

Something to fully understand about heat pumps is that they are a part of an overall system, the heating, ventilating and air conditioning (HVAC) system. That system accounts for 35% to 50% of the annual energy consumed by a typical Florida Home (See pie chart). So, when replacing a heat pump, one must anticipate a 25% or less reduction in the overall electric bill depending on the condition and repair of the various parts of the system. Savings above 25% are rare and usually only occur when replacing very inefficient systems and performing duct repairs.

In order for the HVAC system to operate at its proper capacity and peak efficiency, all parts of the **system** must be installed and working correctly. The four parts of a heat pump HVAC system are:

1. The compressor: The outdoor unit (heat exchanger).
2. The air handler: The indoor unit (heat exchanger) and air fan.
3. Refrigerant loop: The amount of refrigerant (refrigerant charge) and the pipes and valves that transport and control the refrigerant to both heat exchangers.
4. The air distribution system: The ductwork and parts of the home that allow the air to flow to and from the air handler. The air handler is also a part of the air distribution system.

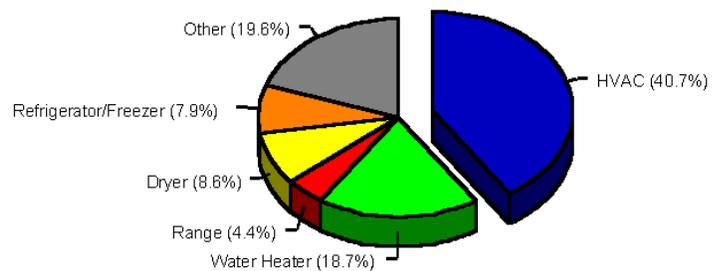
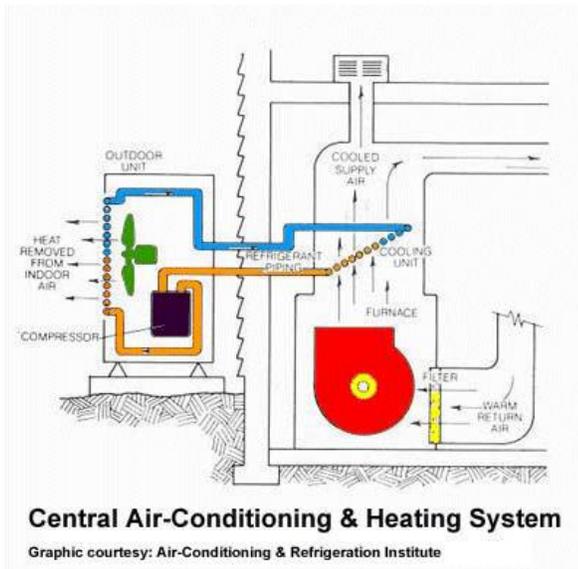


Chart courtesy of the Florida Solar Energy Center

When having a new heat pump installed, most homeowner's feel they will receive full operating efficiency and output by having the equipment replaced. However, depending on the quality of installation and the condition of the duct system, the output and efficiency may be much less than anticipated. A great example is the SEER rating on equipment. Manufacturers label their equipment based on all parts of the **system** operating perfectly. If you install a SEER 15 heat pump on an old leaky duct system, it will not operate at a SEER 15 level of efficiency. That is why many times the cheapest replacement option may not be the most cost effective way to go when replacing a heat pump.

The heat pump installation checklist is designed to address the key factors that affect this system output and efficiency. It is only a guide. When retrofitting an existing home, sometimes budgets, accessibility to parts of the system or other factors may limit the ability to install the system at full capacity and efficiency. The checklist is **NOT** a guarantee of quality or performance but a best practices guide to ensure these items have been addressed by the technician and **understood by the homeowner**.

Terminologies:

Equipment model numbers: The two main pieces of equipment, the compressor and air handler, are designed to work together by the manufacturer. By knowing the model numbers of these two pieces of equipment, one can look at manufacturer's data to see if they were designed to work together, the designed capacity of the equipment and the manufacturers SEER and HSPF ratings.

Capacity: Heat pumps are designed to both heat and cool homes through a refrigerant cycle. The capacity refers to the amount of heating and cooling the equipment can provide. They are labeled in **British Thermal Units (BTUs) Per Hour**. 12,000 BTU's per hour is one ton of heating or cooling capacity. So, a 3 ton unit has the ability to move 36,000 BTU's of energy every hour (in a perfectly installed system).

That capacity is based on indoor and outdoor temperatures and can vary throughout the year. During extreme cold conditions the heating capacity of the heat pump can be cut nearly in half and extra heat energy must be added. This is done with "heat strips" which come on to supplement the heat output of the refrigerant cycle. Heat strips are very inefficient and are the culprits to high winter electric bills.

Heat pumps not only heat and cool but dehumidify as well. Another aspect of capacity that is considered when choosing a heat pump is called "**latent capacity**" or the ability for the heat pump to remove moisture from the air. This helps maintain proper humidity levels in the home and is a major factor in occupant comfort.

Sizing: To properly "size" equipment for a home, the heating and cooling load required for that home must be known. HVAC contractors and Energy Auditors perform what is known as an **ACCA Manual J Load Calculation** which determines the amount of heating and cooling load on a home based on many factors such as: size of the home, types of windows, doors and walls, the amount of insulation in walls, attics and floors, how leaky the home is, etc. Once that load is determined, a properly sized HVAC system can be installed. If the manual J load calculation shows the home will have 38,000 BTUs per hour of load, the contractor will choose a system that is sized accordingly. For that home they will most likely choose a 3.5 ton system which is 42,000 BTUs per hour of capacity. If a 5 ton system is installed, the electric bill will be unnecessarily higher and the home may not function as well as it should in the areas of indoor air quality and comfort.

If replacing an existing system, a manual J load calculation may be a good idea if you have performed upgrades to the home to make it more efficient (windows, insulation, etc.) since the last HVAC system was installed or if you just want to know what size is best suited for the home. Manual J load calculations can take a couple hours to do properly and may cost a few hundred dollars, but can be well worth it in the long run when it comes to electric costs and the comfort levels in the home.

If no improvements have been made and the existing system seemed to work well, replacing the existing system with a new system of the same size should not be a problem.

SEER and HSPF ratings: SEER stands for **Seasonal Energy Efficiency Ratio** and is a ratio of cooling output for every watt of electrical input. A 10 SEER unit can produce 10 BTUs of cooling for every watt of electrical input. A 15 SEER unit can produce 15 BTUs of cooling for every watt of input. The higher the SEER rating, the more efficient the equipment is. SEER is an "average" of the equipment's efficiency throughout the cooling season.

HSPF stands for **Heating Seasonal Performance Factor** and is a ratio of heating output for every watt of electrical input. It works the same as SEER but has lower values. A SEER 15 heat pump will typically have an HSPF rating of 8.1 to 8.5. HSPF is an "average" of the equipment's efficiency throughout the heating season. It is lower since outdoor temperatures are much more extreme during the shorter heating season.

Mastic: Mastic is a spreadable putty-type material used for permanently sealing the joints and seams of sheet metal air ducts and/or connections with flexiduct. Mastic is important because it permanently seals the ducts and won't break down over time like duct tape.

Section 1: Existing System Specifications

In order to better understand what reduction in energy consumption (electricity costs) and improvements in comfort can be expected, it is important to know the status of the existing system. Existing equipment model numbers will help determine capacity, efficiency ratings and other features.

Section 2: System Sizing (SEMI-OPTIONAL)

Optional on homes built after 1992 that haven't had major thermal upgrades performed on them and had an original ACCA manual J load calculation performed (Per Building Department).

Sizing a system properly to the heating and cooling load of the home can have great benefits to comfort, indoor air quality and energy costs. An ACCA manual J load calculation will determine the load on the home and from that a system can be installed to match that load properly. Over sizing a heat pump is the most common practice since bigger usually means better (more heating and cooling). The problem is that oversized units consume more energy than right sized units and since heat pumps also dehumidify a home, an oversized unit may not run enough at certain times to fully mix the air in the home and pull the moisture out of it. Under sizing a unit can create comfort problems during very hot or cold days since they can't keep up with the heating or cooling load in the home and can create moisture problems by not being able to remove enough latent load (moisture) from the air.

If any upgrades that affect the homes heating or cooling load have been performed since the last heat pump was installed, it is highly recommended to have an ACCA manual J load calculation performed.

Section 3: Equipment

As mentioned earlier, model numbers and SEER/HSPF ratings provide information about equipment specifications and efficiency ratings.

Section 4: Air Leakage

This section addresses the main areas of heat pump replacement that can have issues with air leakage. Those areas are the air handler and connections at the air handler. For details about air leakage in the duct system, review the Air Distribution System checklists and guide.

- Supply and return plenums properly secured and supported: The main supply and return plenums are the largest ducts in the system and can be somewhat heavy. Depending on their position and configuration the weight can begin to pull on the connection and they can loosen and leak or even separate. Proper support and securely connecting them will ensure long term stability and performance.
- Supply and return plenum penetrations sealed with foam, caulk or mastic: Depending on the location of the air handler, the main supply and return plenums may penetrate the ceiling or floor to connect to the rest of the duct system. That penetration should be sealed and is a critical detail for air handlers inside the home that do not have a ducted return.
- Mastic applied to all plenum connections at air handler unit: The main supply and return air plenums connect at the air handler and it is critical to ensure these are sealed properly.
- Filter cover at air handler makes a complete seal: Filter covers are notorious places for leakage and they pull outside air into the air handler and air distribution system. This air will reduce efficiency, foul the evaporator coil (heat exchanger) and bring outside contaminants into the home. A tightly sealed filter cover can prevent those problems.
- All seams/penetrations at air handler unit are sealed with putty or UL181 tape and mastic(optional): All air handlers leak a little from the manufacturer. That leakage is around the panel seams, filter covers and pipe penetrations. After the unit is installed and operating properly, the final step is to seal all the seams with a little mastic and tape and putty the pipe penetrations to eliminate that leakage. However, all of the tape can reduce the aesthetic quality of the equipment so it is an option for you as the homeowner.
- Access panels at air handler are sealed with UL181 tape: The same sealing is required for the access panel cover but mastic is not used, just tape. Care should be taken not to cover the screw heads so access is simple. If future service is needed, a razor knife will easily and quickly cut the tape for access

to the inside of the unit. After any maintenance is performed, the technician should reseal the panels. Again, all of the tape can reduce the aesthetic quality of the equipment so it is an option for you as the homeowner.

- All penetrations in air handler (line set, condensation line, etc.) sealed: The copper refrigerant lines, drain pipes, wires, etc, that run into the air handler are potential leakage points and require sealing.

Section 5: Install

This section addresses some of the key installation areas that can dramatically affect the operation and life of the system.

- All wires inside units tightly connected to terminals and properly secured: Loose connections or unsecured wires can cause damage or become damaged over time.
- Lines & coil evacuated to 29 inches (or 500 microns) for a minimum of 10 minutes: The refrigerant lines and evaporator coil are part of the refrigerant loop system and critical to proper operation. Once the equipment has been set and the lines connected, a vacuum is drawn on the system to check for leakage. Drawing a proper vacuum and holding it for a minimum of 10 minutes ensures the system is tight and leak free. This ensures refrigerant can be added to a sealed system. Most of us have heard a colleague, friend or family member say “I had the AC guy come and look at my system and they added some refrigerant to get it working right.” A refrigerant loop, if installed properly, should never have leaks or need refrigerant added.
- Evaporator Fan speed set properly per manufacturer spec: Newer heat pumps can be very complicated pieces of machinery and the air handler fan can have various settings for different equipment configurations. The default settings may not always be the proper settings so it is important to double check them when installing the equipment.
- Condensation drain lines tested for proper drainage: Heat pumps not only heat and cool the home but they dehumidify the air as well. While cooling the home the equipment will also remove moisture from the air helping to maintain proper humidity levels which is a major factor in occupant comfort. The water that is removed from the air is transported outside of the home through the condensation drain lines. These lines should be tested to ensure they drain properly so that the water does not cause damage to the home or equipment.
- Drain Pan over flow and condensation line safety switch tested for proper operation: If a drain pan is installed with the air handler, it is designed to capture any water that doesn't drain properly through the condensate lines. If the drain pan begins to fill with water, a safety switch will turn off the equipment to stop the moisture removal and prevent overflow and water damage to the home. These switches should be tested to ensure they are operating properly.
- If air handler installed vertically, horizontal drain pan removed: Many air handlers can be installed vertically or horizontally. Most manufacturers put in a drain pan inside the air handler unit in case it is mounted horizontally. If the air handler is mounted vertically, that drain pan should be removed to allow for better air flow.

Section 6: Startup

Once the equipment has been installed, it's time to start it up, check it and adjust the system as necessary. Due to the chemical and physical nature of the new refrigerants being used, it is critical to let the **system run for 30 minutes** to allow everything to stabilize out. The 30 minute time frame is critical when doing the final charge on the refrigerant but not as important when looking at air flows or motor/fan amperages.

- Supply and return air temperatures: This is a quick indicator of proper operation by looking at the differential temperature across the evaporator coil (heat exchanger).
- Suction/head pressure, measured refrigerant and subcool/superheat: These values are indicators of the refrigerant charge in the system. Manufacturers will specify what these values should be for the equipment used to ensure a proper charge and operation. These values are critical since the refrigerant loop is a key component of the overall HVAC system's operation and efficiency. Remember, the equipment should be running for about 30 minutes in order to ensure these readings are as accurate as

possible. Over or under charging a refrigerant loop can quickly decrease system efficiency and/or cause premature damage to the equipment. ***NOTE: If outdoor temperature is below 60 degrees, it is recommended that a technician return and verify/adjust the refrigerant charge when temperatures are above 60 degrees.***

- Motor and fan amperage readings: These readings will indicate whether or not they are operating properly per the manufacturers specifications.
- Supply air temperature with auxiliary heat and electric heat amps: Heat pumps lose capacity as outdoor temperatures drop. In order to provide heating during extremely cold conditions for our climate zone, they have electric heat strips to add heat for the short time periods it may be needed. Many times a system is installed during the cooling season and heat strips are not tested or used for a long time. Testing them at startup ensures they work so that problems are not discovered many months later on a cold winter night.

Section 7: Post Installation Diagnostics

- All ducts associated with the replaced HVAC equipment were tested to less than 10% leakage to outside (optional): Florida code requires that all ducts be sealed during a heat pump replacement. The ducts should be tested to achieve less than 10% duct leakage to the outside of the conditioned envelope. A Duct test report should be filled out and submitted.
- A test and balance of the system was performed for delivered BTU output (optional): A special testing procedure called a test and balance determines the delivered BTU's of the system to the home and ensures the system is operating at peak capacity and efficiency. This testing takes specialized equipment and has an extra cost but can be worth it, so it is an optional measure left to the discretion of the homeowner. Talk with the contractor about this test and your options.

Section 8: Homeowner Orientation

This section is a reminder for the technician to review the checklist with the homeowner and explain key maintenance issues for the equipment, how to properly operate the thermostat, and how to shut power off to the equipment. Homeowner operation and maintenance is a critical part in reducing the energy consumed by the HVAC system and ensuring the equipment works properly for many, many years.