

## Heat Pumps

What are heat pumps and how do they work?

- A heat pump installs outside your house and connects to the existing furnace, air handler, electric baseboard system, or pipes installed for the heat pump to move air around. It works like the refrigerator, using the difference in temperature inside and outside the house to cool the house in the summer and heat it in the winter. So heat pumps are both a heating and air conditioning system.
- Heat pumps use refrigerants to move heat in the opposite direction of the natural flow. A heat pump compresses the refrigerant to make it hotter on the side to be warmed and releases the pressure on that side. To produce heat, a compressor pressurizes the refrigerant in its gaseous state and circulates it through the system. When hot and pressurized, the refrigerant is cooled in a condenser to a liquid state and then passes through a device that lowers the pressure. Finally the refrigerant enters the evaporator, where it absorbs heat and boils, emitting heat. It then returns to the compressor to repeat the cycle. For cooling, the refrigerant flows in the opposite direction, reversing the cycle, and providing cooler air.
- Heat pumps run on electric power, so while they replace gas (methane) furnaces, they are as renewable in terms of energy as your electricity source is. Even if your electricity is 100% from gas fired power plants, a heat pump can have half the emission of a gas furnace providing the same heat. (Technical note e.g. Furnace needs 1/0.8 eff. therms of gas to deliver 100,000 BTUs.... HP needs 1/3.5 HP COP /0.5 plant eff/ (1-.07 elec. trans losses).
- The efficiency of an air-source heat pump is measured by its heating season performance factor (HSPF) and seasonal energy efficiency ratio (SEER). Federal standards require air-source heat pumps to have a minimum HSPF of 6.8 and a minimum SEER of 10. However, heat pumps with SEERs around 14.0 and HSPFs around 9.0 are usually available. Look for heat pumps with an Energy Star label. New ductless heat pumps can operate in climates much harsher than ours, with outdoor temperatures down to 22 degrees below zero Fahrenheit.

Are there different kinds?

- The most common system is the air-to-air system, which fans outdoor air across refrigerated lines to either provide or release heat.
- Ductless heat pumps generate heat or cooling and provide it to multiple indoor “cassettes”. Each “cassette” has its own thermostat, usually a remote control with a wall mount. Ductless heat pumps are idea for a house with no ducts, e.g., homes that have electric baseboard heating or electric wall-mounted heaters or floor furnaces. There is an outside unit that delivers heat to inside “cassettes”. The cassette’s appearance ranges from a recessed panel in the ceiling to a floor mounted wall heater. The most common cassettes are mounted high on the wall near the ceiling. The cassettes contain very quiet fans so the system is much quieter than conventional forced air furnaces. The outside unit is connected to the inner cassettes by insulated copper tubes less than ½ inch in diameter. For aesthetic reasons, the tubes are typically routed outdoors or in attics or crawl spaces. Mini-split systems can cost more than ducted systems but are more efficient since the heat/cooling is not lost to ducts and the cassettes can be individually controlled and zoned to provide customized comfort and energy savings. The heat pumps can dehumidify air and would have a drain line to direct collected condensate outdoors or to a drain.
- Geothermal heat pumps, also called ground-to-air pumps, are installed with a heat exchange loop in the ground; they can use heat and cooling energy from the ground or a nearby water

source. They work by conducting heat into or out of the ground at a depth below about 5 feet where it is hardly impacted by seasonal changes.

How much do heat pumps cost?

- According to a 2016 article that could have reflected national prices, whole-house units cost between \$ 2,000 and \$ 8,000, depending on ratings and the type installed. Single room units (for ductless heat pumps) cost about \$ 500 per room. These prices include installation. Because they use refrigerant, the best installers may be HVAC or refrigerator technicians rather than electricians. If the heat pump needs to be installed outside your house instead of opposite the furnace, extra ductwork and wiring may be needed. And if there are no existing ducts or baseboard heating, then the installation of pipes for ductless heat pumps are extra.
- Geothermal pumps run from \$ 2500 to \$ 7000, depending on the model. Installation in the ground adds thousands more. Modern air source heat pumps have advanced to displace ground source heat pumps in all but the most severe climates.
- Choose a contractor that follows ASHRAE ([www.ashrae.org](http://www.ashrae.org)) and Air Conditioning Contractors of America ([www.acca.org](http://www.acca.org)) guidelines. This will help ensure that climate, size, and orientation of the home, as well as heat loss from the building shell and occupant lifestyles are considered in the contractor's calculations.
- Heat pumps require changing the filters once a month or as needed, i.e. when they appear dirty, clearing vegetation from around an outdoor heat pump, occasionally turning off the fan and cleaning it, cleaning the supply and registers in the house, and straightening bent fins. They also need to be serviced by a technician once a year.

Who sells, installs, and services them locally?

- See separate document

What are the advantages of heat pumps?

- They are efficient. They use only a small amount of electricity to reverse the flow of heat or cold out of your home, and generate about 3 kw of heat using 1 kw of electricity. However, air-to-air heat pumps decrease in efficiency as the air gets colder, so supplemental heat may be needed when the temperature is below freezing. However, some newer systems claim they work when the temperatures are far below freezing.
- They have variable speed control so they can adjust to run a moderate level .
- High-efficiency heat pumps can also act as dehumidifiers compared to air conditioners, resulting in less energy usage and more cooling comfort in the summer months.
- Many high-efficiency heat pumps are equipped with a "*desuperheater*", which recovers waste heat from the heat pump's cooling mode and uses it to heat water. A desuperheater-equipped heat pump can heat water 2 to 3 times more efficiently than an ordinary electric water heater.
- Another advance in heat pump technology is the "*scroll compressor*," which consists of two spiral-shaped scrolls. One remains stationary, while the other orbits around it, compressing the refrigerant by forcing it into increasingly smaller areas. Compared to the typical piston compressors, scroll compressors have a longer operating life and are quieter. According to some reports, heat pumps with scroll compressors provide 10° to 15°F (5.6° to 8.3°C) warmer air when in the heating mode, compared to existing heat pumps with piston compressors.

- Ductless heat pump systems can deliver zoned heating to create different temperatures in different areas of the house, so you can turn down the thermostat in some areas.

What are the disadvantages?

- Qualified installers and servicers for ductless heat pumps may be difficult to find.

How long do they last?

- Properly maintained, they last between 20 and 25 years.

**What do local people who have them say?  
(The first respondent also provided additional resources)**

One respondent:

I have just finished a project to replace my ducted furnace and air conditioner with a heat pump. It's all done and we're really happy with it so far (although haven't needed it much yet because the weather's been pretty mild. We got a Lennox XP-25 system and it was quite a bit more expensive than a traditional furnace + A/C (about 40-50% more). My main goal was to get rid of our biggest use of natural gas so by that measure it was a success. It might never pay for itself in savings, though it is much more efficient than the furnace and A/C were. For those who have solar electricity or are planning to get it, it can be a great hedge against future utility rate increases. We do have solar electricity, but are already using our full annual capacity charging two electric cars and running the rest of the house so we don't have a lot of extra for the heat pump. Sometimes contractors will recommend installing a back-up with natural gas or electric resistance heating, but we did not get that. The outdoor unit goes where a traditional air conditioning unit would go and the indoor condenser/blower is in the same closet where the furnace used to be. I'm happy with the contractor I used called "ColdCraft" based in Campbell. There is another type of system that is even more efficient which is a ductless mini split system. Each room has a unit in it and all the units connect to an outdoor unit. This is generally more expensive than the ducted version but also more efficient. Good for new construction or houses that don't have ductwork.

If people are interested in Heat Pump Water heaters, I will refer you to a video of one of the Speaker events in the Sunnyvale Sustainability Speakers Series which was specifically about how heat pump water heaters can make sense, where they get installed, etc. For that event I also created an informational flyer about contractors and equipment that is on the market. - see attached called "Resources for Electrifying Beyond Fossil Fuels v1.1. You can buy heat pump water heaters at Lowe's or Home Depot. Sometimes there is an electrical upgrade needed for 240V outlet or to upgrade the electrical panel. Generally they install in a garage, indoor closet, or outside and are the same size as a traditional tank water heater. Palo Alto (and maybe some other cities) have a rebate for those who install one. Check with Peninsula Clean Energy, PG&E, and Redwood City for rebates in your area... Installation is not complex once a location is chosen and the electrical 240V outlet is available. It can be done by any plumber that installs regular water heaters.

Here's the link to the Sustainability Speakers Series event: "Electrifying! Beyond Fossil Fuels for Homes and Businesses" and content has a lot of info about Heat Pump Water Heaters. [http://sunnyvaleca.granicus.com/MediaPlayer.php?view\\_id=4&clip\\_id=2230](http://sunnyvaleca.granicus.com/MediaPlayer.php?view_id=4&clip_id=2230) Pierre Delforge of Natural Resources Defense Council starts speaking at about 16:15 on the video.

Another respondent

We have a two story house and we used to have air conditioning for the second story. At first, we hardly ever used it but as the years have gone by it has gotten hotter and hotter and we started needing it more and more. We also have solar panels that provide all or most electricity for the house and charging two

cars. To make our cooling more efficient and less wasteful, we installed a heat pump for the upstairs only in December. We rarely heat the upstairs but the few times we did, it worked very well. It hasn't been hot enough to tell how well it works for cooling on the really hot days but we ran it a few times recently to test it out and it seems to work okay. We only run the cooling at night for sleeping and only upstairs so we are hoping we can get some solar coverage for the heat pump. Our existing ducting was okay and was not replaced. The unit is slightly larger than the air conditioning unit it replaced. It sits outside in a corner of our veggie garden. It is quieter than the 20-year-old air conditioning unit was. The company we used was Alternative HVAC of either San Carlos or Menlo Park. They were really busy and in the end came the week of Christmas to do the work, not ideal timing but it is done and I hope we will sleep coolly and peacefully this summer.

Another respondent

I installed a Heat Pump Water Heater (HPWH) that I bought at Lowes for \$950. I replaced my 40 gallon gas water with a 50 gallon electric HPWH model now made by Bradford White. It was easy and it dehumidifies my basement. I've volunteered a few times with SunWork.org installing low cost solar PV systems and that taught me enough to be comfortable installing the 220 Volt power circuit for the water heater. Since I have solar PV power, I like to think of my HPWH as "dry solar water heating". I really like it.