Sustainable Housing: Opportunities for improved energy efficient home construction by Habitat for Humanity in Saskatoon, Saskatchewan

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By

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ABSTRACT

In Saskatchewan, there are many ways for home construction to be improved upon. The purpose of the study was to find ways for energy efficient building practices to be more readily adopted by Habitat for Humanity in Saskatoon, Saskatchewan. To accomplish this goal information was collected on building practices and affordable housing from which recommendations could be made as to what the optimum practices would be in Saskatchewan. In reality this was carried out through a needs assessment of Habitat for Humanity including interviews with employees and the completion of a best practices checklist. Through this needs assessment it was evident that Habitat for Humanity already was using a portion of the home construction best practices for Saskatchewan but could still improve in a variety of areas. The inevitable conclusion to the study was that through a mixture of changes to construction practices, partnerships, and government policy it would be possible for Habitat to Humanity to improve on energy efficiency even though there are currently steps being taken to help move the process forward.
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CHAPTER 1
INTRODUCTION

Although home construction is a common practice in the city of Saskatoon, Saskatchewan, there are many ways in which energy efficiency could be significantly improved. Room for improvement is even more substantial when it comes to the construction of low-income housing such as those constructed by Habitat for Humanity. Habitat for Humanity operates by producing affordable housing for low-income families that could not otherwise afford a home. This process is carried out through volunteer labor and donated material. Inevitably, given a limited budget and volunteer laborers there are numerous portions of the construction process for which energy efficiency could be improved through minimal changes to building practices and at a cost that would be acceptable for the long term homeowner. Current practices such as active solar, passive solar, materials efficiency, improved insulation, and life cycle assessments of products suggest that it is prudent to adapt some of these energy efficient methods of home construction in Saskatoon, specifically within a low-income housing operation.

In Saskatchewan, nearly 58% of heating for homes is derived from natural gas, which is a nonrenewable resource with various environmental implications (Stats Canada, 2012). For the implicit environmental concerns and costs associated with heating of homes in this manner it is vital to find alternative methods of home construction, especially in a prairie climate with annual extremes in weather conditions. Energy efficient homes reduce unnecessary energy consumption,
produce greenhouse gas emissions and raise demand for nonrenewable resources. Increased efficiency simultaneously provide healthier living conditions and offer homeowners significant money savings over conventional homes (USEPA, 2012).

Given the substantial gains to be made by moving toward more energy efficient homes in Saskatoon it is a wonder why these systems have not been put in place at a larger scale, specifically in low-income housing units. This project seeks to understand the advantages and limitations of energy efficient homes in a Saskatchewan context The gains of energy efficient homes is shared broadly across society due to the widespread effects of reduced fossil fuel combustion. The home construction sector has capacity to mitigate fossil fuel usage through changes in practices.
Chapter 2
HOUSING IN CANADA
Overview of Housing Types and Energy Usage

From a global perspective, Canadian households use a substantial amount of energy for both heat and electricity to ensure the comfort and health of Canadians. This immense amount of energy used for heating homes is largely attributed to the Canadian climate that often presents great swings in both temperature and precipitation. Energy is used within Canadian households for a number of purposes including, but not limited to, heating, cooling, and lighting homes, heating water, running vital appliances such as refrigerators, air conditioners, and other devices (Government of Canada, 2012). To meet all these needs energy is derived from electricity, natural gas, oil, propane, or wood. Inevitably, the amount of energy consumed is dependent on a variety of factors including climate, fuel prices, household size, and dwelling size (Government of Canada, 2012).

As of 2007 there are over 12.9 million households nationwide with constant growth throughout the country (Natural Resources Canada, 2010). These dwellings combined for an energy use total that exceeded 1369 petajoules derived from electricity, natural gas, heating oil, propane, and wood use (Natural Resources Canada, 2010). The average household in Canada used a total of 105.9 gigajoules of energy in this year; however, due to the drastic differences in housing types this value may be slightly unrepresentative of the entire nation. The breakdown of dwelling types within Canada can be viewed in Figure 1 where it is evident that the majority of dwellings are single-detached homes.
It is important to note that while single detached homes make up the largest proportion of homes in Canada; they also possess the largest areas requiring heating. This relationship can be viewed in Figure 2.

The type of dwelling that a family or individual resides in has significant implications on the level of energy consumption. The types of homes that require the least amount of energy are apartments of any type. This lower energy consumption is a direct result of apartment units sharing at least one common wall.
In addition, apartments generally consists of a smaller heated area than a single family dwelling. Common wall housing units are more efficient because exposure is reduced to outside air temperatures, which reduces the internal heating or cooling requirements of the home. In contrast, single detached dwellings share no common walls with other units and have larger areas to heat, leading to higher energy consumption levels. Figure 3 displays the energy consumption of each dwelling types within Canada.

![Energy Consumption by Dwelling Type](image)

*Figure 3: Per household energy consumption by dwelling type in 2007 (Natural Resources Canada, 2010)*

The region that a household is located within has also proven to make significant differences on energy consumption. There are numerous potential root causes of why certain areas use more or less energy but the most understandable reason would be varying climates and the composition of dwelling types (Natural Resource Canada, 2010). The breakdown of energy consumption per region can be seen in Figure 4 where Saskatchewan is found to have the second highest level of energy consumption per household. In addition, it has been realized that when considering homes built after 1946 the larger the home the more energy is consumed. However, the larger the household the less energy was consumed per
unit area (Natural Resource Canada, 2010). This is a result of newer and larger homes being significantly more energy efficient than older homes.

![Energy consumption per household by region in 2007 (Natural Resources Canada, 2010)](image)

**Figure 4: Energy consumption per household by region in 2007 (Natural Resources Canada, 2010)**

**Electricity Use**

The energy consumption provided by electricity is used across the board for lighting and running appliances within a home. In Canada, electricity is used as a primary source of heating for over one third of homes. In addition, many homes use electricity as a secondary source of heating through supplementary appliances such as space heaters. The total consumption of electricity for homes in Canada was 520250 terajoules in 2007 (Government of Canada, 2012). The average level of electricity consumption per household in Canada was found to be 40 GJ in the same year (Government of Canada, 2012). Average electricity use per household ranged from a high of 62 GJ in Newfoundland to just 26 GJ in Alberta. In Saskatchewan, electricity only accounted for 20% of total energy use for a total of 30 GJ per household (Government of Canada, 2012).
Natural Gas Use

Natural gas is a valuable fuel in providing energy to Canadian households as it can be utilized for heating the home, water heating, and as fuel for large appliances such as stoves, clothes dryers, and barbeques (Government of Canada, 2012). Consumption of natural gas by Canadian households totaled 587,183 TJ in 2007 with an average of 92 GJ per household using natural gas (Government of Canada, 2012). In Saskatchewan, natural gas use made up 70% of household energy consumption and led to an average per household consumption rate of 102 GJ (Government of Canada, 2012).

Alternative Energy Sources

In Canada, there is a plethora of sustainable alternative energy sources. These alternative sources include solar, wind, geothermal and other sources. Only 111,600 households in Canada are known to use such alternative energy sources, which represents less than 1% of all homes in Canada (Government of Canada, 2012).

Energy use by household

In 2007, the average Canadian household spent $1147 on electricity and $610 on natural gas (Government of Canada, 2012). Figures 5 and 6 display the way in which natural gas and electricity are used in an average western Canadian home. Inevitably, natural gas is used entirely for heating the home and hot water in Saskatchewan while electricity is relied upon to maintain appliances and lighting.
The average household in Saskatchewan consumes 114 GJ of energy per year (Natural Resources Canada, 2010). In Saskatoon residents pay for electricity per kilowatt hour (kWh) at a rate of 12.24 cents per unit (City of Saskatoon, 2012). This value seems like an insignificant amount but the use of household appliances can quickly add up to substantial electricity costs over a monthly term. A single kWh can run a hot shower for about three minutes while 100 kWh is enough to power 50 loads of laundry (Canadian Geographic, 2012). The level of consumption and costs
for household appliances can be viewed in Table 1 where these values are a result of Canada’s national energy use averages and the electricity rates for Saskatoon.

*Table 1: Household appliance energy use (City of Saskatoon, 2012)*

<table>
<thead>
<tr>
<th>Household Appliance</th>
<th>kWh usage</th>
<th>Monthly Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Conditioner - Central</td>
<td>480</td>
<td>$58.75</td>
</tr>
<tr>
<td>Air Conditioner - Window</td>
<td>120</td>
<td>$14.69</td>
</tr>
<tr>
<td>Clothes Dryer</td>
<td>106</td>
<td>$12.97</td>
</tr>
<tr>
<td>Clothes Washer</td>
<td>10</td>
<td>$1.22</td>
</tr>
<tr>
<td>Coffee Maker - Drip</td>
<td>4.5</td>
<td>$0.55</td>
</tr>
<tr>
<td>Color T.V.</td>
<td>36</td>
<td>$4.41</td>
</tr>
<tr>
<td>Computer &amp; Printer</td>
<td>7</td>
<td>$0.86</td>
</tr>
<tr>
<td>Dehumidifier</td>
<td>36</td>
<td>$4.41</td>
</tr>
<tr>
<td>Dishwasher</td>
<td>48</td>
<td>$5.88</td>
</tr>
<tr>
<td>Fax Machine</td>
<td>9</td>
<td>$1.10</td>
</tr>
<tr>
<td>Freezer - 16 cu ft</td>
<td>107</td>
<td>$13.10</td>
</tr>
<tr>
<td>Fry pan</td>
<td>4</td>
<td>$0.49</td>
</tr>
<tr>
<td>Furnace Humidifier</td>
<td>15</td>
<td>$1.84</td>
</tr>
<tr>
<td>Furnace Motor - 45%</td>
<td>161</td>
<td>$19.71</td>
</tr>
<tr>
<td>Hair Dryer</td>
<td>9</td>
<td>$1.10</td>
</tr>
<tr>
<td>Iron</td>
<td>6</td>
<td>$0.73</td>
</tr>
<tr>
<td>Lawnmower</td>
<td>4.8</td>
<td>$0.59</td>
</tr>
<tr>
<td>Microwave</td>
<td>24</td>
<td>$2.94</td>
</tr>
<tr>
<td>Refrigerator - 18 cu in</td>
<td>129</td>
<td>$15.79</td>
</tr>
<tr>
<td>Stereo</td>
<td>6</td>
<td>$0.73</td>
</tr>
<tr>
<td>Stove</td>
<td>115</td>
<td>$14.08</td>
</tr>
<tr>
<td>Toaster</td>
<td>3</td>
<td>$0.37</td>
</tr>
<tr>
<td>Vacuum</td>
<td>10.8</td>
<td>$1.32</td>
</tr>
<tr>
<td>VCR</td>
<td>3</td>
<td>$0.37</td>
</tr>
<tr>
<td>Water Cooler</td>
<td>6.3</td>
<td>$0.77</td>
</tr>
<tr>
<td>Water Heater - 40 gal</td>
<td>480</td>
<td>$58.75</td>
</tr>
</tbody>
</table>

Similarly, Table 2 displays the costs associated with various lighting wattages and methods of use. The table is valuable for displaying the difference that is made by leaving lights on unnecessarily as costs can triple with lights being left on for 24
hours of the day. Additionally, the type of bulb used can also have a large impact on the level of consumption by each household.

Table 2: Household lighting energy use (City of Saskatoon, 2012)

<table>
<thead>
<tr>
<th>Lights</th>
<th>Cost Per Hour</th>
<th>Cost Per Day (8 hours)</th>
<th>Cost Per Day (24 hrs)</th>
<th>Cost Per Month (8hrs/day for 30 days)</th>
<th>Cost Per Month 24hrs/day for 30 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 Watt</td>
<td>1.22 cents</td>
<td>9.76 cents</td>
<td>29.28 cents</td>
<td>$2.93</td>
<td>$8.78</td>
</tr>
<tr>
<td>60 Watt</td>
<td>0.73 cents</td>
<td>5.84 cents</td>
<td>17.52 cents</td>
<td>$1.75</td>
<td>$5.26</td>
</tr>
<tr>
<td>40 Watt</td>
<td>0.49 cents</td>
<td>3.92 cents</td>
<td>11.76 cents</td>
<td>$1.18</td>
<td>$3.53</td>
</tr>
</tbody>
</table>

Chapter 3
SUSTAINABLE HOUSING AND RESIDENTIAL ENERGY EFFICIENCY

Sustainable Housing

The word “sustainable” is increasingly utilized in regards to many factors in daily lives from sustainable development to sustainable agriculture. In terms of housing, sustainability maintains a similar focus on future prosperity. Sustainable housing essentially incorporates homes that are designed to reduce the cumulative environmental effects caused during and after construction in such a way that the needs of the present can be met without compromising the ability for future generations to meet their own needs (Sustainable Housing Foundation, 2012).

Sustainable housing can be accomplished through a number of pathways but focuses on three main points. The first is the efficient use of energy, water, land, and various other resources that are required to operate the general systems associated with the home (Sustainable Housing Foundation, 2012). The second is promoting the health of any and all occupants residing within the home itself. The final important aspect
of sustainable housing is the emphasis on a reduction of greenhouse gas emissions, pollution, waste, and land degradation (Sustainable Housing Foundation, 2012).

**Residential Energy Efficiency**

There are different housing types that work towards the goal of sustainable housing. These include both energy efficient housing and net zero energy housing. The energy efficient home is one that retains the best quality living environment for its occupants while minimizing the consumption and waste of energy. On the other hand, a net zero energy home is one that is capable of producing an annual output of renewable energy that is equal to the total amount of its annual consumed or purchased energy from energy utility service companies (Sustainable Housing Foundation, 2012).

**Measuring Energy Efficiency**

Energy efficiency is an important factor to acknowledge when looking to build a new home or renovate an older home with more sustainable retrofits. Inevitably, it is important to be aware of the state of a current home before planning any potential changes. All in all, measuring energy efficiency of a current home or future home can be vital in preparing for an uncertain future with significantly higher energy costs (Sustainable Housing, 2012.) In Canada, the current measuring method used to evaluate the energy efficiency of homes is the EnerGuide rating system (Sustainable Housing, 2012).

**EnerGuide Rating System**

The EnerGuide rating system was designed by Natural Resources Canada and shows a standard measure of an individual home’s energy efficiency (Natural
Resources Canada, 2010). The rating is calculated from standard operation assumptions that allow for comparisons between different homes. The EnerGuide rating system works on a scale of 0 to 100. For a home to receive a rating of 0 there will be high levels of air leakage, no insulation, and extremely high-energy consumption levels (Natural Resources Canada, 2010). A rating of 100 represents a home that is airtight, well insulated, sufficiently ventilated, and required no purchased energy on an annual basis (Natural Energy Resources Canada, 2010). For a house to be categorized as energy efficient it must score a rating of 80 or higher, which is considered excellent for a newly built house (Natural Resources Canada, 2010; Sustainable Housing, 2012). Table 3 demonstrates the generally ratings that would be applied to certain housing types within the EnerGuide rating system.

Table 3: EnerGuide system ratings (Natural Resources Canada, 2011).

<table>
<thead>
<tr>
<th>Type of House</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Older house not upgraded</td>
<td>0-50</td>
</tr>
<tr>
<td>Upgraded older house</td>
<td>51-65</td>
</tr>
<tr>
<td>New house build to standard building code</td>
<td>66-75</td>
</tr>
<tr>
<td>New house with some energy efficient improvements</td>
<td>75-79</td>
</tr>
<tr>
<td>Highly energy efficient new house</td>
<td>80-90</td>
</tr>
<tr>
<td>House requiring little or no purchased energy</td>
<td>91-100</td>
</tr>
</tbody>
</table>

Barriers to Energy Efficient Practices

Given the environmental advantages of energy efficient practices it is clear that there are certain barriers that have caused for significant restrictions in use for
residential areas. In Canada, and the Saskatchewan more specifically, there are a number of causes leading to the underuse of such practices. The most evident barriers found through literature include the low cost of energy in Canada, a concept known as the “EligAbility gap”, and governance issues including building codes.

**Low Energy Costs**

One of the most significant factors leading to the slow adaptation of energy efficient residential building practices is the relatively low cost of energy in both Canada and the western provinces. When compared to other similarly developed parts of the world, such as Europe, it becomes evident that the amount paid for energy in Canada is significantly lower. In 2007, the National Energy Board of Canada reported that countries like Ireland and Germany paid some of the highest energy prices in the world with average national rates of around 0.25$US/kWh and 0.21$US/kWh respectively (Jackson, 2011). During the same time period consumers in Canada paid less than half the European prices with average rates of 0.075 $US/kWh for electricity (Jackson, 2011). These low rates in Canada are in turn a barrier to residential energy efficient practices because from an economic perspective it does not make sense to invest large amounts of money into developing technologies that would have only minimal financial savings in Canada compared to other nations. Quite clearly, when costs of energy are higher there is a significant increase in the will of users to reduce consumption.
There are a number of reasons for the presence of low energy costs in Canada. The first stems from the fact that Canadian prices do not truly reflect the social and environmental costs that are associated with the production and consumption of various sources of energy (Jackson, 2011). European nations apply these costs by adding taxes to energy consumers, which are used to fund projects such as investments into new technologies and alternate energy sources as well as alternate methods of increasing efficiencies. Another cause for low energy prices in Canada is the abundant supply of natural resources that are available to be used for energy production. Saskatchewan is an excellent example as the province uses significant amounts of coal for electricity production. Saskatchewan is the third largest producer of coal in Canada with over 1.3 billion tonnes of reserves available with current open pit mining technology at a depth of less than 35 meters (Government of Saskatchewan, 2013). Over 90% of coal extracted in Saskatchewan is consumed in the province at “mine-to-mouth” electricity plant generation stations (Government of Saskatchewan, 2013). This essentially means that the mine and the power plant are located in the same immediate location making the electricity production process easier and more efficient. With large reserves within the province and a clear demand for energy it has been possible for the cost of energy to remain low and thus create a barrier against the implementation of energy efficient residential buildings and retrofits alike.
The EligAbility Gap

The “EligAbility Gap” is a concept that is related to energy efficient retrofits for homes within Saskatchewan. Residential energy efficient retrofits are enhancements that can be used to reduce the energy consumption of a particular home. These retrofits can be used to increase comfort, reduce utility bills, and minimize greenhouse gas emissions through methods such as installing insulation, upgrading a furnace, or draught sealing around windows and doors (Dolter et al, 2011). It can be noted that most homes requiring such retrofits are older homes built before the 1980s. The “EligAbility Gap” is a phenomenon referred to by Dolter et al in which these older homes are generally owned or rented by households that do not possess the financial backing to afford such retrofits in their homes (2011). Thus, the major barrier between large portions of Saskatchewan living in sustainable housing is simply the costs associated with implementation. Dolter et al used a case study of a north central neighborhood in Regina to examine the costs associated with energy efficient retrofits. Within this study, it was determined that the costs of retrofitting homes with a new furnace, hot water heater, and insulation for the attic, main walls, and basement walls ranged from $14,000 to $30,000 (Dolter et al, 2011). Inevitably, in each case the savings in utility bills would have paid itself off within 10 years but homeowners in this specific neighborhood lacked the income and equity in their homes to acquire the financing to conduct the initial retrofits (Dolter et al, 2011). Given the similarities between Saskatoon and Regina it is possible to extrapolate the findings from this study to determine that a similar effect would take
place in Saskatoon and that the “EligAbility Gap” is a significant barrier keeping lower income homeowners from conducting energy efficient retrofits in their homes.

**Governance and Building Codes**

Building codes are put in place to ensure minimum guidelines for construction practices within a country. The purpose of these building codes is to protect citizen's health, safety, welfare, and private property (Jackson, 2011). The National Model Code (model code) is developed by the National Research Council for all of Canada (NRCC, 2013). The model code is interpreted by the provincial governments to suit local conditions and to develop provincial building codes (Jackson, 2011). Until 2005, the national model code was prescription based meaning that minimum standards are designed to be met in a specific manner (Jackson, 2011). Such prescriptive methods of regulation can restrict the level of innovative design implemented to residential homes and also reduces the ability of homeowners to transition towards energy efficient housing. To combat these restrictions the model code has changed to a performance based system which allows for a greater level of flexibility as builders can either follow prescriptive acceptable solutions or use alternative solutions that must be evaluated to ensure quality performance (Jackson, 2011). The large issue with this system is that it can cost a significant amount of money to gain approval for a particular practice. For instance, when using an alternative method that is not designated under the prescriptive code it is often necessary to hire an architect or engineer to make it through the approval process. These hurdles often lead builders to stick with current practice. Inevitably, the building codes are put in place to ensure low housing costs.
that focus specifically on the initial costs of energy efficient technologies as opposed to recognizing the overall cost saving potential for homeowners over a lifetime (Jackson, 2011). All in all, these prescriptive methods and a desire to reduce initial costs of home construction create a barrier to the implementation of energy efficient residential housing and sustainable housing as a whole.

**Important factors associated with residential energy efficiency**

When associating with the concept of residential energy efficiency there is a wide array of factors that can come into play in a significant manner. Many of these factors can affect the level of energy consumption that takes place in either a positive or negative fashion. The three concepts that are the most important to understand when focusing on cutting energy costs and overall consumption are in this case the factors that allow for the greatest amount of savings when used in a residential home. However, these factors can also be the root cause of high-energy consumption levels if not used properly in a harsh climatic location such as Saskatchewan. These key factors include R-value, thermal bridging, and air leakage.

**R-Value**

When working to reduce energy usage and utility bills in a climate such as Saskatoon it is important to better prevent the use of heating and cooling. This can be accomplished by providing a better buffer between the home and the outdoors. The ability of a surface to reduce heat flow is known as thermal resistance or the R-value of an insulated area (Wilkins, 2009). In the construction industry a higher R-value means a greater level of insulation and a higher resistance to heat transfer between the indoors and outdoors. R-value ratings are applied to the insulation of a
variety of surfaces involved with residential energy efficiency including walls, ceilings, and floors.

When dealing with thermal conductivity the overall rate of heat flow is dependent on the temperature difference between sides, the thickness of the insulating surface, and the area in contact (Wilkins, 2009). When there is a large difference in temperature between surfaces there is a greater level of heat flow. With larger areas of contact the level of heat flow is also increased. And lastly, the shorter the distance of conduction the greater the amount of heat flow (Wilkins, 2009). These functions are all taken into account when determining the R-value of a surface.

For fixed values of thermal resistance, area and thickness, the transfer of heat increases as the difference in temperature increases between surfaces. The reality that this concept leads to is that the warmer a home is kept in comparison to the outdoors the more heat will be lost as a result of conduction (Wilkins, 2009). In this regard, the most vital reason that it is important to insulate relates to the second law of thermal dynamics. The second law of thermal dynamics explains that if two objects or environments are at different temperatures they will attempt to reach equilibrium by transferring heat from the warmer to the colder (Wolfe, 2013). Inevitably, heat will migrate to a colder area but the R-value separating the two surfaces, such as the interior and exterior of a home, determines the rate of transfer (Wolfe, 2013).
This heat loss will be a serious issue in Saskatchewan where winter temperatures can drop to below 30°C on a frequent basis and homeowners still prefer to maintain a consistent temperature in the mid 20's. This huge difference between indoor and outdoor temperatures often results in substantial levels of heat loss. One of the best methods for reducing heat loss in this situation is to increase thermal resistance by adding more insulation to walls, ceilings, or floors (Wilkins, 2009). The other method of reducing heat loss would be to decrease the interior temperature by turning down the furnace when no one is home or at night (Wilkins, 2009).

When relating R-value to residential energy efficiency it is important to realize that the most effective way to reduce consumption is to simply not require the energy at all (Wolfe, 2013). Increasing R-value of a home allows for the prevention of heat energy from the inside and outside of the home and thus prevents the need for increased energy input. The implementation of better-insulated homes is a valuable method to reduce energy usage on a daily basis and is much more cost effective than investing in other technologies such as heat source pumps or photovoltaic panels (Wolfe, 2013). In addition, insulation is a useful tool in moving towards energy efficiency because once installed properly the system requires next to no maintenance and will pay itself off in utility bill savings long before the home’s lifecycle is complete (Wolfe, 2013). There is a wide array of products that are currently in production that can be used to increase the thermal resistance of a
residential home, some examples of these can be viewed in Table 4, which compares the performance of various insulating materials.

*Table 4: R-values of standard insulating materials (Glassroots, 2013).*

<table>
<thead>
<tr>
<th>Insulation Type</th>
<th>R-value per inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blankets/Batts - Fibreglass</td>
<td>3.0 - 3.8</td>
</tr>
<tr>
<td>Blankets/Batts - Rock Wool</td>
<td>3.0 - 3.8</td>
</tr>
<tr>
<td>Loose Fill - Cellulose</td>
<td>2.8 - 3.7</td>
</tr>
<tr>
<td>Loose Fill - Fibreglass 0.7 lb/cu.ft.</td>
<td>2.2</td>
</tr>
<tr>
<td>Loose Fill - Fibreglass 2.0 lb/cu.ft.</td>
<td>4</td>
</tr>
<tr>
<td>Loose Fill - Rock Wool</td>
<td>3.1</td>
</tr>
<tr>
<td>Loose Fill - Vermiculite</td>
<td>2.2</td>
</tr>
<tr>
<td>Rigid Board - Molded Polystyrene 0.9 lb/cu.ft.</td>
<td>3.6</td>
</tr>
<tr>
<td>Rigid Board - Molded Polystyrene 1.6 lb/cu.ft.</td>
<td>3.6</td>
</tr>
<tr>
<td>Rigid Board - Extruded Polystyrene 1.9 lb/cu.ft.</td>
<td>5</td>
</tr>
<tr>
<td>Rigid Board - Extruded Polystyrene - Urethanes</td>
<td>5.6 - 6.3</td>
</tr>
<tr>
<td>Rigid Board - Extruded Polystyrene - Isocyanurate</td>
<td>5.6 - 6.3</td>
</tr>
<tr>
<td>Sprayed - Cellulose</td>
<td>3.0 - 4.0</td>
</tr>
<tr>
<td>Foam Filled - Urethane</td>
<td>5.6 - 6.2</td>
</tr>
</tbody>
</table>

**Thermal Bridging**

The concept of thermal bridging is one that is widely accepted as a major contributor to heat loss and thus greater energy consumption in residential homes. Thermal bridging takes place when a more conductive material allows an easier pathway for heat transfer to take place across a thermal barrier (North, 2013). It is important to note that not all materials share the same ability to conduct or restrict heat transfers. In most cases, the cause of thermal bridging in residential homes comes from wall studs. This can clearly be displayed by the thermal graphic image below that exhibits how 2 x 6 inch studs within the construction envelope of a building has a much lower R-value than the insulation within the walls (Wolfe, 2013). Inevitably, thermal bridging is a significant source of heat loss in the home.
Colder temperatures such as those experienced during a winter in Saskatchewan only extrapolate the process of thermal bridging.

![Image: Thermal bridging through a 2 x 6 stud wall (Wolfe, 2013)](image)

Given the disadvantages of thermal bridging it is imperative to reduce the presence of such a process if sustainable housing is to be achieved. There are currently a variety of options available when building a new home that can include structural insulated panels or even advanced framing systems that reduce the quantity of wall studs in a home (North, 2013). Another option would be to apply strips of insulation over the studs to provide a thermal break (North, 2013). Overall, any methods that truly reduces thermal bridging in residential houses works by isolating the best conductors of heat between two surfaces so that the conductors are not in direct contact with both warm and cold sites of the assembly (Wolfe, 2013). Preferably, the exterior wall would then be thermally isolated from the interior wall which leads to reduced likelihood of cold spots in the home (Wolfe, 2013).
Air Leakage

Air leakage is the product of infiltrations in the building not being sealed completely or construction assemblages not fitted together faultlessly due to the nature of materials, quality of workmanship, or shifting over time (Wolfe, 2013). Air leakage in residential homes is most prominent in areas where materials don’t fit together properly including around doors, windows, vents, and electrical boxes (Wolfe, 2013). Air leakages can lead to a variety of issues including increased utility bills to heat homes and also health issues, which can illnesses caused my mold buildup within the home (Natural Resource Canada, 2007). It has been estimated that the heating or cooling loss to a home caused by air leakage can be as much as 40% for that home (Wolfe, 2013). Predictably, this loss of heat can lead to steep increases in utility bills and at times lead to cold room that are drafty, uncomfortable, and difficult to heat (Natural Resources Canada, 2007). This occurrence of cold and uncomfortable rooms caused by air leakage generally takes place in basements or main floors with a windward facing wall. In addition, air leakage has been known to lead to cold spots in wall cavities that allows for the collection of condensation that can lead to the growth of molds and, in turn, poor indoor air quality (Wolfe, 2013).

Currently, there are a number of methods that can be used to reduce the amount of air leakage that takes place within a home and in turn reduce utility bills and improve air quality conditions. Some of these measures include wrapping the wall with a membrane, filling voids using spray foam, weather stripping and caulking
windows and doors, upgrading or replacing windows, sealing openings in the attic, and sealing baseboards (Wolfe, 2013; Natural Resources Canada, 2007). These measures allow for improved efficiency and a reduction of heat loss, which is especially valuable in a cold climate such as Saskatchewan.

**Government Programs**

**Provincial Programs**

In Saskatchewan, there are currently a number of energy efficient programs that aim to improve the efficiency of residential homes. These programs vary from providing subsidies or grants for energy efficient retrofits and for newly built homes meeting energy efficiency standards, or providing free inspections for potential retrofits to take place. These programs include the Saskatchewan EnerGuide for Housing Retrofit Programs, Energy Efficient Rebate for New Homes Program, and PST exemptions.

The Saskatchewan EnerGuide for Housing Retrofit Program is set up to allow for current homeowners to get some funding to make energy efficient retrofits to their homes. Homeowners are eligible for up to $5000 in provincial grants to help with any retrofits that are suggested from a pre-retrofit evaluation (Government of Saskatchewan, 2011). Owners of single-family, detached, row and semi-detached homes are eligible to receive this grant money based on a list of approved retrofits. These approved retrofits can include changes to the heating system, cooling system, hot water heater, insulation, doors, skylights, windows, and light fixtures. For this particular program all retrofits must be completed by October 31, 2013 (Government of Saskatchewan, 2011).
The Energy Efficient Rebate for New Homes program is one that allows homeowners that have recently or are planning on building a new home the opportunity for funding to improve home energy efficiency. Homes are eligible if either Energy Star or R-2000 certifies them, or have an EnerGuide rating of 80 or higher (Sask Energy, 2013). The Energy Star and R-2000 programs will be explained in the next section. The program is available for Saskatchewan residents that take possession of their home before December 31, 2013 and offers rebates depending on the level of energy efficiency (Sask Energy, 2013).

Lastly, in Saskatchewan, all Energy Star qualified boilers, furnaces, ground and air source heat pumps are except from provincial sales taxes (Sask Energy, 2013).

**R-2000 Housing**

The R-2000 program is a standard administered by Natural Resources Canada and is delivered through a web of service organizations and professionals across Canada (Natural Resources Canada, 2010). The program was founded in 1981 and has since been used to promote cost-effective, energy efficient building practices and technologies (Natural Resources Canada, 2010). The program includes a Canadian Government sanctioned certification program for homes that involve third-party evaluators to provide homeowners assurance of quality. With over 25 years of activity the R-2000 program has become a benchmark for energy efficient homes in Canada. The program has remained relevant over such a long period of time through the evolution of standards to continually match today’s technology and building practices (Natural Resources Canada, 2010). The changes are determined
through consultation of researchers, homebuilders, product manufacturers, and other experts; all of whom determine whether the R-2000 standard should be updated (Natural Resources Canada, 2010). Inevitably, only licensed R-2000 builders can offer R-2000 homes and each individual dwelling faces a strict and independent quality assurance process including testing and verification and other technical factors (Energy Star Saskatchewan, 2013).

The adoption of the R-2000 program is completely voluntary for both homeowners and homebuilders. Builders chose to take part in the program because they believe in the product and technology available through R-2000 compliance to be superior to conventional practices (Canadian Home Builders Association, 2011). Through these superior practices the builders are able to provide a better built home than competitors. These homebuilders must all take part in a certain level of extra training in the advanced design and construction techniques that are used for R-2000 homes and receive a license for completing this training. Contrary to how it may seem, the homes that are build compliant with the R-2000 program do not use experimental practices and instead use solely proven technology, techniques, and products (Canadian Home Builders Association, 2011). It is through high quality building methods, training, and performance that the R-2000 standard is able to provide a model for environmental responsible housing in Saskatchewan and in the rest of Canada.
Typically houses certified with the R-2000 program exceed building code requirements with high levels of energy efficiency. The homes associated within the program must meet technical requirements for factors including energy performance, indoor air quality, and environmental responsibility (Energy Star Saskatchewan, 2013). However, there are some other vital aspects of the R-2000 program that are worth noting. The program is designed to represent a particular method of building homes and not any design, style, or type of home specifically (Canadian Home Builders Association, 2011). This essentially means that just about any home could fit into the R-2000 program assuming all factors are addressed. Each home built within the R-2000 parameters is designed and built to reduce heat loss and air leakage. Features such as extra insulation, energy efficient windows and doors, and careful air sealing are standard practice (Energy Star Saskatchewan, 2013). The associated mechanical systems used within R-2000 homes for heating, cooling, and ventilation are selected based on high levels of both efficiency and performance. To be compliant with R-2000 standards a home must also have controlled ventilation to maintain high quality air by bringing fresh air inside and exhausting stale air to the outdoors (Energy Star Saskatchewan, 2013). Builders of R-2000 homes are also required to acknowledge various environmental factors associated with home construction. This can come in the form of using only products known for reducing chemicals, dust, and various indoor pollutants as well as through resource conservation. Resource conservation takes place both during construction and during the operational period of the dwelling through the use of recycled
materials and the installation of water saving faucets, showers, and toilets (Energy Star Saskatchewan, 2013).

**Energy Star Homes**

Energy Star is essentially an international symbol for energy efficiency within a residential housing setting. By placing the Energy Star logo on a product a buyer is guaranteed that the product is useful for energy reduction in some respect. What Energy Star represents is a partnership between governments and industry that focuses on saving money for consumers through reduced energy use and allows for greater environmental protection (Natural Resources Canada, 2009). Energy Star was originally created in the United States as part of the Environmental Protection Agency in 1992 (USEPA, 2013). The program was created as a part of the Clean Air Act in the United States. In Canada, Energy Star works as a voluntary program administered by Natural Resources Canada’s Office of Energy Efficiency (Natural Resource Canada, 2009).

Energy Star is a partnership between Natural Resources Canada and organizations that manufacture, sell or promote products that meet Energy Star levels of energy efficiency (Natural Resources Canada, 2009). The program has evolved to include a standard for labeling homes as energy efficient within Canada. Homes built using the Energy Star guidelines for new homes are models of energy efficiency and generally perform around 20% more efficiently than homes built to provincial or national building codes (Natural Resources Canada, 2012). For a home to be designated as an energy efficient home it must meet a number of specifications
that promote energy efficiency and residential sustainability. On-site energy
advisors to evaluate the homes ensure high quality and true energy efficiency. These
evaluators are recruited, trained, and certified by Energy Star for new homes and
Natural Resources Canada (Natural Resources Canada, 2012).

There are a number of specifications that must be met for a home to be
certified as an Energy Star home. These can include more energy efficient space
conditioning systems including furnaces, air conditioners and water heaters to help
reduce consumption. Key areas of heat loss such as windows, patio doors and
skylights can only use Energy Star approved products that are capable of reducing
energy costs by up to 10% without any other features (Natural Resources Canada,
2012). More insulation is required by Energy Star homes than is required by general
building codes in Canada and homes must meet air leakage limits to save heating and
cooling costs while increasing the comfort of the home. Lastly, each Energy Star
qualified home has a minimum of 400 kWh of energy saving measures through high
efficiency appliances and lighting options (Natural Resources Canada, 2012). All in
all the Energy Star program is another valuable system for labeling homes as
sustainable or energy efficient through strict guidelines leading to reduced
consumption and increased comfort to homeowners.

What are best practices?

Best practices are essentially methods or techniques that have consistently
shown superior results to other means that are used as a benchmark (Business
Dictionary, 2013). With respect to sustainable home construction a number of
factors come into play when evaluating best practices. For instance, it is important for residential homes to meet certain levels of energy efficiency to be considered best practices. Cost is also a significant part of the conversation. If a practice is not economically feasible within a Canadian context there is no way that it could be considered a best practice. Obviously there are individual construction aspects of residential homes that could be considered a best practice but the number of interchangeable methods and techniques in this respect is quite immeasurable. For this reason, there are a number of institutions that grant certifications for homes as using a certain level of best practices in construction. These organizations can include the EnerGuide Rating System for New Homes, Energy Star for New Homes, R-2000, Built Green Certified Builders in British Columbia, the Canadian Green Building Council as a LEED certifier, and Net Zero Housing just to name a few (City Green Solutions, 2012). Each of these organizations or systems allow for a measurement of how a home complies with the proven best practices that are available for energy efficient housing. Inevitably, when looking towards best practices it is advantageous to look to such certified organizations to allow for a guaranteed best practice compliant home and thus a step closer to truly sustainable housing in Saskatchewan.
Chapter 4
LOW INCOME HOUSING
What is it?

Social housing is housing that is subsidized by governments and is made available to those who would otherwise be unable to live in adequate and suitable housing in private markets (CMHC, 2011). Social housing initiatives are often developed and carried out in partnership with private or public non-profit sectors in Canada. The range of people that are eligible for social housing in Canada varies significantly depending on the intended purpose of each development but can include low-income singles and families, immigrants, lone parents, persons with disabilities, and aboriginal peoples (CMHC, 2011). In Canada, social housing is funded mainly through agreements between federal and provincial governments and between either federal or provincial governments or social housing providers. As of 2010, the federal government of Canada subsidizes about 613,500 units long term within its social housing portfolio (CMHC, 2011). Annually the federal governments financial contributions to social or low income housing programs for subsidized housing units is $1.7 billion (CMHC, 2011). The majority of these funds are directed to the provincial or territorial governments for distribution throughout the nation.

There are a number of ways for social housing programs to take place in Canada. Habitat for Humanity operates in a way that the residents of the homes have an opportunity to own a home. The organization works through a mixture of
volunteer labor, efficient management, tax-deductible donations of money and material. The organization builds or rehabilitates homes that are safe and affordable with the help of volunteers and homeowner families (Habitat for Humanity, 2013). These homes are sold to partner families at no profit and are financed through affordable, no-interest mortgages (Habitat for Humanity, 2013). The mortgages are held in trust with Habitat for Humanity until paid off when they will be transferred to the family residing within them. The monthly mortgage payments are then placed into a revolving fund with the specific purpose of being used to build more homes for others in need (Habitat for Humanity, 2013).

Origins

Social housing began as a government policy instrument during a time of housing shortages. Affordable housing programs have been facing constant evolution over the past 65 years in Canada. However, throughout this evolution the primary goal of providing shelter for those that could otherwise not afford it have remain unchanged (CMHC, 2011). There are a numerous different associations and policies that have shaped the change of affordable housing in Canada. Each of these can be attributed to different root causes and origins.

Habitat for Humanity

The organization Habitat for Humanity was founded on the idea that partnerships between low income working families motivated to build a better home and others with the willingness to share resources, skills, and time (SaskBusiness, 2012). The roots of the organization began in the United States in 1976. Habitat for Humanity first opened in Americus, Georgia and has since spread to over 92
different nations, including Canada (Habitat for Humanity, 2012). In 1985, Habitat for Humanity began in Canada as construction began on a home in Winkler, Manitoba. Since this time, Habitat for Humanity has expanded with 72 affiliates spread across the country and representation in every single province. Inevitably, with over 50,000 volunteers annually Habitat for Humanity is able to function as a non-profit organization in Canada and globally (Huffington Post, 2012). In Canada alone, over 2000 homes have been built by Habitat for Humanity with the 2000\textsuperscript{th} home being built in 2011 in Winnipeg, Manitoba (Habitat for Humanity 2013).

**Struggles**

When evaluating social housing in Canada it becomes obvious that there are a number of serious hurdles that must be overcome for a valuable system to be in place and functioning. These obstacles are often associated with the costs of building a home and the associated administration costs with running an organization. However, timing issues can also be a factor when it comes to challenges with social housing. The challenges that are most applicable to social housing in Saskatoon include high property values and expensive financing.

**Property Values**

One factor that is frequently a challenge in the social housing industry is the rising prices of property values in certain cities. As cities grow there is an increase in the amount of low income housing necessary to meet the needs of the community. However, as cities grow the price tags associated with the property needed to build these homes can often increase. One example of such a situation that is close to home takes place in Saskatoon, Saskatchewan. Due to many lucrative industries expanding
in the city including natural resources, the oil sector, and a solid agriculture base all leading to increased demand for housing and a significant rise in home values (Remax, 2011). All of these industries have led to increases in property values at significant rates. In fact, between the years 2000 and 2010 property value in Saskatoon has risen, on average, by 163% (Remax, 2011). The average value of Saskatoon homes rose over this time from $112,567 to $296,293 (Remax, 2011). To put this increase in perspective average home value across the nation during this same period of time was valued at 106% (Remax, 2011). Inevitably, as a community grows the value of the property within it can rise significantly as well. Rising property values are something that can lead to significant challenges for social housing, as it becomes a reality that certain properties and areas are no longer feasible to select for building. The reality of this situation is that the social housing units are often erected in areas away from both public transit access and places of work. These are types of issues that surface when rising property values displace fixed income and low income people from affordable housing markets.

**Financing**

Another important factor that must be considered when analyzing the challenges that face social housing development are cost considerations and financing. Inevitably, building a home can be very costly. As in most social housing situations the main goal is to provide homes at an affordable rate and increase the amount of low-income units. To reach these goals it is difficult for an organization to maintain the level of funds that is required (CMHC, 2011). Non-for-profit organizations, such as Habitat for Humanity, also receive some of this government
funding but are mainly responsible for their own financing. An organization like this
must then find creative methods of gaining enough capital to help improve the lives
of various low-income families. Habitat for Humanity then raises the majority of its
funds through either donations of money or the ReStore (Habitat for Humanity,
2013). The ReStore functions by taking donations of new, gently used, or returned
goods that would normally end up in a landfill. Items can include anything from
windows, doors, paint, hardware, lumber, tools, and furniture (Habitat for Humanity,
2013). Inevitably, the profits from these ReStores are used to fund home
construction projects across the nation. This is an example of an “out of the box”
management plan that can be used by organizations to overcome challenges to fund
low-income housing projects and increase the amount of homes produced on an
annual basis.

**Opportunities**

Even though there is a wide range of challenges that face the concept of low-
income housing there are still many opportunities for improvements to take place.
As affordable housing needs to expand in Saskatchewan there will be increased
opportunity for the concept to be approved upon in a way that is valuable to both
homeowners and the community as whole. The two most important opportunities
that could improve the quality of low-income housing in the near future include
increased government partnerships and improvements to energy efficiency.

**Improved Partnerships**

Social housing in Canada is very much reliant on the availability of funds and
support from the government. It is equally important for a number of other
partnerships to be linked together for social housing initiatives to work in conjunction with normal housing growth. There is no simple solution in improve the social housing system but through vital partnerships with builders, developers, financial institutions, municipalities, low-income housing providers, and federal and provincial governments there is a significant opportunity for success in these projects (Government of Saskatchewan, 2011). The Government of Saskatchewan has already developed a Five Point Action Plan to improve the quality of housing within the province (2011). From this action plan there are a number of partnerships that help to improve the social housing situation, either directly or indirectly. These partnerships have spawned three main programs that contribute towards the implementation of low-income housing in Saskatchewan. These include the Affordable Home Ownership Program, the Rental Construction Incentive Program, and the Habitat for Humanity Partnership (Government of Saskatchewan, 2011). Through these partnerships there is the opportunity for a combined 630 owned low-income homes and 2900 rental properties produced within Saskatchewan (Government of Saskatchewan, 2011). This shows that the provincial government has taken solid first steps in improving the low-income housing situation in the province but still given the expanding population more needs to be done. Through similar partnerships and unification of varying industries there is definitely an opportunity for implementation of improved social housing programs in Saskatchewan.
Energy Efficiency

As already acknowledged, the majority of low-income families live in homes that are older and are forced to deal with inadequate insulation for attics, walls, and basements (Loney, 2009). This phenomenon takes place because of the cheaper rental rates or lower down payments required to live in the homes. Inevitably, even though homes are cheaper from the outset the upkeep costs are costlier and also utility bills are significantly larger than newer, more energy efficient homes. For this reason, there is a tremendous opportunity for improvements to affordable housing through the implementation of more energy efficient practices. Given that many low-income housing providers are often forced to deal with issues like tight budgets and limited financial support there are a number of reasons as to why energy efficient practices are advantageous (Affordable Warmth, 2009). Energy efficient retrofits can lead to as much as 30% reductions in household utility bills for the low-income users of the home (Affordable Warmth, 2009). Inevitably, the upfront cost of retrofitting or installing various improvements to energy efficiency within the home will lead to long term savings on utility bills, building operations, and maintenance costs (Affordable Warmth, 2009).

A focus on energy efficiency in affordable housing is often neglected and there are major opportunities for improvements in efficiency. This would help to combat the phenomenon known as “energy poverty” where low-income housing users allocate a disproportional amount of their income to utilities related expenses (Bird and Hernandez, 2012). Energy efficient practices could be administered in a number
of ways. The federal and provincial have administered a number of programs previous mentioned here. There is potential for new or improved government policies to help improve the livelihood of low-income homeowners. Also, there is the opportunity for builders and consultants to provide information to the public and low-income housing producers promoting the use of energy efficient practices and the associated cost savings. Lastly, organizations that develop affordable housing units have the clear opportunity to accept some upfront costs to allow for improved living conditions and cost savings for the low-income families in the long run.
Chapter 5
METHODOLOGY
Needs Assessment

For the project it became necessary to conduct a needs assessment to determine what aspects of home construction by Habitat for Humanity could be improved on and in what ways. The needs assessment consists of two basic sections of primary data collection. The first portion of the needs assessment involved in-depth interviews with Habitat for Humanity’s construction manager and resource development coordinator. The second portion involved a checklist being completed by Habitat for Humanity managers to determine what best practices are currently being used by the organization and what practices could be adopted.

Interview

The interview was conducted in association with Habitat for Humanity at their own office on July 15, 2013. The interview involved Habitat’s construction manager and resource development coordinator. These two were chosen because of differing backgrounds as one is involved in the actual construction process while the other focuses more on the inner workings of Habitat for Humanity as an organization. The interviews were completed on separate days due to scheduling conflicts and allowed for sharing of opinions and perspectives on sustainable housing and its place with Habitat for Humanity in Saskatoon. The interview involved ten pre-planned questions that touched on subjects involving residential energy efficiency including any barriers restricting efficiency or areas of strengths within the organization. Taking part in the study was voluntary for all participants.
The interview was recorded and transcribed to allow for easier interpretation. The interview guide and letter of invitation are available in Appendix A.

The audio-recorded discussions of the interview were transcribed verbatim, and lists of codes were generated. Codes that were similar in content were brought together to build themes. Guided by the objective of the study, the themes were sorted into headings and sub-headings relevant to addressing the problem. Direct quotes or expressions, retaining participants’ language, were used in supporting important points.

Best Practices Checklist

To determine the practices that are used by Habitat for Humanity currently and what techniques could be used in the construction process Habitat for Humanity was contacted directly. For this particular purpose, Habitat’s construction manager agreed to fill out a best practices checklist to help determine what practices are used and what should be used in future. The checklist contains a number of major categories and various techniques listed beneath them. Main categories within the best practices checklist include renewable energy systems, construction envelope, site envelope, appliances, and water conservation and reuse. The list has been filled out for each construction technique from a scale of zero to three. With this scale zero is a practice that is never used, one is rarely used, two is often used, and three is always used. Using this system it is evident which techniques that contribute to improved energy efficient residential construction practices are used and which can be implemented. The checklist was compiled based on research of both academic
and industry sources to determine what are considered best practices in the residential home construction industry.

**Determining Recommendation for Habitat for Humanity**

The results from the needs assessment for improved residential energy efficiency was used as a baseline to begin making recommendations for changes to management practices by Habitat for Humanity. Based on the needs assessment a variety of recommendations were produced. To determine what techniques are the most feasible for low income housing practices in Saskatchewan there has been a number of factors for each technique that must be addressed. Inevitably, cost will be a large part of the solution and thus the amount of time it takes for utility savings to exceed installation costs will be acknowledged wherever possible. From these annual saving values the amount of time a particular energy efficient practices takes to pay it off will be determined wherever possible. However, these values will not be used alone because for many factors the level of energy savings will vary drastically depending on the home. From these values and the needs assessment informed suggestions would be made based on the applicable cost restriction concerns and harsh climatic factors that are associated with the functionality of Habitat for Humanity in Saskatoon, Saskatchewan.
Chapter 6
RESULTS
Interviews

Current energy efficient techniques used by Habitat for Humanity

Understanding that Habitat for Humanity is a non-for-profit organization and faces many challenges there are still many techniques used by the organization that could be considered energy efficient. The quotes below display differing perspectives of the organizations ability to manage energy efficiency in Saskatoon.

The construction manager at Habitat for Humanity took the time to outline a variety of construction features that are used in building affordable housing and the important of combating problems such as air leakage. Habitat’s construction manager also notes that the techniques that they have chosen are ones that have a reasonably short amount of time before initial costs are repaid through utility cost savings. Insulation techniques are the main factor that Habitat for Humanity has placed focus on when considering energy efficiency as well as support structures such as insulated concrete forms.

“First one is our ICF basements, they’re Styrofoam forms they should have far better seals cause that’s part of energy conservation isn’t so much of keeping the heat in though one of the most important things is having a good envelope, air envelope, so you seal the house up you know you don’t have any air leaks coming in or out. The next one on avenue G we’re going to put 2 inches of Styrofoam underneath the basement floor to try to keep the ground from pulling heat out of the house it’s supposed to be quite energy efficient and the repay on it is like 3 years”.

“You know always Energy Star appliances; we get our fridges and stoves from whorl-pool Canada for free for every house we build. And then we buy Energy Star washer and dryer from them for cost plus price. Low flow showerheads. You know low flow toilets all the standard stuff. Yeah we’ve been looking at we do have some of the heat recovery systems for the waste
water heat recovery systems we’re going to try those in the one house on avenue J that we’re doing the ICF forming right up to the trusses. So we’re going to really try and make that as energy efficient as possible for that house. Spray foaming leaks and around windows and things like that of course not every builder does it but we try to do the best we can because the most important thing is our low income homeowners once they move in you know don’t need those great big utility bills when its 40 below in winter or 40 above in summer. I was quite impressed with our house on avenue T we had one side of it been sitting empty and I was in there last week when it was you know close to 32 degrees out and I bet you it was 18 inside. So we must of done a good job on insulating for keeping heat in and out. You know we put the R-50 in the attics too. We’ve pushed that up to 16 inches or something blown in insulation in the attic. Spray foam on the floor joist ends and the seal plate because that’s a tough spot to get good insulation and a good seal in there so we spend a little extra money and put the closed cell spray foam on it.”

In the interview, Habitat’s resource development coordinator took a different approach and instead focused on the other reasons that energy efficient techniques are used. The quote below acknowledges the fact that affordable housing producers can often promote themselves as energy efficient as a means to gain funding from corporations and other contributors.

“We use it, to be brutally honest with you, to leverage for funding. People want to associate themselves with projects that are sustainable or appear to be sustainable. And that are green. And allot of times when we ask for funding corporations will ask us whether or not we incorporate those practices into our homes and they want details.”

Barriers to implementing energy efficient techniques

Through both subsequent interviews with the construction manager and resource development coordinator common themes were drawn upon as barriers that prevent Habitat from Humanity from implementing for energy efficient techniques. Both interviewees focused on the issue of cost when considering these particular barriers. In the quotes below it can be observed that Habitat’s resource
development coordinator directly noted the costs of new technologies to be an issue but also acknowledged that this may simply be a perception. Inevitably, spending more money upfront in home construction would make it difficult to meet the main objective of providing affordable housing to families. Habitat’s construction manager specifically noted windows as an example of how the costs of implementation simply are not worth the investment because of the low value of natural gas at current times.

“The technology that is incorporated or has been developed to increase efficiency is quite costly. Or at least it’s perceived to be costly.”

“If we have to incur extra costs to get sustainability it’s going to go against our main goal which is to build a home that’s affordable for a family at a low income to purchase.”

“Mostly cost. I’d like to upgrade to triple glazed windows but you know that’s just about 40% more and just its really hard to justify it.”

“You know there is a big jump from we use low E double glazed sliders to go to uh triple glazed casement windows, which are like the awning type, you know they’re much more efficient and seal better when they’re closed but you’ll never save the natural gas, at least at our prices today, to make it worthwhile to spend the extra money.”

**Use of rating systems**

During the interviews both men were asked whether Habitat for Humanity had or was planning on having homes certified as energy efficient through an entity such as the EnerGuide or R-2000 program. It was unanimous that there have been no such certifications at this point, however, there have been thoughts about taking part in something of that effect. Habitat’s resource development coordinator noted in the quote below that one of the main barriers to such certifications are added costs when the certification doesn’t truly add any value to the home.
"Part of the problem with getting them built and certified is there is allot of costs to have them inspected and the certification and the registration fees and things like that apparently can add up. Integrated designs had offered to help us, they have a relationship with these organizations and they were going to try and have them wave that fee for us."

Passive solar and climate considerations

Due to varying climatic conditions in the province of Saskatchewan it was asked whether these factors played a significant role in the design of homes for Habitat for Humanity. Also, from an individual basis the utilization of passive solar positioning was put in question for heating and cooling of the home. Passive solar is a method of utilizing the suns energy without any mechanical or electrical equipment involved. It was noted that the homes built here vary different from homes built within the rest of Canada, however, both Habitat’s construction manager and resource development coordinator acknowledged that passive solar systems were generally not used in Habitat build homes. The quotes below explain this lack of utilization and provided reasons for it. Inevitably, there would be higher fees to plan different building for each individual home and to reduce costs Habitat for Humanity sticks to a few approved blueprints for all homes.

“Not so much passive solar, we tend to reuse our blueprint time after time and keep building the same house so you know depending on which way the lot is facing and things like that it really isn’t a concern that we can do.”

“We could built dual wall homes where you have 2 walls where the studs aren’t connecting and there’s no thermal bridging, passive solar we could incorporate that but the problem is that there is fees we would have to pay an architect to approve the designs so what we have done in the past is just have a standard duplex design that we just use.”
Cost effectiveness of energy efficient designs

When considering the cost effectiveness of energy efficient designs there were some very good points made by both Habitat for Humanity employees. Each agreed that the startup costs for the implementation of energy efficient practices would be too large. The quotes below outlined this well as Habitat’s resource development coordinator stated that energy efficient practices would be good for the homeowners long-term but given the nature of Habitat for Humanity this is simply not an option at the time being. Habitat’s construction manager added to this that the return on investment for some practices was simply too long to make sense for an organization like Habitat for Humanity.

“I think the startup cost is too large but I am also speaking from a point of ignorance, I guess, because I can’t say that with authority. I know some technologies are still quite expensive and others are reducing in price really drastically.”

“It would be worth it for the families but we operate not only as the builder but also as the bank. We provide the mortgage for the family as well so as much as we would like to implement efficiency that would create long term affordability for the families it doesn’t…it’s a barrier to building an affordable home.”

“Probably the startup cost like I said we have to take it on a new item by new item basis right and see because you know sometimes it is worth investing money if there’s going to be a fairly short payback but I can’t put things in houses that are going to take 15 years to recoup the costs. It just doesn’t make sense for the homeowners.”

Opportunities for improvements for energy efficiency

When asked about what potential energy efficient would be the best suited for Habitat for Humanity homeowners there were some very useful responses. Initially, Habitat’s construction manager mentioned that based on work with a
thermal imaging camera he is planning changes to the designs of homes. In this way, Habitat for Humanity is willing to make changes when the opportunity arises.

Habitat’s construction manager also noted that increasing insulation into basement floors and adding solar power attic ventilators would be useful. Habitat’s resource development coordinator also mentioned solar power but claims to be in favor of photovoltaic panels to capture energy from the sun. This would allow for the homeowner to save energy costs and to sell the extra energy back to the grid. These related quotes are found below.

“I’m reengineering the way we do around our windows and or window headers and stuff to try and cut out some of the lumber. Then still have it structurally sound but get a little more insulation in there so I noticed that in particular in that house on avenue W we were in with the thermal imaging camera that above the windows was all dark that’s the cold spots in the rooms. Cause that’s usually solid spruce up there so we can cut it down and put 2 inches of high density Styrofoam in there and get R-20 out of it. Or R-15 anyway.”

“I would love to see us be able to farm out solar power from the roofs of our Habitat homes. And I think provincial legislation prohibits that right now. I know it’s done allot in California. We could rent roof space from homes that we have built, sign a contract with the homeowners, that we will pay them either x number of dollars a month to have the solar panels on their roof and we will collect the revenues from energy produced. The homeowners would enjoy reduced energy costs, electrical costs. So it’s a way of supplementing our bills it’s a way of keeping their monthly bills down and it’s a way to produce clean energy.”

“Like I said we’re going to do the Styrofoam under the basement floor I think that’s a really good one. Lots of like uh I emailed you last week about the attic ventilators. Solar powered attic ventilators. I think that’s a heck of a good idea because that really helps keep your house cool. Because the attic in a house can be 150 or 140 degrees on a sunny summer day. Even when the outside temperature isn’t that hot. So it helps keep the house cool. And it’s a pain to do afterwards because they have to be wired and a solar powered one doesn’t and you only need it when the sun shines. So I think that’s going to be really good and we’re getting them free from the manufacturer.”
Habitat for Humanity homes vs. industry standards

When asked to compare the industry standards for energy efficiency to that of Habitat for Humanity, Habitat’s construction manager claimed that the homes build by Habitat would be as efficient if not more efficient. The reason for this is a result of ensuring good air sealing and windows were mentioned as the only significant drawback. These comments can be viewed in the quote below.

“We’d be close or better. Just because I make sure that we do take a little extra time in sealing the house. The ICF basements are just starting to get more popular. So window wise I think that would be about like I said before our only drawback is that we don’t have the best windows. Windows are generally less than 20% of your outside wall. So you know I can build a 2 by 8 wall and put extra insulation in and it would cost minimal amount, a thousand dollars more, per house. And ah if I upgraded the windows it’s going to cost three thousand extra. It just doesn’t make sense.”

Government programs

From the information obtained from these interviews it became clear that government policies are not available to help improve energy efficiency for organizations such as Habitat for Humanity. Both Habitat’s construction manager and resource development coordinator touched on this concept in the quotes below.

“To be honest with you as it stands right now provincially and federally there are no incentives or financial help for us to build in an efficient way.”

“Yeah, they don’t have any not that I’m aware of anyway any grants or anything like that for low cost housing to make it more efficient.”
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Interviews with the construction manager and resource development coordinator proved to be vital to understanding the needs and inevitable setbacks of Habitat for Humanity with respect to the implementation of energy efficient practices. Concerning the practices that Habitat for Humanity is currently implementing to move in a more energy efficient direction there is reason for optimism. Clearly, the organization has acknowledged the value of energy efficiency to homeowners in the long run and have evaluated some practices that are more cost effective. It is important to note that the practices that have been applied through Habitat for Humanity’s builders are ones that focus on the three main topics discussed in the literature review; R-value, air leakage, and thermal bridging. As these have been recognized as the most important areas of focus in terms of heat loss and utility bills it is a step in the right direction to see that Habitat for Humanity is implementing some energy efficient best practices. Some of these practices that Habitat’s construction manager noted briefly included insulated concrete forms, Styrofoam insulation for basement floors, spray foaming sealant issues, and R-50 insulated attics. The importance of these practices is that it displays the foresight to invest money in the construction stage of the home to create a better quality living space for low-income families while saving them money on utility bills in the long run. Another important factor that was revealed during these interviews by Habitat’s resource development coordinator is the fact that Habitat for Humanity considers
the possibility of branding homes as energy efficient to receive extra funding from donors. The possibility of this leverage opens future opportunities for the expansion of the energy efficient practices that are already common practices within the organization.

The interviews also provided an excellent overview of the barriers that face Habitat for Humanity on a daily basis and how these impact the effective implementation of energy efficient practices. Inevitably, these barriers were broken down to include the financial deficits that would be caused by energy efficient techniques in the short term. The issue for an organization such as Habitat for Humanity is that funds must be allocated to provide housing for low-income families first and all other factors must take a back seat. In this case, it does not make sense for the organization to focus on improving energy efficiency when those extra costs would increase the price of the home for potential homeowners and reduce the number of homes that could be produced in total. It is also valuable to note that current low costs of heating homes make this an easier factor to ignore. In the future should costs of natural gas or electricity increase significantly a switch to energy efficient practices would be easier to accept in terms of short-term finances.

One of the most interesting concepts that the interviews brought up was the value of certifying a home as energy efficient through programs such as EnerGuide or R-2000. When consulting literature regarding these programs they appear to be ideal as it is always valuable to improve the energy efficiency of a home. However,
Habitat’s resource development coordinator noted that the costs of having homes inspected and certified is not always worth it. Inevitably, if this certification does not gain the homeowner anything in the long run there is no point allocating funds towards it. This does not mean that homes were not energy efficient it simply means that there are likely a number of energy efficient homes that are not certified simply to avoid the costs of the certification process. In reality, all saving from energy efficiency are bestowed upon the homeowner whether the home is stamped as efficient or not.

Inevitably, climate must come into play when designing a home in a harsh climate like that of Saskatchewan. However, this does not necessarily mean that the designs will change with differing homes in the same area. This became clear for Habitat for Humanity as cost is a factor in determining the amount of passive solar or climate considerations put into building a home. As fees for either an architect or engineer to approve a different blueprint for each home would be understandably large it makes sense that a low budget organization would try to avoid. Those working at Habitat for Humanity explained in the interviews that the same blueprint is essentially used over and over to cut those costs. In terms of climatic factors this isn’t a significant issue as this was addressed in the original blueprint. However, options such as passive solar are disregarded in this process. Passive solar is a relatively inexpensive way to improve the efficiency of a home through simply the direction of large windows in the home or utilizing skylights. For this reason, passive solar is a feature that could be more widely utilized to improve the energy efficiency
of homes built by Habitat for Humanity particularly if the site planning costs can be mitigated or reduced.

The interviews provided valuable information on the thoughts of such organizations on the concept of household energy efficiency. Both acknowledged that startup costs would be too large citing the major barrier of financing to be the primary issue. Truthfully, the cost is not the true disadvantage but the amount of time it would take for the energy efficient practices to pay for themselves through utility savings. If this payback period were merely a few years the adoption of energy efficient practices would be significantly higher. Unfortunately, many energy efficient practices represent long-term investments that will pay themselves off in saving within a decade or more. This timeframe certainly does not fit within the boundaries of Habitat for Humanity because funds within that timeframe must be used to begin other homes for families in need.

The interviews allowed for a look into what Habitat for Humanity's plans for the future were and what could be considered useful for adopting energy efficient practices. What was a good sign of future improvement is that both interviewees had very specific ideas as to what could be implemented and why they would be valuable additions. The construction manager acknowledged that viewing thermal imaging photos of homes has changed perspectives of what should be done when constructing homes and this is a positive sign that progress will be made to address these issues as they arise. Also, as many of the suggestions made by Habitat's
construction manager are already being put to use on a few houses in Saskatoon there is the distinct possibility that these practices could be widely adopted into all Habitat homes. Habitat’s resource development coordinator suggested that photovoltaic panels be put in place to help counter balance utility costs. However, given the payback period of 2.35 KW panels being just under 20 years these may not be feasible under the restrictions acknowledged by Habitat for Humanity. This solar panel pricing information is available within the appendix. Potentially, as the cost of solar panels comes down with wider application this will become a more financially feasible solution as the environmental and long-term utility savings are substantial. However, the idea of solar powered attic ventilators to keep the home cool in the summer is a valuable option for retrofits because expensive wiring and setup costs can be avoided while the home will remain more comfortable and reductions to cooling costs will be found.

Throughout the interview sessions it became evident that as Habitat for Humanity has restrictions in costs there is still a major effort put towards ensuring that the end user receives the highest quality product possible. This meant that Habitat built homes are more efficient than homes build to code because of the desire to ensure a quality home for the homeowners. Habitat’s construction manager mentioned addressing issues such as air leakage to improve efficiency. The only true downside compared to other homes would be using double glazed windows instead of triple glazed, however, this is once again a cost issue that faces the organization.
Currently, there are no government programs to address the implementation of energy efficient practices for low-income housing organizations. This is a factor that was brought up in the interviews and should be addressed moving forward. As the government often provides a good portion of the funding for social housing it would be very important moving forward if government took action in this initiative. Policy decisions such as increasing the minimum building codes or subsidizing costs on energy efficient practices could be acceptable solutions.

**Best practices Checklist**

The best practices checklist, as completed by the construction manager at Habitat for Humanity, distinctly outlines the energy efficient practices that are currently used at Habitat for Humanity and what aspect could be adopted. These practices that are used by Habitat for Humanity clearly outline the need for homes in Saskatchewan to be adequately insulated to allow for as little heat loss as possible in the winters. Habitat has pinpointed many cost effective methods of adding insulation to the homes including super insulating the ceilings and adopting the use of ICF to allow for increased R-values to basement walls. Combating air leakage was considered a priority and based on the checklist this can be confirmed. Inevitably, the barrier of costs plays a large role into what is used in construction by habitat for Humanity and many of the efficient appliances and high efficiency furnaces are available due to partnerships with varying corporation allowing for low cost equipment. These partnerships have proven to be key in the implementation of many best practices around the Saskatoon area by Habitat for Humanity. As noted from the interviews, the implementation of passive solar is limited due to high costs.
of redesigning homes and photovoltaic panels are simply not feasible with the large
payback period they require. However, Habitat for Humanity uses a variety of best
practices that help to improve R-value, reduce air leakage, and stop thermal bridging
which is the key to reducing utility costs. Although there are many techniques that
could be improved upon, given the cost restrictions of this organization there are
still energy efficient practices available in the market to help improve the comfort,
energy costs and living conditions of potential homeowners.
Chapter 8  
RECOMENDATIONS  
Construction practices

Although there are many technical factors that Habitat for Humanity is doing very well there is always room for improvement. As far as construction practices that help contribute to the energy efficiency of the home there are a few practices that would make sense in Saskatchewan given the cost of techniques and the variable climate. Inevitably, these practices generally come back to the three most important factors as discussed earlier including R-value, thermal bridging, and air leakage. As these areas of home construction are widely viewed as having the greatest utility bill savings. Insulation is always a key factor in cost savings and for this reason it would be valuable for Habitat for Humanity to begin super insulating homes with walls to R-50. This would make a significant difference from the current R-30 used in the homes and would help to deal with drastic temperature changes that face Saskatoon, Saskatchewan, on a regular basis. Also, Habitat for Humanity is currently planning to introduce basement floor insulation to R-7 to keep the cold ground temperatures from entering the home. This would be a valuable change as it could be quickly added during the construction process. Another practice that could be used more frequently to combat the process of thermal bridging would be to install double walls within the homes. Within these walls studs do not pass through from one wall to the other and thus hot and cold temperatures are not given an easy pathway to travel through. This process would add lumber costs to the construction
but once efficient building plans are put together this cost would be minimal in comparison to the level of lowered utility bills.

As triple-glazed windows are too expensive to adopt it is vital that the double-glazed windows be used by Habitat for Humanity to avoid air leakage. This can be accomplished through careful installation followed by proper sealant. It was acknowledged that the windows were a weakness of the construction process. This has led to Habitat for Humanity re-evaluating practices to allow for more insulation surrounding the windows, which is an excellent practice to improve home efficiency.

Lastly, the use of solar panel attic ventilators is a practice that could provide significant gains for the homeowners of Habitat for Humanity built homes. As these units are solar powered they draw no power from the system and allow for the home to avoid high temperatures caused by transfer of heat from the sun to the attic. Inevitably, there are a number of other practices that could work in the long run but these practices are those determined to be most advantageous in Saskatchewan given a low construction budget with Habitat for Humanity.

**Partnership arrangements**

There are a number of partnerships between Habitat for Humanity and other organizations that should be initiated or strengthened if the goal of sustainable housing is possible. Most importantly, from a certification perspective it would be advantageous for Habitat for Humanity and groups such as the EnerGuide program or R-2000 homes to help bring in the energy efficient certification of low-income
housing. Habitat’s resource development coordinator noted the potential for fee waivers for inspections and certifications of Habitat for Humanity housing. By waving fees these organizations would gain more widespread acknowledgement as being superior energy efficient homes and likely obtain a positive media presence for working with affordable housing initiatives. From the viewpoint of Habitat for Humanity there are a number of benefits to such certifications. As energy efficient processes are often used, as a way of lobbying for funds amongst other donors and organizations the certification would be valuable in proving the efficiency of homes and increasing the level of funding put towards the construction of new homes. Another advantage to the homeowners themselves would be that these homes would need to meet high standards of energy efficiency to be certified and would thus provide a quality product that is both comfortable and has more affordable utility rates over the years.

**Government Policy**

From a policy perspective there are a number of changes that could be made from either federal or provincial levels to allow for increased adoption of energy efficient housing. This could take place through a variety of pathways to create higher levels of efficiency for both affordable housing and standard housing formats in Saskatchewan. Firstly, as it has become evident that there are far too few government programs in action that work to promote energy efficient housing there is a need for a greater implementation of such programs in Saskatchewan. This could be administered by the provincial government and be focused largely on affordable housing organizations looking to build homes to either be owned or rented by low-
income families. By subsidizing the implementation of energy efficient practices at the initial installation the cost burden placed on the users would be significantly reduced. The real value from a program like this is that it establishes a means for the portion of the population that would benefit the greatest from reduced energy costs the opportunity to benefit from reduced energy costs. As discussed earlier through the idea of the “EligAbility Gap”, low income families struggle to come up with the funds to install much needed energy efficient techniques into the home and a government program would be vital in establishing a greener level of affordable housing within Saskatchewan.

The next suggestion regarding policy decisions requires a more overarching approach to increase efficiency at a larger scale. Inevitably to make such changes it would be pertinent to make significant changes to the building codes within Saskatchewan for new homes. It would be valuable to change these codes to address energy efficiency at a larger scale to help increase the implementation of more sustainable practices in the province. Increasing the minimum standards for housing in the province would allow for more a higher level of availability of these practices in the province and would force homes to accept standards. From a personal perspective, a move away from prescriptive building codes would be the most advantageous. By simply basing codes on energy efficiency results there would be a greater interest in trying new methods to reach the same level of efficiency as other homes and in turn promote new energy efficient practices within the province. Through changes of building codes it could be possible to significantly increase the
adoptability and availability of many energy efficient building practices to all homeowners.
Chapter 9
CONCLUSIONS

Throughout the course of this study there has been a variety of information collected regarding the concept of sustainable housing with Saskatchewan. The end goal has always been to discover what energy efficient practices are the most suitable for Saskatoon, Saskatchewan, while still conforming to the organization limitations associated with low income housing builders such as Habitat for Humanity. To accomplish this, the concept of sustainable housing was examined in depth from a variety of different levels to provide ample background information to apply the concept to the construction practices of Habitat for Humanity. Also, the understanding of the inner workings of social housing programs allowed for the understanding of restrictions and opportunities involving such home construction. There have been a wide range of practices examined for feasibility in Saskatchewan but it is most frequently cost restrictions that deter their use. The most important factors for reducing costs were identified as R-values, thermal bridging, and air leakage. Through a study of Habitat for Humanity including interviews of the construction manager and resource development coordinator as well as the completion of a best practices checklist for construction practices the energy efficiency of Habitat for Humanity could be evaluated. Inevitably, the organization currently uses a variety of energy efficient construction practices to provide the greatest possible product to the associated homeowners. Even through barriers such as limited budgets there is, however, the opportunity for improvement and increased level of energy efficiency for Habitat for Humanity in Saskatoon,
Saskatchewan. This improvement could be improved upon through physical construction practices such as increasing the insulation of walls, ceiling, and floors, double wall construction practices, proper sealing techniques, and the use of solar powered attic ventilators. To make more changes it would be vital for Habitat for Humanity to improve partnerships with sustainable housing organizations to increase the scope of efficiency. Finally, for major changes to be made in the housing market there is the need for policy instruments to become active such as funding and subsidies for social housing groups constructing energy efficient homes or through changes to the provincial building code of Saskatchewan. Overall, Habitat for Humanity has made steps in the direction of sustainable housing but there is still a wide range of techniques that would make this movement further.
Acknowledgements

Throughout the process of completing this project there are a large variety of people that I would like to thank for making this all possible. First and foremost I would like to thank my advisor Dr. Bob Patrick for taking me in and helping to form the main framework of this project. From outside of the academic world I would like to thank all those that contributed in association with Habitat for Humanity in both guidance and providing data for the project. These people include Graham Dickson, John Beechinor, and Shane Wolfe. Last but not least I would like to thank my family as well my loving partner Megan Clarke for all the support over the past year. I really could not have accomplished this without the help of all of those on this list and to all those that helped in any format thank you dearly.
Resources Cited


Appendices

APPENDIX A

A: Interview Guide

1. Explain some of the ways that Habitat for Humanity is currently using sustainable or energy efficient techniques for home construction.

2. What are some of the barriers to an organization like Habitat for Humanity to implement more energy efficient techniques on a wider scale?

3. What types of home retrofits, if any, have homeowners been making to homes after they have been purchased that you are aware of?

4. Has there been any attempt to have Habitat for Humanity built homes rated through the Natural Resources Canada’s EnerGuide system or any other benchmark?

5. Has Habitat for Humanity built any homes in Saskatoon that are certified as Energy Star or R-2000 homes? Has the idea of this certification been brought up in planning sessions at all?

6. Given your connection to the organization what energy efficient measures do you feel would be the most advantageous for both the homeowners and the organization if adopted here in Saskatoon?

7. How much does the climate of Saskatoon come into play when planning a home? Are things such as passive solar considered and do designs vary drastically from other Habitat for Humanity built homes in Canada?

8. Do you feel that more energy efficient designs would be a more cost effective practice for homeowners or is the startup cost too large?

9. How would the energy efficiency of a Habitat for Humanity built home compare to other homes being built in Saskatoon?

10. In what way does the government, either federal or provincial, contribute towards the implementation of energy efficient practices at Habitat for Humanity? Is there any funding accessible for energy efficient low-income housing?
To whom it may concern,

My name is Kurtis Trefry. I am a graduate student within the School of Environment and Sustainability at the University of Saskatchewan. I am conducting a research study as part of the requirements of my degree in Sustainable Environment Management, and I would like to invite you to participate. This study is being conducted in a joint partnership with Habitat for Humanity.

I am studying sustainable housing practices by Habitat for Humanity. If you decide to participate, you will be asked to complete a brief interview regarding the energy efficiency of Habitat for Humanity built homes.

Particularly, you will be asked questions regarding the energy efficiency of residential homes, barriers to implementation of energy efficient practices, and what best practices would be best adopted. The interview will be conducted verbally and will be recorded for easier interpretation later.

Taking part in the study is your decision. You do not have to be in this study if you do not want to. You may also quit being in the study at any time or decide not to answer any question you are not comfortable answering.

I will be happy to answer any questions you have regarding the study. You may contact me at 780-812-0975 and kmt013@mail.usask.ca if you are interested in participating or have any study related questions or problems.

Please place a signature below if you are willing to participate in the study given the above factors.
APPENDIX C
Solar Power Pricing Table

<table>
<thead>
<tr>
<th>Solar Array Peak Power</th>
<th>2.35 kW</th>
<th>3.5 kW</th>
<th>4.7 kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Monthly Output (kWh/month)</td>
<td>350</td>
<td>535</td>
<td>715</td>
</tr>
<tr>
<td>South facing Roof Area required (sq. ft.)</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Savings per month ($)</td>
<td>42.84</td>
<td>65.484</td>
<td>87.516</td>
</tr>
<tr>
<td>Savings per year ($)</td>
<td>514.08</td>
<td>785.808</td>
<td>1050.192</td>
</tr>
<tr>
<td>Cost to install ($)</td>
<td>18000</td>
<td>23500</td>
<td>29000</td>
</tr>
<tr>
<td>Years to Repay Costs</td>
<td>35</td>
<td>30</td>
<td>28</td>
</tr>
</tbody>
</table>

(Suncatcher Solar, 2013; City of Saskatoon, 2012)