**Building Science Education Solution Center – Decision Guidance for HPWH**

Proficiency Level 2: Understand

**Learning Objective 2.1:**

* Identify the proper installation location for a HPWH system

**Lecture Notes 2.1:**

References:

Hot Water Solutions. *Heat Pump Water Heater Installation Best Practices*. Accessed 2023.

 < https://hotwatersolutionsnw.org/assets/img/documents/hws-installation-best-practices- guide.pdf>

Department of Energy. *Heat Pump Water Heaters.* Accessed 2023.

 < https://www.energy.gov/energysaver/heat-pump-water-heaters

Northwest Energy Efficiency Alliance. *Heat Pump Water Heaters in Small Spaces Lab Testing: “The*  *Amazing Shrinking Room”.* 2022, Accessed 2023. <https://neea.org/resources/heat-pump-water- heaters-in-small-spaces-lab-testing-the-amazing-shrinking-room>

Pacific Gas & Electric Presentation. *Overcoming Installation Challenges for Heat Pump Water Heater*  *Retrofits*. 2022. (Requires free registration). <https://pge.docebosaas.com/learn/course/external/view/classroom/1359/overcoming-installation- challenges-for-heat-pump-water-heater-retrofits>

Proper installation is essential to maximizing the energy efficiency gains of a new heat pump water heater (HPWH). Since the initial costs of a new HPWH system can be relatively high compared to a conventional water heater, it is very important to optimize the location where it is installed. There are a variety of appropriate installation locations for a HPWH, which will depend on the homeowner’s availability of space, equipment types to be used, and local building codes. Other important considerations include sound concerns, whether the room is heated or insulated, local climate, and the overall size of the system. For optimal system efficiency and safety, it is therefore recommended to use a qualified contractor to evaluate and perform the installation of the HPWH.

The first step to properly install a HPWH is to identify a location with the appropriate space for the system. The location should have enough room to perform the initial installation procedures, as well as the necessary maintenance requirements specified by the manufacturer throughout the life of the system. The standard space recommendation for most HPWH systems is at least 700 cubic feet of volume, or approximately a 9 x 10 x 8-foot room. Some recent HPWH releases have shown a reduced space requirement as low as 450 cubic feet. Make sure the location meets the clearance requirements specified by the manufacturer, and that the system is easily accessible for controls and maintenance. Typical rooms in a home that meet the space requirement include a garage, basement, utility closet, or laundry room. If the room that the HPWH is in does not meet the space requirement, exhaust ducting or louvered doors can be used to overcome this issue. Louvers on their own can significantly reduce the volume of air space required for efficient operation, while exhaust ducting or a combination of ducting or louvers can remove the minimum air space requirement entirely. However, installing ductwork comes with its own cost and logistical issues, including making sure to insulate all exposed metal on any exhaust ductwork to prevent condensation from occurring. This is even more important if the home is located in a cold climate, where the installation must take into consideration the potential for freezing conditions in the room, especially in unfinished or unheated garages and basements. For any airflow interventions in a space, ensure that negative or positive pressures do not form. If exhaust ducting is used, there must be an adjustment to ensure adequate intake air can enter the space. This could be intake ducting, louvers/grilles, or some other opening.

Occupant health and comfort must also be accounted for when determining the right location for the HPWH. Exhaust air emitted from the HPWH can be much colder than the ambient temperature indoors, so it is important to isolate the exhaust away from highly occupied rooms, particularly if the room is being heated. Check that the air intake pathway is clear and unobstructed. Sound from the HPWH must also be considered by separating the system from occupants, especially near bedrooms, to minimize noise disturbance. If sound issues are a concern and the HPWH cannot be separated any further from occupied spaces, consult the manufacturer for options on sound mitigation, such as isolation pads, foam, or mounting strategies. Depending on the region, make sure the system is secured according to local code in case of an earthquake or other natural disaster.

It may also be important to determine the location of existing wiring or receptacles in the space where the HPWH may be installed. For plug-in 120V HPWHs, verify the length of the cord and evaluate the position of existing receptacles. For 240V HPWHs that are being installed to replace a traditional electric water heater, the existing wiring can likely be reused. For other installs, the presence of existing wiring may make the installation simpler. Make sure to follow national and local codes for all electrical work.

**Problem Set 2.1:**

1. What is the recommended size room for proper installation of a HPWH?
2. List three common rooms in a typical home that would be a suitable location to install a HPWH.

**Learning Objectives 2.2:**

* Recognize the operational differences between 120V and 240V HPWHs
	+ The different operating modes of HPWHs – Heat Pump, Hybrid, Electrical, and Vacation
	+ Location constraints

**Lecture Notes 2.2:**

References:

Building America Solutions Center. *Heat Pump Water Heaters - Code Compliance Brief*. Accessed 2023. < https://basc.pnnl.gov/code-compliance/heat-pump-water-heaters-code-compliance-brief>

ENERGY STAR. *Choose an ENERGY STAR Heat Pump Water Heater*. 2021, Accessed 2023.

 < https://www.energystar.gov/sites/default/files/tools/HPWH\_SalesGuide\_May2021.pdf>

ENERGY STAR. *How it Works – Heat Pump Water Heaters (HPWHs).* Accessed 2023.
 <https://www.energystar.gov/products/water\_heaters/high\_efficiency\_electric\_storage\_water\_hea ters/how\_it\_works>

Rheem Electric Residential Hybrid Water Heater. *Use and Care Manual.* 2016, Accessed 2023.
 < https://rmc-cdn.s3.amazonaws.com/media/uploads/iat/sites/36/2020/04/AP21681- UseAndCare.pdf>

Bradford White Heat Pump Water Heater. *Installation & Operation Instruction Manual.* 2022, Accessed 2023. < https://bradfordwhitecorp.s3.amazonaws.com/wp- content/uploads/residential\_heat\_pump\_aerotherm\_re\_series\_iomanual\_re2h50s\_re2h65t\_re2h80 t\_52169.pdf>

The actual energy usage of a HPWH depends on its operating mode. While the specifics of the modes vary by model, HPWHs generally have four different operating modes:

1. Heat Pump – Only the heat pump is used to heat water.
2. Hybrid – The default setting of the heat pump water heater, which uses both the heat pump and the electric-resistance elements to heat water.
3. Electric – This mode only uses the electric-resistance elements to heat water.
4. Vacation – This mode tells the HPWH to keep the water at a low, warm temperature (usually around 50-60°F, depending on the model) for a set period of days.

The Heat Pump mode is the most energy-efficient operating mode, but also takes the longest time to heat up the water. It is best used during warmer temperatures and other times when the electric resistance element is not needed to meet hot water demand. The Electric mode is the fastest at heating water but uses the most energy to do so. The Hybrid mode, using both the heat pump and electric-resistance components, offers a balance between energy efficiency and speed. The Vacation mode is meant to be used during periods where the residence is unoccupied. The temperature that Vacation mode operates at ensures that the water inside the tank and connected piping does not freeze during the vacation period, which can cause damage to the piping or the HPWH itself. For most applications, Hybrid or Heat Pump mode should be used to ensure maximum savings are realized for the user.

The modes of the HPWHs can vary depending on the specific model. For example, some 120V HPWHs do not have the electric-resistance elements that 240V HPWHs have, these models may be limited to heat pump and vacation modes only. Also, some HPWHs may have additional mode settings that modify how much of the heat pump and electric-resistance elements are used. For example, some hybrid modes might use the electric resistance for backup only, while others might use the heat pump and electric resistance simultaneously. For HPWHs without a Vacation mode, it is recommended to use the Heat Pump mode of operation at a low setpoint temperature (50-60°F) to prevent water freezing while minimizing energy costs during periods where the residence is planned to be unoccupied.

Furthermore, since some 120V HPWHs lack an electric mode, special attention must be paid to the ambient air temperatures in the installation location. If the air temperature drops below the cutoff temperature for the compressor (generally around 40°F), the water heater will not be able to make more hot water. If the low temperatures persist for multiple hours, this may result in hot water runouts. These conditions could be found in a garage or other uninsulated location in a cold climate. However, this factor should be considered even in warmer climates where the water heater is located outdoors. Locations as warm as Climate Zone 2 may see annual lows below this temperature during a cold snap, which could leave occupants without hot water.

**Problem Set 2.2:**

1. What operating mode ensures the most efficient operation for the HPWH?
2. Why is it recommended to have the HPWH continue to operate at a low tank temperature during periods where the residence is unoccupied for an extended period of time, rather than turning off the HPWH entirely?