HOME ENERGY AUDIT REPORT

Nov. 2, 2011   **248 Southgate Drive, Bedford NS**

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EXECUTIVE SUMMARY

This report presents the results of an energy assessment of a residential building, 248 Southgate Drive located in Bedford, Nova Scotia and owned by Andrew Holley. The assessment was completed as part of the Energy Efficiency in the Built Environment (EEBE) project, a collaborative venture between students and faculty from The Netherlands, Ireland, and Nova Scotia. The students that participated in the energy assessment for the Bedford house were: Arwin Hidding from Hanze University in Groningen, Netherlands; John Booth from the Institute of Technology Carlow, Ireland; Fin MacDonald from NSCC Annapolis Valley Campus, Nova Scotia; and Sarah Mitchell from NSCC Waterfront Campus, Nova Scotia.

The onsite audit for the project took place on Monday, October 24th, 2011. The participating students utilized a number of tools such as a thermographic imaging camera, air quality sensors, blower door test equipment, and high quality DSLR camera to record detailed observations about the home that would affect its energy performance. Using provided drawings of the home in AutoCAD as well as information about the home obtained from the audit, a computer program HOT2000, was used to complete an energy profile of the household.

Based on the data obtained from both the onsite audit and HOT2000 model, a series of analyses were made, and research conducted, in order to determine areas of the home where greater energy efficiency could be achieved.

The following report will provide a detailed description of the building envelope and systems, followed by an outline of the methodology used to obtain the information necessary for a complete energy assessment. The report will then follow with a section discussing the recommendations for various low cost and high value solutions that can help achieve energy efficiency and savings in the home. It will conclude with a summary of the savings that can be achieved if all recommended technologies and retrofits are implemented. Appendices with all relevant data and graphical representations are included at the end of the report

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BUILDING AND SYSTEMS DESCRIPTION

Design and Use

The home belongs to Andrew Holley, who resides in the home with his wife and one child. It is located at 248 Southgate Drive in Bedford, Nova Scotia. The home is situated in a residential area on a beautiful lot with lots of solar access and mature pine trees located in the back.

The home was designed and built by Andrew's company Integrity Homes. It is a modern home constructed in 2005. It was configured to harness the natural light available on the site through south-facing orientation of the rear of the house

Building Envelope

The wall construction for the exterior walls is 2x6 studs 16" on center. The walls are filled with R20 fiberglass batting insulation. There is a layer of OSB 7/16" thick. The front walls are brick on the exterior, while the rear and sides of the house are covered in vinyl siding.

The roof construction is also 2x6 studs 16" on center. They are filled with R50 blown in cellulose insulation. There is a vented attic and engineering roof trusses support a 5/32" layer of OSB. The roof is covered with tarpaper and asphalt shingles.

All the windows in the house are double paned, low e-coated, and argon filled. They are also operable, and can be used for natural ventilation. All of them have blinds to block unwanted solar gain except the large window in the dining room on the rear of the house.

There are three doors to the outside; one in the front, one in the rear, and one in the garage. All three are metal doors with an insulated core. The rear door is approximately 85% glass.

The envelope is tight, and the blower door test revealed a leakage rate of 1.32 air changes per hour (Appendix D).

Heating, Ventilation, and Air Conditioning

The house is equipped with a Fantech SHR1504 heat recovery ventilator, which provides 77 cfm of fresh air to the household. There are also mechanical fans in all three bathrooms that operate at a sound level of 71 dB.

A Lennox 13HPX air source heat pump is used for ducted heating and cooling. The heat pump is able to provide heat until -5°C. Once the temperature drops below this point, the heat is provided by a Lennox ECB29 electric furnace. There is also a 60,000 Btu propane fireplace in the living room. This unit is oversized

and not very efficient. It is only used for space heating in the dead of winter when temperatures are extremely low.

The hot water is provided by a Giant brand electric hot water heater that is not energy star rated. The capacity is 63 gallons.

Appliances

The home features two fridges, a freezer, an oven/stove combination, a front-loading clothes washer, clothes dryer, and a dehumidifier. The appliances are all new and most had an energy star logo visible.

Lighting

Lighting is available in every room. Task lighting is available in most of the rooms, which allows the occupants to only light the space they are currently using. There is a mixture of incandescent, compact fluorescent, and halogen bulbs in the house. Because of the homes orientation, there is a great deal of natural lighting that is available at the south-facing rear of the house, which reduces the lighting load.

METHODOLOGY

Utility Data Collection

We collected energy information in the form of utility data for the years 2008 and 2010. 2009 was not available from the home owner. We organized the data in a spreadsheet and used benchmarking methods developed by Natural Resources Canada. We developed a Building Energy Performance Index (BEPI) and Building Energy Cost Index (EBCI). We collected weather data from Environment Canada to help us normalize the data using heating degree days. With two years worth of data we were able to see how the energy performance and energy cost shifts with a change in heating degree days.

Further analysis was done using the Energy Monitoring Targeting and Reporting Tool version 2.1 developed by TdS Dixon Inc. Using this tool we compared energy consumption to the weather data to determine the relationship between heating degree days and energy consumed. We calculated the line of best fit as well as the R^2 regression value. We also developed a cumulative sum chart using the same tool, which graphs energy performance over time.

Building Modeling

An energy model was created using HOT2000 to determine the energy load of the building (Appendix A). A skeleton model was built using the AutoCAD drawings and it was enhanced with data we collected during our site visit. The model was used as a tool to evaluate some of the energy savings measures we recommend.

RETScreen was also used to determine the payback period of the capital intensive energy savings measures that we recommended. RETScreen provides enhanced payback information that allows us to account for factors such as the inflation rate, fuel cost escalation rate, as well as the project life.

3D Modeling

The plans that were provided were originally given in AutoCAD format (Appendix M), and were then imported into Revit. The floor plans were used to determine where the walls had to be placed, and the 3D Revit model was transferred to Google Sketchup. The main floor and the first floor were added to the model, and once all the walls had been drawn in Sketchup, the terrain was added into the model by comparing the side views. In this way, the height of the terrain around the building could be determined.

The CAD drawings that were used were in the imperial system, and so the drawings were converted to metric. At the end of the build, the model was scaled to the right dimensions. The margin of error is approximately 14 mm for the walls.

When the windows were added, the building started to take shape. One window was made to be the correct size. This window could then be used to make all other windows by copying the component to the appropriate places in the building. The heights and lengths that were used were taken out of the AutoCAD drawings. The doors were modeled as well and added to the building.

To make the model appear more like a real building, materials were added. The model was then rendered using Indigo renderer, a program that could be used in combination with Sketchup. Changes were made in materials, colours, and settings in the program to make the building look as realistic as possible.

Finally, a screenshot was taken from Google street view of the area around the building. The rendered image of the building was then Photoshopped into the residential street where the home is located and the result is a jpeg of the street with Andrew Holley's house (Appendix L).

On Site Audit

Our onsite audit was organized using several checklists that we developed prior to the visit. We collected detailed information about the heating system, cooling system, domestic hot water system, and the ventilation system. We also collected an inventory of windows, doors, lighting, and appliances. We limited our inventory to items that we need for our energy model, or identified as problematic to the energy load. This was done to reduce the complexity and effectiveness of the data collection. Several checklists were prepared to assist with the audit (Appendix O).

We used several tools to help us conduct our audit. A thermographic imaging camera (Figure 1) was used to search for areas of heat loss. We used this to check for missing insulation as well as thermal bridges. We also used
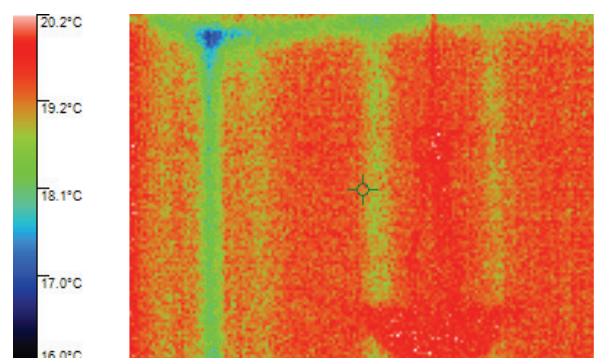

Figure 1: Thermal imaging picture showing thermal bridging at the wall studs.

air quality sensors to test the humidity, temperature, and CO_2 concentration. This gave us an idea of the effectiveness of the ventilation system. A sound meter was used to record the noise levels of the fans in the bathroom. We were also armed with a very good camera, which we used to take images of everything we thought was important (Appendix P). A blower door test was performed to determine that amount of air changes per hour (ACH) (Appendix D).

Interview

An interview with the homeowner was conducted to obtain more detailed information in regards to energy and water usage, as well as any issues the owner has observed in the household operations (Appendix N).

DATA ANALYSIS

Building Energy Performance Index

The BEPI shows a decrease in energy consumption between 2008 and 2010 (Figure 2). This is due to a decrease in heating degree days between 2008 and 2010. The proportions of the changes are similar enough for us to conclude that the heating system is able to adapt well to colder or milder winters.

Household energy consumption in 2008 was 21,995 kWh and in 2010 was 18,857 kWh. When this is normalized with weather data we get 23,134 ekWh in 2008 and 21,317 ekWh in 2010 (Appendix E). Our HOT2000 model calculates the auxiliary power required each year to be 80,826 MJ (Appendix A), which translates to 22,451 kWh per year. This number lines up with the normalized actual consumption and proves the accuracy of our model.
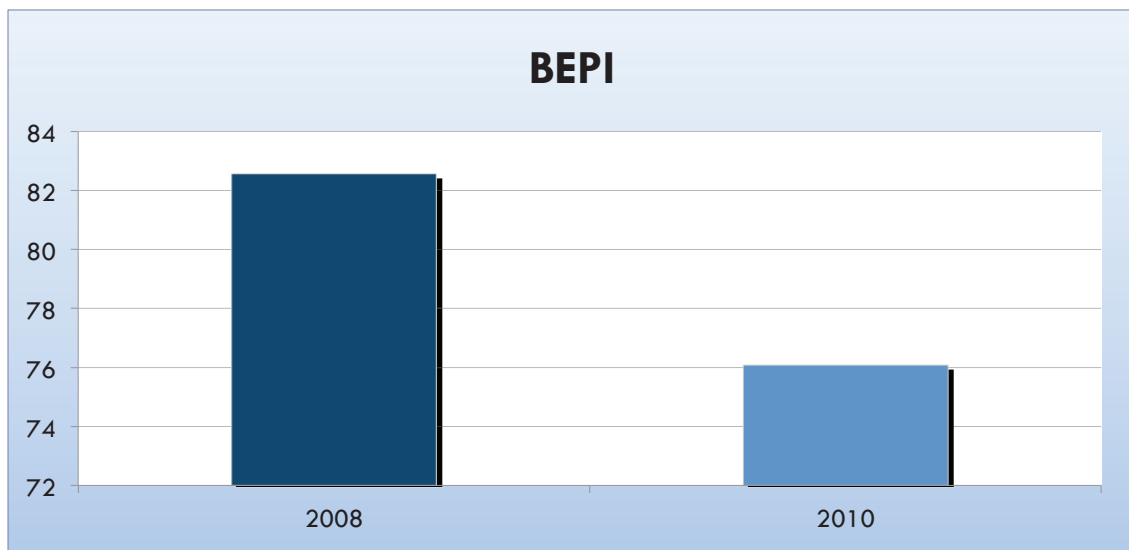

Figure 2: Building Energy Performance Index measured in kWh/m²

Linear Regression Analysis

The regression analysis of electricity and heating degree days (Figure 3) shows a line of best fit with an $R^2 =$ 0.819 (Appendix G). The closer this value is to 1 the more accurate the line of best fit will be. This indicates that there is a good correlation between outside temperature and electrical energy usage. Our Y intercept is 25 kWh per day, which is our electrical base load. This number will be used in our HOT2000 model. The slope of our line is 2.8 kWh per heating degree day. The entire report is available in the appendix (Appendix G) and the 2010 data is labeled 2009 in order to make the tool work properly.
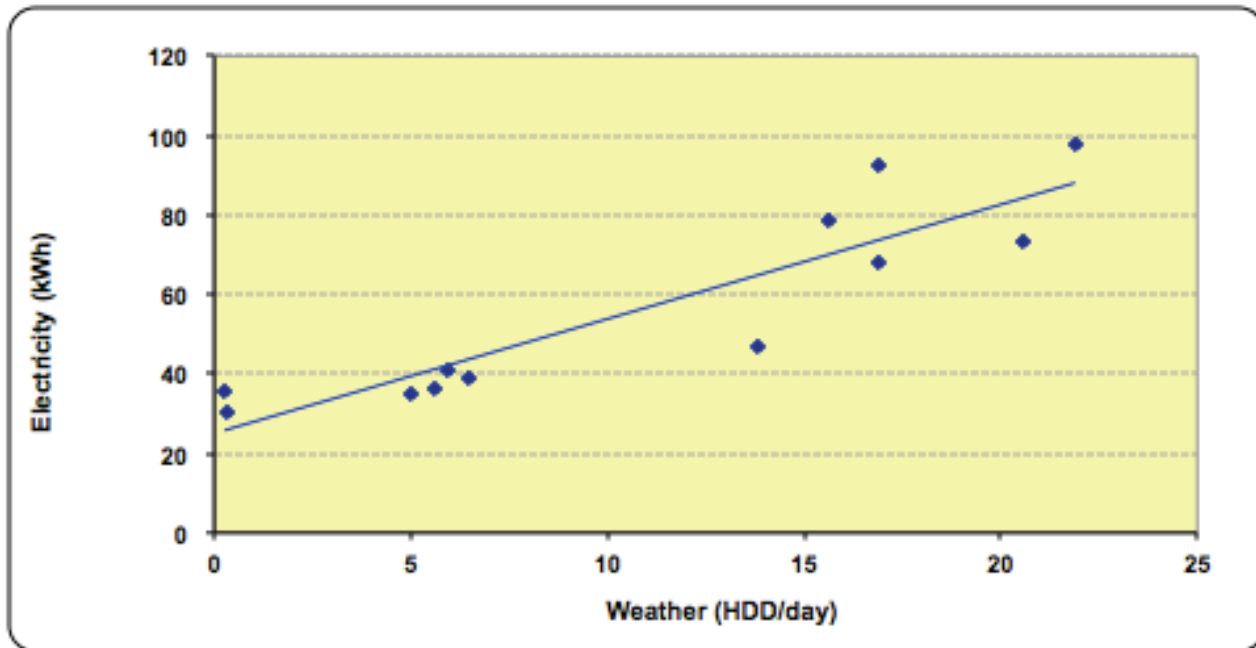

Figure 3: Regression Analysis showing line of best fit.

Cumulative Sum Analysis

Our cumulative sum chart (Figure 4) shows that there has been uniform energy consumption during the period we analyzed. Each month represents a two-month billing period. If there were any shifts in the slope of this line we would know that something happened to impact the energy efficiency of the building, for better or for worse. We can use this same chart in the future to assess the effectiveness of any energy savings opportunities that are implemented. The entire report is available in the appendix (Appendix H).
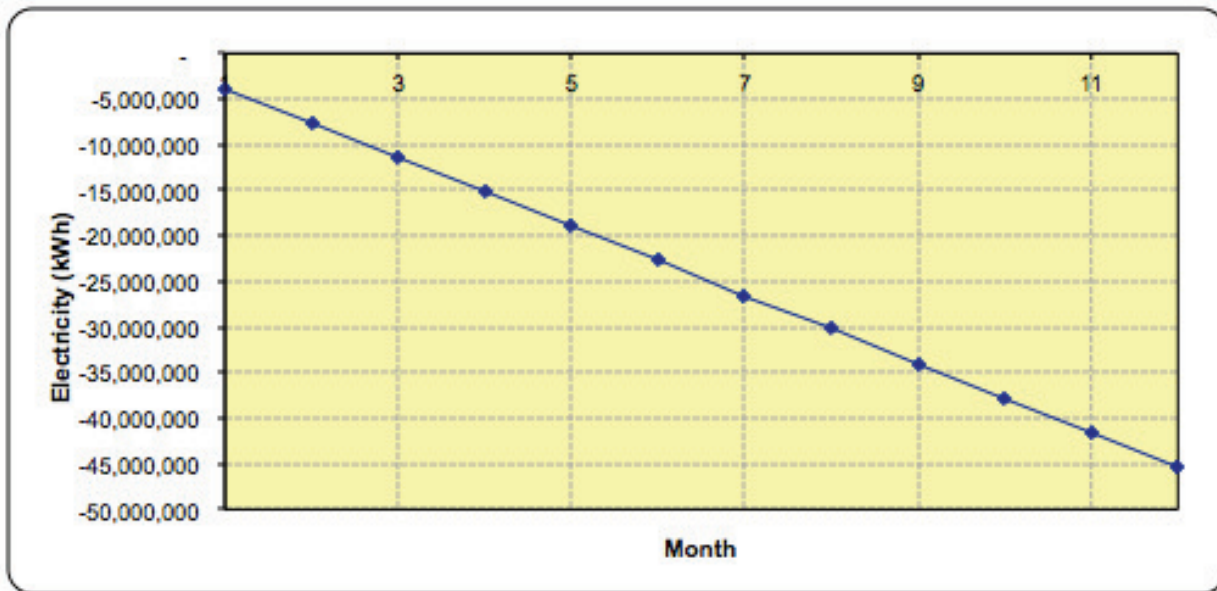
Figure 4: Cumulative Sum Analysis

DISCUSSIONS AND RECOMMENDATIONS

The following section will discuss the different components of the home that represent areas where energy consumption is significant and can be addressed. Opportunities for achieving energy reduction and efficiency will be described for each area. The recommendations for energy saving are organized into two categories; low/no cost savings opportunities, and capital intensive/high value savings opportunities, both defined in terms of energy and finances.

Household Energy Management

The first step towards your household's energy independence is to engage the occupants in energy management. It is one thing to make recommendations and implement certain technological system. However, there is evidence that points to the fact that if occupants are not engaged in efficiency then these new upgrades could yield inadequate result. Being mindful of energy efficiency measures, such as turning off the lights in an unoccupied space, can save more money alone then implementing technology that occupants don't know how to use (Figure 5).
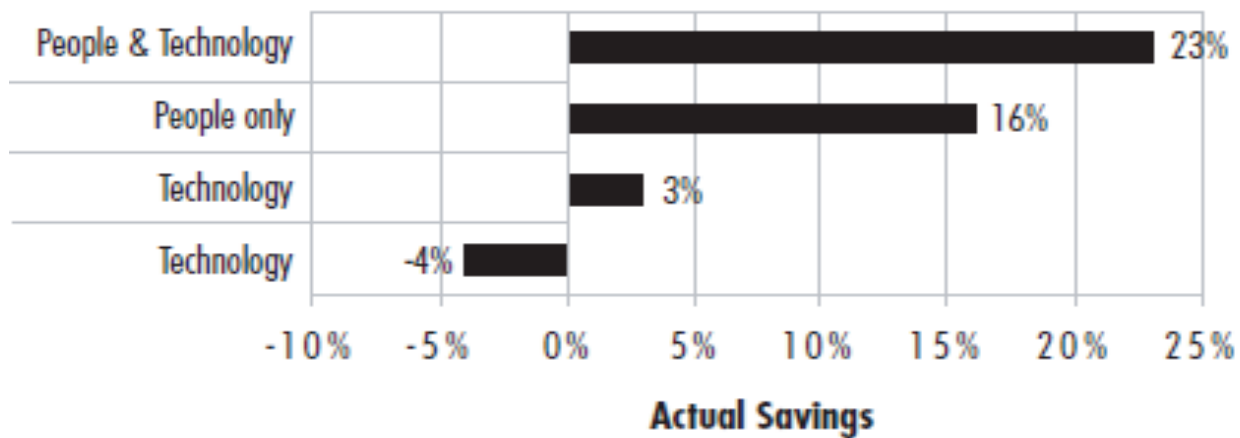
Figure 5: Energy savings associated with people and technology. (Image Source: Natural Resources Canada's Dollars to Sense: An Introduction to Establishing an EMP)

Low Cost / No Cost Energy Savings Opportunities

Installation of Energy Efficient Light Bulbs

Lighting typically represents about 15% of total electricity use in a residential building (Yudelson, 2010). The type of light bulbs installed in the home can have a significant impact on the amount of electricity consumed, and offer a chance to create savings through the replacement of inefficient lighting.

An opportunity exists to replace the incandescent light bulbs in the house with energy efficiency compact fluorescent bulbs (CFLs). Incandescent light bulbs have a low initial cost, but are not energy efficient; only 4% to 6% of the energy that goes into the fixture produces light, and the rest is dissipated as heat (Natural Resources Canada, 2006). CFLs can fit traditional sockets and give off the same amount of light as a traditional incandescent light bulb, but they consume up to 75% less energy and last up to 10 times longer than traditional incandescent bulbs (Natural Resources Canada, 2006). In addition, the halogen pot lights can be replaced with energy efficient LEDs. Efficient light bulbs are used already in some areas of the house, but not others. Information was collected on which bulbs are not efficient. The assumption was made that all the lights involved are used for one hour each day of the year when determining the savings associated with this opportunity. The standard residential rate of $0.12 per kWh is used for calculating the dollar value. A table showing the calculations is available in the appendix (Appendix I).

Retire Second Refrigerator

Retiring older models of energy inefficient appliances is a simple and cost-free solution to achieving energy savings in a household.

In addition to the main refrigerator in the kitchen, the house has a second refrigerator in the garage, which could be retired to save money. There is no energy star rating on the second refrigerator. Efficiency Nova Scotia estimates that taking a second refrigerator out of commission will save a homeowner $125 annually,

which translates to over 1000 kWh of electricity each year (Appendix I). A representative from Efficiency Nova Scotia will even come haul the appliance away for you and pay you $35.

Hot Water Insulation Blanket

A very simple and cost-effective way to achieve increased efficiency and energy cost savings with a residential hot water heater, without making upgrades to the system itself, is through the use of a hot water insulation blanket (Figure 6). A common and costly energy waste associated with the storage tanks of water heating systems is standby heat loss, which is the unused water that requires reheating for future use and can account for 20% of total water heating loss (Lower-My-Energy-Bill, 2011). Insulation blankets, which are relatively inexpensive, are designed to provide additional insulation to water heating storage tanks and can attain significant energy savings.

By investing in a blanket with an R-value of 19, an energy saving of 579 kWh can be achieved, leading to an annual energy cost savings of $68.89 (Appendix J). The investment payback for a Thermwell Products Fiberglass R19 Equivalent Water Heater Blanket, at a price tag of $20 from Home Depot, would be 3.5 months.

Figure 6: Hot water tank with blanket (Image source: Homedepot.com)

Use of Programmable Thermostat

There are conflicting views over the energy and cost savings of thermostat setback versus maintaining a constant temperature in a household. Some homeowners are in the practice of turning down the heating on a thermostat in winter when they are not home, or at nighttime, whereas others maintain a consistent ambient temperature throughout the day and night. This decision is predicated on the belief that it uses more energy to bring the temperature in a household back up to comfort level from a setback temperature, than it is to maintain a constant temperature. These are the views held by the homeowner. However, numerous experiments and field tests have proved that significant energy savings can be achieved, in some cases up to 30% for heating

systems (Moon & Han, 2011). It is a common misconception that it takes more energy to heat up a cold house than it does to keep a house warm all the time. Turning down the thermostat will always

Figure 7: Lennox Signature Stat programmable thermostat at the house

save energy (Moon & Han, 2011). Heat moves from hot to cold, and the rate of heat transfer increases with greater temperature differences between inside and out (Moon & Han, 2011). Smaller temperature differences between the house and outside generally means less heat will be lost from inside the house to the outside. Therefore, there will be greater energy savings by only heating or cooling as much as necessary, for the occupants and time of day.

Proper thermostat strategies, such as changes in setback period, set-point and setback temperature, demonstrate gains in energy efficiency in residential buildings. Studies have shown that compared to a no-setback method that employs constant system operating ranges, nighttime setback and night-and-day-time setback methods saved significant energy annually for heating in cold climates, without diminishing occupant thermal comfort (Natural Resources Canada, 2006).

The homeowner has a Lennox SignatureStat programmable thermostat (Figure 7) installed in the home, which allows the user to program different temperatures for various setback periods throughout the week and on the weekend. However, the SignatureStat thermostat is constantly set at 20 C for heating in the winter, and 18 C for cooling in the summer. Using the EnergyStar savings calculator for programmable thermostats as a base, which assumes a 5.4% savings per degree-Celsius of setback (Natural Resources Canada, 2006), it was calculated that the energy savings by turning back the thermostat 5 C at night during heating months would be 3601 kWh. This equates to an annual cost savings of $435 (Appendix I).

Air flow in Furnaces

A key issue that can arise with forced air heating systems is the available space for the ducts to run. Homes can often be framed in a manner that limits the number of locations for ducts to be placed, causing a duct system to be installed in an inefficient way (Johnston & Gibson, 2008). Cold air returns and air supply registers are not dispersed properly throughout the house, creating pressure imbalances that lead to uneven room temperatures, comfort complaints, and higher energy costs. This is one of the main problems the homeowners encounter in the house in Bedford. The layout of the duct system is such that in the upstairs level of the home there is only one cold air return register. Although each room is equipped with an air supply register, the cold air in the rooms is not able to adequately escape due to its distance from the cold air return. As a result, uncomfortably cooler temperatures are experienced in the bedrooms and additional heating is required, leading to higher energy usage and costs.   Furthermore, on the landing of the staircase leading to the upstairs there is a cold air return and air supply register in very close proximity causing a short circuit of the warm air supply.

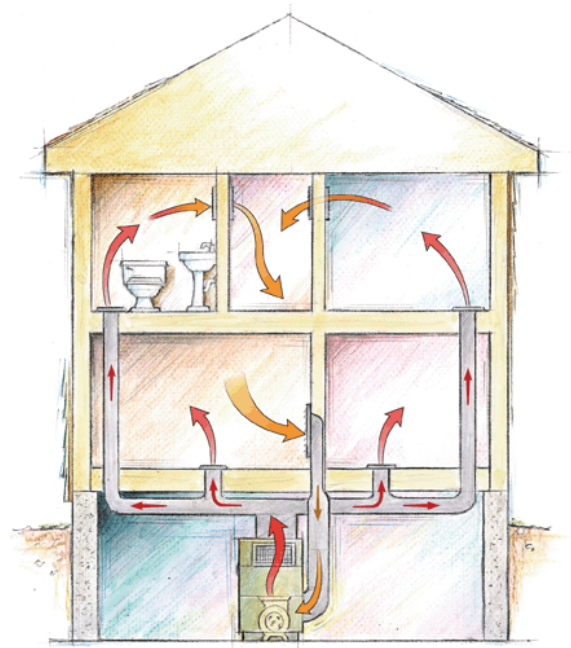Unfortunately, due to the limitations posed by the framing

Figure 8: Effective systems draw cold air from the middle of the house and supply warm air to the perimeter. (Image sourced from www.greenbuildingadvisor.com)

of the house, it is difficult to rectify the problems associated with the layout of the duct system. Ideally, air would be drawn from the center and applied throughout the perimeter of the home (Figure 8), but this could only be achieved by running more duct work, which is not feasible. However, some simple cost-effective actions can be taken to improve the performance of the household's furnace.   The easiest solution is to provide a greater amount of airflow to the furnace, located in the basement of the home. This can be achieved by cutting a large hole approximately 12x12 inches in size in the side of the filter unit and placing a grill over it (Kevin O'Halloran, 2011). A whole would also need to be placed in the mechanical room door to allow more air to flow in. Taking this action can help increase the air circulation through the furnace, running more air through the heating coils, thereby increasing its heating efficiency. In addition to this, by closing off the air supply on the landing, the adjacent cold air return will be able to draw more air from the upstairs area, also increasing circulation, and thus comfort level in the home.

Home Energy Monitoring System

Occupant behaviour is a major factor in determining energy consumption in a household; however, for most household residents it is a challenge to identify the practices that utilize the most energy (Efficiency, 2001). Typically, utility bills only summarize energy costs and consumption for the prior month. This does not provide adequate information for residents to identify what specific practices, appliances, and equipment are consuming the largest quantities of energy, making it difficult to achieve reductions in energy use. Studies have revealed that if residential consumers have more frequent, detailed information about their consumption, they would better understand their energy use patterns and take measures to change them effectively (Efficiency, 2001).

There are a number of technologies available to provide feedback to residents on their home energy use.   These technologies, in the form of energy monitoring systems, display information on current and past energy use from the home's main appliances and systems, and can also provide data on cost, carbon emissions, and other energy metrics. Research has shown that providing feedback to household residents on their energy consumption can enable them to reduce usage by 5% to 15% (Allen, Janda, & College, 2006). One study conducted by a researcher at McMaster University found that on average, households that received a whole-house energy monitor reduced their energy usage by 6.5% (Holladay, 2010). Using this information, the energy and cost savings for the house were calculated. By investing in a device called The Energy Detective 1001 (figure 9), available for $120, the household can save 1225 kWh based on a 6.5% reduction (Appendix I). This translates to a cost savings of $148 annually, which is based on data provided from the household's 2010 energy bills. Payback would occur in 9.7 months.

Figure 9: The Energy Detective (Image source: www.theenergydetective.com)

Water Conservation Opportunities

Rain barrels

It would be beneficial to install a rain barrel to collect rainwater as it provides a cost effective source for the water necessary for landscaping purposes. The rainwater itself provides oxygenated, un-chlorinated water, which is ideal for plants. By reducing potable water consumption used for landscaping the energy required to treat this water before and after its use is eliminated. A typical 190 liter rain barrel would cost around $200.

Mulch

Another mechanism for reducing water use is to put mulch down as it assists in the retention of soil moisture. Maintaining a consistent level of moisture in soil is an important part of maintaining a healthy garden and plants. Using mulch as a soil covering would reduce the amount of water needed for landscaping by blocking the evaporation of moisture in the soil.

Capital Intensive Solutions

Solar Hot Water Heating System

Heating water accounts for approximately 15% of a household's energy use (Energy Star, 2011). There is a variety of hot water heating systems employed in homes, the most common of which are storage tank water heaters (Natural Resources Canada, 2011). An electricity power-sourced storage tank water heater system is the type in use at the Bedford house. This system heats and stores water in a tank so that hot water is available to the home at any time. A drawback of these units is the energy used and wasted to keep the water hot at all times, referred to as standby loss (Energy Star, 2011). In order to avoid such inefficiencies, an alternative energy efficient system such as a solar thermal hot water heater should be installed.

The back side of the Bedford house is south-facing, and despite having a large pine tree, the home still has an excellent solar resource, making it ideal for installing a solar thermal water heater. The roof geometry has roof faces in all directions, and a panel can be installed on any one of them as long as it is pointed to the south with proper racking. An energy model for the solar thermal system was prepared using RETscreen software from Natural Resources Canada (Appendix B). The system selected for installation is a 2 panel glazed flat plate system from Thermo-Dynamics in Dartmouth, Nova Scotia. By selecting a locally manufactured product, the embodied energy of the product has been reduced. Due to the presence of a large pine tree in the backyard, there are anticipated losses of 20% due to shading. The energy model assumes that there will be a 5% fuel escalation rate, which means a 5% price increase in electricity each year. An inflation rate of 2% has been assumed and the life of the system is 25 years. There is currently a federal rebate of $1,250 and two provincial rebates of $1,250 each that are available. The payback period was calculated to be 9.5 years and the annual energy savings would be 2,049 kWh (Appendix B).

Drain water Heat Recovery

As previously mentioned, heating water consumes a significant amount of energy in a household. This heated water is typically used at a temperature of 41 degrees Celsius, and after being used for showering and washing, enters the drainage system at a temperature of around 37 degrees Celsius (Watercycles Energy Recovery Inc., 2011). In a conventional water system this energy is wasted. Installing mechanisms such as drain water heat recovery systems capture this energy and reuse it to heat fresh cold water, thereby reducing energy use and costs.

Installing a drain water heat recovery unit in the Bedford house would reduce the domestic hot water load by approximately 30%. The unit chosen to model is a 5' ReTherm. This model assumes a 2% inflation rate and a 5% fuel escalation rate. The cost is $732 for the unit, and it takes 4-6 hours to install. It was estimated that the installation costs would reach $500. Amounts of $50 in federal and $50 in provincial rebates are available. The payback period for the unit is 6.3 years and the annual energy savings will be 1444 kWh (Appendix C).

Considerations Not For Implementation

In the search for various ways to achieve greater energy efficiency and reduce energy costs for the home, there were a number of technologies that were considered for implementation, but after careful analysis proved to not be viable options.

The installation of Solar Photovoltaic (PV) panels was considered, but proved to not be a reasonable solution for energy use reduction for several reasons. In terms of initial cost to the homeowner, there was a lack of sufficient rebates to cover the cost of a very expensive product and installation. The amount of space that would be taken up by the solar panels on the roof would be significant. This space would be put to far greater use by installing panels for solar thermal energy instead. Also, Solar PV panels represent a great amount of embodied energy, and the payoff to offset the energy used in manufacturing would take decades.

Another technology that was considered, but not recommended, was the use of geothermal energy for heating. The opportunity to replace the air source heat pump with a ground source heat pump was evaluated, but the results were found to not be viable. Because the ground in the area is solid rock, the price to install a system would cost at least $65,000. The air source heat pump installed is already quite efficient so the savings each year are not enough to provide a reasonable payback period. Our initial estimates put it around 40 years.

Finally, the viability of putting in exterior insulation was analyzed. According to the HOT2000 analysis, the majority of heat loss was occurring through the foundation and not the exterior walls on the rest of the building. In order to place more insulation, a high-cost, labour-intensive operation would have to be undertaken, which would not be practical or financially worthwhile.

CONCLUSION

The energy audit and HOT2000 data analysis that was performed on the home located at 248 Southgate Drive in Bedford, Nova Scotia, has delivered a thorough energy profile for the household. This profile provided the necessary information from which to formulate numerous, effective recommendations on the various ways to achieve greater energy efficiency in the home.

Based on our analysis, there are several low/no cost recommendations that should be implemented. The first area where energy savings can be captured is in lighting. By replacing all incandescent and halogen bulbs with CFLs and LED lighting, an energy savings of 384 kWh can be realized, leading to a cost savings of $46 annually. In retiring a second appliance, such as the second refrigerator located in the garage, the homeowner can make a one-time financial gain of $35 from The Appliances Retirement Program through Efficiency Nova Scotia. In addition to this, approximately $125 is saved annually which translates to over 1000 kWh of electricity each year. Savings can be made in regards to hot water heating by investing $20 in a Thermwell Products Fiberglass R19 Equivalent Water Heater Blanket. This simple step will save 317 kWh per year with an annual energy cost savings of $38.00. By putting to use the household's programmable thermostat, and enacting thermostat strategies that include a nighttime setback of 5 C during heating months, it was calculated that the energy savings would be 3601 kWh translating to an annual cost savings of $434. Finally, monitoring energy usage patterns and behaviours in the home proves to be a very effective strategy at achieving energy reductions. By investing in a device called The Energy Detective (TED 1001), available for $120, the household can save $148 per year, equating to 1225 kWh based on a 6.5% reduction.

There are also capital intensive, high value solutions that are available to the homeowner. The installation of a solar thermal hot water heater from Thermo-Dynamics Ltd. would provide ample energy savings and has an excellent rebate program available. The cost of the unit would be $6825 in total; however, $3750 in federal and provincial rebates would bring down the product and installation cost substantially. The savings from this system would be 2,049 kWh annually equating to $247 per year, though this number will increase over the years as energy costs rise. By installing a drain water heat recovery system at a cost and installation of $1232, a 1444 kWh savings is realized.
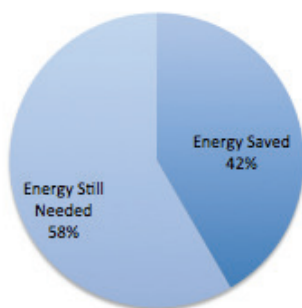

Figure 10: Energy savings available through recommendations.

The recommendations presented in this report are in accordance with our understanding of the systems, appliances, and practices within the household, and are based on data made available by the homeowner. Compared to normalized 2010 energy consumption, a savings of 42% (Figure 10) on energy utility bills can be attained if all the above recommendations are executed (Appendix K). The gains from the drainwater heat recovery system were removed from this calculation because they are already achieved by the solar thermal system. These savings hold a number of positive benefits, both financially and environmentally; they will lead to a significant reduction in energy costs to the homeowner, and a decrease in the amount of GHG emissions associated with the operations of the home. GHG emissions would be reduced by 8.18 tons which is the same as planting 190 trees or taking 1.5 cars off the road.

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