



Emerging
Technologies

National Approach to CHPWH Deployment

September 22, 2022



AGENDA



- Hello and welcome (2 min)
- Updates/News (3 min)
- DOE Update(5 min)
- Project Updates—Andy Brooks, Association for Energy Affordability (40 min)
- Qualified Products—Jon Heller, Ecotope (15 min)
- Program Development—Lois Gordon, D&R International (10 min)
- Workgroups—Scott Spielman, Jenny Haan, Carmen Cejudo (10 mins)

Association for Energy Affordability

*Bringing the benefits of clean energy &
energy efficiency to underserved
communities*

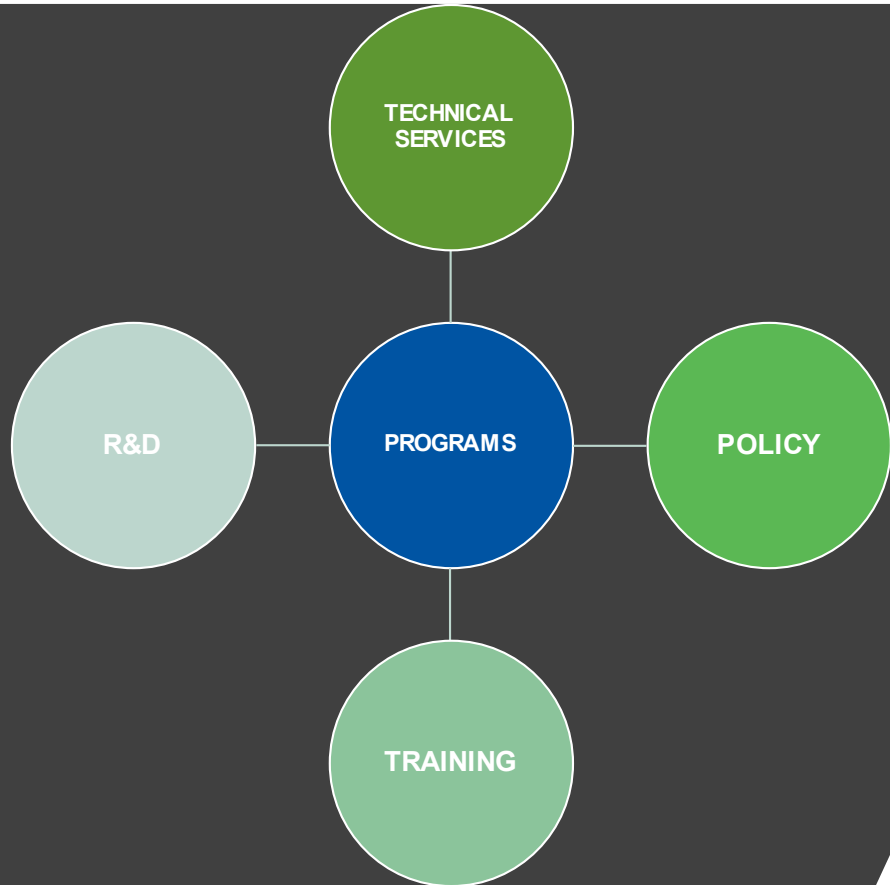
Andy Brooks

Senior Director, AEA West

abrooks@aea.us.org

September, 2022





Utility

Existing Buildings

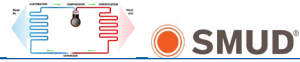
California Public Utility Commission (CPUC)

- Solar on Multifamily Affordable Housing (SOMAH)



Sacramento Municipal Utility District (SMUD)

- Multifamily Electrification Program



Marin Clean Energy (MCE)

- Multifamily Energy Efficiency Program
- Low Income and Families (LIFT)
- Workforce Education and Training Program



Los Angeles Department of Water & Power

- Comprehensive Affordable Multifamily Retrofits (CAMR)



City of Palo Alto

- Multifamily Electrification Program



Pacific Gas & Electric (PG&E)

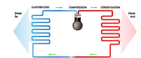
- WatterSaver: Thermal Load Shifting



New Construction

Southern California Edison (SCE)

- Energy Savings Assistance Program New Construction



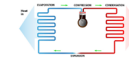
= Incentives for HPWH's

Federal, State & Local Government

Existing Buildings

Community Services and Development Agency (CSD)

- Low Income Weatherization Program (LIWP)



Bay Area Regional Energy Network (BayREN)

- Bay Area Building Enhancements Program



South Coast Air Quality Management District

- MF Affordable Housing Electrification Program (MAHEP)



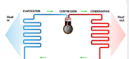
Three County Regional Energy Network (3CREN)

- Multifamily Electrification Program



California Energy Commission

- Technology & Equipment for Clean Heating (TECH)



New Construction

California Energy Commission

- Building Initiative for Low Emissions Development (BUILD)





RESEARCH & DEMONSTRATION



Research & Demonstration



REALIZE-CA: Mass Deployment Model for Zero Carbon Retrofits



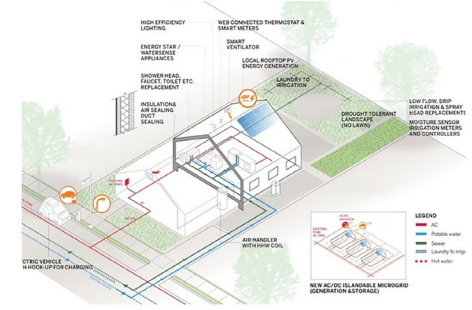
Large Capacity Central CO2 Heat Pump Study



Prefabricated Envelope Solutions for California Low-Rise Buildings



Low GWP Mechanical POD



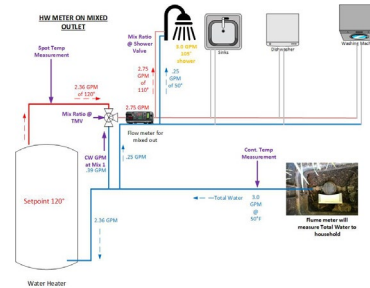
Oakland Ecoblock: ZNE, Low Water-Use Retrofit Neighborhood



Advancing Indoor Air and Environmental Quality Technologies- IAQ Impacts of Gas Cooking



Smart Ceiling Fans & Communicating Thermostats to Provide Energy-Efficient Comfort



Domestic Hot Water Draw Study



Multifamily Building Air Tightness Characterization



DOE Advanced Building Construction Collaborative



ADVANCING HEAT PUMP DEPLOYMENT SINCE 2016

Central HPWH Systems

NYLE



AERMEC

MITSUBISHI



A.O. SMITH

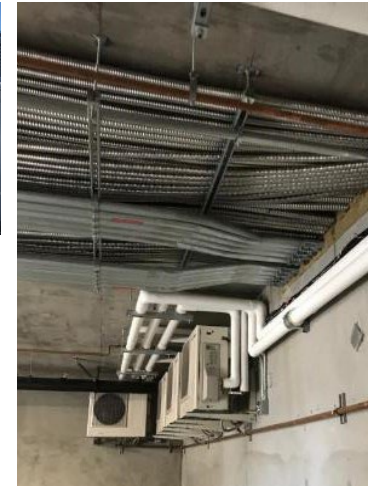


RHEEM

COLMAC



SANDEN





California HPWH Landscape



TECH Clean California



TECH Clean California is a \$120 million initiative designed to help advance the state’s mission to achieve carbon neutrality by 2045. This will be done by driving the market adoption of low -emissions space and water heating technologies for existing single and multifamily homes across California—a notable source of the state’s carbon footprint. Additionally, 40% of program benefits will be targeted towards low -income and disadvantaged communities. The initiative was developed as part of California Senate Bill 1477 and is funded by California gas corporation ratepayers under the auspices of the California Public Utilities Commission.

Mid-Stream Incentives

Quick Start Grants

Regional Pilots

Financing

Electrification HUB

The TECH Clean California Team

TECH will be implemented by a team led by Energy Solutions including the following organizations:



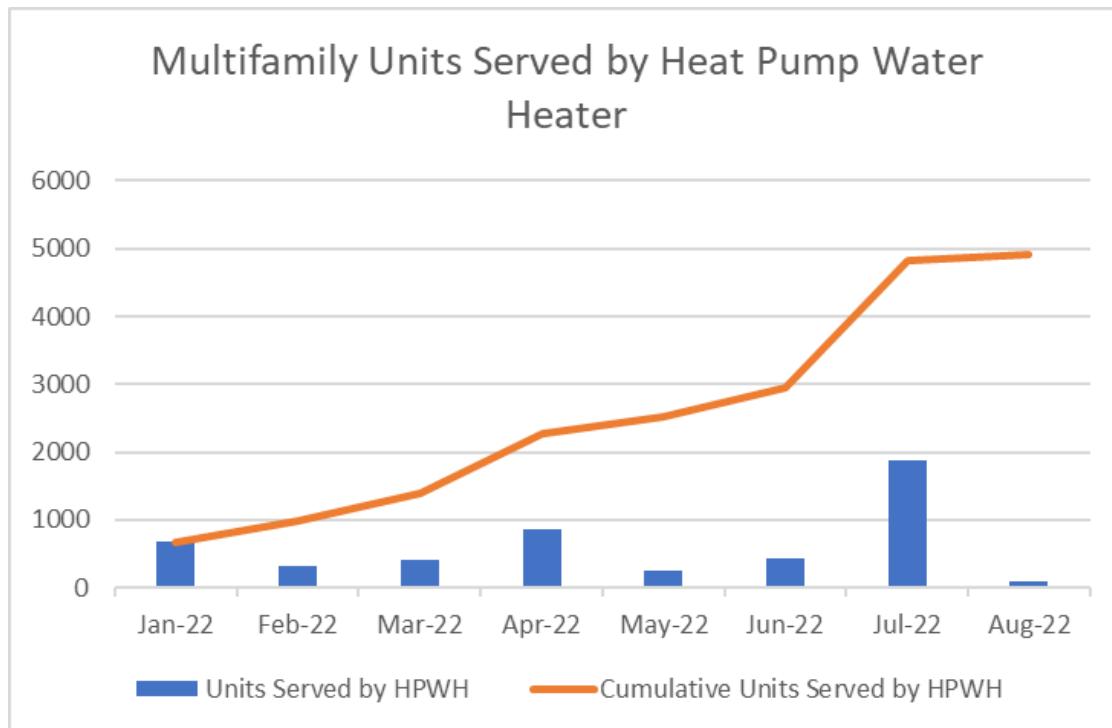
TECH Multifamily

Multifamily HPWH Incentives

Multifamily Heat Pump Water Heaters			
System Type	Previous Water Heating Source	HPWH Tank Size	Incentive for Individual Apartment (Per Equipment)
Individual HPWH (In-Apt or Communal Spaces)	Gas/Propane to HPWH	<55 Gal	\$1,400
		>55 Gal	\$2,100
	Electric Resistance to HWP	All	\$700
System Type	Previous Water Heating Source	HPWH Tank Size	Incentive for Equipment Servicing 2+ Apts (per Apt served)
Central HPWH	All non Heat Pump Systems	<17 Gal per Bdr Served	\$1,200
		≥ 17 Gal per Bdr Served	\$1,800
	Heat Pump Pool Heating	\$2,500 / equipment	
Electrical Upgrades			
Individual Apartment Electrical Upgrades	Undersized apt electrical infrastructure upgraded as part of apt HWP or HVAC Installation	Apt panel or sub panel upgrades, feeder upgrades, or service disconnect upgrades	\$1400/apt (Apt must have received a TECH-funded HP HVAC or HPWH and must be all-electric after the electrical upgrade)

TECH HPWH Multifamily Results

- 4908 Dwelling Units are served by HPWHs
- Participating properties from 4 - 661 units (Avg of 103 units)
- 49% of MF projects are in DAC's, the majority of which are low income
- More central than individual
- 3749 units currently on waitlist



Serving Apartments	% of total Projects
HPWH- Individual:	17%
HPWH- Central:	38%
HP HVAC:	36%
HP HVAC Central:	2%
Panel Upgrade:	8%



New State Funding Coming Soon



Upcoming TECH Funding

Climate Provisions of State Budget Bill just passed which included:

- \$50M for TECH for FY 2022/23
- \$95M for FY 23/24

TOTAL of \$145M through FY 2026

	Agency	Budget Allocations (\$millions)			Totals
		fy 22/23	fy23/24	fy24-26	
Equitable Building Decarbonization	CEC	\$ 112	\$ 665	\$ 145	\$ 922
Community Resilience Centers	SGC	\$ 110	\$ 160		\$ 270
TECH Clean California	CPUC	\$ 50	\$ 95		\$ 145
Low-GWP refrigerants	CARB	\$ 20	\$ 20		\$ 40
School HVAC replacements through CalSHAPE	CEC	\$ 20			\$ 20
Safe indoor temperature policy development	HCD	\$ 5			\$ 5
		\$ 317	\$ 940	\$ 145	\$ 1,402

Merian Borgeson: NRDC 2022

Self Generation Incentive Program (SGIP)

Adding \$40M HPWH Incentives to Accommodate Thermal Storage

- Residential Unitary HPWH's
 - Must be JA-13 compliant (grid integrated, \geq NEEA Tier 3, has mixing valve, TOU schedules, min FHR's, etc.).
 - CTA-2045 Port
 - Programmed for load shifting

SGIP UNITARY HPWH INCETIVES					
Customer Class	Unitary HPWH Incentive	Low GWP Kicker Incentive	55 Gal Capacity Incentive	Electrical Panel Upgrade Incentive	Max SGIP HPWH Incentive
General Market Residential	\$3,100	\$1,500	\$700	\$2,000	\$7,300
Equity Residential	\$4,185	\$1,500	\$700	\$4,000	\$10,385

Central system incentives will be more complex and will be calculated based on load shift potential (\$1000/ shiftable kWh)

Other State Funding for HPWH's

- **\$922M** for new Equitable Building Decarbonization programs through the CEC
- **\$270M** for the [Community Resilience Centers](#) Program in development at the Strategic Growth Council, which will upgrade or build vital gathering places (community centers, libraries, schools, etc.) with efficient electric technology, energy efficiency, renewables, and storage.
- **R&D Funds**
 - California Energy Commission (CEC) Electric Power Investment Charge (EPIC) grant
- **New Program Funds**
 - Low Income Weatherization Program (LIWP): ~\$30M for FY22/23 through 25/26 (with future opportunities to increase)
 - LADWP – Comprehensive Affordable Multifamily Retrofit (CAMR) Program
 - Statewide Workpaper for Central Heat Pump Water Heaters (likely many IOU incentives coming)



Large Capacity Central CO2 Heat Pump Water Heating Project



Project Overview & Funding



Project Description

Early launch demonstration installs of Mitsubishi Heat₂O, large capacity low-GWP (CO₂) heat pump water heater product; extensive post-install monitoring & testing



R&D Funds

California Energy Commission (CEC) Electric Power Investment Charge (EPIC) grant



Southern California
REGIONAL ENERGY NETWORK

Program Funds

Low Income Weatherization Program (LIWP)

South Coast AQMD – Multifamily Affordable Housing Electrification Program (MAHEP)

LADWP – Comprehensive Affordable Multifamily Retrofit (CAMR) Program

SoCal Regional Energy Network (SoCalREN)

The Team



Association for Energy Affordability

Grant prime, site recruitment, project management, Measurement & Verification



Ecotope

Engineering lead



Mitsubishi Electric Trane US

Equipment manufacturer



NBI, EPRI



Market transformation

The Equipment



Image: Mitsubishi

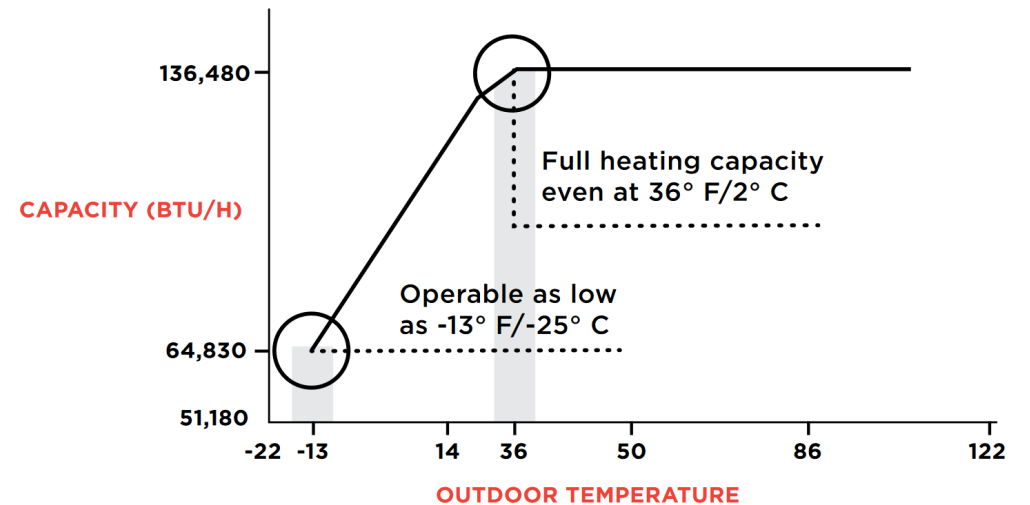
Mitsubishi Heat ₂ O – QAHV-N136TAU-HPB		
Power	3P 208-230 V 60Hz	
Capacity	136,480 BTU/hr / 40kW	
COP (AHRI)	4.11	
Power Input	9.7 - 10.4 kW	
Current Input	27 – 32 A	
MCA	67 A	
Outlet Water Temp	149°F	
Low Ambient Performance	-13°F 50% output	36°F – 109°F 100% output
Dimensions	48" x 30" x 73"	
Sound Pressure	56 dB(A)	
Refrigerant & Charge GWP	R744 (CO ₂) – 14.3 lbs GWP = 1	
Additional Components	Secondary Hx, Secondary Pump, Sensors & Controls, Storage Tank(s), Swing Tank	

Mitsubishi Heat₂O Has Many Advantages

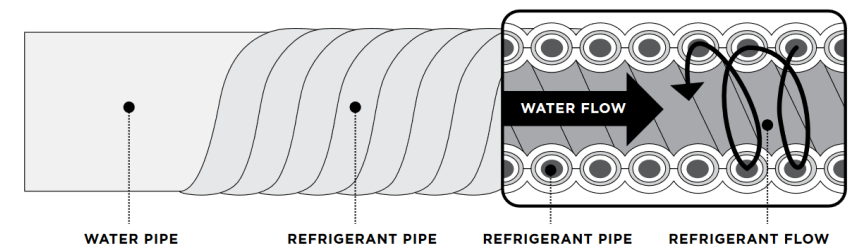
- **Low GWP**
 - Can't really beat CO₂
- **Low Ambient Performance**
 - Maintains output and efficiency well below freezing
- **Reduced Electrical Burden**
 - Very efficient at optimal conditions AND
 - Good low ambient performance means don't need to oversize heat pumps or electric resistance backup to ensure hot water delivery for winter design conditions
- **Quiet**
 - 56 dBA vs
 - 65-80+ dBA for comparable non-CO₂ units

Images: Mitsubishi

Heating Capacity



Patented Twisted Spiral Gas Cooler





Demo Sites & Plant Info



Site & HPWH Plant Overview

Site	# HP Units	Total Storage (gal)	Site Specific Hurdles
A – San Francisco	2	360	Sound ordinance restrictions, reusing existing tanks
B – San Jose	2	500	380V vs 208V unit, switching from another mfg
C – Orange County	3	2,000	Electrical capacity, 11 th hr owner cold feet
D – Riverside	2	500	Electrical circuit runs, HP location
C – San Diego	2	800	Location, garage height

Heat₂O General Plant Schematic

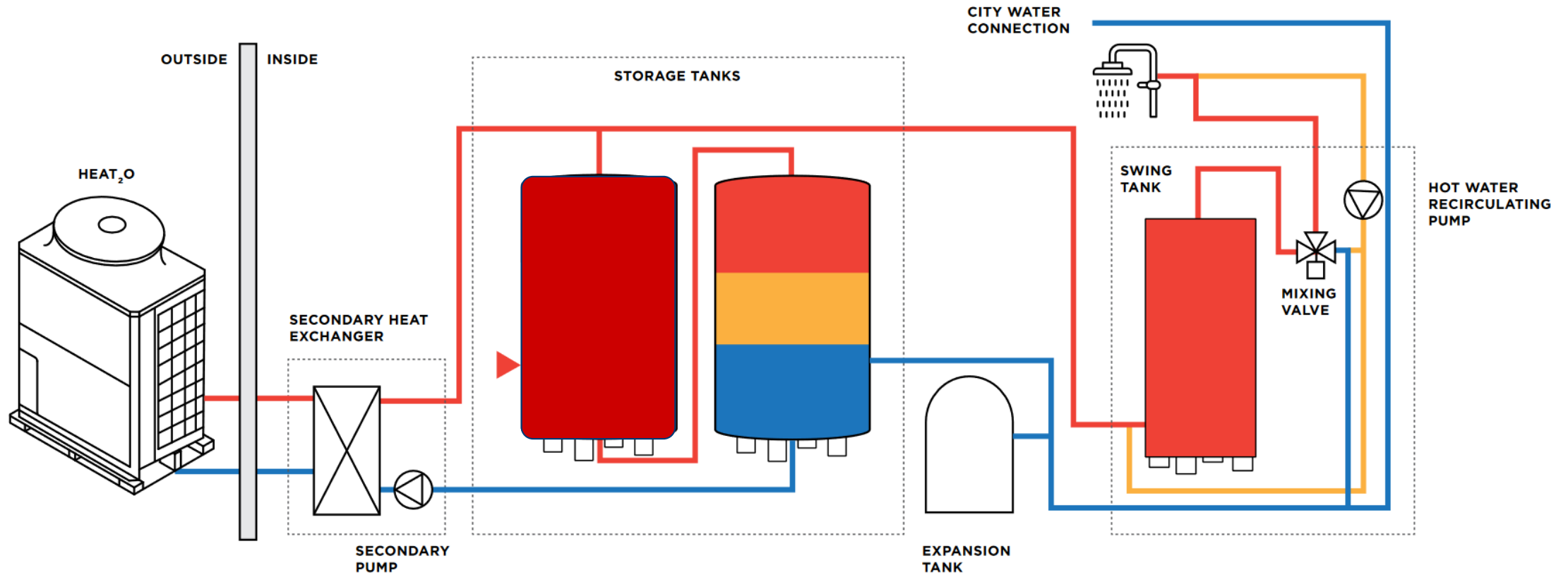


Image: Mitsubishi

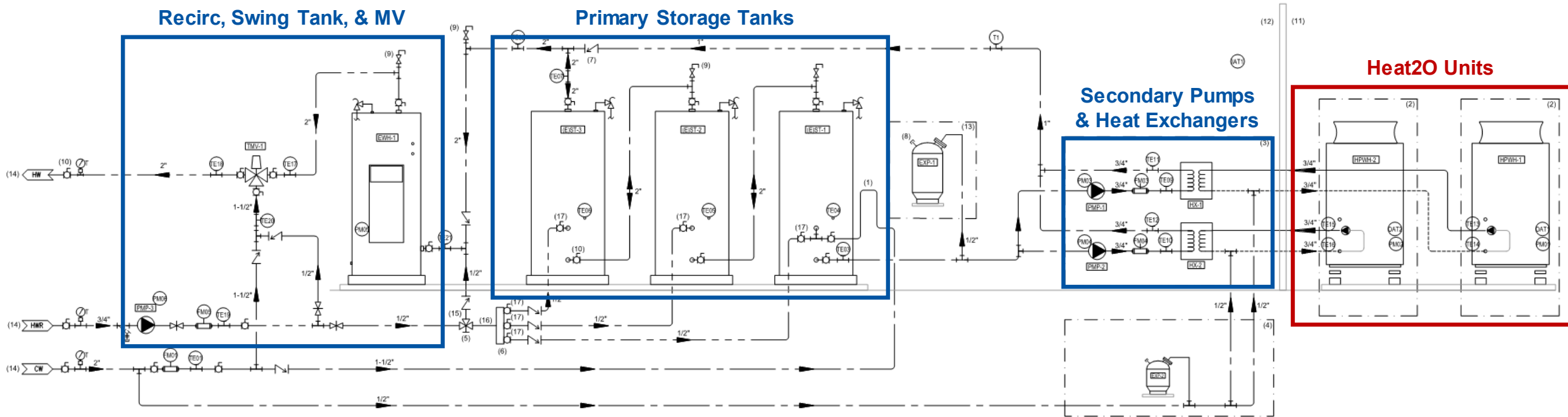
Example Plumbing Drawing

Recirc, Swing Tank, & MV

Primary Storage Tanks

Secondary Pumps & Heat Exchangers

Heat2O Units



NOTES:

- (1) ADD 12" VERTICAL DROP BEFORE STORAGE TANK TO ACT AS HEAT TRAP.
- (2) SEE DETAIL 2 - HPWH PIPING DETAIL
- (3) SEE DETAIL 3 - HEAT EXCHANGER AND LOAD PUMP DETAIL
- (4) SEE DETAIL 4 - MAKEUP WATER DETAIL
- (5) DIVERTING VALVE. DIVERTS HWC RETURN FLOW TO EWH-1 OR BACK TO THE PRIMARY STORAGE TANK

- (6) PRIMARY STORAGE HWC RETURN MANIFOLD FOR DIVERTING FLOW TO ONE OF THE THREE PRIMARY STORAGE TANKS.
- (7) SPRING CHECK VALVE
- (8) AIR CHARGING VALVE PLUG
- (9) MANUAL AIR BLEED VALVE AT HIGH POINT

- (10) BALL VALVE, OR SERVICE ISOLATION VALVE (TYPICAL)
- (11) EXTERIOR ENVIRONMENT
- (12) INTERIOR ENVIRONMENT
- (13) SEE DETAIL 11 - EXPANSION TANK
- (14) POINT OF CONNECTION TO EXISTING PLUMBING DISTRIBUTION SYSTEM

- (15) VALVE POSITION #1. DIRECT FLOW PAGE UP. PRIMARY POSITION
- (16) VALVE POSITION #2. DIRECT FLOW PAGE RIGHT. ALTERNATIVE POSITION
- (17) NORMALLY CLOSED VALVE.

1 HPWH SCHEMATIC

N.T.S.

Image: Ecotope



Challenges & Learnings



Challenges & Learnings (So Far) - 1



Image: AEA

- *Everyone* is learning as we go
 - Product is new to us, but also to the manufacturer's USA team
 - Purpose of study is to work out kinks for bringing Mitsubishi Heat₂O to US market
 - Lots of corrections, changes; challenging to coordinate drawings
 - After these initial demo sites, package system from METUS will be standardized and easy to order
- Tight infill sites - Sound levels at neighboring properties; tank size limitations
- Electrical constraints at existing buildings

Challenges & Learnings (So Far) - 2

- Secondary Heat Exchanger & Pump
 - Required on Mitsubishi Heat₂O, unlike most R134a and smaller CO₂ systems (ECO2)
 - Current Hx spec: SWEP BH85x81/2P
 - Size: 21" x 9" x 5" – Relatively compact
 - SWEP offers insulated shell – Need to specify
- Primary side volume – minimum 10 gal
 - At ¾" run b/w HP & Hx would need to be 50'. OR:
 - Larger piping
 - Flow through expansion tank + insulation
 - Small electric WH w/ element removed



Challenges & Learnings (So Far) - 3

- Operation Modes & Controls
 - Modes are programmed by METUS tech into unit
 - External control panel can tell unit when to enter each mode
 - Product *can* be started and operated w/o external module, but METUS will require the control module for all units



Images: Mitsubishi

Control Wiring

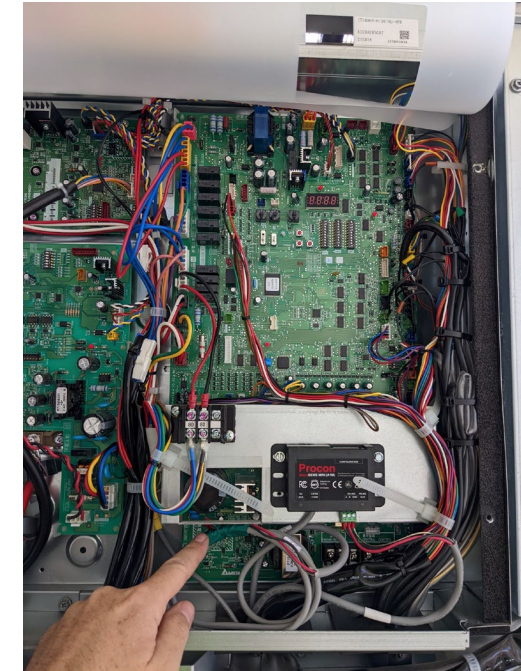
- Control panel wiring too complicated for typical multifamily contractors
 - Project #1: Found an electrician who used to be a controls contractor
 - Project #2: Neither the electrician nor the low voltage contractor were willing to do it. Tried a controls contractor and second electrician. Ultimately AEA did the wiring.



Unfinished Control Panel



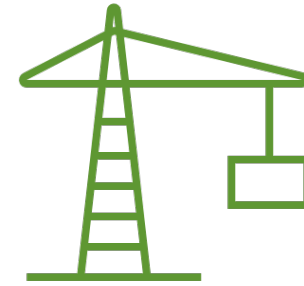
Finished Control Panel



Additional Components
to be Installed Inside
the Units

Challenges & Learnings (So Far) - 4

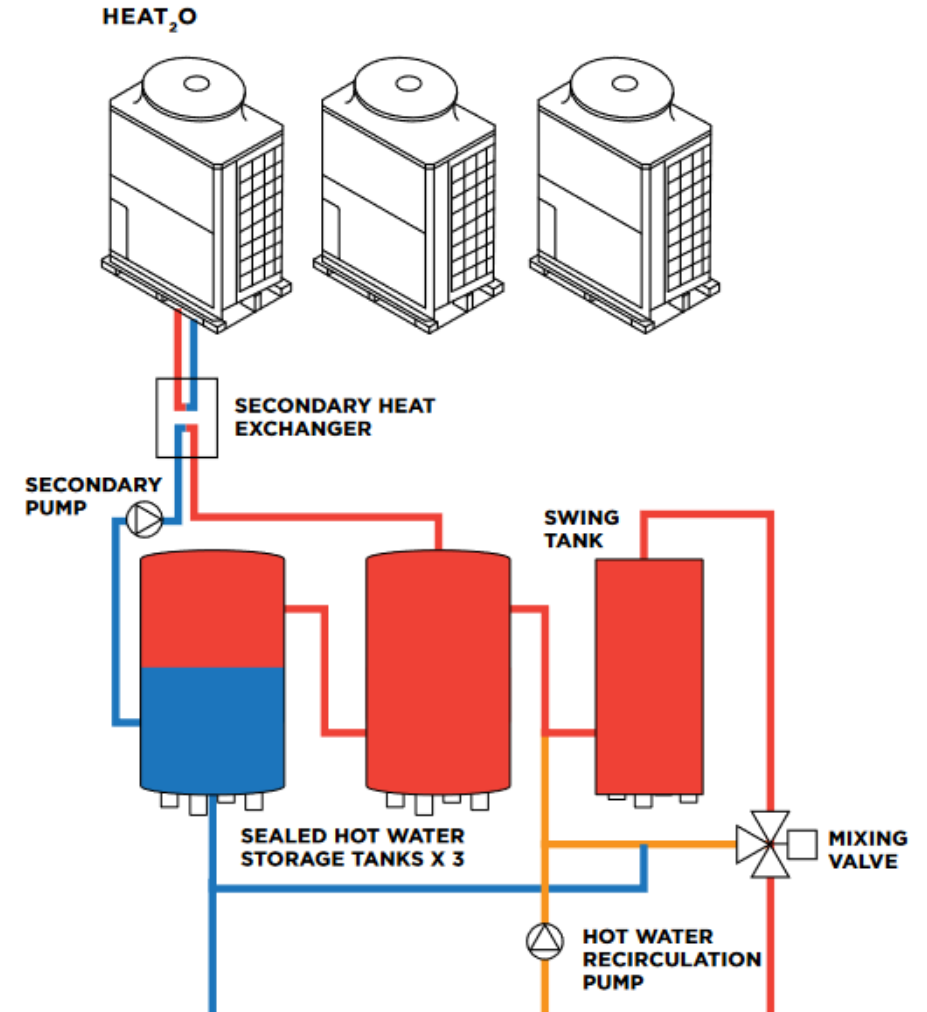
- Distribution channels
 - Local reps may not have a great handle on a product until they have been selling it for a while
 - Supply chain process is being worked out
 - Working through packaging, controls, & distribution as manufacturer has been figuring it out



Major Takeaways

- Early demonstrations have been / are challenging, BUT
- Working with a **responsive and invested manufacturer like Mitsubishi** make them doable.
- Once specifics of packages are ironed out, local reps are trained, and supply chains are standardized, **Heat₂O will be a very competitive offering** that should be relatively easy to specify

Image: Mitsubishi



Thank You!

Andy Brooks

abrooks@aeacleanenergy.org

 ASSOCIATION FOR
ENERGY AFFORDABILITY INC.

Qualified Products Jonathan Heller





CHPWH Measure Development

AWHS

Advanced Water
Heater
Specification

What:

Defines minimum design and performance criteria for a complete CHPWH system

Why:

Reduce risk and uncertainty for designers, owners, program implementers



PADS

Product
Assessment Data
Sheet

What:

Mechanism for manufacturers to submit their products for inclusion on the QPL

Why:

Demonstrates that product meets all requirements of the AWHS



EcoSim

EcoSim

What:

Energy modeling program used to predict performance of CHPWH systems

Why:

Provide savings estimates to use in incentive programs



QPL

Qualified
Products List

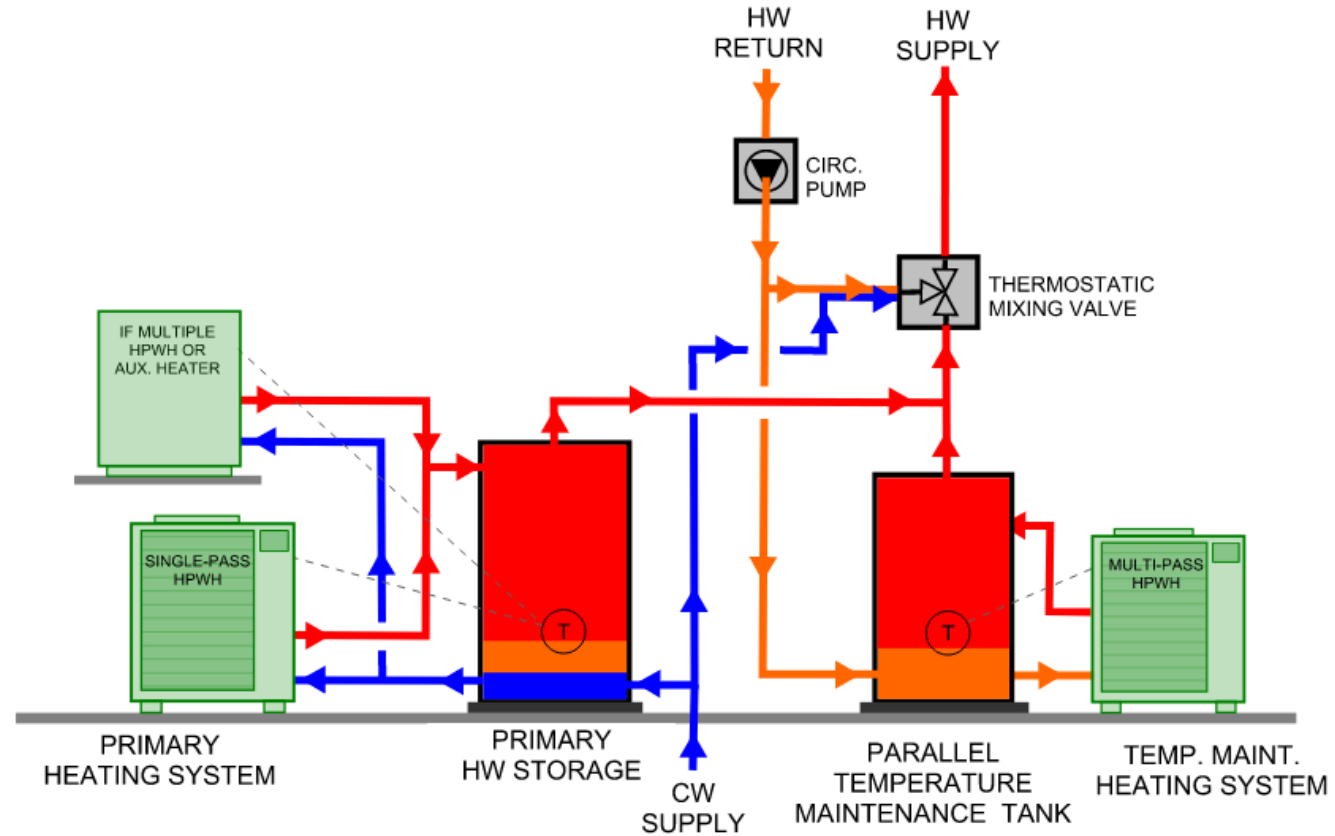
What:

Products which have submitted test data and demonstrated compliance with AWHS

Why:

Provide predicted average annual energy performance for vetted products

<https://neea.org/img/documents/advanced-water-heating-specification-v8.0.pdf>



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



PADS

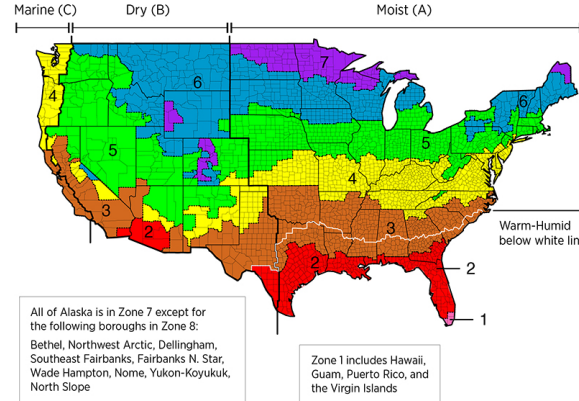
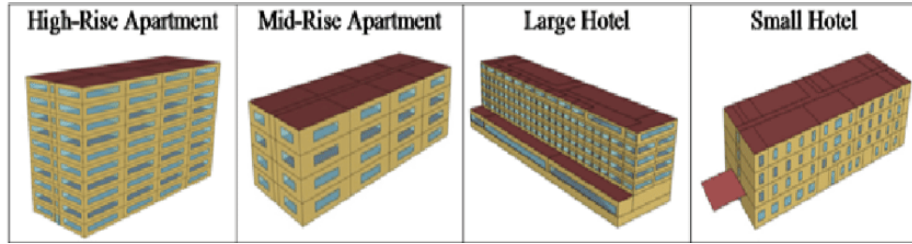
Product Assessment Parameter Submission

Commercial HPWH System

SYSTEM PERFORMANCE MODELING INPUT PARAMETERS

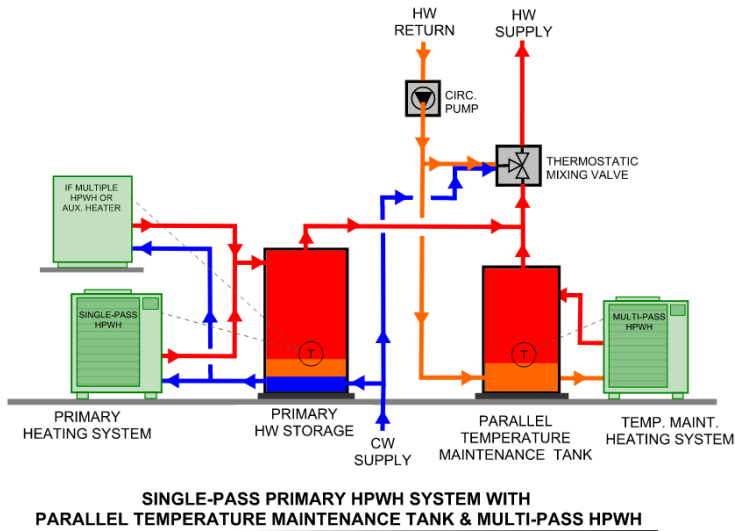
Provide information on the following parameters indicated below in sections A-J. The information provided in these sections will be used in the Ecosim con will determine what tier of the Qualified Product List a product complies with.

SECTION	PARAMETERS		
A	Contact Information	<i>Provide contact details of person submitting this form</i>	
1	Name:		
2	Job Title:		
3	Company		
4	Email		
5	Phone		
B	Equipment Identification	<i>Provide information on the product identification for each product line. A completed PADS must be submitted for each product line. Products with accessory packages shall be noted in the 'Accessory Packages' line below and do not require a PADS submission for each product accessory package variation.</i>	
1	Manufacturer/brand		
2	Model number(s)		
3	Accessory Packages that affect equipment capacity or efficiency (e.g. defrost, supplemental electric resistance, etc..)		
4	Refrigerant Type	[R410a, R134a, R744, R513a, Other]	
C	Product Categorization:	<i>Provide information on the product categorization to inform if the product a Unitary or Split System HPWH product type.</i>	
1	Are the heat pump components and storage tank integrated into the same unit?	[Y / N]	



PADS

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



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
C250A Blower	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
	50°F 60% RH	76300	130	135	120600	16.78	2.1	1.3	3.4
		69100	140	145	113000	16.79	2.0	1.2	3.2
		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
	60°F 60% RH	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
		234400	50	61	270800	14.44	5.5	4.8	10.3
		218400	60	70	258300	15.59	4.9	4.1	9.0
		207000	70	80	250300	16.49	4.4	3.7	8.1
		191500	80	100	239400	17.80	3.9	3.2	7.1
60°F 60% RH	188000	90	109	230100	18.82	3.6	2.9	6.5	
	169200	100	107	223200	19.62	3.3	2.5	5.9	
	154700	110	119	211200	20.34	3.0	2.2	5.3	
	133000	120	128	197300	21.18	2.7	1.8	4.6	
	120300	130	137	181300	21.5	2.5	1.6	4.1	
	108300	140	147	168400	21.7	2.3	1.5	3.7	
	275900	50	63	313600	14.83	6.2	5.5	11.7	
	262000	60	72	303700	16.00	5.6	4.8	10.4	
247800	70	82	294200	17.38	5.0	4.2	9.1		



Emerging
Technologies

QPL (Qualified Products List)

Commercial Heat Pump Water Heater Qualified Products List				
Product Tier Climate Zone: Mild	Product Brand	Model	Qualified Piping Configurations	Modeled System COP
Tier 4 SYSTEM COP: 3.0	SanCO2	GS3-*****_**_**	Single Pass, w/ Swing tank temp. maintenance ^c	3.0
	WaterDrop	WD1T-**_***_***_**_*_*_*_*_*_*	Single Pass, w/ Swing tank temp. maintenance ^c	3.0
Tier 3 SYSTEM COP: 2.5	Mitsubishi	QAHV-*****_***(-**)	Single Pass, w/ Swing tank temp. maintenance ^c	2.5
Tier 2 SYSTEM COP: 2.0				
Tier 1 SYSTEM COP: 1.5	Nyle	C-***_***	Single Pass, w/ Swing tank temp. maintenance ^c	1.9



Program Development

Lois Gordon



CHPWH Program Development

In summary, we already have these elements:

Products on QPL

Savings
Calculator

Advanced
Water Heater
Specification

What else is needed?

CHPWH Program Development



Program
Administration

Energy Efficiency
Incentives

Incentive
Administration

Equipment
Eligibility

Customer
Eligibility

Application
Processing &
Payment Fulfilment

Customer
Marketing &
Recruitment

Technical
Assistance

Financial
Support

QA /QC Process

Contractor
Network
Development

Workforce
Development

Implementation
Plan

Marketing Plan

EM&V Plan

CHPWH Program Development

NEXT STEPS:

- Urgency – the Climate Crisis is here
- Identify funding partners
- Recruit active stakeholder review group

Working Groups



Load Shift Working Group Scott Spielman (Ecotope)



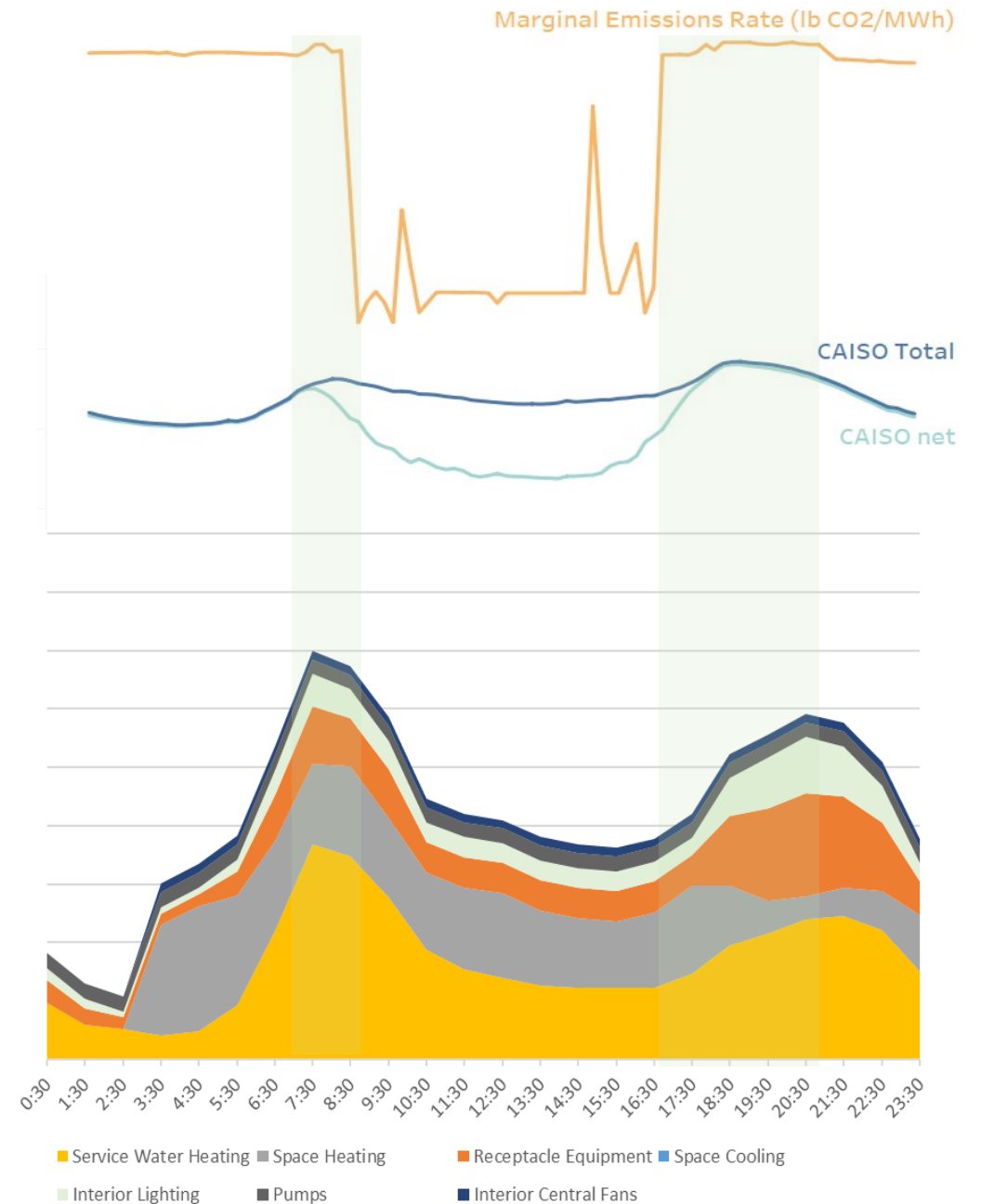
AWHI LOAD SHIFT WORKING GROUP

GOALS:

- Bring down cost.
- Align/move the market.
- Guarantee functionality – reduce peak usage and overall energy use.
- Increase Grid Interactivity

TOPICS

- Best practices for controlling central HPWH Equipment based on EcoPort commands – LoadUp, AdvLoadUp, Shed, CriticalPeakEvent, GridEmergency.
- Discuss/Define simple best practices for converting TOU pricing to EcoPort command for optimizing control.



Commercial AWHI Refrigerants Task Group

Jenny Haan (Ecotope)



Kick off Meeting – September 14

Area Of Focus	Why this is critical	What we need to do next	Milestone	Tasks	Deliverables
Refrigerants	Reduce cost, open US market for wide range of products available in Europe and Asia to meet rising demand	<p>Refrigerant Transition:</p> <p>Research barriers to natural refrigerants. Support US manufacturers bringing low GWP products to market</p> <p>Q4 2022-Q4 2024</p>	Whitepaper & Summer Study presentation of roadblocks to existing propane CHPWH equipment available in other parts of the world.	<p>Review UL requirements, ASHRAE 15, Analysis of flammability and toxicity, examples of equipment available globally</p> <p>Review global propane HPWH regulations.</p>	

Codes and Standards Task Group Carmen Cejudo (PNNL)





Thank You!

