### COMMERCIAL HEAT PUMP WATER HEATING: MULTIFAMILY RESIDENCE

Colin Grist, PE, Ecotope







#### **OVERVIEW**

- Potential for energy savings
- Products, language & applications
- Components of a CHPWH system
- New construction case study

# Joining as a participant?

PORCH

27/8-15 LITE

DINING

No account needed.

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#### We want to hear from you!

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### GO TO SLIDO.COM

Enter event code:







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#### WHY CHPWH?







Clobal, federal & state policies Codes & standards Capture incentives & rebates Lower operating costs Energy efficiency measures

Societal changes

#### WHY CHPWH?



CALIFORNIA ENERGY CODES & STANDARDS A STATEWIDE UTILITY PROGRAM nta Rosa Elk Grove Napa CA-121 an Franc

Interactive REACH Codes Map:" https://localenergycodes.com/content/map

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#### WHY CHPWH?



DHW represents 25% of annual building use

CHPWH systems cut energy usage down by 3x

#### SEATTLE COMMERCIAL ENERGY CODE

#### C404.2.3

Group R-1 and R-2\* occupancies w/ central service water heating systems.

Service hot water shall be provided by an **air-source heat pump water heating system**, not fossil fuel or electric resistance.



\*R-1 and R-2: Multifamily greater than 3 stories; any hotel/motel

#### SUNSET ELECTRIC





**EUI=** Energy Use Intensity (Energy Use/Total Building Area) • 67,000 ft<sup>2</sup>

70% Reduction in DHW Energy

- 92 apartments
- R-134a air-source heat pump water heaters in parking garage

### **ELIZABETH JAMES**





### 70% Reduction in DHW Energy

- Senior/low income
- 60 apartments
- 4 Sanden CO<sub>2</sub> HPs
- ZERO GHG emissions

#### LOWER FIRST OPERATING COSTS

### 965 Weeks Street, East Palo Alto, CA

Affordable apartment homes that include at least 30% extremely low-income units and 50% low-income units

AIR TO H,O FOSSIL VS GAS HPWH 00 4 hot water plants serve 4 buildings • Storage tanks on roof • Plants contain gas water heaters with • Outdoor unit on roof or integral storage tanks in mechanical room Solar Solar PV thermal collector w/ system **PV** system Equipment cost: Equipment cost: \$192,000 \$169,262 Utility connection cost: Utility connection cost: \$84,800 \$27.000 Total cost: \$276,800 Total cost: \$196,262

#### OPERATING COST COMPARISON

FOSSIL GAS SYSTEM

VS

#### AIR TO WATER CO<sub>2</sub> HPWH

#### Gas usage/year: 18,722 therms

Average estimated cost/therm: \$1.75

Estimated gas cost/year: **\$32,829** 

(no load shifting)

Electricity usage/year: 130,154 kWh

PG&E time-of-use rate (peak, partial peak, off-peak)

Estimated electric cost/year: **\$33,065** 

(load shifting)

#### Electricity usage/year: 130,154 kWh

PG&E time-of-use rate (peak, partial peak, off-peak)

Estimated electric cost/year: **\$31,672** 

#### WHY CHPWH: TOU RATES & GRID FLEXIBILITY



## PRODUCTS ON THE MARKET

#### PRODUCTS: LEARN THE LANGUAGE



- Compressor, tank, & controls in a single package.
- Typically small residential product.

 Compressor, and tank in two separate packages

Split System

SANGEN

• Both residential and commercial products available

•

#### MARKET DELIVERY: LEARN THE LANGUAGE





All the pieces are separate & come from multiple distributors and/or manufacturers.





#### SPECIFIED BUILT-UP SYSTEM

All the pieces are separate but come from a single distributors or manufacturer.

#### PACKAGED/SKID

Everything is assembled & delivered in a single package.

#### EXAMPLES OF **SYSTEMS**



Small Commercial System

(closet installation serving 5 apts)



Large Commercial System (basement installation serving 250 apts)



Multiple Commercial Systems (residential equipment serving 4-5 apts)

### Multiple Sizes, Types, & Configurations

#### SMALL COMMERCIAL SYSTEM



#### LARGE COMMERCIAL **SYSTEM**



- Commercial equipment; engineered system
- 200 units
- Dedicated heating system:
  - Single pass primary HPWH
  - Multi pass temperature maintenance system



#### MULTIPLE COMMERCIAL SYSTEMS

- Smaller residential equipment used in a commercial application
- 100 units
- Multiple central/commercial HPWH systems





# LET'S PAUSE FOR QUESTIONS

### CHPWH SYSTEM COMPONENTS





https://drive.google.com/file/d/1UU-KTXEKwshO4m0Jvu3T2PEsMyGsiLS3/view?usp=sharing

# Not a gas water heater!

#### FOUR CHPWH SYSTEM COMPONENTS



- Primary heat pump water heater (HPWH)
- Primary HW storage
- Temperature maintenance system
- Controls

#### PRIMARY HEAT PUMP(s)



#### **PRIMARY** HEAT PUMP



#### PRIMARY HP = ENGINE

#### HOW HEAT PUMPS WORK

#### Air Source Heat Pump with Storage Tank



(not making heat)

#### TWO TYPES OF **HEATING CYCLES**



Heats water to working temp. in single pass (usually for primary heating load)



#### HPWH CONSIDERATIONS



- Air source / heat source
  Heating cycle (single pass / multipass)
  Electrical connection
  Water connections (freeze protection required?)
  - Condensate management
  - Maintenance & access
  - Sound level, noise considerations

#### PRIMARY STORAGE



PR8 1 ----

#### PRIMARY STORAGE TANK(S)



#### A BATTERY BANK



#### PRIMARY STORAGE **PLUMBING**







#### HW STORAGE **CONSIDERATIONS**



Physical space, room & door size  $\langle \cdot \rangle$ Vertical is better than horizontal Multiple tanks, series or parallel? Height of control sensor(s) Pipe connections, size & location Insulation level Thermal isolation Maintenance & access

# LET'S PAUSE FOR QUESTIONS

#### TEMPERATURE MAINTENANCE SYSTEM



#### TEMPERATURE MAINTENANCE **SYSTEM**



#### TEMPERATURE MAINTENANCE SYSTEM VALUE

- HPs are very efficient at making **cold** water **hot**
- HW circulates through the distribution piping
- Water returns from the building slightly cooled
- Return water causes mixing & destratification in the storage tank
- HPs are not very good at making warm water **hot**



#### THERMOSTATIC MIXING VALVE SIZING



Jackson Apartments



Requires accurate sizing for DHW load. Response time is **essential**.

#### CONTROLS



Fight Laws

#### TIERS OF **CONTROLS**



#### CONTROLS: INTERNAL INTERFACE

- Heat pumps control themselves
- No BMS or external controller
- The temperature maintenance system will run independently



#### CONTROLS: HEAT PUMP/BMS INTERFACE

- Heat pumps control themselves but report to a BMS
- The BMS confirms operation
- The temperature maintenance system will also report to BMS





#### CONTROLS: EXTERNAL INTERFACE

- External/third party controls are doing all the work and logic
- Tell the heat pump and temperature maintenance system when to run





CHPWH COMPONENTS



# LET'S PAUSE FOR QUESTIONS



#### JACKSON APARTMENTS INTERACTIVE TOUR

### Visit Jackson Apartments

#### **BUILDING INFO:**

7 Stories, 2 Buildings
East - 163 units
West - 369 units

• Mid-rise; Multi-Family

- (2) CHPWH systems
- Seattle, WA



#### **BUILDING INFO:**

- 7 Stories, 2 Buildings
  - East 163 units
  - West 369 units
  - Total 532 units
- Mid-rise; Multi-Family
- (2) CHPWH systems
- Seattle, WA









#### **BUILDING** INFRASTRUCTURE:

#### • DHW Room:

- 740 ft<sup>2</sup>
- ventilated enclosed parking garage
  - 26 ft<sup>2</sup> exhaust air louver
  - 36 ft<sup>2</sup> intake air opening (door)
- Electrical capacity for HPWH system
  - w/ electric backup: 87.85 kW (540 W/apt)
  - w/out electric backup: **30.85 kW** (190 W/apt)



#### **SHOWN** HERE:

- Primary heaters:
  - Two Single-pass Colmac HPWH
    - 15-tons each
    - CxA series (R-134A)
  - located in an buffered space (enclosed ventilated below grade parking structure)
  - Full backup due to cool Seattle climate & owner decision



### **SHOWN HERE:**

#### Temperature Maintenance:

- Dedicated storage tank with back-up electric element
- Multi-pass Colmac 5-ton HPWH
  - CxV series (R-410a)





#### COMMERCIAL HPWH SKID EQUIPMENT

# Manufacturers are working to provide skid options that are easy to install, reliable and result in energy savings.







#### **RECAP:**

- Potential for energy savings
- Products, language & applications
- Components of a CHPWH system
- Essential design considerations



#### UPCOMING TRAINING & RESOURCES



#### SCL 2021

(WWW. LIGHTINGDESIGNLAB.COM/EDUCATION)

Engineering Deep Dive (2-hour seminar) Jan 11th, 18th

To host a training session, or for more information, contact: Thomasena Philen at: TPHILEN@DRINTL.COM



# THANK YOU

I DESCRIPTION OF





#### ADVANCED WATER HEATING INITIATIVE







### THANK YOU TO OUR COLLABORATORS

#### OCCUPANCY & DHW LOAD



https://ecosizer.ecotope.com/sizer/

#### **IS IT A CANDIDATE?**

- It makes sense for all building applications
- Biggest payback if:
  24/7 occupancy
  - High **DHW Load**