Heat Pump Water Heating

SCL Lighting Design Lab

June 22, 2021

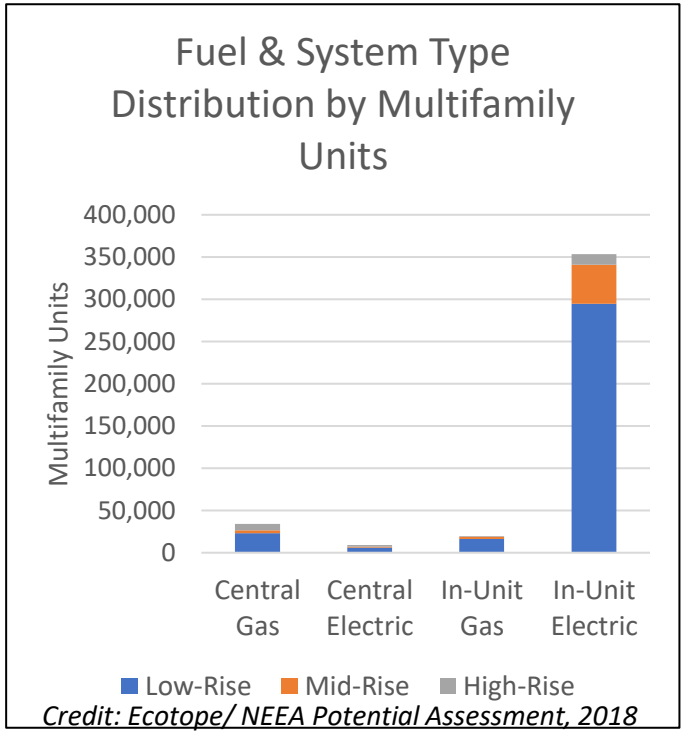
Ready to Electrify Water Heating?

- The market has been slow to move!
  - 2014 - 2019, no change in the % of commercial DWH that is gas (73%).
  - Only 5% of commercial water heating is HPWH

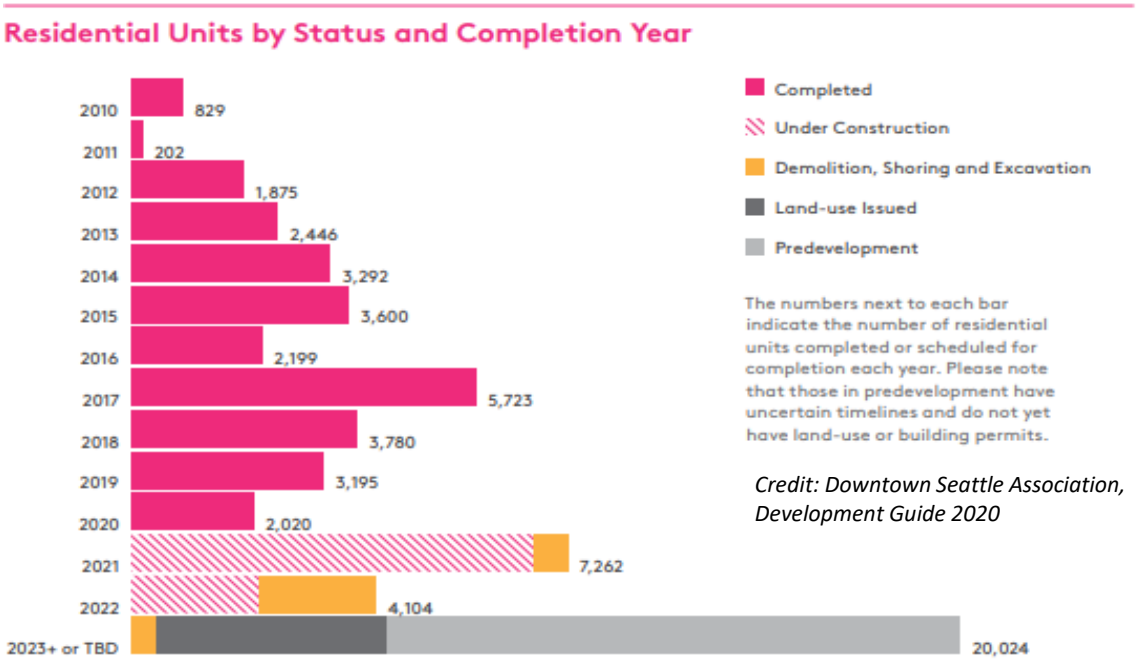
- Only 7.7% of residential electric water heater sales are HPWHs.
    - Majority of sales are in new construction (60-75%)

- Majority of existing DWH is in low-rise MF (80%), in-unit electric

- The future of downtown appears to be residential/ mixed use.
  - 66% of new projects contain a residential component
  - 38,022 new residential units and hotel rooms underway



Credit: Ecotope/ NEEA Potential Assessment, 2018



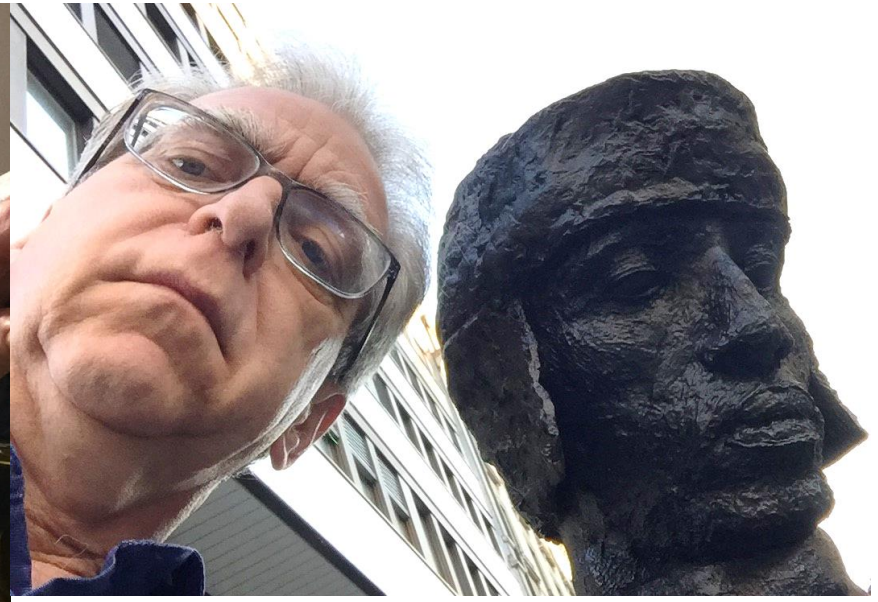
Credit: Downtown Seattle Association, Development Guide 2020

Chris Little, PE, LEED AP

- 14 years in plumbing design world
  - 10 years in Atlanta
  - 4+ years in Seattle
- Avid DIYer
- Chicken farmer

Duane Jonlin, FAIA

- 30 years as technical architect
- 9 years as Energy Code guy
- 4th generation Seattleite
- IECC- Commercial Chair



Seattle, We got this.

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

Washington state:
45% reduction in GHG emissions by 2030

- 95% by 2050

Seattle:
Carbon-neutral buildings by 2050

- …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

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

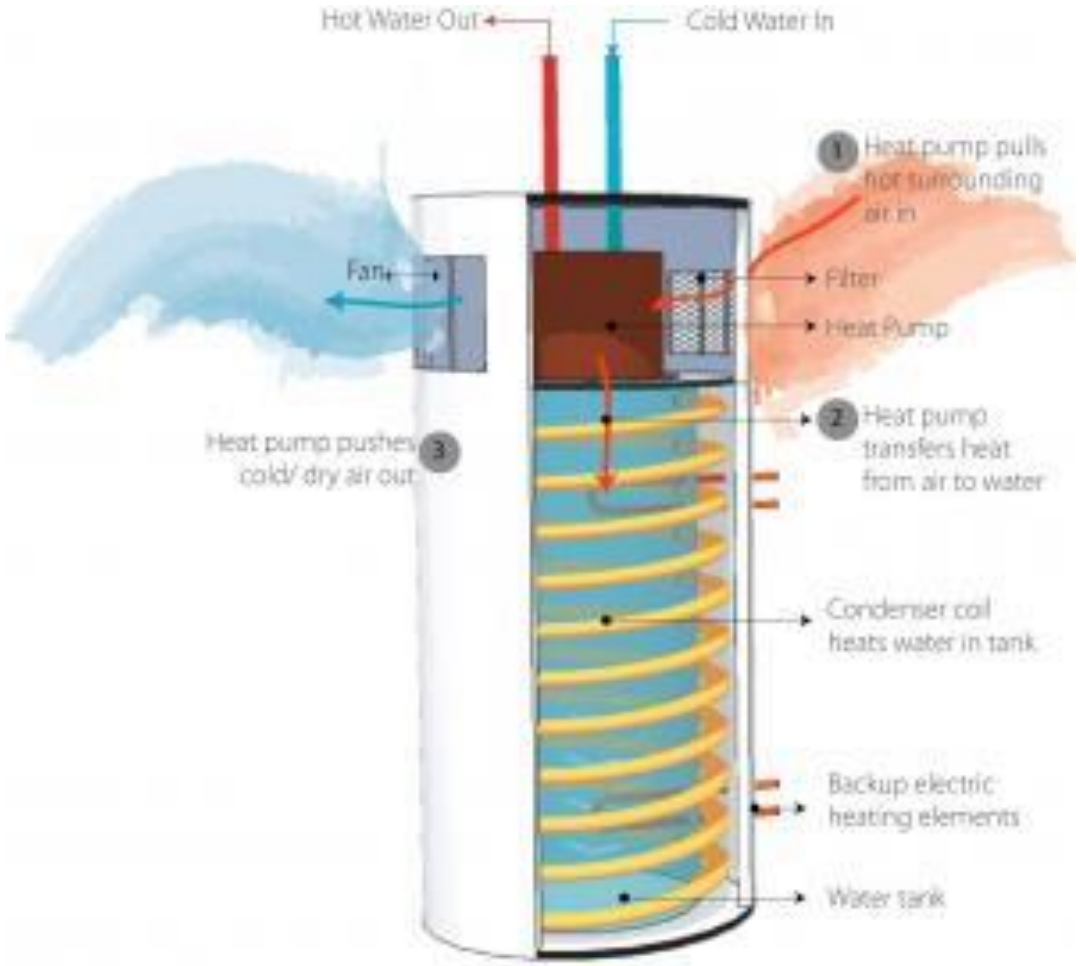
Seattle: Hotel/Multifamily Heat Pump Water Heating

Effective <u>January 1, 2022</u>

Only for hotel & multifamily buildings with central domestic water heating:

(Or maybe *all* commercial buildings?)

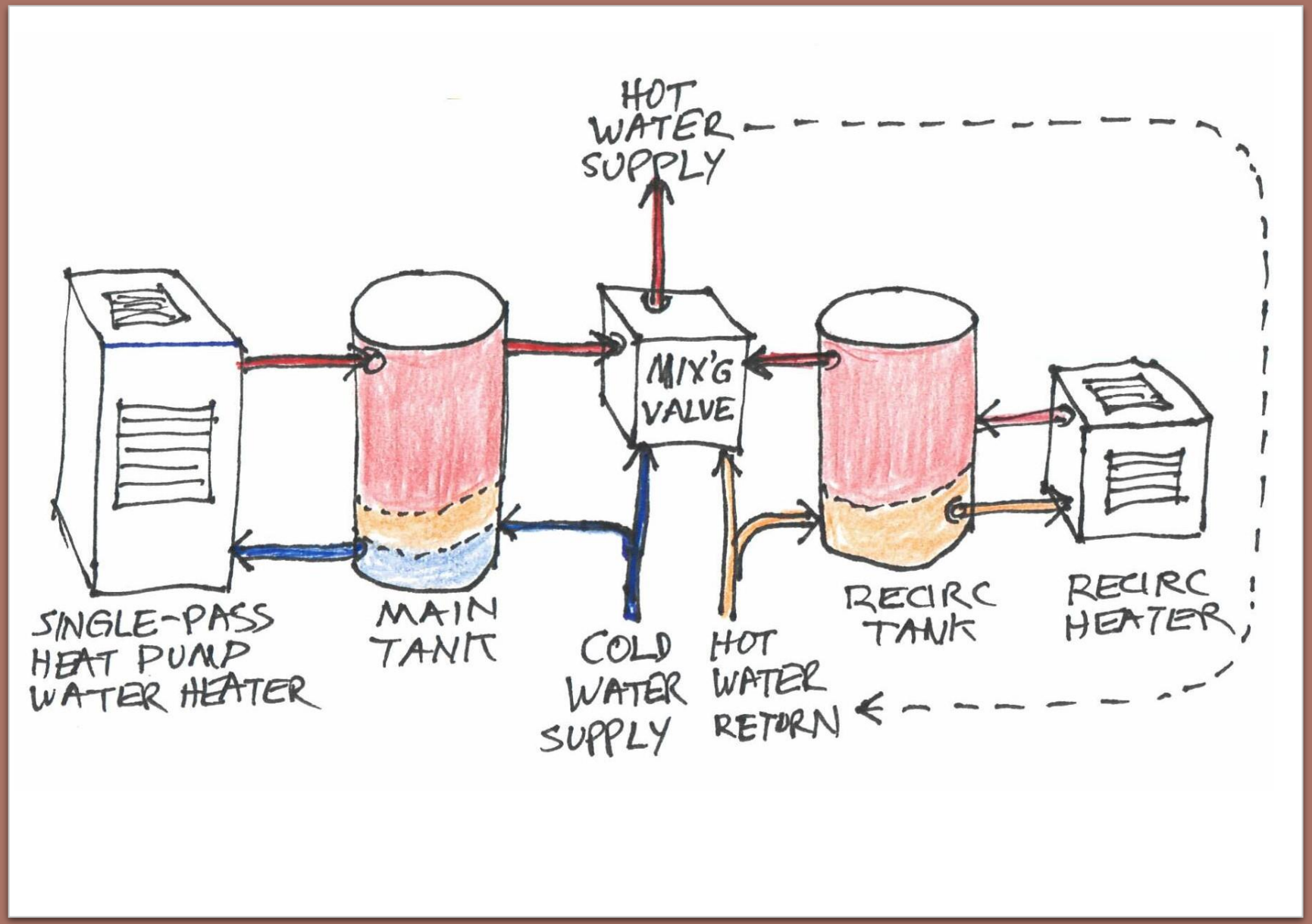
- No electric resistance or fossil fuel water heating equipment permitted.
- Air-source heat pump required
- Options: Solar thermal, recovered heat, ground-source heat pump
- "NEEA Advanced Heat Pump Water Heating Spec for Central Service"



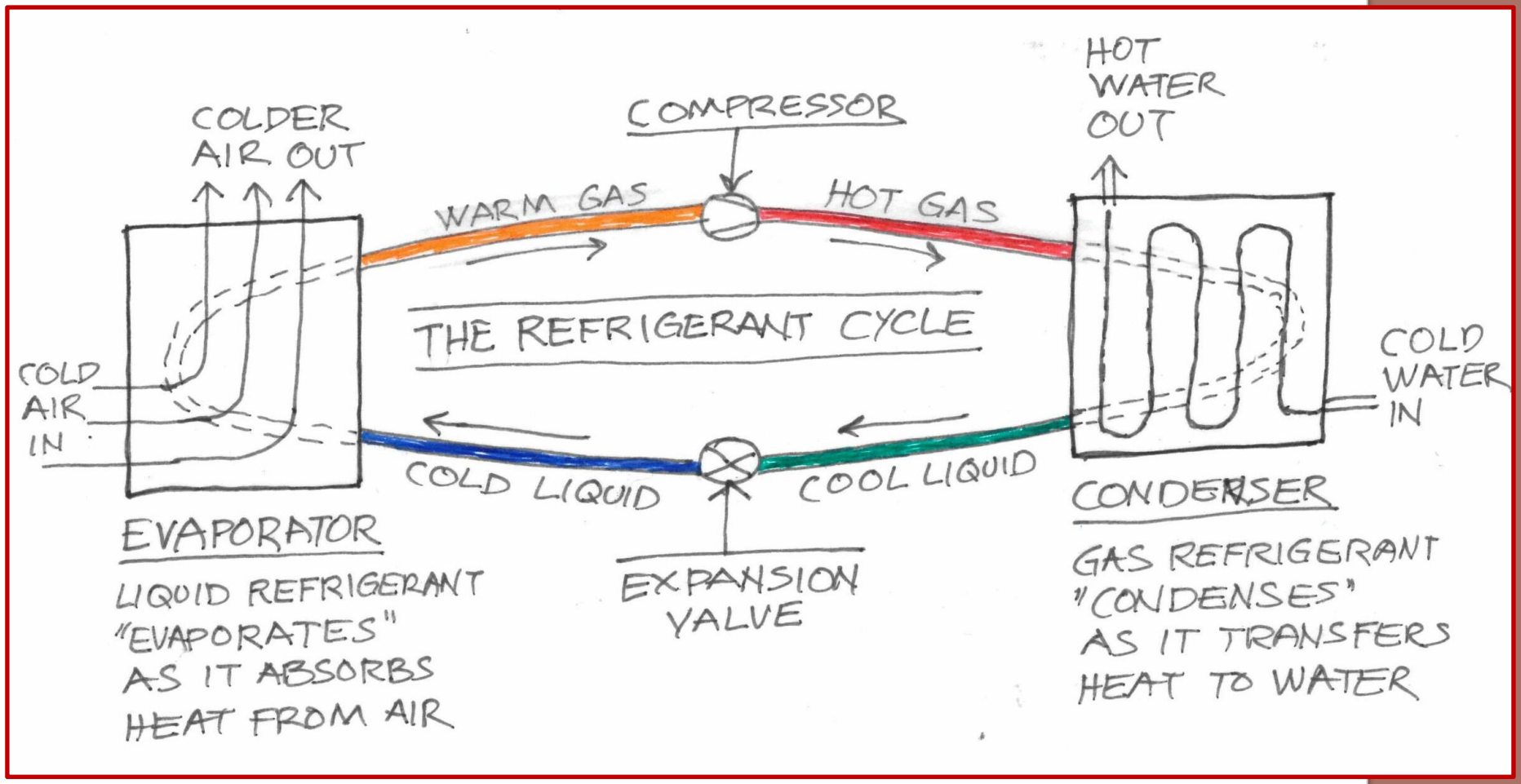
Model	Capacity in MBH (careful, rating cond's)	Ductable	COP (careful, rating cond's)	Refrigerant	Low Temp Limit	Singlepass vs. Multipass	Amps/Voltage (careful, startup current much higher)	Max pipe length
Sanden SanCO2	15	No	5.5	R-744 (CO2)	(-25F)	Multi	7.2A @ 208V/1	66'
Mitsubishi QAHV	136-186	No	4.1	R-744 (CO2)	(-13F)	Multi	32.2A @208V/3	196'
Lync CO2	191-494	Not really	3.8	R-744 (CO2)	(-4F)	Single	39-83A @ 480V/3	190-200'
Colmac CxV	31-79	No	3.7	R-410a	(-4F)	Both	30.4 @ 230V/1	Pump interchangeable
Colmac CxA	137-419	Yes	3.9	R-134a	23F*	Single	19.8-47.4 @ 480V/3	Pump interchangeable
Nyle C Series	16-440	Yes	6.3	R-134a	40F	Both	14.4-106.2A @ 208V/3	Unlisted
Nyle E Series	TBD	Yes?	TBD	R-513a	10-15F	TBD	TBD	TBD
Piranha	60-180	N/A	-- **	R-513a	N/A	N/A	57A @ 480V/3	N/A

*When supplied with freezing weather option – COP suffers.
**Dependent on wastewater temperature & flowrate (i.e. many showers or mostly cold water fixtures?)

Electric	Max Power	kW	19	31	46
	Full Load Current	A	39	53	83
	Max Starting Current	A	175	211	268



Your Basic HPWH



Squeeze hot water out of cold air

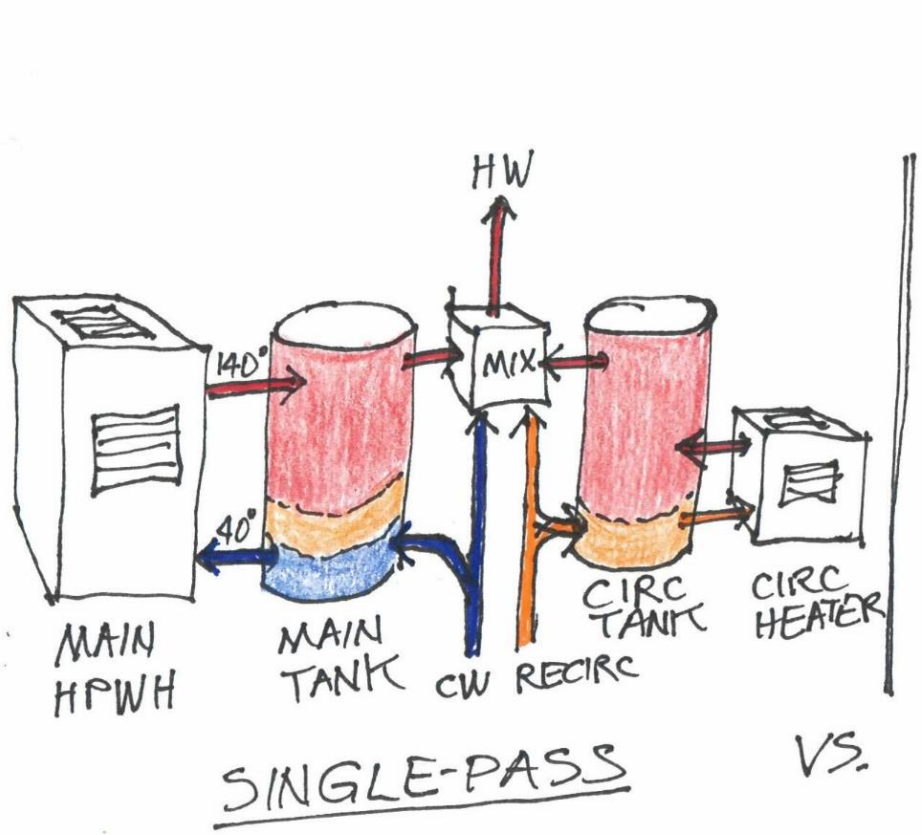
Could also use ground loop, ground water, or lake water

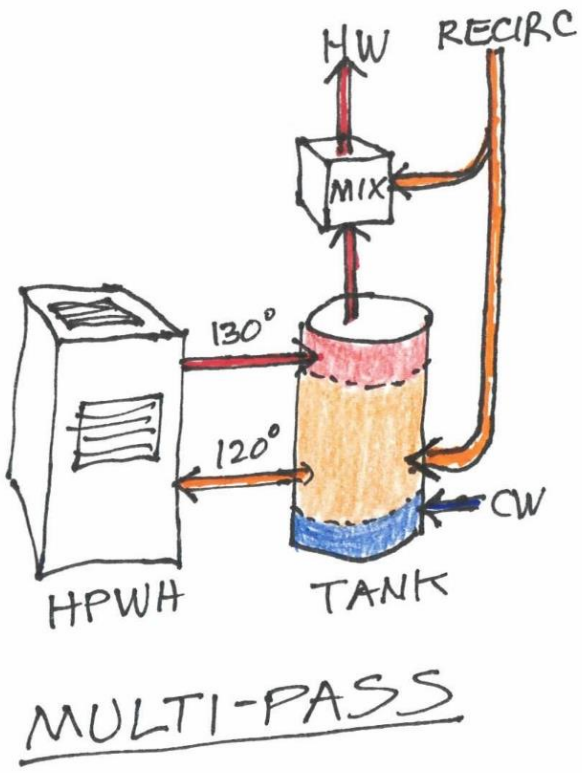
Temp. maintenance: single-pass or multi-pass?

C404.2.3.3. 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.



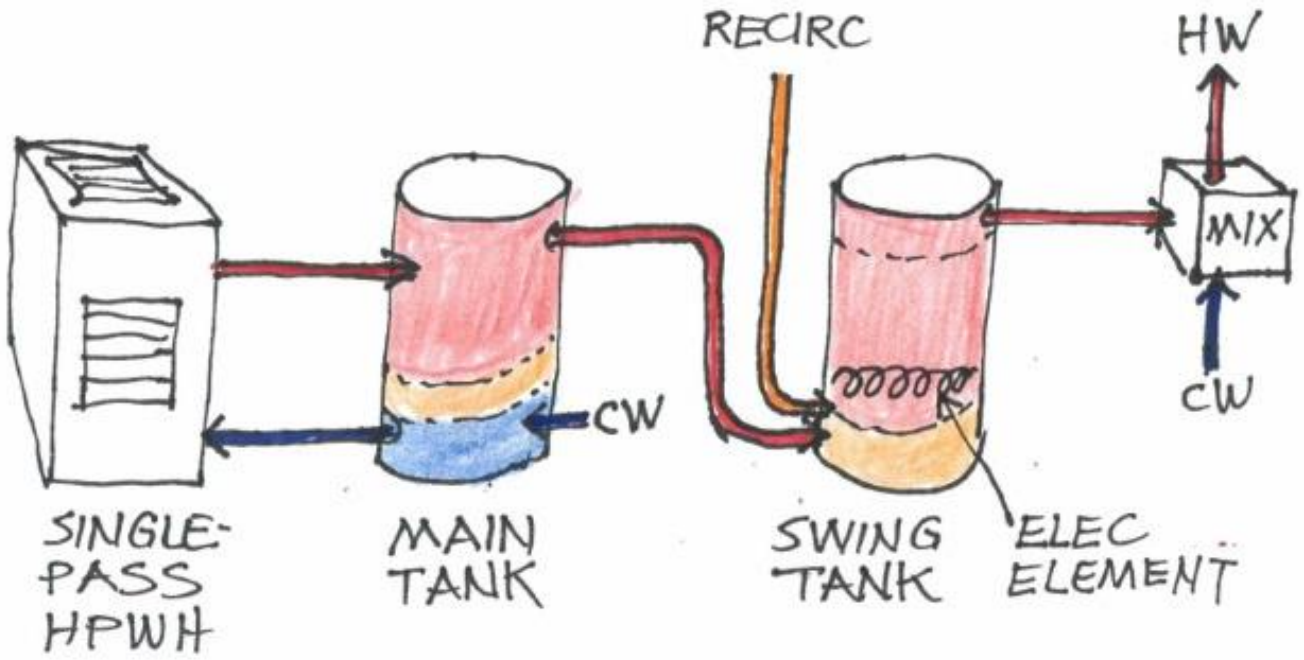


Reliability, redundancy, better COP

Frequent cycling, lower COP, control issues

Single-pass vs. Multi-pass

Can one system optimize both water heating and temperature maintenance?



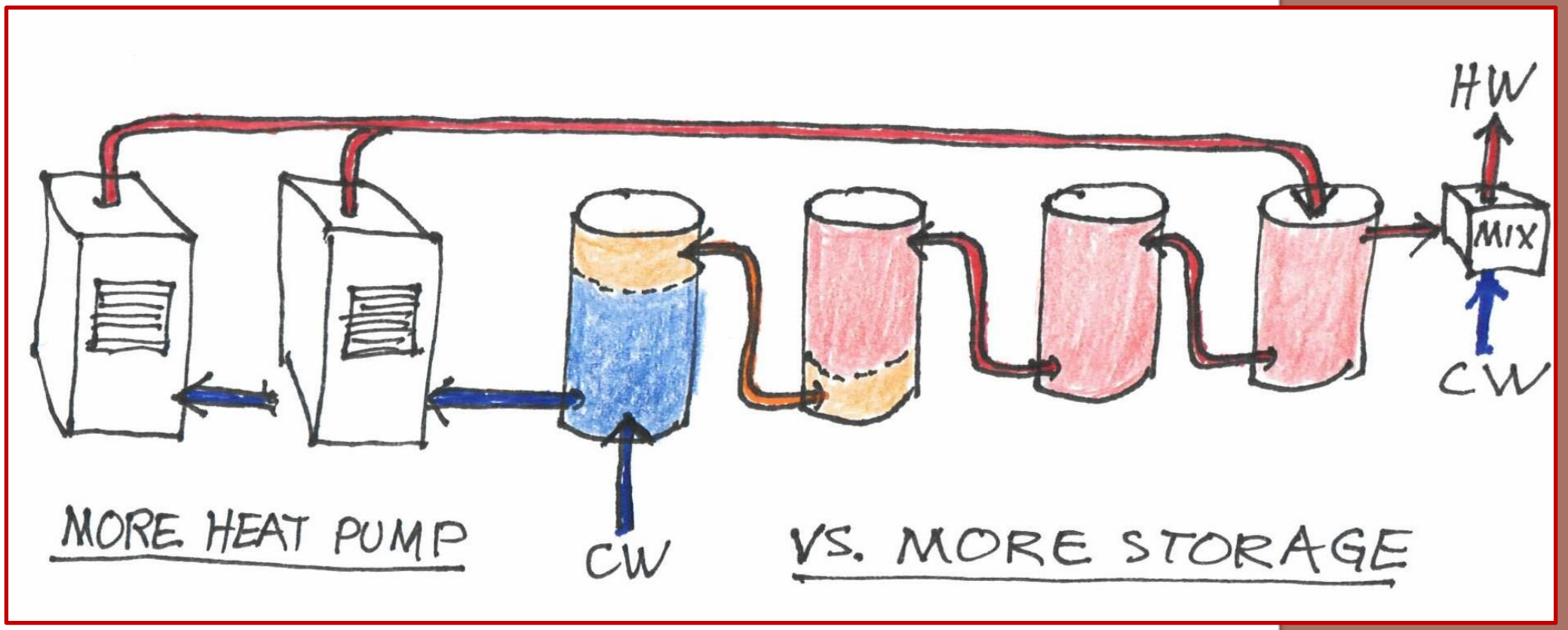
Swing Tank in Series w/ Electric Reheat

Can cause control issues

System size: 100%@40°F 50%@24°F

C404.2.3.1 Primary heat pump system sizing. The system shall include a primary service minimum output **at 40°F outdoor air temperature** that provides sufficient hot water for R-1 and/or R-2 occupancy 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 **50 percent** of the calculated demand for hot water production during the peak demand period when entering air temperature is **24°F**.

Exception. 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.



Size system at Seattle design temp, not mfr rating point

Size big enough to include defrost cycle

Balancing HP & storage

Mail - Jonlin, Duane | Calendar - Jonlin, D | Submetering Multi | RESIDENTIAL END U | Ecosizer

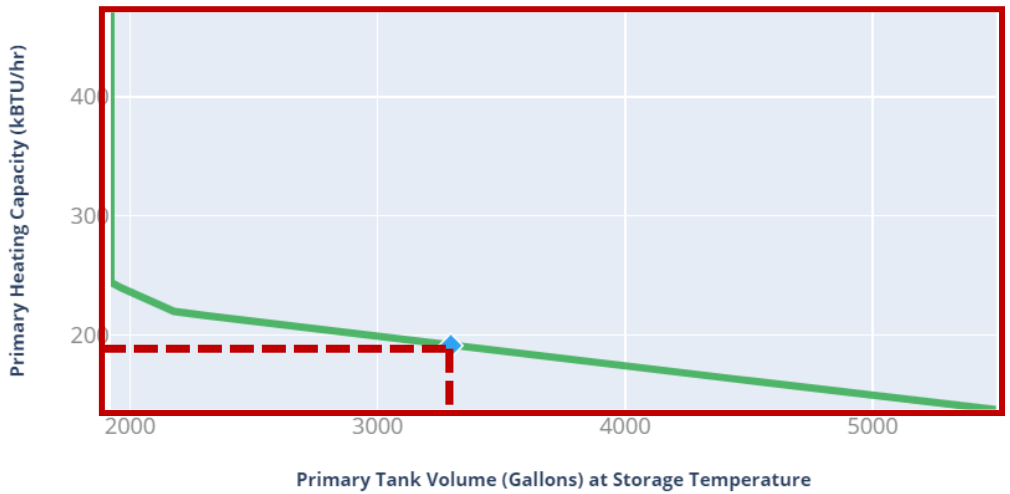
https://ecosizer.ecotope.com/sizer/size/

Results

The graph below represents the trade off between storage volume and heating capacity. The Ecosizer method result is the green curve in the graph. The system sized from user inputs is the blue diamond. Users should pick any point above the green curve to determine their system sizing.

Use the slider bar below the plot to select a different size system.

Primary Sizing Curve



Primary System Size, Storage: **3295.62** Gal, Capacity: **191.1** kBTU/hr

THIS SYSTEM WAS SIZED FOR

Occupancy
175.4 People

Apartments
100.0 Units

Daily Hot Water Usage
25.0 Gallons per Day per Person

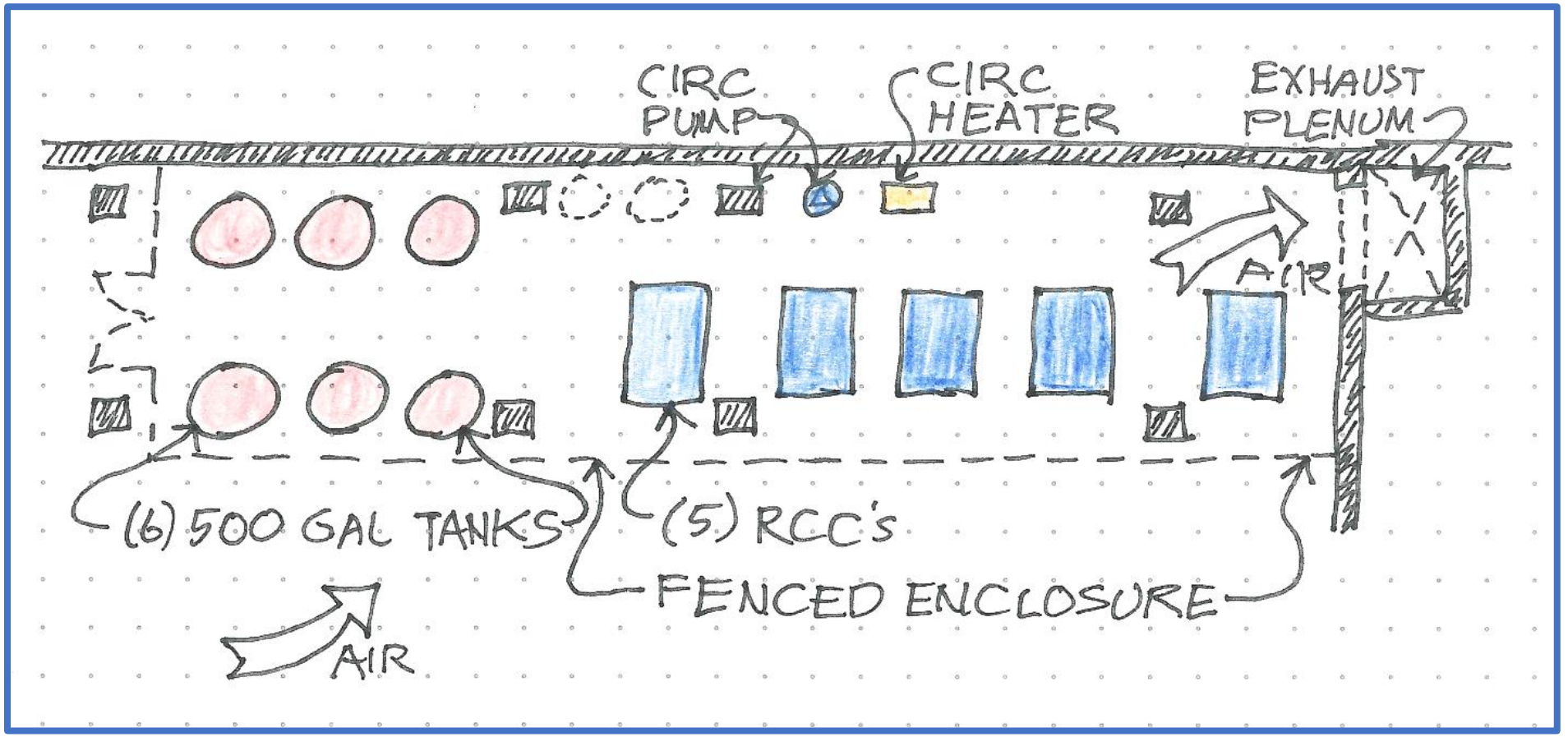
Total Hot Water
4,385.00 Gallons per Day

Recirculation Loop
Heat Loss
100.0 Watts per Apartment

Load Shift Between
Time: 6 - 10 and 16 - 21

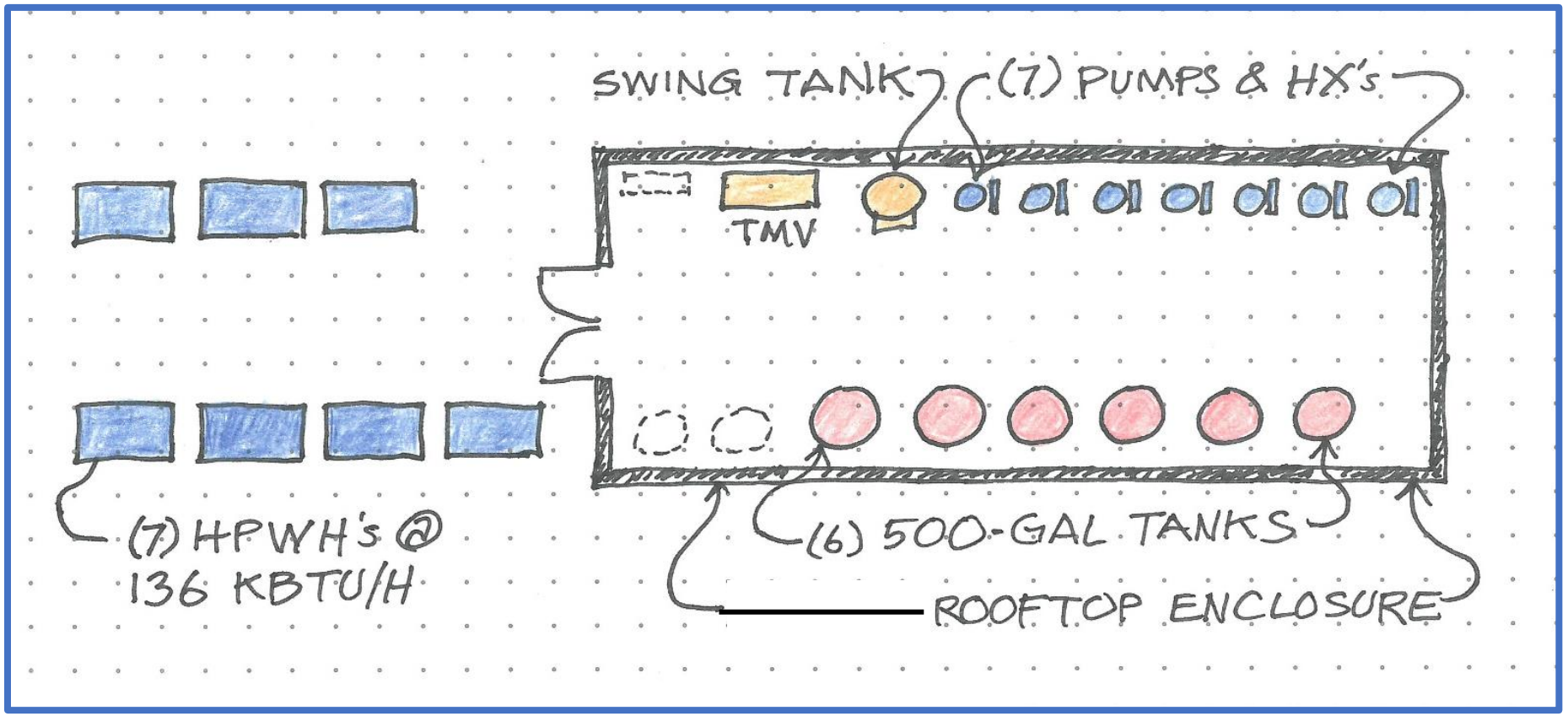
https://ecosizer.ecotope.com

RCC Garage Layout – 228 market rate units



- Mechanical mezzanines?
- Midrise friendly

Rooftop CO^2 HPWH – 228 market rate units



- Got space with PV and green roof?
- Implications with weight?
- Acoustics

Gallery - Sanden

Gallery - Sanden

Gallery - Mitsubishi

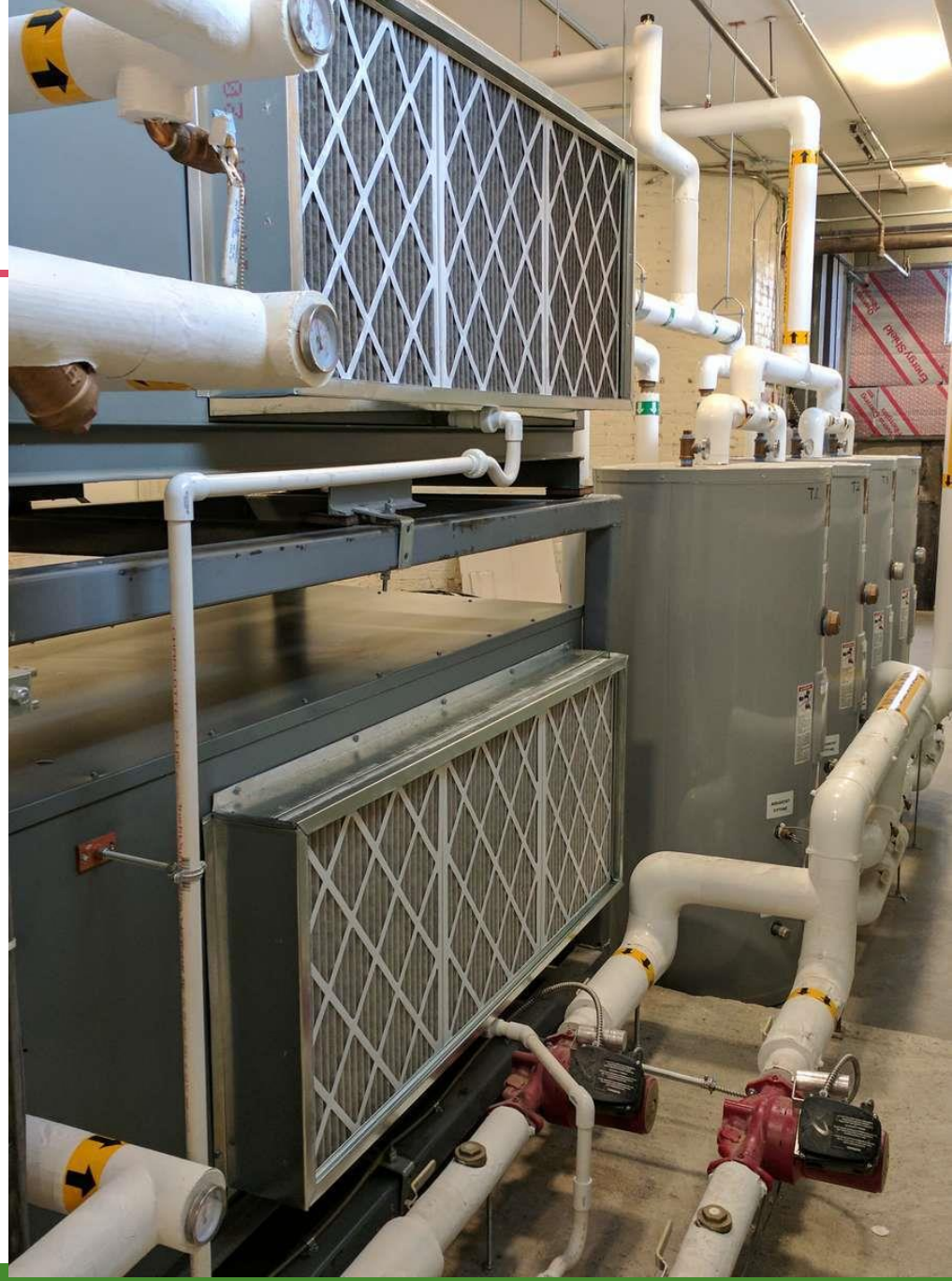
Gallery – Lync CO2

Gallery – Colmac CxV

Colmac CxA

(baby version)

Gallery - Nyle C Series



Don’t forget about us!

C404.2.3 Group R-1 and R-2 occupancies with central service water heating systems. In buildings with central service water heating systems serving four or more Group R-1 or R-2 dwelling or sleeping units, the primary water heating equipment shall not use fossil fuel combustion or electric resistance. Service hot water shall be provided by an air-source heat pump water heating (HPWH) system meeting the requirements of this section. Supplemental service water heating equipment is permitted to use electric resistance in compliance with Section C404.2.3.4.

Exceptions.

1. Permits applied for prior to January 1, 2022.
2. Solar thermal, wastewater heat recovery, other *approved* waste heat recovery, ground source heat pump, water-source heat pump system utilizing waste heat, and combinations thereof, are permitted to offset all or any portion of the required HPWH capacity where such systems comply with this code and the Seattle Plumbing Code.
3. Systems meeting the requirements of the Northwest Energy Efficiency Alliance (NEEA) Advanced Water Heater Specifications for central service water heating systems.

Gallery - Piranha

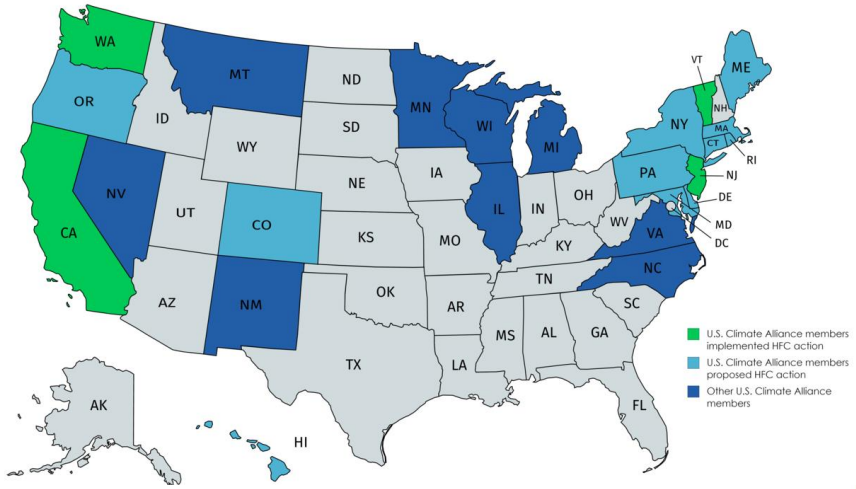
Gallery - Piranha

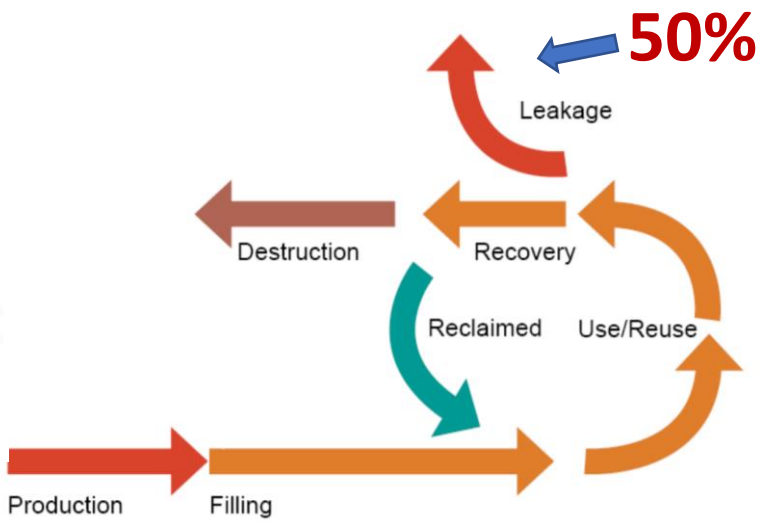
Supplemental electric resistance heat allowed:

- Temp maintenance for circulation
- Defrost
- Heat trace
- Backup or low-air temp, where:
  - Compressor heat can’t satisfy demand
  - Entering air temp is below 40°F
  - Heat pump compressor keeps operating to 17°F
  - No greater than heat pump output at 40°F
- Downstream from multi-pass system
- Single water heaters not served by central system

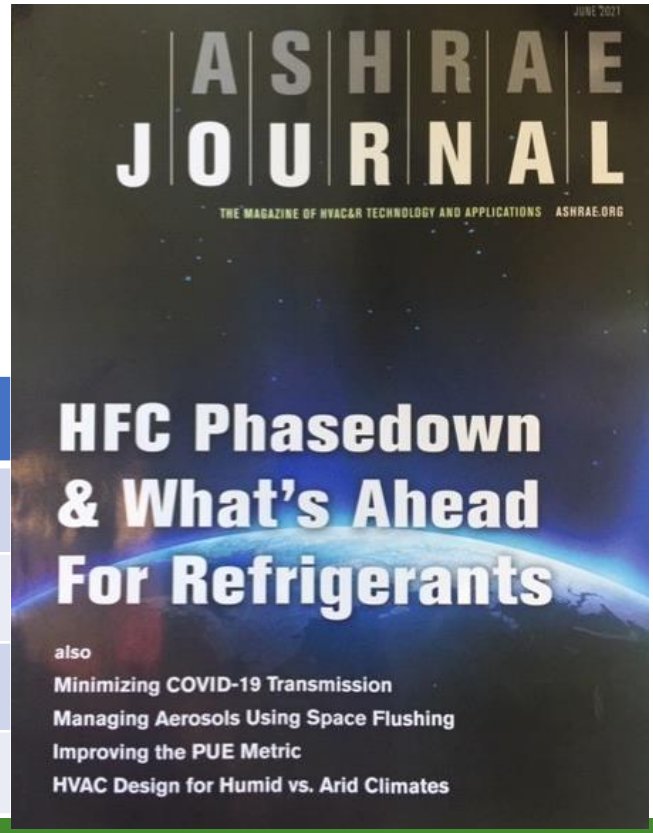
Refrigerant restrictions:

HB 1050: Max GWP 750 after Jan 1, 2025 (manufacture date)





GWP	Refrigerant	Typ Manufacturers	COP	Low Temp
1	R-744 (CO2)	Sanden, Mitsubishi	5.5, 4.1	(-25°) (-13°)
1450	R-134a	Colmac CxA, Nyle C Series	3.7, 3.9	(-4°), 23°
2088	R-410a	LG, GREE, CxV	varies	(-4°)
675	R-513a	Nyle C, E series	6.3, TBD	40°, 15°



Alarms required

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

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

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

Almost same rules as new construction:

- **“Substantial alterations”**
- **Change of occupancy**
- **Change of space conditioning**

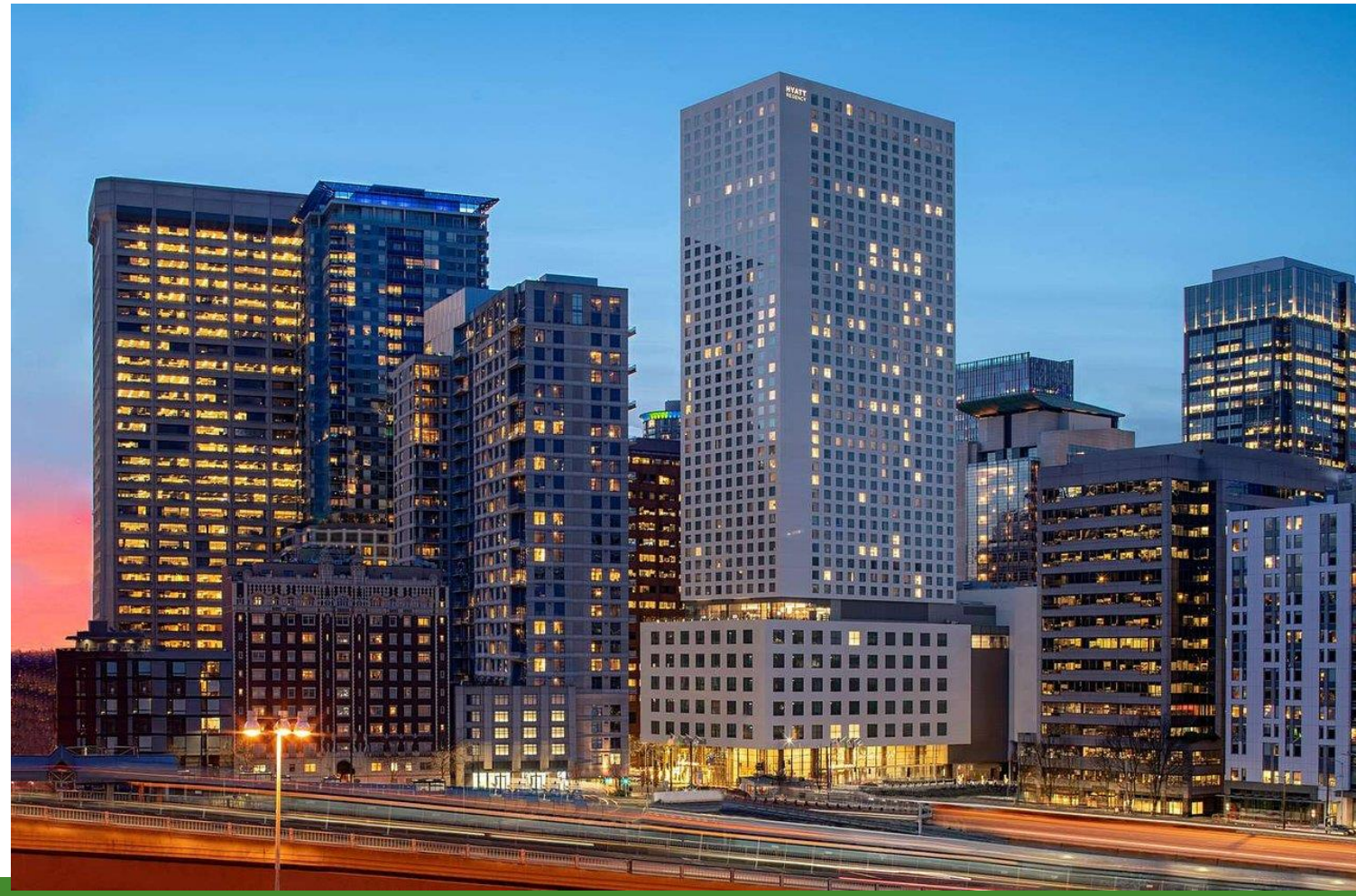
Replacement of hot water system

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

Exception. Where only one service hot water appliance is failing and is replaced by another having the same or lesser heating capacity and the same or higher efficiency, no other alterations are made to the central service hot water system, and this exception has not been used within the same building in the previous 24-month period, this provision does not apply.

HB 1257: Building performance standard

- Either meet EUI target, or…
  - “Conditional compliance”
- Penalty: $5000 + $1/sf/year
- Reporting schedule:
  - 220,000+ sf June 1, 2026
  - 90,000+ sf June 1, 2027
  - 50,000+ sf June 1, 2028
- Equip end of life timing?



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Hybrid* and Heat Pump Water Heater Incentives

Seattle City Light

SCLEnergyAdvisor@seattle.gov & (206) 684-3800

Building Type	Equipment Type	Installer	Application	Incentive $	Quantity
Single-family *electric water heating*	Unitary or split systems less than 200 gallons	Homeowner	Online Rebate Application	$500	1 per household
Single-family (new or retrofit; includes legal ADU and DADU**) *contractor installed*	Unitary or split systems less than 200 gallons	Contractor	Instant contractor discount from distributor	$500	1 per household
Multifamily (new or retrofit) *contractor installed*	Unitary or split systems less than 200 gallons	Contractor	Instant contractor discount from distributor	$500	1 per household
Multifamily Retrofit -or- Commercial Retrofit	Single or multi-pass centralized system	Contractor	Commercial Retrofit Incentive Application and Program Requirements	$0.24/kWh Incentive Table	Per kWh
Multifamily New Construction	Single or multi-pass centralized system *Standard COP***	Contractor	Built Smart Incentive Application	$200/living unit Incentive Table	Per living unit
Multifamily New Construction	Single or multi-pass centralized system *High COP***	Contractor	Built Smart Incentive Application	$350/living unit Incentive Table	Per living unit
Multifamily New Construction	Single or multi-pass centralized system, CO2	Contractor	Built Smart Incentive Application	$500/living unit Incentive Table	Per living unit
Commercial New Construction	Single or multi-pass centralized system	Contractor	New Construction Application	$0.27/kWh Incentive Table	Per kWh

* Electric hybrid water heater and heat pump water heater are terms that are used interchangeably.
** Accessory dwelling unit (ADU) and detached accessory dwelling unit (DADU)
***Coefficient of Performance (COP)

WA State Code Hearing July 9

- HPWH proposals to be discussed at TAG (Technical Advisory Group)
- July 9 at 10:00 AM (meeting starts 8:30 with other topics)
- Washington State Building Code Council web page
- Energy Code TAG | SBCC (wa.gov)
- Link to proposal:
- https://www.sbcc.wa.gov/sites/default/files/2021-06/136_C404.2.1%20Heat%20Pump%20Water%20Heating%20combined.pdf

Click – Call – Connect

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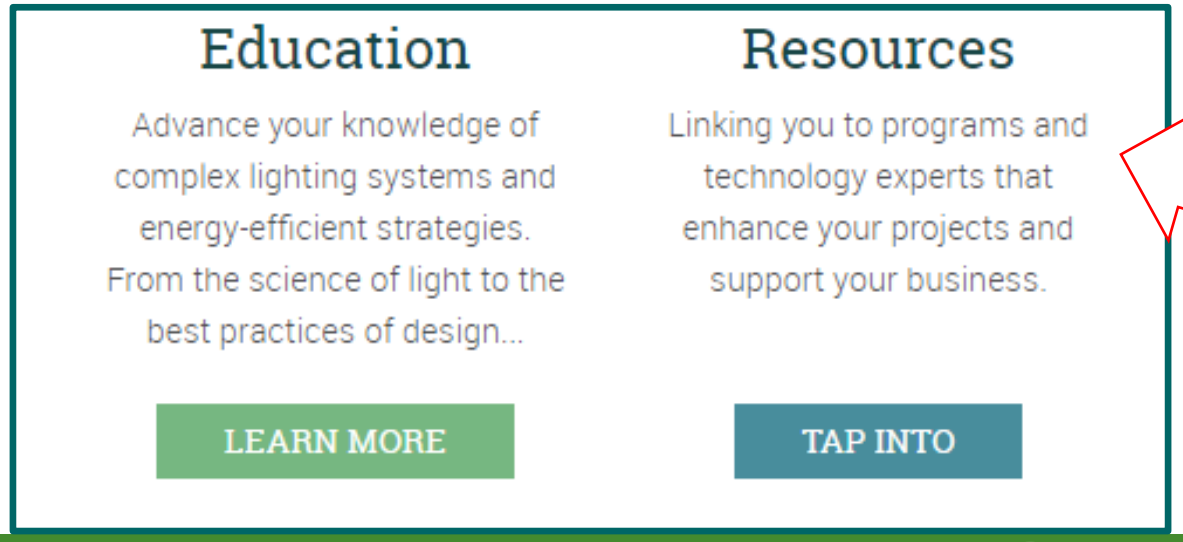

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We'll *SEE* you on the next call… ☺