10/21/2025

Proper Plumbing: Evaluating HPWH in Building Design

How-To Configure and Evaluate in EnergyPlus 25.1

A2 EFFICIENCY

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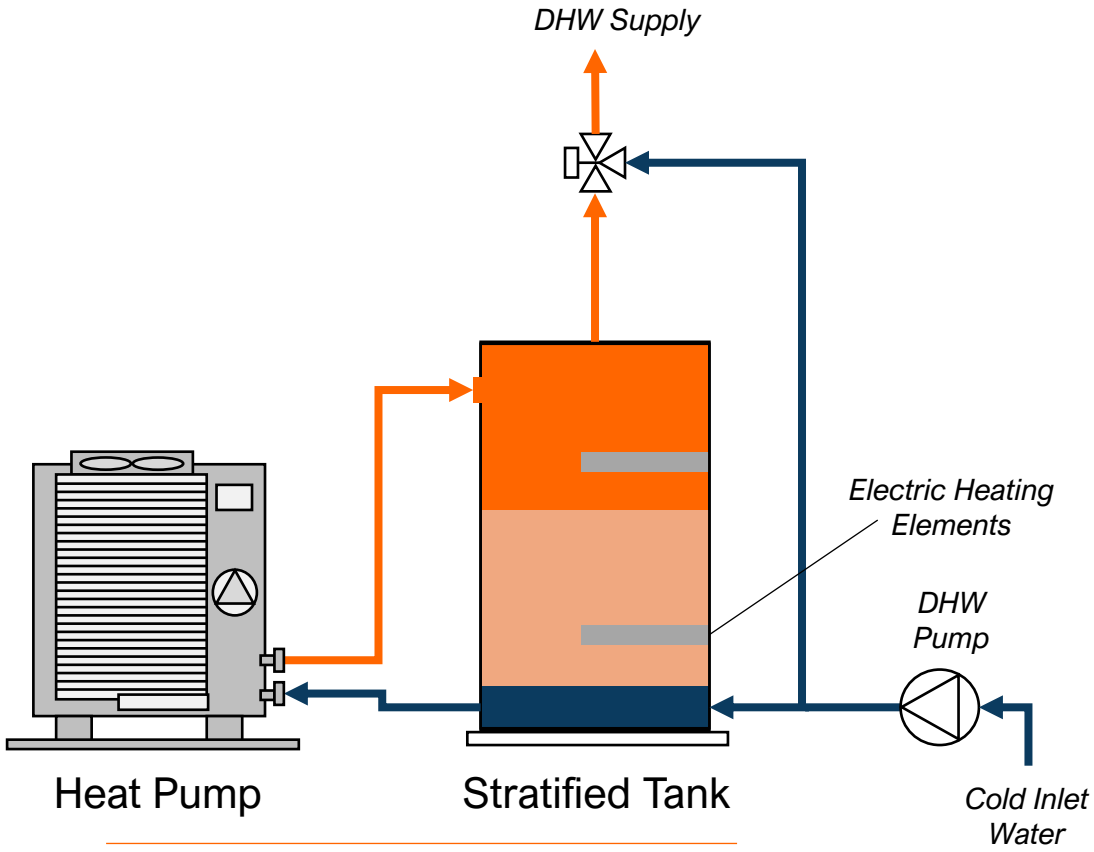
An A2E tutorial on a basic heat-pump-water heater in E+

- How can you evaluate a Heat Pump Water Heater in early design phases with limited information?

Heat Pump Water Heaters
(without a building recirculation loop)



Water Heater Pumped Condenser System

Small Commercial, Low-Rise Multi-Family

The (big) Problems

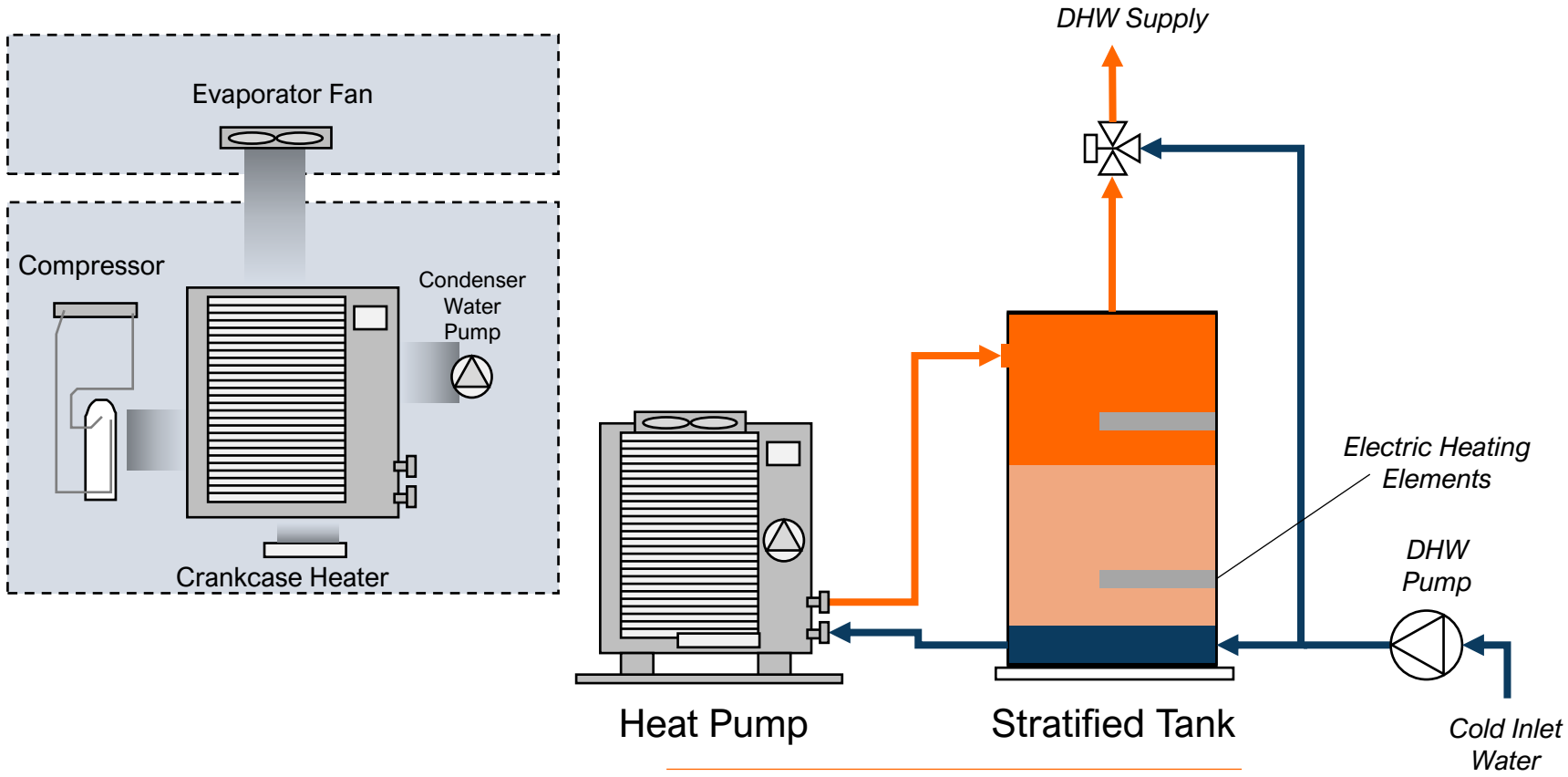
- EnergyPlus HPWH is made up of several components configured in just the right way.
- EnergyPlus HPWH require inputs be specifically defined, matching the climate, peak load, and operating conditions
- HPWH often include backup electric heat which must be properly sized

HPWH Review

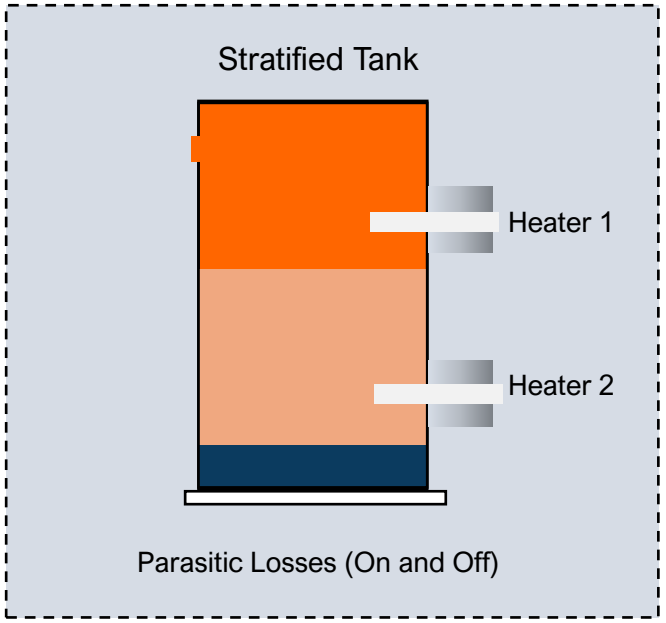
1. Configuration of this Demo HPWH System
2. Configuration of this HPWH in EnergyPlus Components

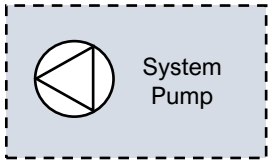
3. Applied HPWH Results in Medium Office
    1. HPWH Thermal Source: Outdoor Air
    2. HPWH Thermal Source: Example Zone
4. Mapping Source to a Zone, How to Change EnergyPlus
5. Sizing the HPWH Object, How to Move Buildings
6. HPWH Objects, How to Add and Stitch Into Other Buildings

Heat Pump Water Heater

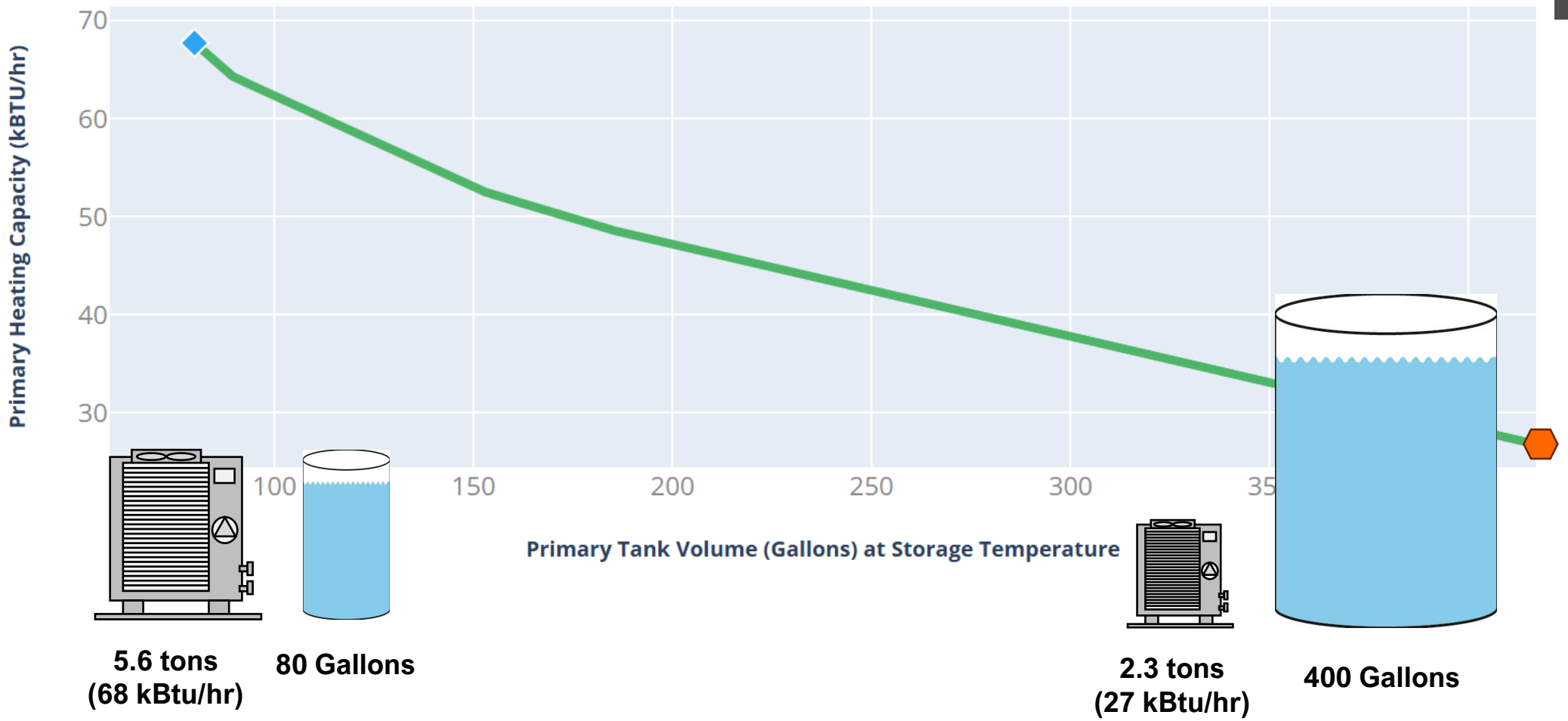


Water Heater Pumped Condenser System





Sizing Storage to HP Capacity (example)



5.6 tons (68 kBtu/hr)

80 Gallons

9.5 hrs run-time

https://ecosizer.ecotope.com/

2.3 tons (27 kBtu/hr)

400 Gallons

24 hrs run-time

Sizing Methodology for HPWH Components

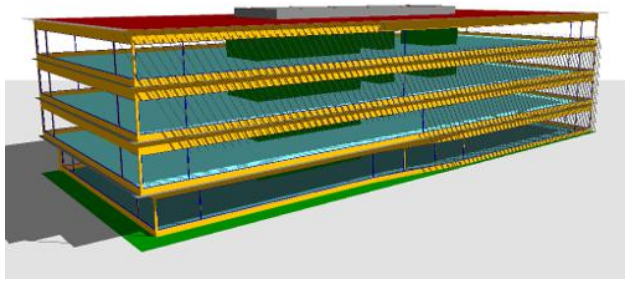
1. Find the peak flow rate of DHW
2. Find the peak daily schedule of hours/day DHW is used
3. Pick a duration to size the HP and Tank for
4. Pick the setpoint and delta-T the HPWH will operate at
5. Size the capacities of the system using the A2E toolkit (HP capacity, backup power, crankcase heater, onboard pump)

- Calculate peak-day gallons of HW
- Pick a desired recovery time in hours (6 hours)

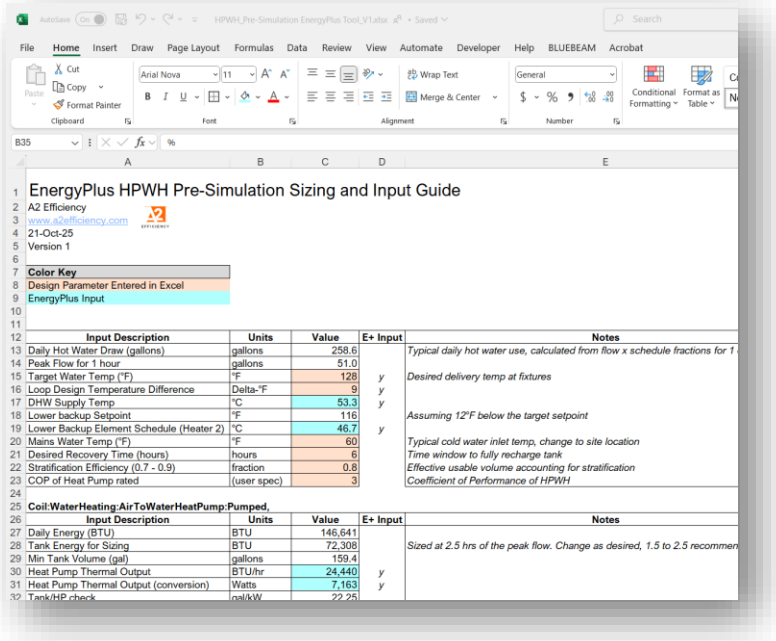
Application	Recovery Time	Rationale
Single family	4–6	Morning/evening peaking
Multifamily	8–12	Draw spread through day
Commercial (office, dorm)	10–16	Continuous recovery possible

- Determine Daily Heating Energy
- Size HP = Energy / Hours
- Size Tank = Backup Heat, Size, Vol.
- Size Additional Components

Workflow for Evaluating a HPWH



System Architecture



EnergyPlus HPWH Pre-Simulation Sizing and Input Guide

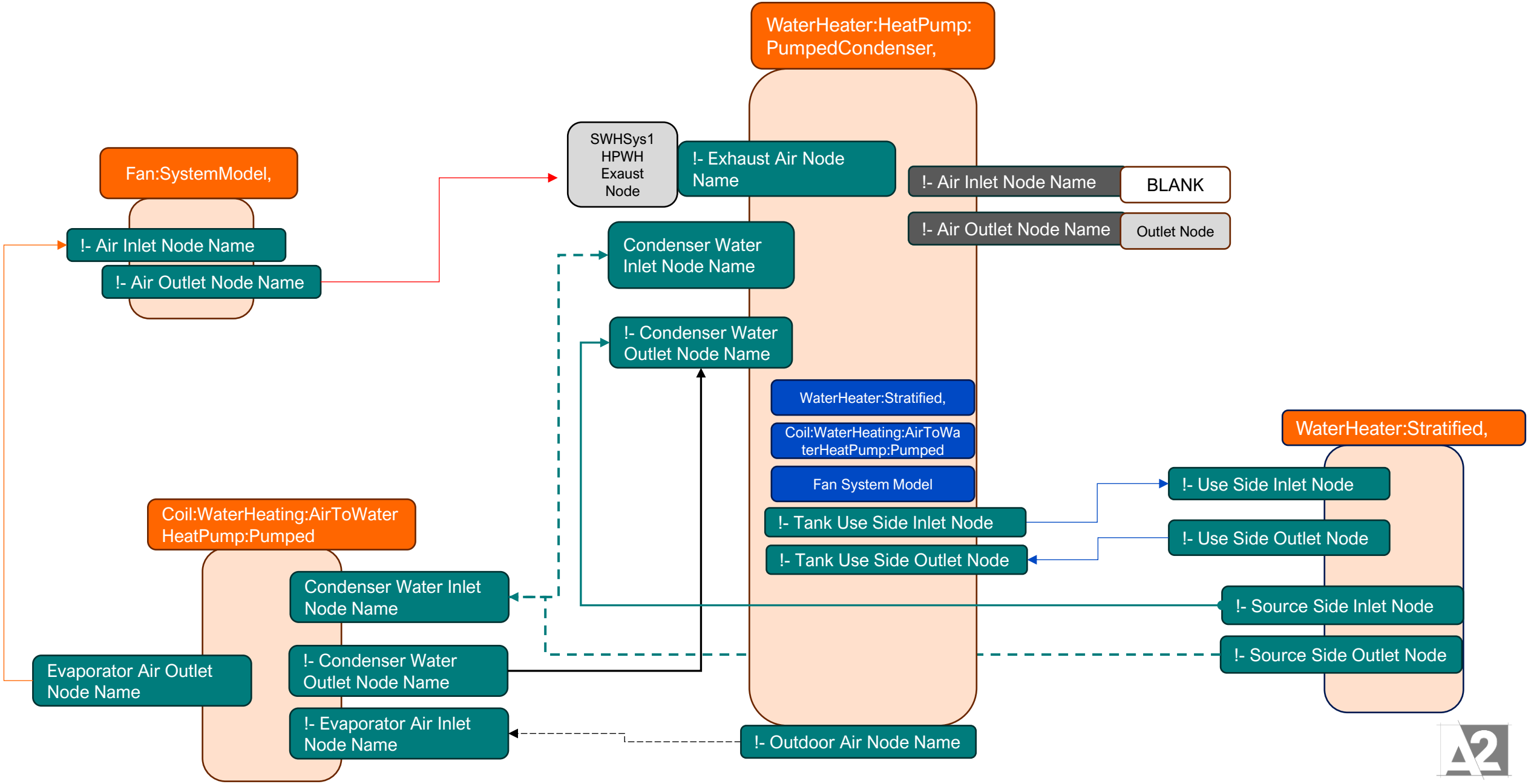
A2 Efficiency
www.a2efficiency.com
21-Oct-25
Version 1

Color Key
Design Parameter Entered in Excel
EnergyPlus Input

Input Description	Units	Value	E+ Input	Notes
Daily Hot Water Draw (gallons)	gallons	258.6		*Typical daily hot water use, calculated from flow x schedule fractions for 1*
Peak Flow for 1 hour	gallons	51.0		
Target Water Temp (°F)	°F	128	y	*Desired delivery temp at fixtures*
Loop Design Temperature Difference	Delta-°F	9	y	
DHW Supply Temp	°C	53.3	y	
Lower backup Setpoint	°F	116		*Assuming 12°F below the target setpoint*
Lower Backup Element Schedule (Heater 2)	°C	46.7	y	
Mains Water Temp (°F)	°F	60		*Typical cold water inlet temp, change to site location*
Desired Recovery Time (hours)	hours	6		*Time window to fully recharge tank*
Stratification Efficiency (0.7 - 0.9)	fraction	0.8		*Effective usable volume accounting for stratification*
COP of Heat Pump rated	(user spec)	3		*Coefficient of Performance of HPWH*

Coil:WaterHeating:AirToWaterHeatPump:Pumped,

Input Description	Units	Value	E+ Input	Notes
Daily Energy (BTU)	BTU	146,641		
Tank Energy for Sizing	BTU	72,308		*Sized at 2.5 hrs of the peak flow. Change as desired, 1.5 to 2.5 recommen*
Min Tank Volume (gal)	gallons	159.4		
Heat Pump Thermal Output	BTU/hr	24,440	y	
Heat Pump Thermal Output (conversion)	Watts	7,163	y	
Tank/HP check	gal/kW	22.25		


WaterHeater:HeatPump:
PumpedCondenser,
SWHSys1
HPWH
Exaust
Node
!- Exhaust Air Node
Name
!- Air Inlet Node Name
BLANK
!- Air Outlet Node Name
Outlet Node
Fan:SystemModel,
!- Air Inlet Node Name
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Condenser Water
Inlet Node Name
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WaterHeater:Stratified,
Coil:WaterHeating:AirToWa
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Fan System Model
!- Tank Use Side Inlet Node
!- Tank Use Side Outlet Node
WaterHeater:Stratified,
!- Use Side Inlet Node
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Condenser Water Inlet
Node Name
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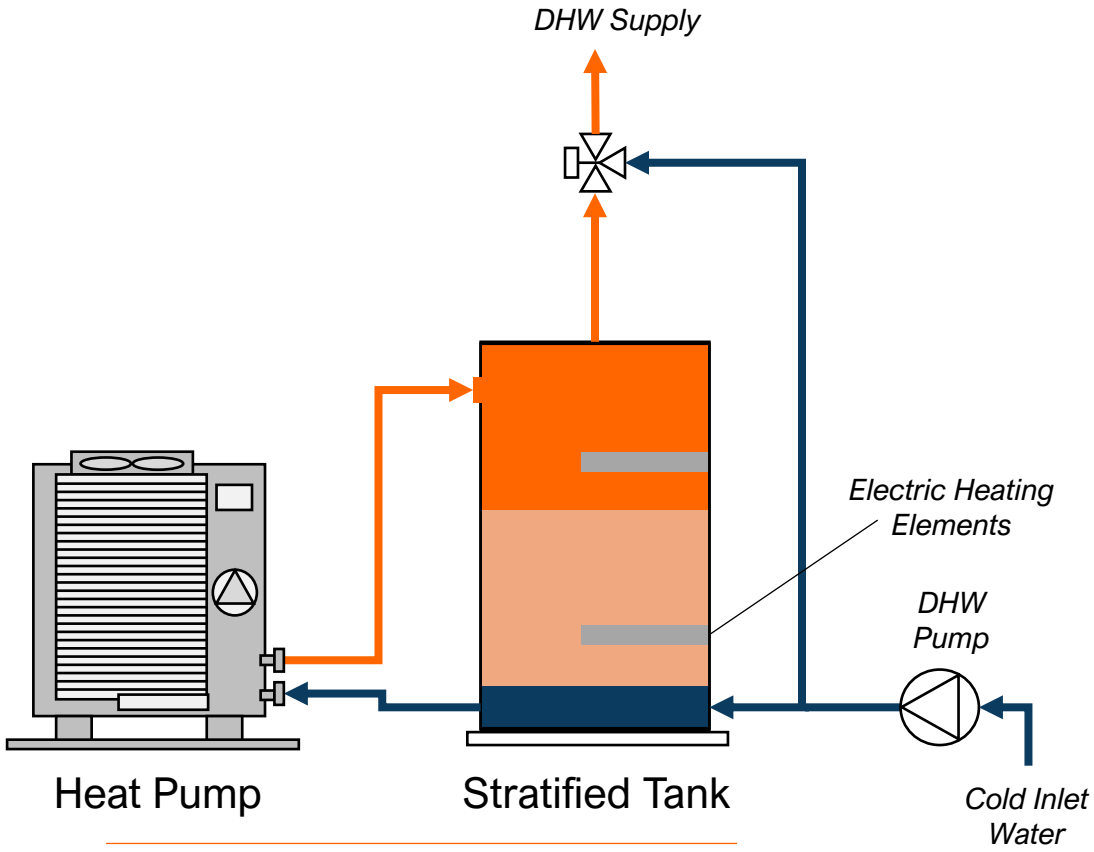
Moving the HPWH Indoors?

Heat Pump Water Heaters
(without a building recirculation loop)



Water Heater Pumped Condenser System

Heat Pump Water Heaters Indoors?

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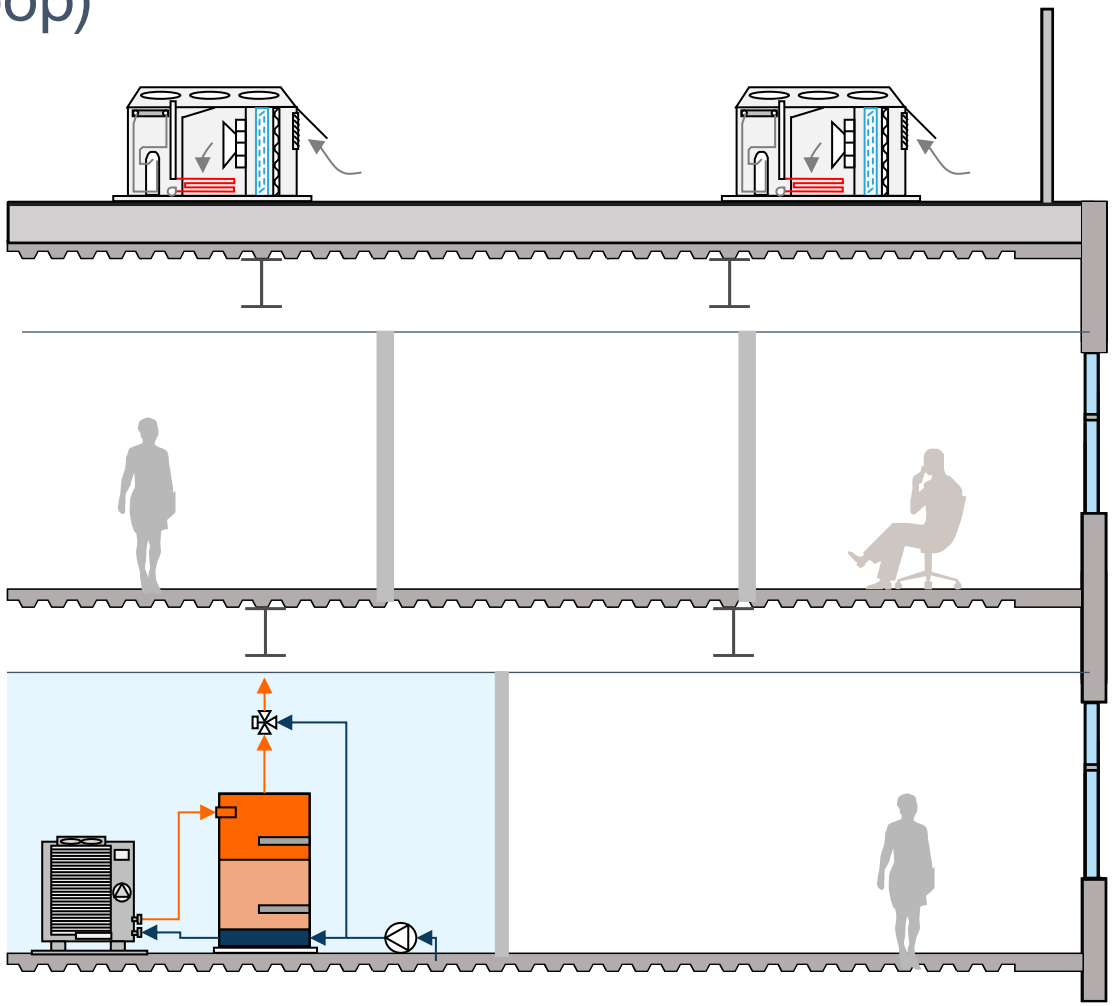

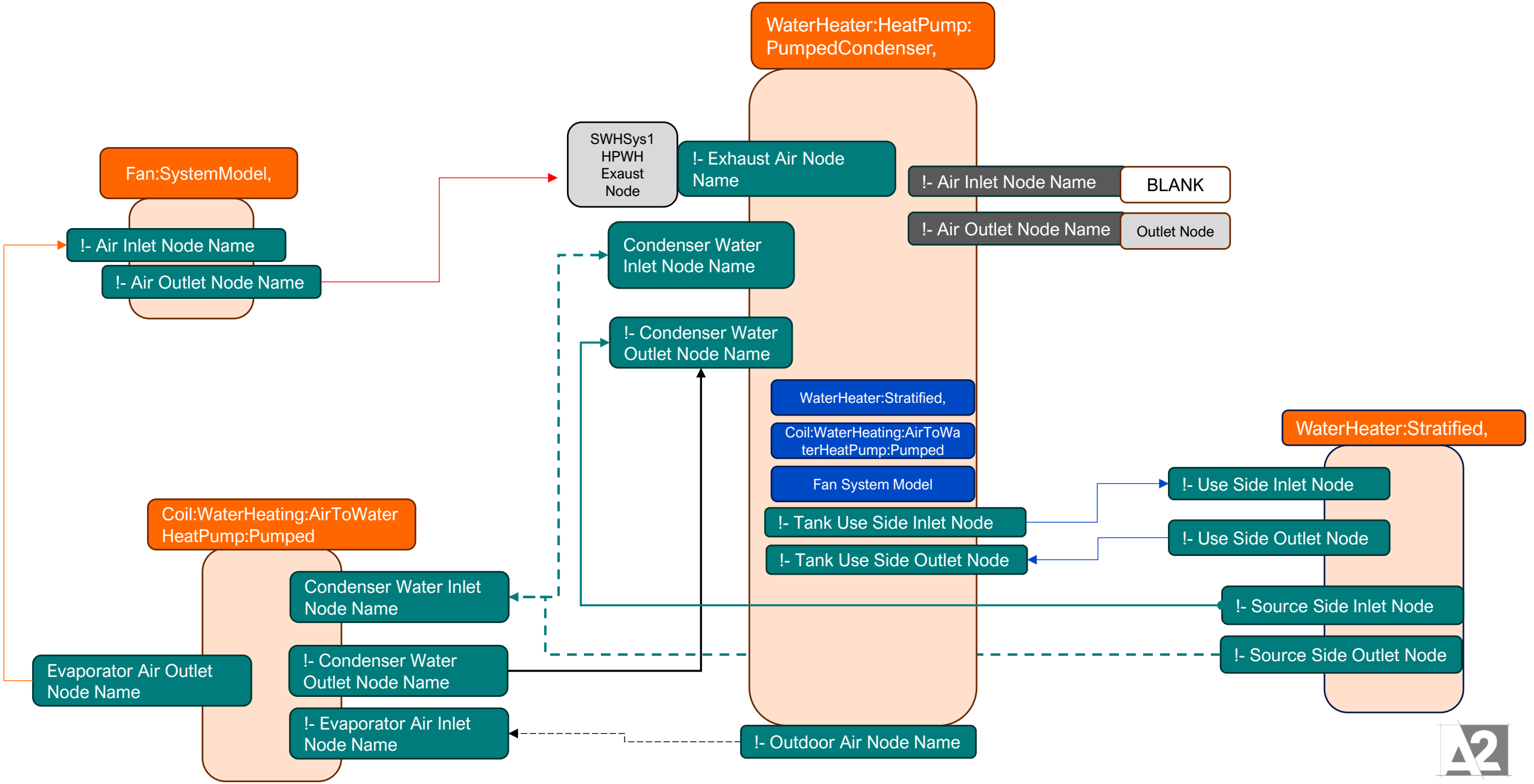
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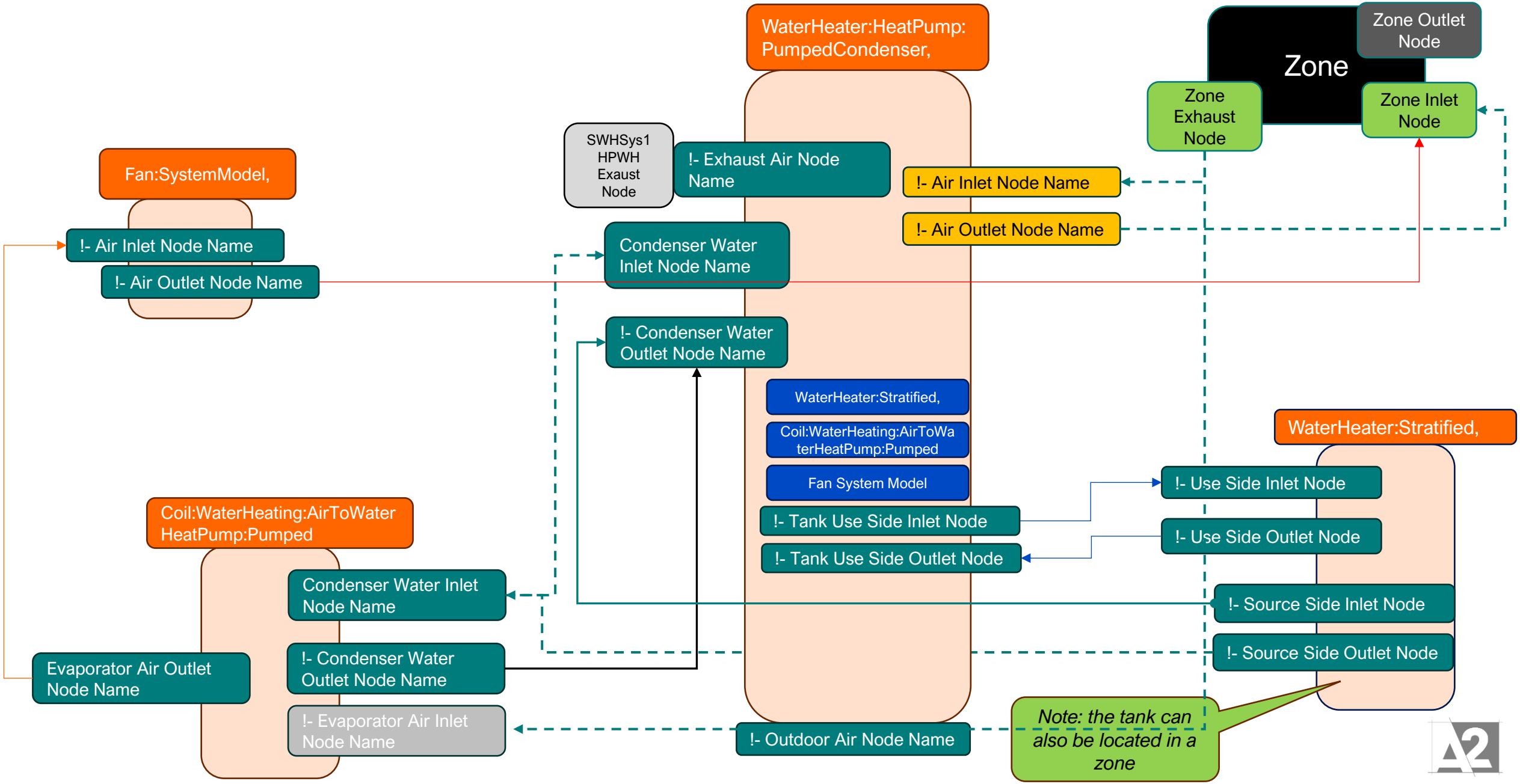
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Zone Exhaust Node
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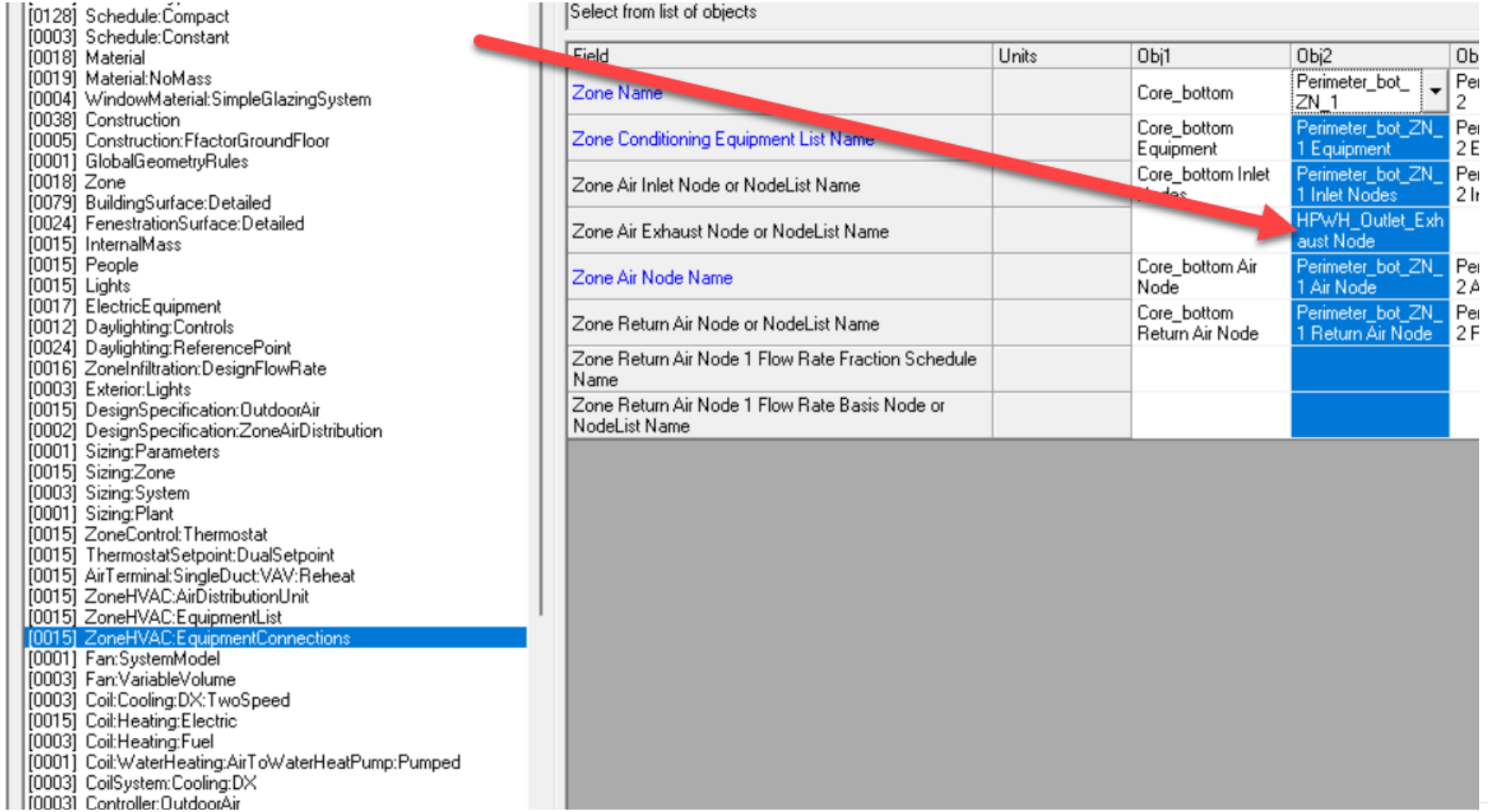
Coil:WaterHeating:AirToWater HeatPump:Pumped
Condenser Water Inlet Node Name
!- Condenser Water Outlet Node Name
!- Evaporator Air Inlet Node Name
Evaporator Air Outlet Node Name
!- Outdoor Air Node Name
Note: the tank can also be located in a zone

Add a HPWH to a Zone

At the Zone you want to add the HPWH, Add a new Exhaust Node you can name anything for that zone.

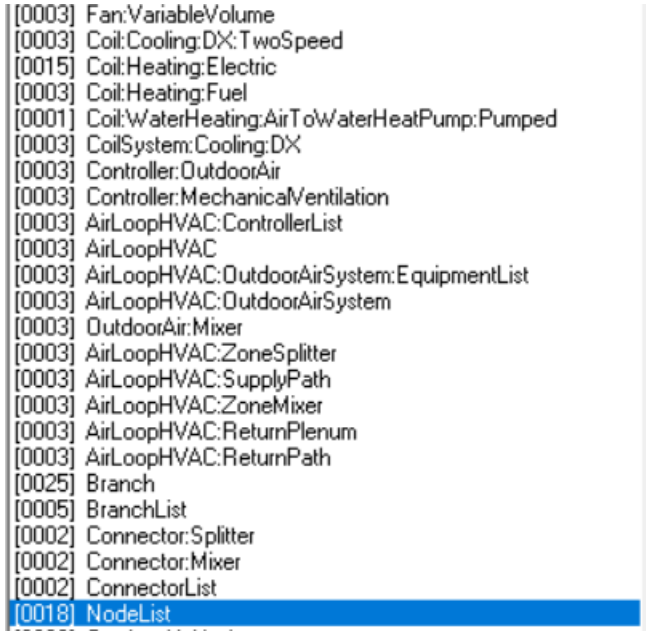
This name will be mapped to the HPWH.

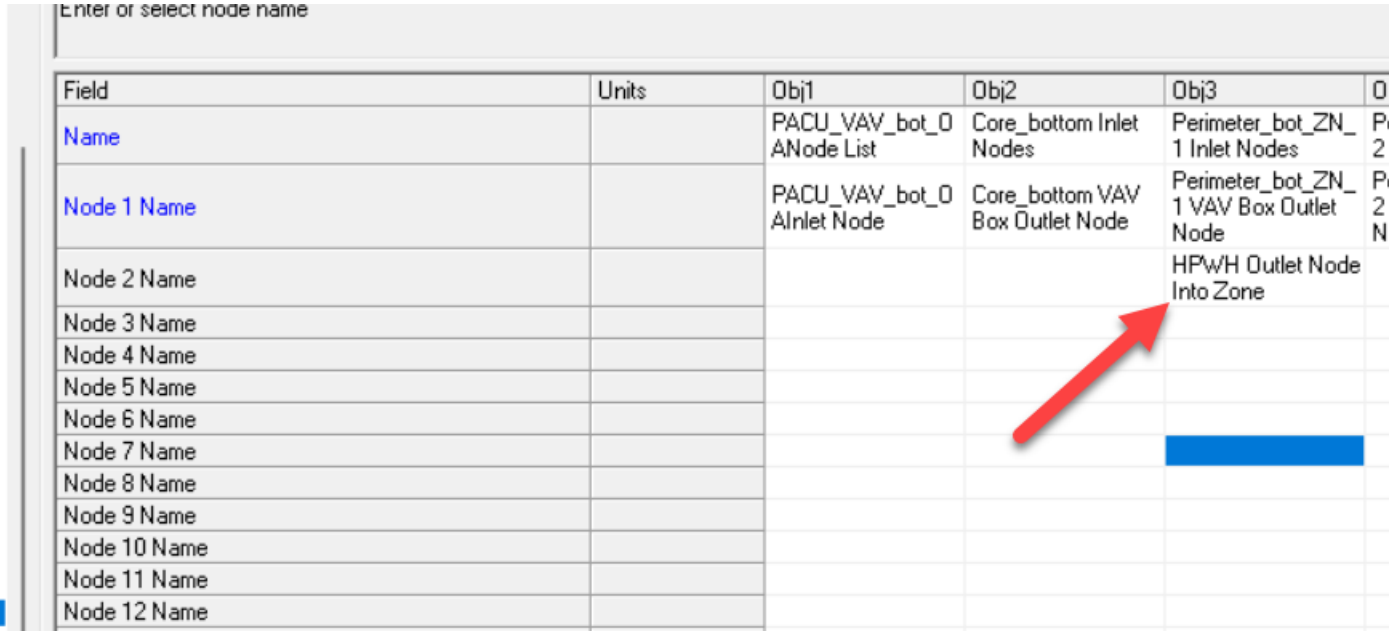
HPWH_Outlet_Exhaust Node



HPWH Inlet Air Node to Zone

Create a second new node called the "HPWH Outlet Node Into Zone" and add it to the NodeList for the specific zone on the INLET to that zone.





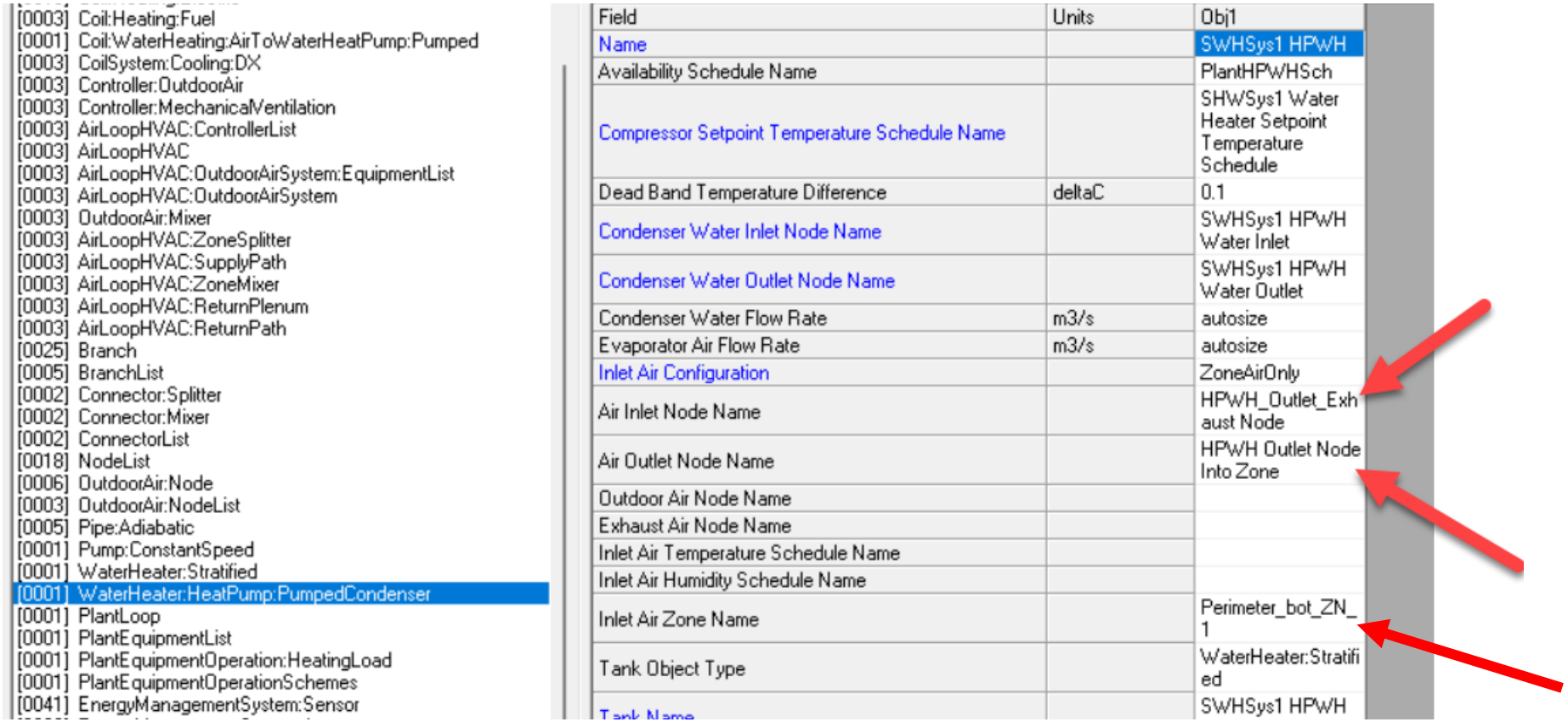
Mapping the HPWH Condenser to the Zone

Change the PumpedCondenser object INLET Configuration to ZONEAIRONLY

Then change the Air Inlet and Air Outlet Node.

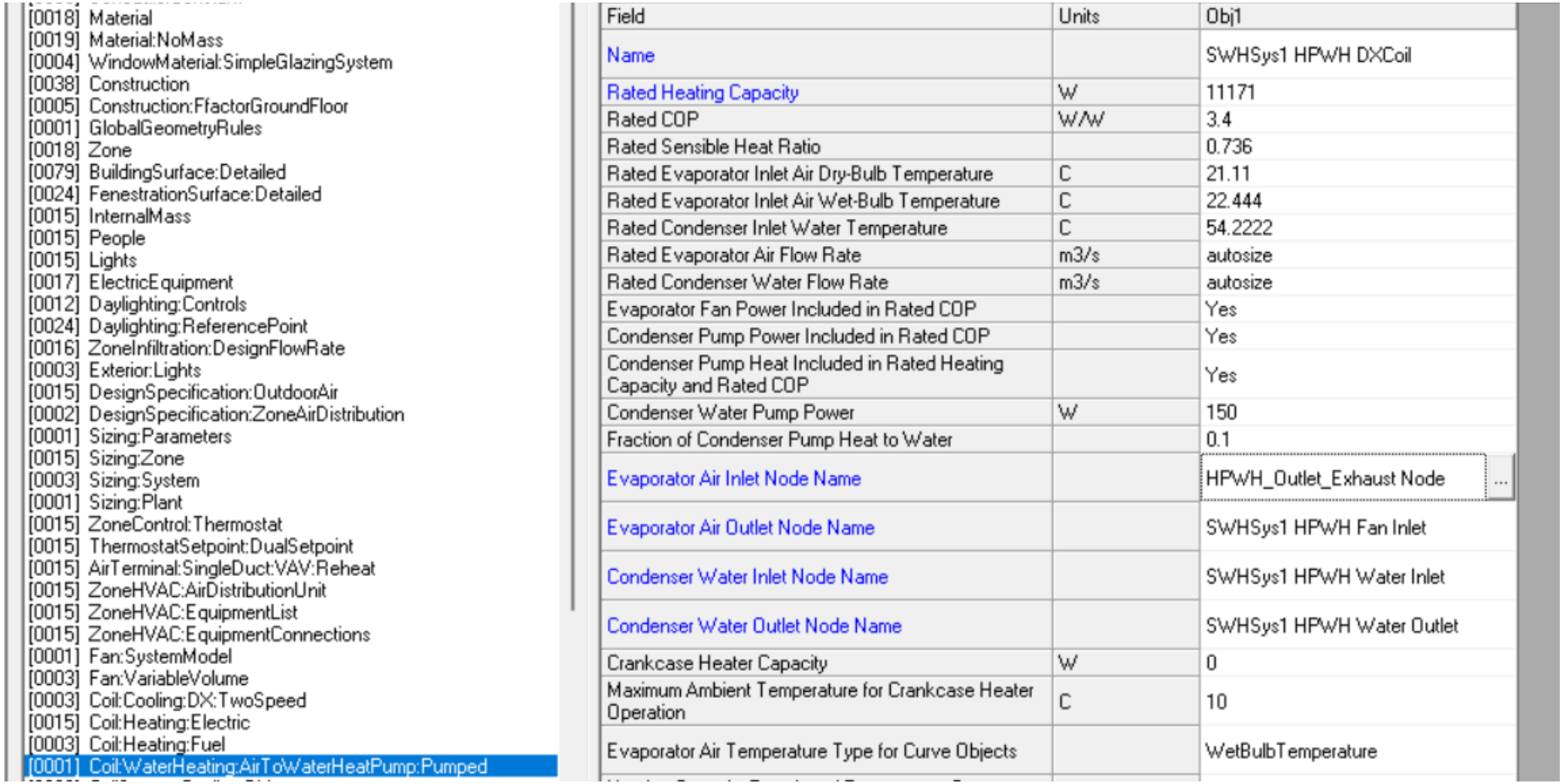
Inlet maps to the node you created for the specific zone on the EXHAUST node location.

Outlet maps to the zone inlet node name we made for the nodelist.



Mapping the HP Compressor to the Outlet Node

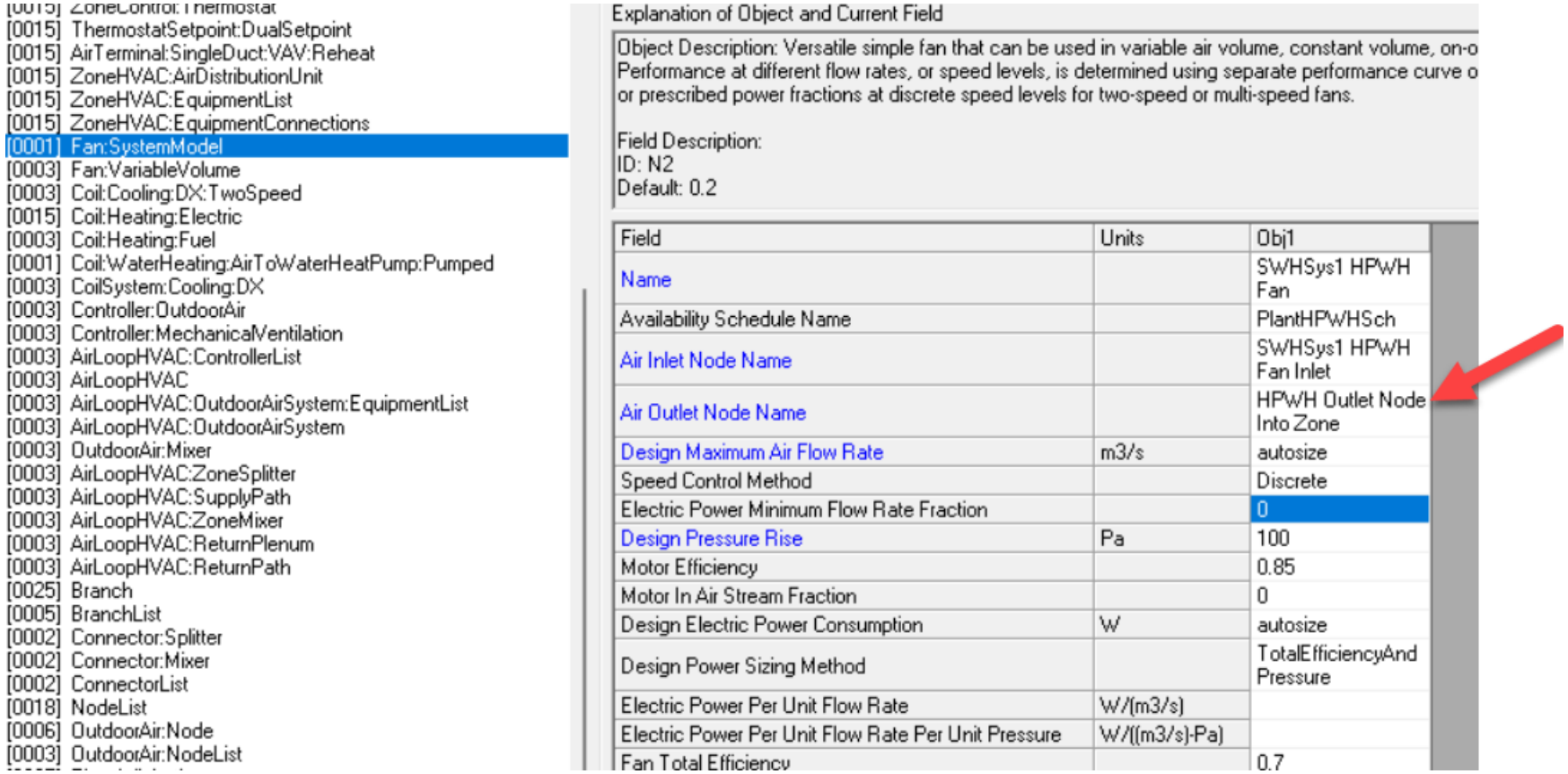
Map the evaporator air inlet node to the created Zone Exhaust Node we created.



Mapping the HPWH Condenser Fan to the Zone Inlet Node

Map the fan which is part of the HPWH to the zone inlet node we created.

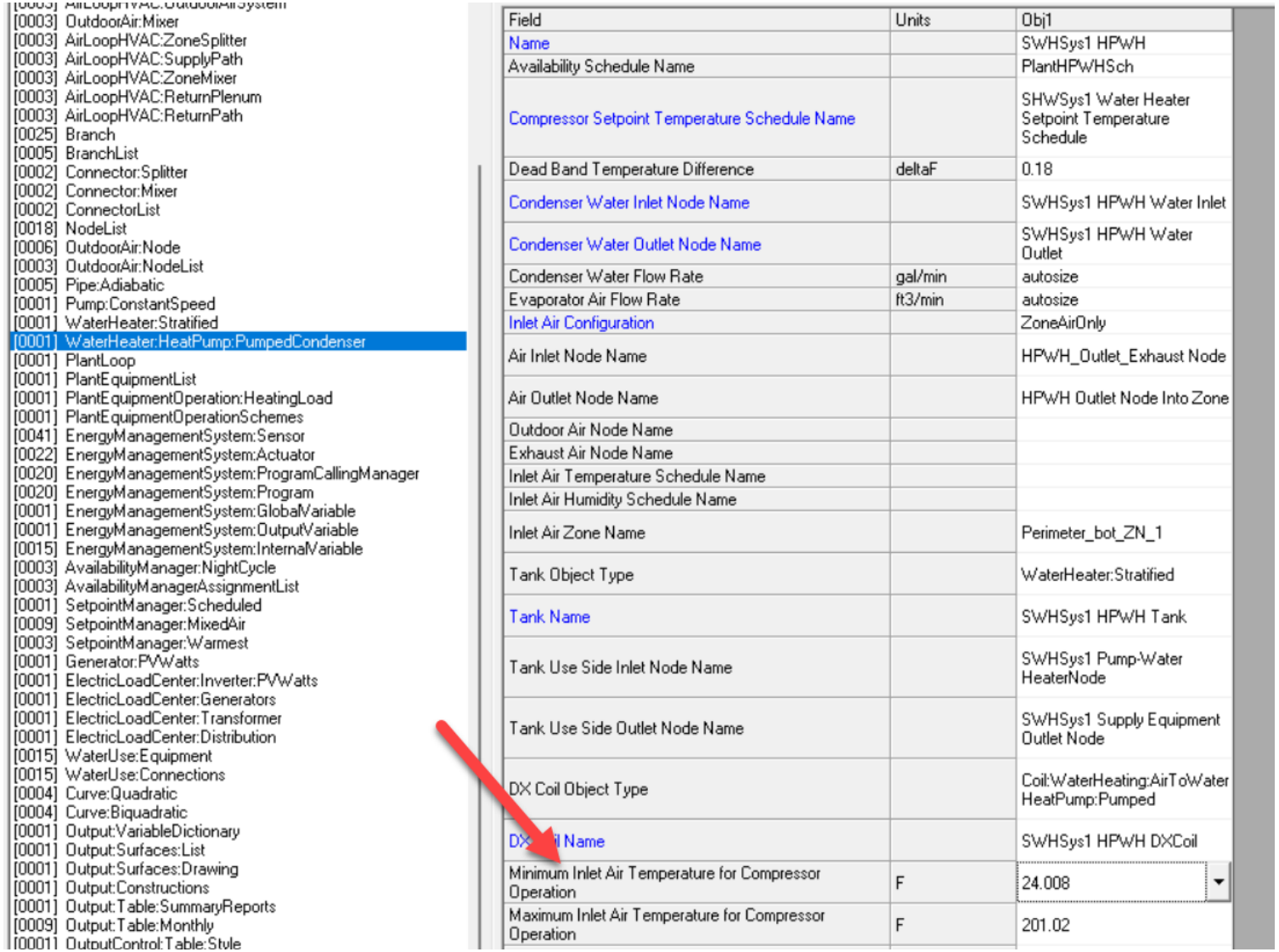
This fan pushes the heat (or coolth) off the compressor into the zone.



Equipment Control for OA Limits on Compressor

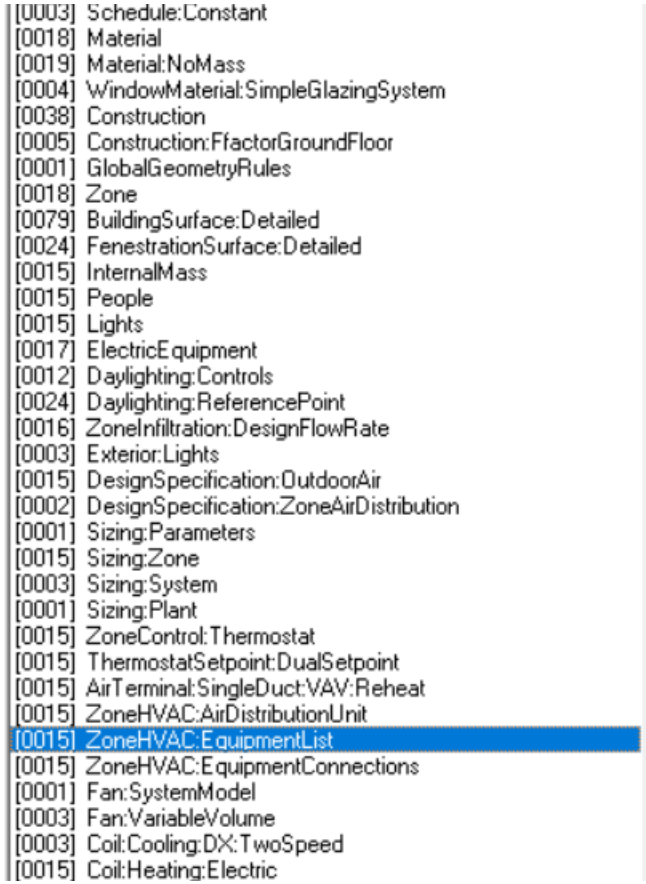
Note that the Compressor for the HPWH can operate down to this limit user specified in the Condenser.

This input will change where the unit relies on the backup electric heater fully. The curve on the compressor that is temperature dependent will still derate the capacity at cold outdoor air however the unit may still be able to partial capacity at low loads.



Last Missed Item, Link to Zone Equipment

Add the HPWH Object to the zone equipment list in E+



Field	Units	Obj1	Obj2	Obj3
Name		Core_bottom Equipment	Perimeter_bot_ZN_1 Equipment	Perimeter_bo 2 Equipment
Load Distribution Scheme		SequentialLoad	SequentialLoad	SequentialLo
Zone Equipment 1 Object Type		ZoneHVAC:AirDistributionUnit	ZoneHVAC:AirDistributionUnit	ZoneHVAC:A butionUnit
Zone Equipment 1 Name		Core_bottom VAV Box	Perimeter_bot_ZN_1 VAV Box	Perimeter_bo 2 VAV Box
Zone Equipment 1 Cooling Sequence		1	1	1
Zone Equipment 1 Heating or No-Load Sequence		1	1	1
Zone Equipment 1 Sequential Cooling Fraction Schedule Name				
Zone Equipment 1 Sequential Heating Fraction Schedule Name				
Zone Equipment 2 Object Type			WaterHeater:HeatPump:PumpedCondenser	
Zone Equipment 2 Name			SWHSys1 HPWH	
Zone Equipment 2 Cooling Sequence			2	
Zone Equipment 2 Heating or No-Load Sequence			2	
Zone Equipment 2 Sequential Cooling Fraction Schedule Name				
Zone Equipment 2 Sequential Heating Fraction Schedule Name				
Zone Equipment 3 Object Type				
Zone Equipment 3 Name				
Zone Equipment 3 Cooling Sequence				
Zone Equipment 3 Heating or No-Load Sequence				
Zone Equipment 3 Sequential Cooling Fraction				

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