GREEN

Humble mini-split has changed the world

March 11, 2015

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I have engineered, designed and installed a geothermal solar hybrid in my house with chilled, hot and solar water to fan coils with zoning and duct work and a comprehensive direct digital control (DDC) system working to coordinate HVAC and solar sequences. My firm, Nelson Mechanical Design, based in Martha's Vineyard, Massachusetts, sells, designs, installs and services every possible way to heat, ventilate and cool a building — with any possible control scheme and any possible delivery system (from radiant cooling with outside dew point reset to baseboard heat to geothermal solar hybrids) in buildings ranging from tiny Passive Haus structures to 20,000-sq.ft. residential and commercial spaces.

Fast-growing segment

The mini-split (and variable-speed heat pumps, including VRF or VRV air source) is the fastest growing segment of the HVAC market. It consists of one or many inside fan coils—most of the time a self-contained wall mounted unit, but sometimes a ducted unit—connected via refrigerant piping (the line set) to an outside heat pump unit (many times with multiple ports for multiple inside units). It is called a "mini-split" because the typical heating and cooling capacities of the different size inside units range from 7,000 Btu/hour to 24,000 Btu/hour, which is much smaller than the typical American split systems of three to five tons (36,000 to 60,000 Btu/hour). The compressor (and many times the inside fan coil blower) is variable-speed with a great turndown ratio, resulting in tight temperature control (and really good energy efficiency).

The mini-split is an amazing and innovative solution in the search for truly distributed heating and cooling, and the conditioning of air, because the inside fan coils are so small that every room now can have its own unit and each room can have its own temperature. Each room will get exactly the right amount of heating, cooling or dehumidification. The more advanced units permit simultaneous operation of some fan coils in heating while others are in cooling — essentially moving solar energy that is hitting one side of the building to the other side.

Remember installing baseboard heating systems and breaking them up into small zones? That was the Cadillac of comfort where each room or area could have its own round thermostat and just the right amount of heating. Well think of the mini-split as the 2015 version because it does not only provide heating but cooling and dehumidification as well.

Where did it originate?

The mini-split has its roots in housing size and energy cost. One hundred years ago, in the early days of AC, the first system was enormous and was used to cool movie theatres. After World War II, the housing boom lead to a great investment in residential air conditioning and ultimately, by the 1960s, to the standardization of split systems into what we are familiar with today. Because we enjoyed low-cost energy, these systems were fine and worked well enough. Meanwhile, the Japanese had high-cost energy and smaller housing, so they pursued smaller units. Because of their success in electronics, they were able to add modern controls to AC systems and develop variable-speed compressors and refrigerant flow, raising efficiency even higher. We didn't pay attention because our homes were bigger and our electricity was so inexpensive.

When mini-splits first arrived here from Japan, many of us regarded them as a toy: the wall unit with the little fan and washable filter — a passing fad that was not worth our time. But just like the first Asian automobiles that arrived in the U.S. in the 1970s, the quality and utility of the mini-split was good enough to ensure its survival in the U.S. market. When energy prices rose dramatically in the U.S., the mini-split dramatically expanded its market share and penetration.

Advantages over other approaches

Cost, efficiency, modularity, scalability and redundancy are all advantages of the mini-split. As we talk to our clients about what systems are available and what each of them can do, so many times the deal is sealed when we tell them that a mini split also has a “dry” mode — not only will it heat and cool, but it will help control your humidity!

From a first-cost and operating-cost point of view, mini-splits are amazing. They are quiet and efficient (they are approaching geothermal efficiency, especially when total pumping energy is included in the energy calculation); they heat, cool and dry the air, and they are simple to install. Because they are so “mini,” we can condition just about any room; because they are so easily scalable, we can keep adding units to condition all of the rooms.

The comparison between the heat-moving ability of air in 20” x 8” duct work or hot water in a ¾-in. copper pipe is now expanded to include the 3/8-in. refrigerant line. This tiny copper pipe can be routed to any room in the building with no need for pitch or freeze protection. If the heat fails in the building, the refrigerant line will not burst or leak. If there is a leak, the refrigerant will not damage anything.

We have installed mini-splits on all sizes of residential projects, from tiny Passive Haus buildings to large mega-mansions. Recently, we installed nine units in a large movie theatre and 15 units in a new bowling alley. The architect had us quote a traditional built-up heating and cooling system versus a mini-split approach with ERV units for fresh air. Bidding against ourselves, the mini-split approach was half the first cost, would provide wonderful redundancy (if the theatre or bowling alley lost a unit, it would still have more than 80% of its cooling capacity unaffected), and would have close to geothermal efficiency at full load and higher at part load (think of a half-empty movie theatre with only one wall unit meeting the entire load).

Disadvantages of mini-splits include exposure to elements, limitations on the size of unit, unsightly wall units and the need for a bazillion units. Foremost is the dependence on an outside air-source heat pump unit that is exposed to the elements. While this is true for any heat pump during winter, we have noted that the larger U.S.-sized units are more robust and deal with ice and snow more efficiently. We typically advise our clients to keep a close eye on their outside units to make sure they don't get overwhelmed.

The wall units are unsightly to some and inflexible in terms of covering them with built in cabinets or soffits. A larger space will require many wall units, which increases the labor and materials to run line sets and condensate drains to all units, instead of one larger fan coil.

Overall, the market has spoken: mini-splits have redefined what folks want. The success of the market at picking winners is evident in the explosion of mini-split sales. There was a time when U.S. automakers complained about Japanese imports and how unfair it was that U.S. consumers were choosing to buy foreign cars. Similarly, the success of mini-splits is not because they are so inexpensive, but because they offer a lot in a small, efficient package that can be incorporated into just about any building project.

As principal of Nelson Mechanical Design, Brian Nelson is a Master Plumber and has a master's degree in engineering. He is also a jazz saxophonist. This progressive contractor won a Green Mechanical Award, plus his firm was CONTRACTOR's Contractor of the Year in 2010.