DOMESTIC HOT WATER HEATING USING AIR SOURCE HEAT PUMPS

Air source heat pumps have been around for a long time. Especially in climates more moderate than the northeastern United States, they have been the primary space conditioning equipment for a large fraction of homes. Relatively recent developments in high efficiency air-source heat pump technology have pushed heat pumps into colder climate zones such as the northeast US, and have pushed the technology into different end uses. Over the past several years, water-source heat pumps for domestic hot water heating applications have entered the marketplace in the US. Five years ago, heat pump water heaters (HPWH) were difficult to find; now, most major water heater brands have a heat pump water heater option.

How They Work

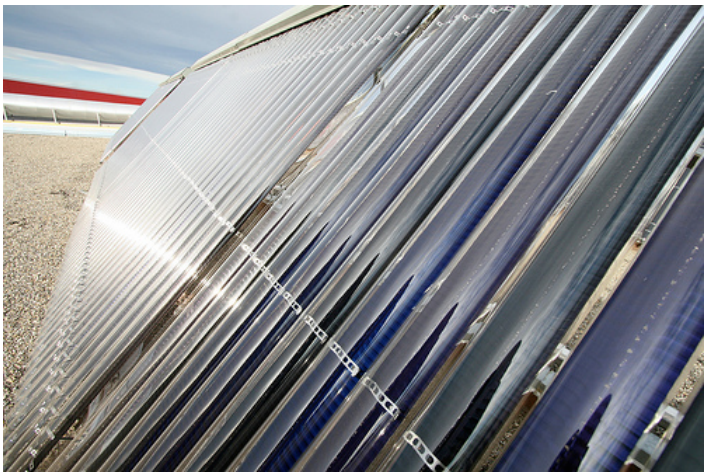
Like any heat pump, a HPWH uses electrical energy to move (or "pump") heat from the air surrounding the heater, into the water in an integral storage tank. Unlike typical electric resistance water heaters, the energy put into the water can be more than the energy consumed by the process of "pumping" heat. Water heater efficiency is benchmarked using Energy Factor – which is basically the useful energy being delivered (hot water) divided by the energy consumed by the equipment. Typical electric resistance hot water heaters have Energy Factors in the 0.9-0.95 range, depending on how well insulated they are. For heat pump water heaters, the energy factors are typically greater than 2.0. That's more than twice as efficient as a traditional electric water heater! When located in warm climates or warm mechanical rooms, their efficiency can be even higher.

Air source heat pump. Image by Flickr user Krzysztof Lis

Efficiency

The conventional wisdom has been that electric resistance water heating, while it can be efficient at the site, is not an efficient choice. This is for a couple of reasons: electricity is more expensive per unit of energy than fuels consumed onsite, and also because the energy lost in the generation and delivery of electrical power results in only 30% of the thermal energy used at a power plant being converted into electricity at a site. In other words, even though an electric hot water heater can be 90-95% efficient at the site, from a source energy and CO2 emissions standpoint, they are actually less than 35% efficient.

Heat pumps can change this equation. While electricity delivered to a building may be only ~35% efficient thermally, if a heat pump water heater can have an Energy Factor of say, 2.5, the effective efficiency could be near 90%. If instead of powering heat pumps only from the grid, heat pump hot water heaters are installed alongside grid-tied solar photovoltaics, the economics appear to be even more favorable than solar thermal hot water heating. This leads some people to claim this combination of solar PV and heat pump water heating means the end of solar thermal hot water.



Solar Vacuum Tube Hot Water System. Photo: David Dodge, The Pembina Institute

Other Advantages

In addition to being significantly more efficient than other electrical water heaters, if placed in moist basements, the cool evaporator coil can dehumidify the space as it heats the water. Further, for commercial applications with warm mechanical rooms, a HPWH can operate at very high efficiency as it draws heat from the space, resulting in a cooler mechanical room.

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