SANCO$_2$ GS4 HPWH
Combi Heating Application

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$SANCO_2$ Water Heater

- Split system HPWH, unique compared products currently sold
- 2 Part system, must use either the 83 Gallon Stainless Steel or 119 Gallon Glass Lined storage tank coupled with the 4.5kw capacity Inverter Compressor Outdoor unit
- Larger tanks store more energy
- Why different? – Based on successful Technology from a Global scale

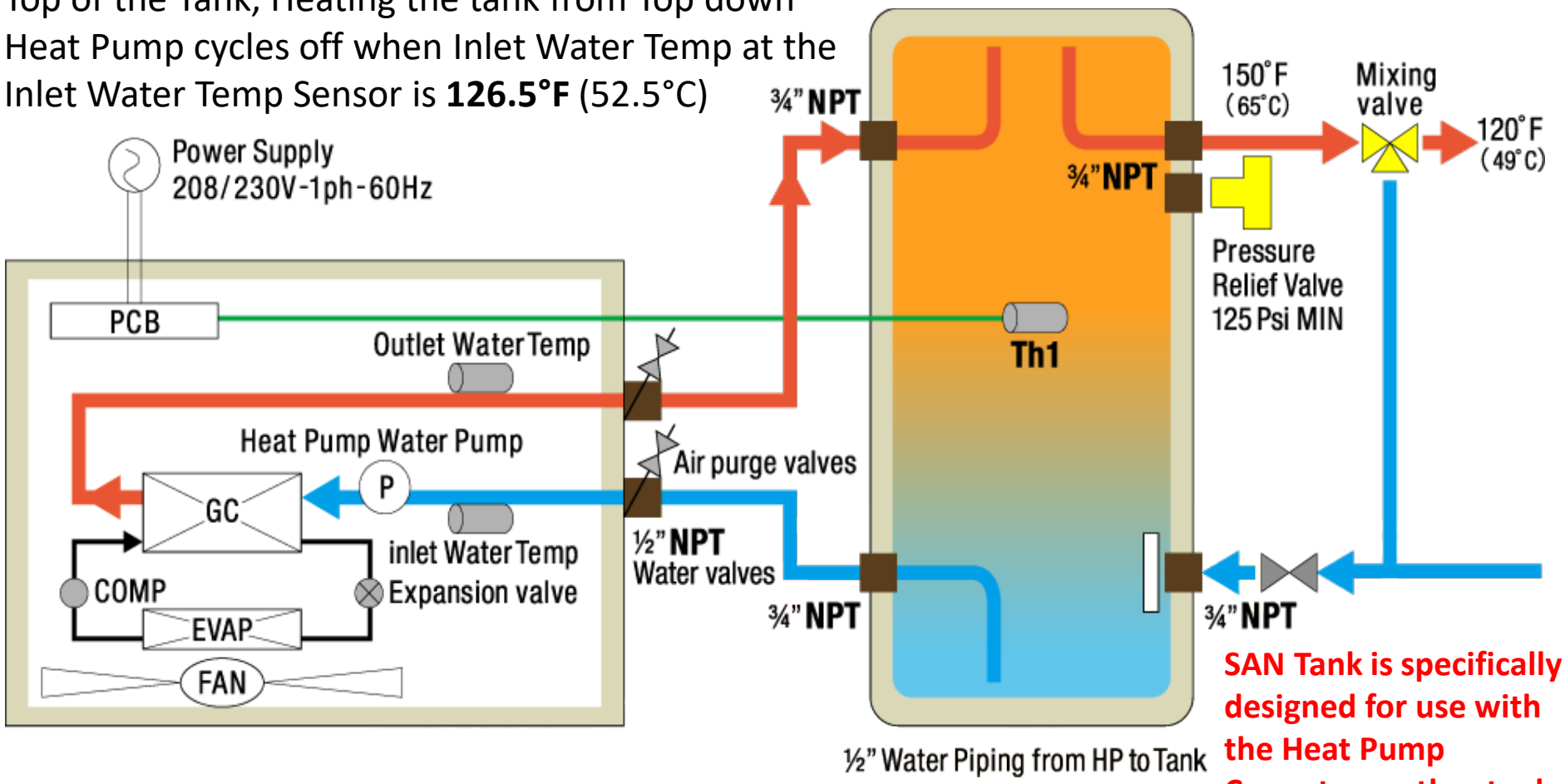
Schematic & System Operation

Tank is designed that Cold Water enters at the bottom of the tank to stratify the Tank Hot Water to the Building from the top of the Tank

Th1, or the Tank Thermistor will start the Heat Pump's water pump when the Tank water temperature falls below 113°F (45°C)

Heat Pump pulls cold water from the bottom of the Tank, Heats it to 150°F, returns it to the Top of the Tank, Heating the tank from Top down

Heat Pump cycles off when Inlet Water Temp at the Inlet Water Temp Sensor is **126.5°F** (52.5°C)



SAN Tank is specifically designed for use with the Heat Pump
Cannot use other tanks

DHW Recovery Rate per Heat Pump

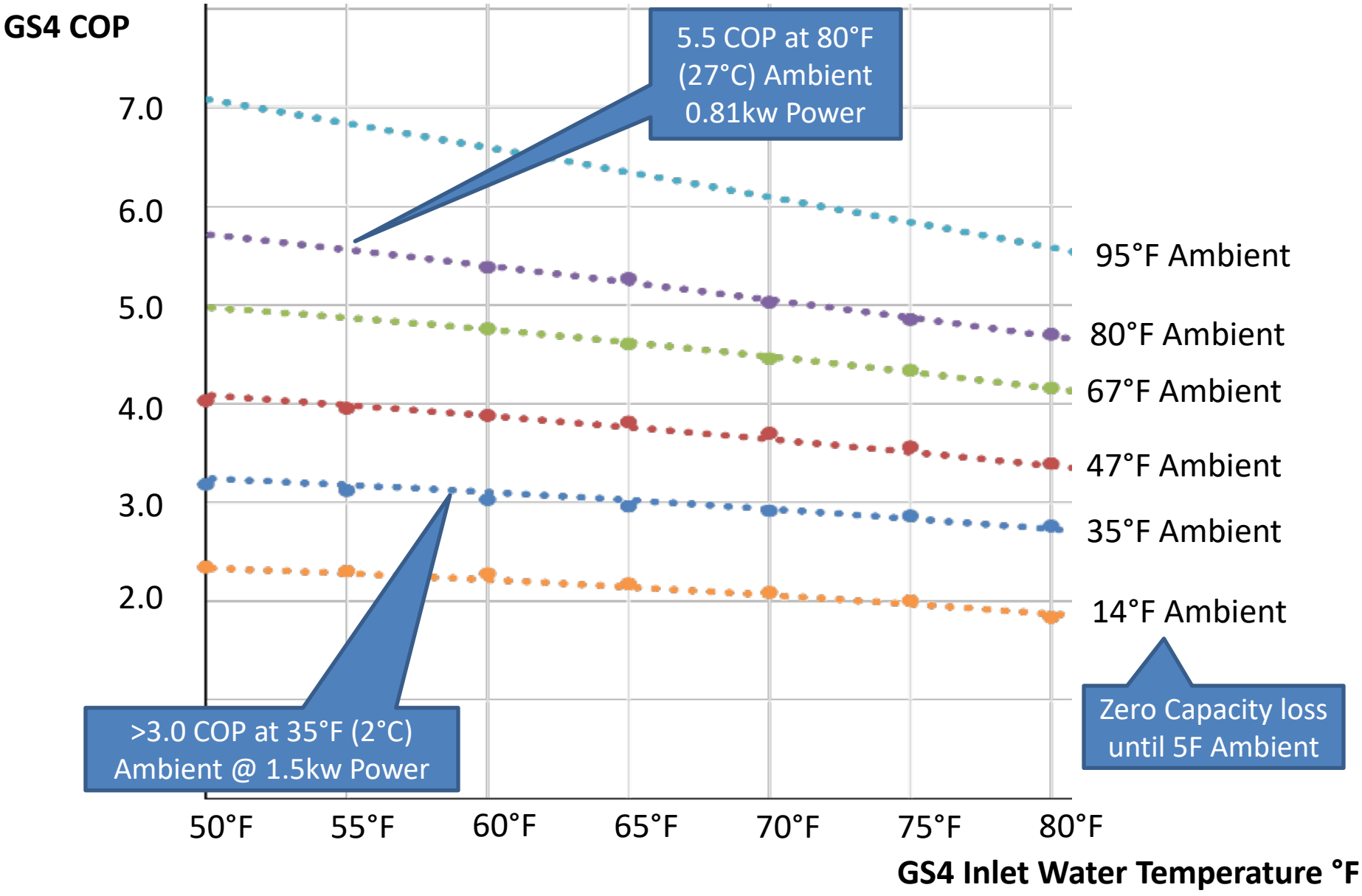
Gallons per Minute (US GPM)						
	Incoming Water Temperature °F / °C					
Heat Pump Set Point	**40 / 4.4**	**45 / 7.2**	**50 / 10**	**55 / 12.8**	**60 / 15.6**	**65 /18.3**
145°F / 62.8°C	0.29	0.31	0.33	0.34	0.36	0.39
150°F / 65.6°C	0.28	0.29	**0.31**	0.33	0.34	0.36
Gallons per Hour (US GPH)						
	Incoming Water Temperature °F / °C					
Heat Pump Set Point °F	**40 / 4.4**	**45 / 7.2**	**50 / 10**	**55 / 12.8**	**60 / 15.6**	**65 /18.3**
145°F / 62.8°C	17.6	18.5	19.5	20.6	21.8	23.2
150°F / 65.6°C	16.8	17.6	**18.5**	19.5	20.6	21.8

Stored water is then mixed down by Mixing Valve and then mixed again at a single outlet fixture

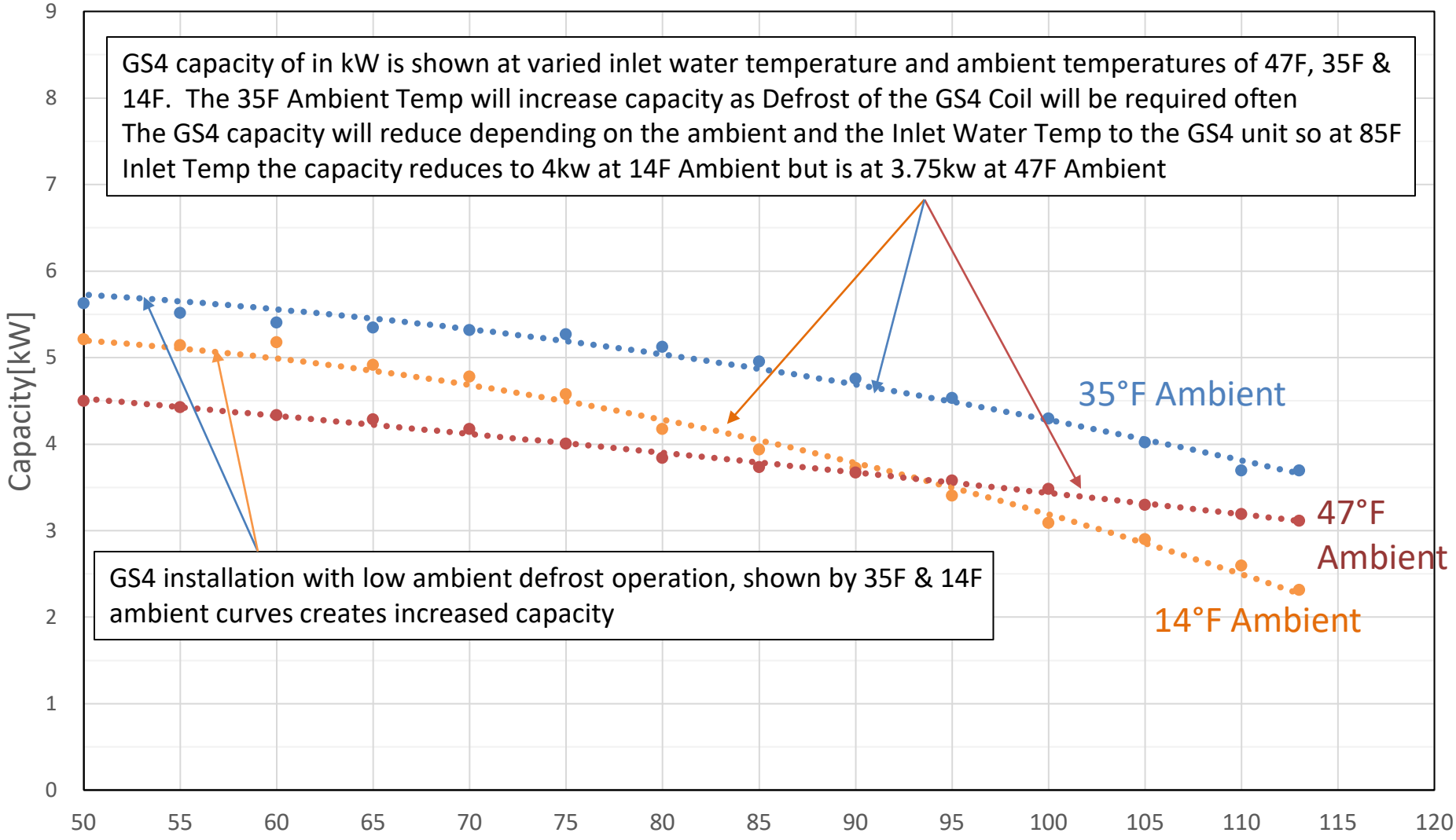
Every gallon at 150°F in the Tank = 1.7 Gallons at 105°F, using 50°F cold water temperature

GS4-45HPC COP/Efficiency

COP is defined as the ratio of Capacity/Power Input



GS4-45HPC Capacity



Capacity is shown in Kw not Btu/h, unit is designed for 4.5kw or 15,400 Btu/h
Capacity curves show the inlet temperature where 4.5kw is delivered to the Inlet Water

DHW & Heating Combi

- Application based on several factors including ambient and Heating system capacity required
- Over 145°F water can be generated by the SANCO$_2$ unit at ambient temperatures down to -20°F
- 150°F water is produced at a 3.0 COP @ 23°F ambient
- Unit testing & flow rates show that a >100 Gallons of DHW @ 125°F use per day only requires 5 to 6 hours of unit operation to recover
- 83 or 119 Gallon tank MUST BE USED, important to keep the stratification of the tank to ensure highest COP and store maximum energy in the tank

DHW & Heating Combi

- **Per the GS4 Capacity curves each SANCO$_2$ Heat Pump reduces capacity based on the Cold Inlet Water Temp providing a HEATING CAPACITY OF 8,000 to 10,000 Btu/h**

- **Not enough Capacity? – Consider adding extra Heat Pumps & 119 Gallon Tanks or add in Auxiliary resistance heating**

- **Only use as a COMBI heating system in Locations & Climates with a design winter temperature (minimum expected coldest winter temperature) of >22°F**

Lower Winter Design Temps?

- **MUST add Auxiliary heat sources such as an Electric Water Heater meet or exceed Heat Load to reduce cycle time on the Heat Pump**
- **Use sparingly for homes in colder climates where Heating load dominates operation**

DHW & Heating Combi

- **Maximum recommended water temperature to the Heating System from the X Block is ≈ 130°F**
- **Higher Temps to emitters cause issues with the GS4 capacity and X Block return temperature to Tank > 126.5°F not being able to having the GS4 unit run**
- **Heating system should be designed for the lowest possible Return water temperature to the Heat Pump, recommended below 100°F**
- **Return water temps over 126.5°F will stop Heat Pump operation**

DHW & Heating Combi

- **DHW use is VERY important to maximize the energy and efficiency in the tank as it reduces the overall water temperature to the Heat Pump**

- **For INCREASED efficiency use a minimum of 20 to 25 Gallons of DHW daily, more DHW = Better performance & efficiency**

Heating Only

STOP & THINK!!!!!!!!!!!!

CONSIDER THE IMPACT OF HIGHER RETURN WATER TEMPS ON EFFICIENCY AND CAPACITY

ALSO HOW THE UNIT IS CONTROLLED BY THE TANK & INLET WATER TEMP SENSORS BEFORE PROCEEDING WITH A HEATING ONLY SYSTEM!!!!!!

Design Load and System Needs

Location	Grass Valley	Nevada City	Olympia
Heating Set Point	70	70	70
Winter Ambient Design Temp.	19	14	22
ΔT	51	56	48
UA + Infiltration	407	210	281
Design Load Btu/hr.	20,757	11,760	13,488
Heating System Type	Air Handler & Aux Mini Split	Air Handler	Low Temp Radiators
DHW T°F	143	121	120
# of Occupants	2	2	2
Home Sq Footage	1,680	1,690	1,152

SANCO2

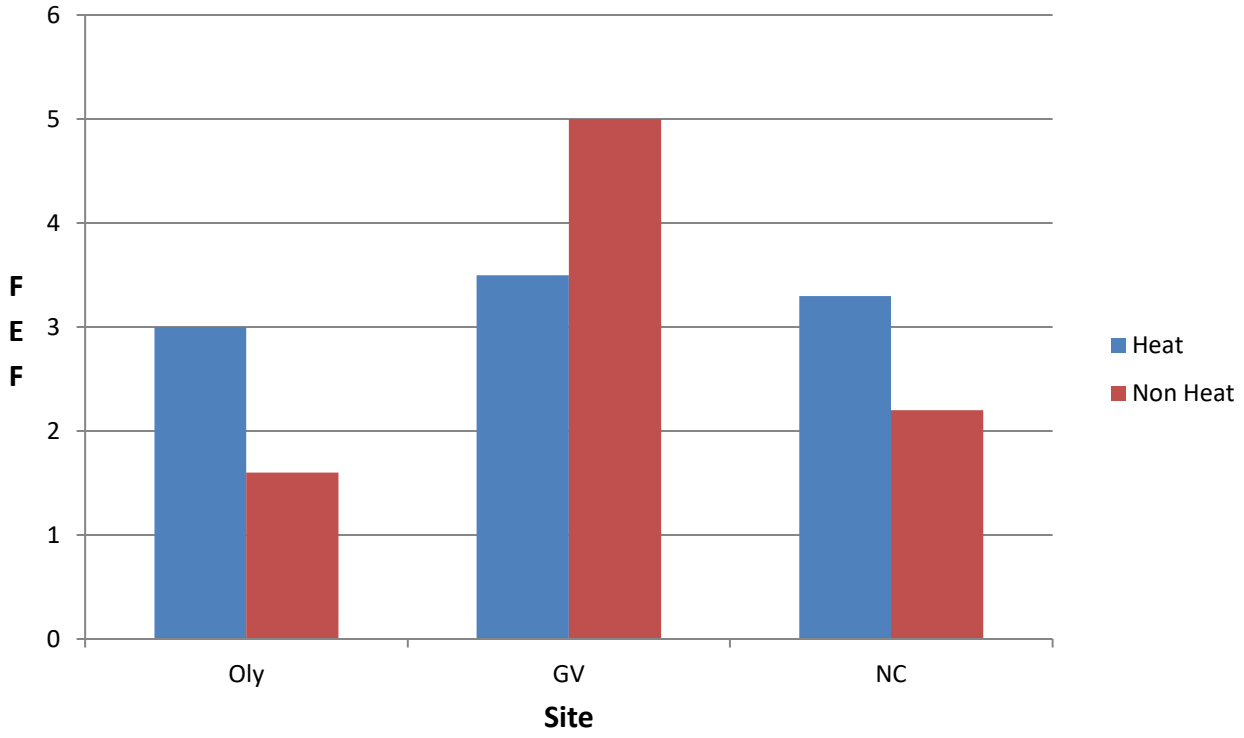
Auxiliary heat must be carefully designed to supplement the heat pump without harming its performance

Energy Measurements

	HP (kWh)		Aux (kWh)		Pump & Control (kWh)		Total kWh	
Season	Heating	DHW	Heat	Cool	Heat	Other	Heat	All other
Olympia	521	49	0	0	120	6	641	55
Grass Valley	1,669	927	312	371	306	176	2,287	1,475
Nevada City	926	526	0	0	105	43	1,031	569

- Auxiliary Heat is only at Grass Valley, a Mini Split heat pump is used 18% of time for backup heating in the winter
- The non heating season auxiliary use of the Mini Split is for Air Conditioning
- Other sites use only SANCO$_2$ as the Heating source

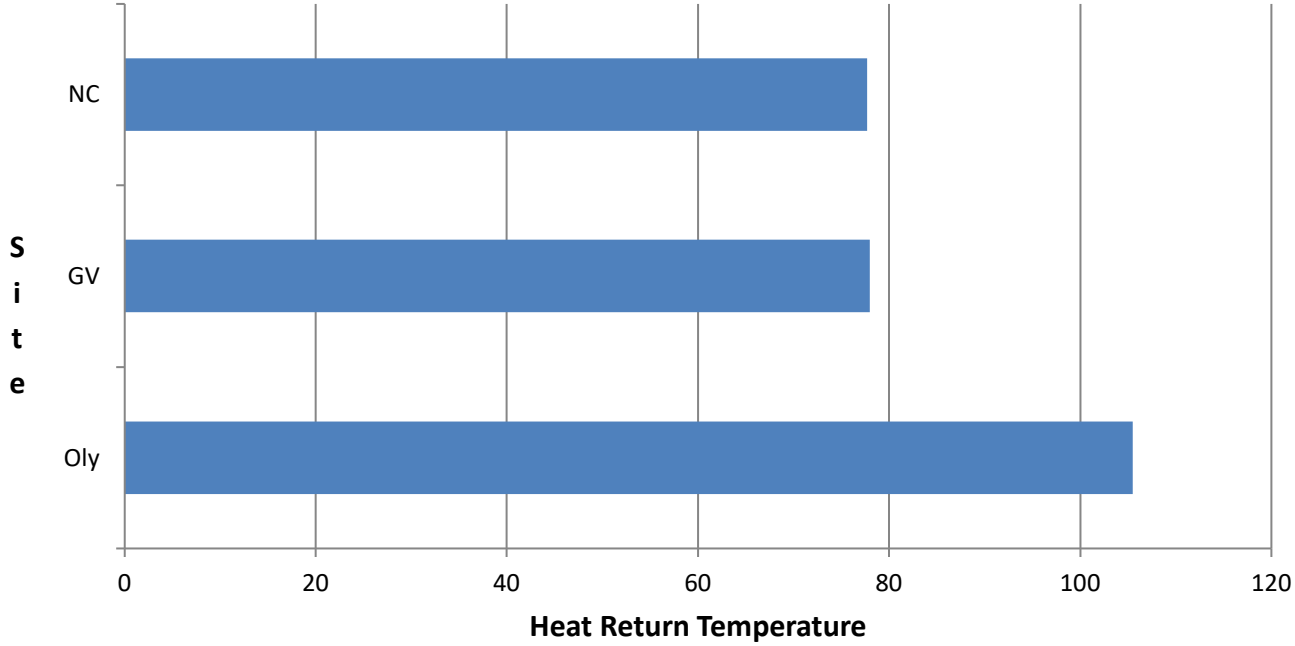
Test Results – Field Energy Factor



- FEF – Field Energy Factor, simply put Energy out of Heat Pump/**TOTAL** Energy used by the system (fans, pumps, controls etc) – A full system COP

- Non Heat = DHW only use measured in the non Heating months

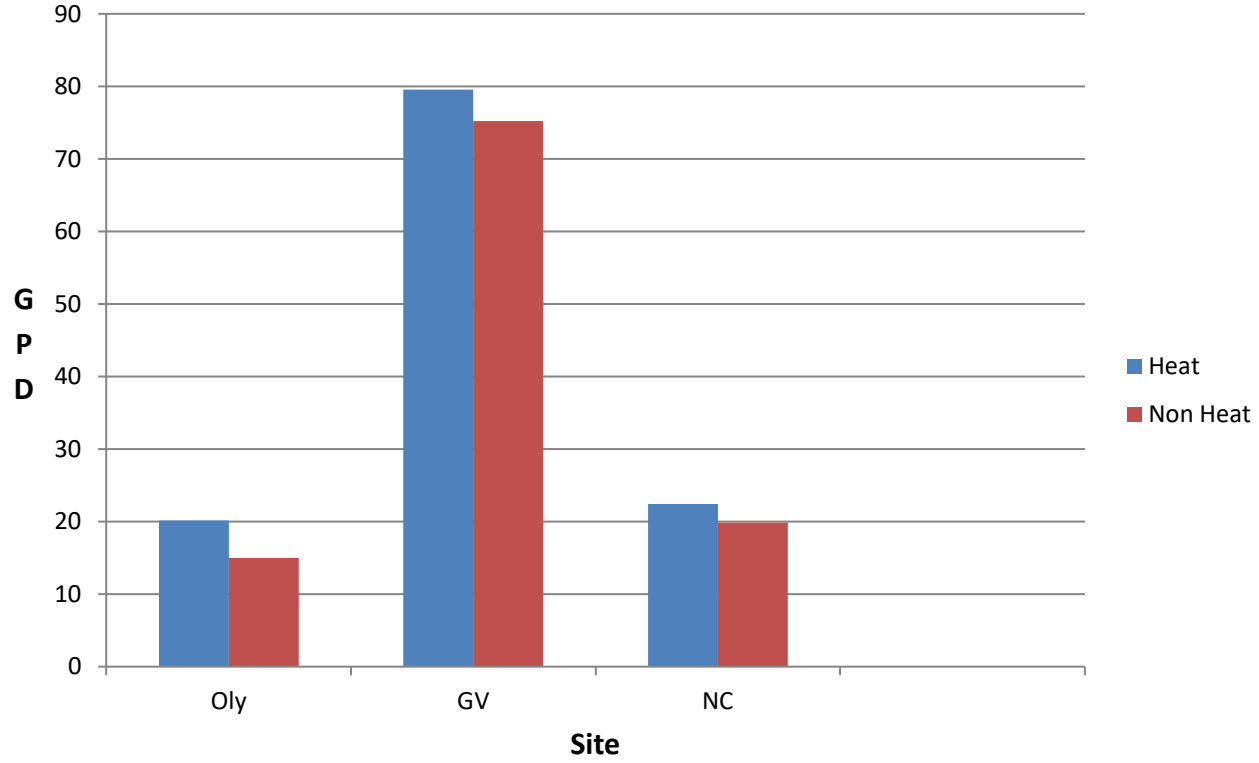
Factors affecting results, #1 Return Water Temp to Heat Pump



- Both Nevada City and Grass Valley designed the Air Handler coil to be oversized which meant that the return temperature to the bottom of the tank was kept below 80°F increasing both Efficiency and Performance

- Olympia had a higher return because of the emitter type and enforced design of the system – radiators need to run hotter to give up heat

Factors affecting results
#2 – DHW Usage



- Grass Valley used a lot of DHW in both the Winter and the Summer – this gave the tank cold water to feed the Heat Pump improving performance

- Olympia used the least DHW so it affected both the efficiency in the Winter and Summer for the system

Comparison of Energy Used for Heating & DHW per Sq. Ft.

Based on Field Measured Data

	CO_2 Split System Combi, kWh/ft²	Air-to-Air Heat Pump (Mini Split) plus Tier 2 HPWH in Garage for DHW kWh/ft²
Olympia	2.4	5.2
Grass Valley	2.9	3.2
Nevada City	1.4	4.1

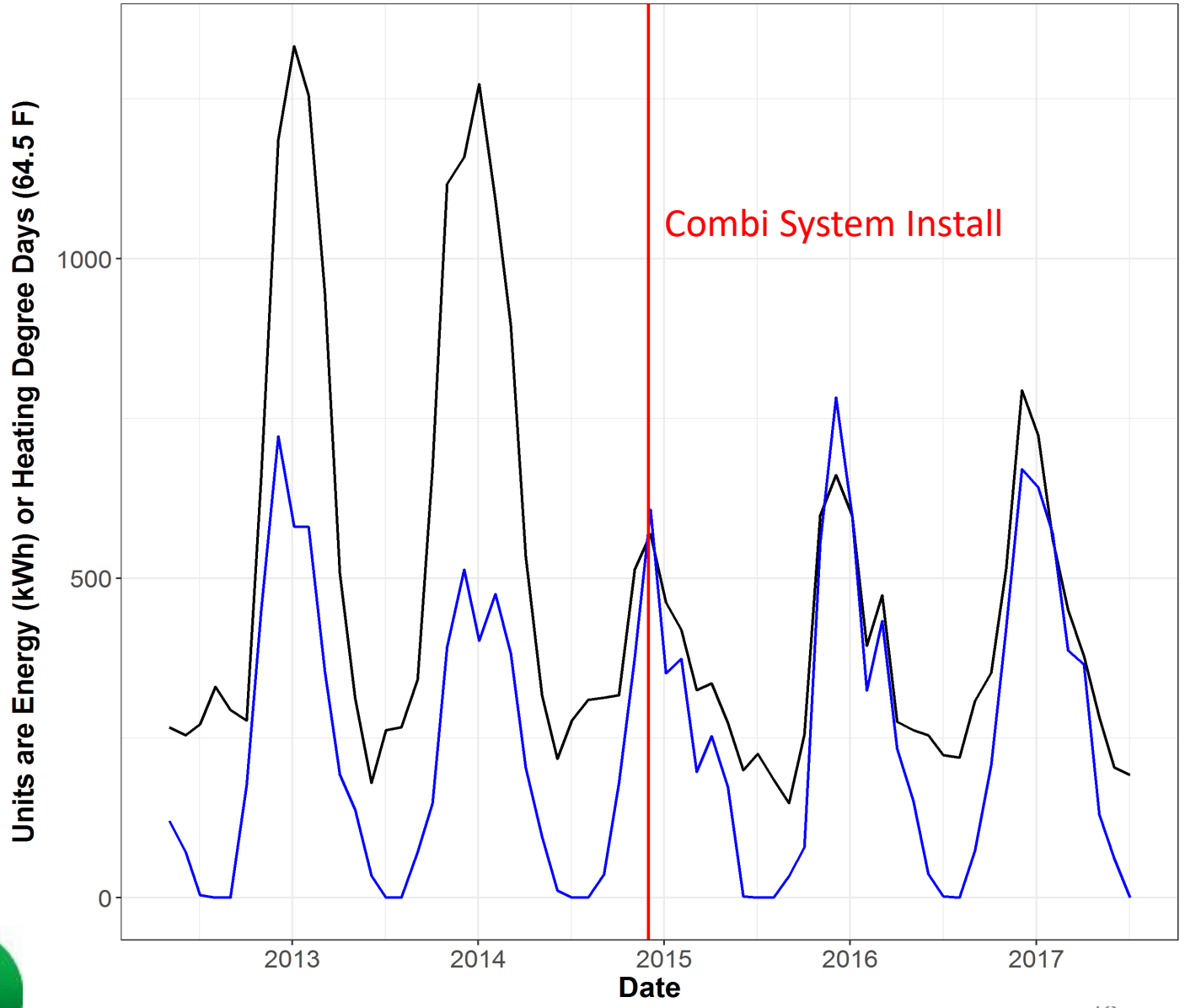
- Space Heat Comparison from 2012 Residential Building Stock Assessment—Ecotope
- Heat Pump Water Heater Comparison from HPWH Model Validation Study—Ecotope

Nevada City Energy Use Over Time

Black line is energy used at Nevada City

Blue line is Heating Degree Days at the VDD base of 64.5

Normalized slope shows savings of 3,191 kWh/yr.



Operation & Efficiency in Heating

The key to performance and a Stratified tank is :

1. Keep the return water temperature to the unit as cold as possible by good hydronic system design
2. USE DHW!!!!! – The more DHW used the colder the bottom of the tank will be and the higher performance and efficiency of the system
3. However be careful about dump load for DHW such as filling a bathtub (surprisingly high Btu/h drain on the system)

- **Therefore we would recommend a MINIMUM of 20 to 25 Gallons per day of DHW, more DHW use, More efficiency and performance…….**

Potable/Non Potable - Taco X Block

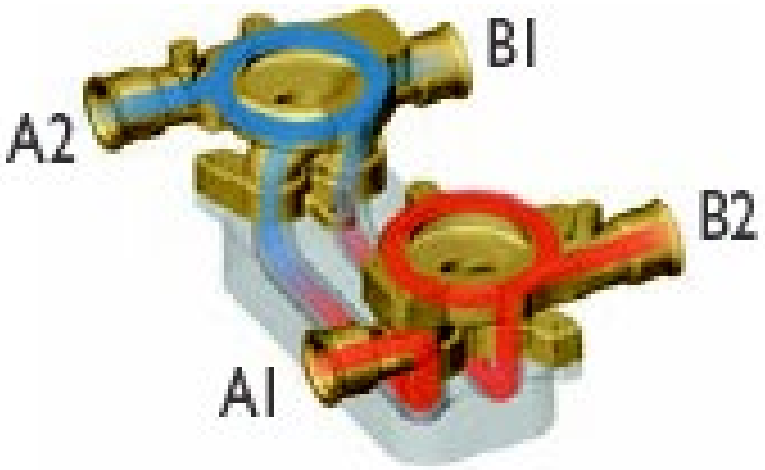
- **ALL SANDEN COMBI SYSTEMS MUST BE INSTALLED USING A TACO X BLOCK WHERE REQUIRED BY CODE***

- **NO X BLOCK NO WARRANTY***

*Air Handlers can be piped directly using Potable Water, if allowed by code and AHU coil is of low lead construction suitable for Potable water

Taco X – Pump Block

X - Pump Block Operation



Hot water from the heat source, enters the X-Pump Block's integral heat exchanger at port (A1) and exists at (A2).

A variable speed circulator controls the speed of the water flowing through the A (heat source) side of the heat exchanger to satisfy the heat transfer requirements.

The heat exchanger is a counterflow style, so system water enters at port (B1) and exists at port (B2).

A constant speed circulator moves the water around the B (system) side.

X Block Settings & Sensors

X Block MUST be used in Outdoor Reset Mode & Boiler Enable Mode, set switch to OFF

Install following Sensors on the X Block Terminal wiring
Sensors are supplied for use with the X Block

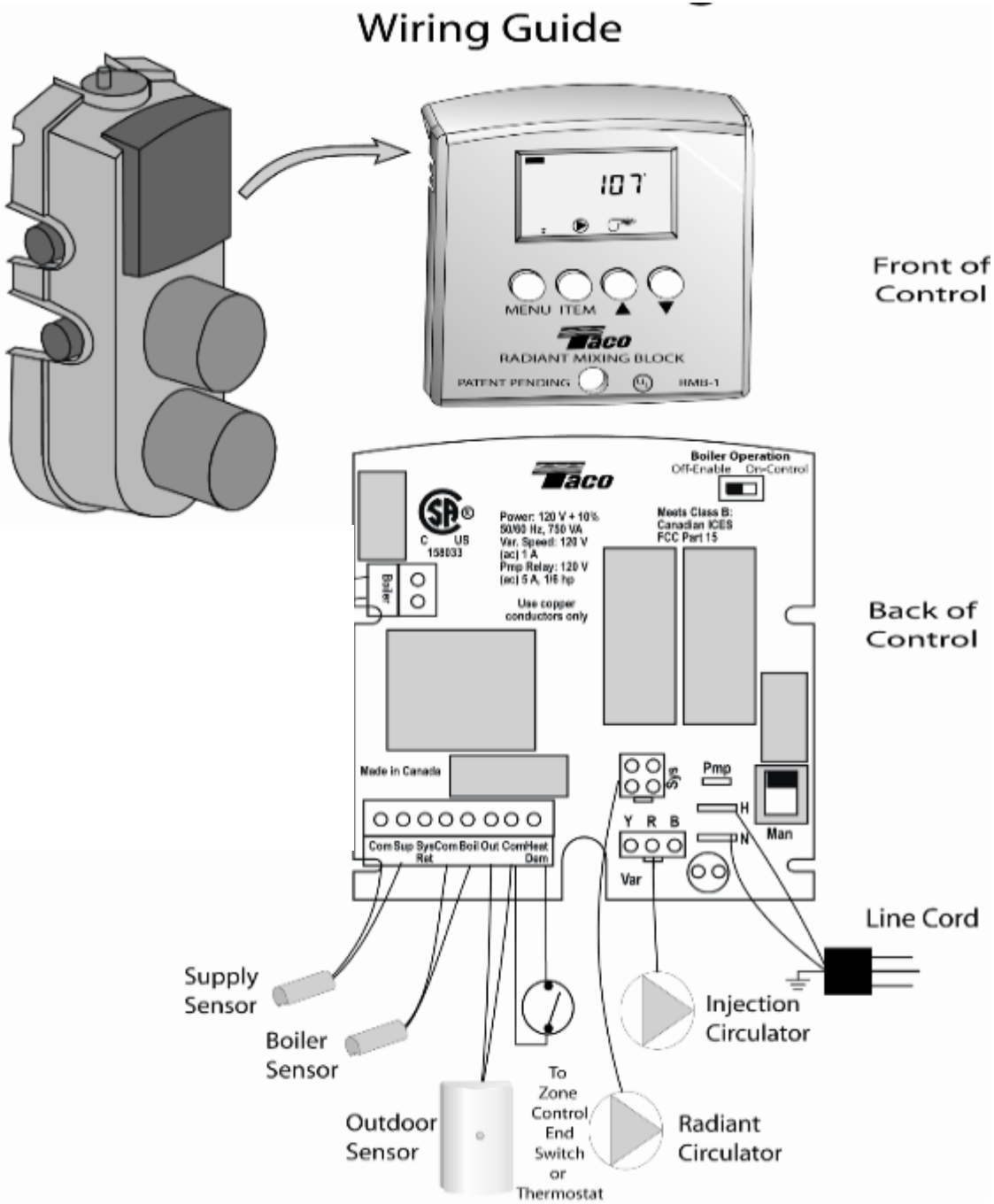
- **Outdoor Temperature Sensor -** Wired for the installation of the Sensor external to the house

- **Supply Temperature Sensor** – Wire and install at the outlet temperature sensor of the X Block to the house

- **Boiler (Water Heater Protection) Sensor** – Wire and install to the sensor location on the Storage Tank to slow down the X Block energy usage based on the tank temperature Assists to prevent cool showers in the heating months

X Block Wiring

- Power – 115V, comes with lead to plug directly into a receptacle
- Wire in the 3 Sensors are provided with the X Block to the terminals provided
- Depending on the application (# of zones etc) either a Taco SR relay or simply a zero volt open closed thermostat can turn on the X Block in a call for heating



Outdoor Temperature Sensor

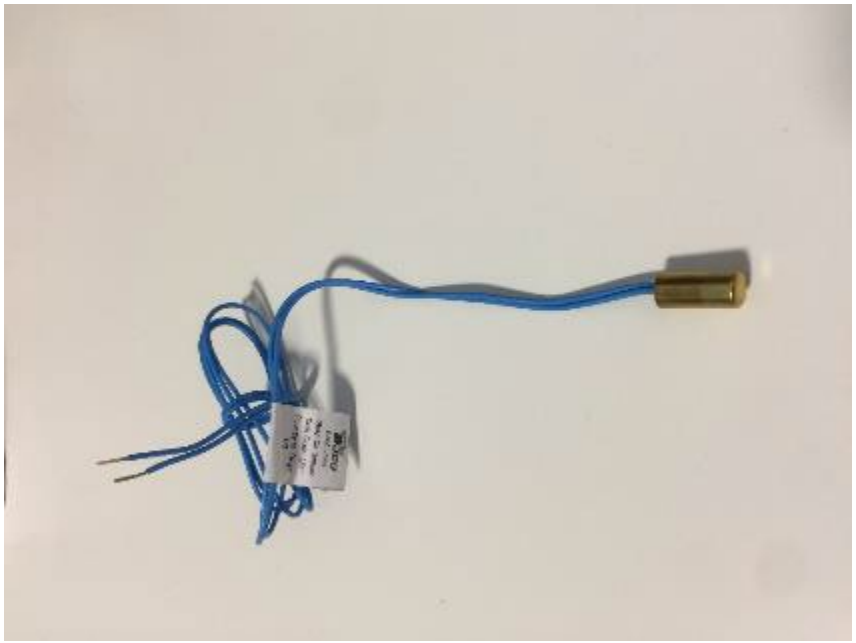
- Install away from direct sunlight or reflective surfaces
- Install above anticipated snow line
- Can be installed behind Sanden unit and wire run with Sanden thermistor
- If away from SANCO$_2$ unit recommended is underneath an building Eave or other sheltered space

MUST BE INSTALLED !!!!!

DOES NOT NEED AN ADDITIONAL SENSOR
JUST WIRE TO IT!!!!

Supply Temperature Sensor

- This should be installed on the Supply line to the Heating emitters
- Install approx. 3” from the X Block on a straight section of pipe
- Secure with provided tie wraps
- Insulate sensor on pipe with closed cell insulation



Boiler Protection Sensor

- This should be installed adjacent to the Thermistor on the Storage Tank
- Remove cover and Foam insulation
- Secure sensor onto the tank connection
- Secure with provided tie wraps
- Insulate sensor with closed cell insulation

Thermostat

- This can be any standard North American 24V Thermostat from Nest to T87 or even a switch

- If you are zoning the Heating system then each individual zone Thermostat should be wired to a Taco SR relay control

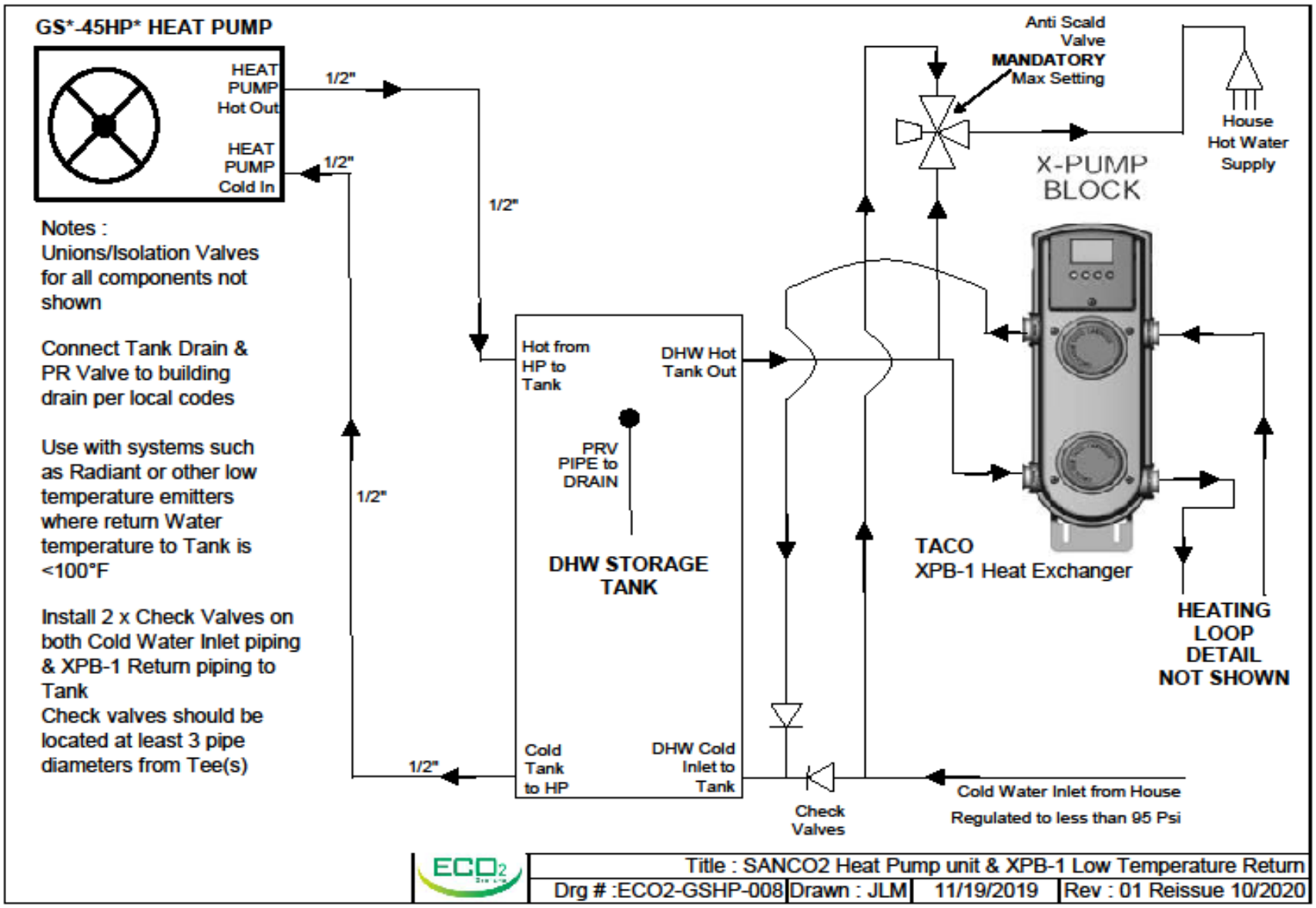
- Wire the X-X contact to the X Block thermostat terminals

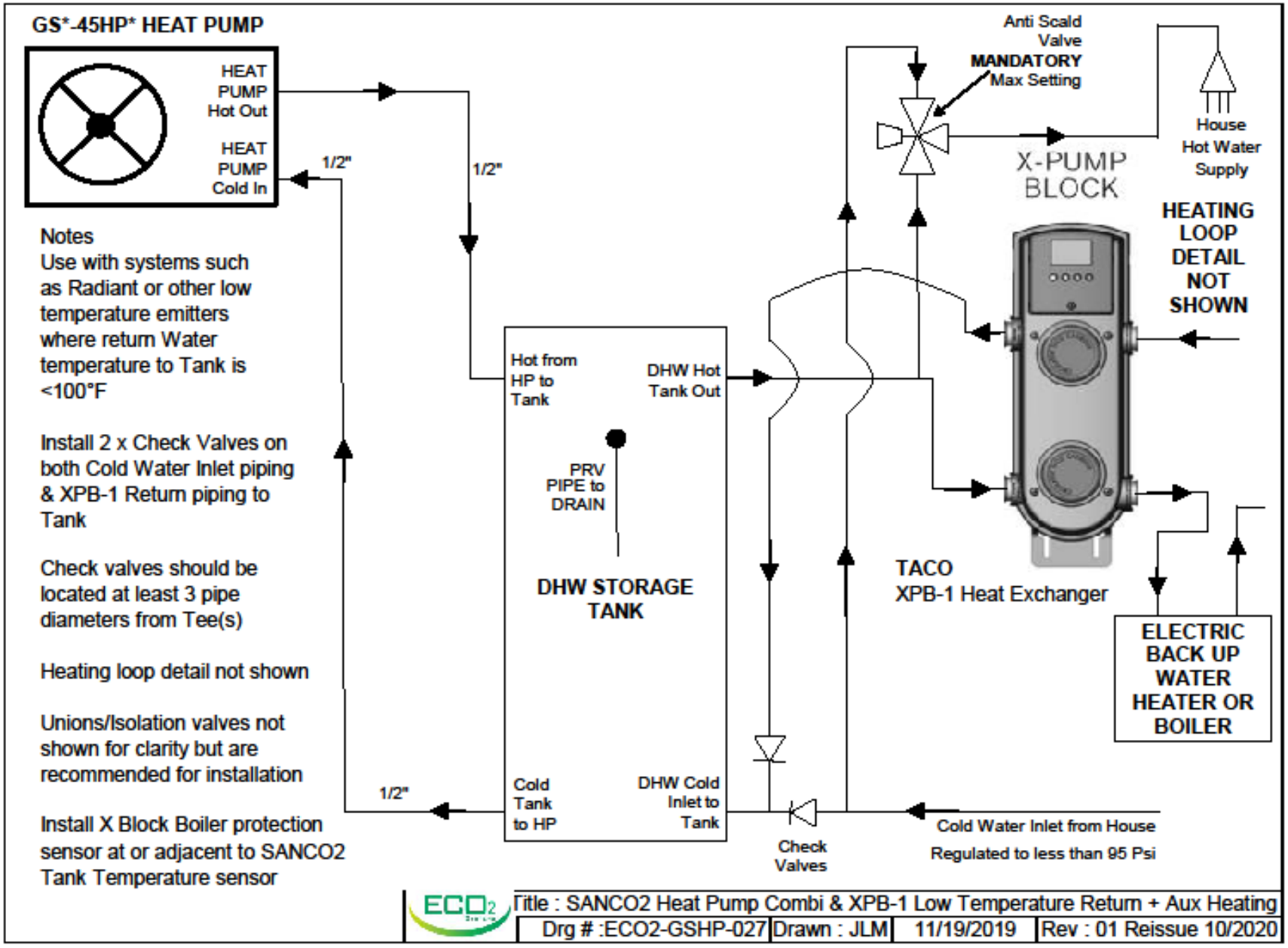
X Block Programming

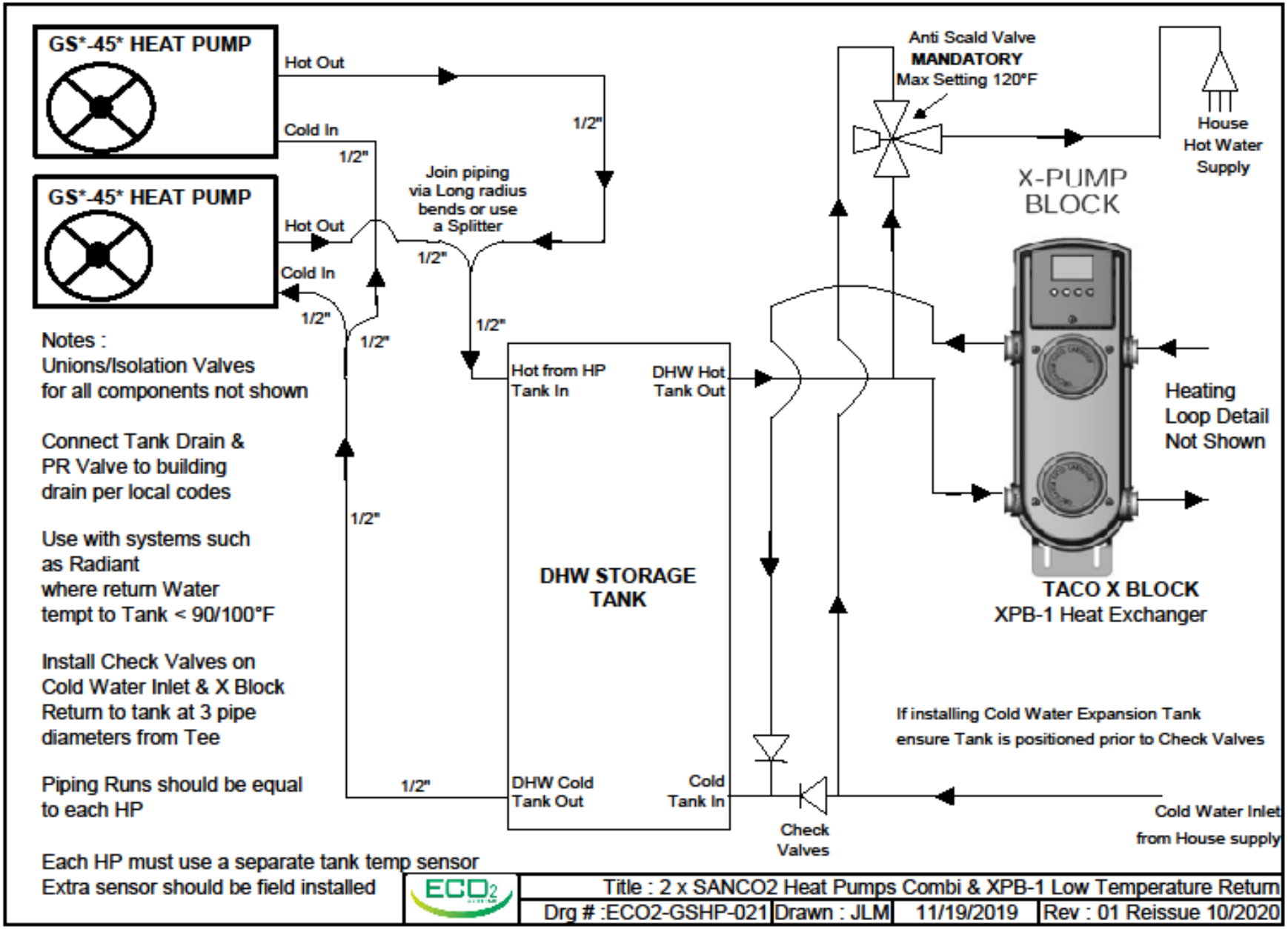
	Emitter Type			
X Block Menu Item	**Radiant in Slab**	**Radiant Staple Up**	**Low Temp Radiators**	**Fan Coils**
Outdoor Design Temperature	Set at the 99% Temperature from ASHRAE Design Conditions			
Mix Design Temperature	90	105	120	130
Mix Maximum Temperature	95	110	125	135
Mix Minimum Temperature	OFF	85	OFF	125
Boiler Protection Temperature	125 OR 130	125 OR 130	125 OR 130	125 OR 130
Warm Weather Shut Down	50	50	50	50
(WWSD)				

Piping Diagrams
&
Sensor X Block Wiring

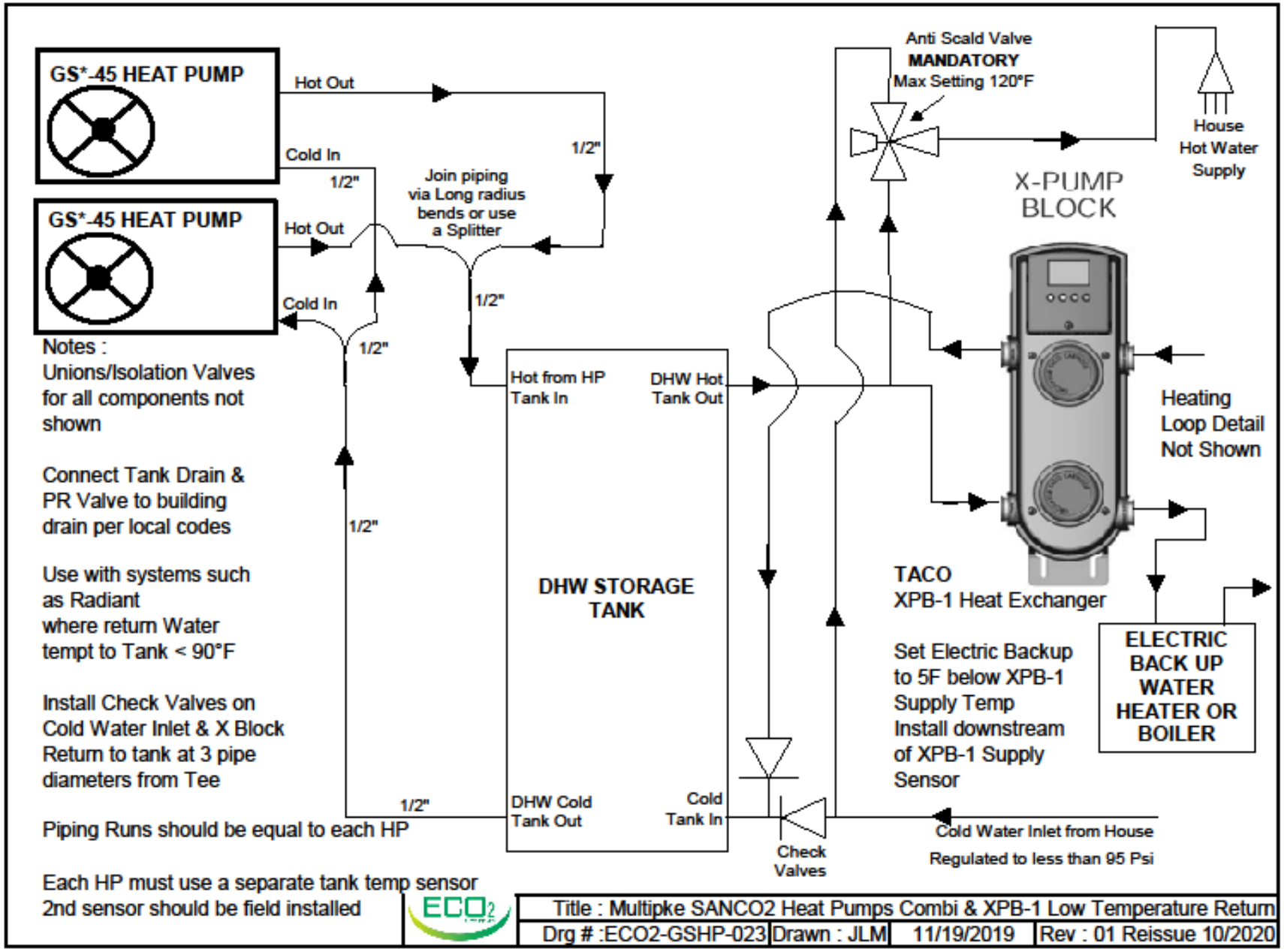
DHW & Heating Combi




GS*-45HP* HEAT PUMP
HEAT PUMP Hot Out
HEAT PUMP Cold In
1/2"
1/2"
Anti Scald Valve MANDATORY Max Setting
House Hot Water Supply
X-PUMP BLOCK
HEATING LOOP DETAIL NOT SHOWN
Notes
Use with systems such as Radiant or other low temperature emitters where return Water temperature to Tank is <100°F
Install 2 x Check Valves on both Cold Water Inlet piping & XPB-1 Return piping to Tank
Check valves should be located at least 3 pipe diameters from Tee(s)
Heating loop detail not shown
Unions/Isolation valves not shown for clarity but are recommended for installation
Install X Block Boiler protection sensor at or adjacent to SANCO2 Tank Temperature sensor
Hot from HP to Tank
DHW Hot Tank Out
PRV PIPE to DRAIN
DHW STORAGE TANK
TACO
XPB-1 Heat Exchanger
ELECTRIC BACK UP WATER HEATER OR BOILER
1/2"
Cold Tank to HP
DHW Cold Inlet to Tank
Check Valves
Cold Water Inlet from House
Regulated to less than 95 Psi
Title : SANCO2 Heat Pump Combi & XPB-1 Low Temperature Return + Aux Heating
Drg # :ECO2-GSHP-027
Drawn : JLM
11/19/2019
Rev : 01 Reissue 10/2020



Title : 2 x SANCO2 Heat Pumps Combi & XPB-1 Low Temperature Return			
Drg # :ECO2-GSHP-021	Drawn : JLM	11/19/2019	Rev : 01 Reissue 10/2020


GS*-45 HEAT PUMP
GS*-45 HEAT PUMP
Hot Out
Cold In
1/2"
Hot Out
Cold In
1/2"
Join piping via Long radius bends or use a Splitter
1/2"
1/2"
1/2"
Anti Scald Valve
MANDATORY
Max Setting 120°F
House Hot Water Supply
X-PUMP BLOCK
Heating Loop Detail Not Shown
Hot from HP Tank In
DHW Hot Tank Out
DHW STORAGE TANK
TACO
XPB-1 Heat Exchanger
Set Electric Backup to 5F below XPB-1 Supply Temp
Install downstream of XPB-1 Supply Sensor
ELECTRIC BACK UP WATER HEATER OR BOILER
DHW Cold Tank Out
Cold Tank In
Check Valves
Cold Water Inlet from House
Regulated to less than 95 Psi
Notes :
Unions/Isolation Valves for all components not shown
Connect Tank Drain & PR Valve to building drain per local codes
Use with systems such as Radiant where return Water tempt to Tank < 90°F
Install Check Valves on Cold Water Inlet & X Block Return to tank at 3 pipe diameters from Tee
Piping Runs should be equal to each HP
Each HP must use a separate tank temp sensor
2nd sensor should be field installed
Title : Multipke SANCO2 Heat Pumps Combi & XPB-1 Low Temperature Return
Drg # :ECO2-GSHP-023
Drawn : JLM
11/19/2019
Rev : 01 Reissue 10/2020

X Block Recap

- Radiant, Fan Coil and Low Temperature Radiators can be used to heat the space
- Connect based on the piping required for Supply from and Return to the 83 or 119 Gallon tank,
- Follow piping diagram – Use Potable / Non Potable separation and standard installation practice to ensure Radiant or other heating systems have a filter installed to prevent debris returning to the X Block

Thank You!

www.Eco2waterheater.com

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