OPTIMIZING RETROFIT SUCCESS: GETTING HOMES HEAT PUMP READY

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2023

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Introduction

Why Heat Pumps Should Only Be Retrofitted into Existing Houses After the Building Envelope Has Been Insulated and Sealed Against Air Leakage

Over the last three or four decades, we've learned a lot about Building Science and how to improve the energy performance of existing houses. And one of the most important things we've learned is that the first step in the retrofit process should always be to improve the thermal integrity of the building envelope (walls, foundation, ceiling, windows, and doors) by adding insulation and performing air-leakage sealing. Once that is completed, then upgrades to the mechanical system can be considered.

However, upgrading only the mechanical system, without first attacking the building envelope has some serious limitations.

As we explore the importance of improving the thermal integrity of a building envelope before upgrading the mechanical system, it is crucial to understand the potential drawbacks of focusing solely on mechanical upgrades. While these upgrades can certainly lead to improved energy performance, they may not address fundamental issues related to the building envelope that can significantly impact the efficiency and comfort of a home.

By prioritizing improvements to the building envelope, homeowners can ensure that their upgrades are based on a solid foundation, leading to a more effective and sustainable retrofit process.

Life Expectancy: Heat Pumps vs. Insulation

Heat Pumps are mechanical devices which operate for thousands of hours per year, most of which occurs during winter months when they are exposed to harsh operating conditions. Like all mechanical devices they require periodic servicing and maintenance if they are to operate with optimum performance. Most manufacturers recommend servicing once a year, typically at a cost of a few hundred dollars.

Assuming such conditions are met, they still have a finite life expectancy – generally around 15 to 20 years for newer units. Some units will last longer, although their performance will degrade with time. One industry source suggests that after 20 years, the performance of most heat pumps will drop to 95% of its original value while after 25 years, this figure will be further reduced to 80% (Refs. 1, 2 and 3).

On the other hand, properly-applied insulation (to the walls, basement, attic, etc.) will last the life of the house and requires zero maintenance. Further, little if any degradation in performance occurs over time.

Heat Pump Technology Is Still Maturing

While air-source heat pumps have been in use in Canada for a number of years, their actual performance under real-world conditions is still being assessed.

However, field monitoring to date of actual installations has indicated that their performance may be lower than expected (Ref. 4 and 5). While the reasons for this have yet to be fully established, these results suggest that the technology is not yet fully understood.

Undoubtably, improvements in the technology and how it is implemented will occur. But until then, it should be recognized that the technology is still maturing and could threaten any large-scale implementation program for heat pumps.

Oversizing Heat Pumps Can Reduce Performance

Heat pumps must be properly sized to provide optimum performance. However, sizing depends on the thermal integrity of the building envelope – which basically means how well is the house is insulated and sealed.

If a heat pump-equipped house is subsequently retrofitted with additional insulation and air-sealing, then the heat pump will be oversized and provide less-than-expected performance for both heating and cooling. Oversizing can also reduce the life expectancy of the unit since it will cycle more frequently which takes a toll on life expectancy.

Upgrades May Be Required to the Home's Electrical System

Since heat pumps add a significant electrical load to the house, it may be necessary to upgrade the home's electrical system.

Generally, a 200 amp. service is required. While this is standard in most new homes, older houses often have 100 amp. capacity (or even less). This adds a potentially significant cost to the overall upgrade.

Comfort – A Big Plus for Insulation

Heat pumps provide a secondary means of supplying heat to the house. While they do so at a much higher efficiency than conventional gas, oil, or electric heating systems, they have only a limited impact on comfort levels in the house. A heat pump retrofitted into a cold, drafty house will still result in a cold, drafty house – albeit one which is cheaper to heat.

In contrast, insulation retrofits, coupled with air leakage sealing, will invariably produce a much more comfortable home with more even temperatures and fewer cold drafts.

What If the Power Goes Out for an Extended Period of Time?

If electrical power is disrupted for hours or days, especially now as we're seeing an increase of extreme weather events across the country, a house which is well-insulated and sealed will cool down much slower and make the house much more habitable. While comfort levels may be affected, the house can usually still be occupied.

Heat pumps, since they are electrically driven, provide no such protection when the power goes out.

Domestic vs. Foreign Manufacturing

At present, there is only one Canadian manufacturer of residential heat pumps. The vast majority of heat pumps now being installed in this country are produced in the United States or Japan.

In contrast, virtually all thermal insulation now being used for domestic residential construction is produced here in Canada – creating thousands of jobs. In addition, upgrading insulation and air leakage sealing is more labour intensive than installing a heat pump, producing even more Canadian jobs all across the country.

Industry Capacity

At present, residential heat pumps heat and cool a relatively small percentage of Canadian homes. For example, as of 2016, there were an estimated 767,000 heat pump installations in Canadian homes, mostly in Ontario and Quebec, which represents about 10% of the single-detached market (Ref. 6). A large-scale heat pump program would seriously tax the industry's ability to provide properly-designed, reliable, quality installations.

In contrast, the insulation and air-leakage sealing industries are large and well-established across the country and have the capacity to meet an expanding market. Utilizing their capabilities first would give the heat pump industry the time to ramp up their capabilities in a controlled manner.

Air Quality and Outdoor Noise Transmission

Insulating and air-sealing a house not only reduces the heating and cooling bills, it also improves indoor air quality by reducing the level of outdoor contaminants which enter the house, particularly from the soil (through cracks in the basement) and from attached garages. Likewise, the transmission of outdoor noise into the house is reduced – a major factor in our increasingly noisy world.

Heat pumps have no impact on indoor air quality or the transmission of outdoor noise.

Outdoor Noise Generation

Heat pump compressors generate noise and clusters of heat pumps in a single neighbourhood can increase the ambient noise levels. Given the prior comments about the transmission of outdoor noise, installation of multiple heat pumps in a neighbourhood, without air leakage sealing and upgraded insulation of these houses, may actually increase indoor noise levels.

Will Electrical Utilities Have the Capacity to Power Tens of Thousands of Additional Heat Pumps?

Depending on the electric utility as well as the location, the addition of tens of thousands of new heat pumps could cause capacity issues for some electric utilities since most of this extra load will occur at, or close to, the utility's peak winter design conditions.

Further, if the electric utility uses coal or oil for thermal generation, then the additional heat pumps may actually increase Greenhouse Gas Emissions compared to that which would occur with natural gas heating systems.

In Conclusion

There is no doubt that residential heat pumps have a major role to play in Canada's future. However, upgrading a house by adding insulation and air leakage sealing should always be the first step in retrofitting a house and making it "Heat Pump Ready".

It's just good Building Science and common sense.

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