## Central Heat Pump Water Heating Q2 2020

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## Agenda

- Heat Pump Water Heating
- Technology Innovation Roadmap
- Advanced Water Heating Initiative (AWHI)
- Heat Pump Water Heating Tool
   Development
- Prescriptive Heat Pump Water Heater Design California T24 Approved
- Packaged Plug and Play Water Heater Skids
- On the Horizon





# Heat Pump Water Heating Background





#### **Refrigerant Phase Out**





GWP limits of 700 will be required in 3-5 years. Manufacturer's are already working on this transformation.

CO2, Propane, R-1234yf and R-32 are the leading refrigerants replacements.

#### **GWP OF SELECTED REFRIGERANTS**

10900

(Carbon Dioxide Equivalents, CO<sub>2</sub>e)

4657



### Single Pass Heats up water to working temp in single pass

## Multi-Pass

Heats up water to working temp in multiple pass Loop or Swing Tank with Single Pass





Roof -

## • <u>Primary Heating:</u>

- Heating water for use
- Making cold water hot
- 16-22 gal DHW/pp/day
- <u>Temperature Maintenance</u>:
  - Reheating water due to energy losses in the distribution system
  - Keeping hot pipe hot.
  - 40-120 W/Apt.



High Level Strategic Goals (3-5 Year)



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Heat Pumps are Standard Practice in New Construction and =Retrofit

Deliver COP of 3.0 for HPWH

✓ Use Low-GWP Refrigerants (GWP<10)

Plug-and-Play

Gost Effective

Reliable and Redundant systems

 $\implies$  Ability to Load Shift

# Advanced Water Heating Initiative (AWHI)

### Advanced Water Heating Initiative (AWHI)

#### **Current Advanced Water Heating Intiative Members:**

1. Association for Energy Affordability 2. BC Hydro 3. Beyond Efficiency 4. Bonneville Power Adminstration (BPA) 5. Bradford White Water Heaters 6. Building Decarbonization Coalition 7. California Energy Commission (CEC) 8. Carbon Free Silicon Valley 9. California Public Utilities Commission (CPUC) 10. East Bay Community Energy 11. Ecotope 12. Efficiency First CA 13. Energy Solutions 14. Electric Power Research Institute (EPRI) 15. GE Appliances 16. Grasteu Associates 17. Guttmann & Blaevoet's 18. HTP Comfort Solutions LLC 19. HWR 20. Laars Heating Systems 21. Larson Energy Research 22. Los Angeles Dept. of Water & Power (LADWP) 23. New Buildings Institute (NBI) 24. Northwest Energy Efficiency Alliance (NEEA) 25. National Renewable Energy Lab (NREL) 26. National Resources Defense Council (NRDC) 27. Nyle 28. Pacific Gas & Electric (PG&E) 29. People's Self Help Housing Corp 30. Redwood Energy 31. Repcor Plumbing 32. Rheem 33. Sacramento Municipal Utility District (SMUD) 34. Sanden 35. Silicon Valley Clean Energy 36. Southern California Edison (SCE) 37. StopWaste 38. Skycentrics 39. Turnbull Energy



#### BUILDING DECARBONIZATION COALITION

#### 2020 Working Groups

- 1. 120V Unitary HPWHs
- 2. 240V Unitary HPWHs
- 3. Central HPWHs
- 4. Connectivity and Controls

the initiative directly to help us shape the future of the heat pump water heater market.

#### **nbi** new buildings institute



#### AWHI's Market Transformation Approach

The collaborators on the Advanced Water Heating Initiative range from manufacturers, to efficiency advocates to utilities and others interested in increasing the market share for these products. They are working to build better awareness among consumers and understanding of the product value. In addition, AWHI is helping installers and builders understand the opportunities for specifying HPWHs and is supporting the supply chain to break down the barriers preventing HPWHs from market adoption.

Specific objectives of the AWHI include:

• Provide alignment in the design, marketing and messaging efforts for a coordinated effort surrounding HPWHs which will assure the manufacturing industry to invest more in this technology.

• Support utilities with efficiency program offerings. Programs will provide strategic utility investments in heat pump water heating market chain development and program incentives in order to catalyze overall market transformation.

• Bring all the key stakeholders i.e. policy makers, program administrators, utilities, manufacturers, installers, industry experts, etc. together to share their experience and learn from each other in order to move the market in the same direction.

To achieve these ends, the AWHI consortium has established four working groups that are focused on market deployment of 120V unitary HPWHs, 240V unitary HPWHs, Central HPWHs, and connectivity and controls of all units.

The initiative and the working groups rely on the support and contributions from our members. How can heat pump water

heaters support your service territory, project, or jurisdiction? Join the initiative, participate in a working group, or support

- 2020 Working Groups 1. 120V Unitary HPWHs
- 2. 240V Unitary HPWHs
- 3. Central HPWHs
- 4. Connectivity and Controls

Join us! To learn more, or to join the Advanced Water Heating Initialitive or a working group, contact Amruta Khanolkar, NBI project manager, at amruta@newbuildings.org. Sign up to get the latest news by email.

The shorter term tactical goals are:

- Use Technology Innovation Model to support development of new products, support incorporation of existing
  products in the market, and push industry to fully integrated plug-and-play solutions away from custom
  engineering to support rapid wide-scale adoption.
- Expand communication between all parties working in this field and improve coordination, standardization of language and metrics, and coordinated funding for priorities.
- Expand CBECC-RES simulation tool to allow for additional available HPWH technologies (Colmac and Nyle singlepass are next)
- Expand CBECC-RES tool to allow for multi-pass configurations and equipment
- Use existing high GWP refrigerant equipment as bridge while low GWP equipment is developed and brought into the market.
- Use PG&E test lab to test impact of wide range of installation variables especially associated with handling of hot water recirculation and controls settings
- Create open source free sizing tool for HPWHs with support for designing for load shifting
- Advocate for expanded research on temperature maintenance system losses and load shapes for range of commercial applications.







## Technical Innovation

## **System Metrics** Predictable and Specific Outcomes

Policy

Utility Programs

Market Adoption



## Parallel Development Paths



## Technology Innovation Model (TIM)



Ganged up 134a Integrated Res. Units (Rheem, AO Smith, etc.)

□ Sanden CO2 Ganged Up Prescriptive Design

□ Colmac 134a Single Pass Central HPWH and Controls

□ Nyle 134a Single Pass Central HPWH and Controls

□ Multi-Pass 410a Products (Colmac, Nyle, Aermec)

□ Mitsubishi CO2 in pilot testing phase of the TIM



# HPWH Tool Development

## Central HPWH Sizing Tool - "HPWHuLater"

#### Expected September, 2020

HPW	/HuLater - Mi	ultifamily Co	entral HP	WH Sizing	<b>TOOI</b> (Beta Proof of Concept)							
									Advanced	Optic	ons	
ect the Do	emand Type				Advanced Options				Water Heater O	haracte	eristics	
Marke	et Rate with Low Flow	Fixtures	(20 GPD pe	r person)	•						Recommended	
									Parameter	Input	Values	Units
Input GPD	D per Person							% Of Useable	Primary Storage Volume	0.8	0.8 - 1.0	
22	Range: 18 - 46 GPI	) Per Person						Max Daily Cor	npressor Run Hours	16	12 - 16	hours
								Defrost Facto	r	0.9	0.9	
e the Apai	rtments Individu	ally Metered?										
Yes									Recirculation	Loop Lo	osses	
											Recommended	
						_			Parameter	Input	Values	Units
oose Inp	out Method:							Recirculation	Loop Heat Loss Rate	90	70 - 120	W/apt
Number of	People and Number of	of Apartments						Swing Tank Re	esistance Turn On Temperature	122	120 - 125	°F
								Nightly No Dra	aw Span	5	3 - 8	Hours
	Number of Units	1		Number of F	eople and Number of Apartment	s						
Qty	Unit	Occupancy Rate		100.1	Number of People			25.0				
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8	1 BR	1.7						<b>p</b> 20.0				
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24	°F Design Air Tem	perature (Coldest /	Air Temperatur	re Expected for	the Sanden to Expeirence)			0.0				
	- U				, , ,			(	500 1000 1	500	2000	
									Primary Storage Volume (	Gal)		
		Prima	rv Storage	e Size								
	Minimum Storage:	688	Gal									
	Storage Tank Size:	250	Gal			IS_						
Numb	per of Storage Tanks:	3		Look up by p	rimary storage volume (Gal):		SINGLE-PAS	S HPWH SYST	EM WITH SWING TANK	HWC	HW N SUPPLY	
	Total Storage:	750	Gal	4		1				<u>+</u>	<b>↑</b>	
									нис	РИМР 🕥		
	Primary He	ating Size		487	Gallons					T		STATIC
	Heating Capacity:	6.1	Tons	14.7	Tons for Primary					1		ALVE
	Number of Sandens:	6	Units	13	Units					s s		
								_			"SWING TANK"	
	Temperature I	Aaintenance					HEAT PUM	Р				
	Storage Volume:	442	Gal				WATER HEATER(S	)	·········			
					EC			<b>₩</b>				
	Heating Capacity:	1.7	Tons or								TEMPERATURE	
							DDIMADV		DBINA BY		IEMPERATURE	

## Load Shift Sizing and Modeling

Figure 2: The duck curve shows steep ramping needs and overgeneration risk









#### Forecast 2021 WeekDAY Monthly Net Load Distribution

#### http://www.caiso.com/Documents/CaliforniaISO Time UsePeriodAnalysis.pdf

#### Load Shift Sizing and Modeling

#### **Grid Harmonization**



16 Hour Runtime - Cumulative Hot Water in Storage









## Load Shift Sizing and Modeling



#### 100 Person Skid Sizing

	Tons	Storage	kW	Watts/apt
16 Hrs	6.1	775	6.6	120
8 Hrs	12.1	1538	13.2	240

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Prescriptive Central Heat Pump Water Heating Design

### Prescriptive Central Heat Pump



Docket Number: 19-BSTD-01 Project Title: 2019 Alternative Calculation Method Reference Manuals and Compliance Software Tools TN Number: 231318 Title: Excecutive Director Determination Pursuant to Section 1501(c)8C for Central Heat Punmp Water Heating System Description: Filer: Danny Tam Organization: California Energy Commission Role: Commission Staff Submission Date: 12/26/2019 9:43:32 AM Docketed Date: 12/26/2019 Subject(s): Submission Type: Document Page(s): 7 Temporary solution to allow central heat pump water heaters in Title 24 compliance software while the policy/software changes in CBEC RES/COMM are being developed.



### Prescriptive Central Heat Pump Specification

"Executive Director Determination Pursuant to Section 1501(c)8C for Central Heat Pump Water Heating Systems",



### **Prescriptive Sizing**

- 5. System Sizing
  - The number of HPWH compressors shall be no less than calculated by Equation 6.1. (Each compressor heating capacity assumed to provide 15,400 BTU/hr)

Equation 6.1 Compressor(s) = (0.037 \* Bedrooms) + (0.106 \* Dwelling Units)

b. The primary storage capacity shall be no less than shown by Equation 6.2.

Equation 6.2 Primary Storage = 80 gallons \* number of compressors

Loop Tank Sizing Table

Number of Dwelling Units	Minimum Capacity (Gallons)			
1 - 7	40			
8 - 11	80			
12-23	96			
24-47	168			
48 - 95	288			
96 and greater	480			

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#### Example Prescriptive Sizing: Market Rate – 60 Units, 90 Bedrooms

**Heat Pump Sizing** 

(.037)\*90 + (.106)\*60 = **9.7 compressors** 9.7 compressors \*15,400 btu/hr = 149,226 btu/hr = **12.1 Tons** 

#### **Primary Storage**

9.7\*80 gal = **775 gallons at 120F** 

= 620 gallons at 150 F

#### Loop "Swing" Tank Storage:

60 units from table is 288 Gallons of storage

Loop "Swing" Tank Backup Heat:

Temperature Maintenance Load ~ 100W/Apt = **6kW** System Backup Power – (TM Load \* 2.5) = **15kW**  Plug and Play DHW Skid Development

## Manufacturer Plug and Play Packages Development



100 Person, Load Shift Capable, Plug and Play Sanden Skid for Menlo Park Apartment Projects (840 units)

- Working with Manufacturer to develop standardized packages around number of people served (25, 50, 75, 100 people)
- Crane up to roof, mount to stanchions plug in water lines, electrical lines, internet and ready to go.
- System will be configured around a skid of storage and a skid of heat pumps and controls.
- Controls add on for Monitoring, M&V systems and DDC connection
- Load Shift Capable
- COP 3.5 (Annual)



#### Manufacturer Plug and Play Packages Development



есоторе

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Ecotope counteracts the climate crisis with research-proven engineering and visionary leadership; we drive the building industry toward transformative and scalable low-carbon solutions, informed by four decades of learning and technical innovation. Our clients seek holistic designs that optimize energy efficiency and are in harmony with the future grid.

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