Cost-Effective Code Compliance

Water Heating

Seattle City Light

Lighting Design Lab

May 30, 2023

Before we Begin…

During the Webinar

- Attendees will be muted
- Please use the chat feature in the control panel to submit questions to LDL staff
- The presenter will pause to address questions periodically.
- Please participate in the online polls.

Following the Webinar

- Please take the short survey
- A recording and the slide deck will be posted on LDL's webpage
- Reach out to LightingDesignLab@seattle.gov with comments or questions.

Seattle City Light

lighting design lab

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ECOTOPE

Seattle Department of Construction & Inspections

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Seattle City Light

It's not *whether* we're going to do this, it's *how*

Washington state:
70% less building energy use by 2030

- Zero-carbon buildings
- …or by 2027?

Washington state:
45% reduction in GHG emissions by 2030

- 95% reduction by 2050

Seattle: Carbon-neutral buildings & vehicles by 2050

- …or sooner with Green New Deal?

Seattle amendments: 4 Guiding Principles

1. Envelopes meet our “2050” standard
   - We have to decide what that 2050 standard is
2. No “internal combustion buildings”
   - Electrical infrastructure for exceptions
3. Efficient use of electricity
   - Typically heat pumps for space heating & water heating
   - Highly efficient systems & controls
4. Increased on-site renewables
   - Options for off-site purchase
   - Plus “solar readiness” for bigger future system

Today:
Water
Heating

New buildings must be *capable of* meeting Seattle’s 2050 targets
(without major surgery)

Shawn Oram

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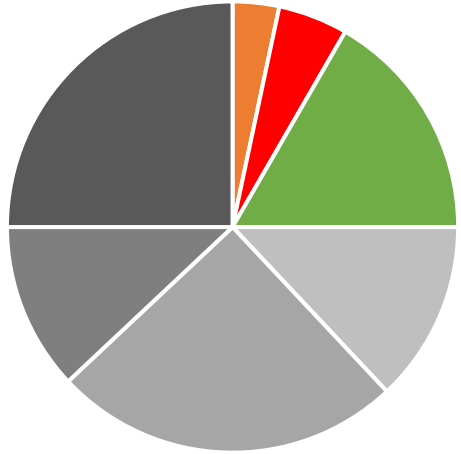
www.ecotope.com

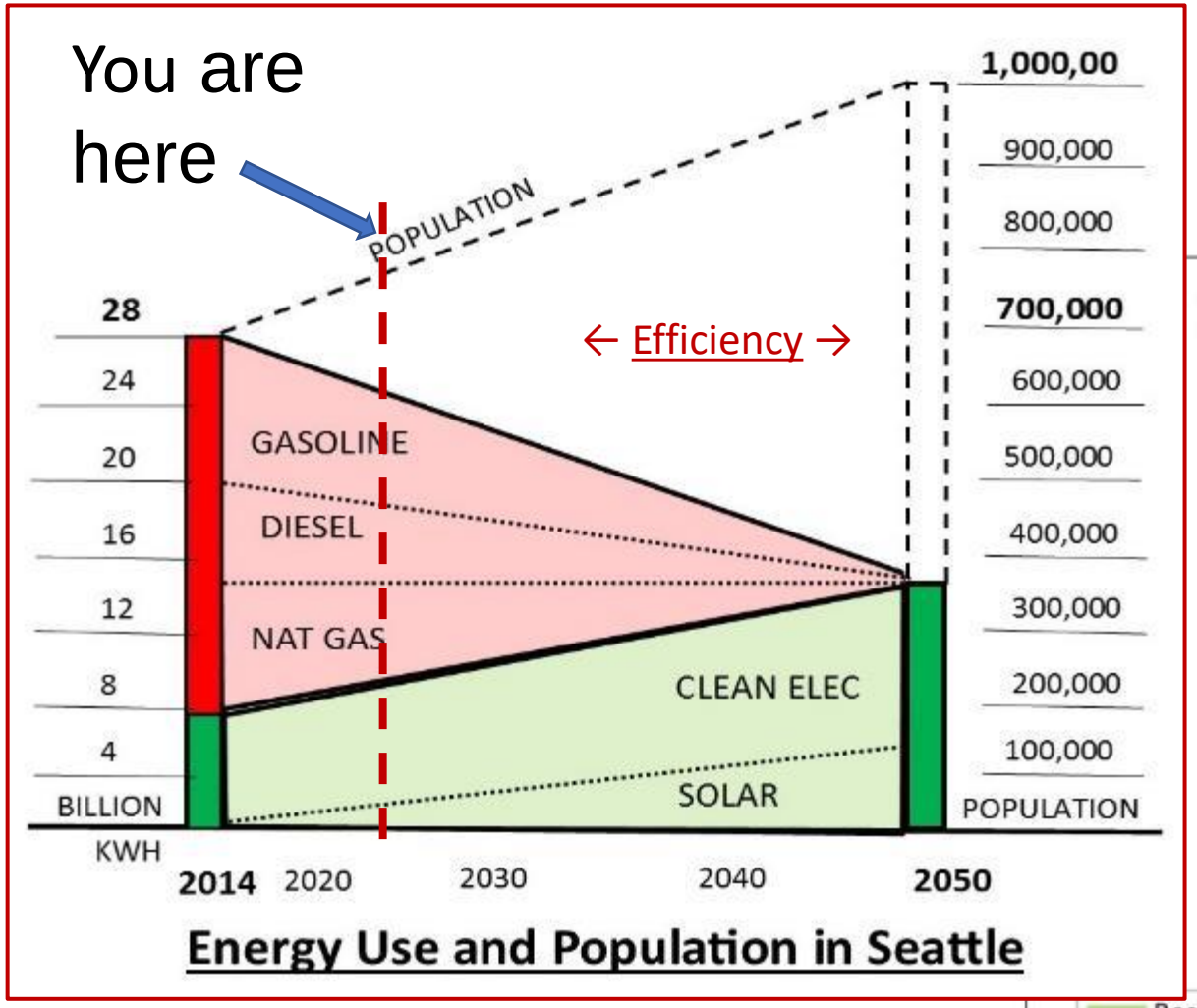
Baseline MF Building

- **DHW Temp. Maintenance**
- **DHW Primary Heating**
- Energy Savings
- Common HVAC
- Common Plugs/Lights
- Apartment HVAC
- Apartment Plugs/Lights

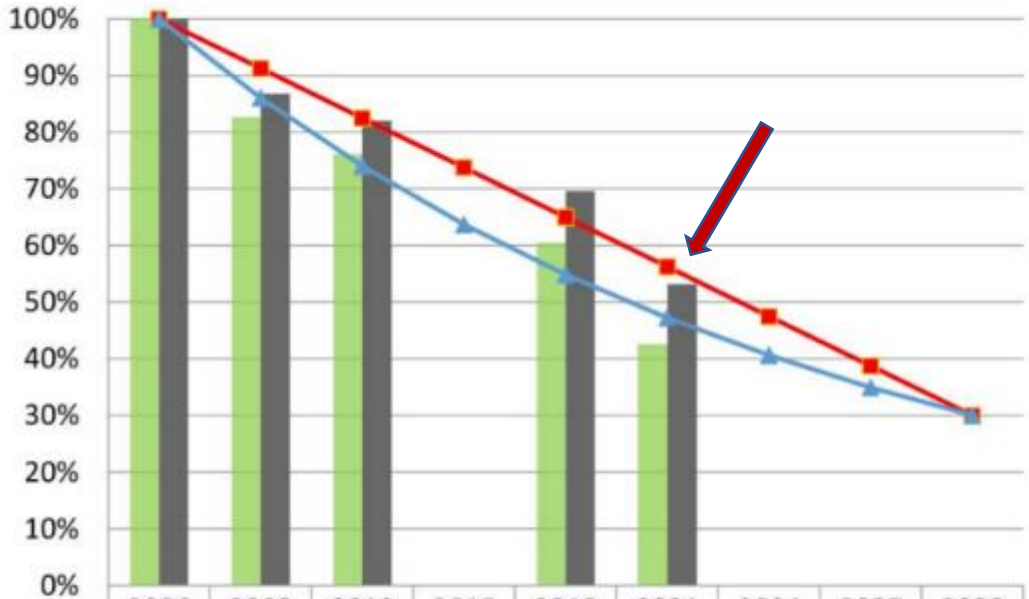
MF Building w/ HPWH



- **DHW Temp. Maintenance**
- **DHW Primary Heating**
- Energy Savings
- Common HVAC
- Common Plugs/Lights
- Apartment HVAC
- Apartment Plugs/Lights

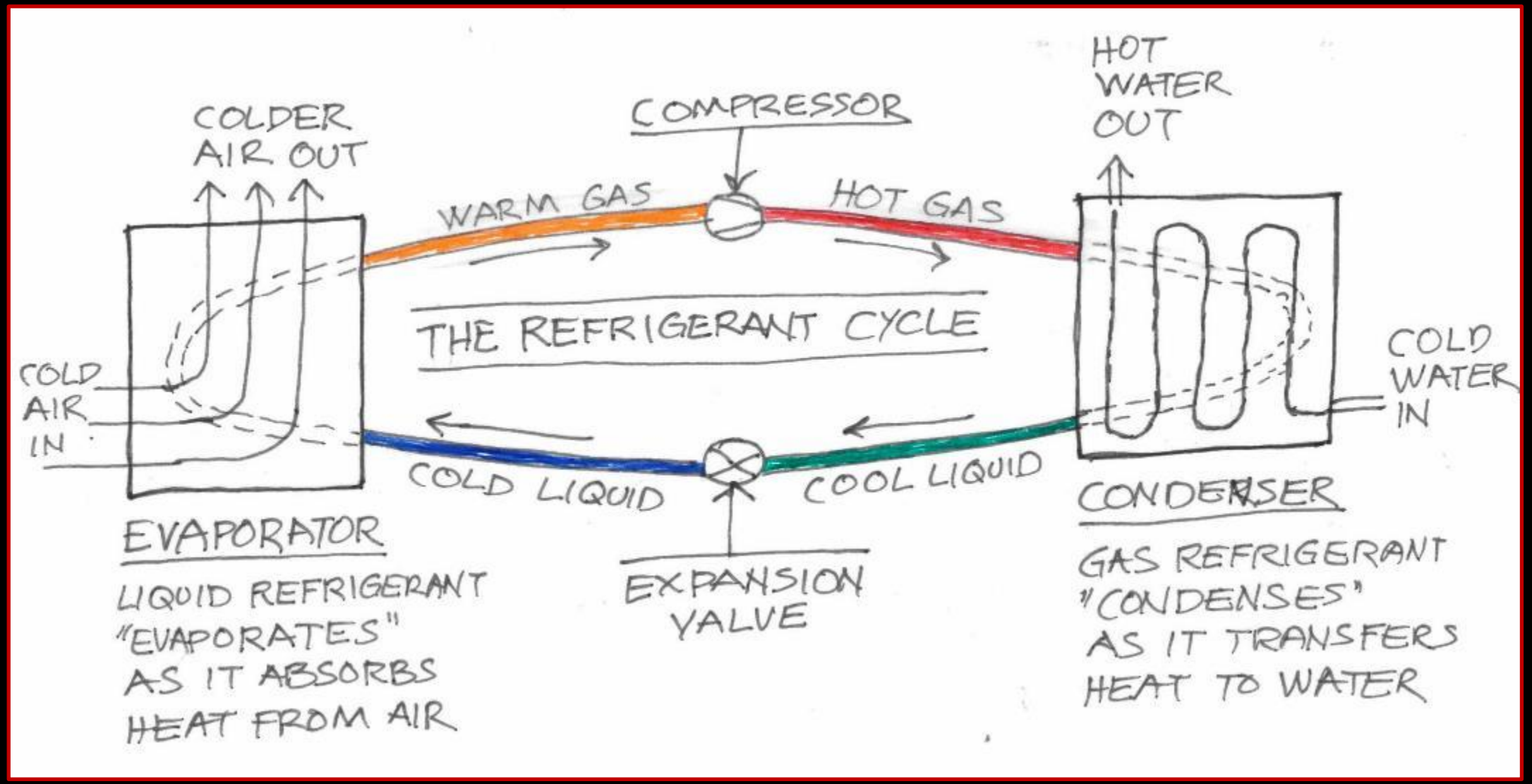


Incremental Improvement Compared to Targets



	2006	2009	2012	2015	2018	2021	2024	2027	2030
Residential	100%	82.7%	76.1%		60.5%	42.4%			
Commercial	100%	86.8%	82.0%		69.6%	53.0%			
Target: 8.75 % savings compared to the 2006 WSEC	100%	91%	83%	74%	65%	56%	48%	39%	30%
Target: 14% savings compared to each previous code	100%	86%	74%	64%	55%	47%	41%	35%	30%

Heat pumps squeeze heat out of thin air



Using a fraction of the energy of gas or resistance

Heat Pump Water Heating
It's not just Seattle anymore

2021 WA code adopts 2018 Seattle HPWH rules (mostly)

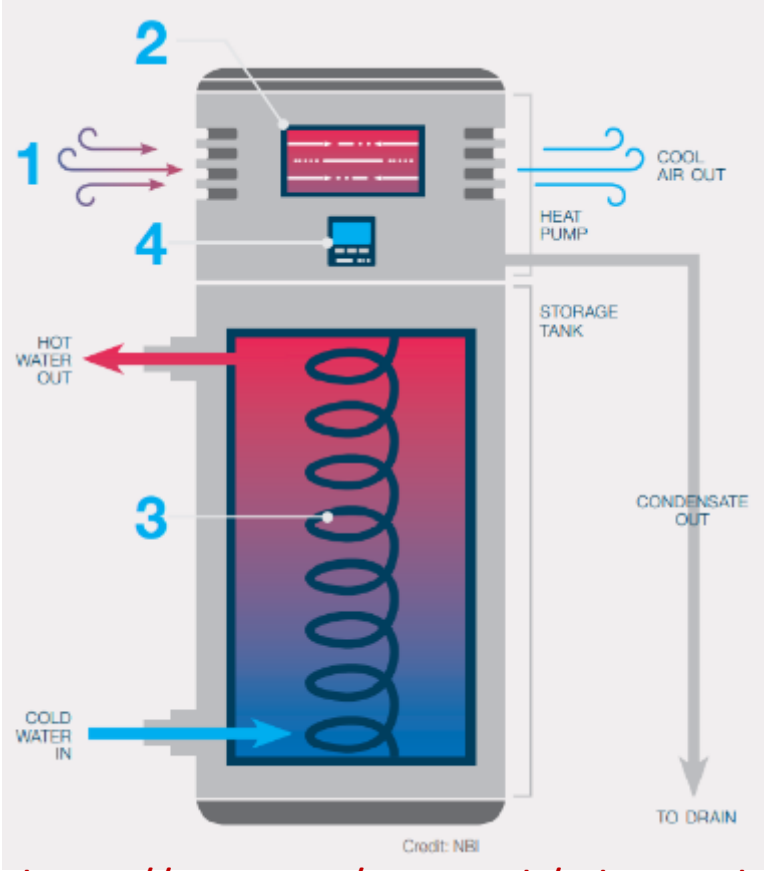
- Commercial *and* multifamily
- Central systems *and* unitary equipment
- Primary SWH system must be heat pump, air source or ground source.
  - WA allows gas or resistance for supplemental heating
  - Seattle allows minor electric resistance
- Exceptions? next slide

Exceptions

1. 24 kW plus 0.1W/sf resistance
   - So, a dozen mini-water heaters?
2. Solar thermal, wastewater heat recovery, GSHP, or water source heat pump using waste heat
3. NEEA Commercial Advanced Water Heating Specification
4. Served by existing district energy system (CenTrio, UW)
5. Booster water heaters for commercial dishwashers, commercial food service equipment, other approved process equip
6. ~~Connected to a low-carbon district heating system~~ (seriously now)
7. I-2 & I-3 institutions (hospital, jail) need redundant backup
8. **(Seattle) Instantaneous electric water heaters, max 8 feet developed pipe length from water heater**
9. **(Seattle) Unitary HPWH in conditioned space, if sized to use only HP compressor**
10. **(Seattle) Standby equipment**

What's this "Advanced Water Heating Spec"?

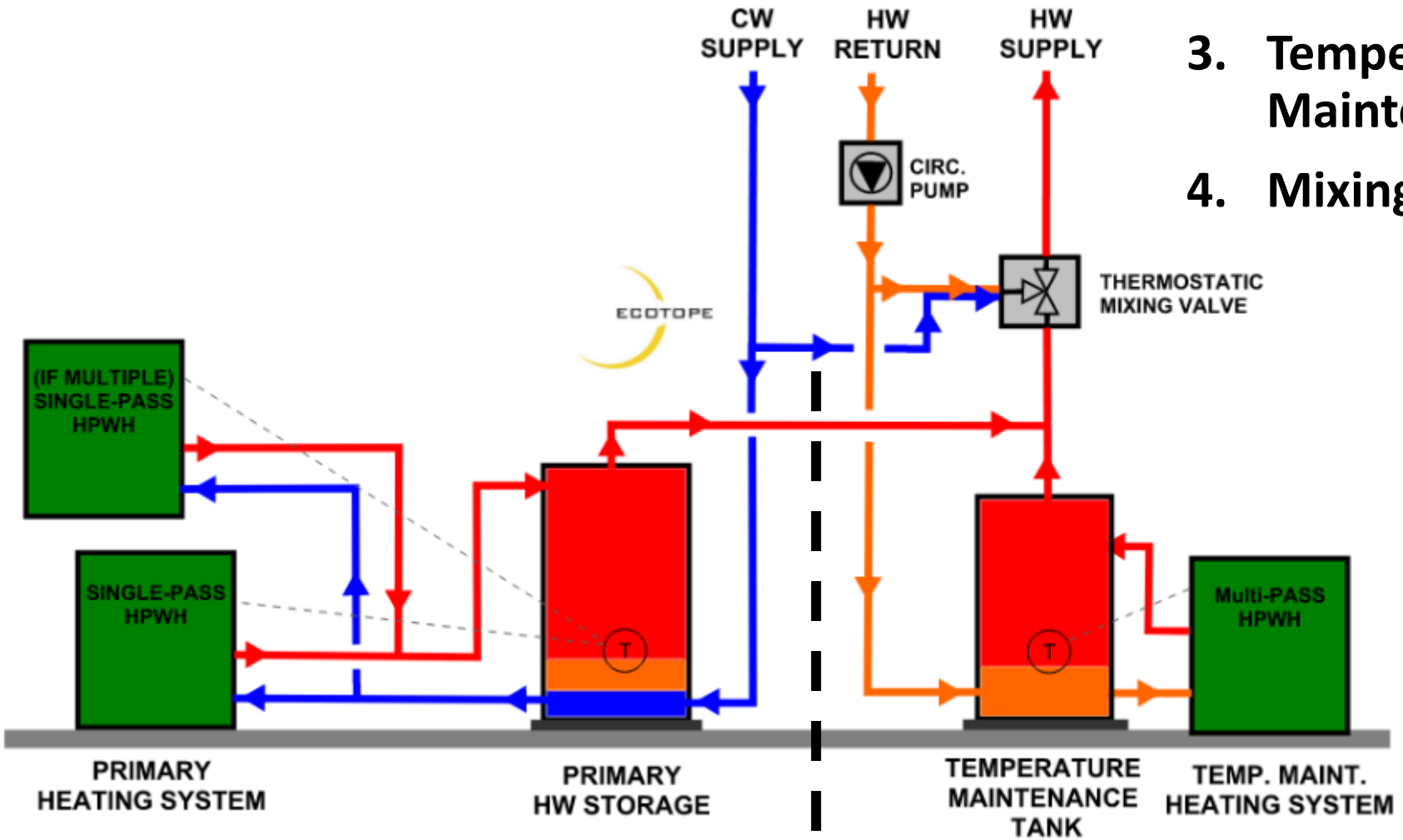
- AWHS added commercial/multifamily (Version 8.0)
- 4 key topic areas in spec:
  - Performance
  - Comfort/satisfaction
  - Demand response
  - Installation/startup/operation
- 4 Tiers of increasing efficiency, with system COPs from 2.0 – 3.5
- QPL (next slide)



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

Four HPWH System Components

1. **Heat pump**
2. **Primary storage tank**
3. **Temperature Maintenance System**
4. **Mixing valve**

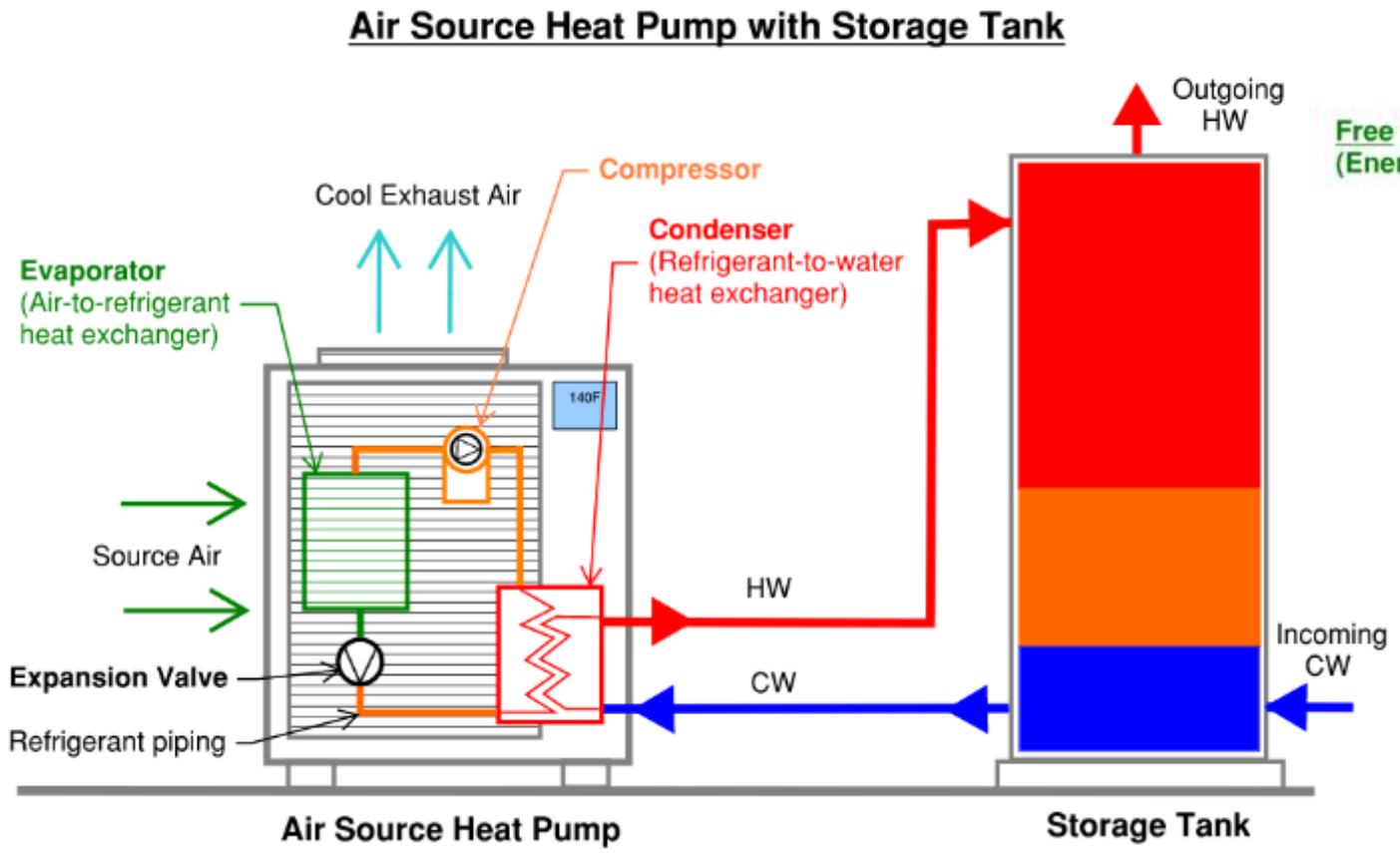


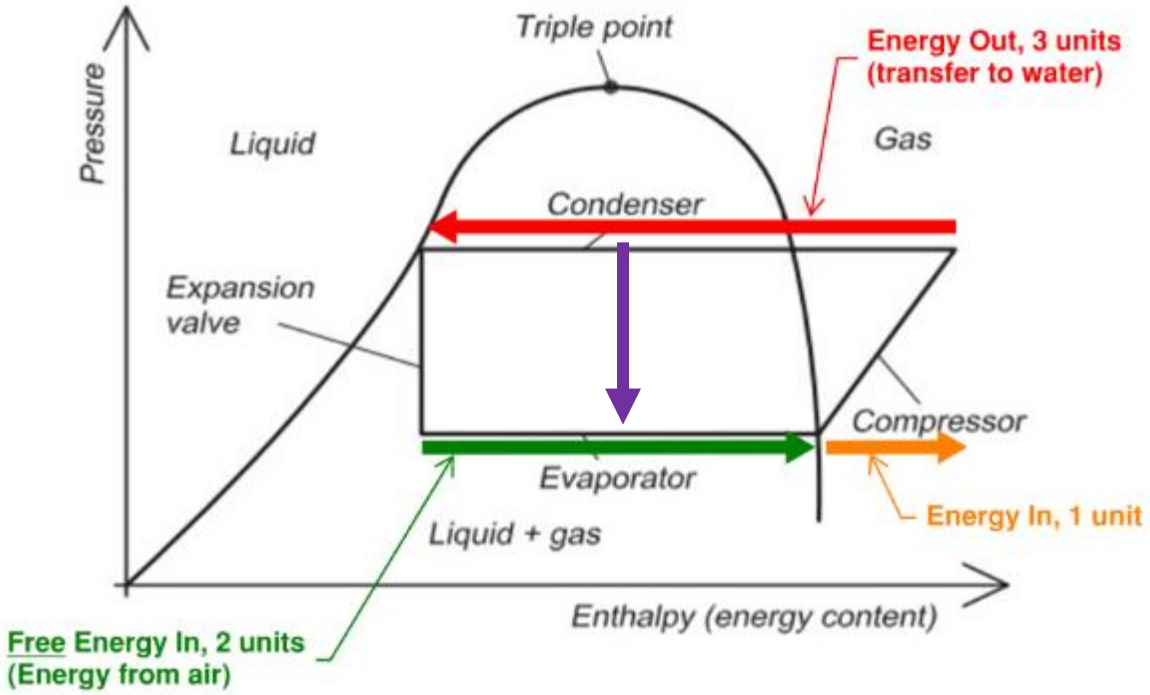
1. Heat Pump Water Heater

The engine

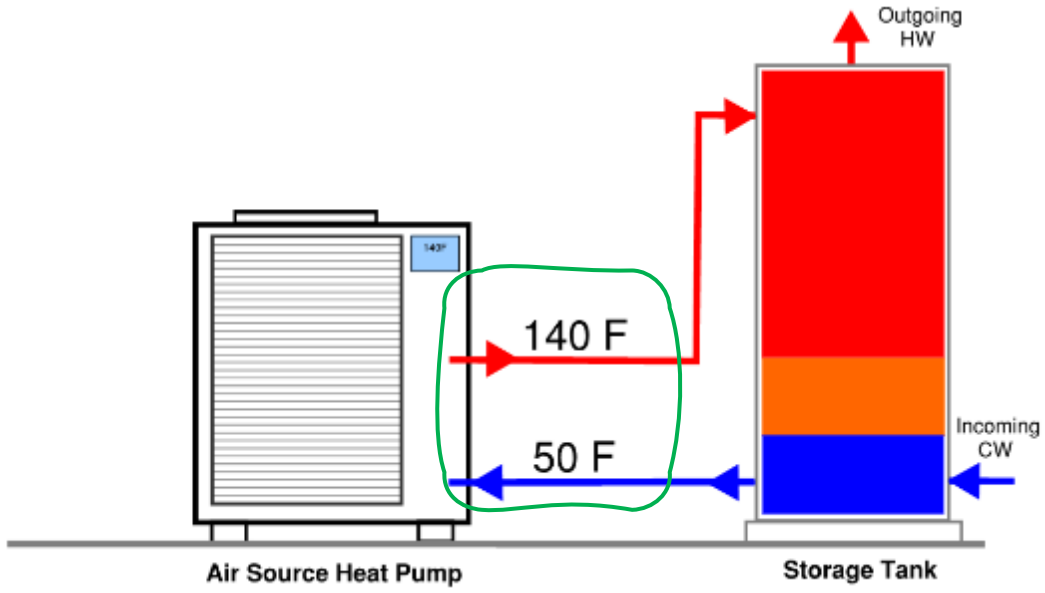
Not a boiler

How Heat Pumps Work



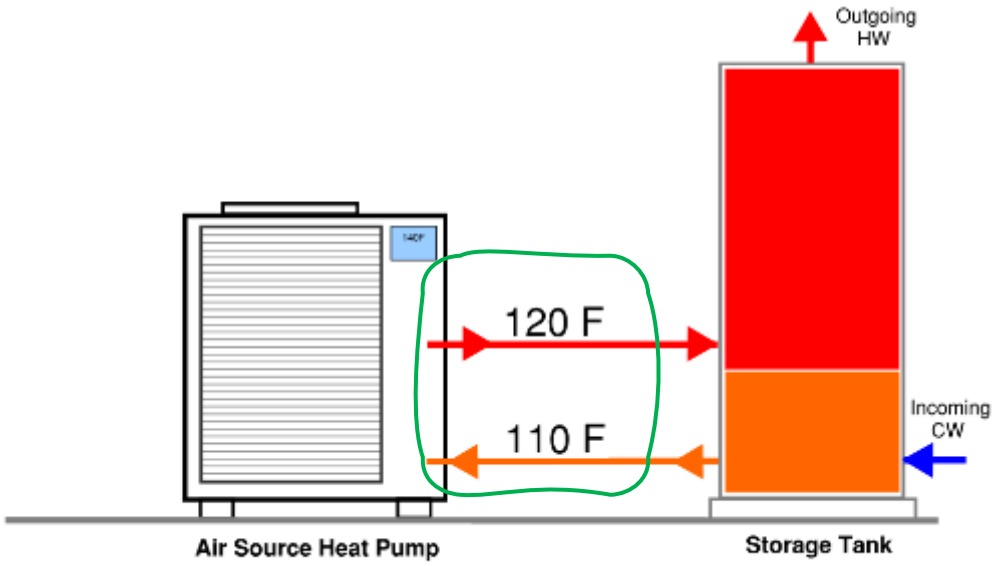


Two types of heating cycles



Single-Pass

Heats water to working temp in single pass

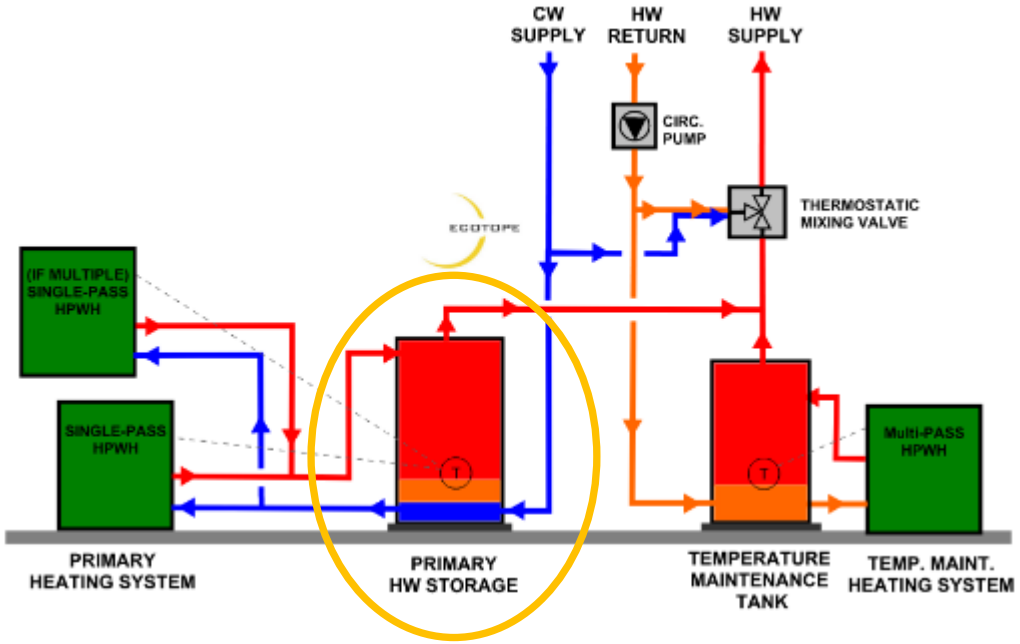


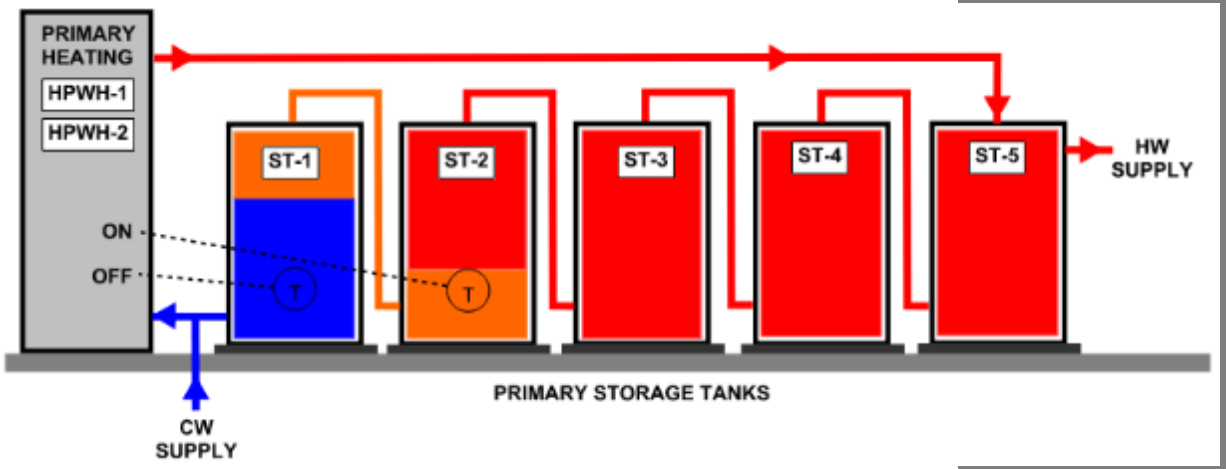
Multi-Pass

Heats water to working temp in multiple passes

2. Primary Storage Tank(s)

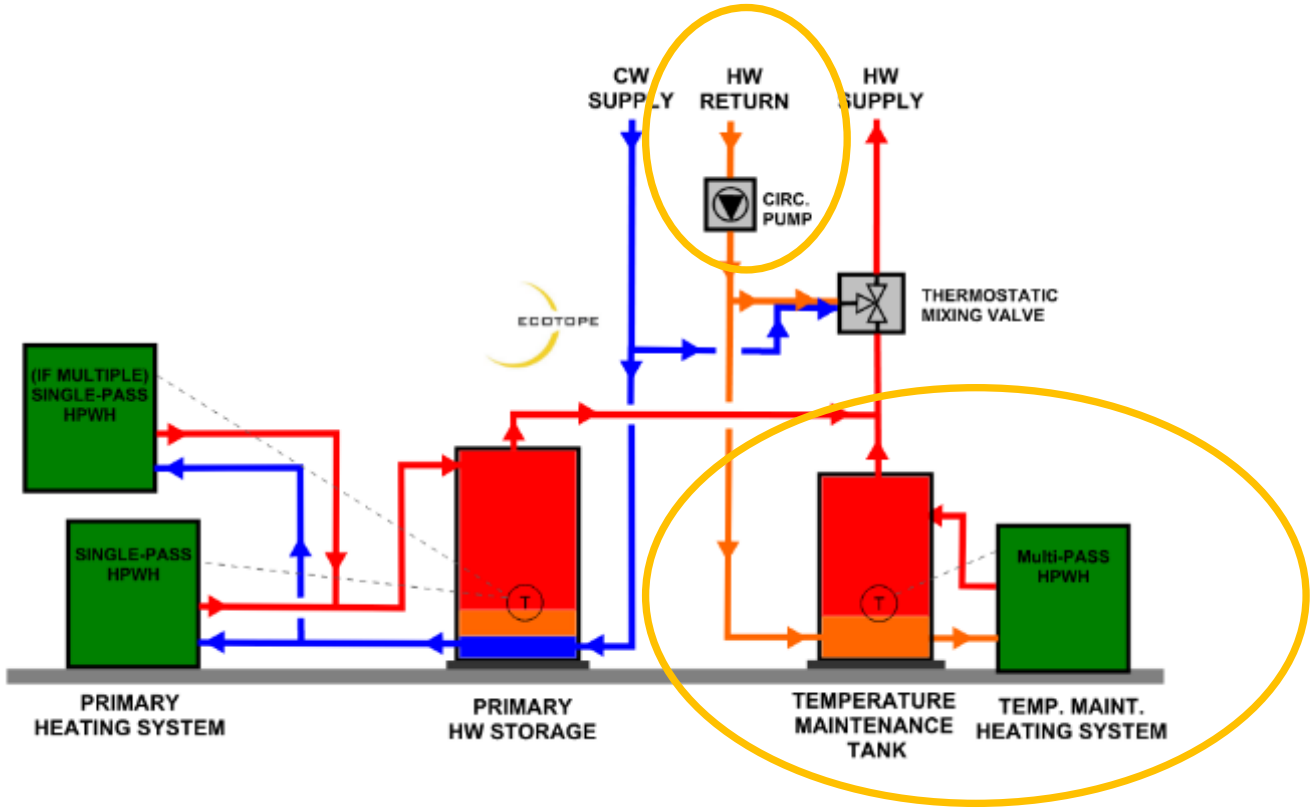
The battery bank

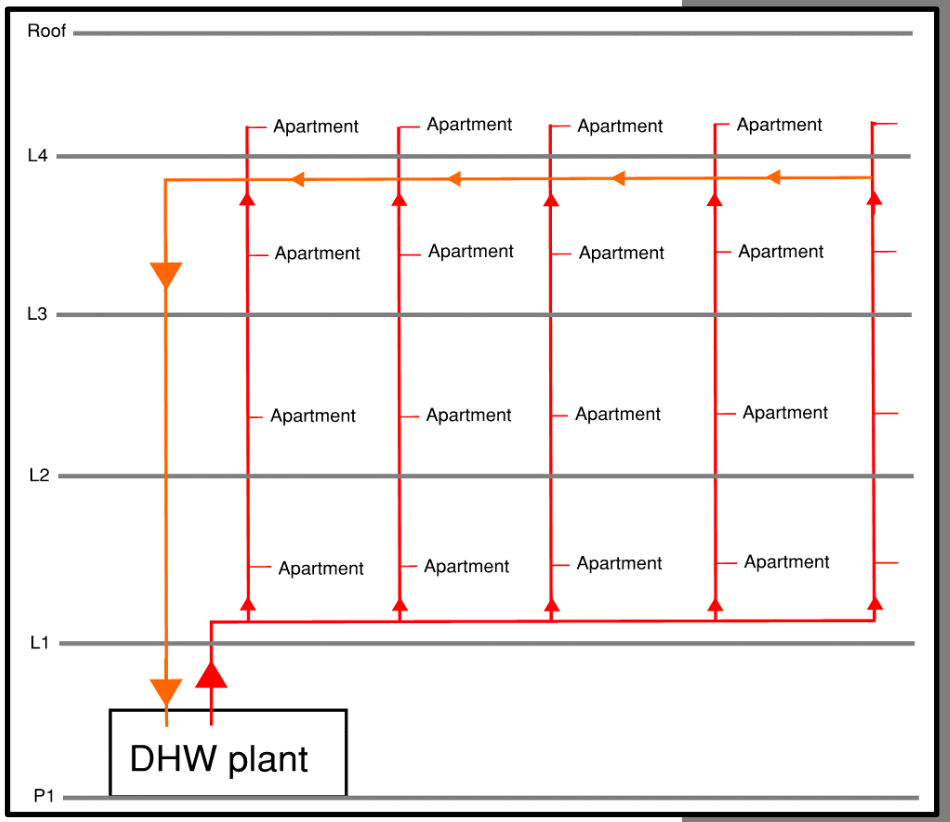




3. Temperature Maintenance System

Keeping the water in the distribution system hot





Single Pass + Swing Tank

Single Pass + Parallel Multi-Pass

Figure 4. Single-Pass Primary HPWH with Series Temperature Maintenance Tank System (Swing Tank)

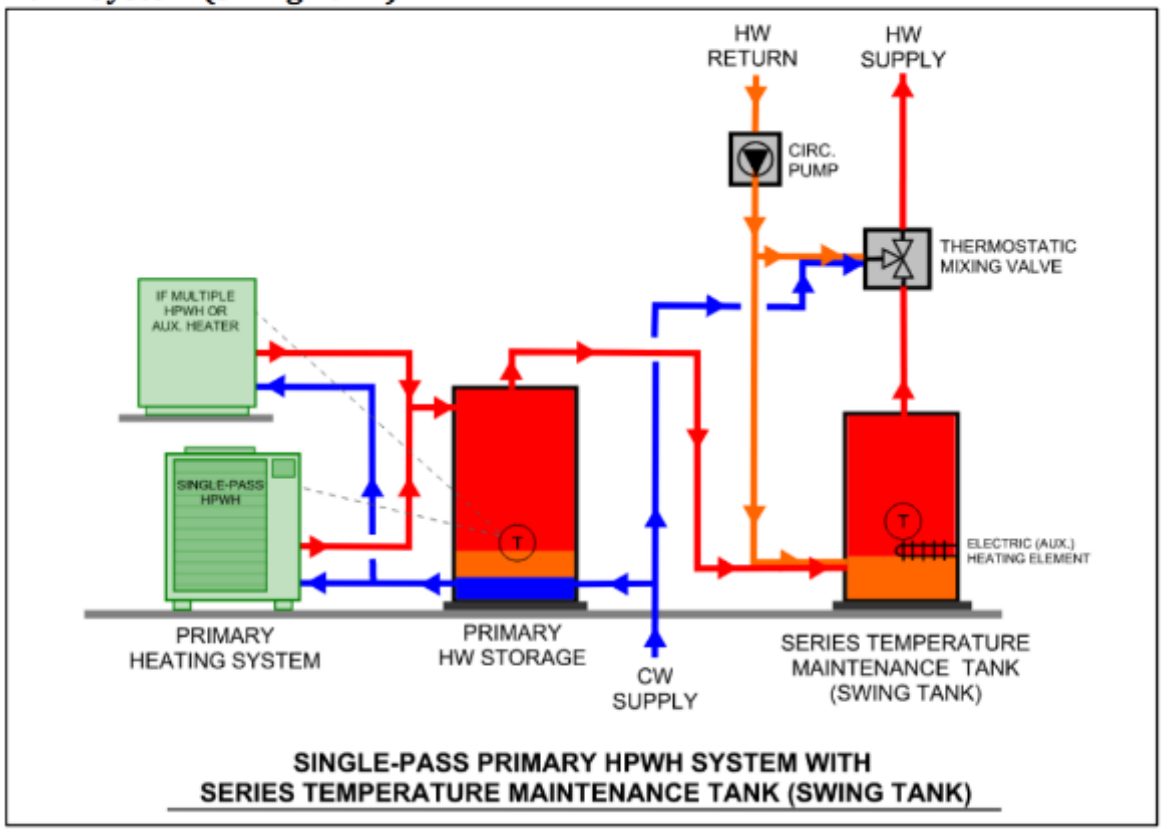
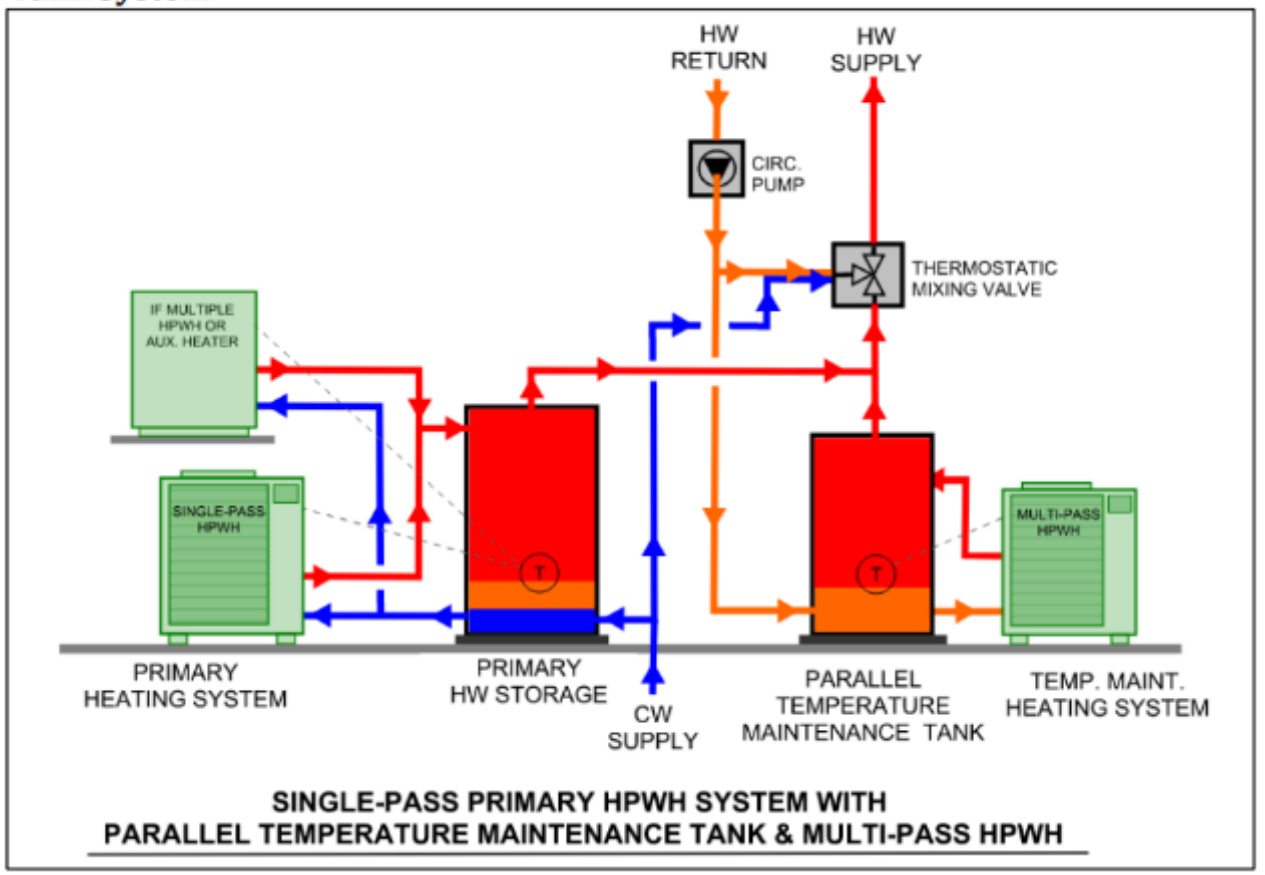
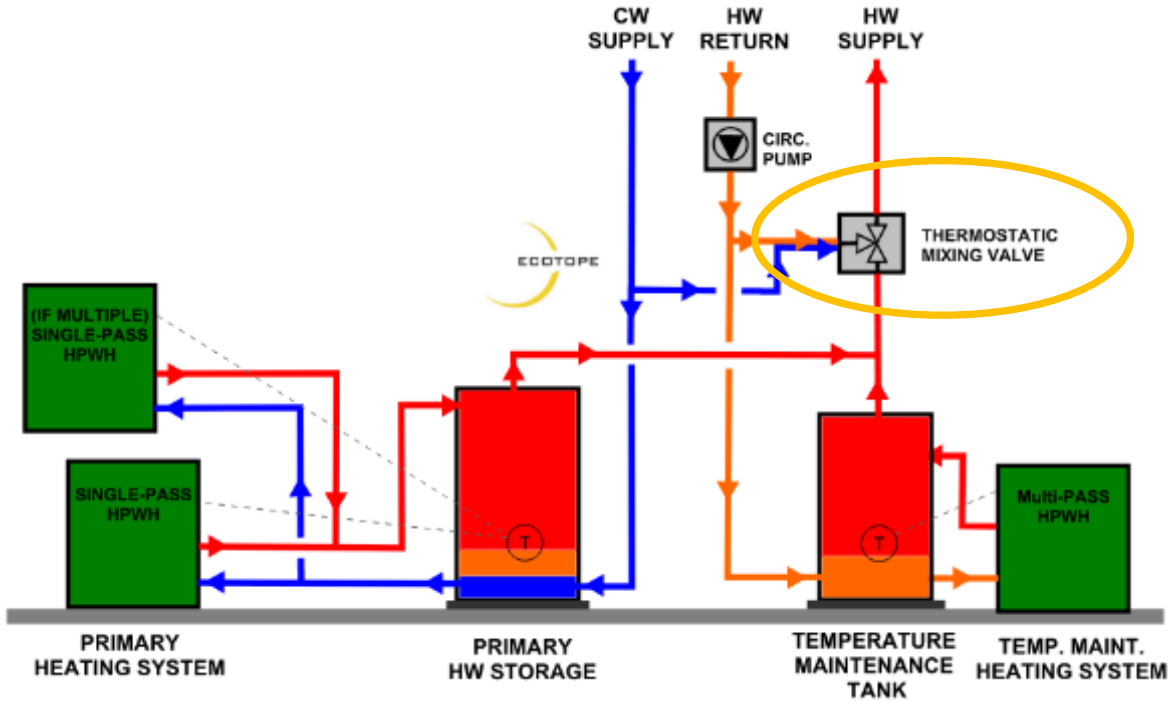


Figure 5. Single-Pass Primary HPWH with Parallel Temperature Maintenance Tank System



4. Thermostatic Mixing Valve

HW delivery temperature control



Circulation controls

C404.7.1.1 Single riser systems. (One hot water riser or zone)

1. Pump turns off when water in loop hits supply temp, turns back on at 10°F below supply temp or
2. Automatic time switch turns off pump during unoccupied hours and
3. Manual switch to turn off the pump during extended periods when hot water is not required.

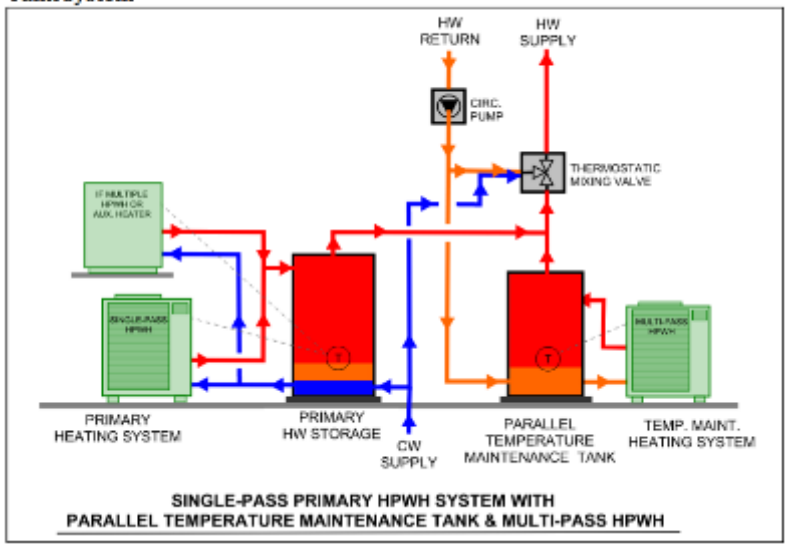
C404.7.1.2 Multiple riser systems. (Multiple hot water risers or zones)

1. Pump turns off during extended periods when hot water is not required.
2. Means for balancing the flow rate through each supply riser or piping zone
3. (Seattle) Self-actuating thermostatic balancing valve for systems with multiple risers and variable flow pump

Key Design Considerations

1. Building Hot water distribution systems and the impact on thermal stratification
2. How to Size a HPWH system: Ecosizer (https://ecosizer.ecotope.com)
3. Refrigerant and Equipment Selection
4. Alarms, Notifications and Maintenance

Figure 5. Single-Pass Primary HPWH with Parallel Temperature Maintenance Tank System



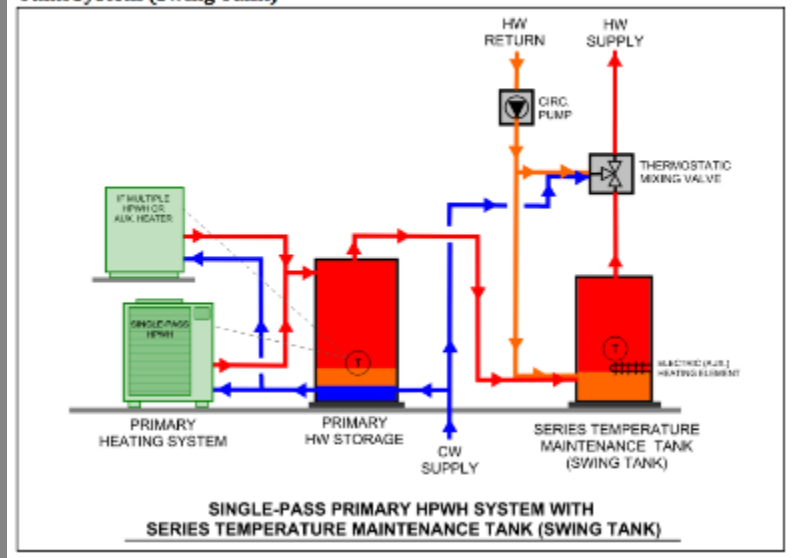
SINGLE-PASS PRIMARY HPWH SYSTEM WITH PARALLEL TEMPERATURE MAINTENANCE TANK & MULTI-PASS HPWH

Pasadena, CA
2022 Completion
77 Unit Senior Housing

Primary Heat Pump (6x) and Secondary Heat Pump for High Temperature Maintenance Load.

DHW Heat Plants go on roofs in Southern Cal.

Figure 4. Single-Pass Primary HPWH with Series Temperature Maintenance Tank System (Swing Tank)



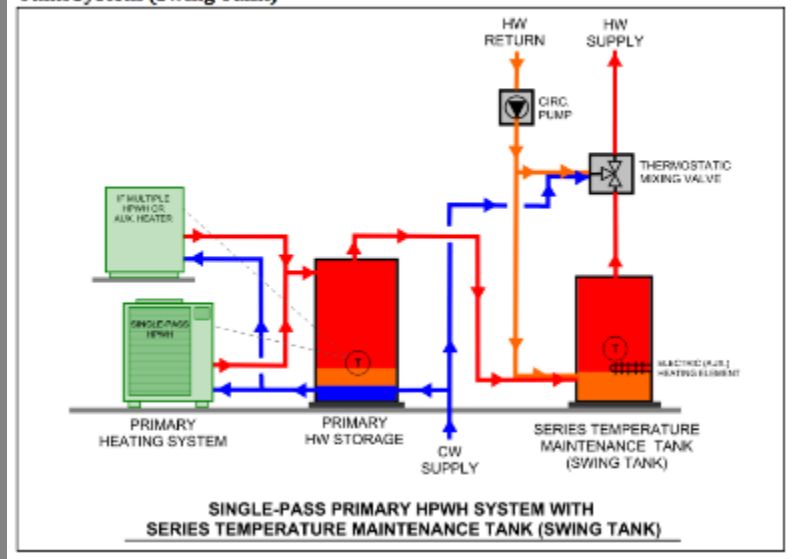
SINGLE-PASS PRIMARY HPWH SYSTEM WITH SERIES TEMPERATURE MAINTENANCE TANK (SWING TANK)

Jackson Apartments
Seattle, WA
2020 Completion
525 Units

Primary Heat Pump and Swing Tank

Load Shift

Figure 4. Single-Pass Primary HPWH with Series Temperature Maintenance Tank System (Swing Tank)



SINGLE-PASS PRIMARY HPWH SYSTEM WITH SERIES TEMPERATURE MAINTENANCE TANK (SWING TANK)

Bayview Apartments
Seattle, WA
2022 Completion
100 Unit Senior Housing

Primary Heat Pump and Swing Tank

Load Shift

NEEA AWHS QPL (any tier acceptable)

Climate Zone Mild

Product Tier See Notes	Product Brand	Model	Qualified Piping Configurations	Modeled System COP	CTA-2045 Compliant Communication Port
Tier 4					
SYSTEM COP: 3.0	SanCO2	GS3-*****-**-**	Single Pass, w/ Swing tank temp. maintenance[c]	3	Y
	WaterDrop	WD1T-**-***-***-**-*-*-*-*-*	Single Pass, w/ Swing tank temp. maintenance[c]	3	Y
Tier 3					
SYSTEM COP: 2.5	Mitsubishi	QAHV-*******-***(-**)	Single Pass, w/ Swing tank temp. maintenance[c]	2.5	Y
Tier 2					
SYSTEM COP: 2.0					
Tier 1					
SYSTEM COP: 1.5	Nyle	C-***-***	Single Pass, w/ Swing tank temp. maintenance[c]	1.9	N

Climate Zone Cold

Product Tier See Notes	Product Brand	Model	Qualified Piping Configurations	Modeled System COP	CTA-2045 Compliant Communication Port
Tier 4					
SYSTEM COP: 2.75	SanCO2	GS3-45HPA-US-SP	Single Pass, w/ Swing tank temp. maintenance[c]	2.9	Y
	WaterDrop	WD1T-**-***-***-**-*-*-*-*-*	Single Pass, w/ Swing tank temp. maintenance[c]	2.9	Y
Tier 3					
SYSTEM COP: 2.25	Mitsubishi	QAHV-N136TAU-HPB(-**)	Single Pass, w/ Swing tank temp. maintenance[c]	2.4	Y
Tier 2					
SYSTEM COP: 1.6	Nyle	C-Series	Single Pass, w/ Swing tank temp. maintenance[c]	1.8	N
Tier 1					
SYSTEM COP: 1.25					

Seattle HPWH inspections
(separate permits required: Mech, Plumbing, Boiler)

SDCI Mechanical

- HPWH, sizing, controls
- Fans & ductwork
- Equip height/location on rooftop or site
- Refrigerant/hydronic piping
- Noise regulations
- Structural support

Seattle-KC Public Health

- Potable water piping & distribution components
- Pipe insulation
- Mixing valve
- Hot water temp @ design outdoor air temp (24°F)
- Water heaters & storage tanks >120 gallons
  - > 200 kBTU/H
- Condensate drain system

SDCI Boiler

- Storage tanks >120 gallons
- Seismic bracing
- Tank insulation

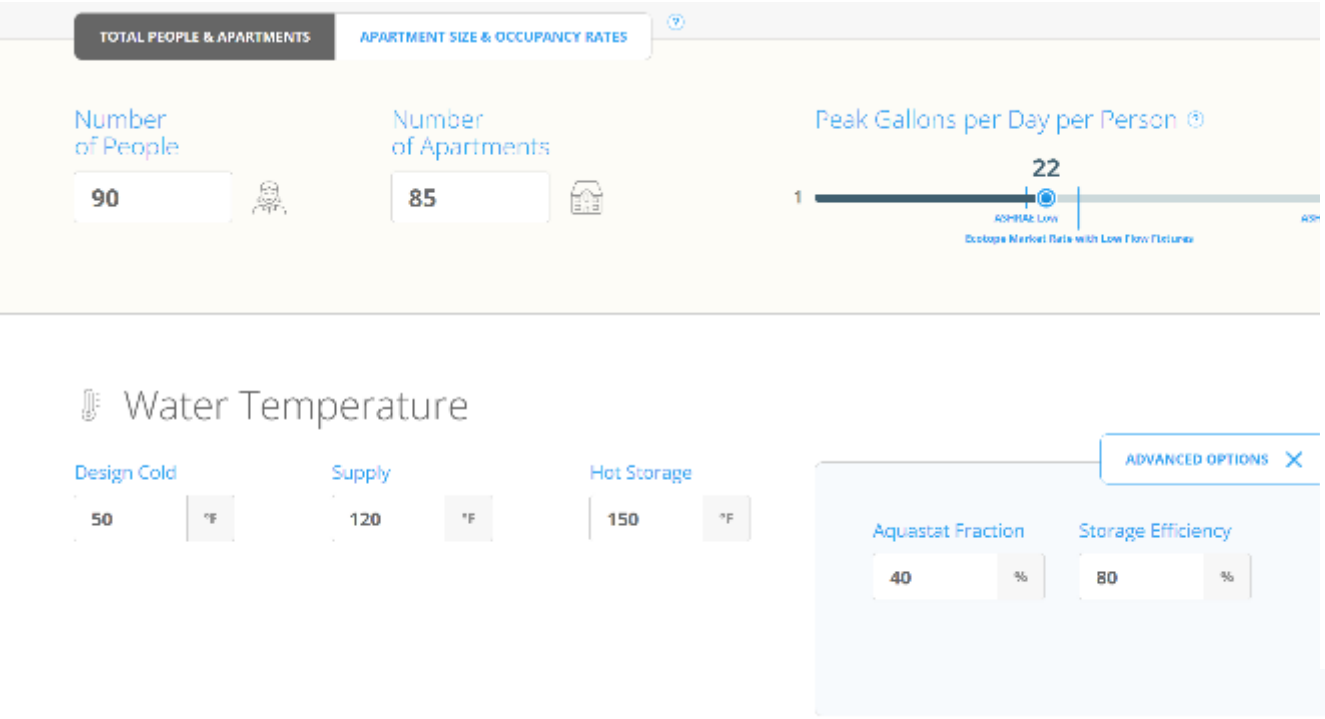
SEA HP sizing: **100**%@40°F…50%@24°F
WA HP sizing: **50**%@40°F…25%@24°F

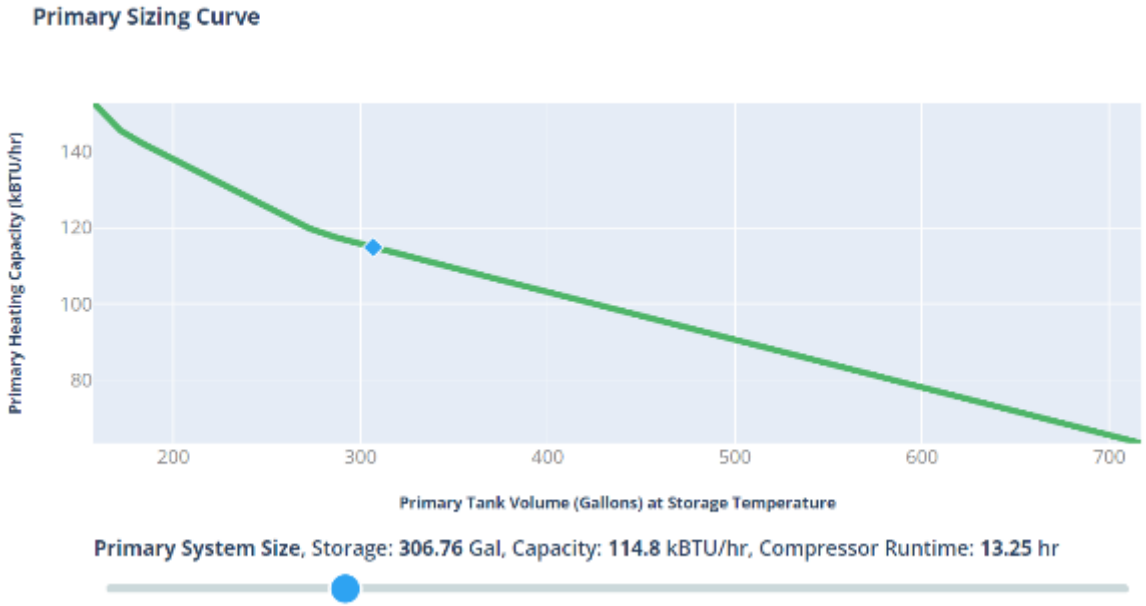
C404.2.3.1 Primary heat pump system sizing. The system shall include a primary service **output of ((~~50~~)) 100 at 40°F** dry bulb or wet bulb outdoor air temperature for air-source heat pumps, or 44°F ground temperature for ground-source heat pumps, that provides **sufficient hot water** for uses as calculated using the equipment manufacturer's selection criteria or another approved methodology. Air source heat pumps shall be sized to deliver no less than **((~~25~~)) 50 percent** of the calculated demand for hot water production during the peak demand period when entering air temperature is **24°F**.

Exception: ((~~25~~)) 50 percent sizing at 24°F is not required for heat pumps located in a below-grade enclosed parking structure or other ventilated and unconditioned space that is not anticipated to fall below 40°F at any time.

Ecosizer™

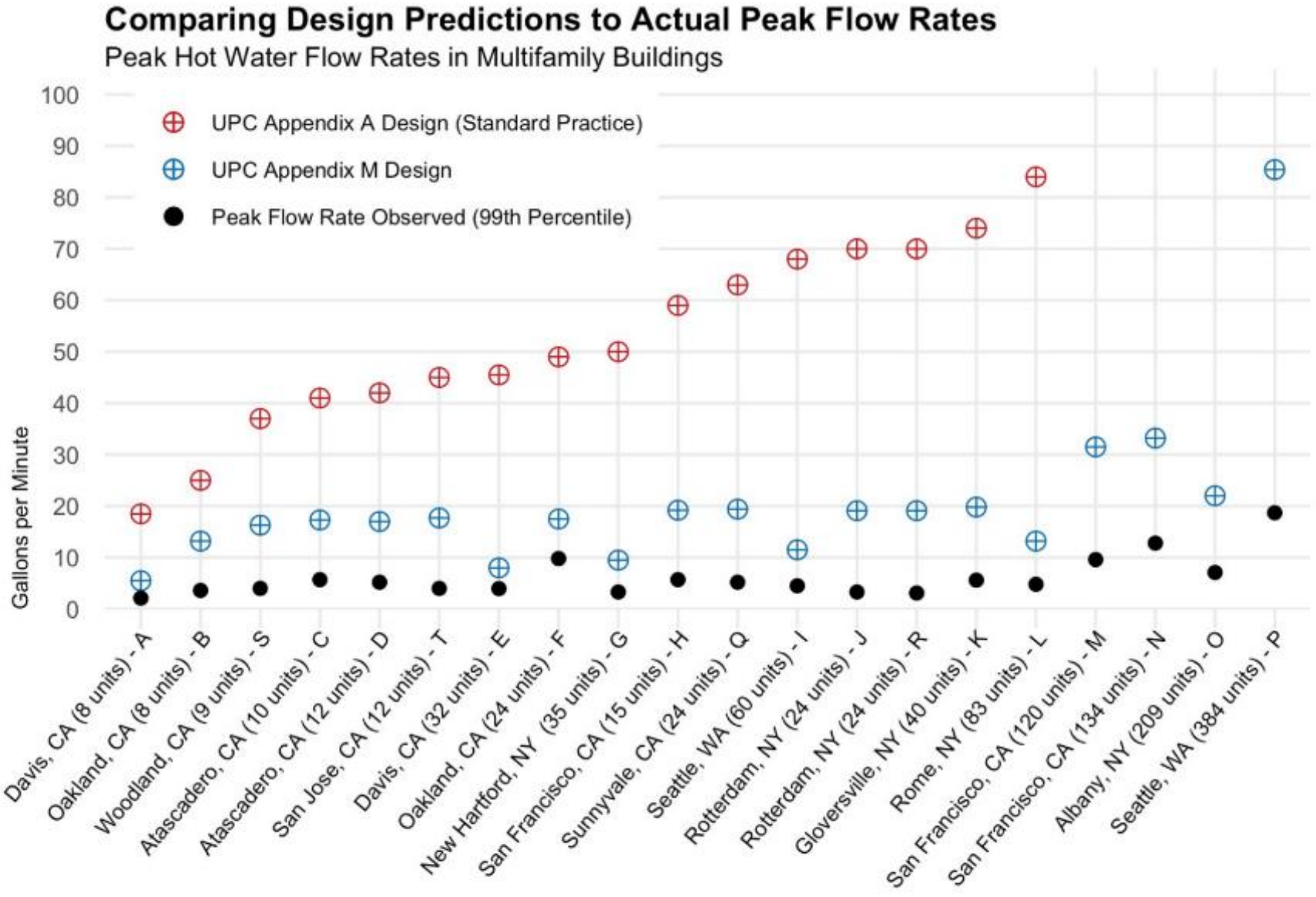
https://ecosizer.ecotope.com/sizer/





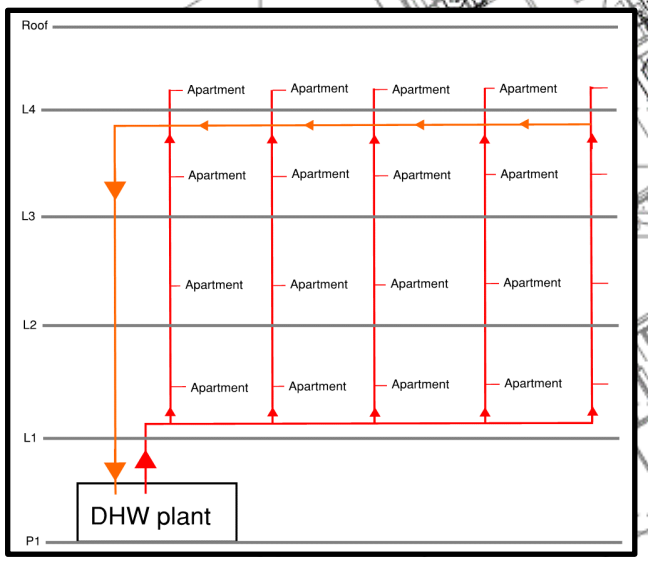
What Else Do You Want From Ecosizer?
Email – Info@ecotope.com
Subject: Ecosizer Request

Hot Water Pipe Sizing



Many thanks to the Association for Energy Affordability, Ecotope, Frontier Energy, Peter Skinner, and the UC Davis Western Cooling Efficiency Center for providing data.

2050 PARTNERS
DECARBONIZATION EXPERTS



1. Building Hot Water Distribution Systems & Temperature Maintenance

Temp. maintenance: single-pass or multi-pass?

C404.2.1.3. System Design. The service water heating system shall be configured to conform to one of the following provisions.

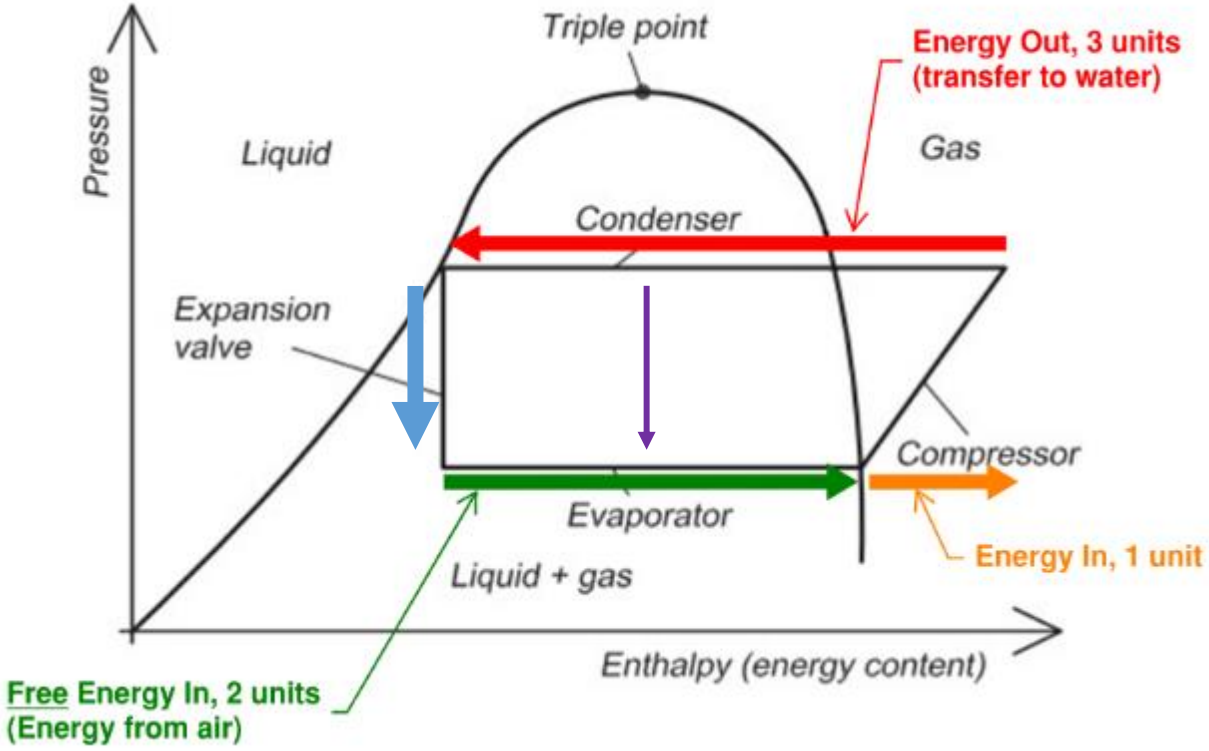
For *single-pass* HPWHs, *temperature maintenance* heating provided for reheating return water from the building's heated water circulation system shall be physically decoupled from the primary service water heating system storage tank(s) in a manner that prevents destratification of the primary system storage tanks. *Temperature maintenance* heating is permitted to be provided by electric resistance or a separate dedicated heat pump system.

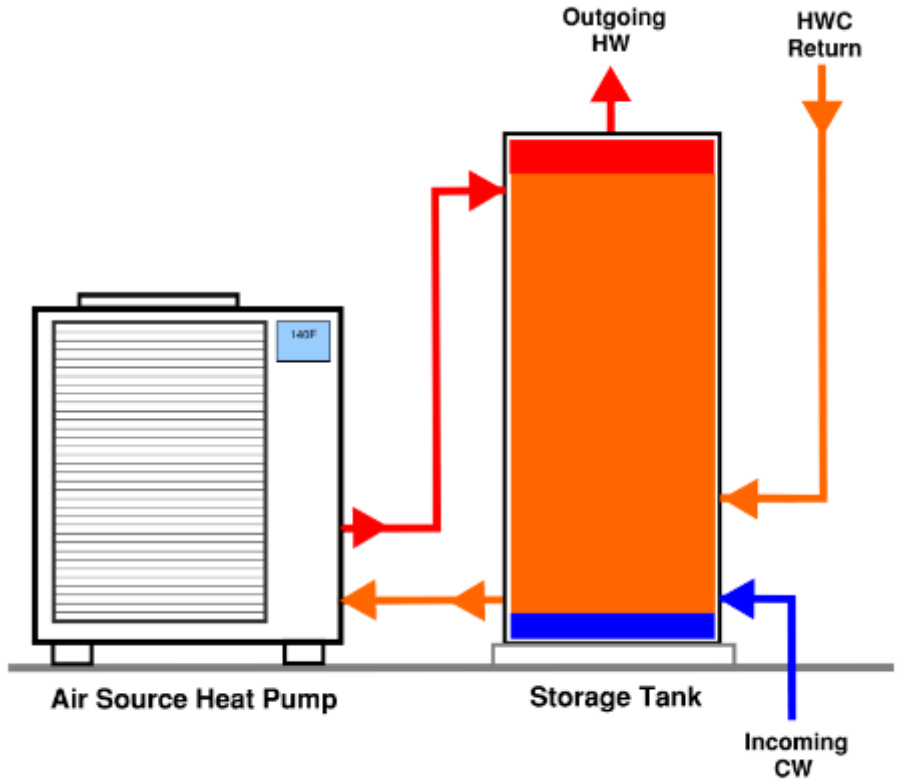
For multi-pass HPWHs, recirculated *temperature maintenance* water is permitted to be returned to the primary water storage tanks for reheating.

Unitary HPWHs, located in conditioned space, are permitted, where they are sized to meet all calculated service water heating demand using the heat pump compressor, and not supplementary heat.

HW Distribution System

Impact on Thermal Stratification



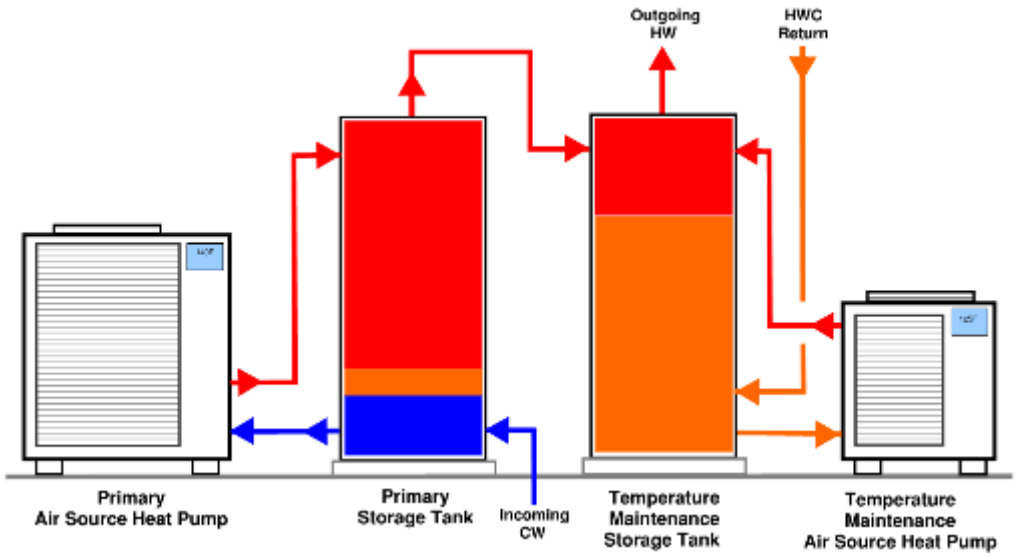


HWC Return to Primary Storage Tanks

- Mixed tank
- No (low) stratification
- Low effective storage volume <60%
- Lower HPWH efficiency

Thermal Stratification and System Performance

Single-pass HPWH = Dedicated Systems

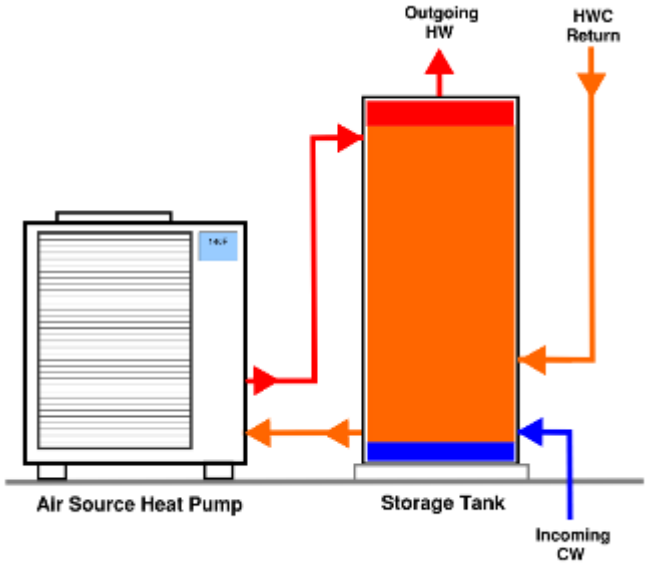


Primary and Temperature maintenance heaters tuned to load HPWHs that are tuned to the load

Advantages:

- Better equipment reliability
- high effective storage volume >80%
- Higher HPWH COP
- Higher system COP
- Redundancy

Multi-pass HPWH = “All eggs in one basket”

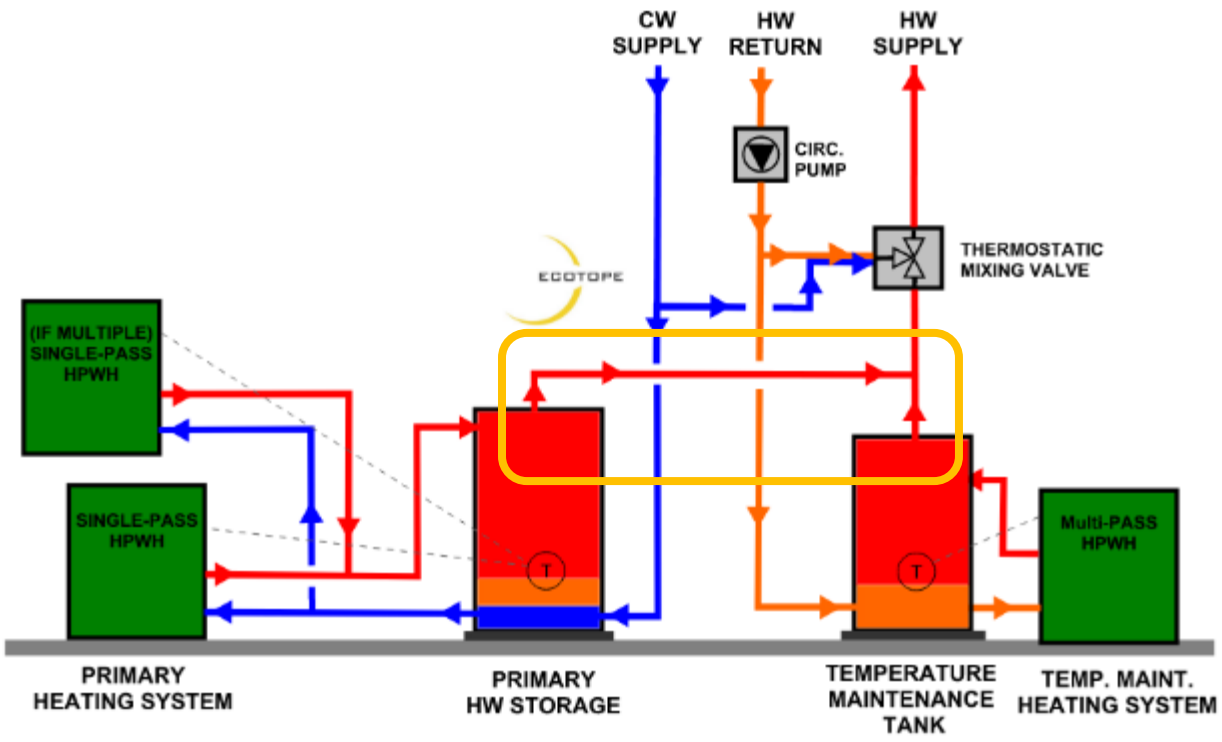


Primary and temperature maintenance loads heated by a HPWH(s)

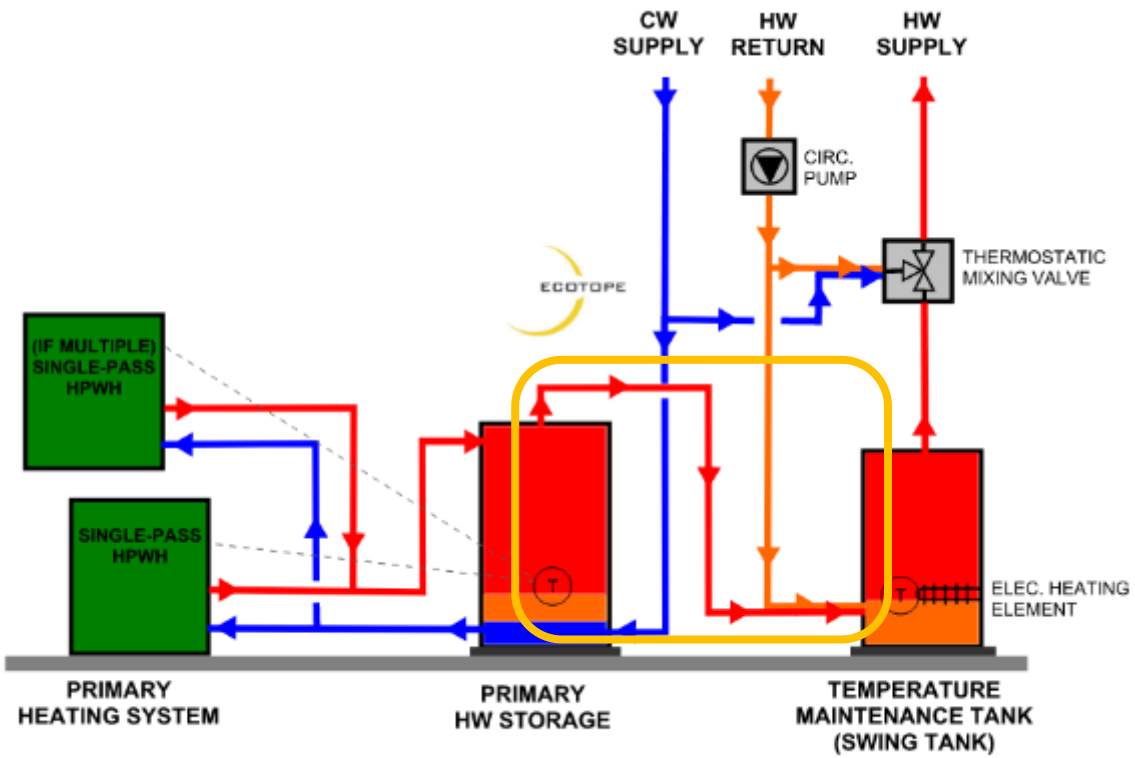
Challenges:

- Cycling issues
- Sizing issues (HW load and HWC load scale difference)
- Cycling issues
- Low effective storage volume <60%
- Low HPWH COP
- A functioning system is technology and control dependent

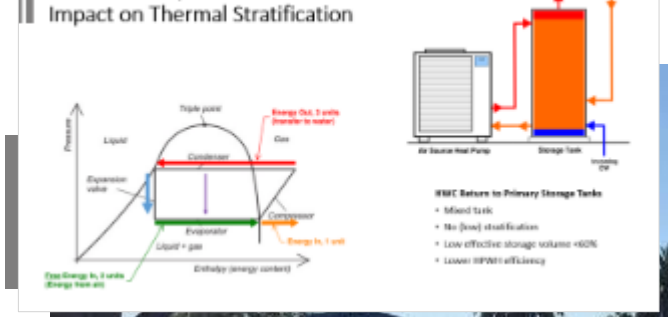
Two Options for Temperature Maintenance



SINGLE-PASS PRIMARY HPWH SYSTEM WITH PARALLEL LOOP TANK



SINGLE-PASS PRIMARY HPWH SYSTEM WITH SWING TANK



55 Tons
1,000 Gallons

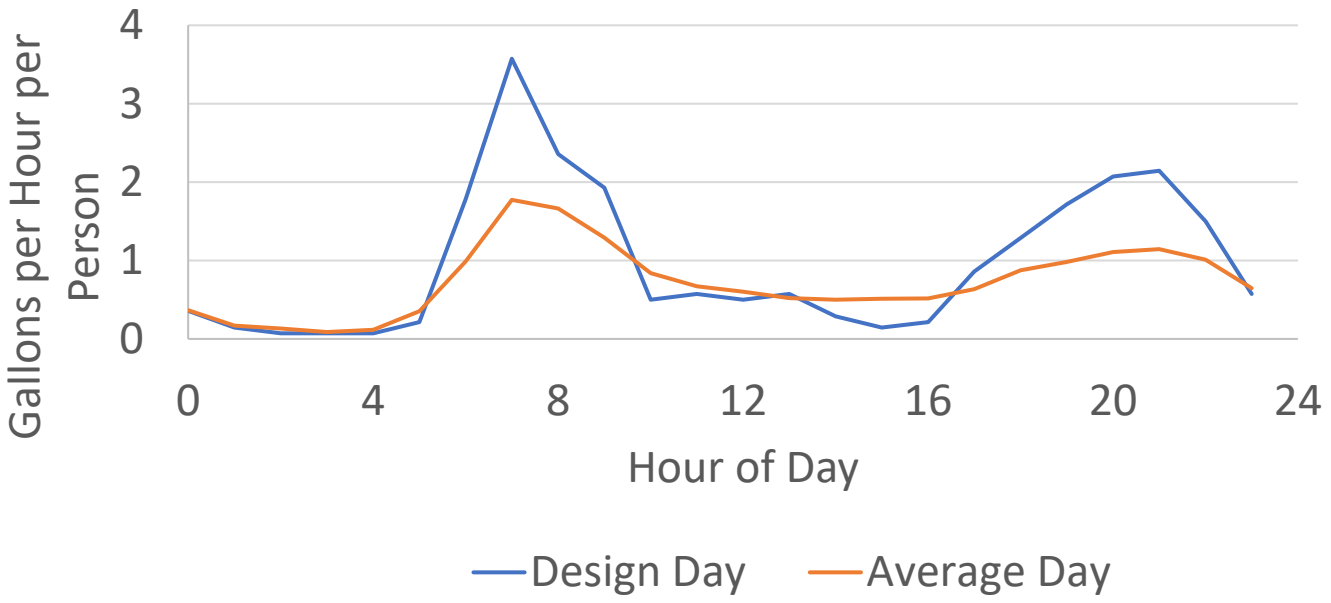
5 Tons
520 Gallons

2. Central HPWH System Sizing

Supplemental electric resistance heat allowed:

- Temp maintenance for circulation system
- Defrost
- Heat trace
- Backup for low-ambient temps, where:
  - No greater than heat pump output at 40°F, and
  - Entering air temp is below 40°F, and
  - Compressor heat can't satisfy demand

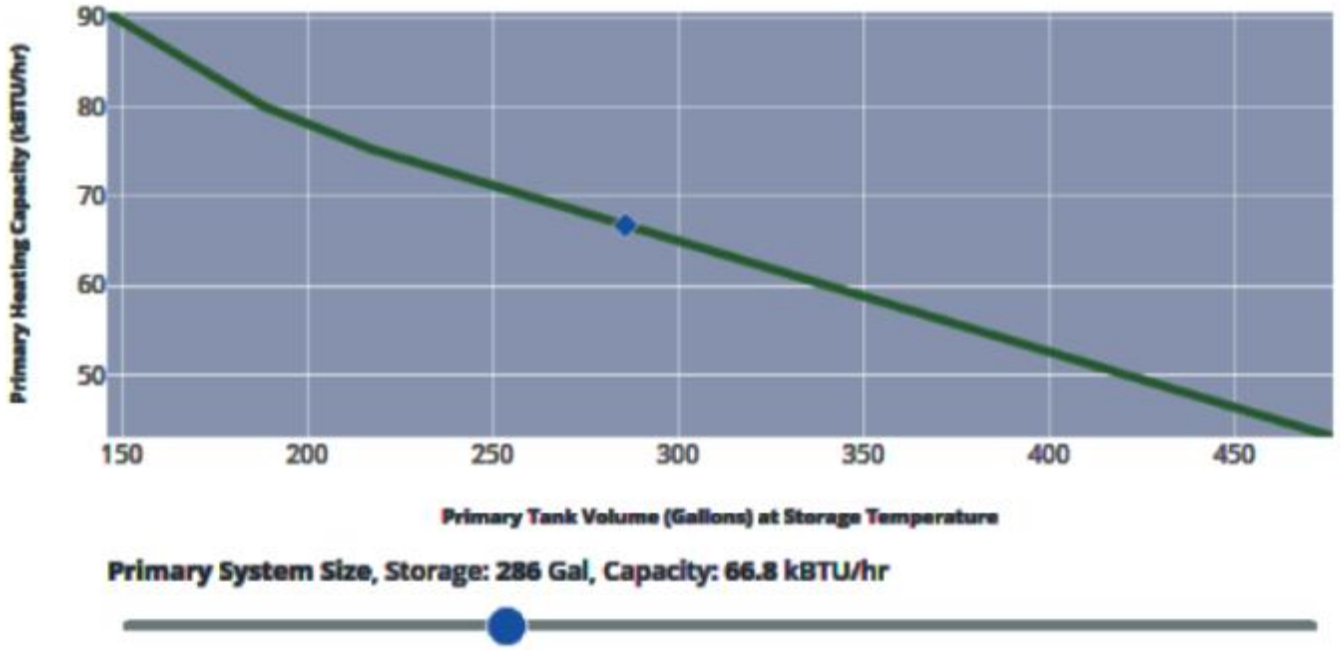
Domestic Hot Water Load



- **Hot water load defined by:**
  - the number of occupants
  - how much hot water they use
- At the Design Conditions (cool air and water temperatures)

Ecosizer

ecosizer.Ecotope.com



THIS SYSTEM WAS SIZED FOR

Occupancy
60.0 People

Apartments
30.0 Units

Daily Hot Water Usage
25.0 Gallons per Day per Person

Total Hot Water
1500 Gallons per Day

Tank Volume
285 Gallons

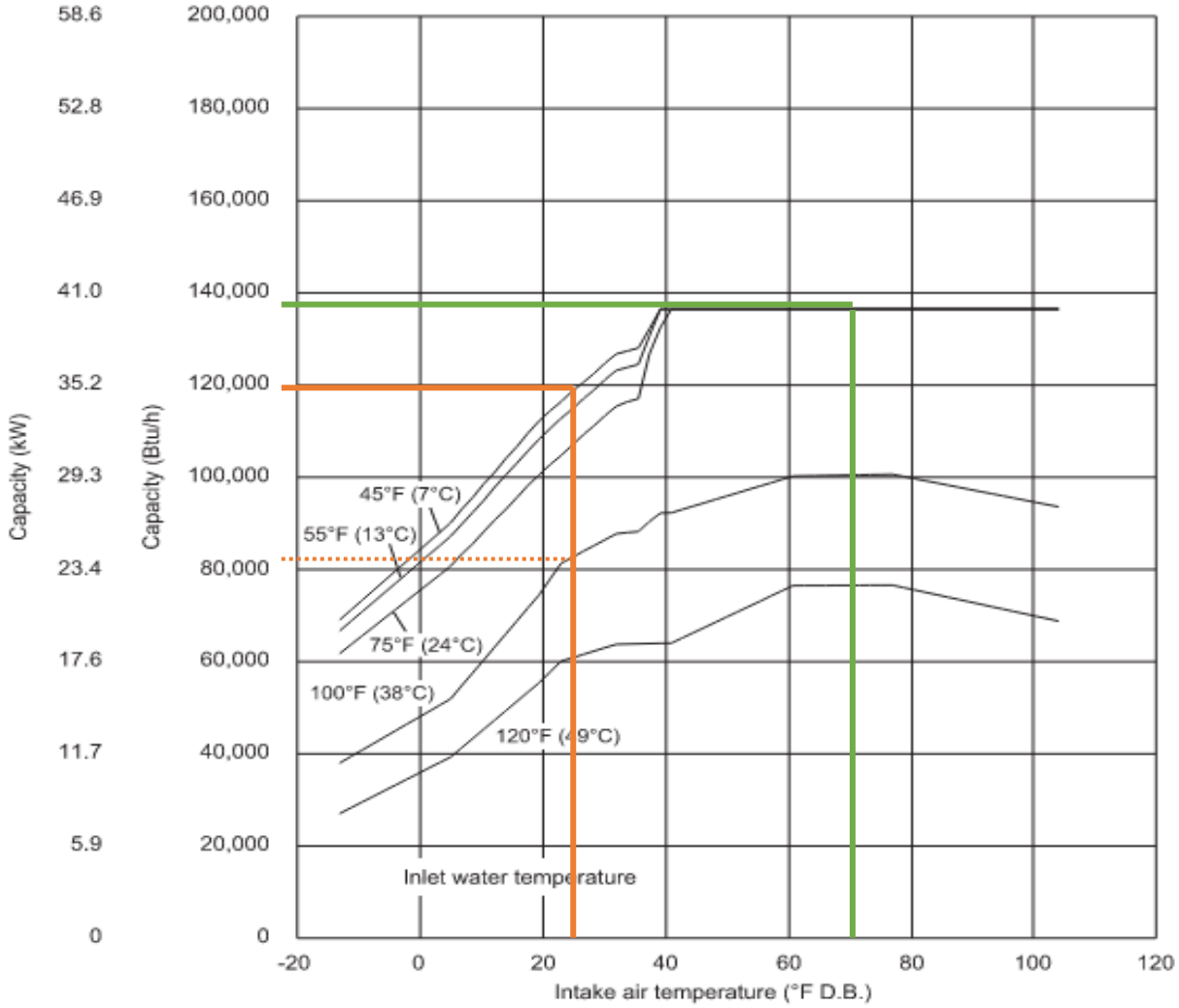
Heating Capacity
66.8 kBTU/hr

Swing Tank Volume
80 Gallons

Swing Resistance Element
4.7 kW · **15.9** kBTU/hr

Central HPHW System Sizing

Don’t forget about defrost!



Manufacturer's nominal heat capacity

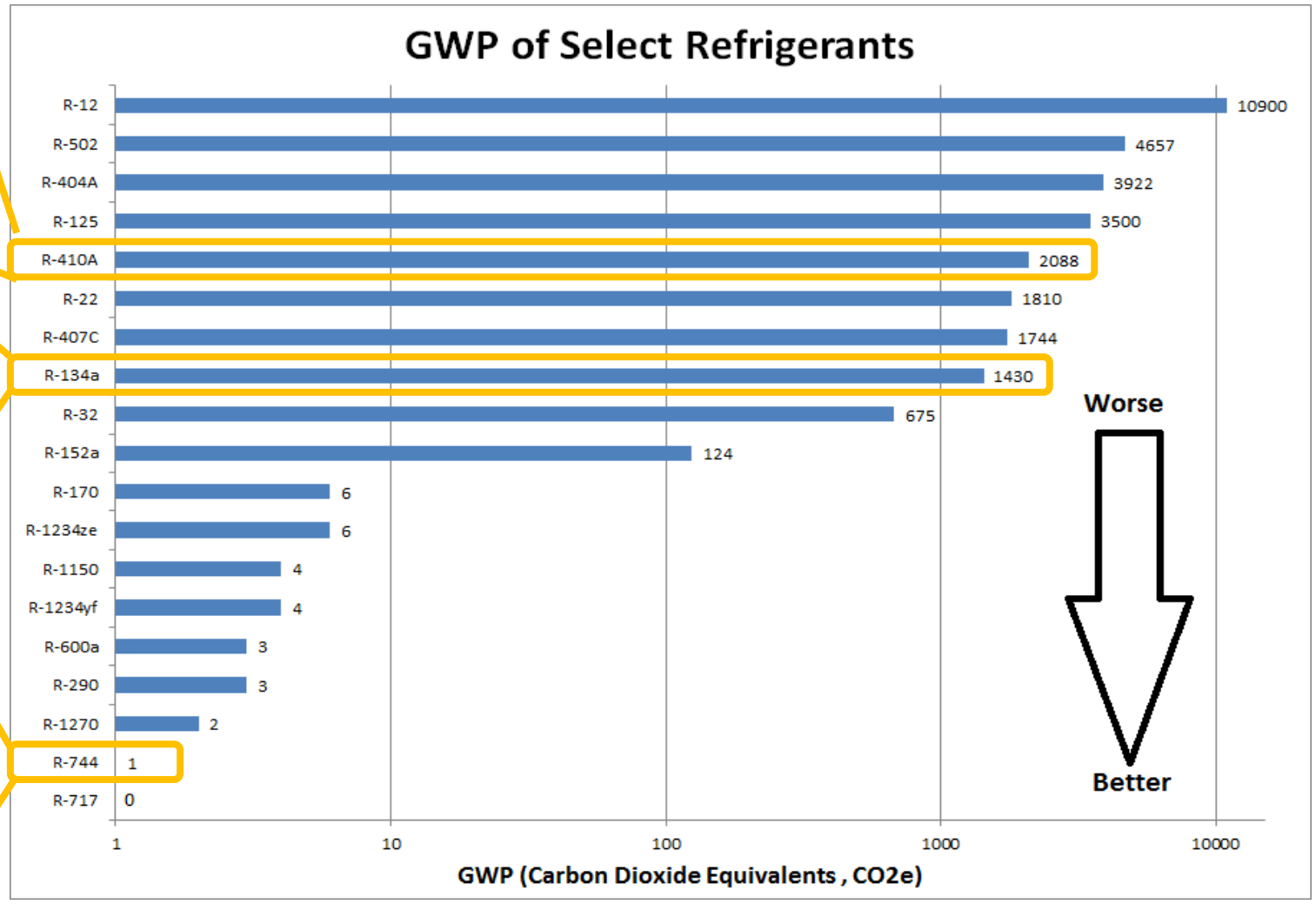
vs.

Heat capacity at design air conditions

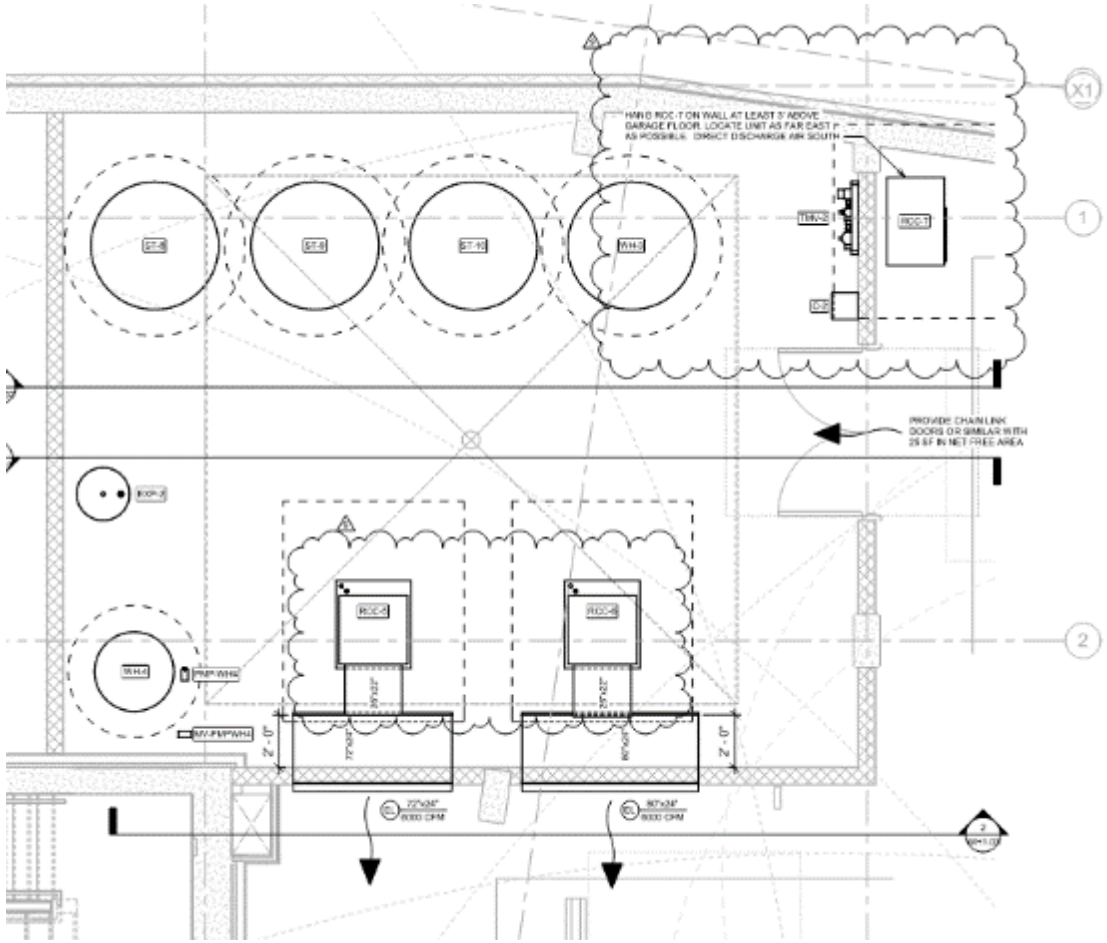
3. Refrigerant & Equipment Selection

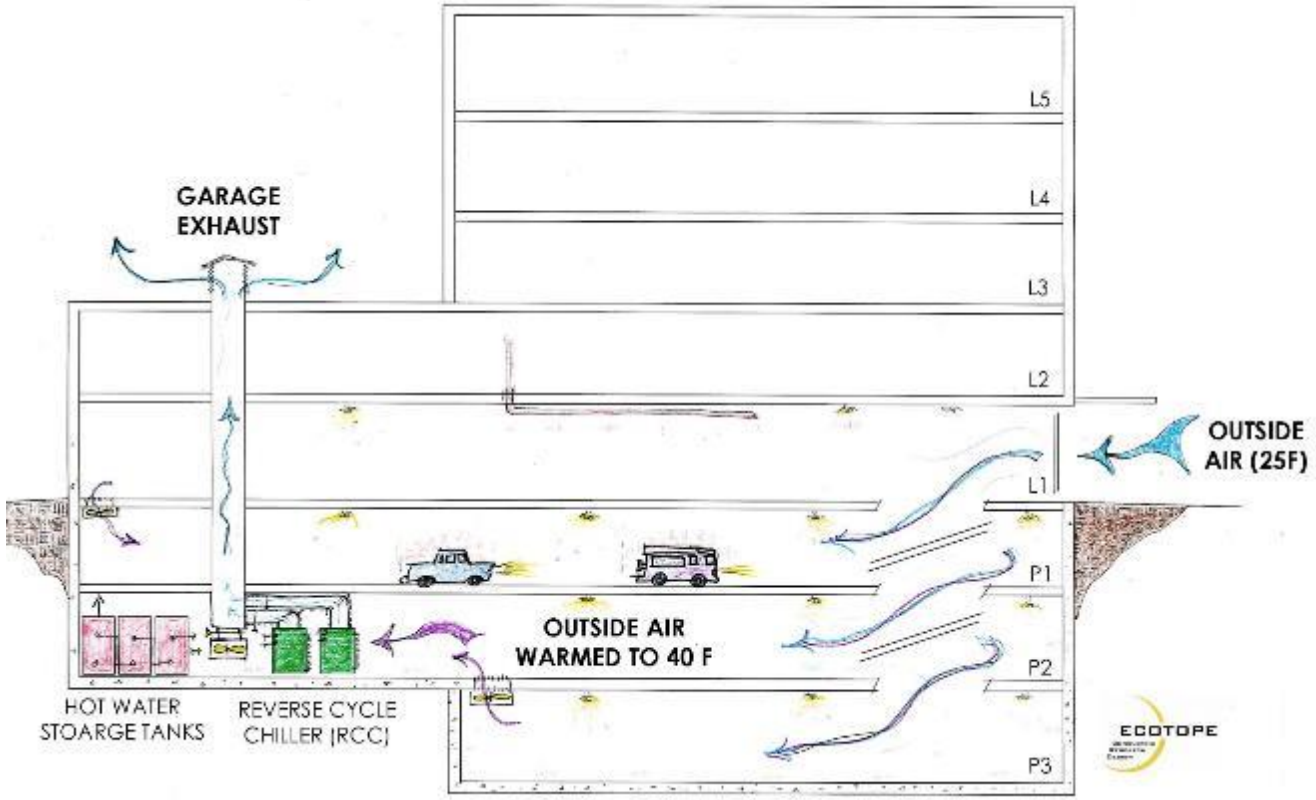
Refrigerant Types

	Refrigerant		
	R-134a	R-410a	R-744 (CO2)
COP (average Seattle annual)	2.7	2.5	3.2
Low ambient air temperature	35 F	-5 F	-25 F
Maximum discharge water temperature	160 F	120 F	190 F



Air buffer zones





Efficient HW distribution Systems

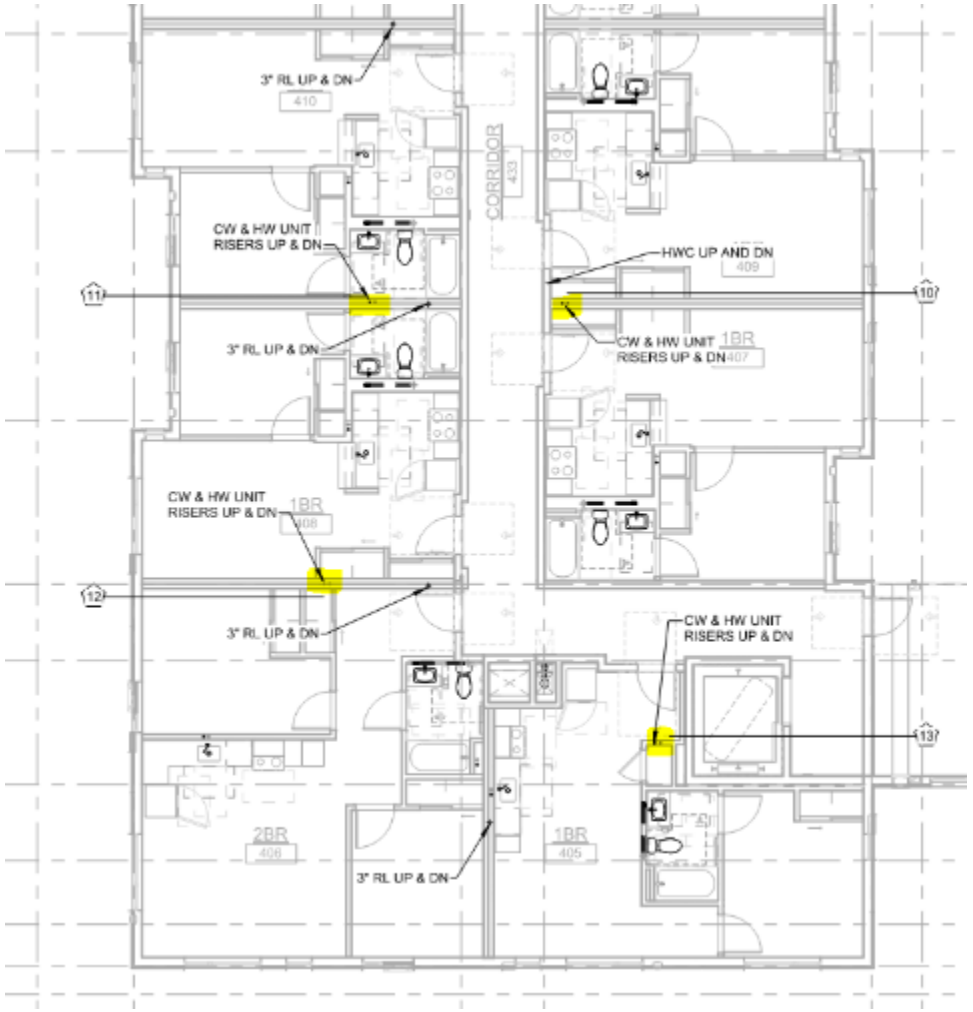
Appendix M sizing

114-unit Seattle area MF building: (assumes booster pump, due to low entering water pressure

96 1bed/1bath

18 2bed/2bathbathroom

Sizing Method	Flowrate (GPM)	CW main	Notes
Appendix A	260	4"	Top end of 4” range – at about 280 gpm we are pushed up to a 6” connection
Appendix A + C	205	3.5"	Likely requieres a 4” connection from city
Appendix M	**54**	**2"**	**2018 UPC**



Water heating equipment efficiency Table C404.2

- The performance equations look somewhat bizarre, but you can really **ignore** this whole table, because it's just parroting the minimum federal standards
- **80% *Et* (Q/800 +110√*V*SL), Btu/h**

TABLE C404.3.1
PIPING VOLUME AND MAXIMUM PIPING LENGTHS

Nominal Pipe Size (inches)	Volume (liquid ounces per foot length)	Maximum Piping Length (feet)	
		Public lavatory faucets	Other fixtures and appliances
1/4	0.33	6	50
5/16	0.5	4	50
3/8	0.75	((~~3~~)) 8	50
1/2	1.5	((~~2~~)) 8	43
5/8	2	((~~1~~)) 8	32
3/4	3	0.5	21
7/8	4	0.5	16
1	5	0.5	13
1 1/4	8	0.5	8
1 1/2	11	0.5	6
2 or larger	18	0.5	4

WA plumbing fixture standards – 2019

- **Shower heads 1.8 GPM**
  - 1.5 & 1.25 GPM heads also on market
- **Kitchen and lavatory faucets 1.8 GPM**
- **Toilets 1.28 GPF**
- **Urinals 0.125 GPF**
  - (1 pint per flush)

SEA: Appendix M Mandatory
(and besides, why *wouldn't* you use it?)

C404.3.3 Demand load for Group R-2 occupancies. Demand load for water supply of Group R-2 occupancies shall be determined using **Appendix M** of the Seattle Plumbing Code. Piping shall be no more than **one pipe size larger** than the minimum size permitted when sized for maximum allowable velocity based upon the specified piping material in conjunction with the Appendix M demand load flow rate at any specific node within the water distribution system.

Exception. Existing buildings are not required to comply with this section if the existing plumbing fixtures have higher flow rates than those listed in Table M102.1 of the Seattle Plumbing Code.

Pipe Insulation
direct vs. circulating

Direct Piping (assume <140°F)

Less than 1-1/2” = 1” insulation

1-1/2” & up = 1-1/2” insulation

R-3 insul in stud space

Table C403.10.3

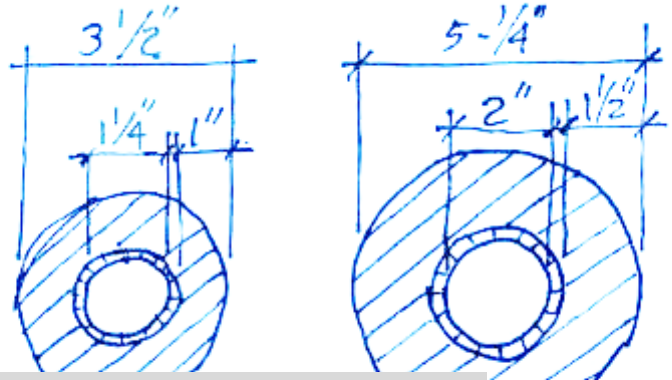
Circulation Loop 1” thicker

Less than 1-1/2” = 2” insulation

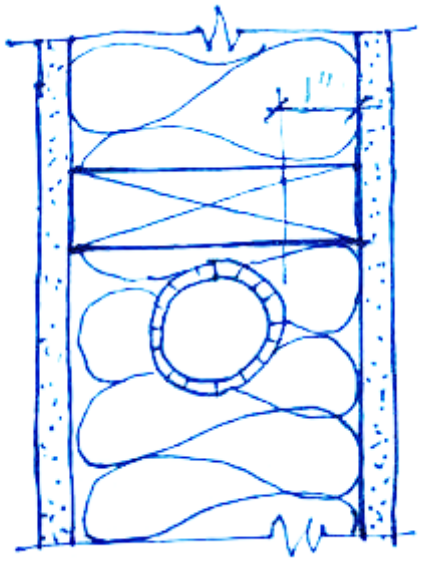
1-1/2” & up = 2-1/2” insulation

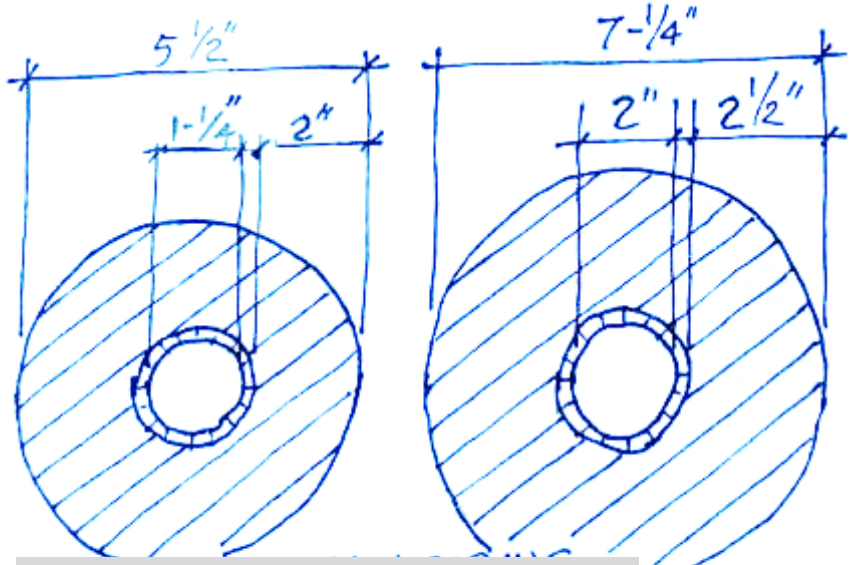
Min 2” insulation in stud space

SEC C404.7.3.1

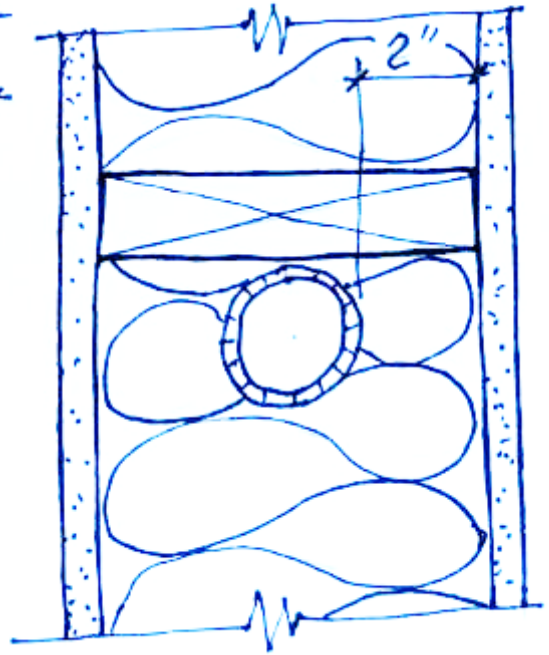


Direct HW piping





Circulating HW piping



Pipe insulation – One-way vs. circulating pipe

C404.6 Pipe insulation. Per Table C403.10.3 (100°F - 140°F):

- Up to 1-1/2” = 1” insulation
- Over 1-1/2” = 1-1/2” insulation
- Continuous through hangars

Exceptions:

- Valves, pumps, strainers and threaded unions in piping <1 inch
- Surrounded by R-3 building insul
- Final run from circ pipe to fixture

C404.7.3.1 Pipe insulation. For heated water circulation systems, both supply and return pipe insulation shall be at minimum 1.0 inch thicker than that required by Table C403.10.3.

Exception. Where piping is centered within a wall, ceiling, or floor framing cavity with a depth at least 4” greater than the diameter of the pipe and that is completely filled with batt or blown-in insulation, additional pipe insulation is not required.

Table C404.6

Required Pipe Insulation Thickness for Service Water Heating

		Nominal Pipe or Tube Size					Insulation Conductivity	
Location	Water Temp	**< 1”**	**1 to < 1-1/2**	**1-1/2 to < 4**	**4 to < 8**	**8 or larger**	Conductivity Btu • in. / (h • ft^2 • °F)[b]	Mean Rating Temp, °F
Circulation Loop Piping not in-partition	105 – 140°F	2.0	2.0	2.5	2.5	2.5	0.21 - 0.28	100
	141 – 200°F	2.5	2.5	3.0	3.0	3.0	0.25 - 0.29	125
All other piping not in-partition	105 – 140°F	1.0	1.0	1.5	1.5	1.5	0.21 - 0.28	100
	141 – 200°F	1.5	1.5	2.0	2.0	2.0	0.25 - 0.29	125
In-partition[a] Circulation Loop Piping < 1-1/2 inch	105 – 140°F	1.0	1.0	N/A	N/A	N/A	0.21 - 0.28	100
	141 – 200°F	1.5	1.5	N/A	N/A	N/A	0.25 - 0.29	125
In-partition[a] All other piping < 1-1/2 inch	105 – 140°F	1.0	1.0	N/A	N/A	N/A	0.21 - 0.28	100
	141 – 200°F	1.0	1.0	N/A	N/A	N/A	0.25 - 0.29	125

Refrigerant piping insulation - Seattle

C403.10.4 Insulation of HVAC system refrigerant piping. Field installed HVAC refrigerant piping, other than piping factory installed in HVAC equipment, shall have insulation as listed below, at a conductivity rating of 0.21 to 0.26 Btu × in/(h × ft2 × °F) with a mean temperature rating of 75°F. Piping insulation exposed to weather shall be protected from damage, including that due to sunlight, moisture, physical damage and wind, and shall provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be permitted. Manufacturer's required minimum pipe insulation shall be maintained.

1. For lines that convey hot gas for space heating:

1.1. Minimum 1-inch insulation on the portions outside the building thermal envelope.

1.2. Minimum 1/2-inch insulation on the portions within the building thermal envelope.

2. Minimum 1/2-inch insulation on the liquid line for mini-split systems and other systems for which insulation is required by the manufacturer, or where the metering device is located in the outdoor unit.

3. No insulation is required on the liquid line for other heat pump types or for cooling-only units where insulation is not required by the manufacturer.

Tank insulation (Seattle & WA)

C404.6.1 Storage tank insulation. Unfired storage tanks used to store service hot water at temperatures above 130°F shall be wrapped with an insulating product, installed in accordance with the insulation manufacturer's instructions and providing a **minimum of R-2 additional insulation for every 10°F increase in stored water temperature above 130°F**. Such additional insulation is also permitted to be integral to the tank. The insulation is permitted to be discontinuous at structural supports.

Circulation controls

C404.7.1.1 Single riser systems.
(One hot water riser or zone)

Thermostatic pump control:

- OFF at supply temp
- ON 10°F below supply temp

OR

Pump control:

- Manual switch for long weekends, etc.

C404.7.1.2 Multiple riser systems.
(Multiple hot water risers or zones)

Automatic pump control:

- OFF if more than 4 hours when hot water is not required.
  - Except Groups R & I occ
- OK to turn ON 4 hours before scheduled occupancy

Thermostatic balancing valve at end of each riser or piping zone.

Variable speed circulation pump that maintains constant pressure.

Temperature Maintenance Losses = Watts/Unit

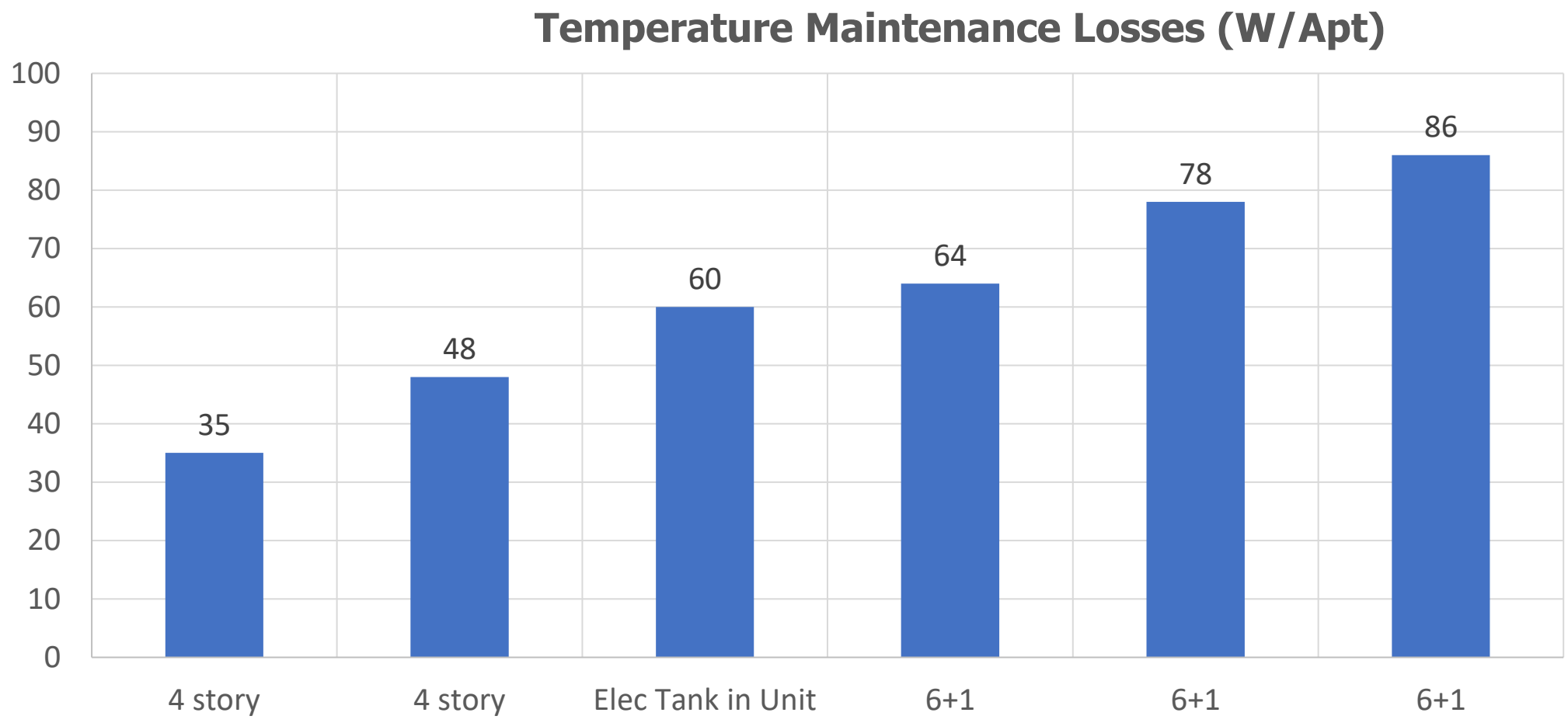
Q = UA*dT

Figure 16. Temperature Maintenance Load

Seasonal Effects - UA

Sampling of Apartments- UA

Temperature Maintenance Losses Sampling of Seattle Apartments



Mixing valve (Seattle & WA)

C404.7.1.3 Electronic thermostatic mixing valve (TMV). Where a heated water circulation system utilizes an electronic TMV to control the temperature of hot water supplied to the building, the TMV shall be configured so that it either **reverts closed (fully COLD)** or **maintains its current valve position** upon power failure or cessation of circulation flow.

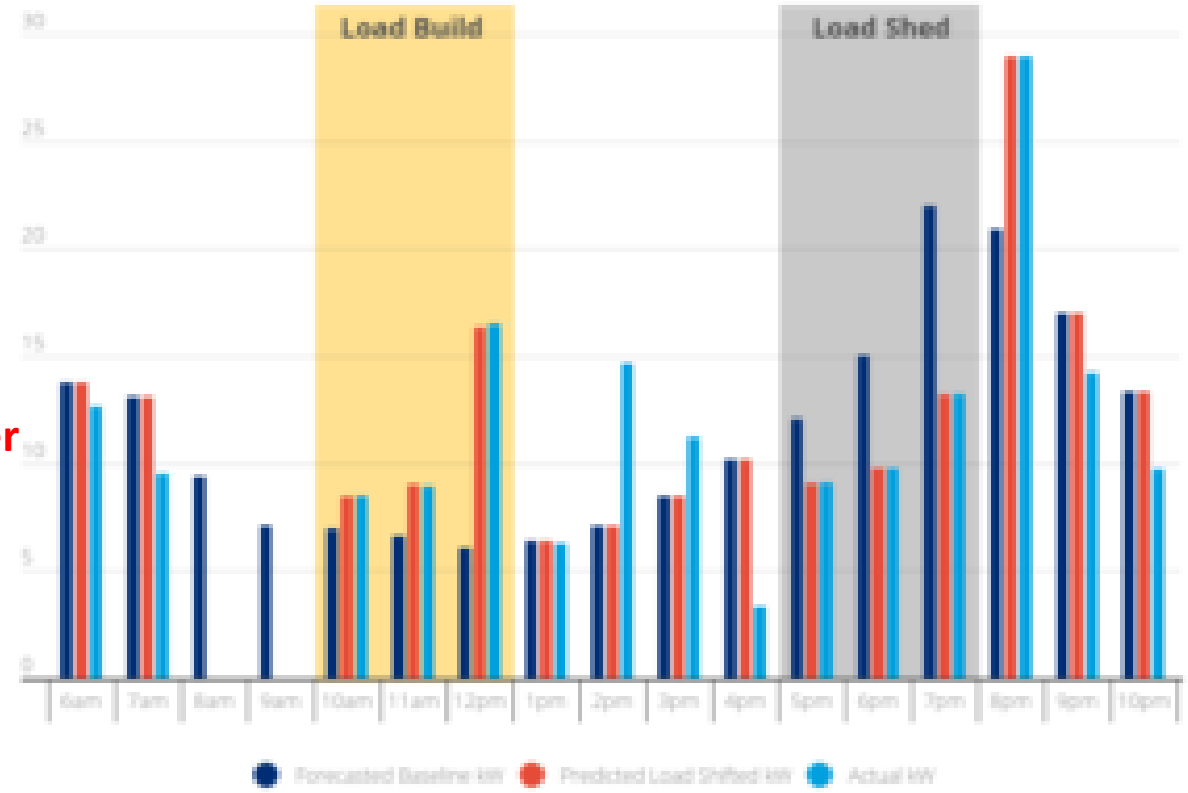
Thermostatic Mixing Valve Selection

- **Circulation System Flow rate should be min flow rate for valve selected.**
- **If Circ rate flow is too small, add flow with a bypass circuit to get the minimum.**
- **Most of the valves will be fine for the upper end, focus on selection at the lowest flow end for your designs.**
- **TMV is typically 1-2 nominal sizes smaller than hot water main sizing**

Demand response for certain water heaters

- Electric storage water heaters:
  - between 40 and 120 gallons
  - 12 kW or less
- ANSI/CTA-2045-B Level 2 or equal
- Exceptions
  - 180°F or higher delivery temp
  - Section IV, Part HLW **or Section X of the ASME Boiler and Pressure Vessel Code (?)**
  - 3-phase power
  - With *demand responsive controls* that comply with ANSI/CTA 2045-A or ANSI/CTA 2045-B Level 1 (?)

C404.14



New C406 credit system (1 old credit = 6 new credits)

Table C406.1 Energy Measure Credit Requirements

Required Credits for Projects		Occupancy Group					
	Section	Group R-1	Group R-2	Group B	Group E	Group M	All Other
New building energy efficiency credit requirement	C406.2	((~~54~~)) 59	((~~41~~)) 45	((~~42~~)) 46	((~~48~~)) 53	((~~74~~)) 61	((~~49~~)) 54
Building additions energy efficiency credit requirement	C406.2	((~~27~~)) 30	((~~20~~)) 22	((~~21~~)) 23	((~~23~~)) 25	((~~36~~)) 30	((~~21~~)) 23
New building load management credit requirement	C406.3	12	15	27	15	13	26

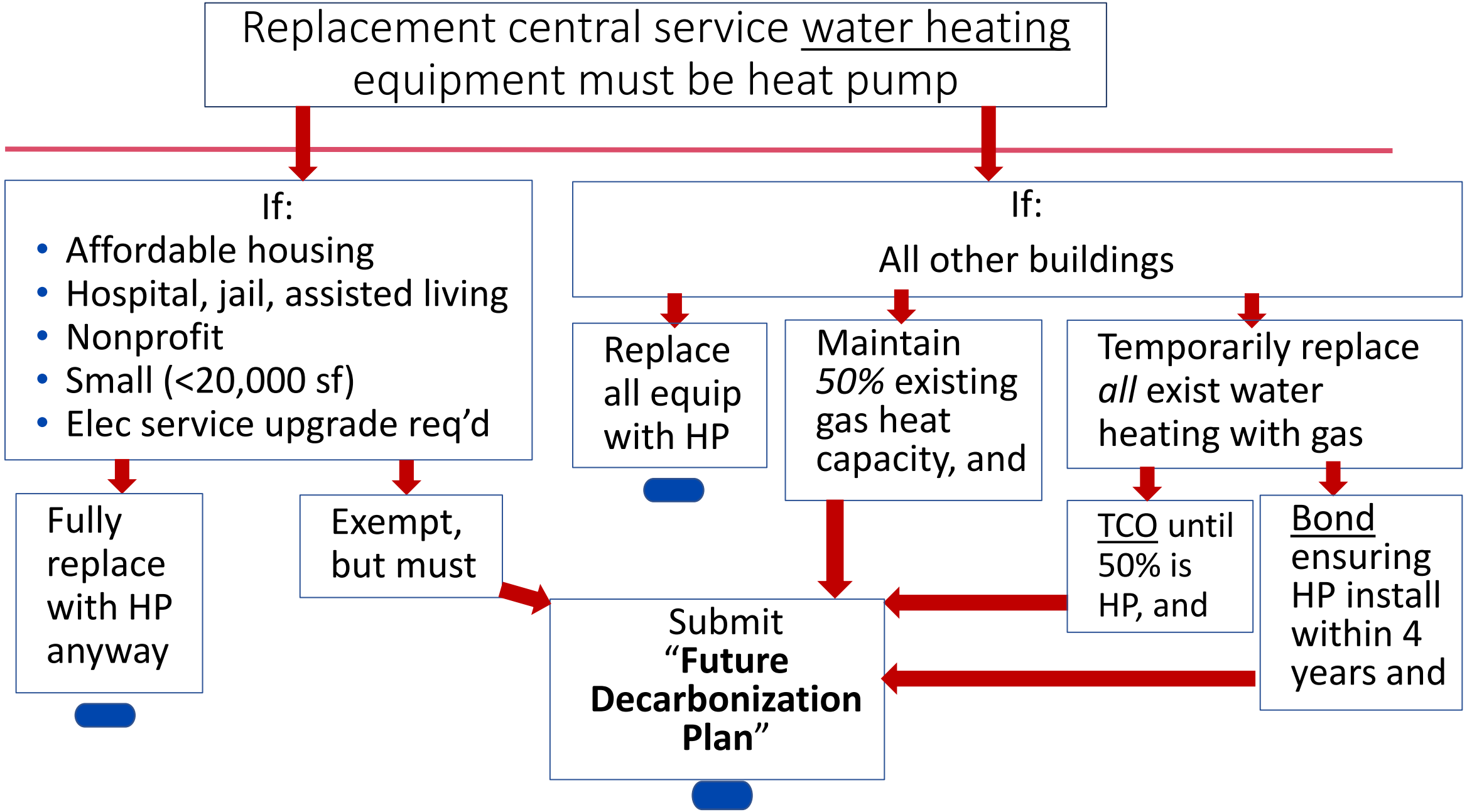
Hot water C406 credits

Appendix M

Measure Title	Applicable Section	Occupancy Group					
		Group R-1	Group R-2	Group B	Group E	Group M	All Other
15. Shower drain heat recovery	C406.2.6.1	9	30	NA	3	NA	NA
16. Service water heat recovery	C406.2.6.2	35	111	13	14	(Grocery) 41[e]	NA
17. ((~~Heat pump water heating~~))	((~~C406.2.6.3~~))	((~~81~~))	((~~261~~))	((~~17~~))	((~~33~~))	(~~Grocery~~) ((~~95[e]~~))	(~~A 2~~) ((~~95[f]~~))
18. Heat trace system	C406.2.7.1	6	13	4	1	NA	6
19. Point of use water heater	C406.2.7.2	NA	NA	19	5	NA	NA
20. Service hot water distribution right sizing	C406.2.8	13	((~~42~~)) 10	NA	NA	NA	NA
21. High performance service hot water temperature maintenance system	C406.2.9	6	13	4	1	NA	6
22. ((~~High efficiency service hot water circulation system~~))	((~~C406.2.10~~))	((~~3~~))	((~~6~~))	((~~2~~))	((~~1~~))	((~~NA~~))	((4))
23. Low flow residential showerheads	C406.2.11	3	3	NA	NA	NA	NA

Commissioning (Cx) Compliance (Seattle)

- Cx note on mechanical permit documents
- Cx plan submitted before first mech inspection
- Cx report submitted before final inspection
  - And Cx checklist
  - And owner's acknowledgement
- If any unresolved deficiencies or incomplete Cx tasks:
  - TCO, or;
  - Bond for 2% of project valuation, or;
  - Remaining Cx work on new mechanical permit


Replacement central service water heating equipment must be heat pump
If:
• Affordable housing
• Hospital, jail, assisted living
• Nonprofit
• Small (<20,000 sf)
• Elec service upgrade req'd
If:
All other buildings
Fully replace with HP anyway
Exempt, but must
Replace all equip with HP
Maintain *50%* existing gas heat capacity, and
Temporarily replace *all* exist water heating with gas
TCO until 50% is HP, and
Bond ensuring HP install within 4 years and
Submit "**Future Decarbonization Plan**"

Future Decarbonization Plan (schematic)

Prepared by PE, not stamped or signed, no obligation for future work

a. Completed SDCI **decarbonization planning form**, available on the SDCI website

b. One-line system diagrams, showing only the impacted portions of systems

c. Equipment **sized and laid out to scale** on plans of the existing facility. Only the impacted areas need be depicted, at a simple schematic level of detail.

d. Required **louvers, ducts, and air handling** equipment

e. Required **structural** modifications

f. Required **partitions, doors**, and other architectural modifications

g. Required **electrical** infrastructure, including any electrical service upgrade and vault

h. Allowable roof coverage area and mechanical equipment height according to Seattle land use code, and whether departures are required

i. Schematic-level **cost estimate**, AACE Level 5, ROM, or equivalent, including separate line items for structural, mechanical, electrical, architectural, and utility costs.

j. Applicable **compliance dates** for Washington State Clean Buildings Performance Standards and Seattle Building Performance Standards, w max allowable energy use index (EUI) & carbon emissions

4. Alarms, Notifications & Maintenance

Impacts to system efficiency and performance

- Notify building owners/maintenance team back up system engaged
- Prompt remediation necessary for system longevity
- Maintenance procedure is often simple but critical for reliability

Alarms required

- Equipment faults
- Low leaving temp from primary tanks
- Low hot water delivery temp to distribution system

- Q: Who sees these alarms?
- How will they result in something getting fixed?

Hot Water Metering

C404.9 Domestic hot water meters. Each individual *dwelling unit* in a Group R-2 occupancy with central service domestic hot water systems shall be provided with a domestic hot water meter to allow for domestic hot water billing based on actual domestic hot water usage.

Exception: *Dwelling unit*s in **other than Group R-2 multi-family and live/work units** are not required to provide domestic hot water metering at each *dwelling unit* where domestic hot water is metered separately for each of the following building end uses:

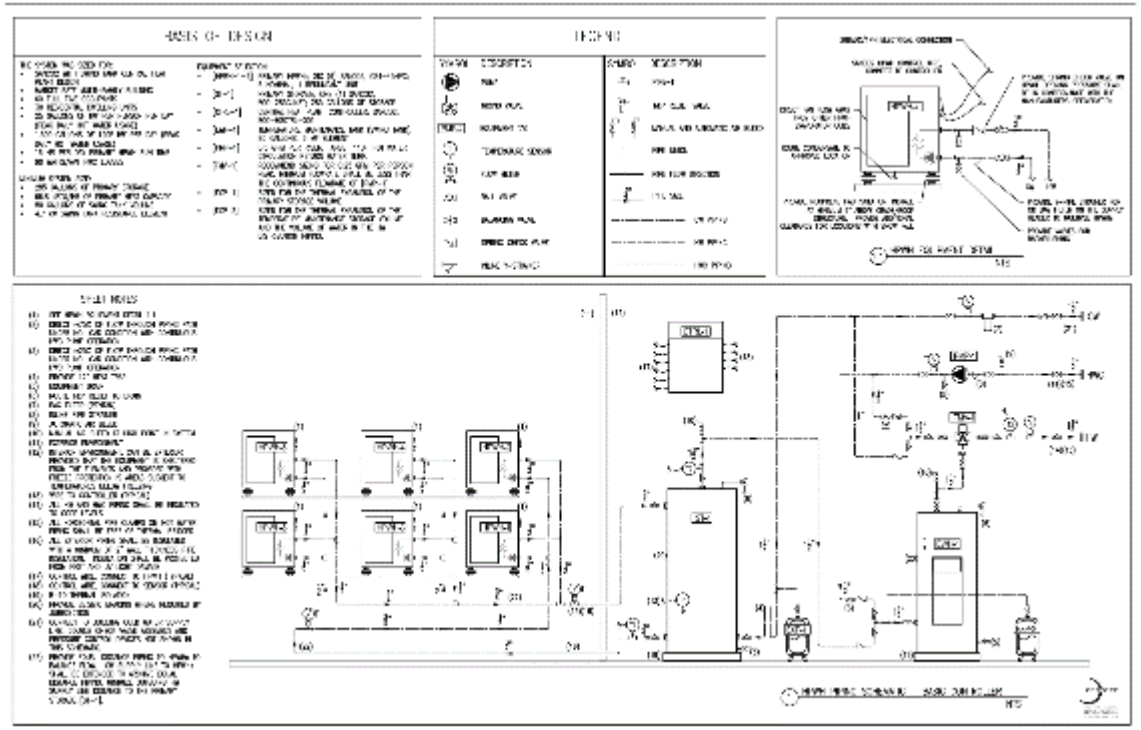
1. *Dwelling unit*s.
2. Sleeping units.
3. Commercial kitchens.
4. Central laundries.

This has caused difficulties for plumbing replacement in existing buildings, when the team didn't know it was required!

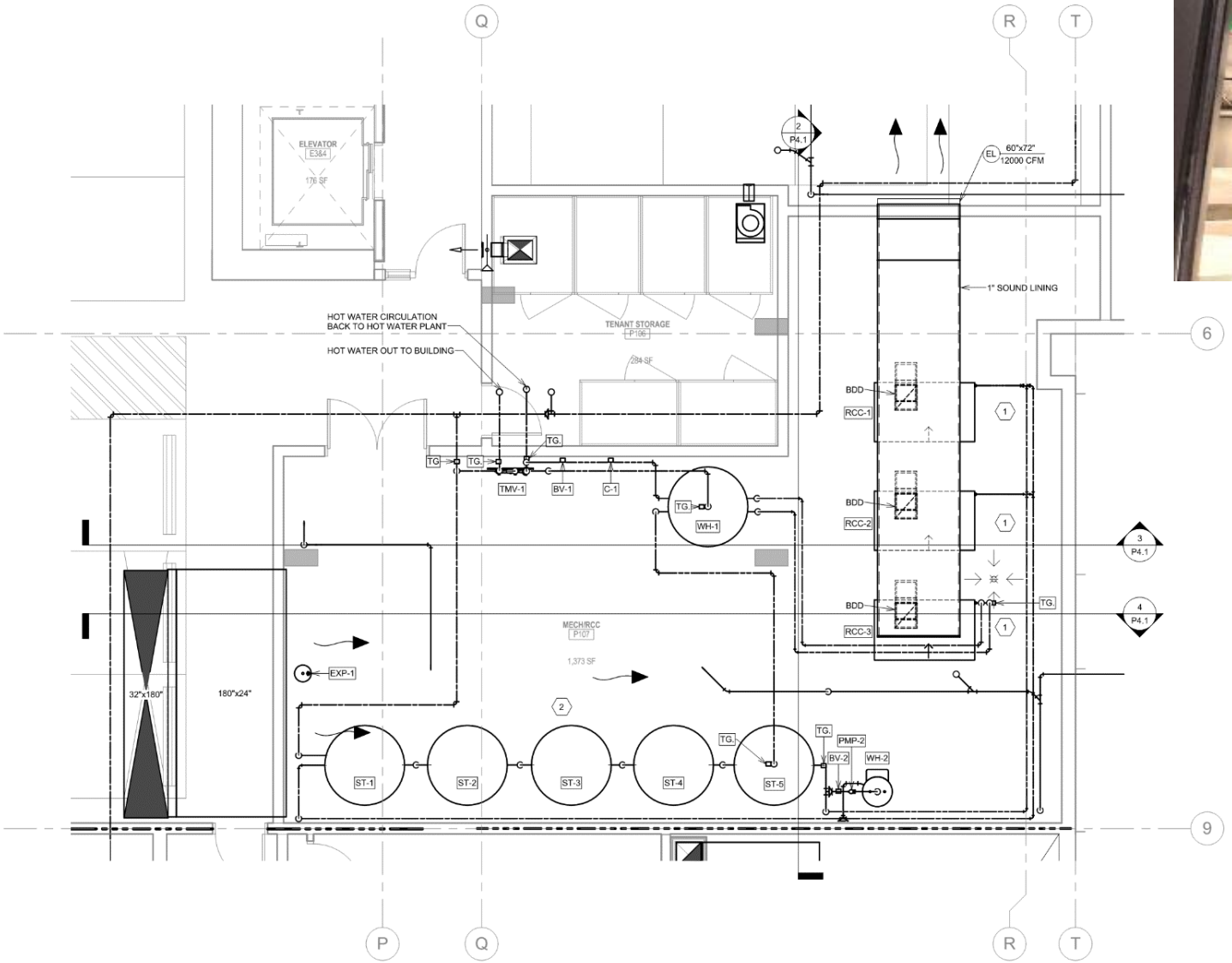
C409.3.2 Service water heating energy use. This category shall include all energy used for heating of domestic and service hot water, but not energy used for space heating.

Exception: Service water heating energy use less than 50 kVA does not require end-use metering.

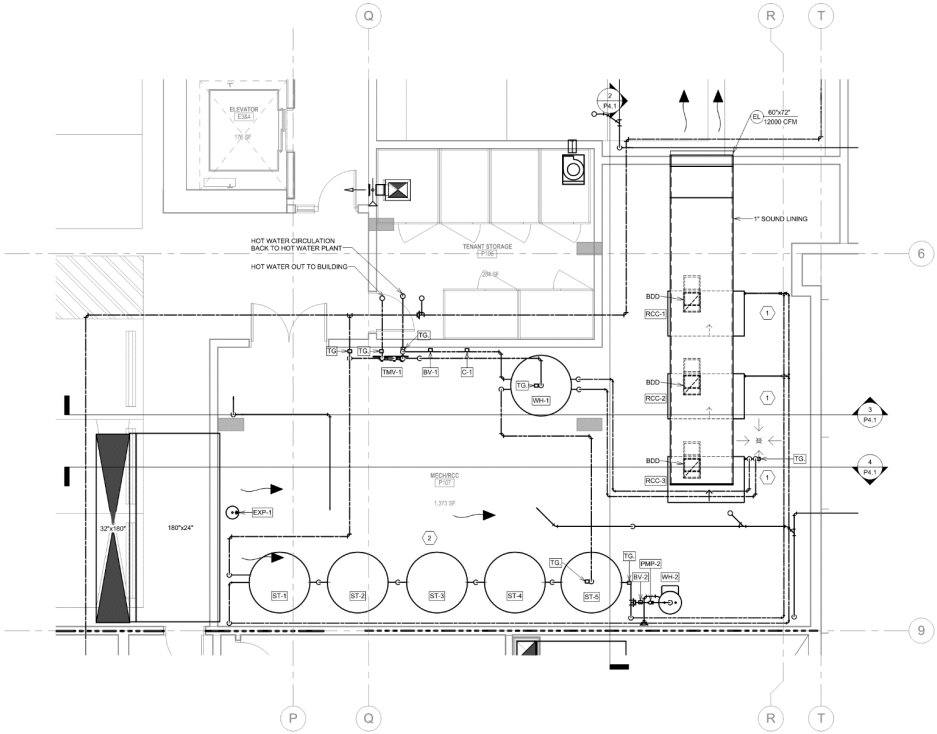
CO2 Central HPWH system



Common Challenges
- Air Source



Common Challenges
- Physical space

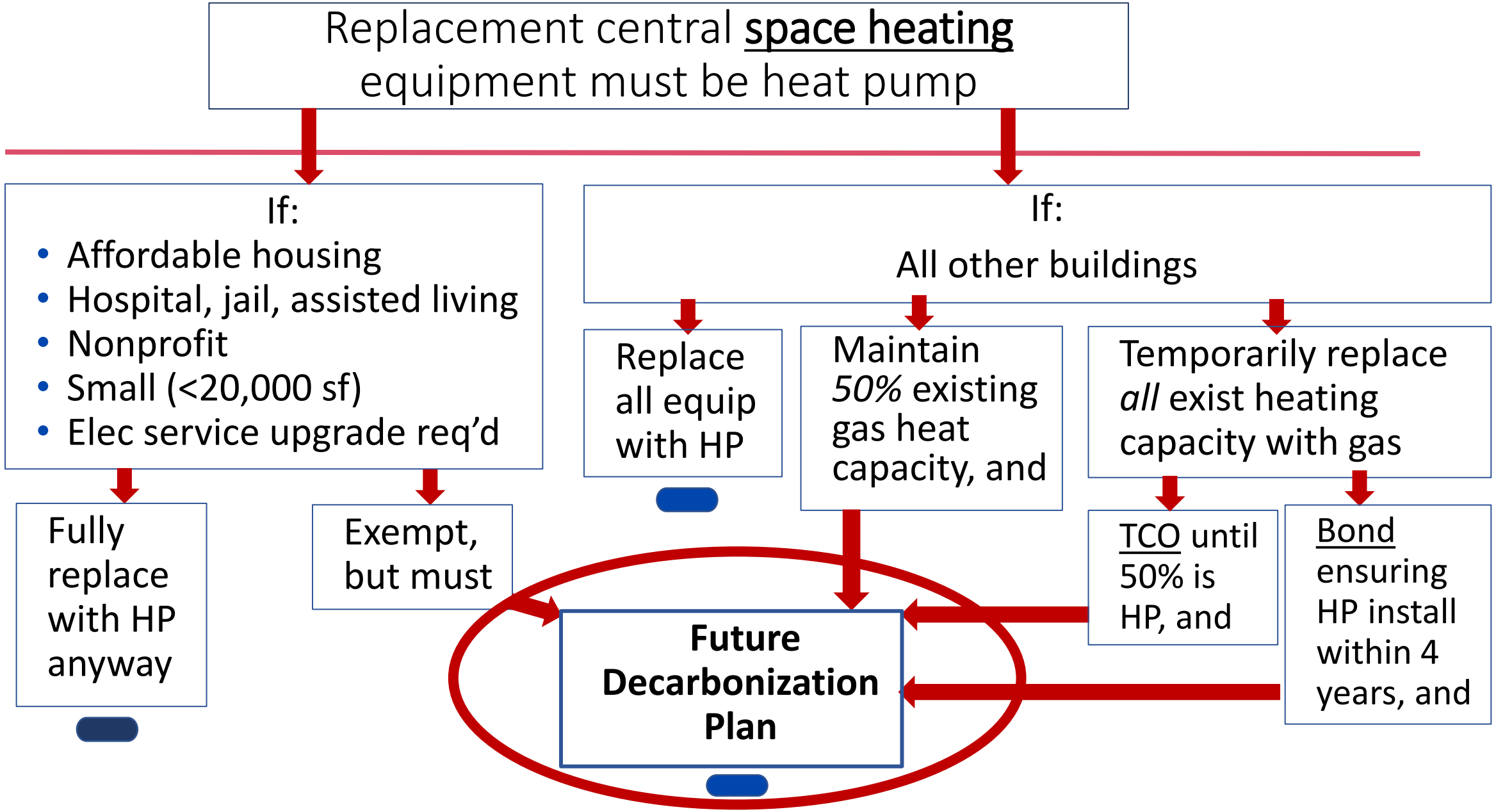


Existing Buildings

- **Legally-built existing can remain forever**
- **Repairs can be like-for-like**
- **Historic fabric of Landmarks protected**
- **All new work usually has to meet code**

C503.5 Service hot water systems. New service hot water systems that are part of the *alteration* shall comply with Section C404.

- **Almost same as new construction:**
  - **"Substantial alterations"**
  - **Change of occupancy**
  - **Change of space conditioning**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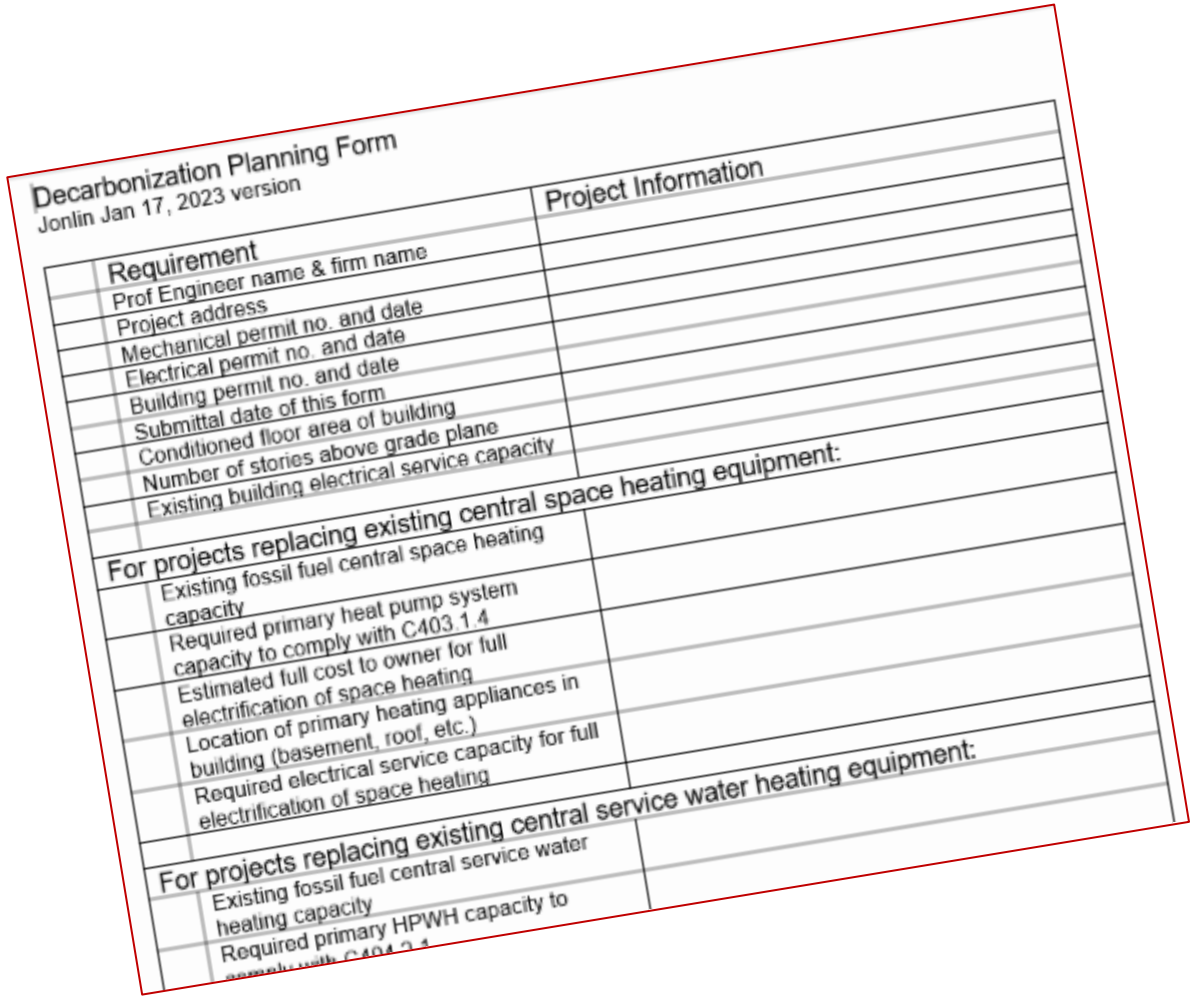
All other buildings
Fully replace with HP anyway
Exempt, but must
Replace all equip with HP
Maintain 50% existing gas heat capacity, and
Temporarily replace all exist heating capacity with gas
TCO until 50% is HP, and
Bond ensuring HP install within 4 years, and
Future Decarbonization Plan

Future Decarbonization Plan

Full engineered schematic design & cost estimate

a. **One-line system diagrams**
b. **Equipment** laid out to scale.
c. **Louvers, ducts, & air handling** equipment
d. **Structural** modifications
e. **Partitions & doors**
f. **Electrical** infrastructure
g. **Allowable roof coverage area & height**
h. **Decarbonization planning form**
i. **Schematic cost estimate**
j. **Compliance dates** for WA & Seattle Building Performance Standards



Decarbonization Planning Form
Jonlin Jan 17, 2023 version

Requirement	Project Information
Prof Engineer name & firm name	
Project address	
Mechanical permit no. and date	
Electrical permit no. and date	
Building permit no. and date	
Submittal date of this form	
Conditioned floor area of building	
Number of stories above grade plane	
Existing building electrical service capacity	
For projects replacing existing central space heating equipment:	
Existing fossil fuel central space heating capacity	
Required primary heat pump system capacity to comply with C403.1.4	
Estimated full cost to owner for full electrification of space heating	
Location of primary heating appliances in building (basement, roof, etc.)	
Required electrical service capacity for full electrification of space heating	
For projects replacing existing central service water heating equipment:	
Existing fossil fuel central service water heating capacity	
Required primary HPWH capacity to	

Existing Buildings: HPWH

C503.5 New Service water heating equipment. All new service water heating systems shall comply with Section C404.

Section C503.5.1 Addition or replacement of service water heating equipment. All existing service hot water systems, equipment, and components of existing systems that are altered or replaced shall comply with Section C404, C408.3, ((~~C409.5~~)) C506.1, and C501.6. Additions or alterations shall not be made to an existing service water heating system that will cause the existing system to become out of compliance.

Binding Pledge format pdf.docx

Seattle: Exception for $$ electrical upgrades

EXCEPTIONS: ((~~The following equipment is not required to comply with Section C404.2.1~~))

1. ((~~Reserved~~.)) Utility service upgrade. Compliance with Section C403.1.4 is not required where the requirements of Section C503.4.6.2 are met, and where such compliance would trigger an unplanned utility electrical service upgrade, based on the Seattle Electrical Code Section 220.87 method for determining existing loads, where one or more of the following is required:

   a. A new utility transformer vault located in the existing building or on the site, or an enlargement of the floor area of such a vault.
   b. Trenching across the vehicle lanes of a public way.
   c. The estimated construction cost for the required electrical service enlargement exceeds 50 percent of the project valuation for the remainder of the work, as determined in accordance with the fee subtitle. Construction cost shall be documented by an AACE Level 3 or equivalent cost estimate, including required demolition, construction, site work, and utility fees.

   The replacement equipment shall comply with the minimum efficiency in Table C503.4.6.

Seattle: Exempt systems & building types

2. **Exempt Systems.** Replacement of any of the following water heater appliances is not required to comply with this section or with Section C404.2.1:

2.1. Electric water heaters with an input of ((~~12~~)) 24 kW or less.

2.2. Gas storage water heaters with an input of 75,000 Btu/h or less.

2.2. Gas storage water heaters with an input of 75,000 Btu/h or less.

4. Exempt buildings. Replacement service water heating equipment for the following buildings is permitted to use the same fuel type as the existing equipment, provided the new equipment has no lower efficiency and no higher capacity than the existing, and that the requirements of Section C503.4.6.2 are met.

Affordable housing

Group I-1, I-2, or I-3 occupancies

Buildings with more than 50 percent of conditioned floor area occupied by organizations recognized as nonprofit by the State of Washington or by federal tax law

Buildings smaller than 20,000 square feet

Seattle: 50% rule

5. Retention of portion of existing system capacity. A maximum of 50 percent of the existing central fossil fuel or electric resistance water heating capacity is permitted to be provided as supplemental heat for the new heat pump water heating system, provided that the supplemental heat is controlled to be used only when the heat pump system capacity is insufficient to meet the load, in compliance with Section C404.2.1.4, and that the requirements of Section C503.4.6.2 are met. Where an alteration replaces less than 50 percent of the existing fossil fuel or electric resistance service water heating capacity, the remaining service water heating appliances are permitted to be retained. Where the alteration project decreases the peak service water heating load, the fossil fuel or electric resistance heating capacity shall be limited to 50 percent of the calculated peak heating load.

Seattle: Temp replacement, 4-year window

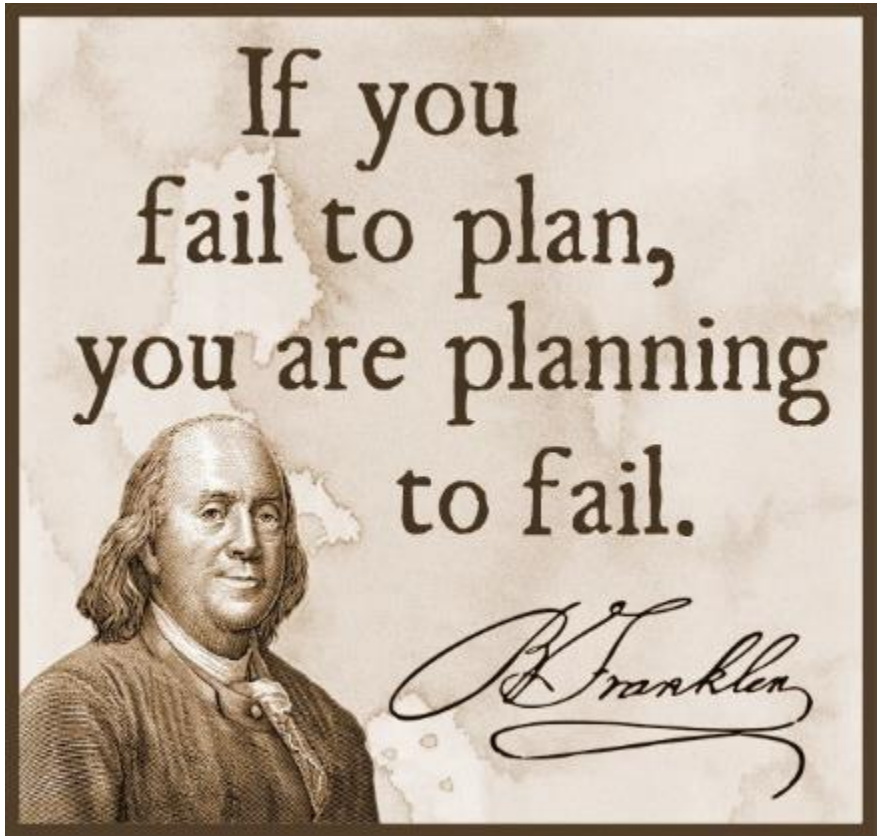
6. Temporary replacement of failing equipment. Temporary like-for-like replacement of one or more service water heating appliances, in excess of the 50 percent capacity permitted by Exception 5 above, is permitted where those appliances require immediate replacement, and where no other work on the service water heating system is planned. When using this exception, it is acceptable to replace a single appliance with two or more smaller appliances, provided the total capacity is not greater than that of the original appliance. In addition, the requirements of Section C503.4.6.2 shall be met, and the applicant shall ensure completion of the required heat pump water heating system in compliance with one of the following options.

a. SDCI will issue a temporary certificate of occupancy (TCO), which will remain in force until the heat pump water heating system is installed and the final inspection of the system has been completed.
b. Applicant shall post a performance bond in the amount of the full estimated cost of installation of the required heat pump water heating system, to ensure completion of the system within 48 months.

BEPS & Code: Two paths, same destination

Building Emissions Performance Standard

- BEPS sets date certain for decarbonization
- Energy code requires heat pump as systems are replaced
  - with options to postpone
- Postpone, or not, based upon:
  - Construction cost: Pay me now
  - Years until BPS or BEPS would mandate upgrade anyway: Pay me later



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(But wait, there's more!)

Upcoming 2021 Code Update Deliveries

Webinar Topic	Delivery Date	Time
Alterations, Heat Pump Upgrades	June 6	10:00 – Noon
Lighting, Electric & Solar	June 13	10:00 - Noon

Today's slide deck and video recording can be found on
www.lightingdesignlab.com

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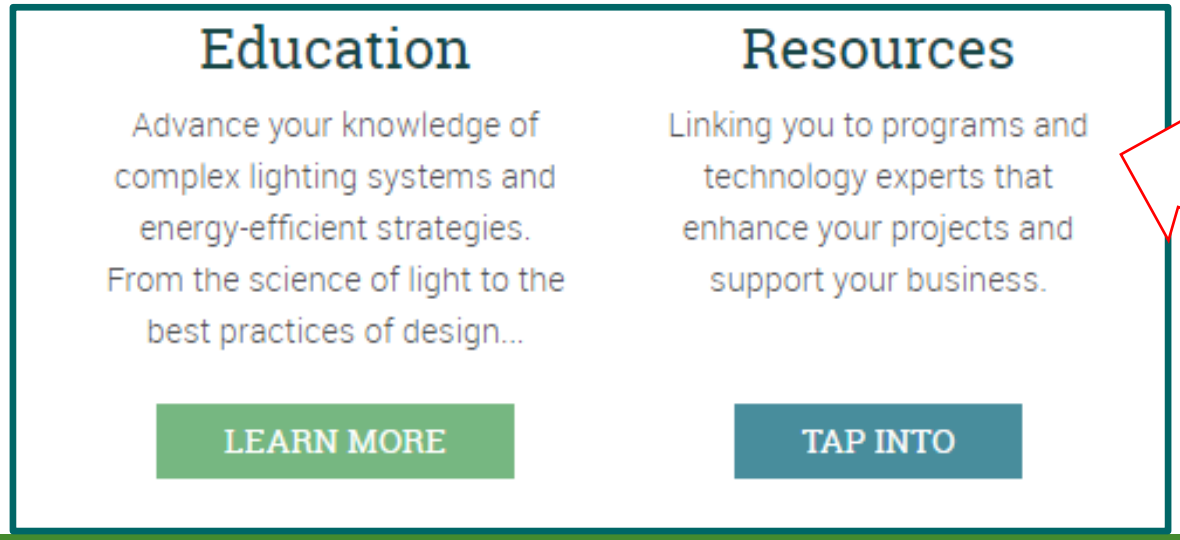

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Todays slide deck will be posted here!

Please take the online survey once you exit the webinar

We'll *SEE* you on the next call… ☺