ANESI CWH

Commercial Water Heating Application Guide

Employing the Anesi high-efficiency gas absorption heat pump within commercial water heating systems to achieve decarbonization goals and cost savings.

CONTENTS

Anesi Commercial Water Heating Application Guide

IMPORTANT	References to "GAHP" are independent of the system capacity of any referenced heat pump model.

Introduction

The Anesi model HP80 (series 0808H*****) gas absorption heat pump (GAHP) is an air-to-water heat pump fueled by natural gas, propane, and renewable natural gas or propane blends. For every unit of fuel energy consumed, the heat pump will add up to 1.4 units of heat into the hydronic system, significantly reducing fuel consumption and CO_2 emissions. Additional environmental responsibility is accomplished using ammonia, a natural refrigerant with zero ozone depletion potential, zero global warming potential, and no PFAS chemicals.

HP80 TECHNICAL DATA	UNIT	VALUE
Heating Capacity*	BTU/h	78,000
Gas Input (Higher Heating Value)	BTU/h	54,500
CoP (Higher Heating Value)*		1.43
Max Return Temp (at full fire)	° F/C	132/55.6
Max Return Temp (at min fire)	° F/C	142/61.1
Delta T (full fire)	° F/C	20/6.7
Nominal Hydronic Flow	gpm/lpm	8.5/30
Nox Compliance (Ultra-Low Nox)	ng/J	<14
Refrigerant		R717
Ambient Temp (min-max)	° F/C	-40 to 130 / -40 to 54
Performance at standard ANSI rating conditions of 47°F ambient, 95°F return		

When used for hot water production, the GAHP can be combined with an indirect storage tank (IST), with or without plate heat exchangers. In most applications, the GAHP and IST are best applied as a pre-heater upstream from the conventional water heater(s).

Commercial Water Heating System Overview

The Anesi GAHP commercial water heating system combines HP80 air-to-water heat pumps (outdoors) with one or more indoor storage tanks (IST). The system design depends on many situational factors and the project's goal. The Anesi system can optimize the amount of hot water delivered to maximize cost savings and its contributions to fuel efficiency and decarbonization.

Low Volume Applications

For low-volume applications that use less than 750 gallons of hot water per day (gpd), one HP80 GAHP and one 119-gallon IST will provide approximately 100% of the hot water load (Figure 1), depending on the actual draw pattern. Alternatively, leaving the legacy water heater within the system design (Figure 2) provides redundancy and coverage for unusual peak draws, leveraging the high efficiency of the Anesi GAHP.

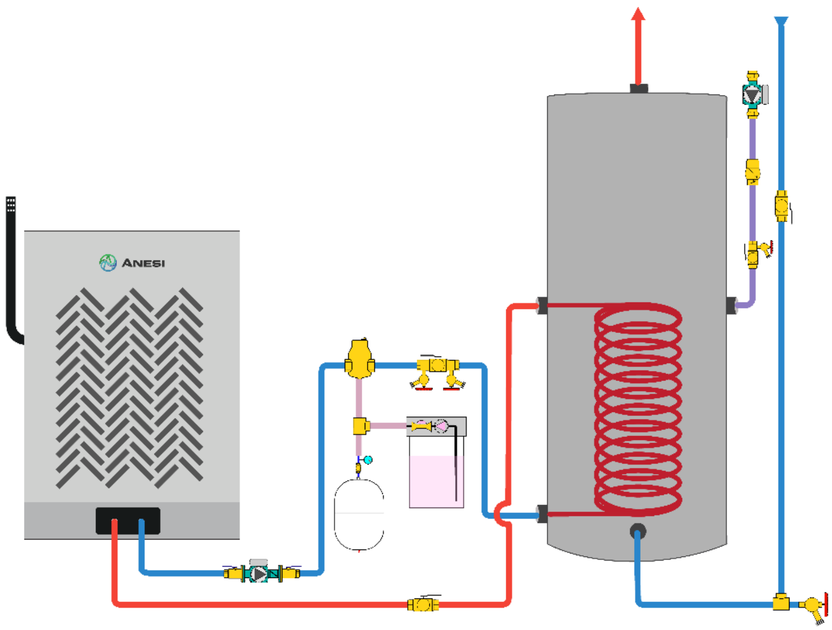


Figure 1: Example Standalone GAHP and IST Installation

Medium Volume Applications

For applications that use more than 750 gpd but less than 5,000 gpd, a baseload/peak load configuration is recommended. In this design, the legacy water heater (gas-fired storage tank or tankless) is left to handle peak loads (Figures 2 and 3), while the Anesi GAHP handles the baseload. This configuration allows system redundancy when the legacy water heater or GAHP requires maintenance. If present, the recirculation loop can be plumbed to the legacy system (as shown in Figures 2 and 3) or to the IST. If plumbed to the IST, the recirculation flow must enter near the center of the IST to maintain proper temperature stratification inside.

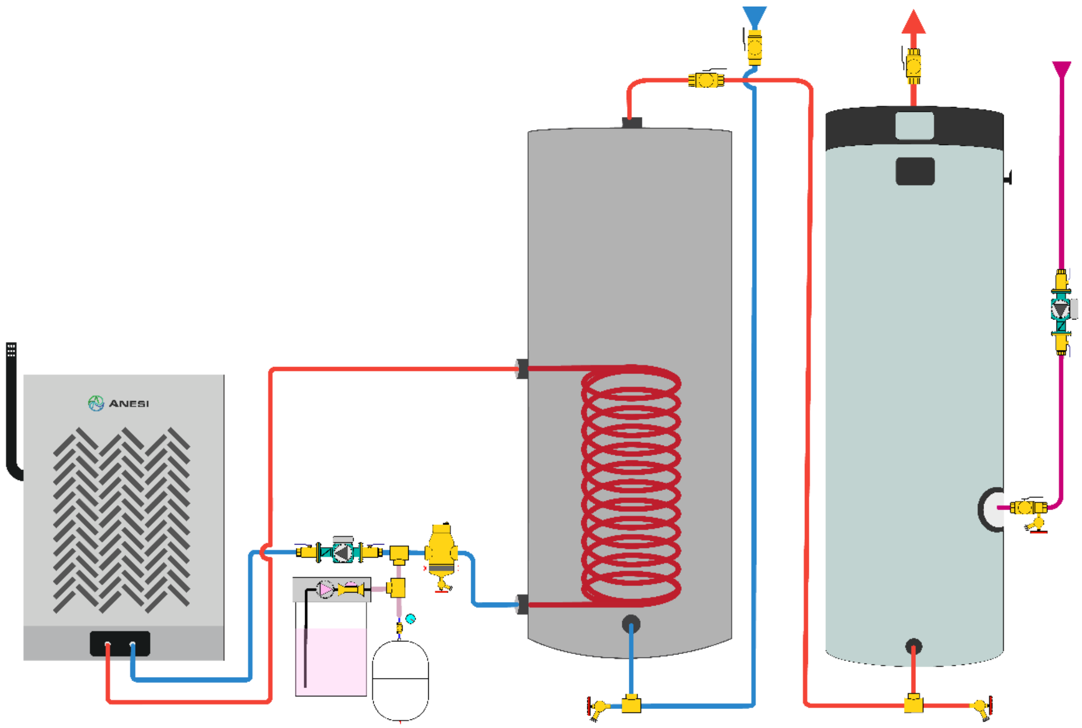


Figure 2: Example Installation GAHP With Gas-fired Storage Tank Peak Demand Unit

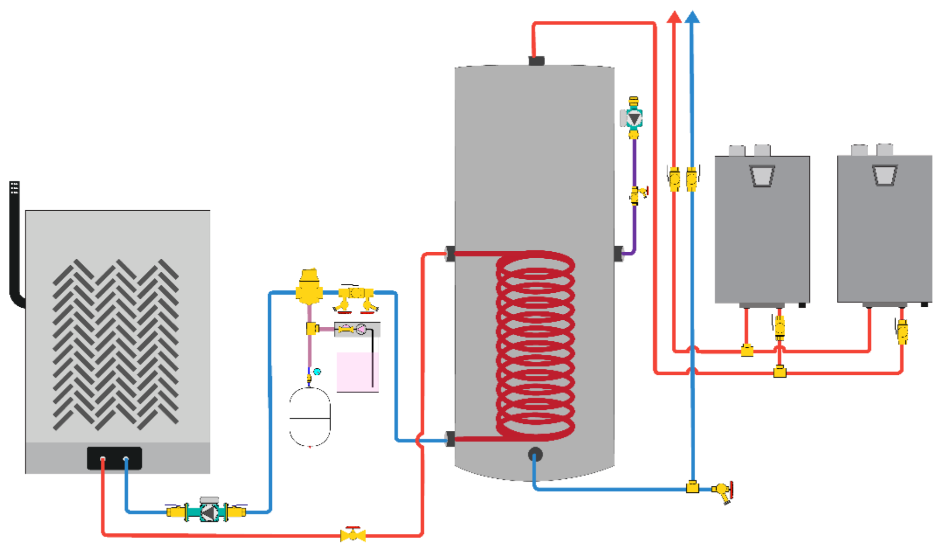


Figure 3: Example Installation GAHP With Gas-fired Tankless Peak Demand Unit(s)

High Volume Applications

For larger applications using more than 5,000 gpd, system designers can specify multiple GAHPs with hydronic connections through a manifold. This configuration provides additional capacity (Figure 4). Another design option includes multiple storage tanks (STs), ISTs, or a single large tank plumbed in parallel for maximum efficiency and hot water delivery capacity. Figure 4 shows the recirculation return entering one of the STs at the vertical mid-point of the tank. Specifiers can indicate that the recirculation return connects to the line between the STs and the peak demand units. Figure 4 also shows a plate heat exchanger (PHX) between the GAHPs and the STs as an alternative to ISTs.

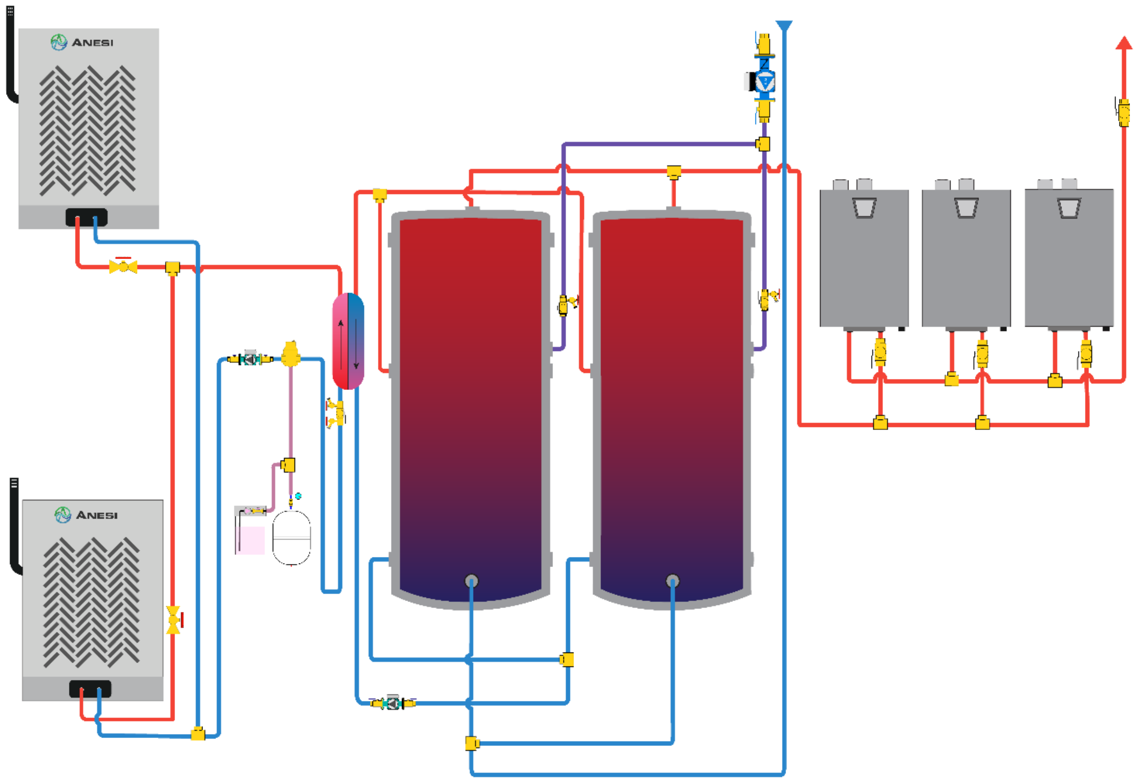


Figure 4: High Volume Usage Example with Multiple GAHPs, Tankless Peak Demand Units, and a PHX

The number of GAHPs installed is a function of the average hot water usage per day (gpd). While there is no set rule, Table 1 shows sizing recommendations.

Hot Water User (gpd)	HP80 Quantity	IST or ST Capacity
<5,000	1	100 -120
4,000 – 10,000	2	119 - 240
8,000 – 15,000	3	240 - 360
12,000 – 20,000	4	360 - 480
16,000 – 25,000	5	500

Table 1: Commercial Water Heating Sizing Recommendations

Piping Design

For an Indirect Storage Tank (IST)

Refer to Figure 5.

1. Piping
    a. Single HP80: Use 1” nominal pipe.
    b. Multiple HP80s: Increase the pipe size accordingly. Example: 1.5” pipe for two HP80s and 2” pipe for three or four HP80s.
    c. To minimize the pressure drop and required pump size, use fewer fittings, especially 90-degree elbows.
2. Hydronic Circulating Pump
    a. Select a suitable hydronic circulating pump capable of providing at least 7 GPM for each GAHP at the total hydronic loop head pressure.
    NOTE: the pressure drop through the HP80 with 40% inhibited propylene glycol at 8 GPM and 70°F is approximately 5 PSI.
    b. Calculate the total hydronic loop head pressure as:

$$H\_t = H\_hp + H\_ist + H\_pipe + H\_fittings$$

H_t = Total head pressure
H_hp = GAHP pressure drop at 8 GPM (5 PSI)
H_ist = Pressure drop through the IST at 8 GPM
H_pipe = Pressure drop through the hydronic loop piping at 8 GPM
$H\_fittings$ = Pressure drop through all the hydronic loop

3. Hydronic Fill/Purge Valve Assembly
    a. A suitable valve assembly for filling and purging the hydronic loop should be installed at the highest point in the circuit to facilitate purging air during filling.
4. Flow Setting Valve
    a. A suitable valve for setting the flow rate through the hydronic loop should be installed for each GAHP. This valve can be a commercially available balancing valve or a globe valve.
    b. The approximate flow rate can be monitored via the GAHP mobile app.
5. Filter and Air Separator
    a. A suitable filter and air separator should be installed upstream of the circulator pump. The filter should be between 40 and 100 mesh.
    b. The air separator should be at a high point in the circuit where air will tend to collect.

6. Expansion Tank
    a. To maintain constant pressure, a suitable expansion tank, sized based on the total volume of the hydronic loop, must be installed upstream of the pump.
    b. The recommended charge pressure of the tank is 15 PSIG.
    c. The hydronic loop maximum glycol temperature is 150°F.
    d. The HP80 contains roughly 1.5 gallons of inhibited propylene glycol.
7. Glycol Feeder
    a. A suitable water-glycol feeder for maintaining the hydronic loop system pressure should be installed upstream of the pump.
    b. A makeup water system is not an allowable alternative as it will dilute the glycol concentration when used, allowing corrosion in the GAHP and voiding the warranty.
    c. See Hydronic Fluid and Water Quality for more information.

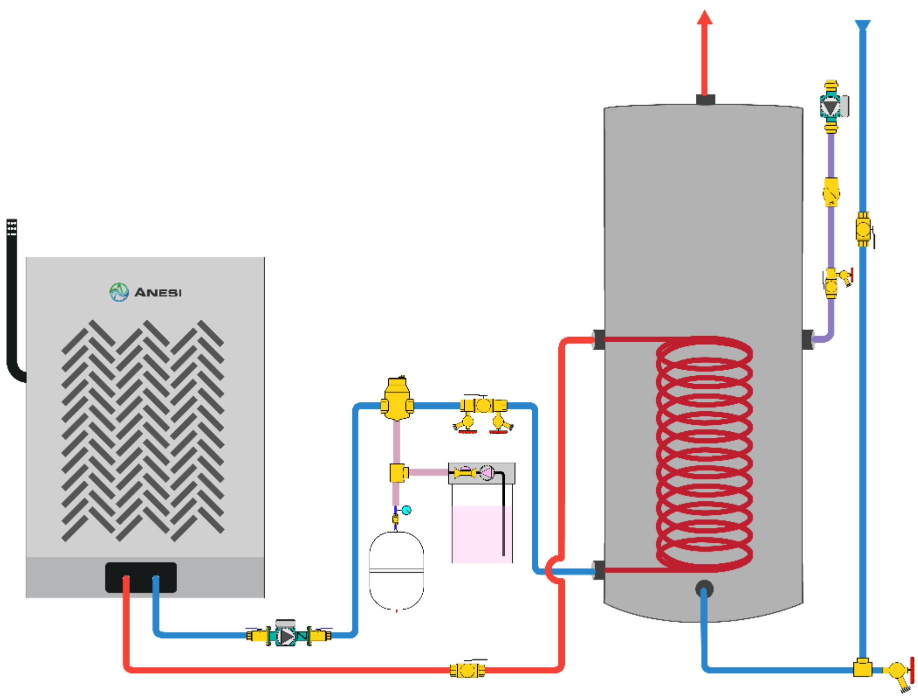


Figure 5: Hydronic Loop Components with IST

FOR A STORAGE TANK (ST) AND A PLATE HEAT EXCHANGER (PHX)

Refer to Figures 5 and 6.

1. Plate Heat Exchanger (PHX)
    a. The PHX inlet and outlet ports for both hydronic and potable water must be at least one inch.
    b. Also see the “Sizing Plate Heat Exchanger” section
2. Circulating Pump

a. Select a suitable circulating pump capable of providing at least 7 GPM at the total domestic water loop head pressure.
b. The pump MUST be rated for use with potable water.
c. Calculate the total domestic water loop head pressure as:

$$H\_t = H\_phx + H\_pipe + H\_fittings$$

H_t = Total head pressure H_phx = Pressure drop through the PHX at 8 H_pipe = Pressure drop through the hydronic loop piping at 8 GPM $H\_fittings$ = Pressure drop through all the hydronic loop fittings (valves, elbows, tees, Y's, strainers, etc.) at 8 GPM

3. Isolation (ball) Valve
   a. Minimum one inch

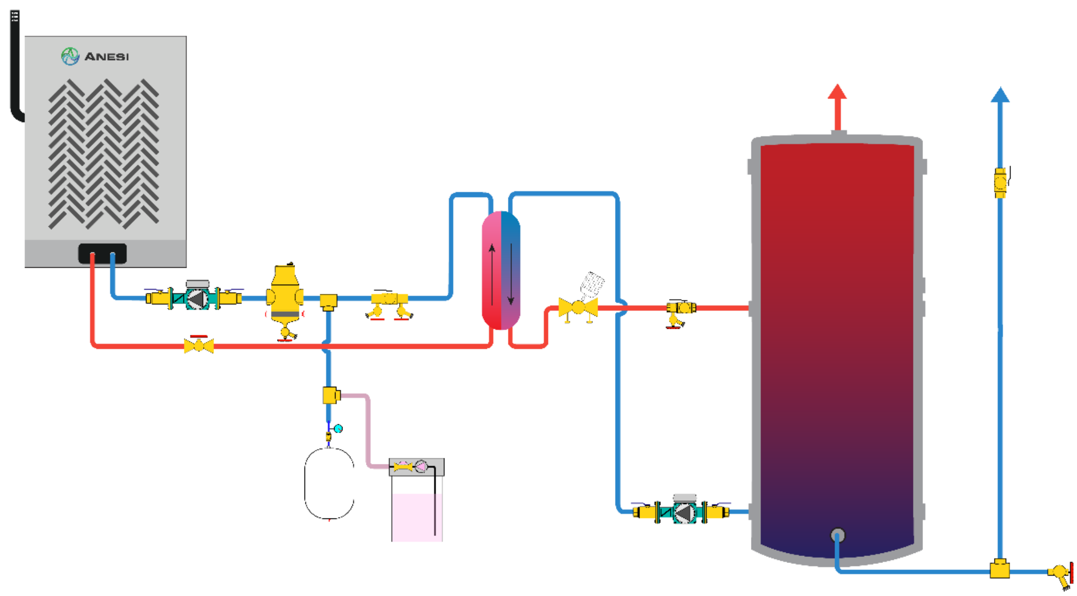


Figure 6: Hydronic Loop Components with PHX

TANK SPECIFICATIONS

The GAHP is designed for multi-pass operation. The storage tank temperature is raised incrementally in several "lifts" from the beginning to the end of the heating cycle. **This rise means that the supply temperature of the GAHP could be significantly lower than the temperature of stored water in the top half of the tank at the beginning of a charging cycle and during high draw periods.** Therefore, the supply from the GAHP must enter the IST or storage tank at approximately the tank's mid-point to prevent diluting the hot water temperature at the top of the tank. Additional considerations include:

- The internal heat exchanger (for IST) must reside in the bottom half of the tank.
- The internal heat exchanger (for IST) must have a surface area of at least 20 sq. ft. (more is better).
- When using a storage tank and PHX, the return to the PHX should be connected near the tank bottom, and the supply from the PHX should be connected at the approximate mid-point of the tank. For storage tanks with supply/return fittings in the top head, dip tubes should be used to draw the return from the bottom of the tank and insert the supply to the mid-point of the tank. A flow distribution or diffuser feature (like periodic holes near the bottom closed end of the dip tube) should be used in configurations requiring dip tubes.
- The aquastat (thermostat) should be at the approximate mid-point of the tank and at or slightly above the top of the internal heat exchanger. Aquastats located near the bottom of the tank will cause short cycling.

The following ISTs should provide acceptable performance:

1. HTP model SSU-119C
2. Lochinvar model SIT 119

Sizing Plate Heat Exchangers

A plate heat exchanger will be warranted in applications where an IST does not have sufficient heat exchange capacity to meet requirements or where the total capacity required mandates a large storage tank without internal heat exchange. The installation professional should install the plate heat exchanger per manufacturer guidelines and code while adhering to these sizing requirements.

PHX Sizing Requirements

<table>
<tr><td>Connections</td><td colspan="4">Minimum size: 1” NPT (Male or Female) to match hydronic lines</td></tr>
<tr><td>Load</td><td colspan="4">80,000 Btu/hr (23.4 kW)</td></tr>
<tr><td>Log Mean Temperature Difference (LMTD)</td><td colspan="4">target 6 °F (3 °C)</td></tr>
<tr><td>Max Pressure Drop (either side)</td><td colspan="4">2.0 psid (13.7 kPa)</td></tr>
<tr><td>PHX Options (based on successful tests with HP80)</td><td>Single Wall</td><td>Alfa Laval CB60-60H</td><td>Double Wall*</td><td>SWEP BDW16DWHx50/1P</td></tr>
</table>

*A double-wall PHX option should be specified only where required by code, as the single-wall option will, by design, be more efficient.

PHX Fluid Flow Guidelines

	Hot Side	Cold Side
Fluid	Propylene Glycol (40%, but varies based on location)	Potable Water
Flow	8.5 GPM (32 Lpm)	Minimum five GPM (19 Lpm)
Temperature in	140 °F (60 °C)	110 °F (43 °C)

Specifications for Storage Tank with PHX

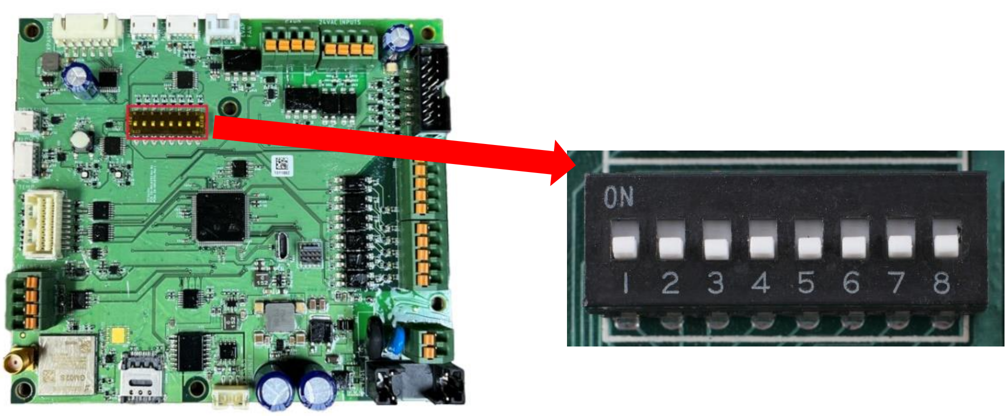
- Minimum Volume: 100 gallons (379 L).
- Dip Tube for domestic cold water in.
- Return (cold) water to PHX must come from the bottom of the tank.
- Supply (hot) water from PHX must empty into the vertical mid-point of the tank.
- A distribution or diffuser tube should be used to prevent mixing.
- Aquastat and/or Thermistor Vertical Location: Middle of the tank

Controls

Reference Figures 7 and 8 for control wiring diagrams.

DIP Switch Settings

The HP80 control board should have Dip #1 switched to OFF for commercial water heater applications.



Control Wiring: One GAHP and One IST

Use a suitable aquastat (thermostat) located at the approximate vertical mid-point of the tank and route the thermostat wire from the aquastat to the GAHP control board's "R" & "WH" terminals.

The 24 VAC output signal from the relay control board within the GAHP should be used to control the circulating pump(s). After receiving a signal to turn off, the GAHP executes a 3-minute cool-down period and keeps the circulating pump(s) running.

CAUTION	The 24 VAC output signal from the relay board within the GAHP must be used to close an installer-provided relay to provide electric power to the circulating pump(s). Failure to do so may overload the GAHP's internal 24VAC transformer, damaging the heat pump controls.

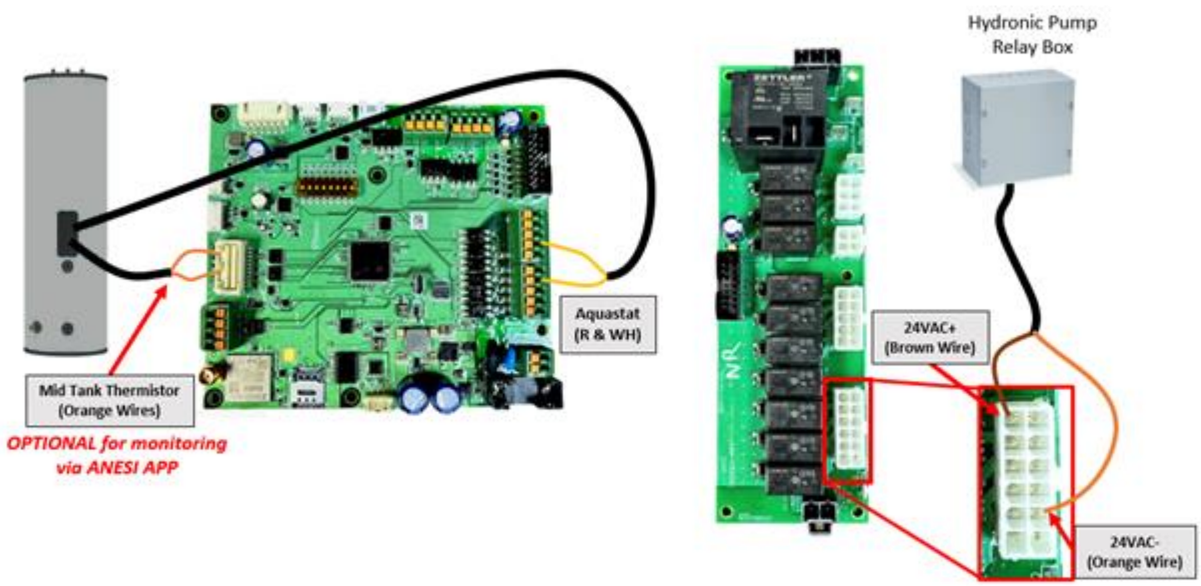


Figure 7: Control Wiring, One GAHP, and One IST

Control Wiring: One GAHP and One Storage Tank with PHX

When two circulating pumps are used, the 24 VAC output signal from the GAHP should be used to control both pumps.

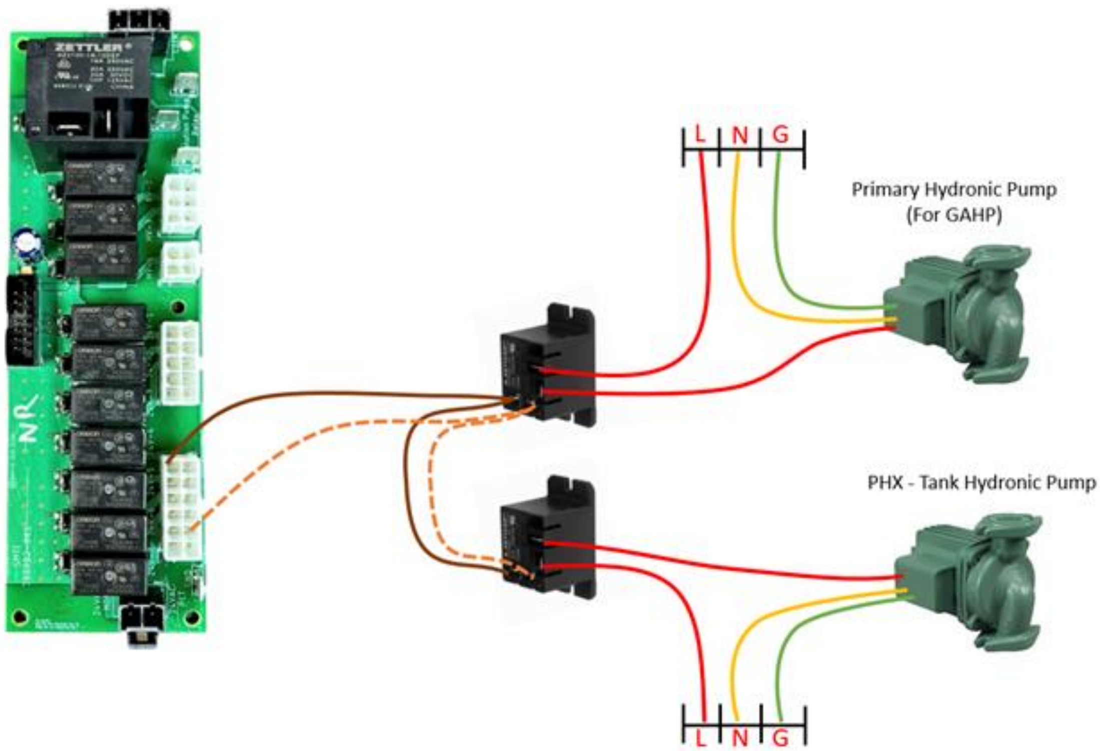


Figure 8: Control Wiring, One GAHP, and One Storage Tank with PHX

Hydronic Fluid and Water Quality

The hydronic piping within the shipped GAHP contains 40% inhibited propylene glycol.

When outdoor ambient temperatures require freeze protection, GAHPs require a mixture of INHIBITED propylene glycol and distilled or deionized water. The lines must be cleaned and pressure tested before the hydronic system is filled with glycol.

CAUTION	The hydronic lines must **NEVER** be cleaned by flowing through the GAHP. Debris could clog the internal heat exchangers, causing performance issues and possibly high-pressure faults.

CAUTION	Tap water may be used only during the circuit line-cleaning process. Adding tap water within the hydronic circuit may degrade the corrosion inhibitors and damage the system.

IMPORTANT	Do not open the ball valves on the GAHP hydronic connections until the circuit is cleaned and ready to fill to avoid introducing air into the lines.

Glycol pH and Concentration

Installers should check the glycol mixture's pH level. If the range is outside of 7.5 – 8.5, it should be adjusted using "pH Up" or "pH Down" until the reading is within the correct range.

The required concentration of inhibited propylene glycol depends on the installation location. Installers should fill the system with a concentration that provides freeze protection against the minimum expected outdoor temperature at the installation site.

Below is a generic guide to the freeze protection expected from inhibited propylene glycol. The installer must verify the required concentration for each brand used.

Minimum Outdoor Temperature		Percent (volume) Inhibited Propylene Glycol Concentration Required For Freeze Protection
°F	**°C**	**Volume %**
20	-7	19.1
10	-12	30.9
0	-18	38.3
-10	-23	44.7
-20	-29	48.9
-30	-34	53.2
-40	-40	57.4

IMPORTANT	Using more than the recommended volume of inhibited propylene glycol will negatively impact system performance.

APPENDIX A: QUESTIONS & ANSWERS

Question	Answer
How much hot water can a single Anesi HP80 provide per day?	Theoretically, a single Anesi HP80 can provide up to 2,200 gallons of hot water per day (GPD), given suitable hot water demand. This volume assumes a 70°F rise, and the heat pump operates full fire for 16 hours. The GPD increases to 2,750 GPD over a 20-hour day. The actual volume is installation-specific, however, and in the real world, with hot water usage patterns fluctuating throughout the day, the HP80 heat output will modulate up and down and perhaps shut off for short periods during parts of the day with lower hot water demand.
How much hot water can a single "conventional" gas water heater provide daily?	It depends on the gas input rate and average efficiency. Theoretically, a conventional gas water heater with a gas input rate of 199,999 BTH that averages 90% efficiency can provide about 4,900 gpd, assuming a 70°F rise operating full fire for 16 hours. This volume increases to 6,100 gpd over a 20-hour day. The actual volume is based on fluctuating usage patterns and will result in a lower gpd as the water heater modulates or turns on/off in response to the hot water demand pattern. A system with a single GAHP operating in series with a conventional gas water heater achieves the optimal balance between volume and efficiency. This configuration can provide a high volume of hot water daily, significantly reducing gas use and carbon emissions. Higher hot water demands can easily be met using multiple GAHPs and/or conventional water heaters.
What happens in the system during hot water demand periods?	The Indirect Storage Tank (IST) connected to the GAHP acts as a "thermal battery" to react to increased and decreased hot water usage throughout the day. At the same time, the GAHP works to recharge the IST continuously. During low hot water demand periods, the GAHP may shut off after satisfying the IST thermostat. During periods of high demand, the GAHP will operate at maximum output to recharge the IST. If there is a high demand for an extended period, the outlet temperature of the IST may decrease below the set-point temperature. At this time, the downstream conventional gas water heater will turn on to "top off" the delivered water temperature. If the usage pattern throughout the day is even, the GAHP can cover more of the hot water load. Conversely, if there are one or two periods during the day where the demand is very high for an extended period, the use of the

	conventional water heater will increase. The overall impact is optimizing the amount of hot water the GAHP delivers to maximize its gas efficiency and decarbonization contribution.
Should I use glycol in the hydronic loop circulating through the GAHP?	The GAHP requires a suitable mixture of **inhibited** propylene glycol and distilled or deionized water in a closed loop. Higher concentrations of glycol are needed for freeze protection in colder locations. A glycol-water makeup tank plumbed into the closed loop at the appropriate location should provide makeup fluid for the closed loop. DO NOT, under any circumstances, flow 100% city or well water through the GAHP. This could dilute the glycol concentration in the closed loop, increasing the risk of freezing and corrosion of the GAHP internal heat exchangers.
What size plumbing should be used between the HP80 and the IST?	A 1-inch pipe size is recommended between the HP80 and the IST. The hydronic flow rate between the HP80 and the IST should be 7.5-8.5 gpm, and it has been established that 1-inch plumbing handles flow at a low-pressure loss. Installers should minimize fittings, specifically elbows, to reduce the total pressure drop so that the smallest hydronic pump can be used.
What type of IST should be used with the GAHP?	An appropriately sized and configured IST must be paired with the GAHP to maximize the delivered hot water volume and total system efficiency. The IST must have an internal heat exchanger large enough to transfer energy from the GAHP to the stored water at minimal temperature differences. Since the GAHP is a multi-pass type air-to-water heat pump, the internal heat exchanger must be located in the bottom half of the IST to prevent inadvertently diluting hot water temperature at the top of the tank. Additionally, the IST must have suitable temperature sensors (thermostat, aquastat) appropriately located on the tank to provide the required temperature feedback to the GAHP operating software. Contact Stone Mountain Technologies to determine the compatibility of an IST before making a purchase.
When should a plate heat exchanger (PHX) and storage tank be used instead of an IST?	A properly sized and installed PHX with a storage tank is always a good option. Additionally, a PHX is recommended anytime the local code requires a double wall between the water-glycol loop and the domestic hot water. A PHX is also an option if a suitable IST is not readily available. If using a PHX, a second hydronic pump capable of a flow rate of at least seven gpm is required to pull domestic water from the bottom of the storage tank and return it to the midpoint. This secondary pump can

	be controlled in parallel, using the same signal as the primary hydronic loop pump. See Figure 8.
How should the GAHP be controlled?	The best practice is to install a conventional aquastat (thermostat) in the IST or storage tank connected to the Water Heater (WH) input terminals on the GAHP control board. When the aquastat calls, the GAHP will provide a control signal to turn on the hydronic pump(s), and after the flow is confirmed, the GAHP will turn on. The GAHP will modulate its input to the IST or storage tank to maintain a target supply (set point) temperature. As the set point approaches, the GAHP will modulate down and turn off once the aquastat is satisfied. Installers should set the aquastat differential to at least 15 degrees (20 degrees is preferred) to prevent short cycling.
When using multiple storage tanks, how should they be plumbed?	Installers should plumb multiple storage tanks (or ISTs) in PARALLEL to the domestic cold/hot water AND the hydronic supply/return from the heat pump.

APPENDIX B: SYSTEM ECONOMICS

The Anesi HP80 gas heat pump's high efficiency of 1.4 Coefficient of Performance (CoP)* means water is heated at lower gas consumption and energy cost than traditional gas water heaters. This high-efficiency results in a 20% to 30% reduction in fuel used to heat water and a corresponding percent decrease in carbon emissions. For example, comparing conventional gas water heaters with the Anesi commercial water heater, the traditional gas water heater would consume 1 unit of heat for .95 unit of heat output. The HP80 would consume 1 unit of heat for 1.4 units of heat output. For applications where the GAHP is in a base load/peak load situation, savings and decarbonization efforts are most significant when the GAHP heats more water than the legacy condensing gas tank or tankless water heater. Additionally, the reduced demand for water from the legacy system results in less wear and lower maintenance on the legacy system, thereby extending its life.

The amount of energy saved by a GAHP depends on several factors, including the total amount of hot water used per day, the actual draw pattern, the local climate, and the efficiency of the current water heating equipment.

Figure 9 shows the approximate annual energy savings for a "typical" commercial water heating system using a single HP80 connected to a suitable 119-gallon IST or storage tank. This assumes the current water heating equipment operates at an average efficiency of 85% (experiences will vary). The higher the percentage of the total water heating load covered by the HP80, the higher the energy savings. Similarly, the lower the efficiency of the legacy water heater, the more significant the difference in efficiency of legacy vs. GAHP, and the higher the net energy savings.

*Coefficient of performance (CoP) is the ratio measuring how efficiently a system uses energy for heating in the case of the Anesi HP80. The CoP equals the energy output divided by the energy input, and the Anesi CoP at 1.4 means more energy is output than input at the evaluation point.

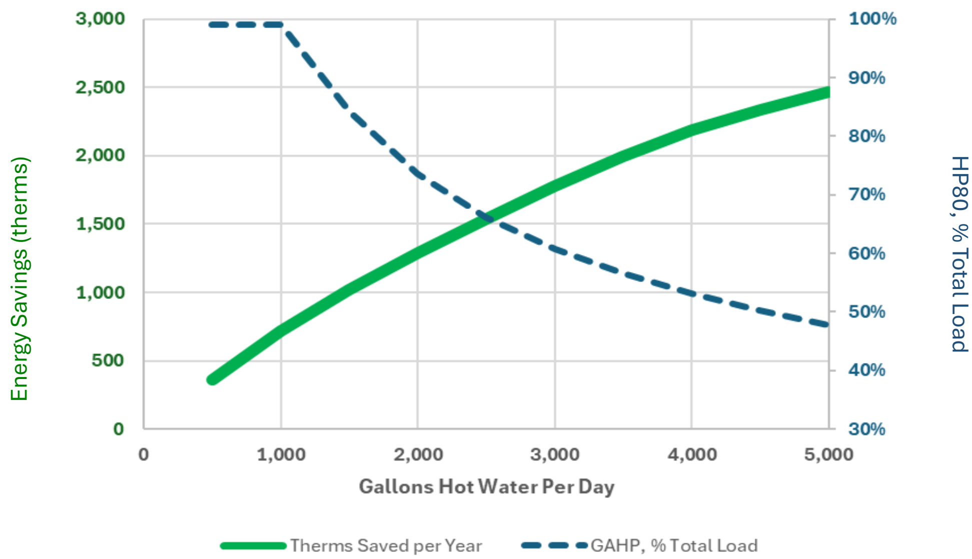


Figure 9: Typical Annual Energy Savings, One HP80

Energy saved is shown in therms (one therm = 100,000 BTU), a function of the total volume of hot water used daily. The data illustrates that more energy is saved when higher quantities of hot water are used and a higher percentage of the water heating load is handled by the GAHP. To determine the annual savings in dollars, multiply the therms saved by the gas cost (in $/therm).

Figure 10 shows the approximate annual reduction in CO_2 emissions. While actual results will vary based on your specific installation characteristics and location, CO_2 emission reductions can be significant, up to 16 metric tons when using 5,000 gpd of hot water.

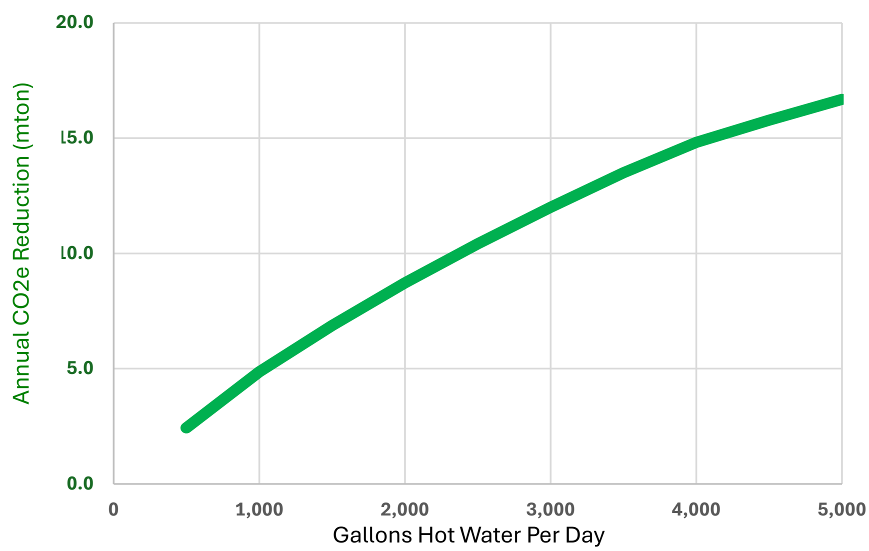
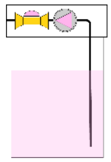
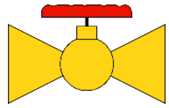
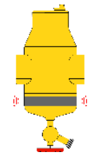
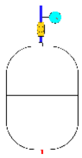
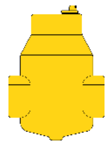
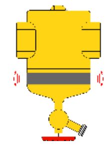
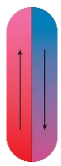
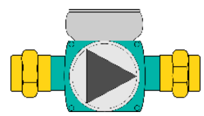
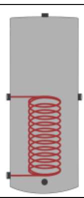
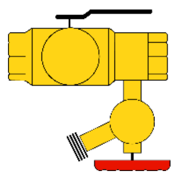
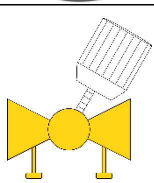
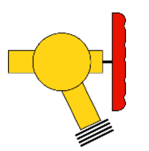
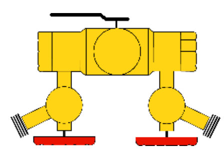
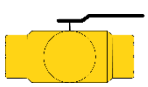
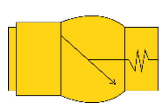
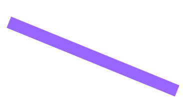


Figure 10: Typical Annual CO2e Reduction, One HP80

APPENDIX C: WIRING DIAGRAM ICONS

	Glycol Feeder		Globe Valve		Combination Air & Magnetic Dirt Separator
	Expansion Tank		Air Separator		Magnetic Dirt Separator
	Tankless Water Heater		Plate Heat Exchanger (PHX)		Domestic Recirculation Pump
	Indirect Storage Tank (IST)		GAHP		ECM Circulator
	Storage Tank (ST)		Single Purge Valve		Hydronic Circulator
	Fixed Orifice Balancing Valve		Drain Valve		Double Purge Valve
	Ball Valve		Spring Check Valve		Cold & Hot Water
	Glycol (Pink)		Domestic Recirculation (Purple)		