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High Efficiency Air to Air Heat Pump

Benefits

Reduced Energy Consumption

- Extracts more energy from the air (in the form of heat) than it consumes (in the form of electricity).
- New high efficiency models can operate cost-effectively at lower outdoor temperatures.
- Supplies both space heating and space cooling.

Reduced Energy Costs

- Reduces electricity space heating bills by producing 3 to 10 kilowatts of heat energy for each kilowatt it consumes.
- Replaces or augments existing space heating and cooling systems.

Reduced Environmental Impact

- For electric space heating systems, can lower pollutant emissions associated with thermal electricity generating plants.
- Reduces consumption of non-renewable fuel resources.

Reduced Installation Requirements

- Works with existing furnace ductwork.
- Mini-split, or ‘ductless’ units can be installed in houses without furnaces.

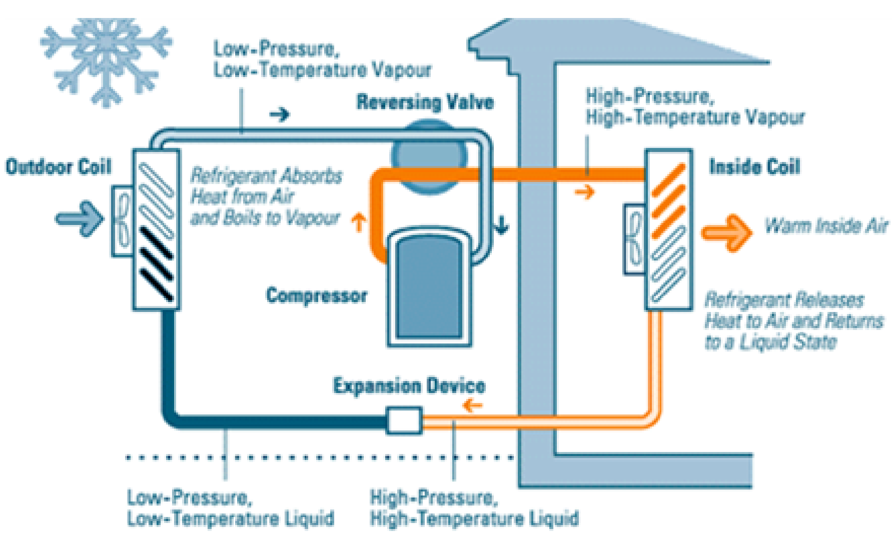
Description

- Air-to-air heat (A2A) pumps extract heat energy from the outside air and transfer it indoors during the heating season and extract heat energy from the interior air and deliver it outdoors during the cooling season. An outdoor unit houses the compressor and heat exchange coil that captures or rejects heat depending on the season. The indoor part of the systems typically consists of a packaged fan-coil unit that delivers either heating or cooling to the house. It typically contains a back-up electric heating coil to provide auxiliary heat.
- All types of air-to-air heat pumps have an outdoor heat exchanger

coil for extracting heat and an indoor heat exchanger coil, which transfers the heat into the house. In the summer, the process is reversed.

- An air-to-air heat pump can be added on to an existing gas, electric or oil furnace, or used as a stand-alone replacement for a furnace with its own built-in auxiliary heat source.
- A ductless, or 'mini split' heat pump can be installed in a house where there is no pre-existing central ducting such as houses with electric baseboard or hydronic heating.
- The efficiency of a heat pump is measured by the coefficient of performance (COP). The COP is the energy output of the heat pump divided by the amount of electricity needed to run the unit. The higher the COP, the more efficient the unit. Another measure of efficiency is the heating seasonal performance factor (HSPF). The HSPF is the total heat output during the heating season divided by the total energy used during that time. This number is similar to the seasonal efficiency of a fuel-fired heating system. For cooling, the measure of efficiency is the Seasonal Energy Efficiency Ratio (SEER).
- A new generation of heat pumps have been designed specifically for cold climates. Heat pumps lose efficiency when outdoor temperatures drop. Most heat pumps installed before 2010 required a backup heating source or had to be over-sized to provide 100% of the space heating needs. Performance has been improved by using variable capacity compressors with 'inverter' technology. As the outdoor temperatures drop and the first stage or low speed cannot meet the required comfort level, the second stage or high speed activates. Other improvements include more efficient blowers and motors; larger coil surface areas; time delays on controls; and expansion valves to control the flow of the refrigerant more efficiently. These new 'Cold Climate' heat pump systems can supply up to 100% of a home's heating needs without back-up for weather conditions as cold as -20°C which is an improvement over pre-existing air to air heat pumps.

Figure 1 — Air-Source Heat Pump Schematic



Source: "Components of an Air-Source Heat Pump (Heat Cycle)", Natural Resources Canada, 2004. Reproduced with the permission of the Minister of Natural Resources Canada, 2014.

Design/Installation/Operation/Maintenance Considerations

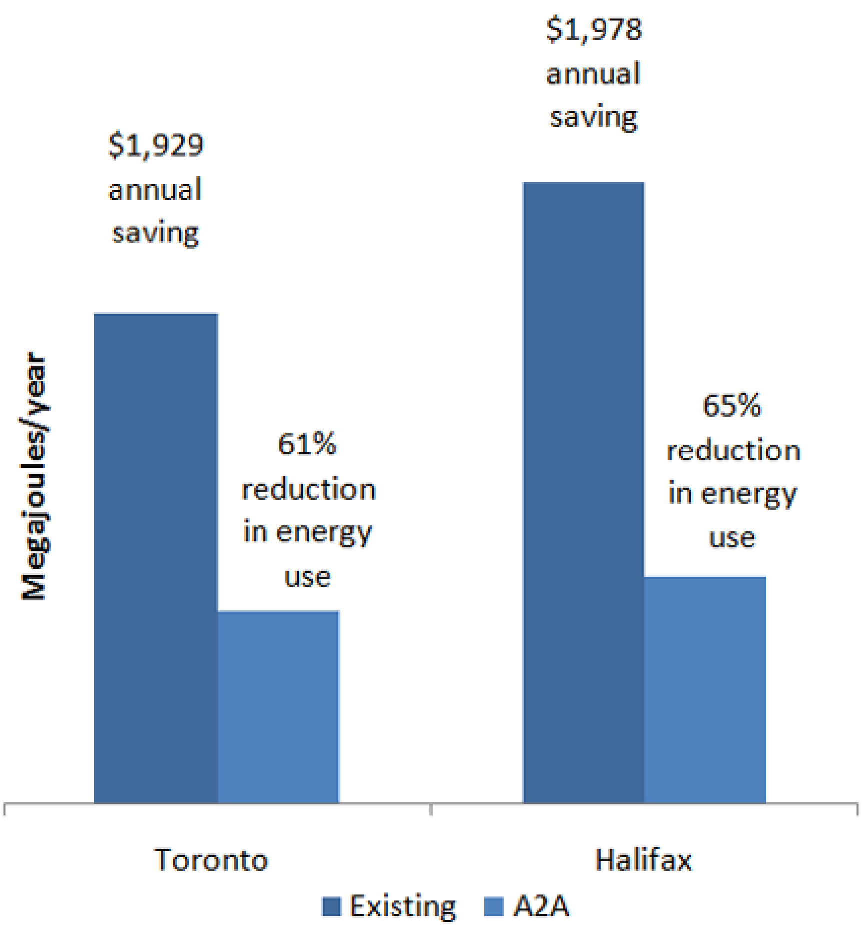
- Professional design and installation is required.
- The outside unit should be located away from prevailing winds, but in a clear area so there is free air flow around the whole unit and it can be easily serviced. Avoid placement under roof drip lines or where the unit may be blocked by snow drifts.
- The outside unit must be installed on a stand so that it is above expected snow depths.
- If the outside unit is to be installed in the side yard between two houses, consider the noise level of the unit to ensure it is as unobtrusive as possible in both neighbouring dwellings.
- The unit must be sized properly to take full advantage of the energy savings and to prevent noise and comfort problems associated with the delivery of the conditioned air to each room. Best practice is to have a room-by-room heat loss/heat gain calculation done to ensure that the heat pump is sized properly for the house. The calculation can also be used to properly size the forced air system (in new house applications).
- Ensure the installation package includes a condensate drain for the indoor coil that complies with manufacturer specifications and local codes, an air filter package, and that all exposed ducts and plenums are sealed to minimize air leakage.
- If the heat pump is an add-on to an existing fuel-fired system, provision must be made for the safe venting of fuel-fired units.
- In colder temperatures, the efficiency of a heat pump goes down. Air-to-air heat pumps are not cost-effective solutions for applications where winter temperatures dip regularly beyond -25°C.
- Look for units with variable capacity compressors, or dual compressors.
- Ozone-friendly R410A refrigerant is used in most current models.
- Ask your installer for all documentation and instruction on how to operate thermostats and any other controls, and what the proper service and maintenance schedule should be.

What Does it Save?

The cost savings associated with the replacement of a conventional furnace with air-to-air heat pump is dependent upon a number of factors including the efficiency, condition and location of the original equipment, energy type and cost, and the climatic region.

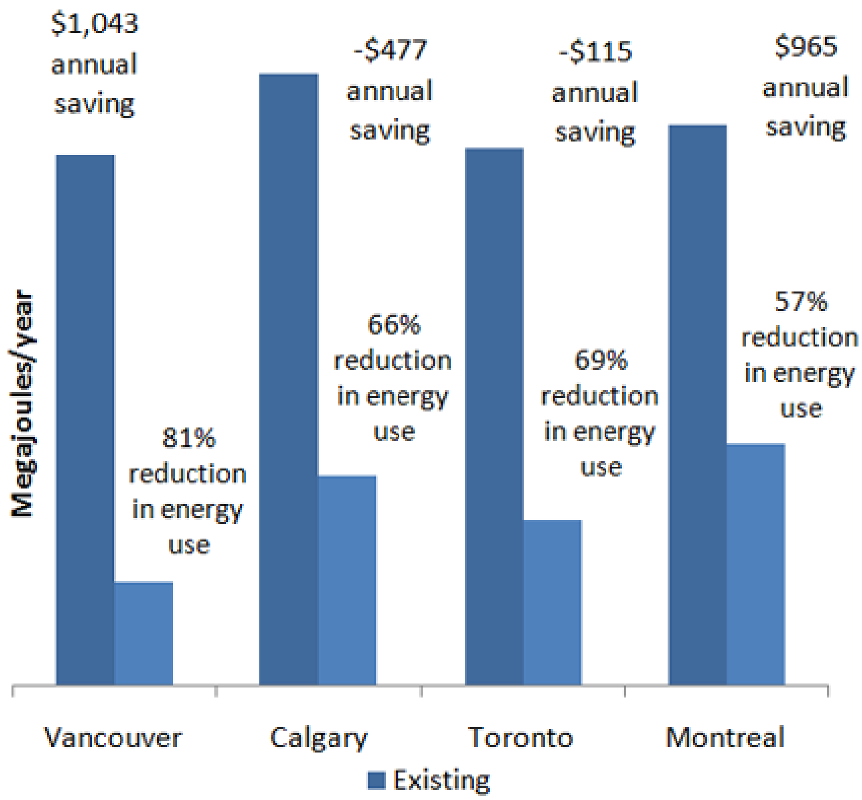
Here is an example of the possible savings a family of four could see with an ENERGY STAR-rated air-to-air heat pump. The example family lives in a 2-storey house built in 1973. The air-to-air heat pump in this example is a 13 kW all-electric unit with a HSPF of 10, and ties into the existing ductwork for a forced-air system. It replaces a mid-efficiency gas or oil furnace, or electric baseboard. In regions where the current cost of natural gas is low and that of electricity is high, the savings are shown as negative, meaning it would cost more to run the heat pump through the winter than a gas furnace. However, the heat pump could supply air conditioning at a much lower cost, resulting in a net annual cost saving. The following tables show the savings associated with space heating only.

Replacing Oil Furnace (83% eff.) with Air-to-Air Heat Pump



Replacing Oil Furnace with Heat Pump (A2A)	Toronto	Halifax
Existing Megajoules/year	104,838	132,668
A2A Megajoules/year	41,033	48,510
% Reduction in Energy use	61	65
$ Annual Savings	1,929	1,978

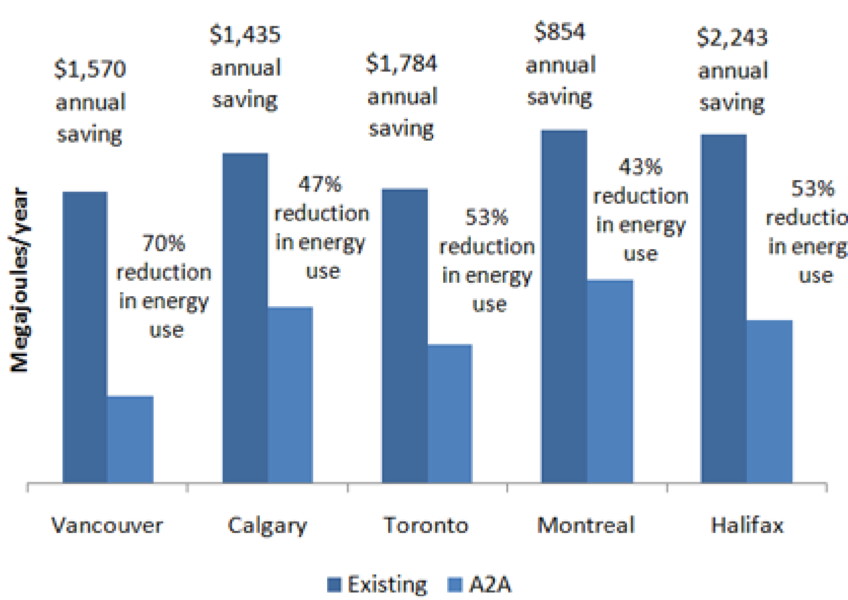
Replacing Gas Furnace (78% eff.) with Heat Pump (A2A)



Replacing Gas Furnace (78% eff.) with Air-to-Air Heat Pump

	Vancouver	**Calgary**	**Toronto**	**Montreal**
Existing Megajoules/year	131,681	151,741	133,575	139,191
A2A Megajoules/year	25,612	52,185	41,033	60,158
% Reduction in Energy use	81	66	69	57
$ Annual Savings	1,043	-477	-115	965

Replacing Baseboard Electric with Heat Pump (A2A)



Replacing Baseboard Electric with Air-to-Air Heat Pump

	Vancouver	Calgary	Toronto	Montreal	Halifax
Existing Megajoules/year	86,400	97,911	87,241	104,734	103,430
A2A Megajoules/year	25,612	52,185	41,033	60,158	48,510
% Reduction in Energy use	70	47	53	43	53
$ Annual Savings	1,570	1,435	1,784	854	2,243

Not applicable in the North because of the proportion of the heating season that is below the low temperature rating.

Figure 2 — Outdoor Condenser Units for Air to Air Heat Pumps

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