Shifting Demand:
Yukon Home Heating Trends

Introduction

As the population of Yukon continues to grow, so does the demand for energy, particularly for home heating. This document reports on the results of the *EnerGuide for Homes* evaluation program: several years of data show trends in fuel-shifting and new-home energy use. We also summarize observations collected by experts at the Yukon government's Energy Solutions Centre (ESC) who assist clients with heating system installations and replacements. Overall, this report offers some insight into current trends in home heating and can assist as we predict and plan for the growth of electrical heating demand in the territory.

EnerGuide for Homes

For several decades Yukon has participated in the federal government's *EnerGuide for Homes* (EGH) program. This program provides home owners with a source of properly trained, independent energy assessors to assist in making energy-efficient-retrofit decisions.

The Yukon Housing Corporation (YHC) has been Natural Resources Canada's Service Organization (SO) for delivering home energy evaluation programs in Yukon and northern BC since EGH's inception. YHC has had the opportunity to gather information on client heating choices from approximately 2,800 homes which have had energy evaluations.

On April 1, 2014, the City of Whitehorse instituted the requirement for new homes to have an EGH building plan, *EnerGuide for New Homes* (EGNH) evaluations, and an EGH energy label attached to the home. This resulted in reliable data collection on home heating systems in new construction in Whitehorse.

Collecting and analyzing this data reveals trends in preferred home heating energy sources and is useful in assessing potential future energy demands. It also emphasizes differences between home heating options for new construction and existing homes.

The Energy Solutions Centre

The ESC is the program delivery arm of the Yukon government's Energy Branch. ESC includes a storefront office which sees approximately 1,500 clients per year. These are people applying for rebates under the Yukon government's energy efficiency and Demand Side Management (DSM) programs, as well as asking questions related to energy efficiency and energy use.

"Fuel Shifting" Trend

For at least the past three decades, homes in Yukon have been heated primarily using oil and/or propane, with about a quarter of these using cord wood as either a backup or principal fuel source. Over the past five years, we have noted anecdotal evidence of "fuel switching" from these traditional heating forms to electric based heating. This has been particularly evident in new home construction. This

transition is likely a result of increased traditional heating fuel costs, combined with increased challenges with oil tank insurance, and regulatory requirements and home safety concerns.

EGH data collected over the past decade suggests that new home construction has shifted almost entirely to electricity based heating. New condominiums, townhouses and single detached residential units are being built with electric heating as the preferred system. This is shown in Figures 1 and 2[1]:

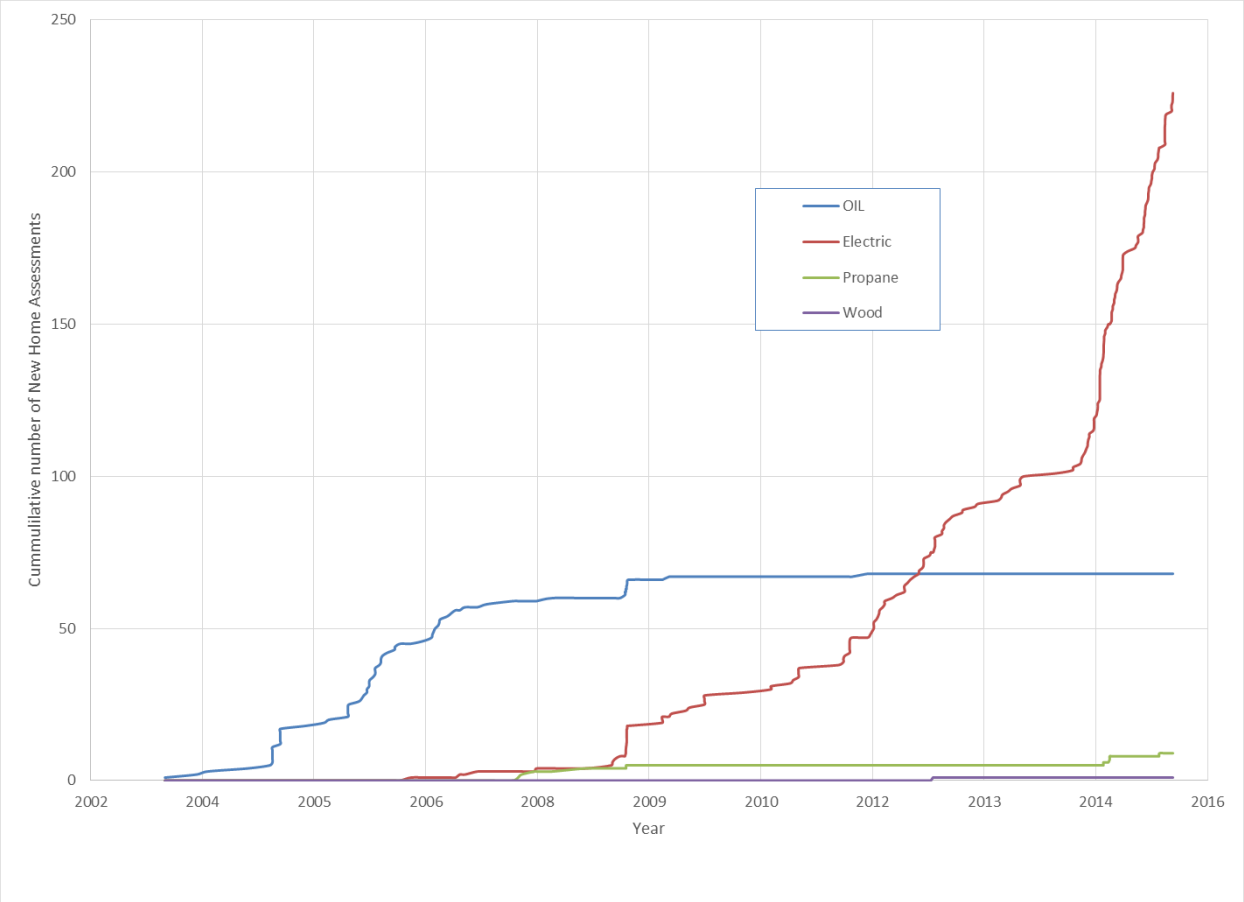

Figure 1: Cumulative Primary Heating Fuel Source: New Homes Assessment (derived from EGH data for new home construction)

[1] This data is known to be somewhat biased toward electric heating and away from wood heating in existing homes, as many home owners (for insurance purposes) will use wood, but cite electricity as their primary source of heat.

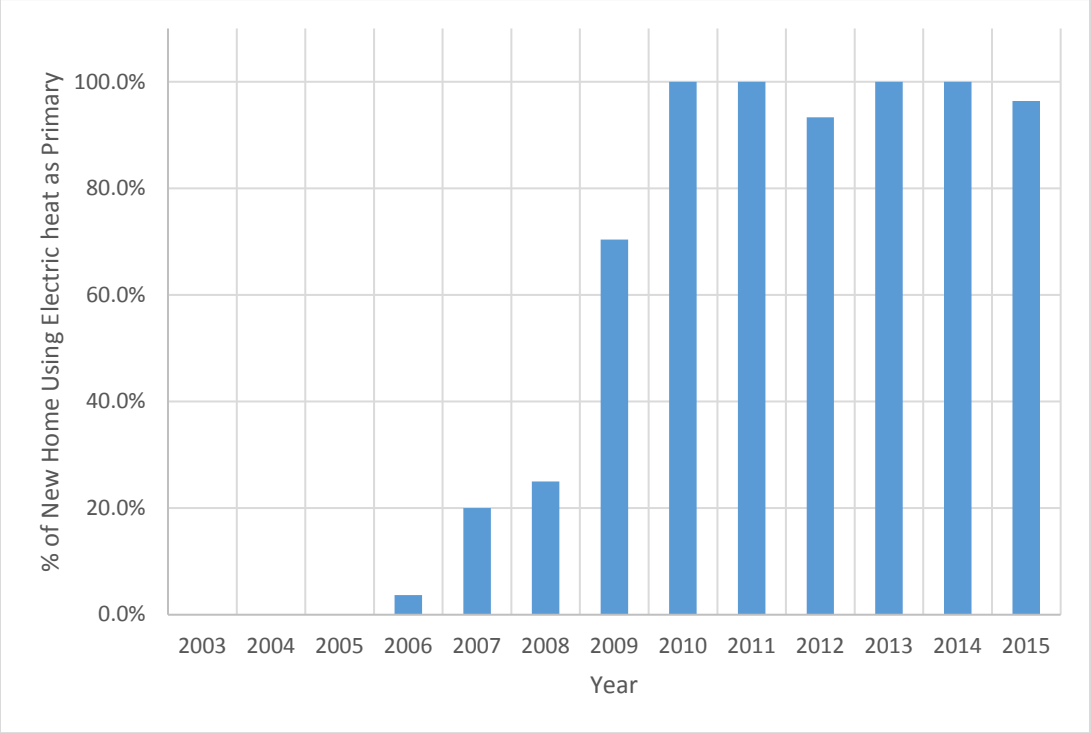

Figure 2: Percent of new homes using electricity as primary heat
(Derived from EGH data for new home construction)

While the trend in new home construction is undeniably towards electricity based heating, data collected from over 2,800 home energy assessments show that most existing homes in Yukon are still equipped with conventional fuel heating systems, particularly oil.

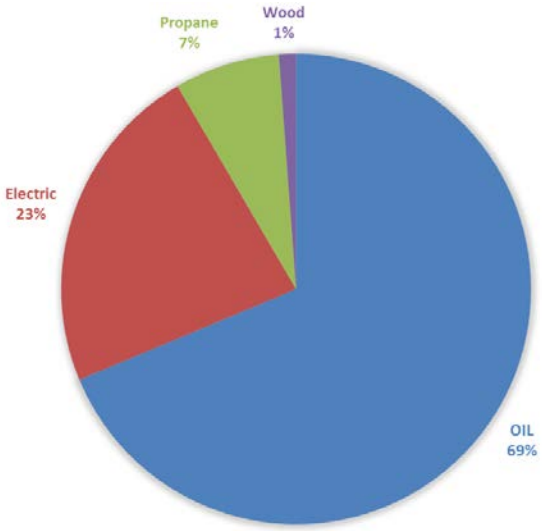

Figure 3: Percent breakdown of primary heating systems based on assessments conducted 1999-2015
(Derived from EGH data)

By examining the available data and exploring the variables around home heating options for existing homes, it is possible to identify some factors which will likely influence the rate of future conversions in existing and new homes away from traditional heating fuels.

Why New Homes are Heated with Electricity

There are likely a number of reasons why new homes are heated with electricity. Some of the primary reasons observed and identified by ESC staff include:

1. Cost: Over the past decade traditional fuels (i.e. oil and propane) have become more expensive, while electrical rates have remained relatively stable. Currently, for the average new home owner, there is little difference in the cost of heating with oil, propane and electricity. Also, the capital costs for installing electric baseboards can be much less expensive than a conventional fuel system.
2. Oil Tank Concerns: Over the past several years, insurance companies and regulators have become increasingly concerned with oil tank leaks and implemented increasingly stringent criteria for oil tanks in residential settings. This has added to costs, and diminished confidence in the technology.
3. Health and Safety: Recently, as a result of improper heating system installation and maintenance, combustion gasses entered a Whitehorse residence and caused the death of a family. This tragic event highlighted the potential dangers of heating a home with hydrocarbons such as oil and propane and may be contributing to a preference for electricity.
4. Decrease in Heating Demand: Most heating appliances have a minimum design size that is significantly greater than the peak demand of new homes, which are built to a very high energy efficiency standard. It can be difficult to find a traditional, primary heating appliance designed for this decreased heating demand. Electric-based heating is easily scaled down to meet smaller, modern demands.
5. Environmental Considerations: Amongst Yukon population, there are those who see heating with electricity as an environmentally ethical choice, since most of the territory's electricity is generated from hydro, which is renewable.
6. Space Considerations: Choosing to heat with electricity can save space, as electric heating appliances typically have a much smaller footprint than traditional heating appliances.

Barriers for Existing Housing to Shift to Electric Heat

While there are a number of reasons for the shift to electric heating and the data shows that new home builders are consistently choosing electricity as their primary heating source, ESC has identified some barriers to existing homeowners shifting to electric heating.

More than just cost per liter: variables that influence decisions

A heating system is a significant financial investment, and sometimes timelines are tight, so homeowners without expertise rely on others for information and advice. The options can be overwhelming and homeowners may feel ill equipped to decide which heating system is best.

Fuel cost is one of the considerations when evaluating the financial and social factors of home heating choices. Over the past several years, the cost of heating fuels has varied and each of oil, propane, and electricity has had a turn at being the most economical. For conventional heating sources, wood based

heating is consistently the lowest cost fuel in the territory, but requires a significant amount of work on the homeowner's part.

Additionally, there are capital costs for repairing or replacing home heating systems. Electric heating appliances are often less expensive than conventional heating appliances, but other factors that influence decisions include:

- State of current heating system (including chimney and fuel tank)
- Current home's electrical system ability to support electric heating
- Utility service ability to facilitate significantly larger electrical loads
- Contractor advice (typically biased towards traditional heating sources)
- Awareness and willingness to investigate alternate options such as electric, which requires a different procedure than replacing conventional fuel systems
- Uncertainty about electric rates
- Concern for environment

If a homeowner takes the time to get multiple quotes, they are likely to get a variety of opinions and options to consider. Opinions on what works best for the layout of the house, the current system in place, and the relative condition of the parts of the system are assessed by an expert contractor. An aging oil furnace system may be working well, but have a chimney that needs replacing. Although replacing the chimney may seem like the cheaper option, the whole system may eventually fail. There are many factors to consider and a homeowner's tolerance for risk and uncertainty plays a part in decision-making.

What does it take to switch to electricity?

Switching from a conventional fuel source to electricity involves several steps, as well as several third parties.

1. To have electricity serve as a primary heating source, a medium to large home must have a 200 amp panel. Most existing homes have 100 amp service only. The upgrade cost is approximately $5,000.
2. Next, homeowners must call their local utility to discuss their plans with a staff engineer, who will visit the location and determine whether any upgrades to the transformer are needed. The utility will often cover the cost of upgrading the transformer, but the costs for cable upgrades or connection materials are borne by the customer. The engineer will advise the homeowner of any costs that might be expected.
3. An electrical inspector can be contacted in advance for opinions on potential costs or considerations for a change in heating system. Once the system is installed, the inspector will be responsible for ensuring the system meets current code requirements and issuing a permit for it. There is potential for the discovery of outdated wiring or other unexpected electrical issues, especially in older homes, which may add to the cost of switching to electric heat.

The Future of Electrical Demand in Yukon

Despite the dramatic increase of electrical home heating systems in new construction and the overall increase in electricity demand, space heating demand is generally decreasing, as shown in Figure 5. However, as time goes on, more new construction favouring electric heat will increase annual demand for electricity (as seen above). There have been over 500 new living units constructed in Whitehorse

since 2013 (202 single family dwellings and 209 multi-family units), all with electric heating systems. If the trend persists, new construction will add over 100 new living units each year, in Whitehorse alone, and most of those will be electrically heated. In 2015 the average heating load of a new home was approximately 10,000 kWh/year; however, both heating demand and other electrical loads are likely to continue to decrease over time. Based on this analysis, an overall decrease in heating and non-heating electrical demand of approximately 25 per cent would result in new homes having an overall electrical demand (including heating) that is comparable to existing homes built between 1960-1980 with non-electricity based heating. Based on data collected through the EGH program, this is not an unrealistic expectation. This data shows nearly a 30 per cent reduction in home energy demand from homes built in the 2000s to homes built today.

Decade Built	Average Electrical Consumption (MJ/Year)	Total Home Energy Consumption (MJ/Year)	Average Space Heating (MJ)	% Total Home Energy relative to previous Decade
pre-1950	62,291	193,520	140,860	
1950s	56,388	190,693	137,791	-1.46%
1960s	57,696	191,767	138,659	+0.56%
1970s	65,280	176,164	123,197	-8.14%
1980s	63,020	167,917	114,504	-4.68%
1990s	57,541	153,103	98,173	-8.82%
2000s	64,287	134,506	80,170	-12.15%
2010 to present	90,437	95,673	40,609	-28.87%

Figure 4: Average electrical consumption based on decade home was built
(Derived from Home Energy Assessment data (n=2800) collected by Certified Energy Assessors)

Similarly, each year existing homes will need heating system upgrades but until there are fewer barriers to switching away from conventional heating fuels or a significant increase in the cost of conventional heating fuels, they are less likely to contribute significantly to the overall electric demand projections.

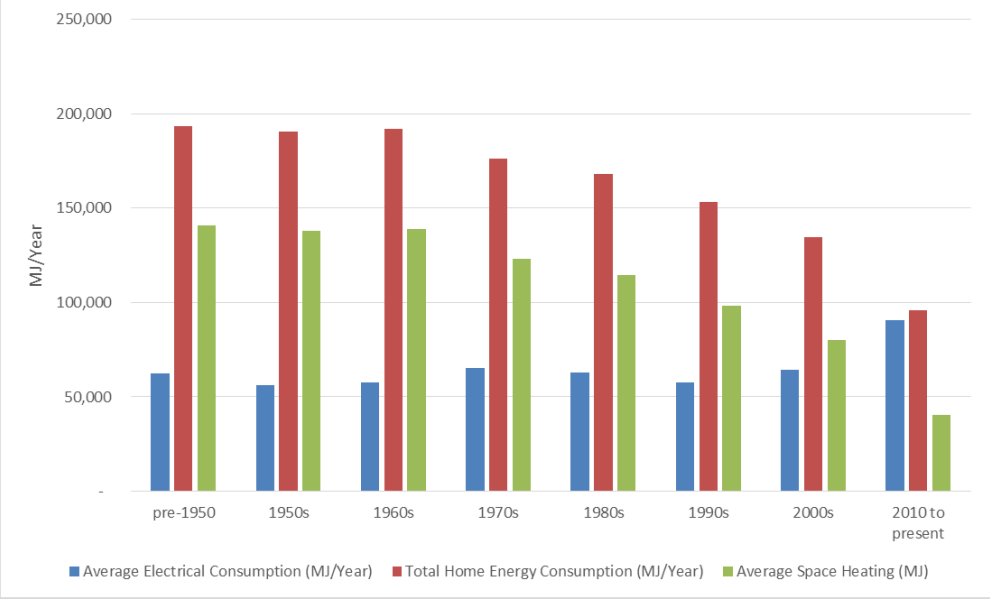

Figure 5: Average annual energy use by decade in which home was constructed
(Derived from Home Energy Assessment data collected (n=2800) by Certified Energy Assessors)

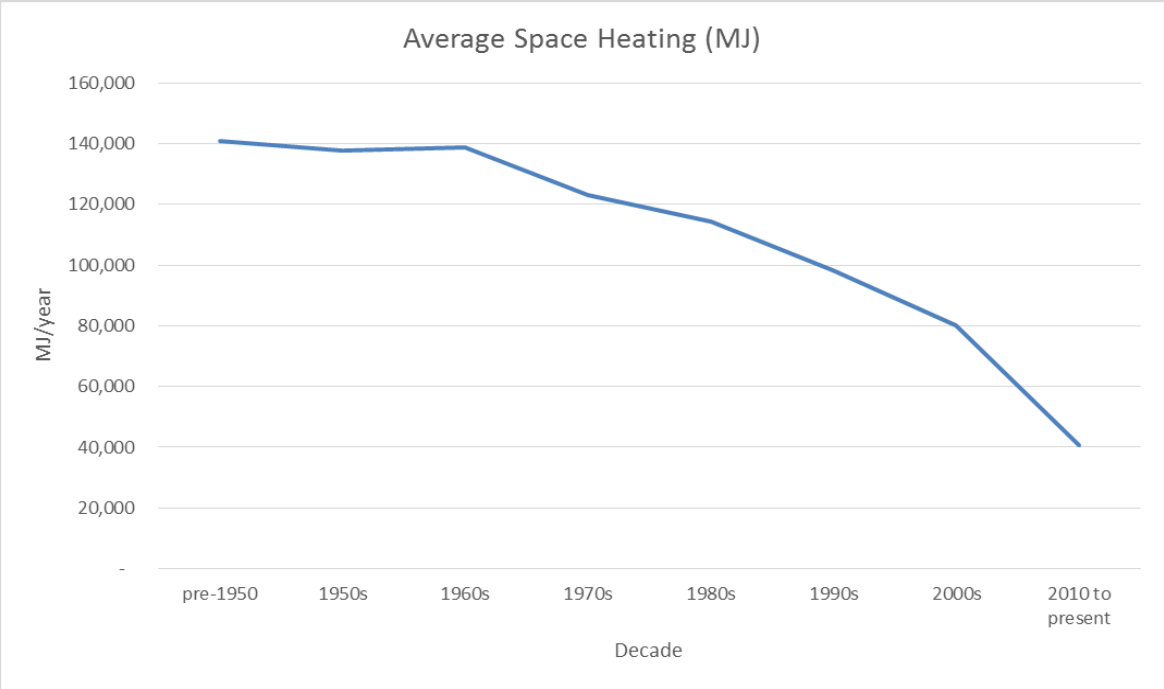

Figure 6: Average annual space heating demand by decade in which home was constructed
(Derived from Home Energy Assessment data (n=2800) by Certified Energy Assessors)

Assuming a trend of between 75 and 125 new homes per year the follow estimate of load growth is projected assuming modest energy efficiency improvements of 2 per cent per year.

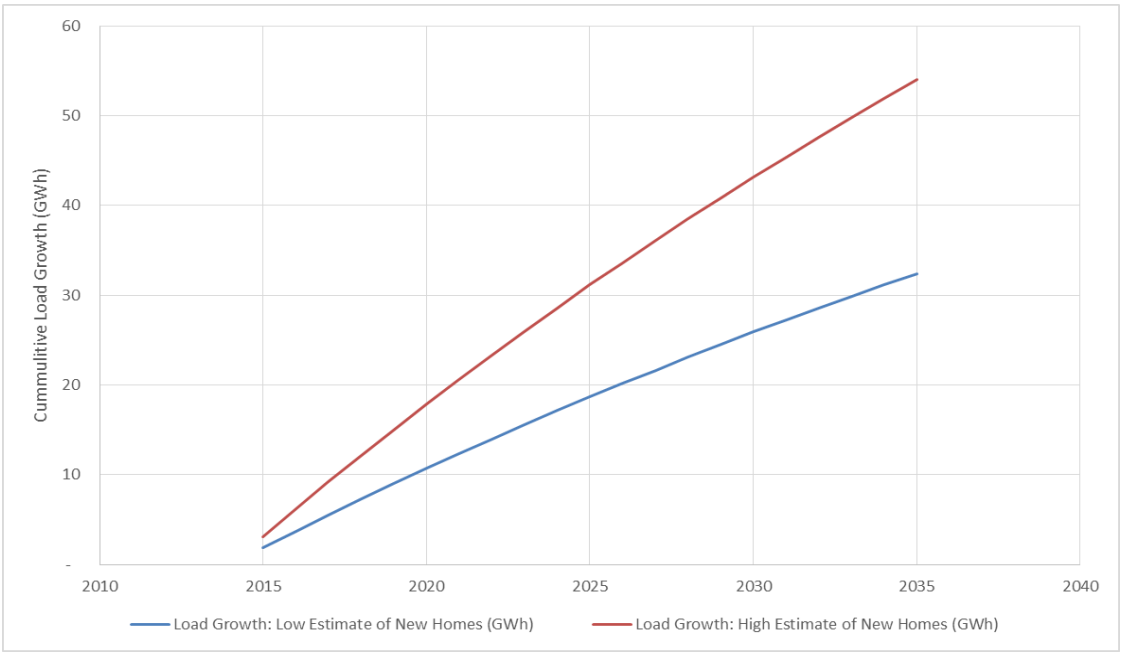

Figure 7: Estimate of cumulative load growth
(Derived from Home Energy Assessment data (n=2800) collected by Certified Energy Assessors)

It should be noted that this analysis in no way attempts to estimate the expected implications of electric heating on annual peak demand. It is expected that demanding large amounts of electricity for heat could substantially increase electrical peaks and costs associated with accommodating those peaks. Some technologies are currently available to assist in mitigating the effects of heating demand on diurnal peaks (i.e. thermal storage technologies), however seasonal peak shifting will present a more significant challenge to utilities.

Other Considerations: Biomass Heating, Air Source Heat Pumps and Electric Space Heating

As the data presents, it is clear that Yukon home owners are engaging in a transition away from traditional heating fuels. Electric heating is playing a big part in this transition and will likely continue to be a key option for new homes as well as super energy efficient retrofits of existing homes.

It is worth noting that there are other heating options likely to make up part of this transition. The main source that is likely to play an increasing role in the Yukon's residential heating market is biomass. Wood heating has always made up a portion of the Yukon's heating market. Unfortunately the wood heating industry is poorly documented in the territory (statistics are limited). Based on (relatively old) survey data we know that approximately 25 per cent of homes heat with cord wood. ESC has also seen a significant increase in clean burning cord wood and pellet stove installations in the territory over the past several years (i.e. based on Good Energy Program rebate applications). Unfortunately many of these homes will, for insurance purposes, choose to formally list electricity or oil as their primary source of heating, making data integrity a challenge.

Both cord wood and wood pellets consistently cost significantly less than conventional heating sources including electricity. Until now, the barrier to adopting biomass systems is likely inconvenience; however, advances in pellet based heating systems may eventually facilitate the uptake of this technology. It is also likely that home owners may choose to combine biomass and electricity based heating: biomass heating is inexpensive and can meet large heating demands, while electric heat is extremely reliable and simple to install, operate, and maintain.

Pairing biomass with electric heating may also improve the seasonal load discrepancy in Yukon: electric heating could be encouraged (i.e. incentivized) during spring and fall, and biomass heating could be used during the colder months, when electrical demand is at its highest.

In addition to biomass heating, innovative technologies such as Air Source Heat Pumps (ASHP) may also play a role in changing home heating. These devices are highly efficient electric heaters that may prove to be a more appropriate source of electric heating for homes with large heating requirements (and even air conditioning needs that may occur as part of a changing climate).

Conclusion

At this time, it is appropriate to expect that nearly all heating needs for new home construction will be met through electricity. In estimating the impact of electricity based heating from new homes on energy demand, it is important to recognize the significant energy efficiency advancements in residential building envelopes and other efficiencies that are resulting in significant decreases in overall demand.

Existing homes will still largely remain reliant on conventional (non-electric) heating technologies. Until there are significant decreases in the cost of electricity (or significant increases in the cost of conventional heating fuels) to compensate for necessary home upgrade costs, existing homes are more likely to continue to use conventional fuels for heat. New homes are likely to continue to favour electric heating. It would be wise to project an expected increase in electrical demand overall, with an increasing proportion of the home heating market contributing annually.

In longer term planning, the potential for alternative heating technologies such as biomass and ASHPs may also play a part in the transition away from conventional heating fuels.