engineered solutions with a wide range of performance around:
  + Cost
  + Efficiency
  + Reliability
  + Savings persistence
+ Variability and specialized knowledge currently limits CHPWH-specific programs
+ Custom projects likely require expensive pre/post M&V and project review and delay project approvals

EXAMPLE

+ Measure Identifiers for the old/defunct Seattle City Light CHPWH program:
  + $350/apt for ***ANY*** HPWH
  + $500/apt for ***ANY*** CO_2 HPWH
+ Pros:
  + No need to worry about a baseline
  + Quick project approval
+ Cons:
  + Massive variability in performance (Cost, Efficiency, Reliability, Savings persistence)
  + No design guidance/requirements

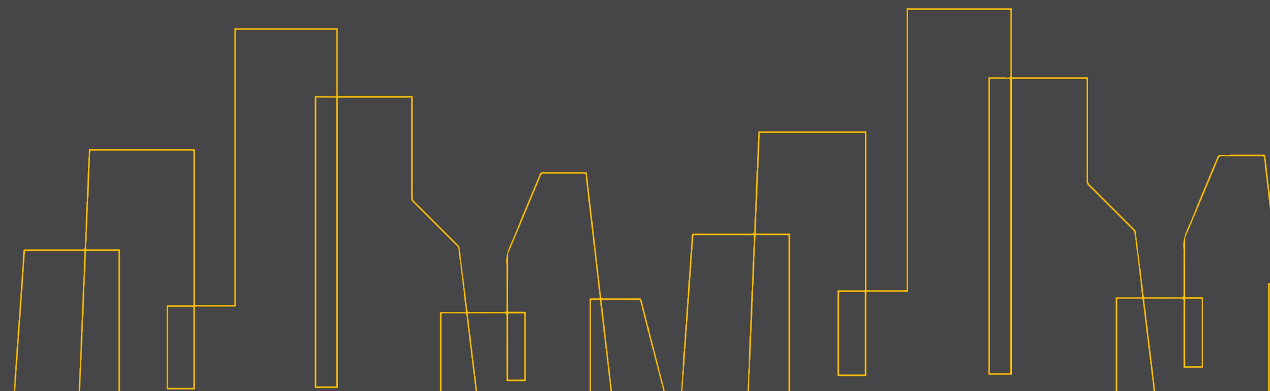
UTILITY PROGRAM DEV

- A new, simplified utility prescriptive program for CHPWHs
  - Establish a prescriptive calculator and supporting prescriptive measure and mechanism for custom programs (if needed)
  - "Last mile" improvements of the collaborative work to date to deliver an efficient, high impact, high value, light-lift utility program that can be adopted across the nation.



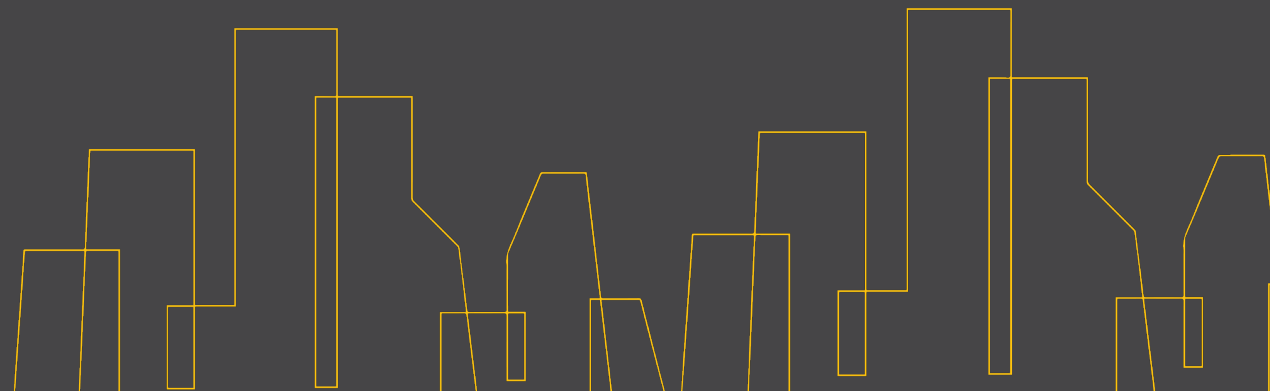
UTILITY PROGRAM

- **Questions we're asking:** to establish a prescriptive calculator and supporting prescriptive measures
  - What are the measure identifiers?
  - How do we manage variability in cost, efficiency, reliability, and savings persistence?
  - How might we include Load Shift?
  - What's the baseline?



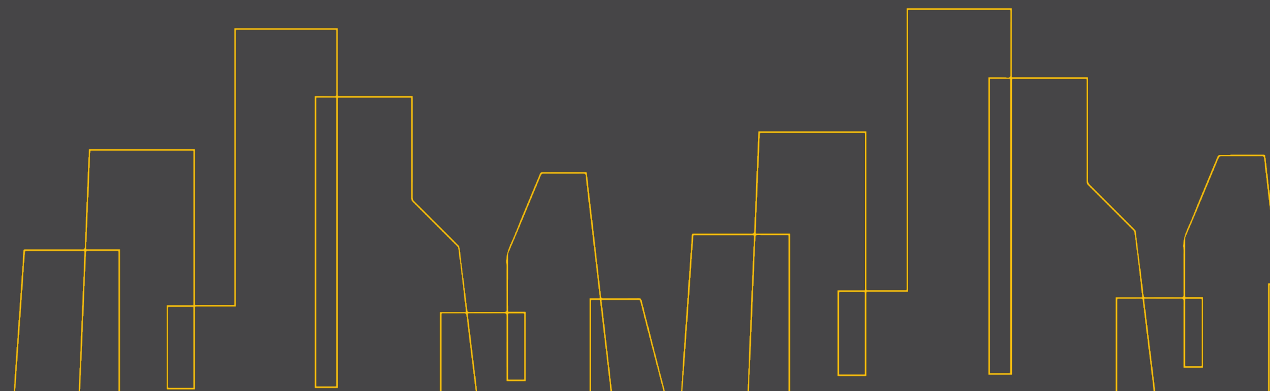
UTILITY PROGRAM

- **Questions we're asking** to fullfull the "Last mile" improvements to deliver a utility program that can be adopted across the nation:
  - How can we support the RTF Process?



MARKET MOVERS

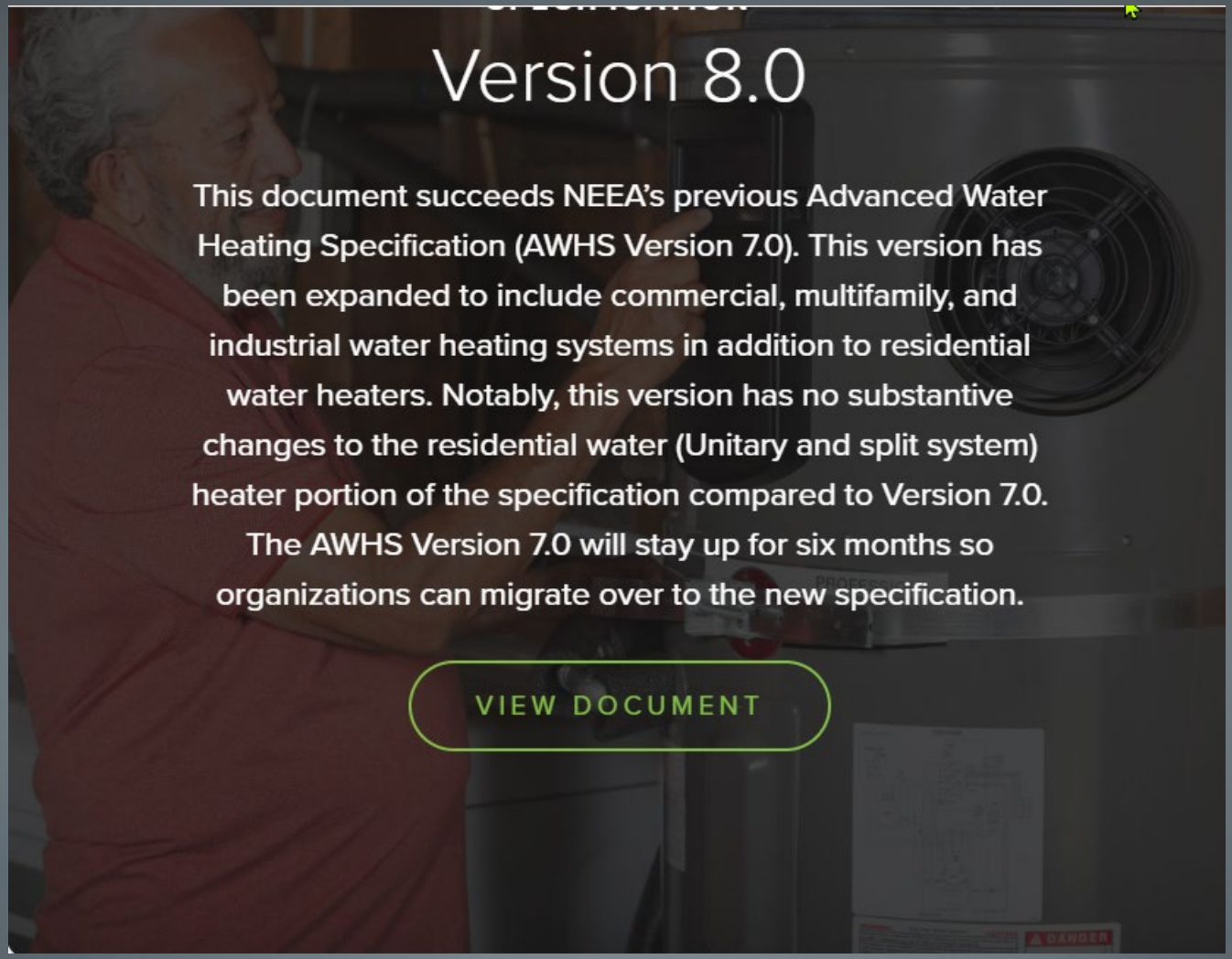
+ What other program work is under way?
+ What haven't we considered?
+ Other insights?



Qualified Products List

- Jon Heller
- Principal, President Technology Transformation, Ecotope

- Geoff Wickes
- Senior Product Manager, Emerging Technologies NEEA



https://neea.org/our-work/advanced-water-heating-specification

AWHS
–>
PADS
–>
ECOSIM
->
QPL

-- THE PROCESS --

THE PROCESS

AWHS

- Defines the process and compliance criteria
- Outlines what the AWHS is and the goal for reliable and efficient CHPWH systems
- Establishes a tiered rating structure by climate zone based on SystemCOP
- Defines minimum system criteria
- Reduce risk for designer, installer, owner

PADS

- Mechanism for MFG to define HPWH system requirements and submit performance map data
- Used to define mfg specific Ecosim inputs
- Used to define and guide designers on MFG's HPWH best practices
- MFG submits performance map data and completed PADS
- Equipment performance criteria, product basis of design

EcoSim

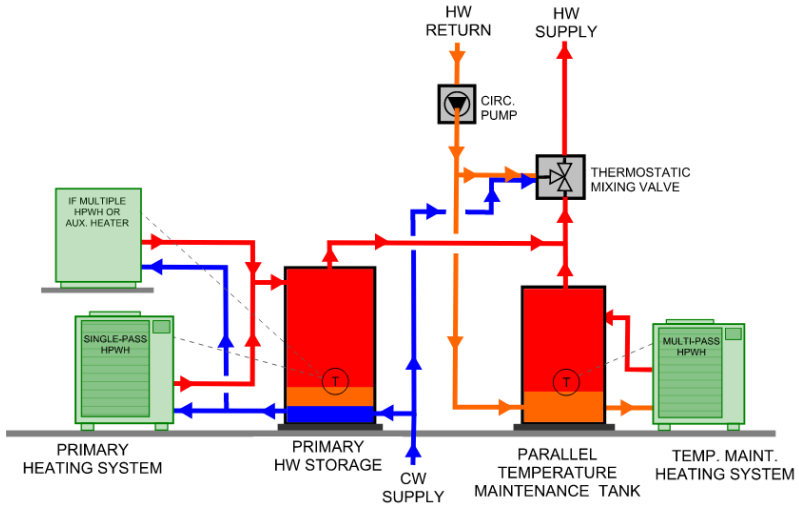
- Simulation tool for modeling SysCOP
- Utilizes info from the PADS and performance map data as modeling inputs
- Simulates a SysCOP for a MFG product in four climate zones for prototype buildings
- M&V data used to validate predictions and as feedback mech.
- Sensitivity analysis to uncover key drivers of performance

QPL

- Documents the HPWH products that have complied with the AWHS
- List HPWH system performance (SysCOP) for a given HPWH product and configuration in each of 4 climate zone categories
- Referenced by utilities/code officials for compliance and/or incentives
- Referenced by designers and energy eff. consultants to help them understand performance impacts

ADVANCED WATER HEATER SPECIFICATION (AWHS)

- Defines minimum performance criteria for CHPWH system including heat pump, storage, piping configuration, temperature maintenance system, and controls
- Ensures the repeatable and reliable CHPWH system performance
- Creates a Qualified Products List that designers, installers, and governing bodies can reference when designing, regulating, incentivizing, or comparing HPWH systems.



SINGLE-PASS PRIMARY HPWH SYSTEM WITH PARALLEL TEMPERATURE MAINTENANCE TANK & MULTI-PASS HPWH

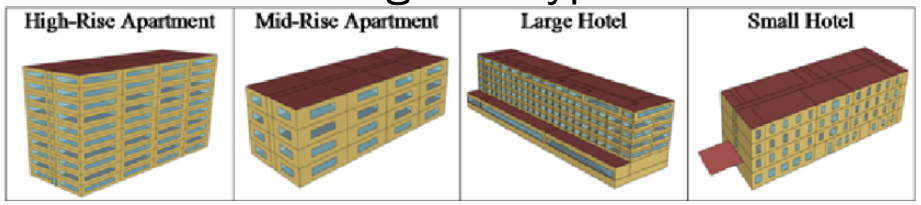
PRODUCT ASSESSMENT DOCUMENTATION SHEET (PADS)

Manufacturers shall provide access to detailed HPWH system design and installation guidance that includes:

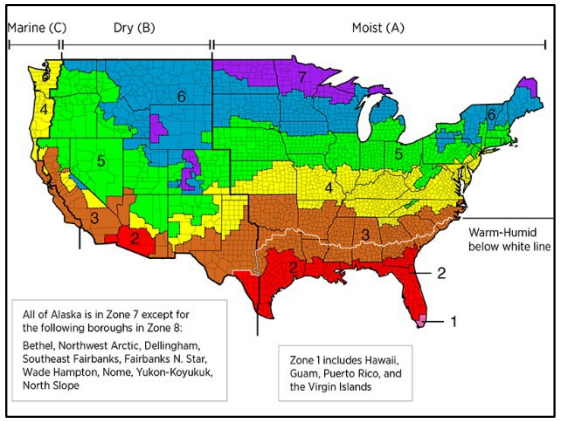
1. General summary of HPWH system operation
2. Detailed piping schematics
3. Detailed performance specification for all components
4. Requirements for additional ancillary DHW system components (valves, pumps, strainers, air vents, etc…)
5. HPWH output heating capacity and Storage sizing guidelines
6. Potable water quality, pressure, and flow considerations that affect DHW system piping design
7. Air source design considerations
8. Electrical specifications
9. Sounds levels testing method
10. Installation specifications and requirements
11. Maintenance requirements
12. Equipment operating manuals and warranty documentation
13. Sequence of Operation

ECOSIM

Building Prototypes



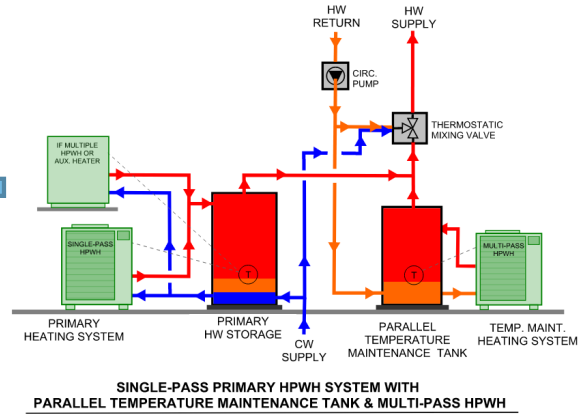
Climate Data



Specifications

PADS

Product: Colmac CxA
Configuration: 1c, or 1d
SP with Parallel TM system in MP HPWH
Control: ON: ST<125
OFF: EWT>110F
more...



Piping Configuration

Model	Entering Air Condition	Air Cooling Capacity (Btu/hr)	Entering Water Temp (°F)	Leaving Water Temp (°F)	Supply Heating Capacity (Btu/hr)	Power Input (kW)	Heating COP	Cooling COP	Combined COP
	40°F 60% RH	169300	50	58	202000	13.39	4.4	3.7	8.1
		152700	60	68	187800	14.06	3.9	3.2	7.1
		141700	70	77	178900	14.70	3.6	2.8	6.4
		131300	80	87	170900	15.38	3.3	2.5	5.8
		122000	90	97	163600	16.14	3.0	2.2	5.2
		112400	100	106	155400	16.41	2.8	2.0	4.8
		105800	110	116	150500	16.48	2.7	1.9	4.6
		89700	120	125	133700	16.68	2.3	1.6	3.9
		76300	130	135	120600	16.78	2.1	1.3	3.4
		69100	140	145	113000	16.79	2.0	1.2	3.2
	50°F 60% RH	196200	50	59	231500	13.97	4.9	4.1	9.0
		185600	60	69	223400	14.87	4.4	3.7	8.1
		172800	70	79	213700	16.01	3.9	3.2	7.1
		163400	80	88	207000	16.59	3.7	2.9	6.5
		152300	90	98	199300	17.65	3.3	2.5	5.8
		134200	100	108	183600	17.88	3.0	2.2	5.2
		127000	110	117	177600	18.64	2.8	2.0	4.8
		113600	120	127	165100	18.89	2.6	1.8	4.3
		93900	130	136	145600	18.94	2.3	1.5	3.7
		88100	140	146	139400	18.99	2.2	1.4	3.5

Performance Map

SysCOP	Hot	Mild	Cold	Extremely Cold
Max	2.74	2.41	2.27	2.10

System COP - Tiers

QUALIFIED PRODUCT LIST (QPL)

Northern Climate Product Tier	Product Brand	Model	Volume (gallons)	Northern Climate Energy Factor	Northern Climate Delivery Rating	Qualified Date
Tier 2						
	AirGenerate	ATI66	66	2	3	11/10/2011*
Tier 1						
	American	HPE10280H045DV	80	1.8	4	2/1/2012
	American	HPE10260H045DV	60	2	3	2/1/2012
	A.O. Smith	PHPT-80	80	1.8	4	11/10/2011
	A.O. Smith	PHPT-60	60	2	3	2/1/2012
	GE	GEH50DNSR	50	1.9	2	11/10/2011
	GE	GEH50DEEDSR	50	1.9	2.5	5/10/2012
	GE	GEH50DEEDSC	50	1.9	2.5	5/10/2012
	Kenmore	153.32118	80	1.8	4	2/1/2012
	Kenmore	153.32116	60	2	3	2/1/2012
	Reliance	10 80 DHPT	80	1.8	4	2/1/2012
	Reliance	10 60 DHPT	60	2	3	2/1/2012
	State	EPX 80 DHPT	80	1.8	4	2/1/2012
	State	EPX 60 DHPT	60	2	3	2/1/2012
	Stiebel Eltron	Accelera 300	80	1.9	5	2/27/2012
	U.S. Craftmaster	HPE2K80HD045V	80	1.8	4	2/1/2012
	U.S. Craftmaster	HPE2K60HD045V	60	2	3	2/1/2012
	Whirlpool	HPE2K80HD045V	80	1.8	4	2/1/2012
	Whirlpool	HPE2K60HD045V	60	2	3	2/1/2012

* The current version of the Air Generate ATI66 is shipping without condensate management features found in section 5.5.2 of the Northern Climate Specification. This product is provisionally approved for Tier II based on manufacturer plans to incorporate this functionality by June 1, 2012.

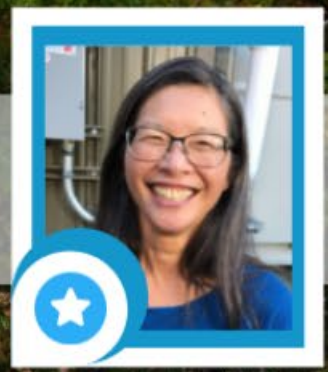
Bayview Tower Apartments

This multifamily residence offers low income housing to the elderly and disabled. With an eye towards environmenta
stewardship, the Bayview Tower Apartments recently completed a retrofit project: replacing the electric resistance
water heaters with an ultra energy efficient commercial heat pump water heating system. Learn more by clicking bel

Site Tour

ystem Tour

Meet the Experts:



LEARN

BAYVIEW TOWER
LOAD SHIFT TESTING

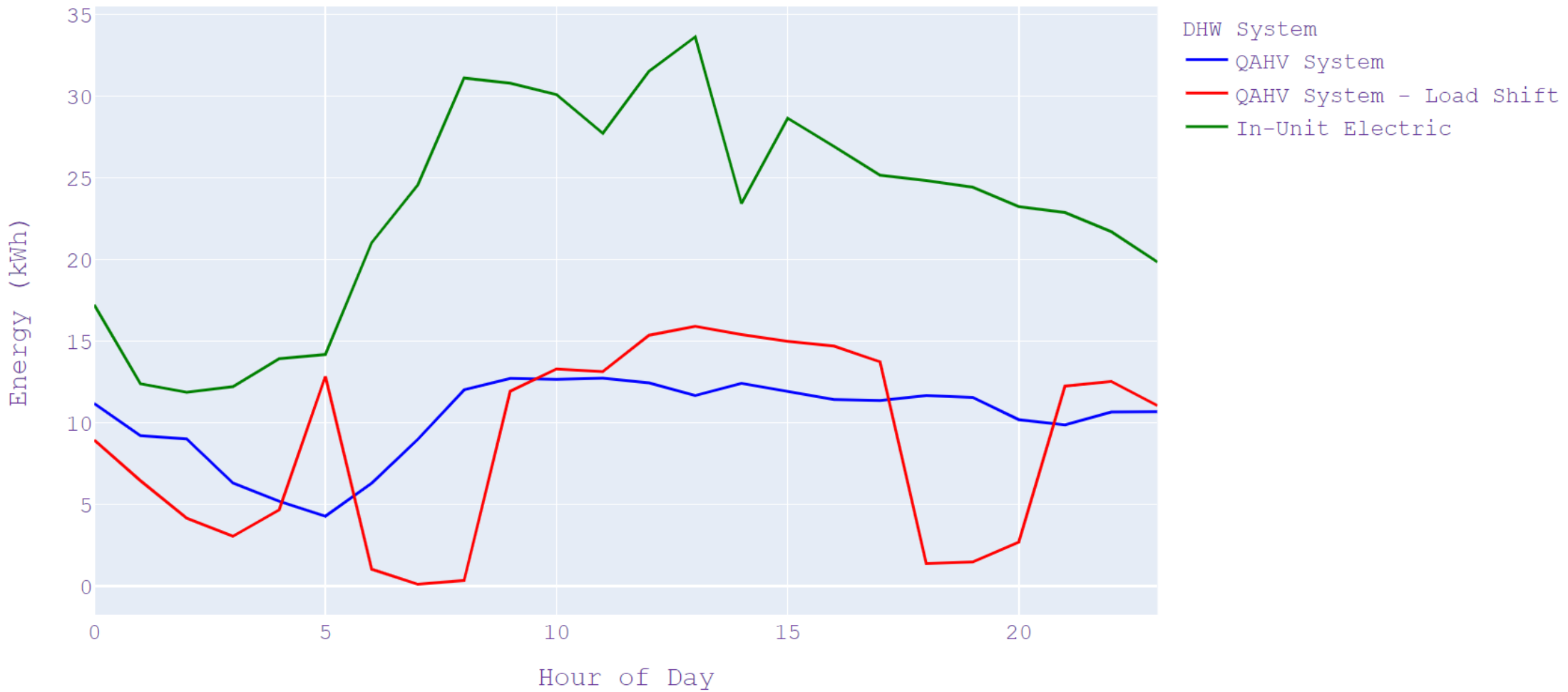
ECOTOPE

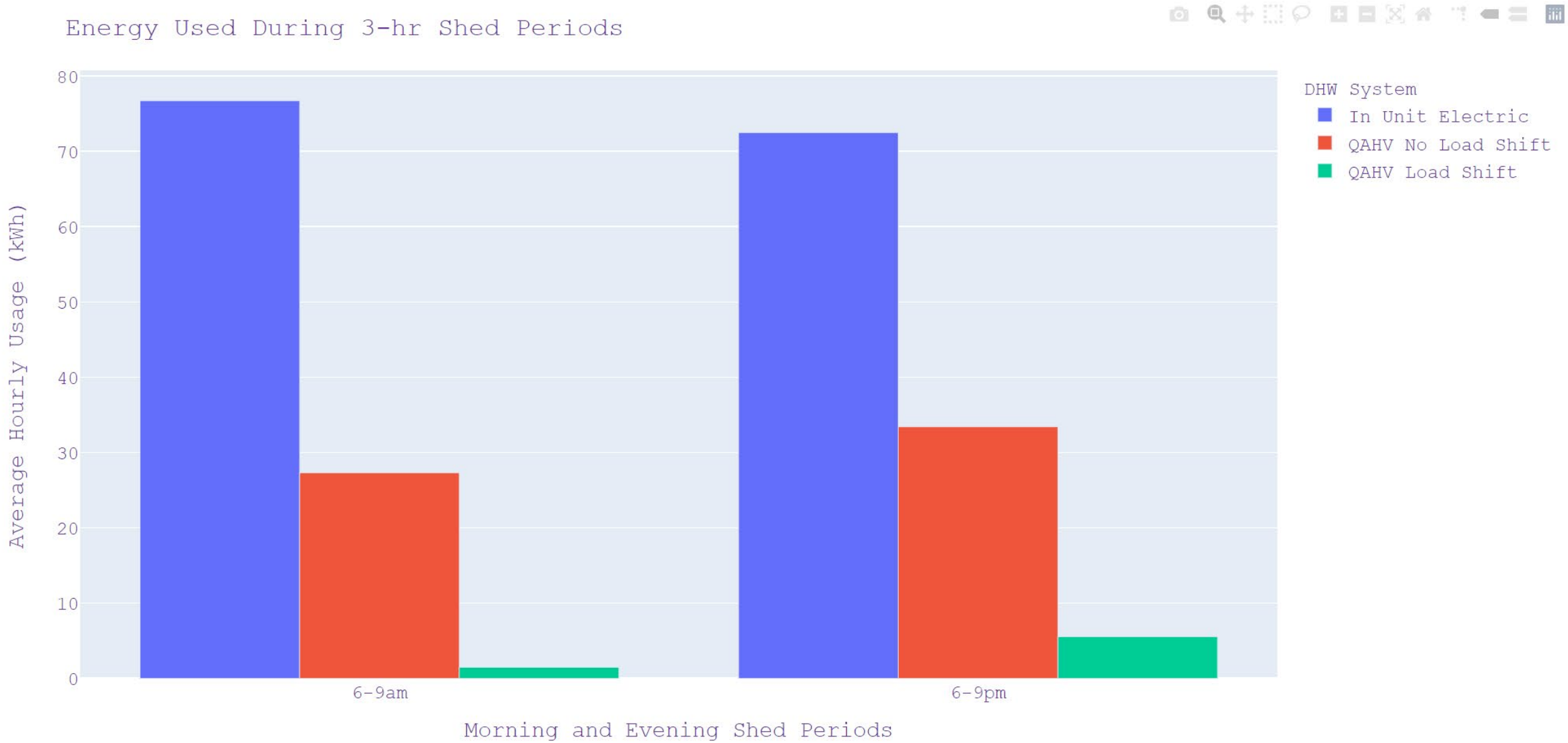
Presented by:

Scott Spielman, PE
Research Engineer
Ecotope, Inc.

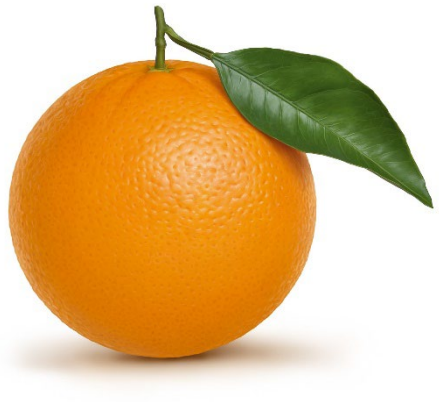
6/30/2022

Average Hourly Energy Usage




Energy Used During 3-hr Shed Periods
Average Hourly Usage (kWh)
0
10
20
30
40
50
60
70
80
6-9am
6-9pm
Morning and Evening Shed Periods
DHW System
In Unit Electric
QAHV No Load Shift
QAHV Load Shift

Resource	500 Building	30% CA Apartment Buildings	90% CA Apartment Buildings
In Unit Electric vs QAHV Load Shift	25 MW	12 GW	35 GW



QUESTIONS / DISCUSSION

- In order to take advantage of load shift capable central systems, utilities will want to control the "orange tree" or "orange grove" not just the "orange". How can signals be affectively aggregated to control the population rather than the individual system?
- Getting the system set up and commissioned for consistent load shifting was not an insignificant amount of work. Internal HPWH controls sequences were adjusted based on M&V data. Timing of LOAD UP commands were changed to allow for full storage at the beginning of each SHED. Once tuned the system has meet every SHED with nearly zero use of the HPWH – it can be an extremely reliable resource. Every building cannot require the attention given to Bayview. How can we take demand response commissioning to scale?
- How can we keep things as simple as possible while also getting desired results?

Wrap Up