2021 Energy Code
Water Heating

Seattle City Light

Lighting Design Lab

April 19, 2025

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)

Today's Guest

ECOTOPE

Shawn Oram, PE, LEED AP

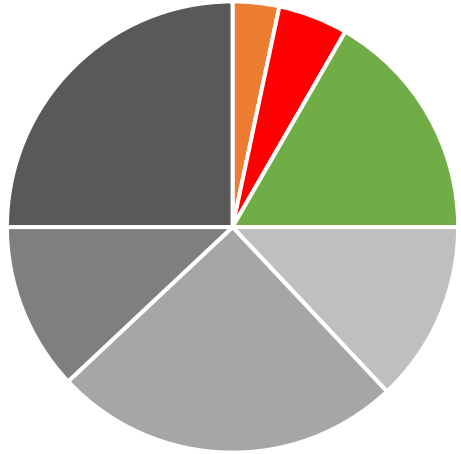
Vice President, Principal of Design and Engineering

The basic concept

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



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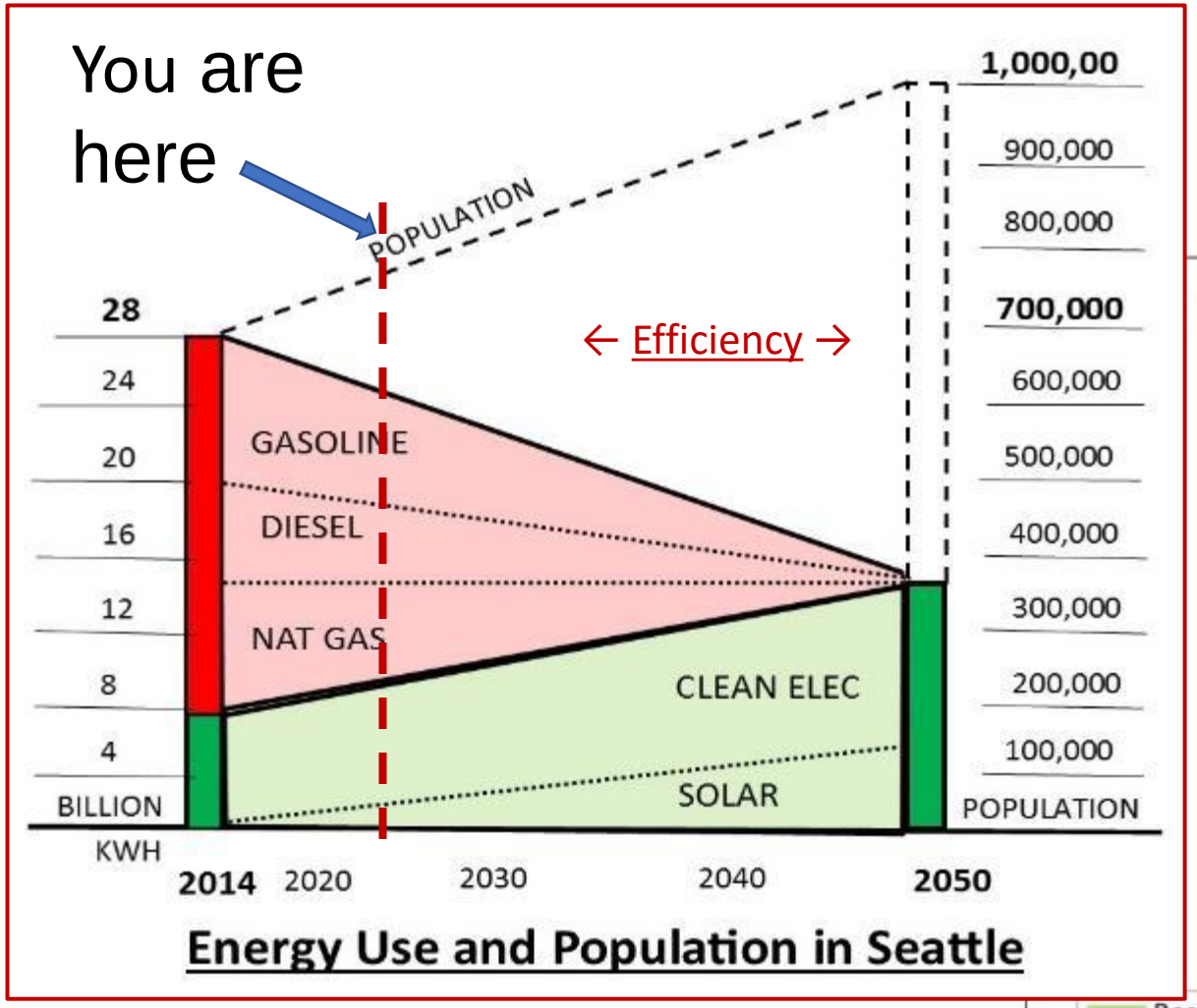
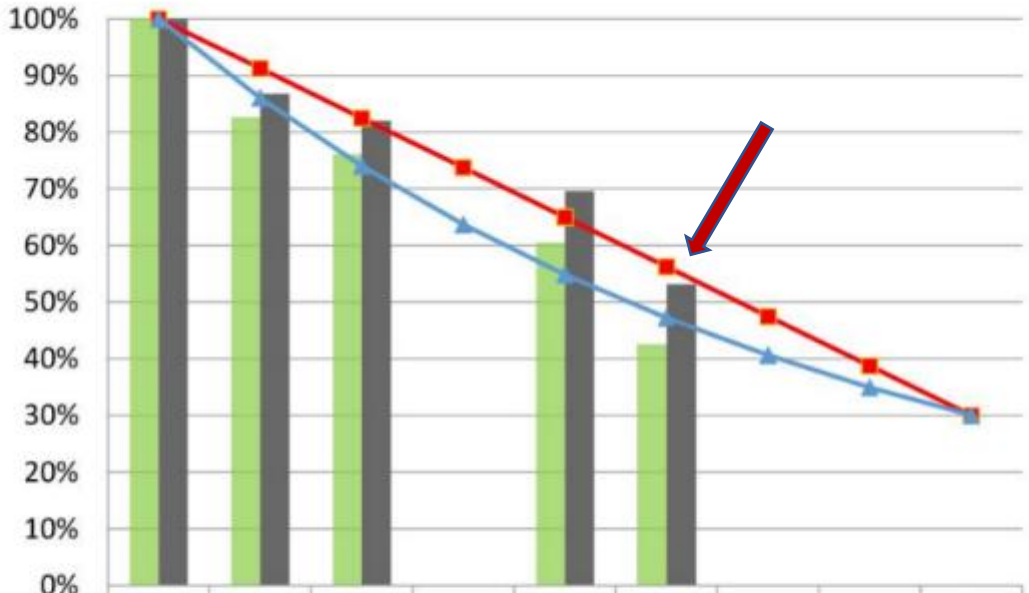


Incremental Improvement Compared to Targets



	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 Pump Water Heating
It's not just Seattle anymore

Use "fossil fuel compliance path" or:

Use heat pumps.

(WA code *mostly* adopted 2018 Seattle Code)

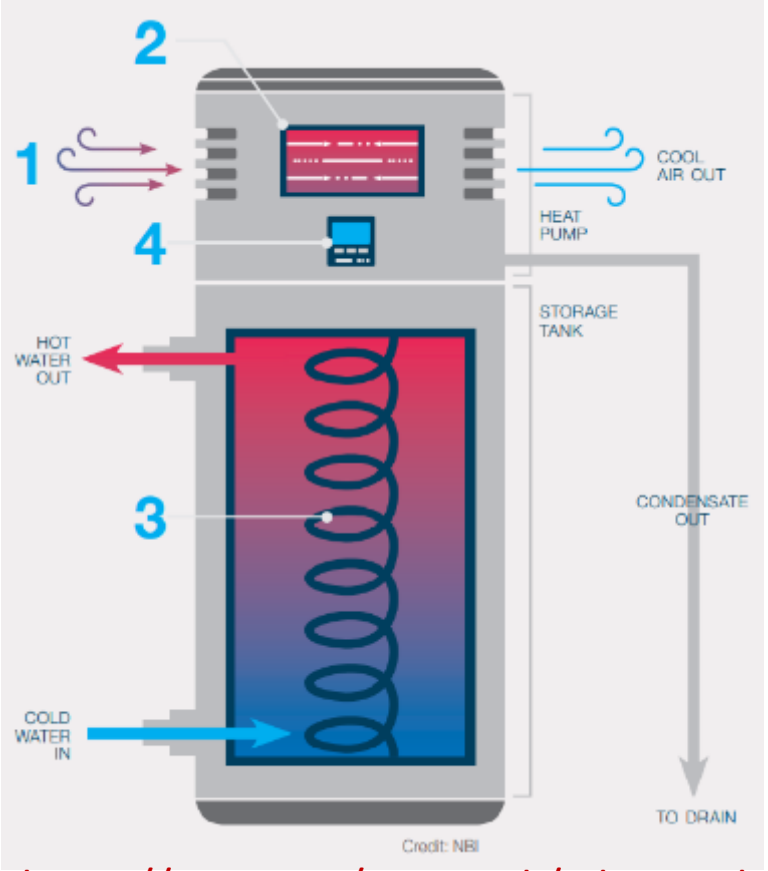
- Commercial *and* multifamily
- Central systems *and* unitary equipment
- Primary SWH system must be heat pump, air source or ground source.
  - WA allows gas or resistance for supplemental heating
  - Seattle allows minor electric resistance
- Exceptions? next slide

Exceptions

1. 24 kW plus 0.1W/sf allowance for resistance
   - So, a few 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 (theoretically)
7. I-2 & I-3 institutions (hospital, jail) that must provide 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 requirement categories in AWHS:
  - 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

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

Last year's list

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					

Commercial/Multifamily HPWH Systems Qualified Products List

for

A Specification for Residential, Commercial - Multifamily, and Industrial Water Heaters and Heating Systems

Advanced Water Heating Specification

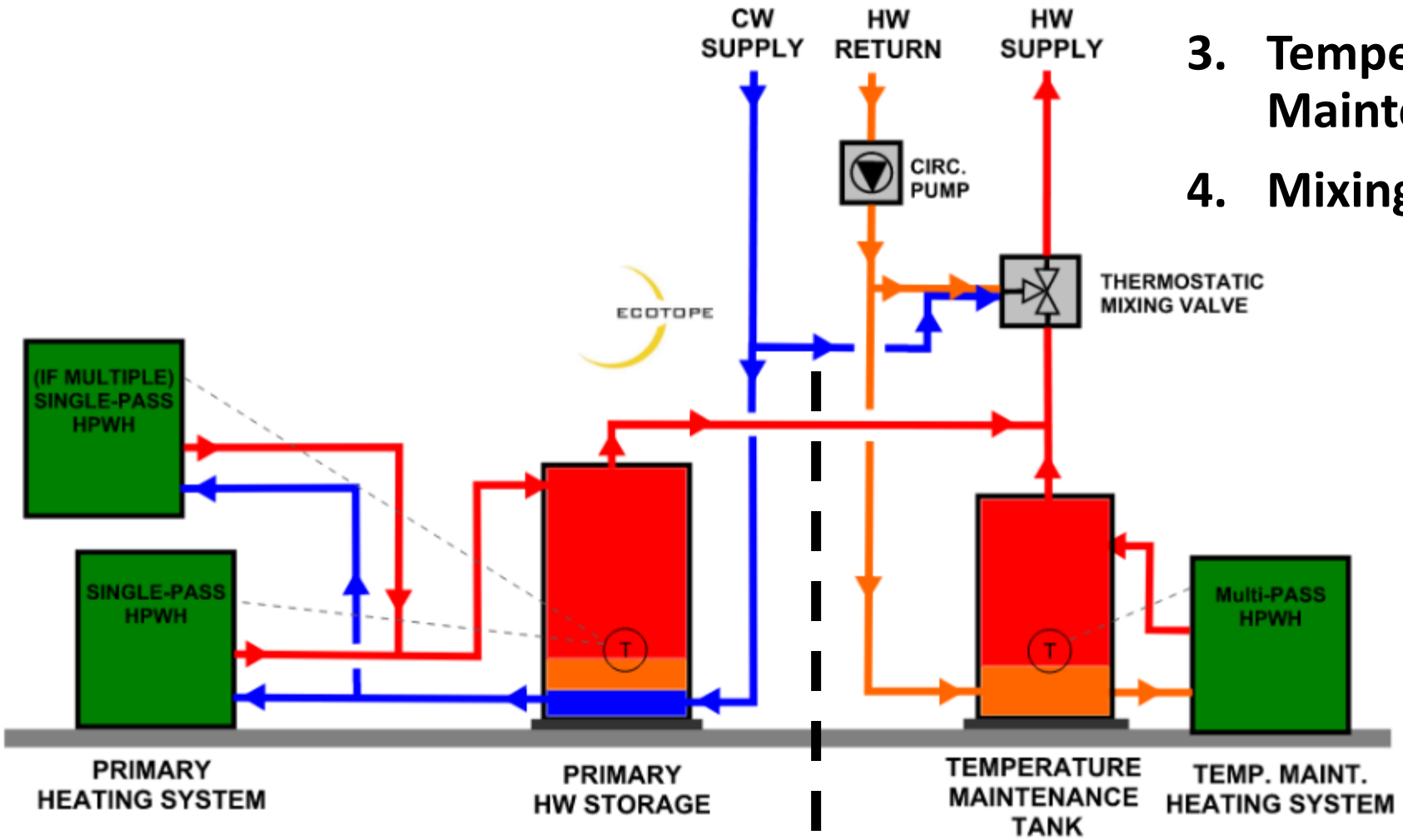
Updated: 3/8/2024

Company	Identifier	Configuration	Market Delivery Method	Hot Climate Zone		Mild Climate Zone		Cold Climate Zone		Very Cold Climate Zone		EcoPort[a]	ANSI 1181.1 Performance Map	Performance Monitoring[b]
				Tier	SysCOP	Tier	SysCOP	Tier	SysCOP	Tier	SysCOP			
CHC with Nyle	C185A	Swing Tank	Fully Specified Built-Up	1	2.0	1	1.7	1	1.5	1	1.4	No	No	No
CHC with Nyle	C250A	Swing Tank	Fully Specified Built-Up	1	1.9	1	1.8	1	1.6	1	1.4	No	No	No
CHC with Nyle	C90A	Swing Tank	Fully Specified Built-Up	1	2.0	1	1.7	1	1.5	1	1.4	No	No	No
CHC with Nyle	E360	Swing Tank	Fully Specified Built-Up	2	2.4	2	2.4	3	2.3	2	2.0	No	No	No
Colmac WaterHeat	CxA-10	Multi Pass Return to Primary	Custom Engineered	1	2.2	1	1.8	1	1.5	1	1.4	No	No	No
Colmac WaterHeat	CxA-10	Single Pass Return to Primary	Custom Engineered	2	2.3	1	2.0	2	1.8	2	1.6	No	No	No
Colmac WaterHeat	CxA-10	Swing Tank	Custom Engineered	1	2.0	1	1.8	1	1.6	1	1.4	No	No	No
Colmac WaterHeat	CxA-15	Multi Pass Return to Primary	Custom Engineered	1	1.8			1	1.3	1	1.3	No	No	No

This year's list...5 pages

Four HPWH System Components

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

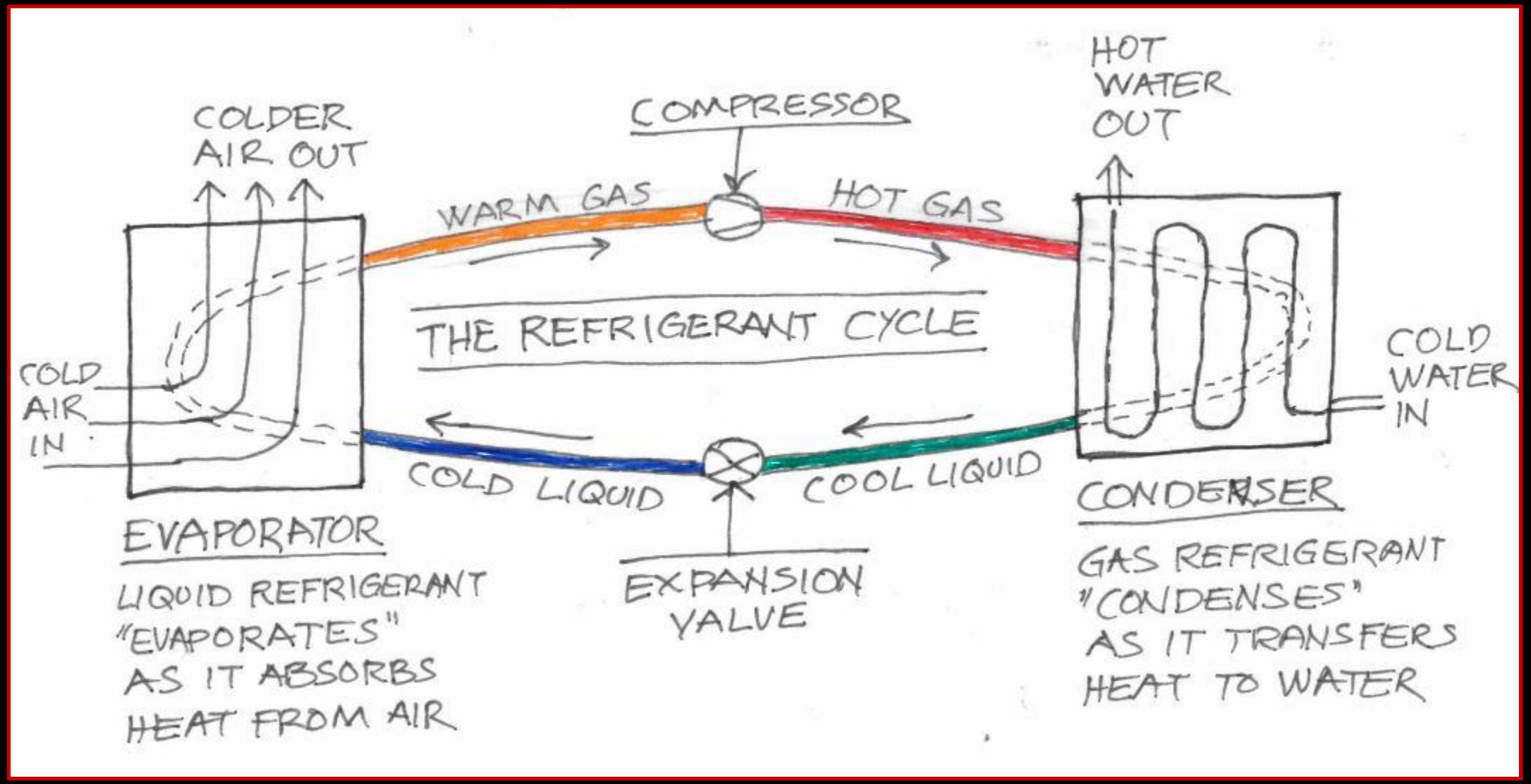


1. Heat Pump Water Heater

The engine

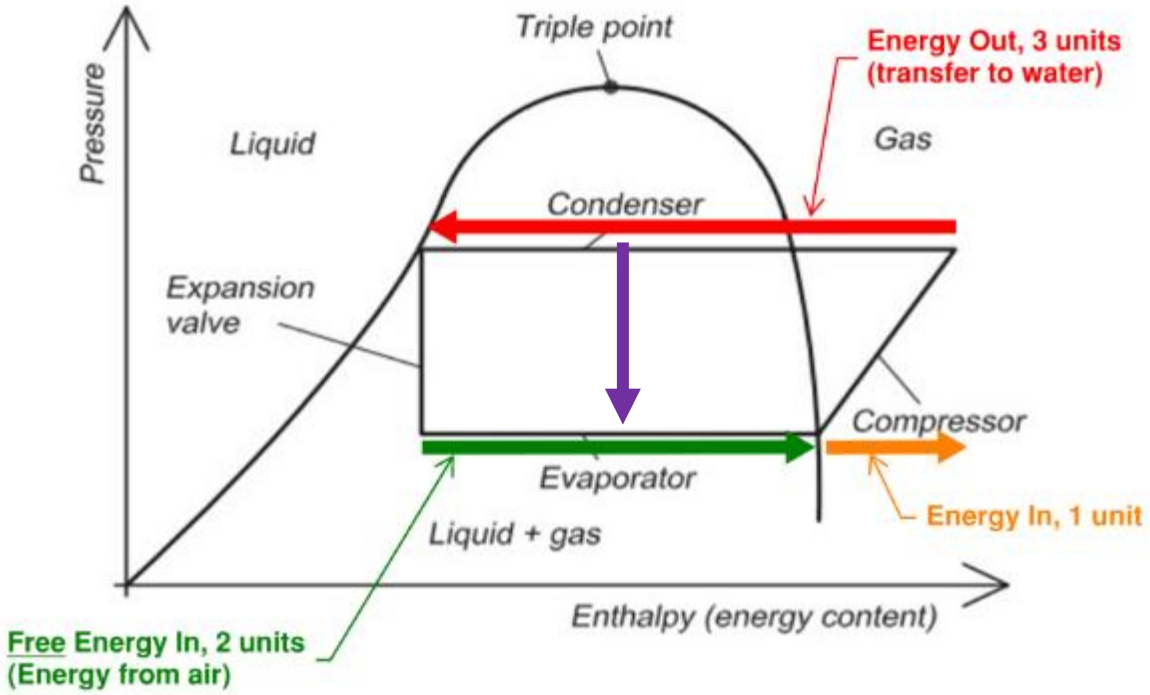
Not a boiler

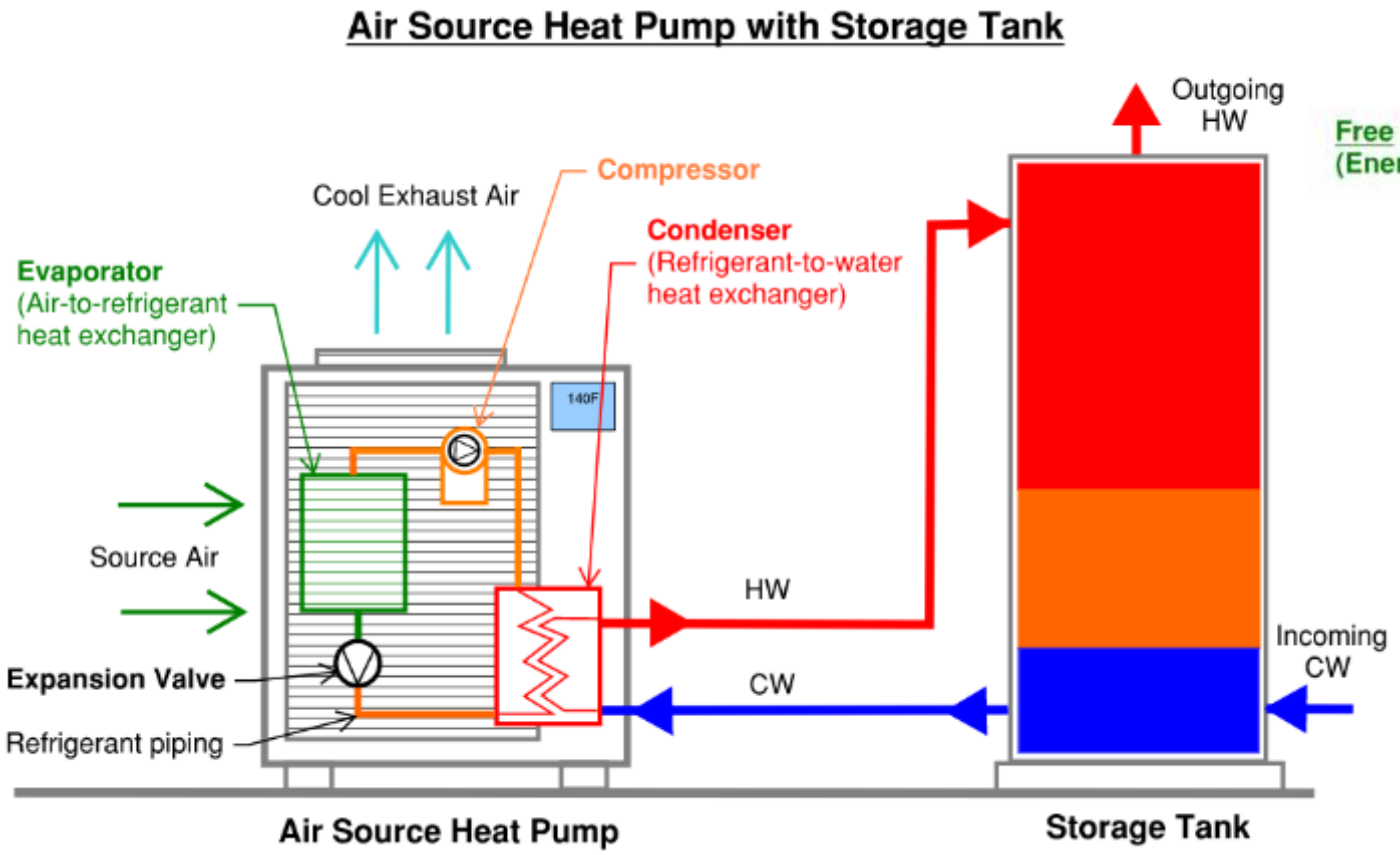
Heat pumps squeeze heat out of thin air



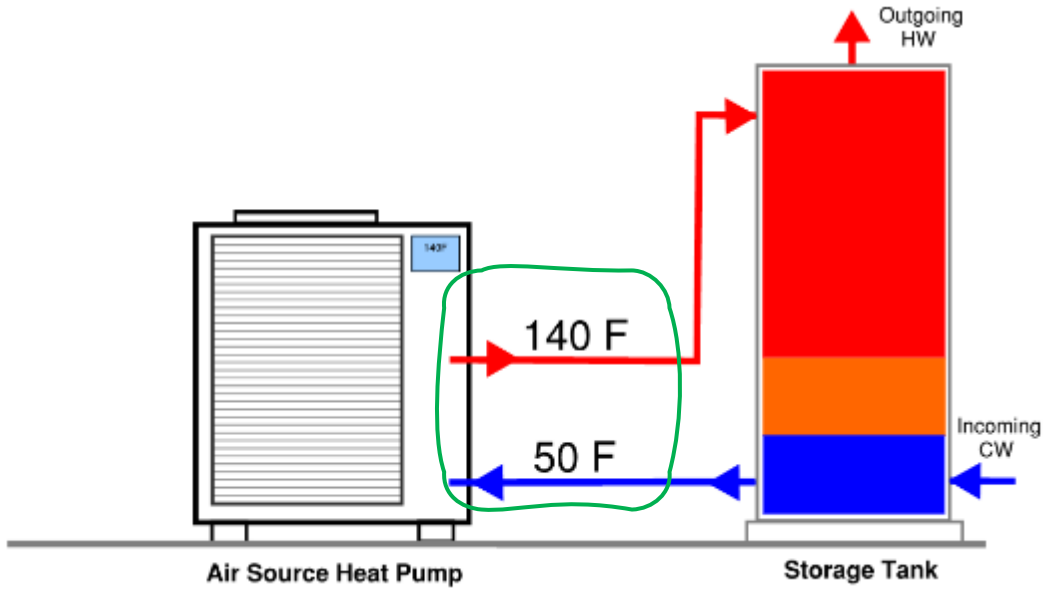
Using a fraction of the energy of gas or resistance

How Heat Pumps Work



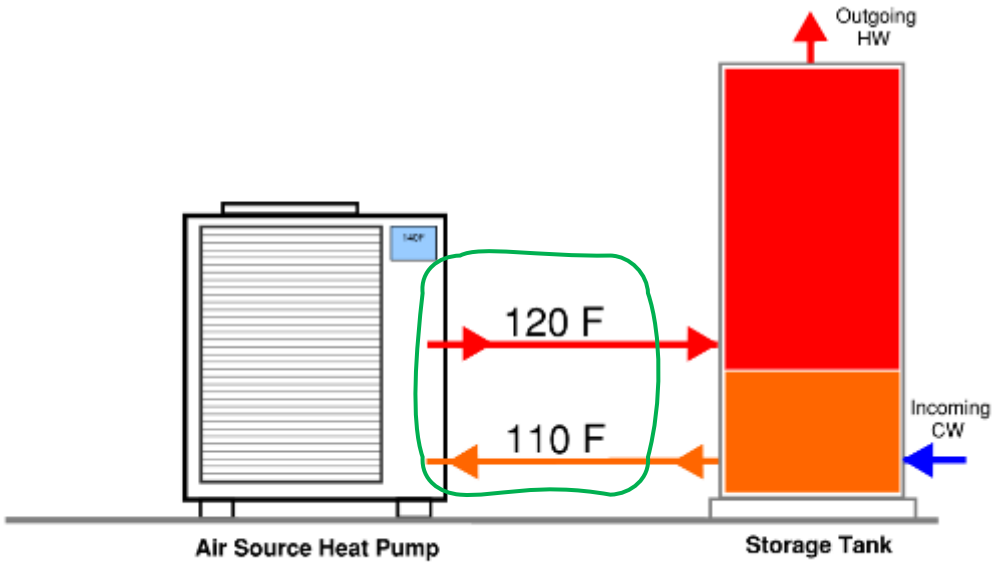


Two types of heating cycles



Single-Pass

Heats water to working temp in single pass

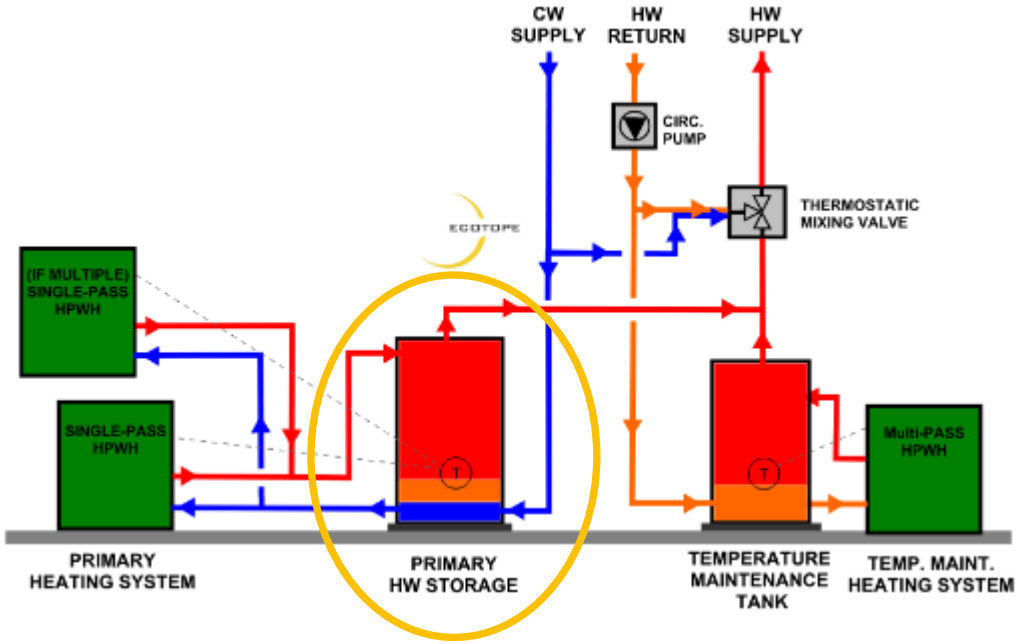


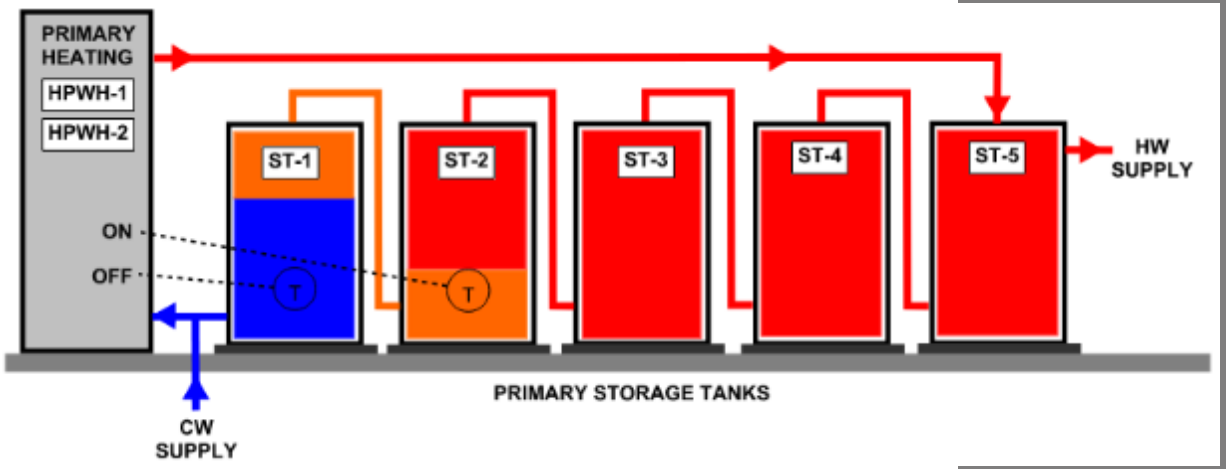
Multi-Pass

Heats water to working temp in multiple passes

2. Primary Storage Tank(s)

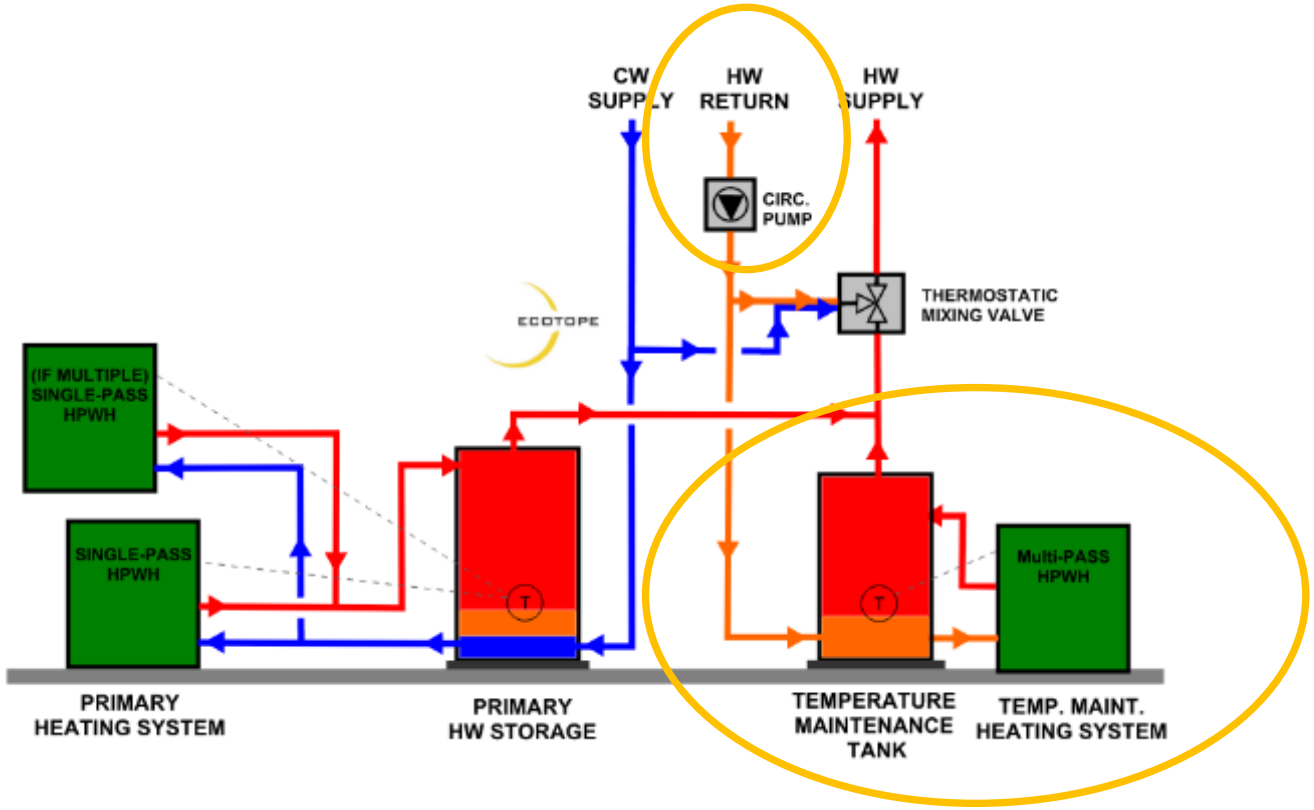
The battery bank

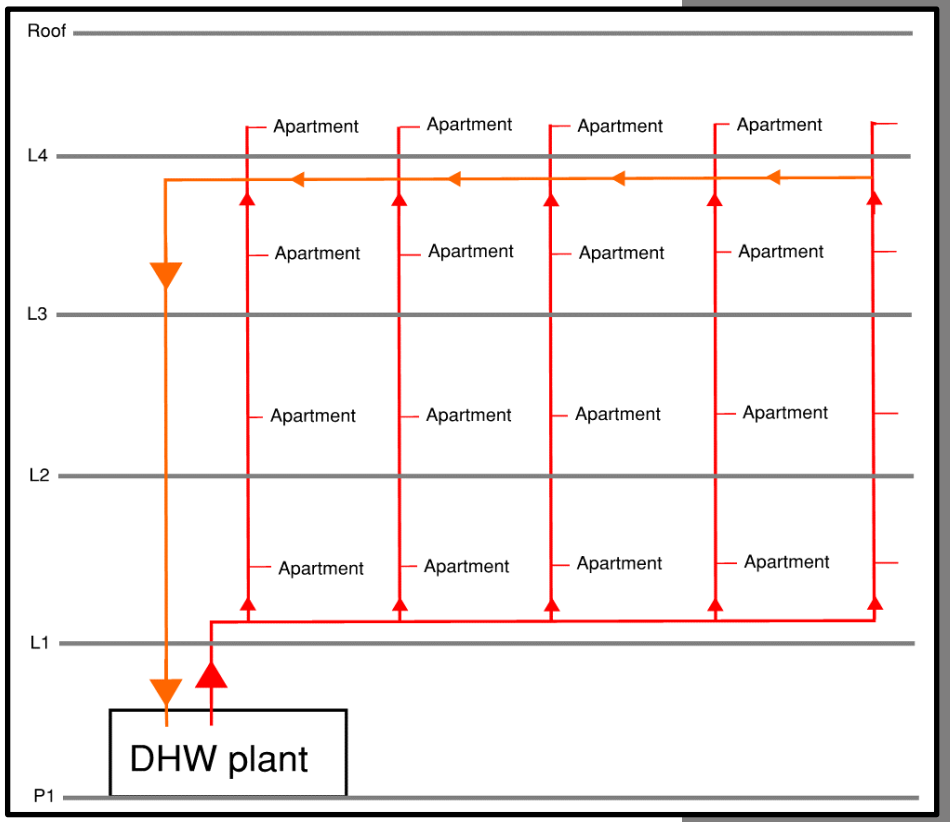




3. Temperature Maintenance System

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)

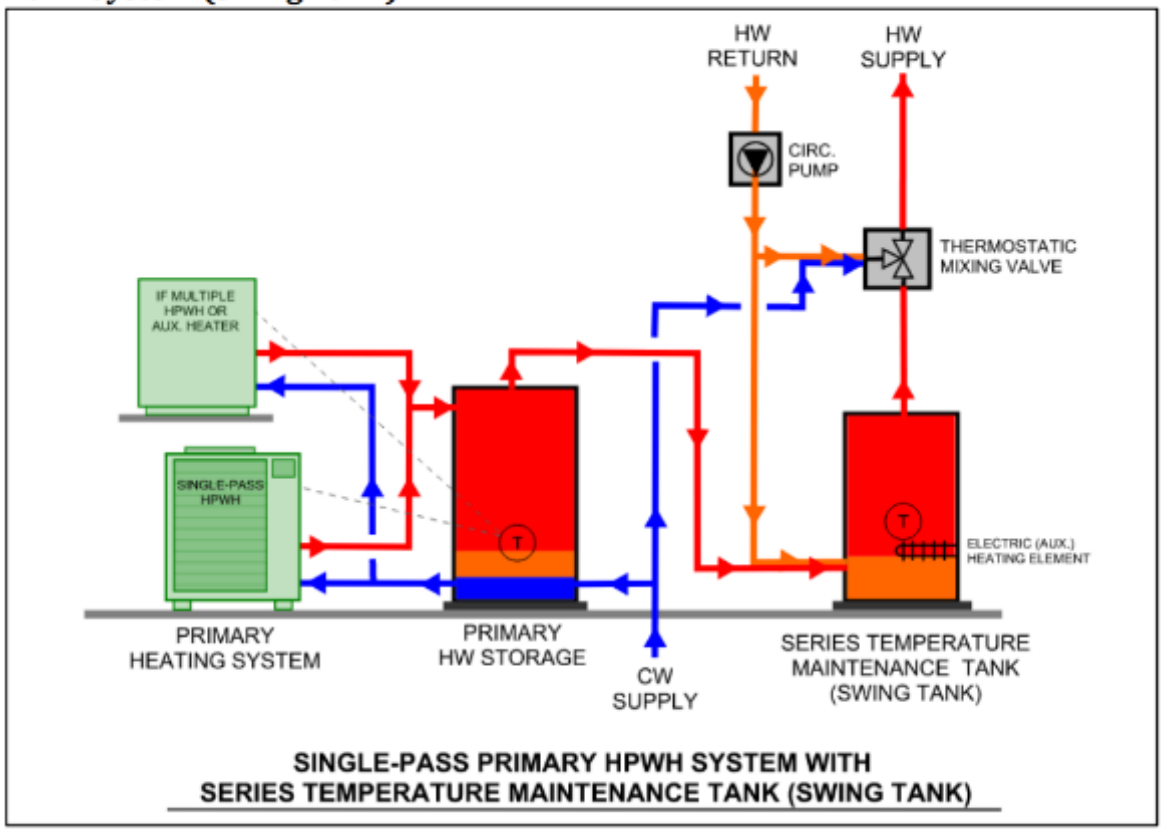
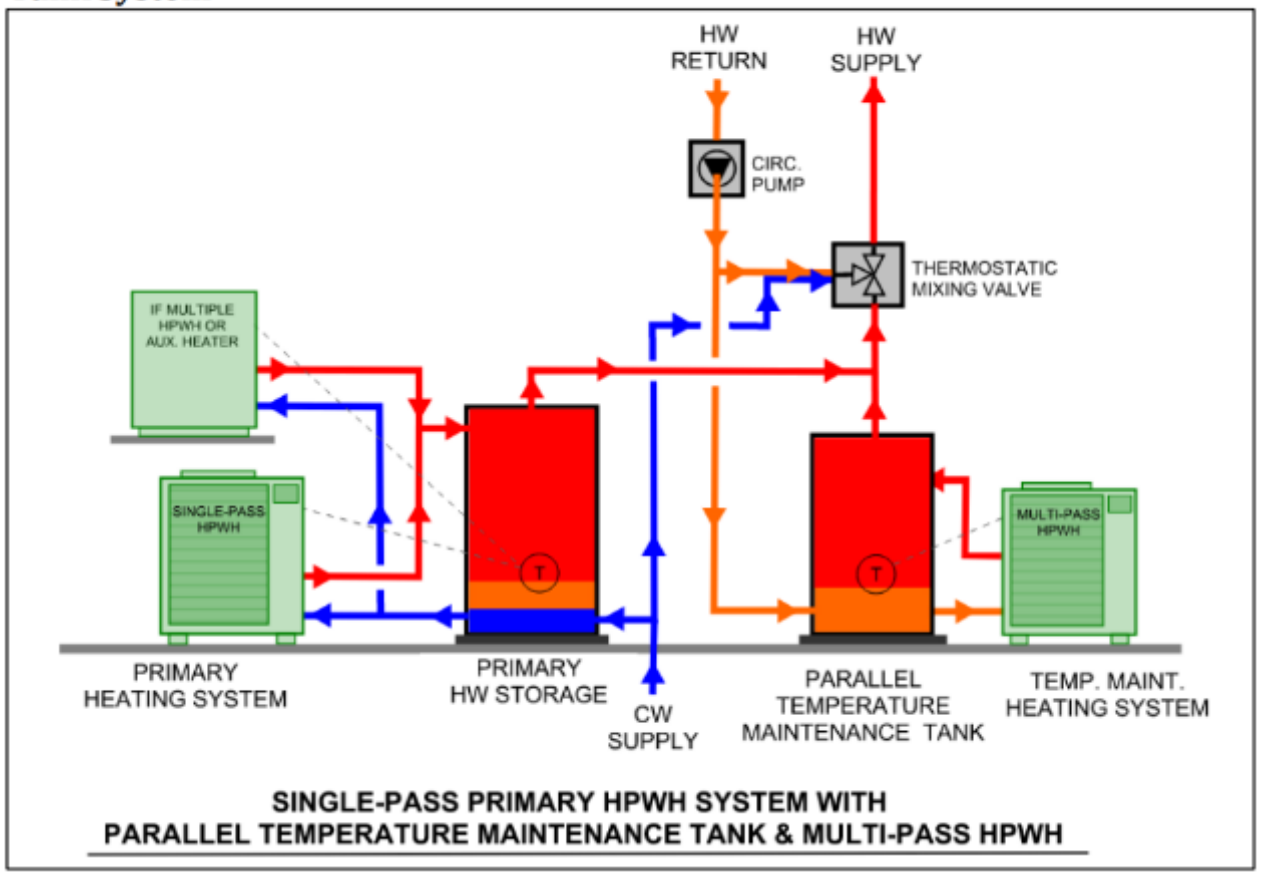
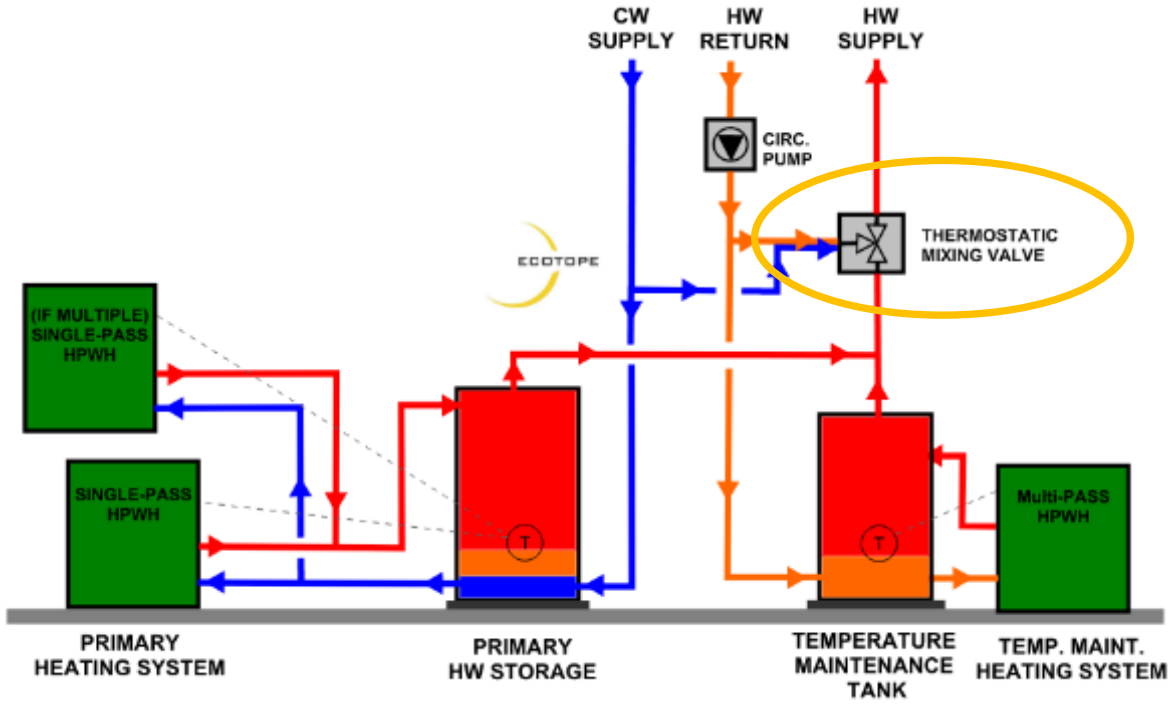


Figure 5. Single-Pass Primary HPWH with Parallel Temperature Maintenance Tank System



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 *off* at target supply temp, back on 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)

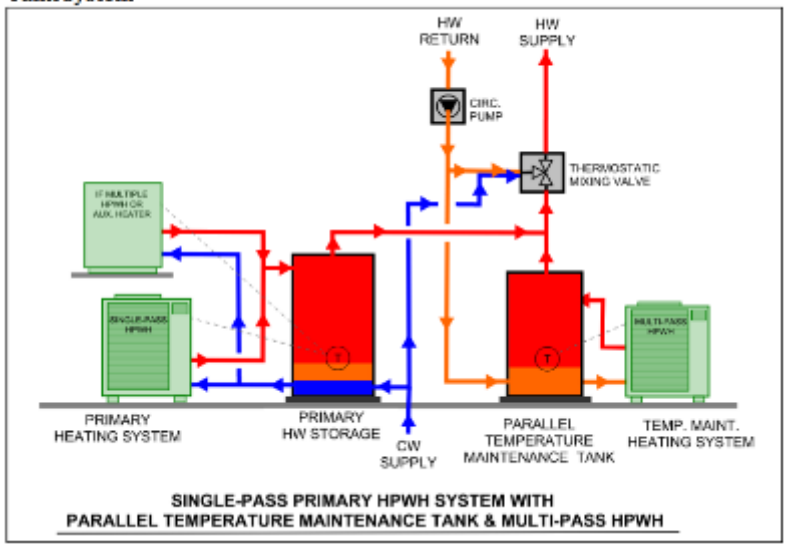
1. Pump *off* during extended periods when hot water is not required.
2. Means to balance flow rate through each supply riser or piping zone
3. (Seattle) Self-actuating thermostatic balancing valve for systems with multiple risers and variable flow pump

(Seattle exception) Groups R & I don't need control to shut off 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

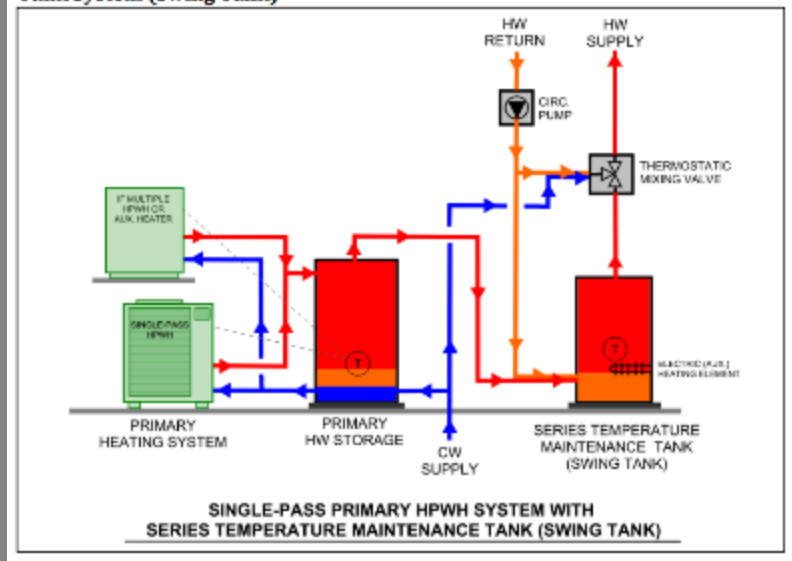


Pasadena, CA
2022 Completion
77 Unit Senior Housing

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)



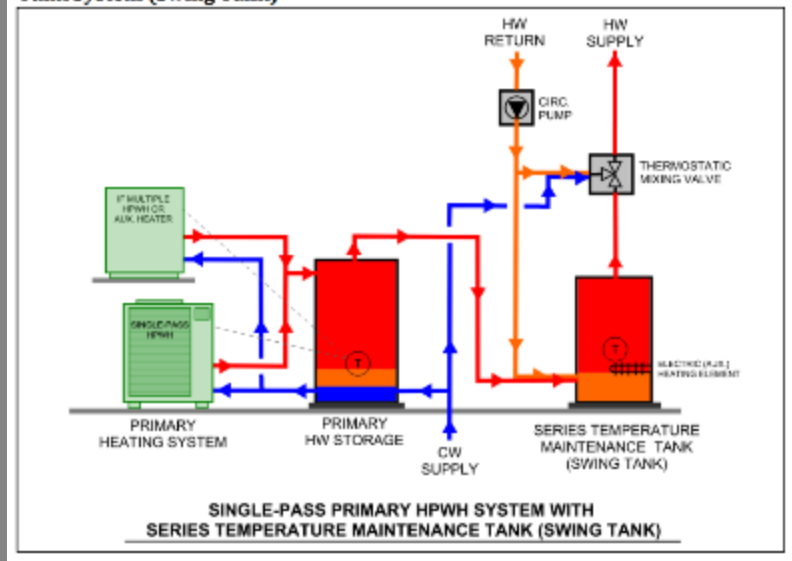
SINGLE-PASS PRIMARY HPWH SYSTEM WITH SERIES TEMPERATURE MAINTENANCE TANK (SWING TANK)

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

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

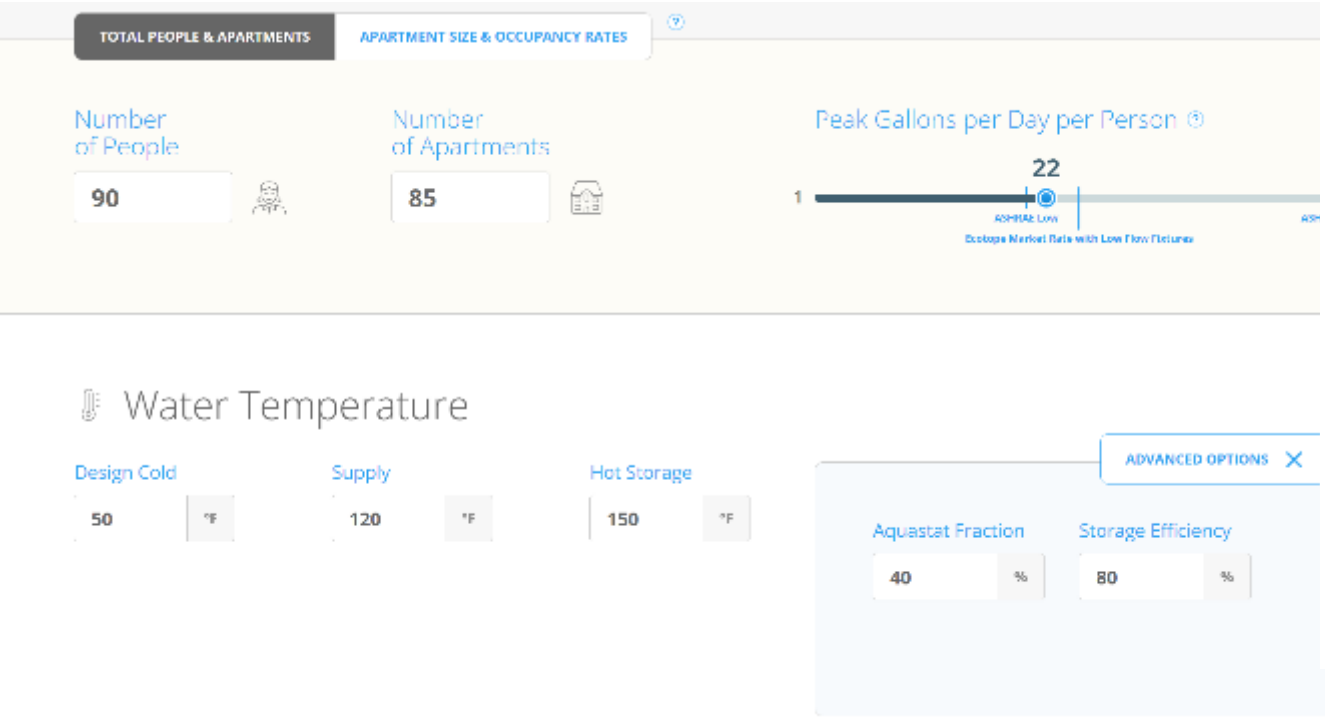
C404.2.1.1 Primary heat pump system sizing. The primary heat pump service water heating system shall be sized to deliver no less than **((~~50~~)) 100 percent** of the calculated demand for service hot water production during the peak demand period. Demand shall be calculated using the equipment manufacturer's selection criteria or another *approved* methodology with entering dry bulb or wet bulb outdoor air temperature **at 40°F** (4°C) for air source heat pumps or 44°F (7°C) ground temperature for ground-source heat pumps. Electric air source heat pumps shall also be sized to deliver no less than **((~~25~~)) 50** percent of the calculated demand for service hot water production during the peak demand period when entering dry bulb or wet bulb outdoor air temperature is **24°F** (-4°C). The remaining primary service output may be met by ((~~fossil fuel,~~)) electric resistance, or heat pump water heating systems.

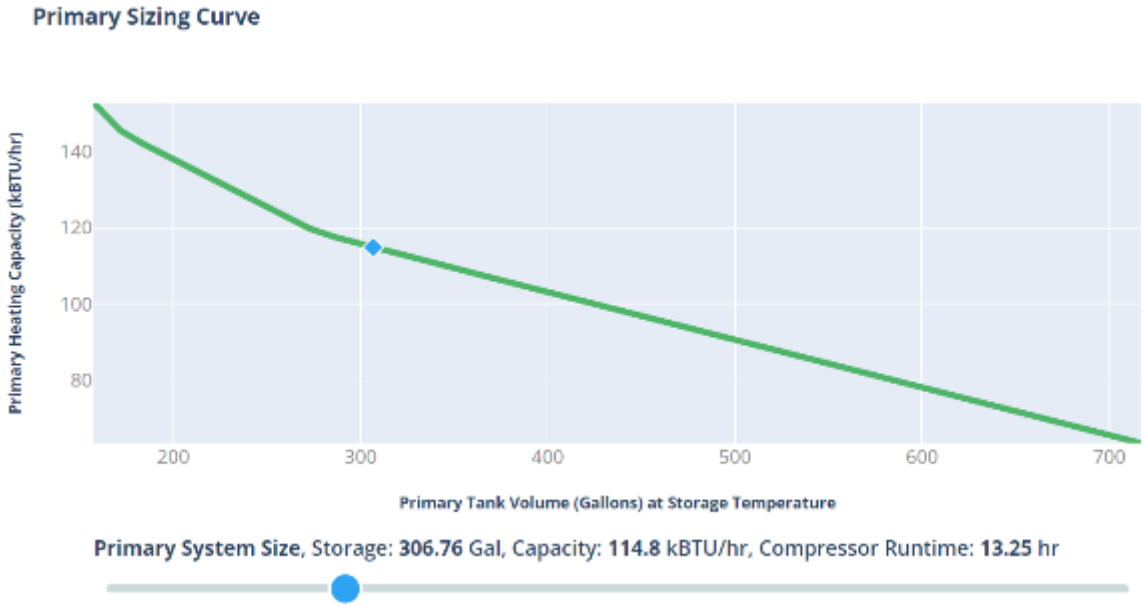
Exceptions: 1. ((~~25~~)) 50 percent sizing at 24°F is not required for heat pumps located in a below-grade enclosed parking structure or other ventilated and unconditioned space that is not anticipated to fall below 40°F at any time.

2. Allowable replacements: (Wastewater heat recovery, solar thermal, water-source heat pump system utilizing waste heat from year-round mechanical cooling loads)

Ecosizer™

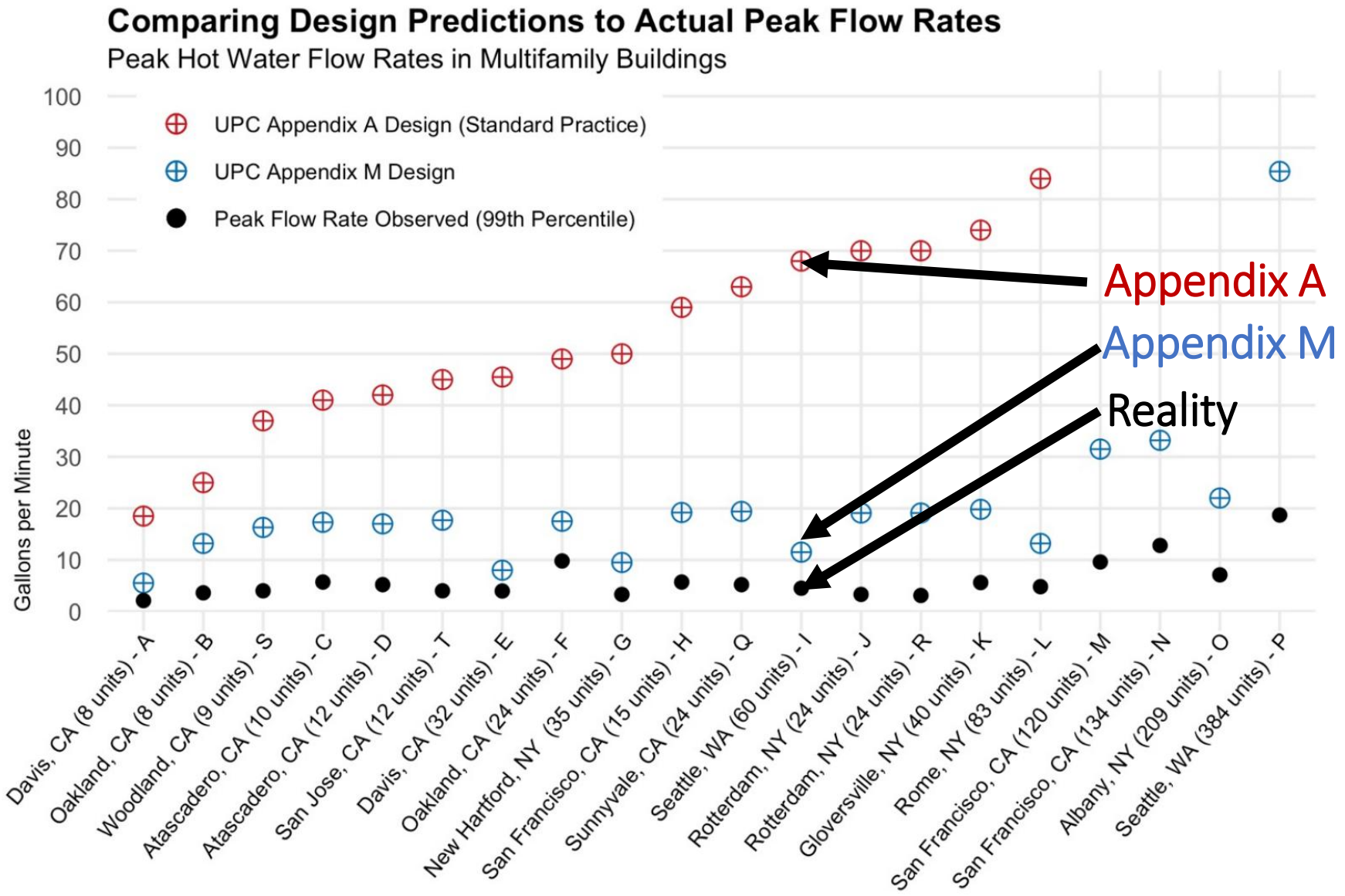
https://ecosizer.ecotope.com/sizer/





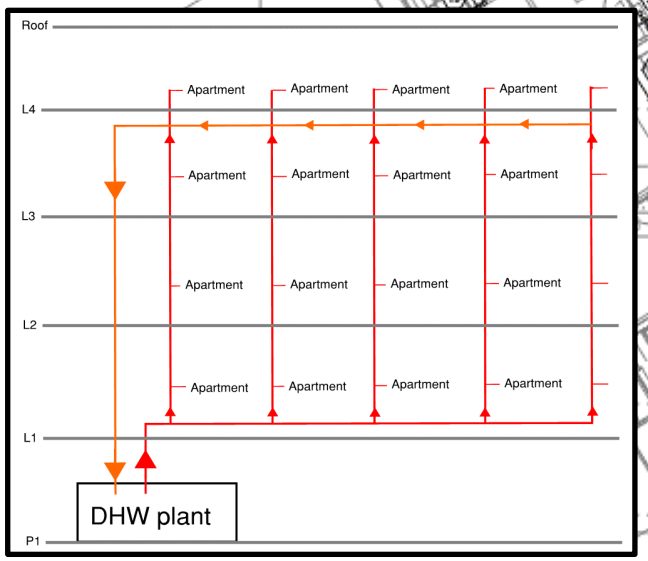
What Else Do You Want From Ecosizer?
Email – Info@ecotope.com
Subject: Ecosizer Request

Hot Water Pipe Sizing



2050 PARTNERS
DECARBONIZATION EXPERTS

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



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.

Single-pass: *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.

Multi-pass: recirculated *temperature maintenance* water is permitted to be returned to the primary water storage tanks for reheating.

Unitary: 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. If heat in indoor air comes from heat pump or waste heat.

Central system vs. in-unit: Pro & Con

Central system

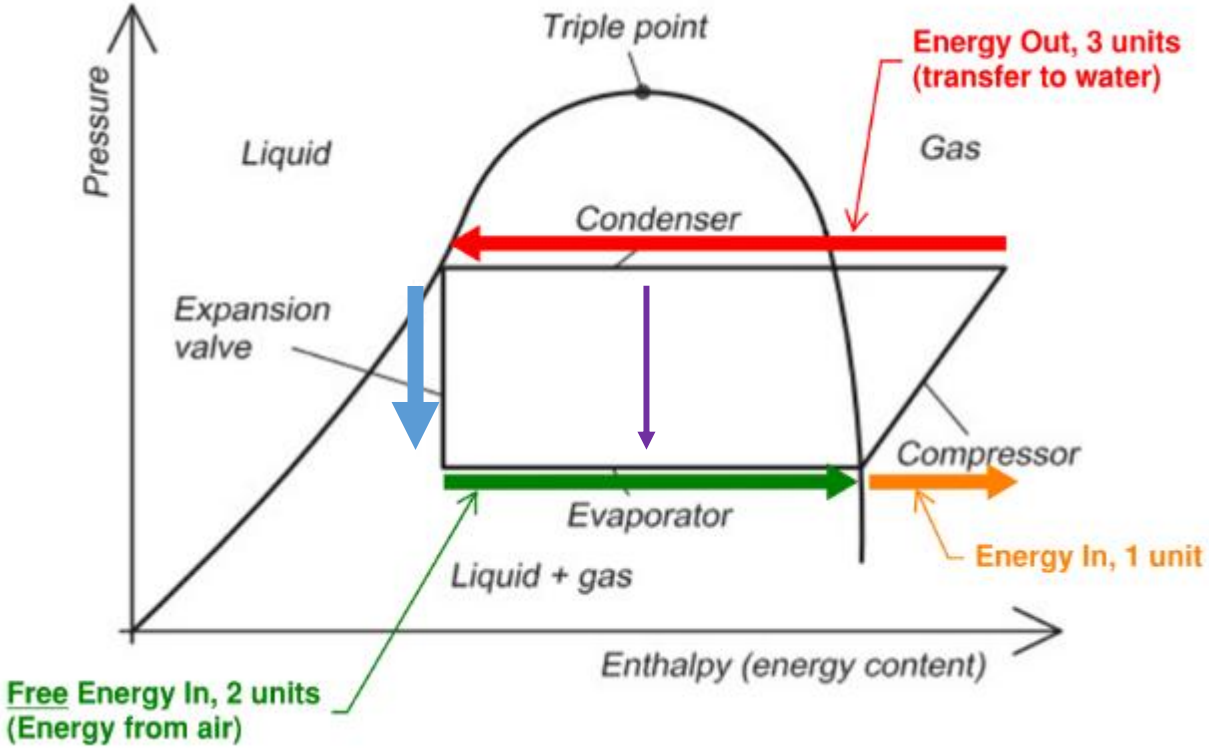
- All in one location
- Use garage or roof space
- Separate hot water meter already required for each apartment, so can direct bill to tenant

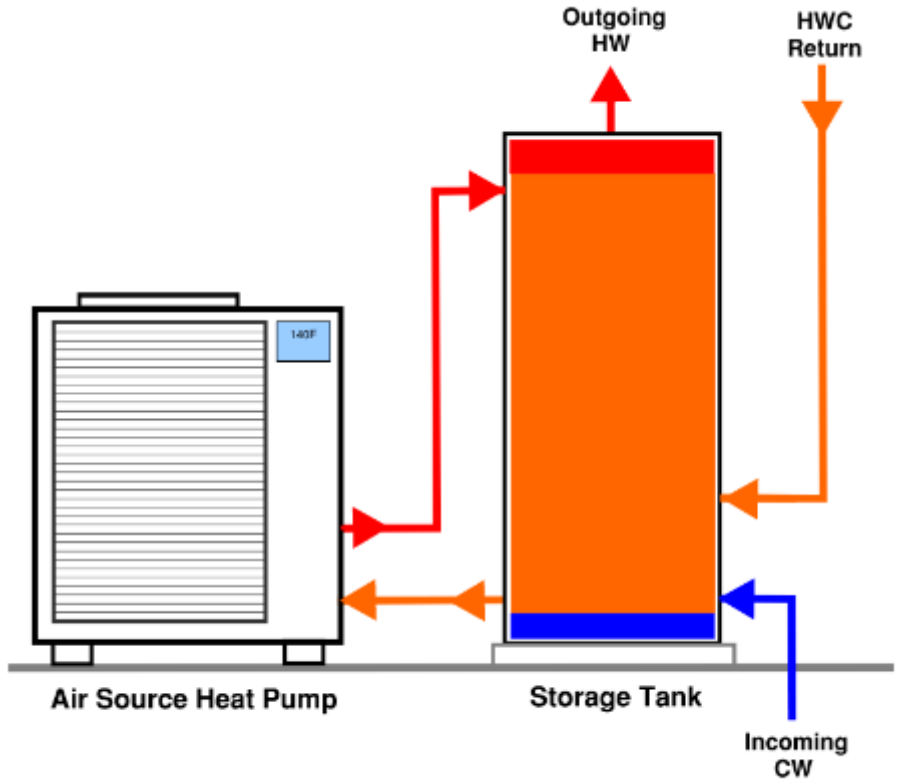
In-unit water heaters

- Have to maintain 102 separate units
- Leakage damage risk to interiors
- If HPWH in closet, can cause condensation & mold
- If HPWH, comfort complaints from cool air exhausted into smaller space
- Billing included in tenant electric bill

HW Distribution System

Impact on Thermal Stratification



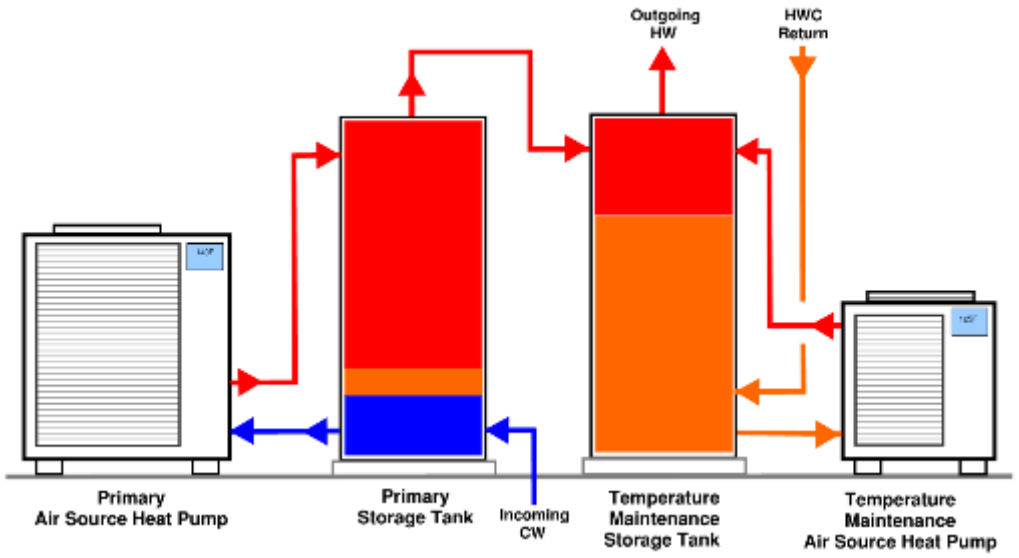


HWC Return to Primary Storage Tanks

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

Thermal Stratification and System Performance

Single-pass HPWH = Dedicated Systems

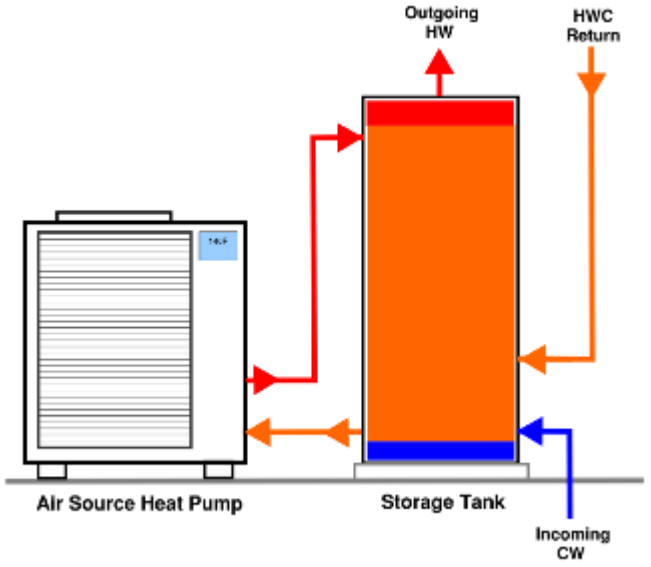


Primary and Temperature maintenance heaters tuned to load HPWHs that are tuned to the load

Advantages:

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

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

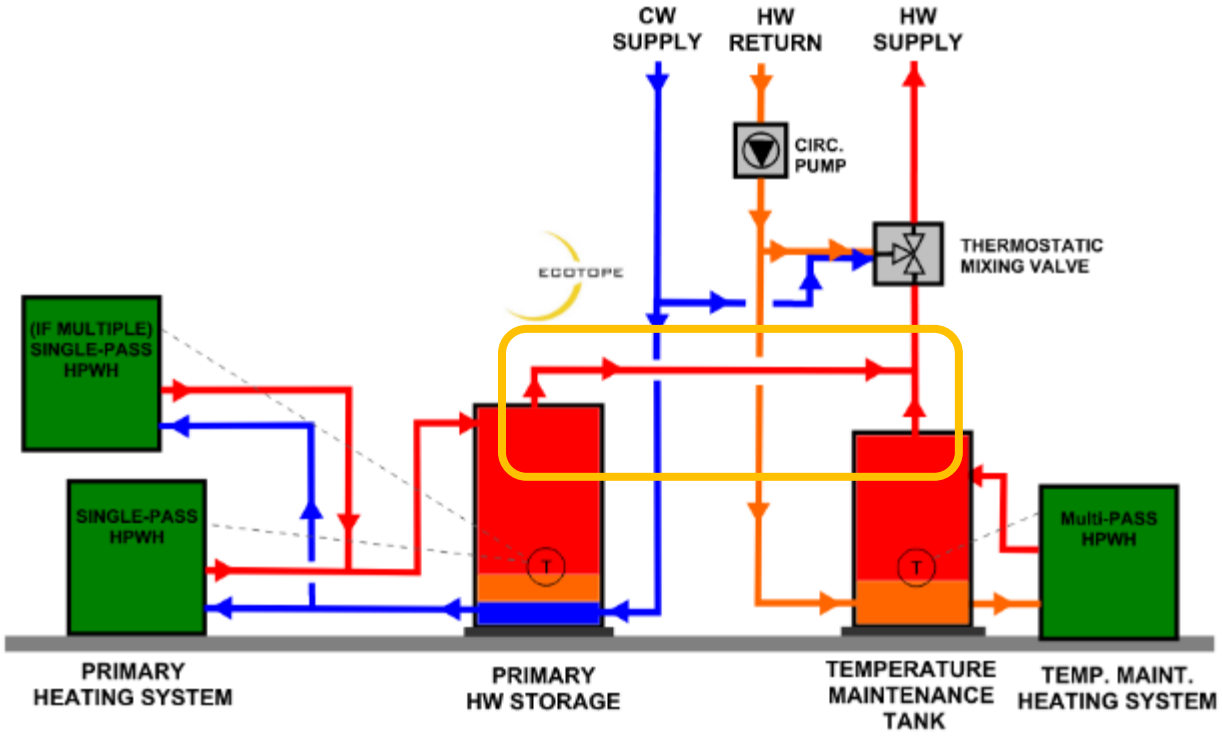


Primary and temperature maintenance loads heated by a HPWH(s)

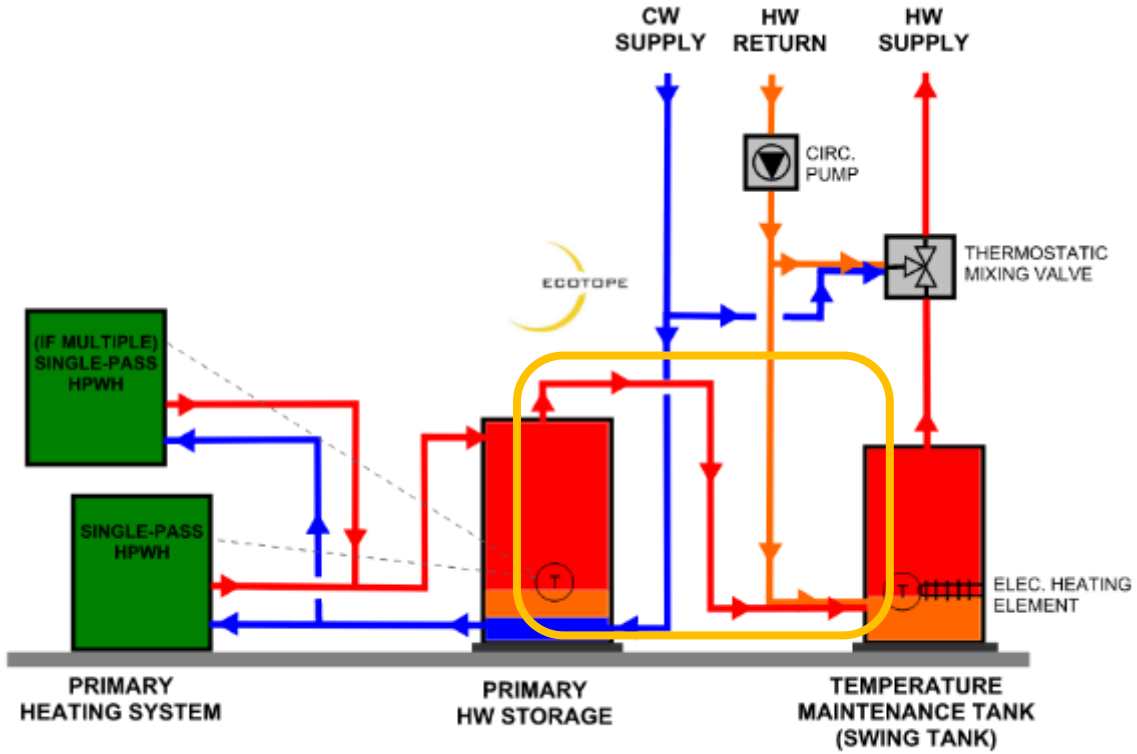
Challenges:

- 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

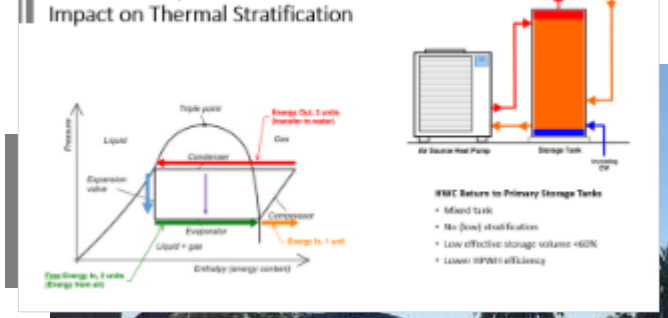
Two Options for Temperature Maintenance



SINGLE-PASS PRIMARY HPWH SYSTEM WITH PARALLEL LOOP TANK



SINGLE-PASS PRIMARY HPWH SYSTEM WITH SWING TANK



55 Tons
1,000 Gallons

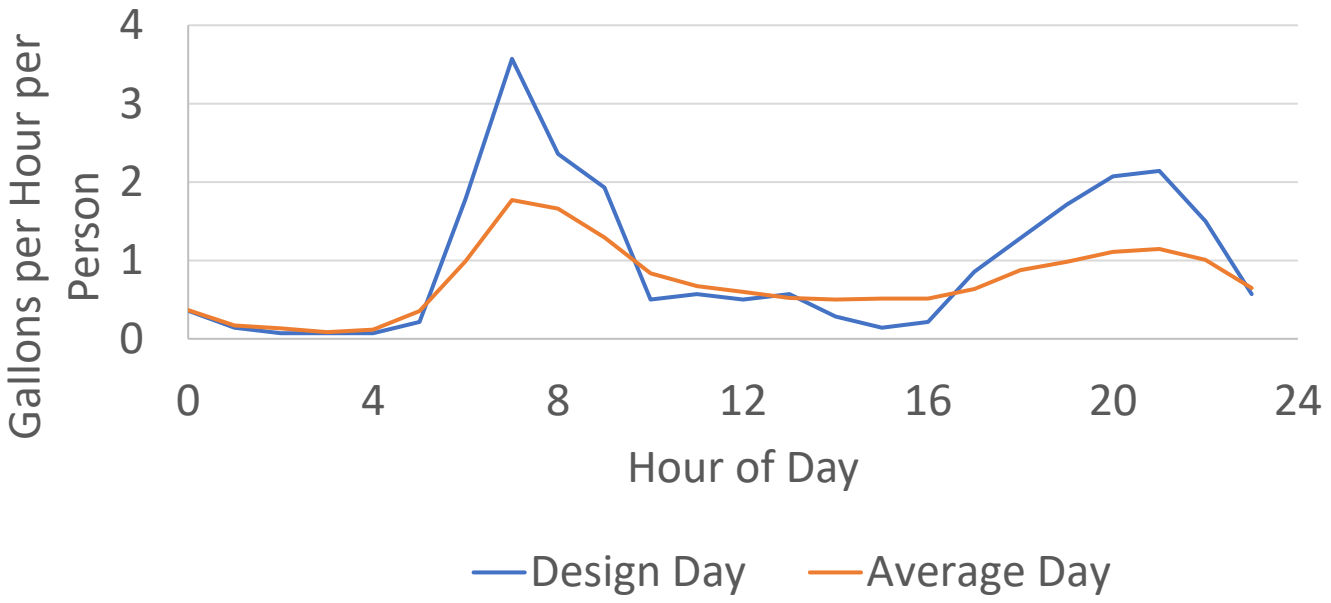
5 Tons
520 Gallons

2. Central HPWH System Sizing

Supplemental heat OK for:

- Temp maintenance for circulating water
- Defrost
- Heat trace
- Backup or low air temp, if:
  - No greater than heat pump output at 40°F
  - Entering air temp is below 40°F
  - Equipment failure
  - Compressor heat can't satisfy demand
- Elec resistance *or* fossil fuel OK

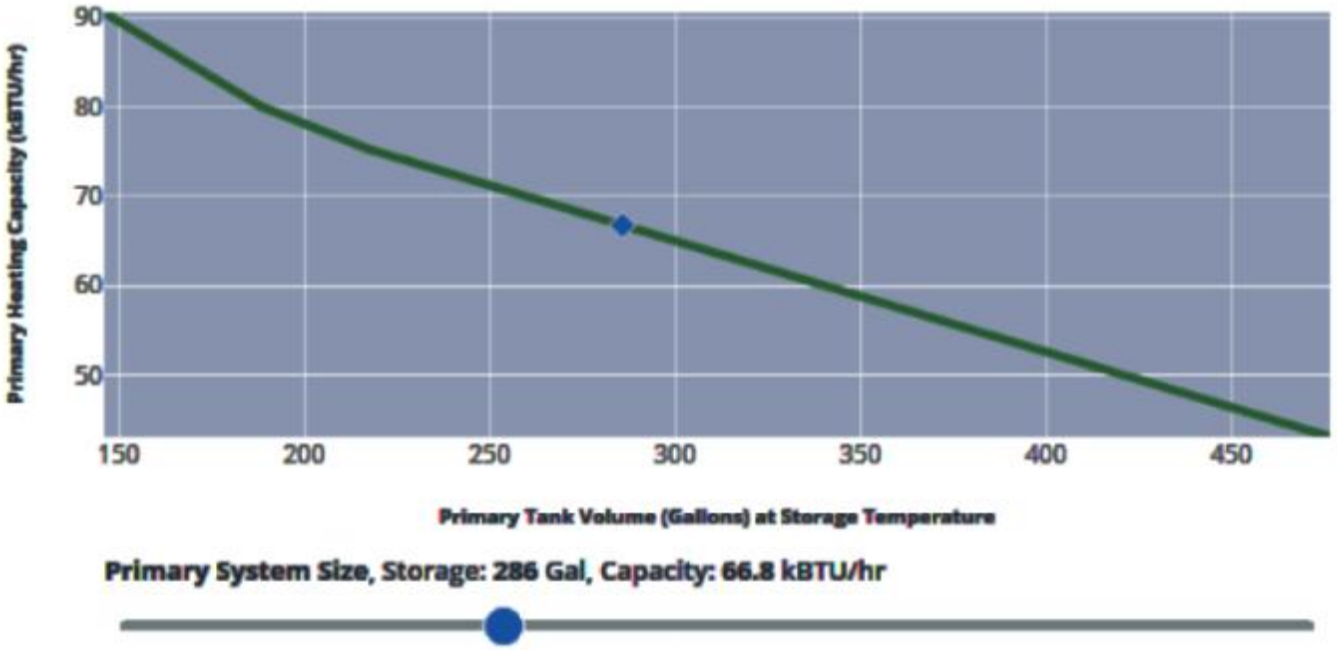
Domestic Hot Water Load



- **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

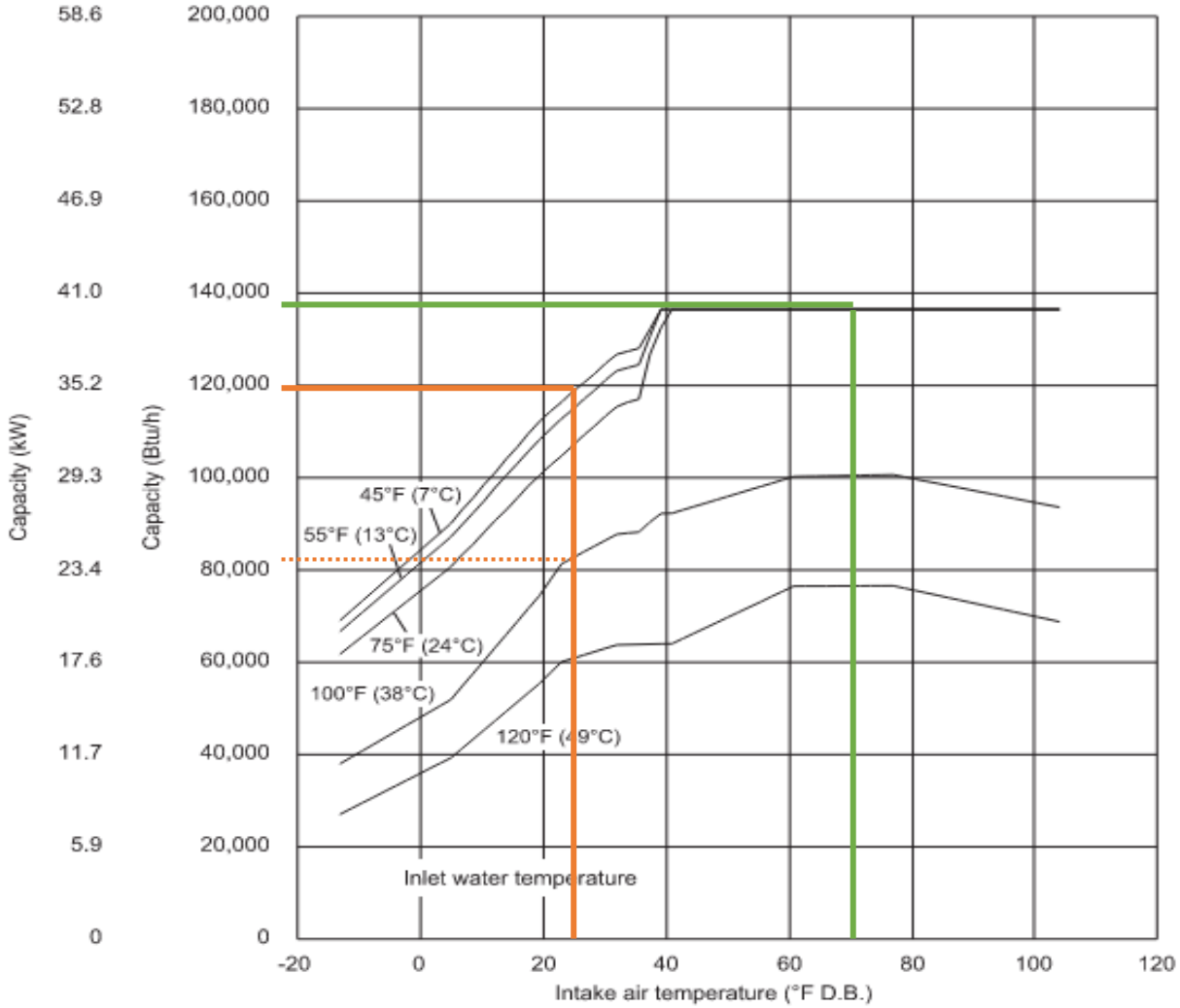
Heating Capacity
66.8 kBTU/hr

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

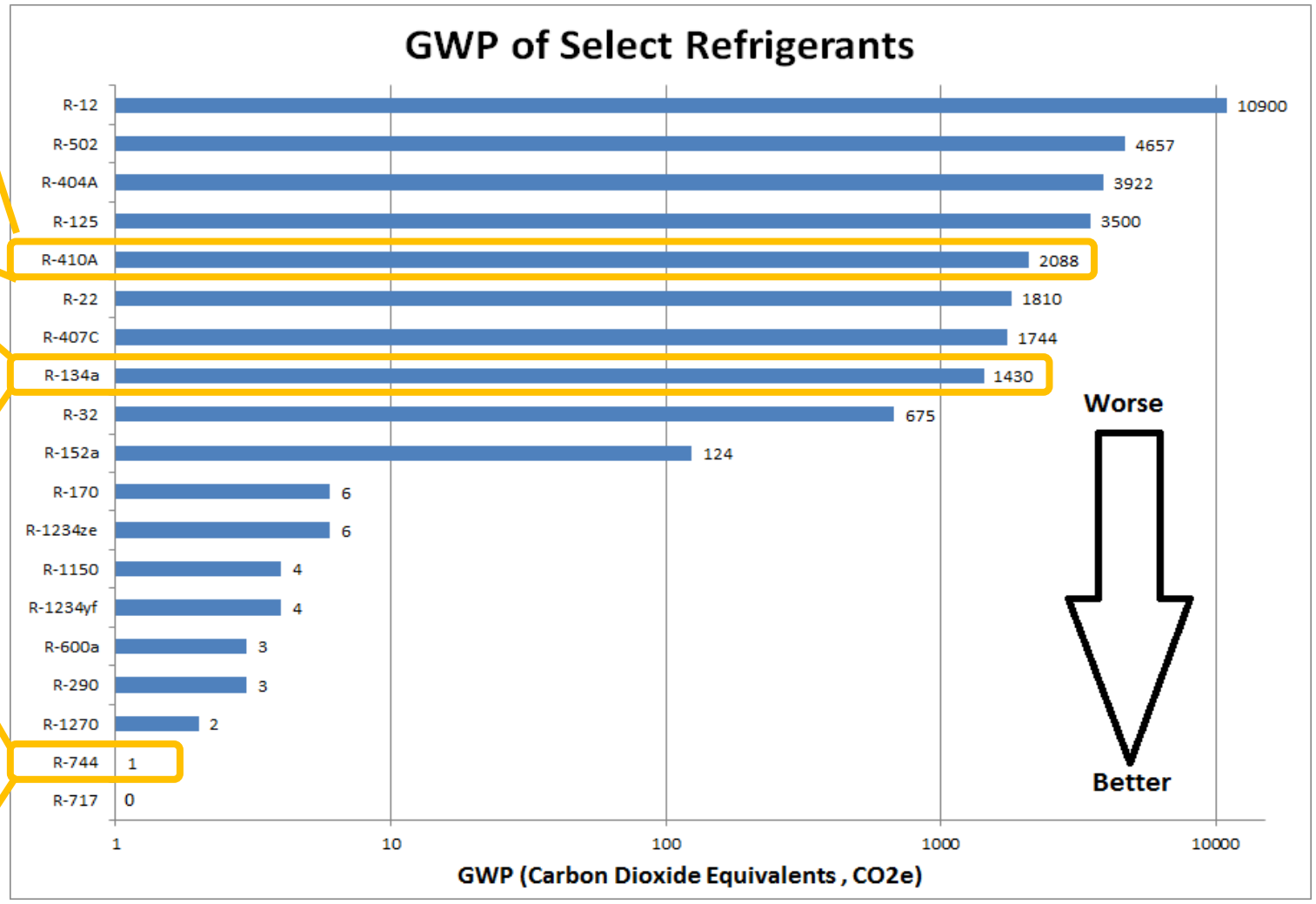
vs.

Heat capacity at design air conditions

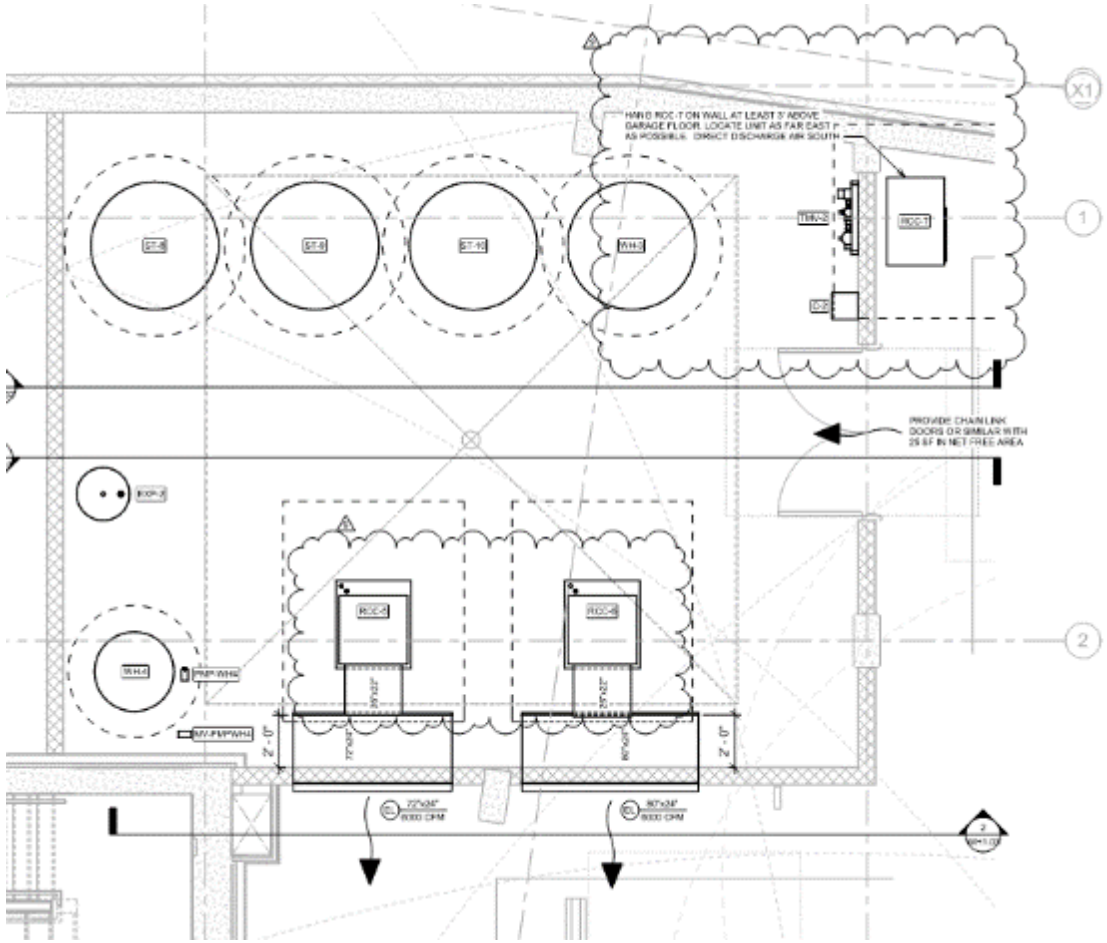
3. Refrigerant & Equipment Selection

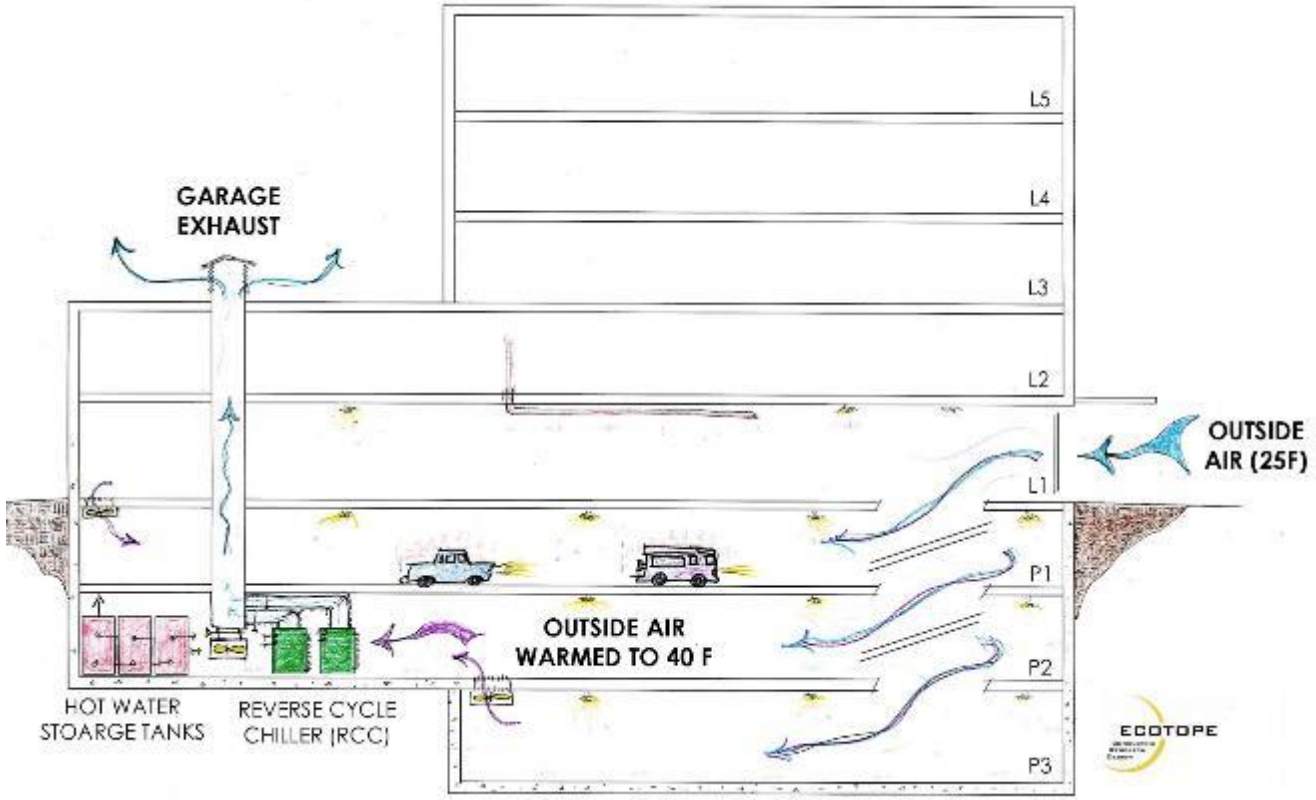
Refrigerant Types

	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

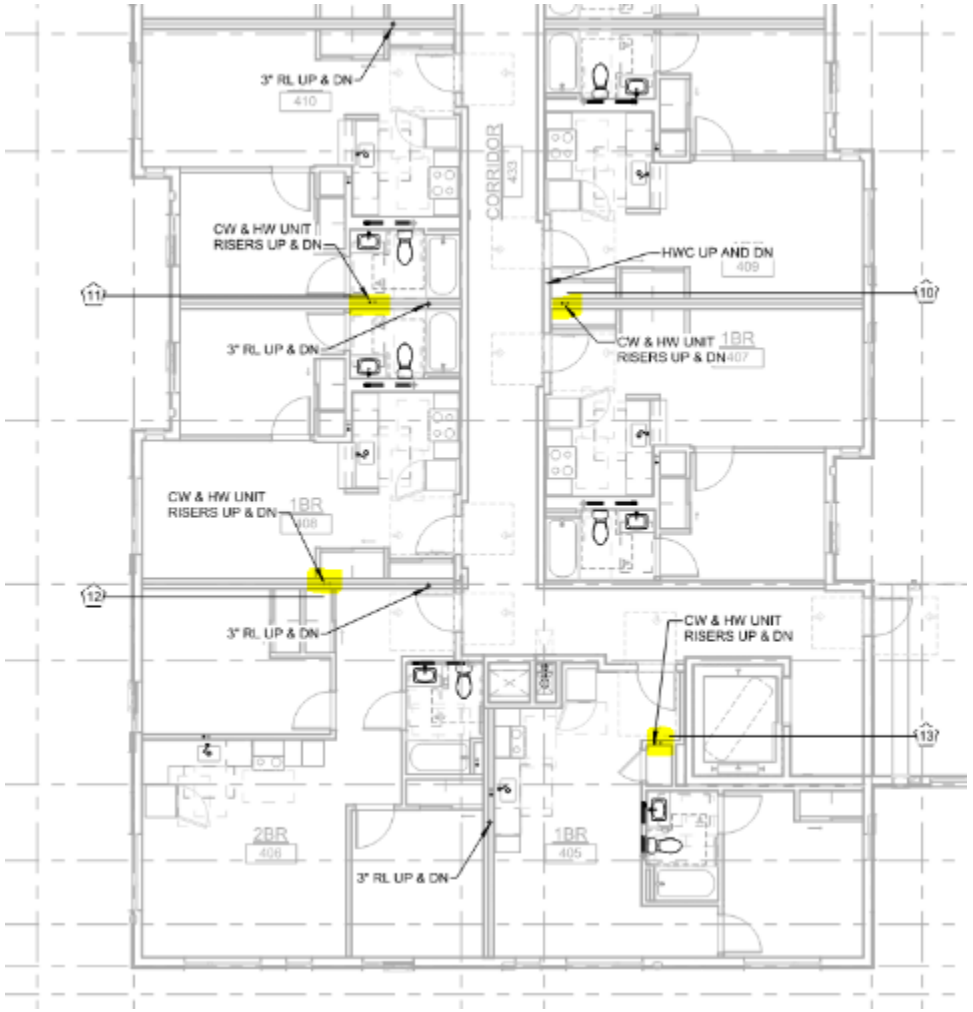
Appendix M sizing

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 just parrots he 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

Seattle: 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.

WA plumbing fixture standards

- **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)

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

In stud space = R-3 insul

(Table C403.10.3)

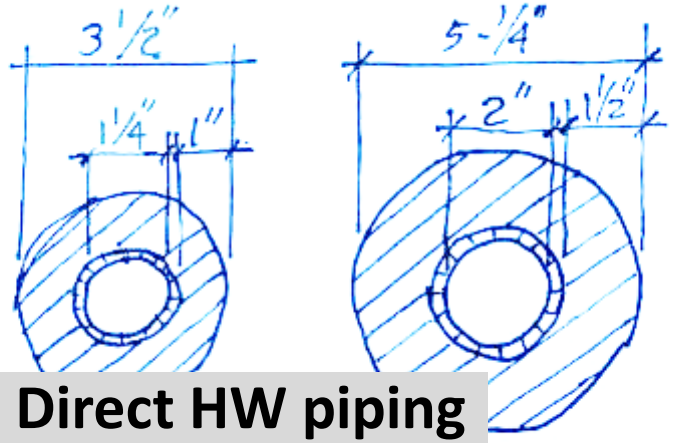
Circulation Loop 1” thicker

Less than 1-1/2” = 2” insulation

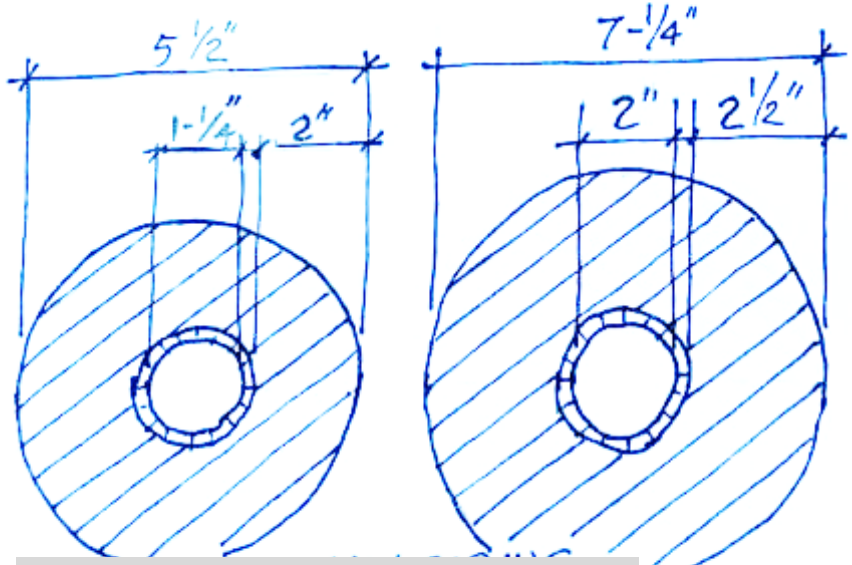
1-1/2” & up = 2-1/2” insulation

In stud space = 2” insulation

(SEC C404.7.3.1)



Direct HW piping



Circulating HW piping

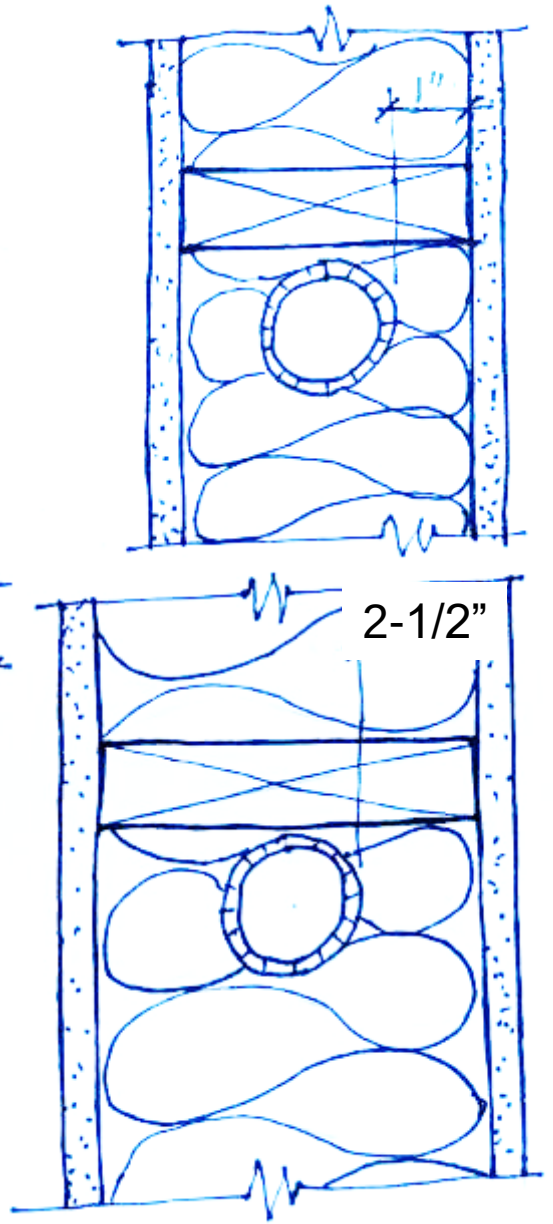


Table C404.6
Required Pipe Insulation Thickness for Service Water Heating

		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	105 – 140°F	1.0	1.0	2.5	2.5	2.5	0.21 - 0.28	100
	141 – 200°F	1.5	1.5	3.0	3.0	3.0	0.25 - 0.29	125
In-partition[a] All other piping	105 – 140°F	1.0	1.0	1.5	1.5	1.5	0.21 - 0.28	100
	141 – 200°F	1.0	1.0	2.0	2.0	2.0	0.25 - 0.29	125

Refrigerant piping insulation - Seattle

C403.10.4 Insulation of HVAC system refrigerant piping. Field installed HVAC refrigerant piping, protected from damage.

Minimum hot gas line insulation:

- 1-inch outside building thermal envelope.
- 1/2-inch inside building thermal envelope

Minimum liquid line insulation

- 1/2-inch for mini-splits, or others if required by manufacturer
- None for other heat pump types or for cooling-only units where manufacturer doesn't require insulation

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 – Seattle clarifications

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

and

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
  - Not just “extended periods”
- OK to turn ON 4 hours before scheduled occupancy

Thermostatic balancing valve at end of each riser or piping zone.
Controls flow to maintain max 5°F below supply temp

Temperature Maintenance Losses = Watts/Unit

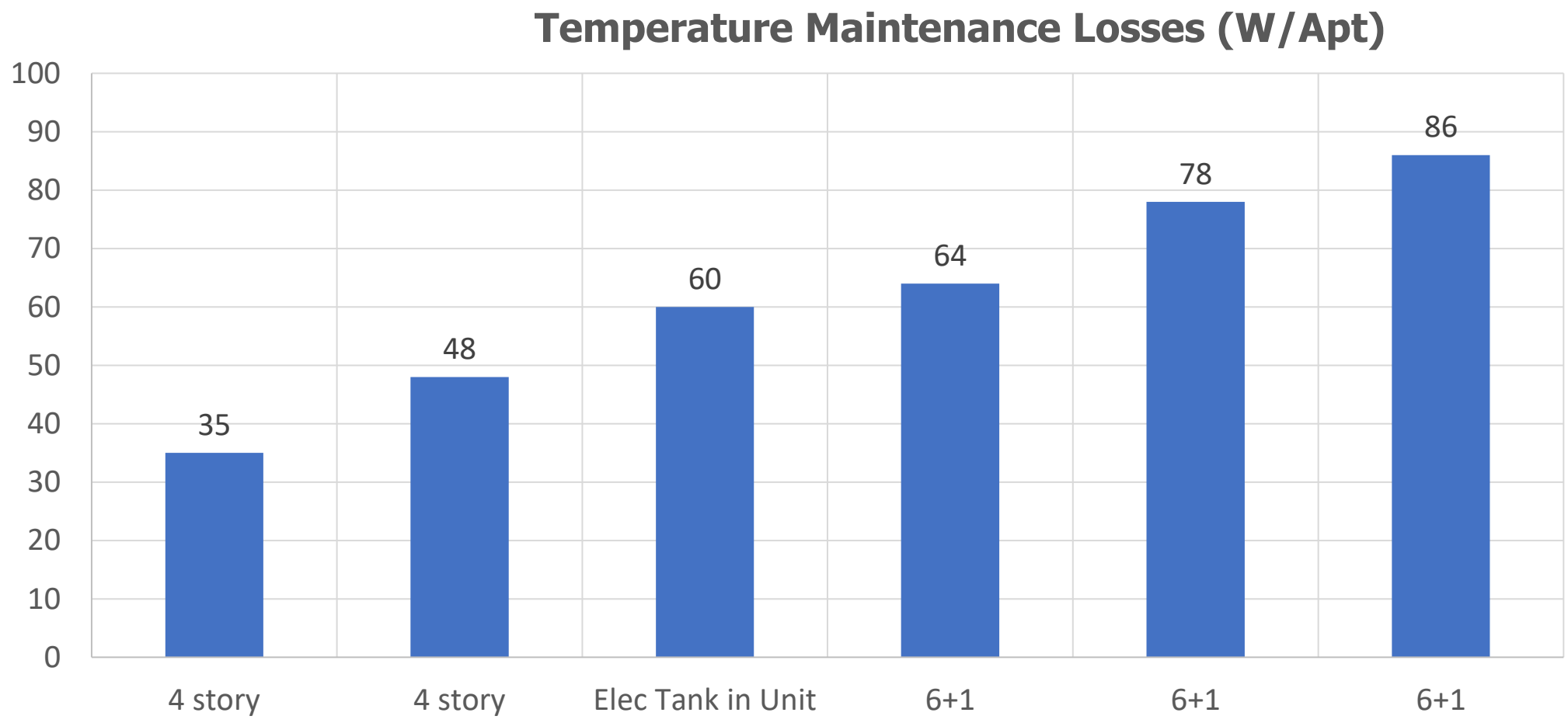
Q = UA*dT

Figure 16. Temperature Maintenance Load

Seasonal Effects - UA

Sampling of Apartments- UA

Temperature Maintenance Losses Sampling of Seattle Apartments



Mixing valve (Seattle & WA)

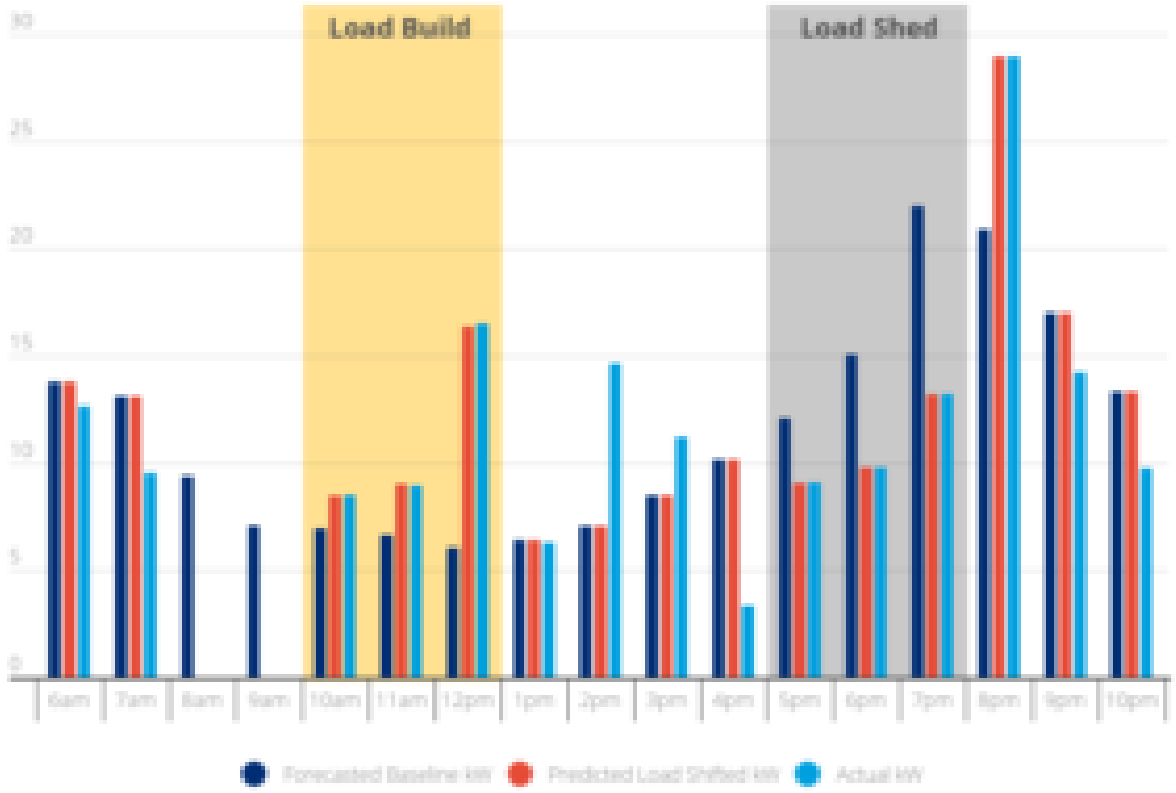
C404.7.1.3 Electronic thermostatic mixing valve (TMV). Where a heated water circulation system utilizes an electronic TMV to control the temperature of hot water supplied to the building, the TMV shall be configured so that it either **reverts closed (fully COLD)** or **maintains its current valve position** 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 C404.14

- Demand response required only for
  - For electric storage water heaters:
  - between 40 and 120 gallons, and
  - 12 kW or less
- ANSI/CTA-2045-B Level 2 (or approved)
- Exceptions – water heaters with:
  - Delivery temp 180°F or higher
  - Use 3-phase power
  - Compliant with ASME Boiler & Pressure Vessel Code
    - Section IV, Part HLW, or;
    - Section 10
  - *Demand responsive controls* that can initiate water heating via a demand response signal, and comply with
    - ANSI/CTA 2045-A or
    - ANSI/CTA 2045-B Level 1



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

Problem with Group M!

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	41	42	48	74	49
Building additions energy efficiency credit requirement	C406.2	27	20	21	23	36	21
New building load management credit requirement	C406.3	12	15	27	15	13	26

Hot water C406 credits

Already in Seattle code

Appendix M

Already in Seattle code

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 (C408.1.1)
- Cx plan submitted before first mech inspection (C408.1.2)
  - And in-house Cx disclosure & conflict management plan
- Cx report submitted before final inspection (C408.1.3)
  - And Cx checklist
  - And owner's acknowledgement
- **Post-occupancy Cx completion**: (C408.1.4.1.1) If any unresolved deficiencies or incomplete Cx tasks:
  - TCO, or;
  - Bond for 2% of project valuation, or;
  - Show remaining Cx work on new mechanical permit

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:

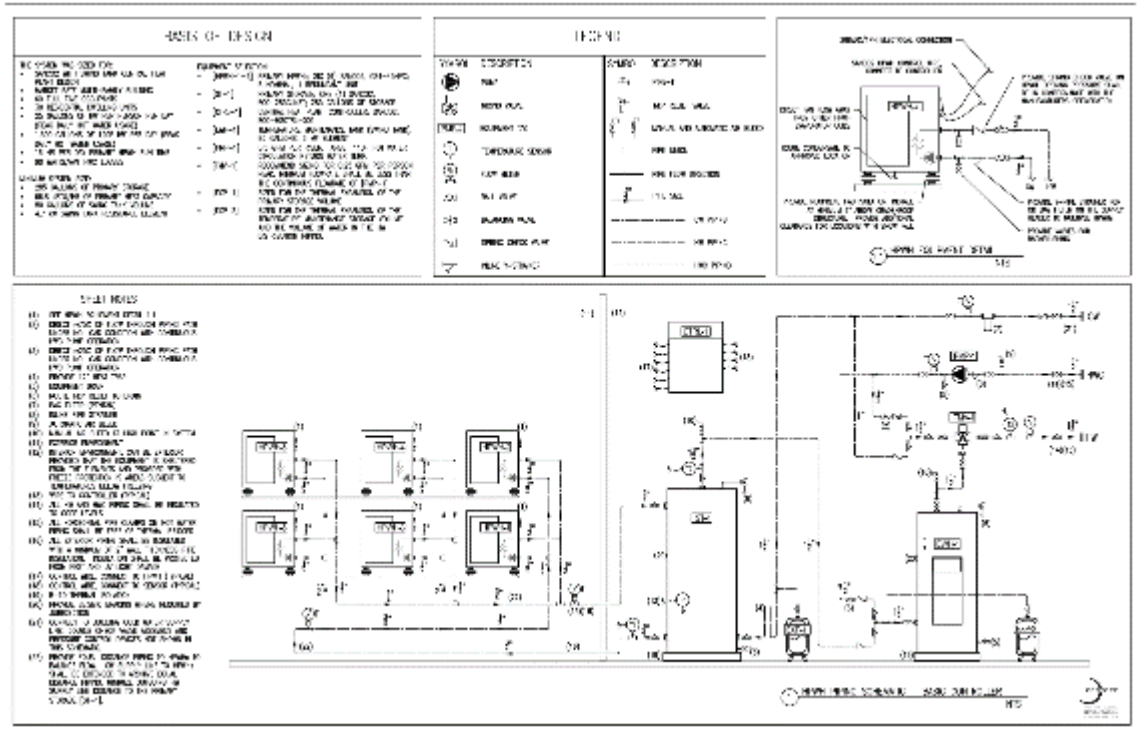
1. *Dwelling unit*s.
2. Sleeping units.
3. Commercial kitchens.
4. Central laundries.

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

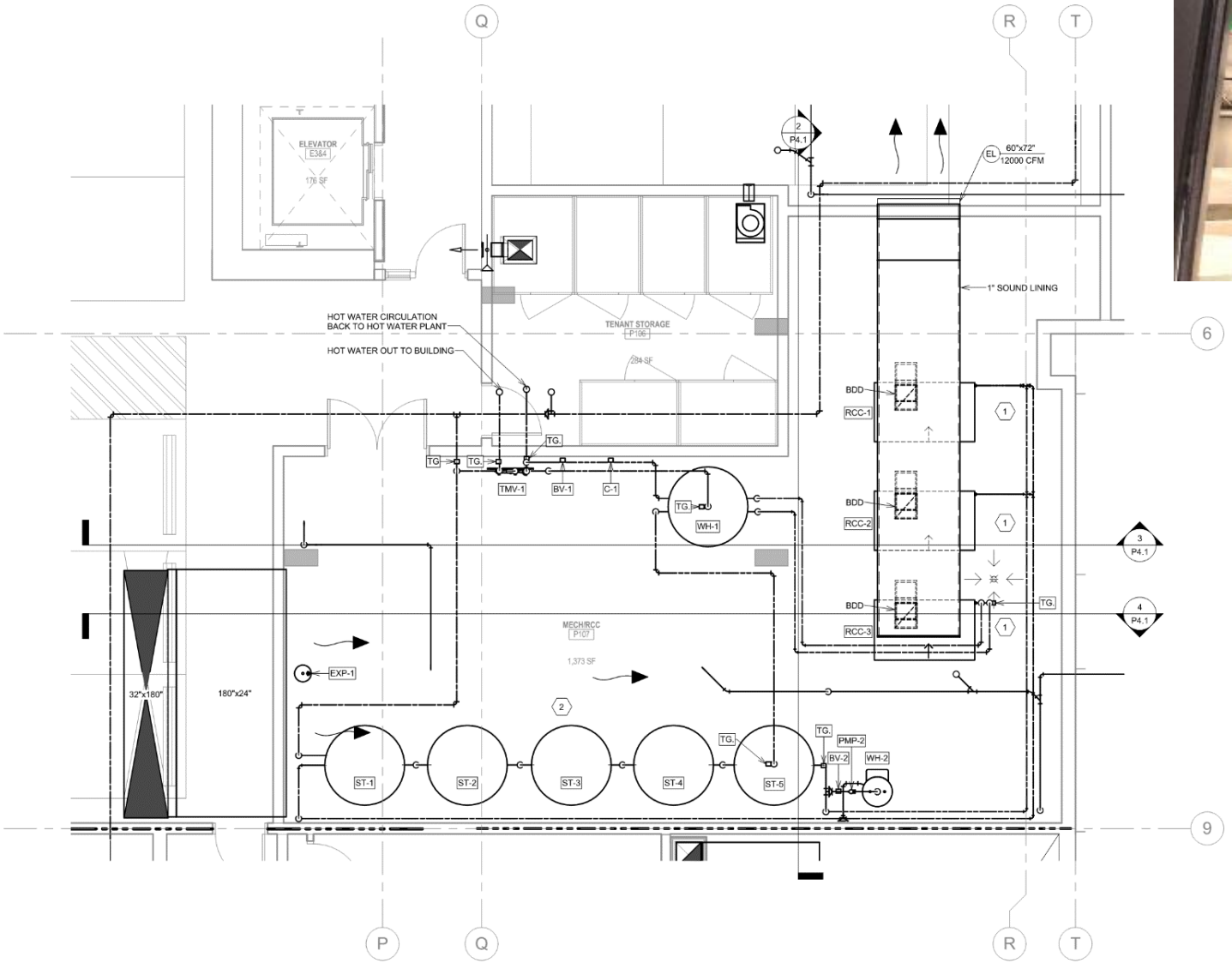
C409.3.2 Service water heating energy use. This category shall include all energy used for heating of domestic and service hot water, but not energy used for space heating.

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

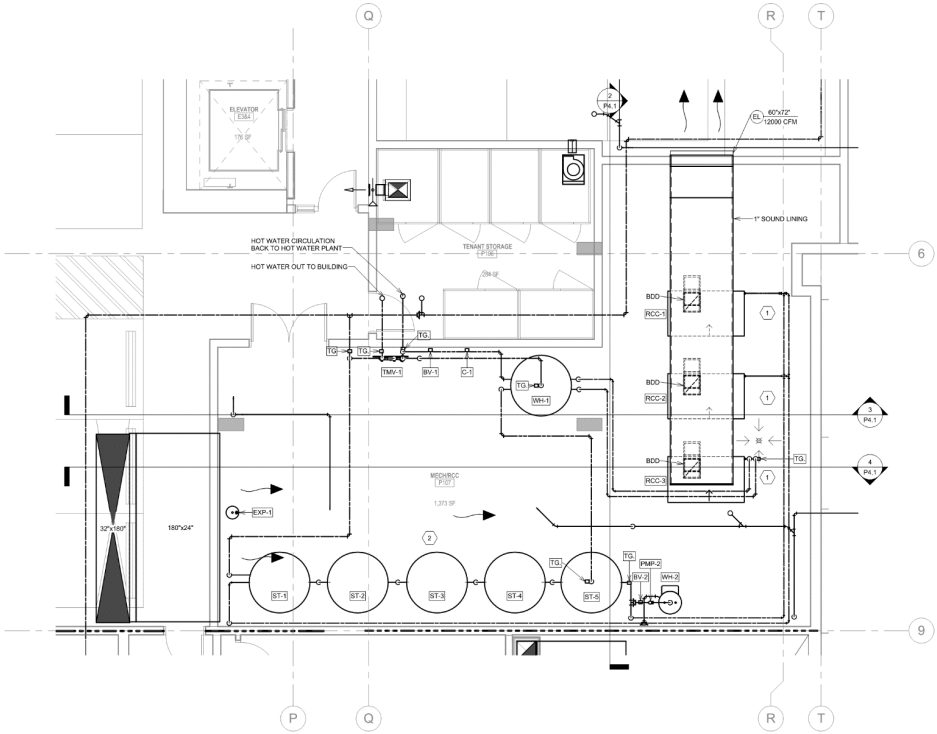
CO2 Central HPWH system



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**

SWH: Washington Code for Existing Buildings

New system must comply with

- C404 SWH, plus:
  - C408.3 SWH Commissioning
  - C409.5 Metering
  - C501.6 Commissioning

Exceptions: replacement of:

- Electric water heaters max 12 kW
- Gas storage water heaters max 75 kBTU/h
- Gas instantaneous water heaters max 200 kBTU/h (2 gallons max storage)

SWH: Seattle Code for Existing Buildings

New SWH systems comply with C404

Altered SWH systems comply with C404, plus

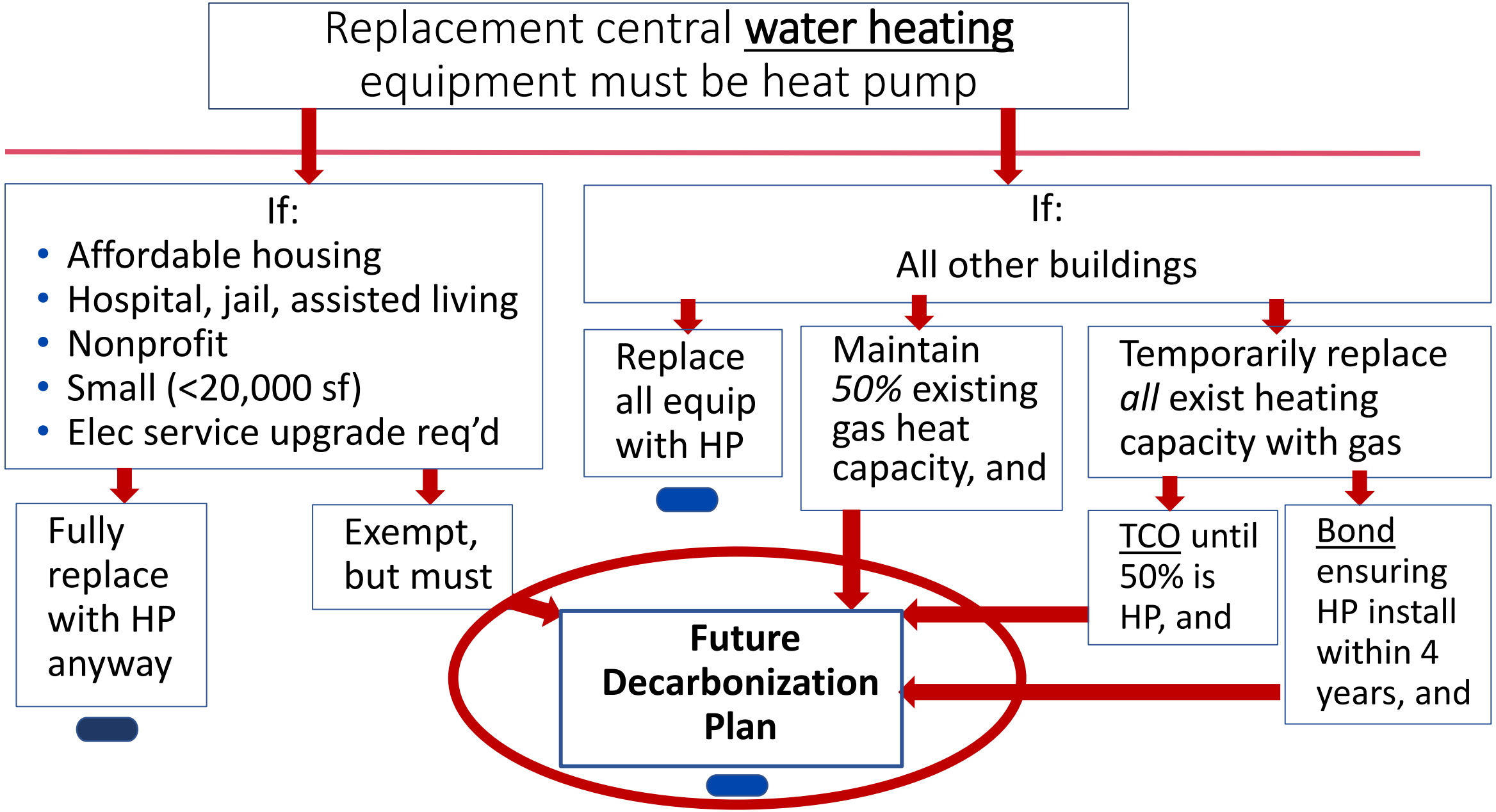
- C501.6 (Commissioning) &
- C506.1 (Metering)

Exceptions:

- Major electric service upgrade triggered by the change to heat pump water heating
  - New or enlarged vault
  - Trenching across traffic lanes
  - Service upgrade over 50% of valuation
- Small equipment replacement
  - Electric water heaters max 24 kW
  - Gas storage water heaters max 75 kBTU/h
  - Gas instantaneous water heaters max 200 kBTU/h (2 gallons max storage)

More exceptions:

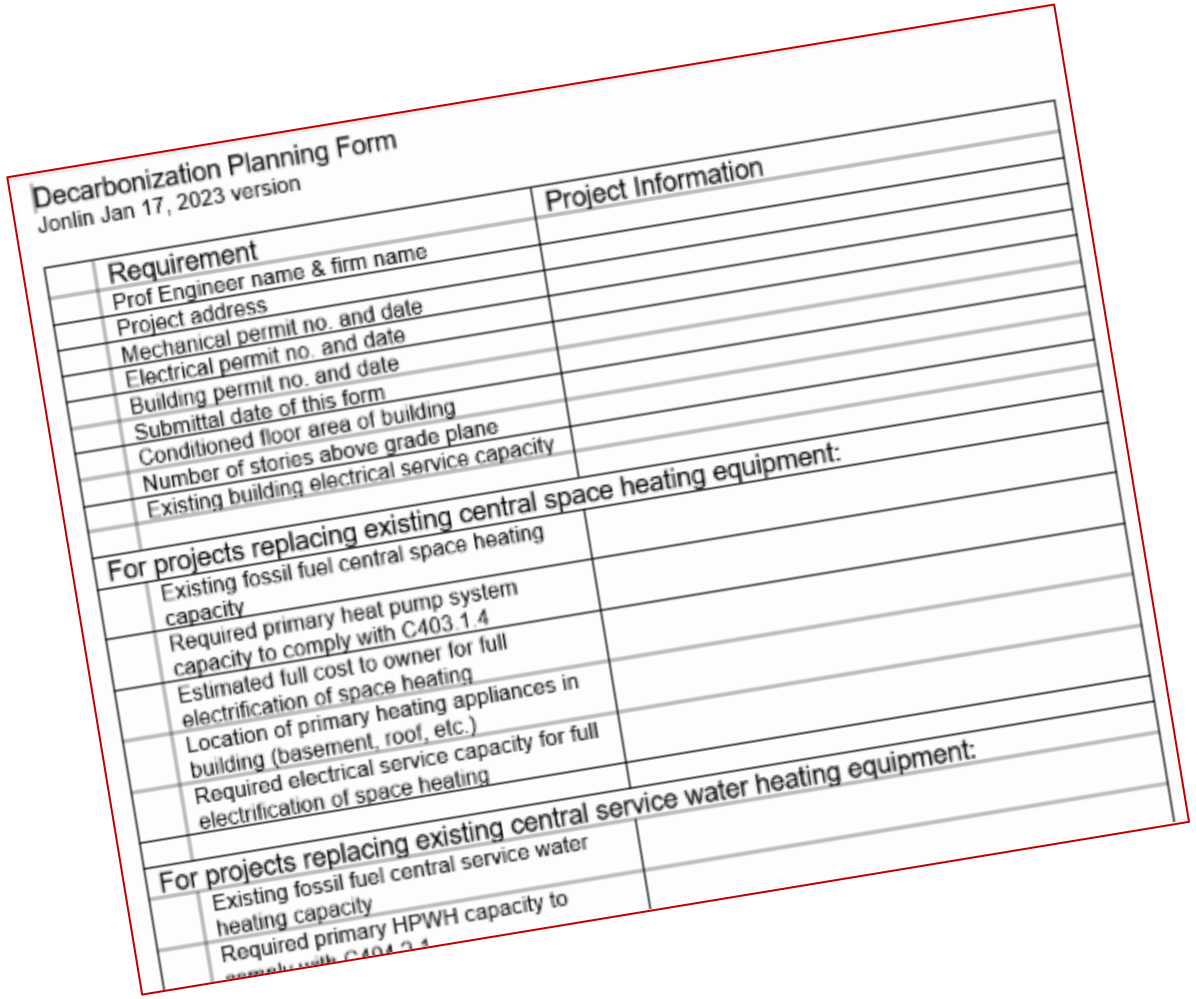
- Exempt buildings
  - Affordable housing
  - Group I-1, I-2, I-3 (assisted living, hospital, nursing home, correctional)
  - Occupied by nonprofit organizations
- Partial switch: OK to maintain 50% of existing gas or electric resistance equipment capacity
  - If the heat pump 50% is first stage of heating
- Temporary 100% switch: OK to maintain 100% of existing capacity
  - If only a temporary C of O is issued, or;
  - If a bond is posted agreeing to build the 50% heat pump capacity within 4 years.


Replacement central 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 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

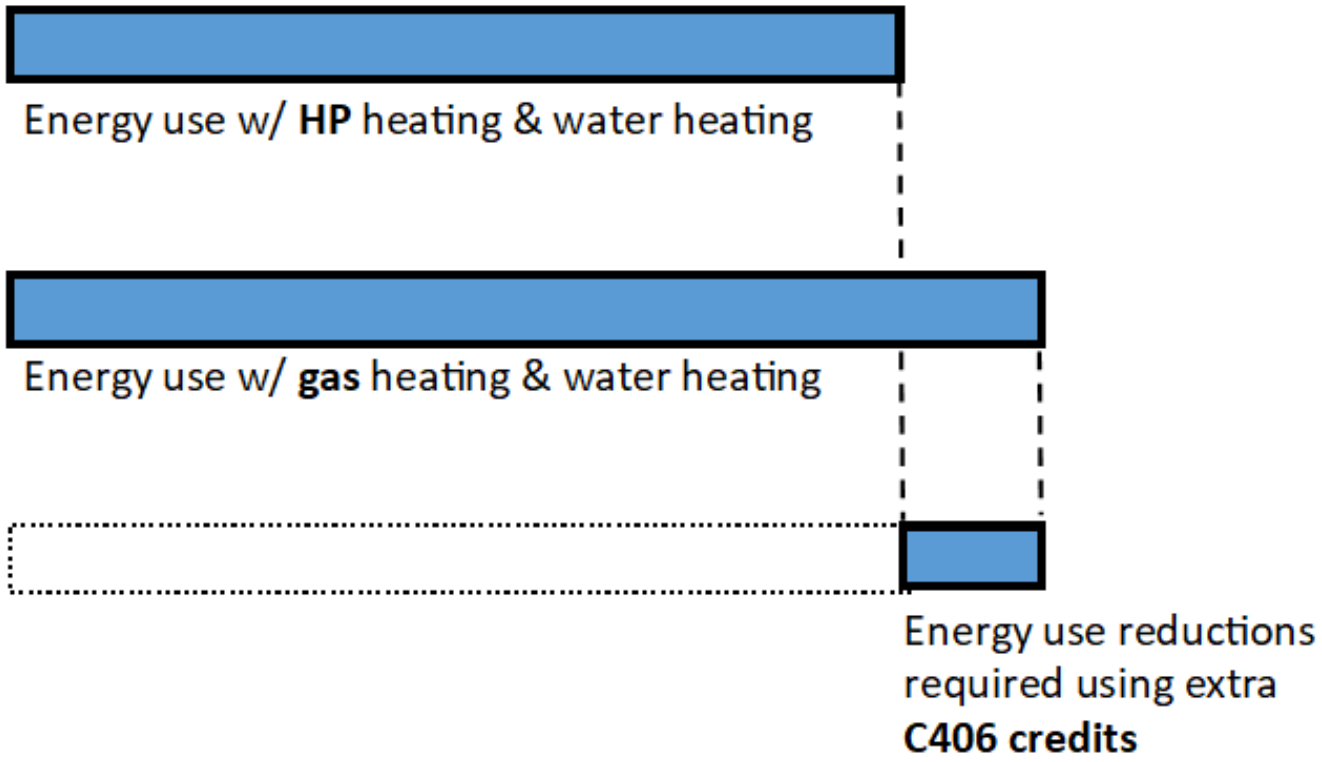
Requirement	Project Information
Prof Engineer name & firm name	
Project address	
Mechanical permit no. and date	
Electrical permit no. and date	
Building permit no. and date	
Submittal date of this form	
Conditioned floor area of building	
Number of stories above grade plane	
Existing building electrical 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	

Fossil Fuel Compliance Path

When you really want to use gas or heating oil equip

Compliance path explicitly permitting gas heating & water heating, while maintaining overall energy efficiency of heat pump buildings.

1. Calculate difference in annual energy use between buildings using gas & using heat pumps
2. Require sufficient additional C406 credits from buildings with gas equipment to equalize annual energy use.



It’s now the primary code path

CHAPTER 4 [CE]

COMMERCIAL ENERGY EFFICIENCY

SECTION C401
GENERAL

C401.1 Scope. The provisions in this chapter are applicable to commercial buildings and their building sites.

C401.2 Application. Commercial buildings shall comply with the fossil fuel compliance path according to Section C401.3, or with one of the following:

1. Prescriptive ((~~compliance~~)) path. The prescriptive compliance option requires compliance with ((~~Sections C402 through C406, and Sections C408, C409, C410, C411, and C412~~)) all of Chapter 4, other than Sections C401.3 and C407.
2. Total building performance path. The total building performance option requires compliance with Section C407.
3. Appendix F is not adopted by The City of Seattle. ((~~adopted by the local jurisdiction, the requirements of Appendix F, Outcome-Based Energy Budget, Sections C408, C409, C410, C411, C412 and any specific sections in Table C407.2 as determined by the local jurisdiction. The Proposed Total UA of the proposed building shall be no more than 20 percent higher than the Allowed Total UA as defined in Section C402.1.5.~~))
4. Target Performance Path. The requirements of Section C401.5.

The fossil fuel compliance path

C401.3 Fossil fuel compliance path. Buildings complying with the fossil fuel compliance path shall comply with the prescriptive compliance path of this code as defined in Item 1 of Section C401.2, and as modified by this Section C401.3.

C401.3.1 Modification of code requirements. For use of this compliance path only, the following changes shall be made to this code:

1. Section C403.1.4 – Space heating. Strike the phrase "...or fossil fuel combustion..." from the first sentence of Section C403.1.4.
2. Section C404.2.1 – Service water heating. Revise the first sentence of Section C404.2.1 to read: "Service hot water shall be provided by fossil fuel water heating equipment, electric air-source heat pump water heating equipment, electric resistance water heating equipment, or a combination of these equipment types meeting the requirements of this section."
3. ((~~Section C406.2.5 Renewable energy. When determining renewable energy credits in Equation 4-17 of Section C406.2.5, strike the phrase "...limited to 50 percent of the required credits in Section C406.1" in the definition of the factor AEC_{RRa}~~)) Reserved.
4. Table C406.2(1) – Efficiency measure credits. Use Table C406.2(2) credit values in place of Table C406.2(1) credit values.

C401.3.2 Fossil fuel equipment. Fossil fuel combustion appliances are permitted for HVAC heating, and shall comply with the applicable efficiency standards referenced in Section C403.3.3.2. Fossil fuel combustion appliances are permitted for service water heating, and shall comply with applicable efficiency standards referenced in Table C404.2.

Credits & exceptions

Exceptions:

1. Low energy space
50% table credits

2. Small additions
50% table credits

3. Semi-heated space
50% table credits

4. Garages and other unconditioned spaces – No credits

C401.3.3 Additional efficiency credits. The number of additional efficiency credits required by Table C406.1 shall be increased by the number required in Table C401.3.3, modified as permitted in this section, and is in addition to the energy efficiency credits and load management credits required by Section C406.

EXCEPTION: The required number of space heating additional efficiency credits are permitted to be reduced in the following instances:

1. Low energy spaces in accordance with Section C402.1.1.1 and equipment buildings in accordance with Section C402.1.2 that are served by space heating systems shall comply with sufficient measures from Table C406.2(1) or Table C406.2(2) to achieve a minimum of 50 percent of the efficiency credits required for new construction by Table C401.3.3, modified as permitted in this section.
2. Building additions that have less than 1,000 square feet of conditioned floor area and that comply with sufficient measures from Table C406.2(1) or Table C406.2(2) to achieve a minimum of 50 percent of the additional efficiency credits required for additions by Table C401.3.3, modified as permitted in this section.
3. Semi-heated spaces in accordance with Section C402.1.1.2 that comply with sufficient measures from Table C406.2(1) or Table C406.2(2) to achieve a minimum of 50 percent of the space heating additional efficiency credits required by Table C401.3.3, modified as permitted in this section.
4. Unconditioned spaces, open parking garages and unheated enclosed parking garages are not required to achieve the additional efficiency credits for space heating required by Table C401.3.3.

Additional credits required per building type

TABLE C401.3.3
ADDITIONAL CREDITS REQUIRED

Measure Title	Applicable Section	R-1	R-2	B	E	M	All other
New building – Additional efficiency credits required for space heating systems using the fossil fuel pathway	C401.3.3.1	7	24	101	38	111	56
New building – Additional efficiency credits required for service water heating systems using the fossil fuel pathway	C401.3.3.2	198	212	27	17	79	107
Building additions – Additional efficiency credits required for space heating systems using the fossil fuel pathway	C401.3.3.1	4	12	51	19	56	28
Building additions – Additional efficiency credits required for service water heating systems using the fossil fuel pathway	C401.3.3.1	99	106	14	9	40	54

Turns out that it takes a *lot* of credits to match heat pump efficiency with gas equipment

Adjustment for “exempt” heating capacity
(separately for both space heating and water heating)

Corrected error

Formula: CR = A x (C – B)/D

Adjusted Credits = Credits required by Table C401.3.3 x (Heating capacity using an exception – Fossil fuel or resistance heating capacity) / Total heating capacity

Ensures that *credits* won’t be required for spaces where *heat pumps* aren’t required

Example: Dwelling units with electric resistance heating

FFCP has its own C406 credit table

Table C406.2(2)
Efficiency Measure Credits for use with Fossil Fuel Compliance Path

Measure Title	Applicable Section	Prorating Flag	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	SWH	10	~~33~~	NA	3	NA	NA
16. Service water heat recovery	C406.2.6.2	SWH	35	111	13	14	(Grocery) 41[e]	NA
17. Heat pump water heating	C406.2.6.3	SWH	81	261	17	33	(Grocery) 95[e]	(A-2) 95[f]
18 High efficiency service water heating, gas-fired	C406.2.6.4	SWH	59	65	6	11	18	32
((~~18~~)) 19. Heat trace system	C406.2.7.1	SWH	6	13	4	1	NA	6
((~~19~~)) 20. Point of use water heater	C406.2.7.2	SWH	NA	NA	19	5	NA	NA
((~~20~~)) 21. Service hot water distribution right sizing	C406.2.8	SWH	((~~13~~)) NA	((~~42~~)) 10	NA	NA	NA	NA
((~~21~~)) 22. High performance service hot water temperature maintenance system	C406.2.9	SWH	6	13	4	1	NA	6
((~~22. High efficiency service hot water circulation system~~	~~C406.2.10~~	~~SWH~~	~~3~~	~~6~~	~~2~~	~~1~~	~~NA~~	~~4~~))
23. Low flow residential showerheads	C406.2.11	SWH	3	3	NA	NA	NA	NA
24. Enhanced envelope performance[g]	C406.2.12	Heat	24	20	13	5	19	14

…and a few more details

80% of credits can be renewables

Area-weighting OK

Electrification readiness:

1. Spare branch circuit sized for HP
2. Service conduits for upgrade to HP
3. Space in elec room
4. Space for future transformers & other electrical equipment

C401.3.4 Renewable energy credit limit. No more than 80 percent of the efficiency credits required by Sections C401.3.3.1 and C401.3.3.2 are permitted to be Renewable Energy credits defined in Section C406.2.5.

C401.3.5 Discrete area-weighted project compliance. In addition to the area-weighted credit requirements in Section C406.1.2, where a building includes multiple occupancies, the additional required credits per Table C401.3.3 shall be determined separately for each occupancy group. Additional required credits shall be prorated on an area-weighted basis for each occupancy group in the same manner as required project credits per Section C406.1.

1. Where a single space heating or service water heating system serves multiple occupancies, the number of additional required credits shall be prorated on an area-weighted basis for each occupancy served.
2. Additional required credits for envelope systems shall be prorated on an area-weighted basis for all occupancies.
3. Occupancies are permitted to be subdivided into discrete areas, with required and achieved credits for each area prorated on an area-weighted basis as required for the occupancy group.

C401.3.6 Electrification readiness. Additionally, the following provisions shall be required for new construction for each fossil fuel space heating or service water heating appliance installed:

1. Provide a spare electrical branch circuit conduit to the location of a future replacement heat pump appliance to support an equivalent heating capacity.
2. Provide spare electrical service entrance conduits for the purpose of upgrading the main electrical service to support all heat pump appliances throughout the building.
3. The main electrical room has sufficient space to accommodate increasing the main electrical service's size to support all heat pump appliances throughout the building.
4. Additional accommodations for the equipment comprised of transformer(s) and other equipment necessary to support an electrical service upgrade. These accommodations shall include adequate space on the site. If the equipment is located in a transformer vault, that vault must include not only the space to support electrical service upgrade but also include accommodations for additional cooling for larger transformer(s).

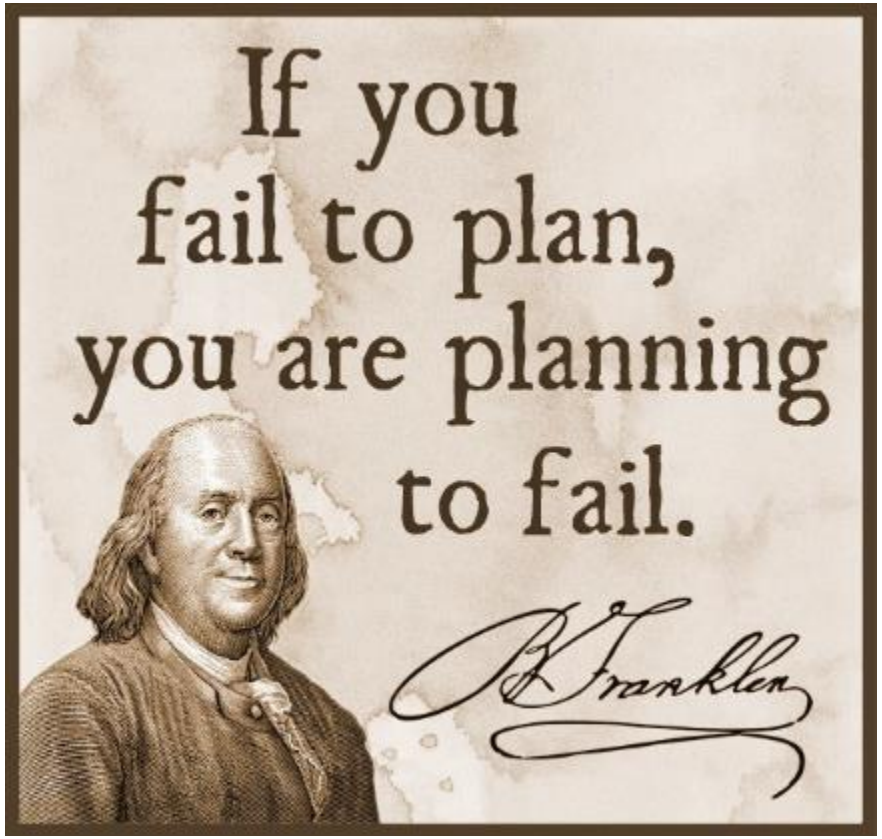
FFCP available for existing buildings too

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

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 or Section C407 ((~~or Sections C404, C408.3, C409.5~~)) and in all cases with 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. Where use of heat pump equipment for space heating is required by this section, it is permissible to utilize the **Fossil Fuel Compliance Path** in Section C401.3 to attain the credits required for building additions shown in Table C401.3.3.

BPS, BEPS & Code

- Seattle's Energy code requires heat pump as systems are replaced
  - with options to postpone
- Seattle's BEPS Building *Emissions* Performance Standard
- sets date for decarbonization
- WA CBPS Clean Buildings Performance Std requires 60% of buildings to reduce EUI
- Postpone, or not, based upon:
  - Construction cost: Pay me now
  - Years until BPS or BEPS would mandate upgrade anyway: Pay me later



A Smooth Plumbing Permit Experience!

From Dave Price at PHSKC – Public Health Seattle King County

1. Is plan review required?
   - Required for commercial projects with fixtures on more than 3 floors
   - Large projects
   - Special systems: Grey water, lift stations, commercial kitchens…
   - See PHSKC 'Occupancy and Use' document for plan review triggers
   - Email planreviewinfo@kingcounty.gov with specifics for quick opinion
   - If inspectors find that your OTC permit should have had plan review, you go on hold until plan review is completed!

2. Is plan review project info complete?
   - See PHSKC Plumbing Design Guidance
   - Make & model of all equipment regulated by energy code
     - Boilers, water heaters…
   - Pipe insulation matrix and detail
   - Use correct code edition (2018, 2021)
   - Code alternate request? Ask SDCI.

3. Keep approved drawings on site
   - See PHSKC Plumbing Design Guidance
   - Text scale large enough to read (typ 1/8")
   - Plumbing, building, or food service plans

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Please take the online survey once you exit the webinar

We'll *SEE* you on the next call… ☺