BY TED CUSHMAN

Heat Pumps for Cold Climates

Mini-split heat pumps were a major topic at the Northeast Sustainable Energy Association (NESEA) BuildingEnergy 14 conference in Boston this year, and with good reason: Heat pumps have grown beyond their roots as a southern-state solution and are making in-roads in cold climates from Idaho to Minnesota to Maine.

Heat pumps don't use electricity to create heat; they simply transfer heat from outdoors to indoors (or vice versa). In mild climates, where the difference in temperature between inside and outside the house is relatively small, heat pumps are a no-brainer. As the air gets colder, though, air-source heat pumps lose capacity. Until recently, this has limited their usefulness in cold climates.

The newest mini-splits, however, can keep pumping out heat (although not at peak efficiency) even when outdoor temperatures drop below 0°F, and on a seasonal basis can supply nearly three times as much energy in the form of heat as the energy they consume in the form of electricity. They're not the answer for every house. But with installed prices starting at around $4,000 and capacities ranging from 12,000 Btu per hour (1 ton) to 30,000 Btu per hour (2.5 tons), mini-split heat pumps hit the sweet spot in a growing number of situations. Let's take a look at scenarios where mini-splits shine in cold climates.

Photo: Ted Cushman

ReVision Energy's Dave Ragsdale connects the control circuit of the outdoor unit of a 1-ton Fujitsu mini-split on a home near Portland, Maine. In combination with a wood stove, the mini-split will mostly idle the home's existing oil boiler, except during the coldest part of the year.

HEAT FOR SUPER-INSULATED HOUSES

For some Passive House builders, mini-splits are becoming routine. The affordable Passive House home built by Chris Corson in Knox, Maine, (see "An Affordable Passive House," Part I, May/12, and Part II, Jun/12) relies on a single one-ton (12,000 Btu) Mitsubishi "Mr. Slim" mini-split (mitsubishielectric.com) to heat about 1,600 square feet. In Oxford, Maine, a 2,016-square-foot house under construction by Passive House builder Jesper Kruse will be heated by the same appliance. And mini-splits heat all four of the New England homes featured in "Building Above-Code Walls" (Dec/13).

Mini-splits work well for these projects because they come in capacities close to the loads in a Passive House, and they deliver AC and heating in one small, easy-to-install package. Good ones are extremely quiet and also extremely efficient—according to one Idaho study, their seasonal average coefficient of performance (COP) is 2.8.

SUPPLEMENTAL HEAT FOR OLD HOUSES

It takes a lot of work to get a home's total load down to 12,000 Btu in the dead of a Maine winter, and not many Maine houses are built to Passive House standards (or even to code). Still, heat pumps have found a niche in Maine's existing homes. The state's energy efficiency utility, Efficiency Maine, has used Recovery Act funding to organize a mini-split retrofit program, offering mini-splits to homeowners in northern Maine, with a small rebate incentive to sweeten the pot.

"We had funding for 1,000 units, and Mainers put in 1,000 units very quickly," says Efficiency Maine manager, Andy Meyer. The average installed price for the appliances—mostly Fujitsu units (fujitsugeneral.com)—was $3,230. Customers were offered 7% financing for the cost, with payments automatically included in their electricity bills, but about four out of five customers chose to pay up-front instead.

Efficiency Maine surveyed all 1,000 customers to find out whether the buyers were satisfied, and more than 90% said they would recommend a mini-split to their friends. Calculated payback for the up-front cost,

based on heating cost savings, averages around five years. Efficiency Maine is showcasing the example of a couple living near the Canadian border whose heat-pump investment was paid back in two years, thanks to a 50% savings on their annual heating cost.

Heat pumps pay off best when they're displacing a heat source that is inefficient, expensive, or both. Where the heat pump substitutes for electric resistance heat, oil, or propane, it competes well. The advantage is not so clear-cut, however, when a heat pump goes head-to-head against natural gas, which has dropped in price as new "fracking" techniques boost U.S. supply.

But rural Maine is unlikely to ever see widespread distribution of natural gas. In Maine, 70% of homes are heated with oil—an expensive fuel burned in, typically, an inefficient appliance. The beauty of teaming a mini-split with an oil boiler is that the heat pump carries most of the heating load during the fall and spring "swing seasons"—times when heat requirements are moderate because the weather is relatively mild. When the heat source—the outdoor air—is relatively warm, heat pumps show their best efficiencies. That's also when stop-and-start operation tends to degrade the performance of an oil boiler or furnace.

By contrast, during the coldest part of the year, when the heat pump is relatively inefficient and may struggle to achieve its rated output or to produce comfortably warm air, the oil furnace functions at its best. Because it will tend to operate for longer periods, an oil system will spend more time operating at top efficiency and less time losing energy to "standby losses." Plus, the electricity that a heat pump consumes may be partially offset by the savings from not running the pumps and fans that are part of oil-burning equipment. In a case reported by energy consultant Marc Rosenbaum at the NESEA conference, 32 tons of heat-pump capacity (in the form of multiple 8-ton Mitsubishi commercial split systems) was installed in a public school building in Plainfield, N.H. The school has been saving more than 8,000 gallons of oil a year, Rosenbaum says, without any increase in electricity use.

Chris Blaisdell of ReVision Energy mounts an indoor unit in a finished basement. Compared with the blower needed to move air through a ducted system, the small fan in this unit uses very little electricity.

Photo: Ted Cushman

DRAWBACKS & CAUTIONS

Mini-splits account for a large proportion of heating and cooling worldwide, but they're new to the northern U.S. Early adopters in this country are still learning lessons (see "Lessons Learned on Energy-Efficient Affordable Housing," Jul/13). HVAC installers may lack the experience to install the systems correctly, and homeowners sometimes don't use them to best advantage. (For example, Andy Meyer says, it's worth advising homeowners to set the units on "heat only" in winter, not on "auto"—otherwise, the system may switch over to cooling if the house hits 72°F on a sunny winter day.)

The most efficient mini-splits are the models with no ducts or air handlers. Units with fans and ducts waste a small amount of wattage on air movement. But without heat distribution, single-point mini-splits may fail to satisfy some customers. Both Jesper Kruse and Chris Corson install a few hundred watts of electric heat in some rooms in their Passive House homes—mainly as backup in case a heat pump breaks, but also in case the owner wants more heat in a room that's remote from the indoor head of the heat pump.

That's the same strategy recommended by Fortunat Mueller of ReVision Energy, in Portland, Maine. Mueller runs room-by-room heat-loss calculations to estimate in advance whether a mini-split head located in a central room will pack enough punch to warm rooms near the periphery. He expects backup heat to be used rarely, if at all; usually, experience bears that out. But when in doubt, Mueller's company wires remote rooms for a bit of supplemental resistance heat, even if the company doesn't actually install any electric baseboard. Says Mueller, "Ten feet of Romex cable is cheap insurance against having a ticked-off customer if one room won't come up to temperature."

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