By Gord Cooke

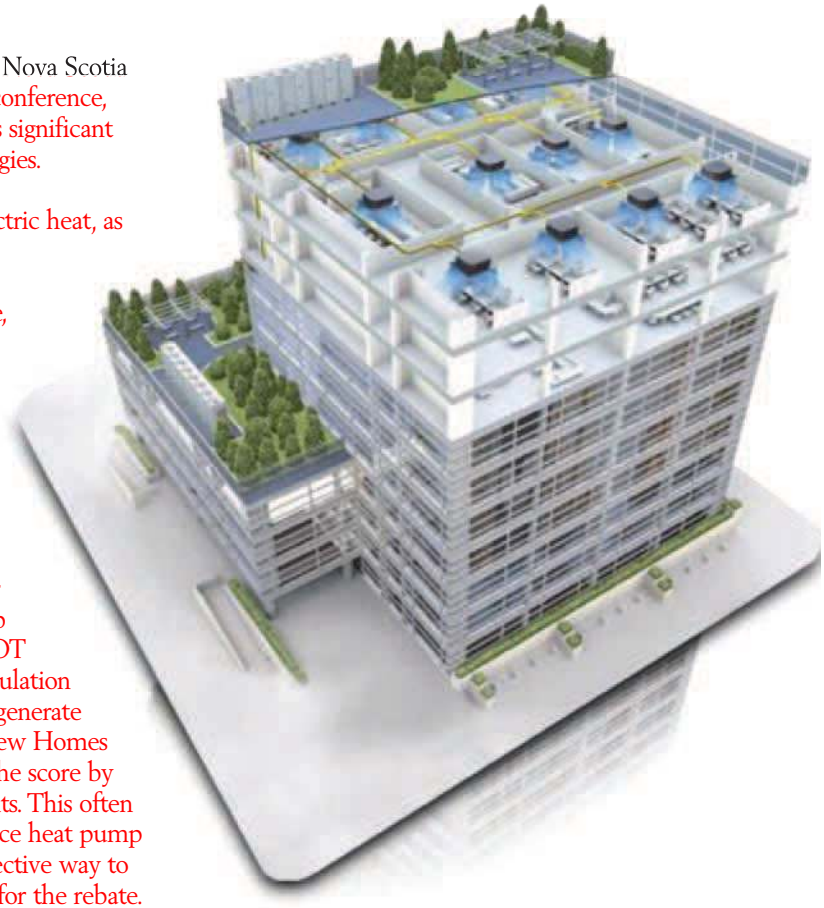
Gord Cooke is a professional engineer who has spent 20 years helping builders and HVAC contractors implement innovative technologies into high-performance homes. He has particular expertise in IAQ and air flow management in houses, and can be contacted at gcooke@airsolutions.ca.

Heat Pumps:

Advances in air-source technology

I was recently at ENERhouse 2013, the Nova Scotia Home Builders' Association biennual conference, and I was pleased to see that there was significant interest in air source heat pump technologies.

That province has a long history with electric heat, as well as supportive utility and provincial government programs designed to cut electrical usage and demand. For example, new home builders in the province can expect a rebate of $3,000 if they build homes that achieve an EnerGuide rating of at least 83.



It turns out that even a modest air source heat pump applied in the HOT 2000 Energy Simulation software used to generate EnerGuide for New Homes ratings can raise the score by two or three points. This often makes an air source heat pump the most cost effective way to meet the criteria for the rebate.

While this may seem like an isolated, limited market opportunity for air source heat pumps, there are important industry changes that should have HVAC professionals across Canada recalibrating their thinking on applying heat pumps in both residential and commercial buildings.

It is time to rethink the suitability and application of air source heat pumps. High performance low load buildings, buildings with variable load spaces, and near- or net-zero homes are all excellent candidates for the new generation of air source heat pumps.

Exciting advances

From a Canadian perspective, what's really exciting in modern heat pumps are the new refrigerant management systems, ECM or variable-speed fans, and compressor technologies and control strategies that enable air source heat pumps to work reliably and maintain a reasonable capacity at very low ambient temperatures.

Looking at the specification sheet for one commonly available residential mini-split heat pump shows it is able to operate down as low as -21°C – and it maintains a COP of 2.0 at that temperature.

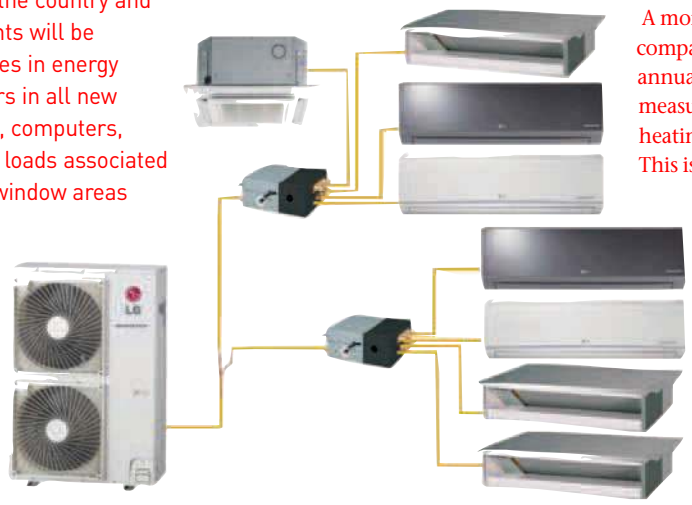
These same technical advancements also allow better control of indoor discharge temperatures to help avoid the comfort complaints that were common with older heat pumps.

Furthermore, the full variable refrigerant flow (VRF) technology allows multiple indoor modules or heads with one large capacity outdoor unit, and even simultaneous heating and cooling capabilities.

The influence
of building design

The continual drive to improve the energy efficiency of buildings is starting to show dramatic changes in heating and cooling loads associated with the building envelope.

Provincial code changes across the country and even local municipal requirements will be driving 15 to 20 per cent increases in energy efficiency every three to five years in all new buildings. Internal loads (people, computers, appliances) and the intermittent loads associated with the seemingly ever-larger window areas will factor into HVAC design parameters, however.

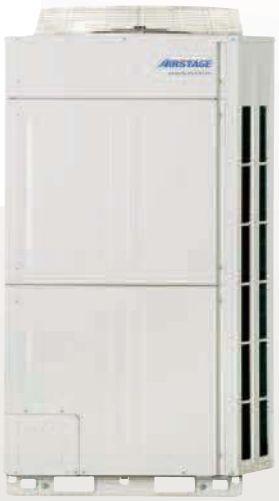


Total loads will be lower, but the loads will be highly variable, and HVAC systems will have to be able to respond quickly and efficiently to changing loads within a building.

The growing interest in "net-zero" buildings – buildings that only use as much energy as they are able to generate on site – will also impact HVAC equipment choices. The knock on heat pumps is that while they are energy efficient they also use expensive electricity. But if electricity is being generated on site, then tapping that energy source with heat pumps negates much of that cost disadvantage.

For these reasons, new building designs will be very conducive to the flexibility that the new generation of air source heat pumps may be able to offer.

A much-improved option



There is no such thing as the good old days of heat pumps in Canada. Poor output performance in cold weather, durability issues and inadequate technical support from manufacturers plagued the early attempts at using air source heat pumps in this country, but all of that has changed for the better. While the technology is still tied to the relatively expensive electrical supply grid, there has to be recognition that the industry support network for mini-split A/Cs and heat pumps, along with forced air heat pumps, has improved dramatically.

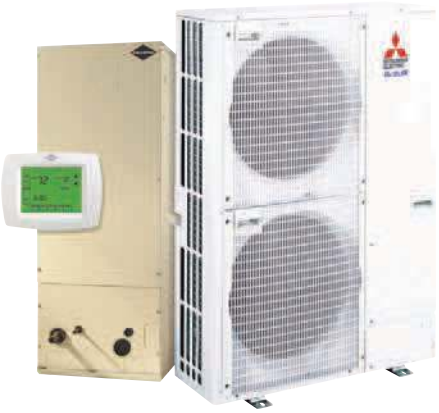
Efficient measures

There can be no denying the incredible efficiency offered by heat pumps. There are two commonly used efficiency measures reported for heat pumps. Most contractors will be familiar with the COP or coefficient of performance. That's the ratio of heat energy delivered to electrical energy supplied or consumed.

A more recent term that is better for comparing heat pump performance than the annual fuel utilization efficiency (AFUE) measure used for fuel-fired appliances is the heating seasonal performance factor, or HSPF. This is the ratio of BTU of heat output over the heating season to watt-hours of electricity used over the same season. The units of measurement with HSPF are BTU/watt-hr.

The HSPF can be converted to an average seasonal COP by multiplying the HSPF by 0.293. For example, an HSPF of 7.1, the current level required for Energy Star certification in Canada (Heating Region 5) would be equal to an average seasonal COP of 2.08.

The HSPF of a particular heat pump is determined using standard rating conditions for both inside the building and outside climate. As such, applying the results to calculate or predict energy performance in a specific building or climate zone can be difficult.



The intricate control strategies, refrigerant management systems and the effect of different climates makes it tricky to assume that the percentage performance difference between two heat pumps can be applied to expected energy usage.

For example, a device with a 25 per cent better HSPF, say 8.75 as compared to a unit with a rating of 7.0, may not result in a full 25 per cent energy savings when applied in a particular building in a specific climate.

Of course, similar anomalies can result from application of AFUE or SEER ratings as they too are determined using standardized rating conditions that may not reflect actual application conditions. This isn't meant to discourage selection of more efficient equipment, but rather to point out the need for thorough consideration of all available data.

When selecting a heat pump, the HSPF for the specific climate region should be considered, along with knowledge of the actual heating output of the device at the design heating temperature for the location.