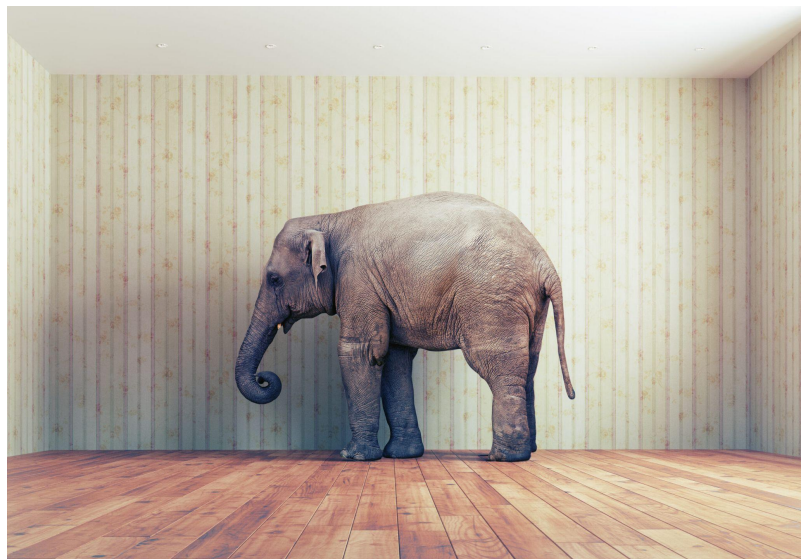


Monday, October 3, 2022

# Heat Pump Water Heaters: Example Apartment Building (Part 9)

Monday Morning Minutes | by Norm Hall, October 3, 2022

Air source heat pumps are beginning to get attention in conversations among engineers in the northern climates. I appreciate everyone's patience as you opened this blog over the last couple of months to have the story unfold. Today, I will use an example building to address the "elephant in the room," **comparing the equipment required for heat pump water heaters vs. electric water heaters vs. gas fired water heaters.**



## The Example Apartment Building

In Ann Arbor Michigan, the architect and engineer are asked to design a 4-story apartment building with a total of 100 units expecting to serve 215 people. Each apartment has a kitchen with a dishwasher and a single bathroom with a private low flow shower. Each apartment also has a washing machine. There is a handful of other hot water fixtures. We expect each floor to have 4 hot water supply lines and the recirculation rate from each loop will be about 0.75 GPM.

The owner has requested a solution that reduces the carbon output of the building. There are no current codes limiting the use of gas fired appliances in Ann Arbor. The engineer wants to look at a traditional gas fired tank type water heater and the same solution using electric water heaters. The third option to look at is commercial heat pump water heaters. The engineer decided to explore a heat pump water heater using R-744 refrigerant.

The engineer wants a minimum storage temperature of 140°F and will use a mixing valve to meet the temperature requirements. The hot water return temperature will be designed at 126°F.

## Gas Fired and Electric Solutions

The load calculations for domestic hot water can be described as bordering on “art backed by science”. When we are designing a comfort heating system, the heat transfer rate of building materials is known. The impact of people on the load is important but not usually the determining factor. In service water or domestic hot water calculations it is all about people. Family size, work schedules, home routines, various events and holidays all contribute to variations in sizing.

The American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE), Systems Handbook, chapter 50 has tables and figures that are the basis for many of the manufacturer’s sizing programs. ASHRAE will tend to indicate much more storage than we see in the sizing programs. PVI by Watts has a program online which is branded with the [OptiSize™](#) name. Using that program, we have the following solutions.

### Gas fired water heaters

The gas fired solution will be:



(3) PVI Conquest series tank type condensing water heaters with 130-gallon duplex stainless steel storage tanks.

700,000 BTUH input each which includes the domestic water recirculation load of 84,000 BTUH.

This solution includes a N+1 standby.

### Electric water heaters

The electric resistance solution will be:



(3) PVI Durawatt tank type heaters with 119-gallon duplex stainless steel storage tanks with proportional sequencer.

216 KW input each which includes the domestic water recirculation load of 25 KW.

This solution includes an N+1 standby.

It is interesting to note that the gas fired storage solution above meets the [ASHRAE definition of a tankless water heater](#) since the recovery capacity is so great compared to the storage volume. When we look at the heat pump water heater there will be much more storage required. A heat pump can never be used as a tankless solution. The igniting of gas in an appliance has significantly more instantaneous capacity than pulling heat out of the air.

## Heat Pump Water Heater Solution

The heat pump solution was determined using the [Lync® by Watts Aegis A](#) air-source heat pump water heater. The sizing is based on a modified ASHRAE platform but can also be adjusted for the recovery rate determined by the engineer's in house calculations. The solution is as follows.

### Aegis A Heat Pump



The heat pump solution will be:

(2) Lync Aegis A 500 series water heaters with (4) 250-gallon duplex stainless steel storage tanks designed to store at 160°F and piped in series.

The heat pump will produce 549,000 BTUH at 77°F OAT with 60% RH and have a COP of 3.8. The heat pump will produce 239,400 BTUH at -4°F OAT with 90% RH and have a COP of 2.1.

Sizing was based on meeting the load in the very cold winter months. There is resistance backup heating for 63% of the load. One of the 250-gallon tanks with electric resistance heaters will serve the recirc load.

## What Happens If We Lose Power?

What if the electric power goes out in a storm or emergency? Both the heat pump and electric resistance water heaters are electric. A backup generator would have to handle both the heating of the building and the service water (hot water) load. This may be the time to have a talk with the owner. It may be the time to get real. The hot water load is based on peak demand. We have 1000 gallons of stored water available when the power

goes out. If we temper the kW backup resistance load it may help the emergency generator cost and size.

If the engineer wishes to operate at full capacity, for example at a hospital, the [Durawatt](#) solution will require 648 kW of generator capacity, whereas the [Aegis](#) solution will only require approximately 60 kW of generator capacity plus the capacity for the recirculation heater.

## Hot Water Recirc. Tank

The recirculation load is about 84,000 BTUH. This obviously changes with the layout, pipe size, and design temperature difference. I chose the load with some simple assumptions. The recirc. load requires a separate tank. Read more about the recirc tank in the blog: [Heat Pump Water Heaters: Hot Water Recirculation \(Part 6\)](#)

## Low Outdoor Air Temperature (OAT) Backup



We understand that the R-744 heat pump solution was sized for very low outdoor temperatures. That said, our Ann Arbor Michigan project will have some hours when the temperature is below  $-4^{\circ}\text{F}$ . We will require backup as we discussed in the [last Monday Morning Minutes](#).

I chose 63% for both backup and standby. The reasons come out of the ASHRAE Systems handbook chapter 50. There are several figures for apartments and residential use which show peaks for a couple of hours in the AM and again in the evening. No surprise there. Other than that, the load is 40% or less most of the time. The 63% will have enough for the recharging of the tanks and usage. There may be

times when the water at peak load may be tempered but that can be explained in a power outage or record setting low temperatures. The owner should understand the reasons and be aware of the consequences.

Next week we will continue the example system by comparing some pricing schemes and the payback periods.

[Part 1: Heat Pump Water Heaters: The Road to Decarbonization](#)

[Part 2: Heat Pump Water Heaters: How They Work](#)

[Part 3: Heat Pump Water Heaters: Refrigerants and Weather](#)

[Part 4: Heat Pump Water Heaters: Temperatures & Storage](#)

[Part 5: Heat Pump Water Heaters: Parts & Pieces & Storage](#)

[Part 6: Heat Pump Water Heaters: Hot Water Recirculation](#)

[Part 7: Heat Pump Water Heaters: Standby Capacity](#)

[Part 8: Heat Pump Water Heaters: Capacity, COP, and Weather](#)