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Reducing The Energy Consumption Of New Constuction Residential Buildings In Ontario: The Development Of Prescriptive Compliance Packages 20% Below Ontario Building Code Requirements

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REDUCING THE ENERGY CONSUMPTION OF NEW CONSTRUCTION RESIDENTIAL BUILDINGS IN ONTARIO

The Development of Prescriptive Compliance Packages 20% Below Ontario Building Code Requirements

by

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Abstract

Reducing the Energy Consumption of New Construction Residential Buildings in Ontario: The Development of Prescriptive Compliance Packages 20% Below Ontario Building Code Requirements

Alejandra Nieto
Master of Building Science, Ryerson University, 2013

To address energy concerns in new home construction in Ontario, advanced compliance packages have been developed that meet an energy reduction of 20% compared to SB-12 standards. The prescriptions are based on measures identified by homebuilders in the Savings by Design program.

Energy simulations using HOT2000 have been conducted to establish the optimum combination of measures that will enable builders to meet the target, for 3 different house archetypes. Additional analysis was conducted to determine the effect of building orientation; climate; thermal bridging; air conditioning; and the SHGC of windows.

A total of 9 advanced packages were developed. The findings from this study indicate that builders are more comfortable upgrading the systems components of a house as opposed to the building envelope components; different archetypes can reach the reduction target using different measures; and the other design factors must be considered in order to ensure the reduction target is achieved.

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List of Acronyms

AFUE	annual fuel utilization efficiency
AP	advanced package
ASHP	air source heat pump
BPI	building performance index
BTEC	benchmark total energy consumption
CCHT	Canadian Center for Housing Technology
CHBA	Canadian Home Builders Association
CMHC	Canadian Mortgage and Housing Corporation
CP	compliance package
EEP	energy efficiency practices
EF	energy factor
EGH	EnerGuide for Homes
EnEV	German Energy Conservation Regulations
EPA	Environmental Protection Act
ER	energy rating
ESTS	Energy Star for Homes Technical Specifications for Ontario
ETEC	estimated total energy consumption
DBC	Danish Building Code
GFA	gross floor area
GTA	Greater Toronto Area
HSPF	heating seasonal performance factor
IDP	interdisciplinary design process
IEA	International Energy Association
MMAH	Ministry of Municipal Affairs and Housing
NRCan	Natural Resources Canada
NZBC	New Zealand Building Code
OBC	Ontario Building Code
RCI	residential construction industry
SBC	Sustainable Building Canada
SBD	Savings by Design
SEER	seasonal energy efficiency ratio
TRCA	Toronto Region Conservation Authority
UKBC	United Kingdom Building Code
UNECE	United Nations Economic Commission of Europe
WWR	window to wall ratio

List of Units

GJ	gigajoules
GJ/m2	gigajoules per meter squared
kWh	kilowatt hours
m	meter
m^2	meter squared
m^3	meter cubed
MJ	mega joules
RSI	thermal resistance; $(m^2 \cdot K)/W$
U	thermal transmittance; $W/(m^2 \cdot K)$

1.0 Introduction

Energy consumption of buildings is a rising concern in the topic of energy conservation. According to Natural Resources Canada (NRCan, 2011), the residential building sector in Canada is the third highest sector in both energy consumption and greenhouse gas (GHG) emissions. Therefore, if we wish to reduce energy use and GHG emissions, it is crucial that new buildings be designed, constructed, and operated with energy efficiency in mind. However, in order to do so, builders and designers must understand the principles and practices of efficient design. Furthermore, government regulations and policies must act to support energy efficiency in order to ensure energy consumption reductions.

Building codes have recently begun to include energy efficiency requirements as an attempt to address the rising concerns of environmental impacts associated to the construction of buildings and building operations (Mark, 2012). The release of the Ontario Building Code (OBC) Supplementary Standard SB-12 (SB-12) in 2010 is an effort by the Ontario government to address the issues of energy efficiency within the residential sector. However, environmental concerns and industry feedback exemplify the fact that further improvements to the standards can be enacted.

The purpose of this research is to demonstrate that homebuilders can design and build buildings with higher energy efficiency using typical residential construction practices. To do so, prescriptive compliance packages that meet a reduction target of 20% compared to existing SB-12 OBC requirements for residential (Part 9) building have been developed. The packages have been developed utilizing practices and techniques homebuilders have identified to be appropriate and feasible during participation in the Savings by Design Program (SBD). In turn, this research will identify the capabilities of the residential construction industry (RCI) in Ontario, and potentially serve a guide of practices and techniques for the industry as a whole to adopt.

2.0 Background on the Residential Construction Industry in Ontario

The residential construction industry is composed of large to small scale companies specializing in either single family dwellings, multi-family dwellings, renovating and remodelling existing dwellings, developing neighbourhoods and communities or a combination of the above (Statistics Canada, 2010). Single family homebuilders can be sub-divided into three different categories: custom homebuilders, small volume homebuilders, and production homebuilders (CHBA, 2011).

Custom builders focus on building unique, usually higher-end homes, for specific clients. The land on which custom homes are built is usually owned by the client. Custom homebuilders are usually small firms which build an average of 5-10 homes per year (CHBA, 2011).

Single family small volume builders build standard or semi-custom homes. These homes are usually owned by the builder and sold after the home is constructed. Small volume homebuilders build an average of 5-10 homes per year (CHBA, 2011).

Single family production builders build standard homes at different price points; but build several homes using the same or similar set of floor plans. Production homebuilders, or developers, are large scale companies who usually focus on building communities within a specific region; often referred to as sub-divisions. The homes are built on land owned by the builder, and are usually sold during the pre-construction phases. Production builders build an average of 50-150 homes per year (CHBA, 2011). Many Ontario production homebuilders build both on a regional and national scale.

2.1. Typical Ontario House Archetypes

The Canadian Mortgage and Housing Corporation (CMHC) identifies the types of residential house archetypes as single-family detached, semi-detached, row/townhouse and apartments (CMHC, 2012). New home start statistics from 2003 to 2011 indicate that single-detached homes form the majority of

the new home developments in the Ontario Region; with an average of approximately 70%. Row/townhouses and apartments form approximately 20%; with semi-detached homes forming approximately 10% (Refer to Figure 1 below).

Figure 1: New Home Starts, Ontario Region, 2003-2011
Source: Adapted from (CMHC, 2012)

For the GTA Region, trends between 2009-2012 indicate that there has been an increase of new home starts for apartments; while the ratio between detached, semi and row houses have remained constant. Of the latter house archetypes, the detached house has the highest amount of starts and semi-detached the lowest (Refer to Figure 2, pg. 4). For the Ottawa region, the growth in new home starts of apartments has only seen a minor increase in 2012; while the construction of detached and row/townhouses form a similar, almost equal part of the total new home starts (Refer to Figure 3, pg. 4).

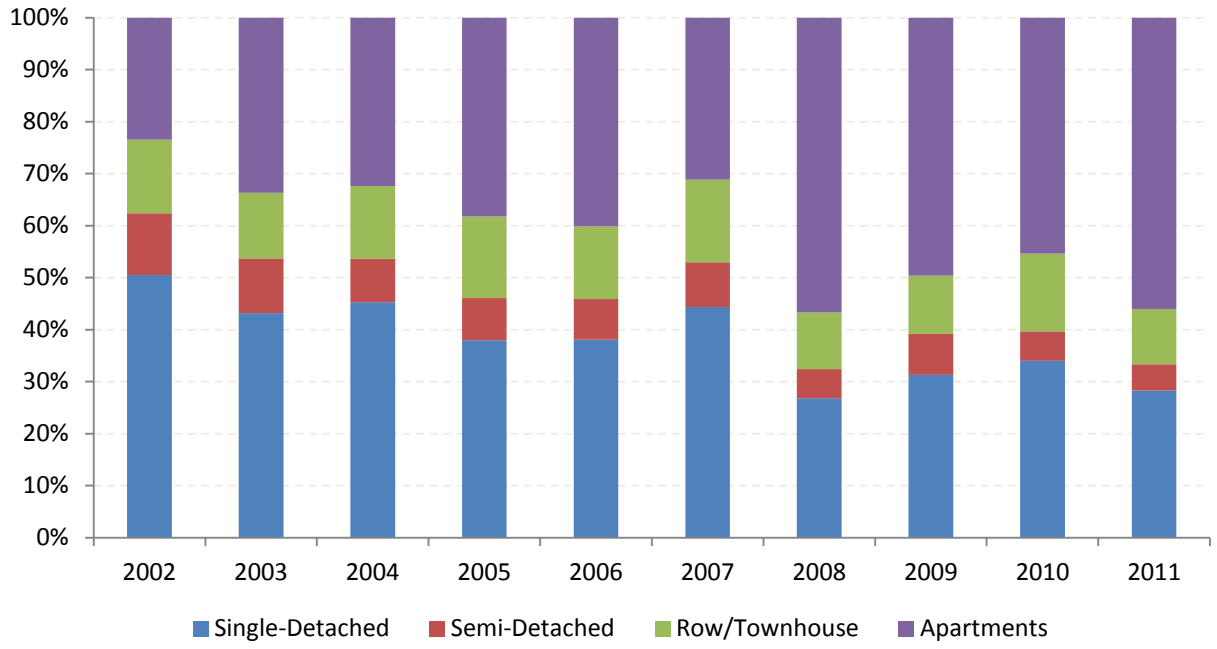


Figure 2: New Home Starts, GTA, 2009-2012f
Source: Adapted from (CMHC, 2012)

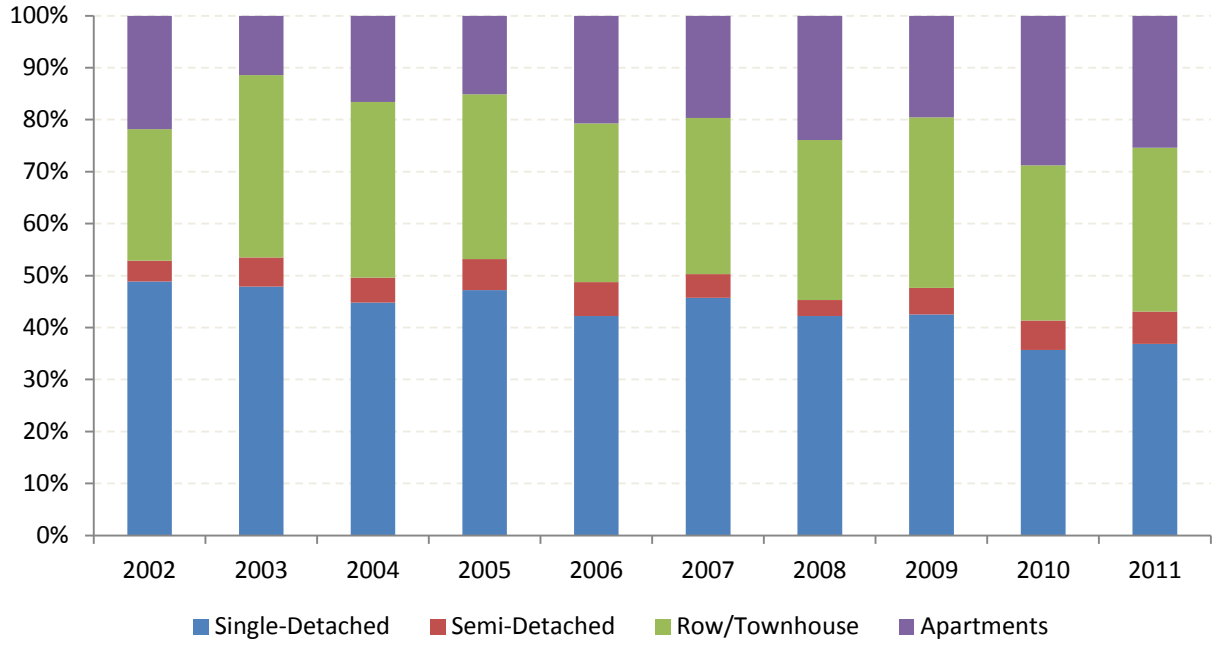


Figure 3: New Home Starts, Ottawa, 2009-2012f
Source: Adapted from (CMHC, 2012)

Based on the trends indicated by CMHC statistics, is can be concluded that the GTA region has seen a significant increase in apartment development, dominating the new home starts with approximately 55%. However, although the Ontario region as a whole also indicates the apartment as the highest new home start, the detached house still remains a significant house archetype, with 40% of the new home starts, followed by the row/townhouse and semi-detached respectively.

2.2. OBC Supplementary Standard SB-12

The OBC Supplementary Standard SB-12 (SB-12) is the latest update to building code requirements for Part 9 (low rise, single family residential) buildings in Ontario. The new residential standard requires all new home construction to meet and EnerGuide Rating (ER) of 80 or more when assessed in accordance to National Resources Canada's (NRCan) procedures. In order to ease the transition for builders, a series of prescriptive compliance packages were developed, with energy efficiency building envelope and mechanical specifications that will enable builders to reach the target. By following the prescriptive packages, the new houses are expected to achieve a 30% energy savings in comparison to homes built in accordance to OBC 2006 (Ontario Ministry of Municipal Affairs and Housing, 2010). Additionally, anecdotal references suggest that a new supplementary standard is expected to be released in 2014 with requirements that are 13% more efficient that SB-12.

2.3. EnerGuide for Homes

EnerGuide for Homes is a rating system, developed by NRCan's Office of Energy Efficiency, that demonstrates the energy performance and efficiency of a house in comparison to a benchmark. The energy efficiency of the home is rated on a scale of 1 to 100 where a rating of 1 represents poor performance such as a house with no insulation, and large air leakage rates while a rating of 100 represents a net zero energy house (NRCan, 2010). EnerGuide for Homes was developed as an optional guideline, to provide both builders and homeowners with the necessary expertise to build an energy

efficient house. The process of assessing a home under the EnerGuide rating system involves an evaluation of the original house to plans to provide recommendations for energy improvements. Once the house has been built, a third party certifier verifies that the upgrade have been applied and conducts a blower door test, prior to labelling the house with an EnerGuide Rating (NRCan, 2007).

2.4. Savings By Design Program

Savings by Design (SBD) is a program initiated by Enbridge Gas Distribution to help builders, by means of incentives and internal support, to improve the energy performance and limit the environmental impacts on new construction projects both in the residential (Part 9) and commercial (Part 3) sectors. The program began in 2011 and has been approved by the Ontario Energy Board. SBD focuses on four key areas: energy, storm water, resource use and engagement (Enbridge Gas Distribution). The end goal of the program is for the builders to achieve an energy reduction target of 25% compared to OBC requirements on the specified project. The reduction target can be achieved through building envelope and systems upgrades, with a minimum requirement of 20% reduction, and approved energy credits for the remaining 5%. In order to achieve the reduction target, the SBD program requires the builder to participate in an integrated design process (IDP), facilitated by Sustainable Buildings Canada (SBC). SBC is a non-profit organization dedicated to advancing building performance through training and support in best practices, IDP, and fostering opportunities between green member organizations and individuals (Sustainable Buildings Canada, 2012).

SBC describes the IDP as a multidisciplinary dialogue on energy and sustainability. During the IDP, builders are exposed to the necessary knowledge and skills of other industry professionals and experts that will allow for their project to reach the reduction target. The participants in the IDP include members of the participating builder's organization; members of supporting organizations such as Toronto Regional Conservation Authority (TRCA), EnerGuide for Houses, and the Federation of Canadian

Municipalities; and industry professionals such as energy modellers, building science consultants, product manufacturers and suppliers and city planners from the appropriate jurisdiction. The final outcome of the IDP includes a summary report of the proposed changes to the building design that the builder will be adopting in order to reach the reduction target; justified through an energy simulation (Sustainable Buildings Canada, 2012).

As part of the SBD program, Enbridge offers a financial incentive to the builders if their specified buildings (projects) successfully meet the reduction target. The process of determining the eligibility of this incentive and ensuring that the predicted savings has been achieved is based on validating the energy model and performance testing by means of a blower door test of the building after construction completion, similar to those conducted to EnerGuide certify a house (Enbridge Gas Distribution).

3.0 Literature Review

The current state of building regulations in Ontario is steadily attempting to place higher forms of enforcement regarding the energy consumption of new buildings. Therefore, it is important to understand how building codes address energy efficiency strategies. Furthermore, it is important to understand how the industry addresses more stringent energy codes and how they adopt energy conservation strategies. With that in mind, the focus of the literature review was to establish the role of building codes in the adoption of EEP, and look into the different compliance methods used to successfully implement efficiency strategies. In order to correlate the findings with the RCI in Ontario, a literature review was first conducted to determine the barriers and motivators in the adoption of EEP within the residential construction industry; in both the global and national context. Through determining the main barriers for Ontario homebuilders, insight will be shed on the role the OBC must play in the adoption of EEP. Additionally, a review of the methodological approaches taken to develop energy standards was carried out to compare with the methodological approach taken in this research study.

3.1. The Adoption of Energy Efficiency Technologies and Practices

The residential building sector has large potential to reduce the energy consumption used in the operation of buildings. Although the adoption of energy-efficient technologies is occurring in slow increments, contractors do see a rise in the market for clean technologies and practices (Dommisse & Pinkse, 2009). A vast amount of literature that identifies the barriers that hinder the adoption of energy efficient practices within the residential building sector is available. Specifically, the literature classifies the barriers and identifies the capabilities that are required to overcome them. A study by Deda and Golubchikov (2012) conceptualizes the key indicators for improved energy efficiency into five key "in" words: incentives, information, initiatives, innovations and investment. The common challenges

identified by this study can seen in Table 1 below. Other studies that present similar findings include those by Dommisse & Pinkse (2009); Hoffman, Theyel, & Wood (2012); and Mark (2012).

Table 1: Key conditions and barriers to improved energy efficient housing

Conditions	Barriers
Incentives	Low priority for energy efficiency
	Energy price subsidies
	Split incentives or principal-agent problems
	Poor enforcement of standards, corruption
Information	Information asymmetries
	Lack of awareness
	Lack of knowledge and expertise
Initiative	Lack of management or leadership
	Fragmentation of building sector
	Poor coordination and communications
	Political, organisational and structural barriers
Innovation	Path dependence in decision-making
	Technological lock-ins
	Market barriers for efficient technologies
	Technological backwardness, territorial inequalities
	Lack of affordable technologies, loss of traditions
Investment	Short-term investment horizons
	Uncertainties, risk
	Lack of financial capacities, limited affordability
	High "transactional costs", high upfront costs
	Opportunity cost barriers

Source: Adapted from Deda & Golubchikov, 2012

3.1.1. Barriers and Potential Solutions

Many of the barriers identified in the table can be categorized under more than one condition. Therefore, it is more beneficial to consider the barriers and associate them with their responsive condition. The following sections discusses the findings from other studies, relates them to the identified conditions, and considers solutions.

Split Perspectives between Primary Stakeholders

The stakeholders in the RCI can be divided into three different categories: primary internal stakeholders, primary external stakeholders, and secondary stakeholders. Figure 4 below identifies the main stakeholders within each category. While each of the categories provide unique levels if influence over the industry, studies have shown that under normal circumstances, primary external stakeholders demonstrate significantly more influence over the others (Mark, 2012).

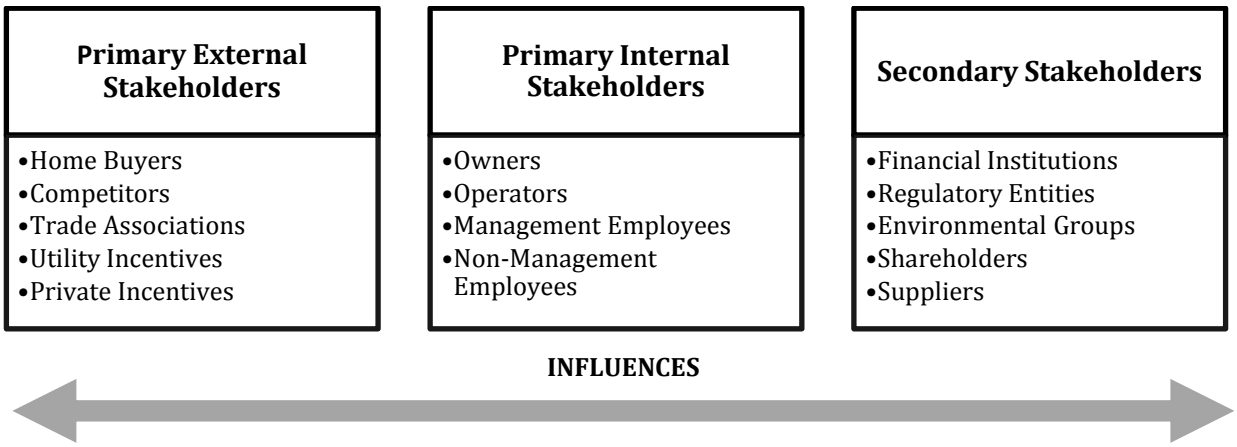


Figure 4: Stakeholders in the Residential Construction Industry
Source: Adapted from Mark, 2012

As society increasingly becomes more aware of energy efficiency, the market demand for energy efficient buildings has expanded. As indicated in Figure 4, homebuilders fall under the category of primary internal stakeholders, homebuyers are considered primary external stakeholders, and government regulators are secondary stakeholders; all of who are primary stakeholders in building energy efficient buildings. That said however, the construction industry has a low priority for energy efficiency. Anecdotal references claim that the construction industry is a conservative industry, where it can take many years for changes in practices and technologies to become accepted. Therefore, in an attempt to adhere to the market, there is the often misuse of marketing slogans such as "energy efficient buildings" or "low energy buildings". This misuse of slogans leads to either homeowners mistakenly believing that newly constructed buildings are automatically more energy efficient than older

homes; that the efficiency of a building is good even though it is not; or the stigma against energy efficient buildings where homeowners do not believe a building is energy efficient even though it is (Laustsen, 2008).

Indications also exist which suggest that the varying incentives and benefits between the builder and the other stakeholders can create contradictory situations depending on the viewpoint of the stakeholder. The study by Laustsen for the IEA (2008) , suggest the theory that since the decision makers in the building design (the builders and architects) will not commonly pay the future energy bills, the focus is kept to the initial capital costs of constructing the homes. Inversely however, those who will pay future energy bills (the homeowner), are not commonly involved in the decision making process. Similarly, if incentives exist between the builder or supplier where either party will benefit from continuous collaboration, the use of new practices and technologies will fall short due to the potential lack of benefits (Deda & Golubchikov, 2012).

Uncertainty and Risk

Uncertainty can be defined as a situation where the current state of knowledge is such that the nature of things is unknown; the conditions, consequences and magnitude of circumstances is unpredictable; and credible possibilities to outcomes cannot be assigned. Directly related to uncertainty is the prospect of risks; defined, from a business standpoint, as the probability that an actual return on investment will be lower than the expected return on investment (Web Finance Inc. , 2013). Therefore, as it relates to the RCI, homebuilders often see the adoption of different or new strategies and methods as a risk due to uncertainty.

Although too much uncertainty is undesirable, manageable uncertainty provides the freedom to make creative decisions (Web Finance Inc. , 2013). However, the ability to manage uncertainty requires certain capabilities. Builders, as with any established company, have existing internal methods and

processes. In order to adopt to changes in their methods and practices, builders must be able to gather information from the various stakeholders about new practices and technologies and combine them with their internal complementary knowledge. However, many times, builders lack this capability, and in turn, see potential improvements as risk factors (Bowen, Meacham, Moore & Traw, 2005; Deda & Golubchikov, 2012; Geels, 2004).

Management (Homebuilder) Capabilities

In order for a company to be successful in managing risks and addressing environmental challenges, the company must demonstrate high level leadership skills (Hoffman, Theyel, & Wood, 2012). Specifically, the company requires a higher level of integration between the involved parties and the ability to control or influence the primary stakeholders; including contractors and sub-contractors, suppliers and manufacturers, local governments and the local market (Albino & Berardi, 2012). In order to create this integration, a combination of capabilities, often referred to as dynamic capabilities, is required by the builders. Consequently, studies have argued that for the construction firms that are interested in adopting energy efficient practices, the lack of the company's dynamic capabilities can be considered the primary driving force, or lack thereof, in adopting energy efficient practices and technologies in residential buildings (Dommisse & Pinkse, 2009; Hoffman, Theyel, & Wood, 2012).

The study by Domisse and Pinkse (2009) found that the dynamic capabilities required by a contractor includes the following: the ability to gather information from various stakeholders about practices and technologies and combine them with their internal knowledge; architectural innovation that enables the required changes in building components to be achieved; and the ability to control the influence of the primary stakeholders in order to accomplish the required changes necessary to adopt new technologies and practices.

Innovation and Incentives

The concept of architectural innovation is a vital connection between the management capabilities required and the integration of the stakeholders involved. In order for architectural innovation to be successfully applied to a project, the new technology or method of practice must optimize the core design of the building. This can only be achieved if the company has a degree of specialization and qualifications, either through in-house or a direct relationship with the associated stakeholder (Dommisse & Pinkse, 2009; Albino & Berardi, 2012). Therefore, innovation must be further accompanied by internal motivation which is usually driven by incentives. If the builder or contractor does not have the expertise, they cannot properly communicate the technology to the home owner and thus, do not want to invest in new marketing strategies (Dommisse & Pinkse, 2009; Mark, 2012).

Subsequently, the role of incentives plays a vital role in the adoption, or lack thereof, of energy efficient building practices due to the lack of financial viability (Dommisse & Pinkse, 2009; Deda & Golubchikov, 2012; Laustsen, 2008). Given that the position of the homebuilder in the life cycle of a house is not during the operational period, builders are not motivated to change their practices due to the associated risks; such as potential increased capital costs and the inability to recuperate those costs due to market restrictions (Laustsen, 2008; Mark, 2012). Therefore, there is a need for governments to financially support homebuilders and manufacturers to offset increased initial capital costs of implementing new or unconventional technologies (Dembo & Fung, 2012).

In addition to providing the necessary incentives, government bodies and policy makers they can act as the innovators to providing the necessary changes required in the industry to adopt EEP (Dicke & Weber, 2001). However, it is important to note that they too require the connection with different industry stakeholders to acquire the necessary knowledge in current technologies and systems that will lead to reduced energy consumption in buildings (Geels, 2004).

3.1.2. Adoption of Energy Efficiency Practices in Ontario

Limited studies have been conducted on the RCI in Ontario, specifically identifying the barriers that hinder the adoption of energy efficiency practices or the existence of dynamic capabilities within the industry. One of the few studies, conducted by Dembo and Fung (2012), attempts to demonstrate whether or not Ontario builders are willing to adopt energy efficiency practices. The findings of the study conclude that homebuilders are willing to adopt changes in building components such as the amount of insulation in walls (to a certain extent) or the efficiency of the installed furnace. However, the areas on where they would not adopt changes, unless mandated by regulation, were in the roof insulation, window performance, and HRV efficiency. Further anecdotal references indicate that the internal motivation to adopt energy efficiency practices does exist within the RCI; but the associated capital costs and lack of financial incentives limits the areas of willingness to improve. This is especially demonstrated with production homebuilders where although they want to address energy efficiency in their homes, the market to which they cater to does not allow for increased capital costs. For example, if the homes are being built outside of the GTA, where the market value of a house is relatively lower, the builder will not recuperate the added capital costs because they are not able to increase the selling price of their house, due to the market restrictions.

A different angle to take into account is the perspective of the homeowner. In a study conducted by Gamtessa (2013), whose research was to explain the retrofit behavior in Canada based on EGH database between 1998-2004, found that a high energy intensity was the result of a poor thermal building envelope and low efficiency heating systems. Additionally, the comparison between pre-retrofit audit and post-retrofit audit found that a higher furnace efficiency resulted in a higher ER. Although this is indicative of retrofit behavior as opposed to new construction, it demonstrates that homeowners are

interested in higher energy performance for their homes. This study also serves as an indicator of the practices and technologies that can be specified to reduce the energy consumption of new homes.

3.2. Building Codes and Energy Efficiency

Regulatory intervention with means such as building codes and energy standards represent the foundation to overcoming barriers that hinder the adoption of energy efficient building practices (Deda & Golubchikov, 2012). The original intent of building codes was to set the minimum level of performance required. However, more often than not, the requirements tend to be the literal level of performance that is met by most buildings, especially those in the residential sector. That said, it can be argued that it is the enacted codes and standards that will either motivate or inhibit energy efficiency in buildings (Laustsen, 2008).

Since there are many barriers that hinder energy efficiency in new buildings, there is a strong obligation for policies to address energy efficiency for new construction. Studies show that building codes with more stringent energy requirements effectively reduce the energy load of a building (Laustsen, 2008). These requirements are provided either as part of the code, or as a separate standard. Within these requirements, methods of compliance include either prescriptive methods, performance methods, or a hybrid combination methods.

Prescriptive compliance methods set separate energy efficiency requirements for each building part and for each part of the systems equipment. To comply with the prescriptive method, the individual components must adhere to the identified targets. Some of the targets identified, as indicated by the different standards, includes the level of insulation required, the orientation of the building, the maximum allowable window percentage and the efficiency of the heating and cooling systems, among others. Performance based methods however identify requirements for a buildings total allowable

energy consumption and/or carbon emissions; with values of energy performance based on consumption per area, in the specified energy unit (Laustsen, 2008).

References suggest that there is a debate between the ability of different types of codes, i.e. prescriptive of performance, to promote the adoption of new methods and technologies in the RCI. In general, prescriptive methods are easy to implement because all of the design parameters are already identified (Laustsen, 2008). However, many believe the use of prescriptive compliance can limit the flexibility for the builder as they are limited to certain parameters and do not encourage builders to adopt different practices and methods to achieve a lower energy consumption in their buildings (Gann, Hawkins, & Wang, 1998).

Energy efficiency standards for residential buildings that use prescriptive compliance methods include the Ontario building code (as discussed in Section 5), and the New Zealand Building Code (NZBC); among others. Similar to the OBC, the NZBC has a separate standard, Clause H1, for energy efficiency in residential buildings. This separate standard consists of different sets if compliance prescriptions; separated by climate zones and construction type (The Department of Building and Housing, 2011).

Although the above mentioned codes are considered to follow prescriptive methods, they are in fact a hybrid between performance and prescriptive. Although they are based on a series of compliance prescriptions, both are set to ensure that new residential dwellings reach a certain target; EnerGuide 80 in SB-12 and a maximum building performance index (BPI)[1] of 1.55. In fact, most energy efficiency standards in building codes follow hybrid methods; such as the German Energy Conservation Regulations (EnEV) (2009) , the Danish Building Regulations (DBR) (2010), and the UK Building Regulations (UKBR) (2010). Both the EnEV and DBR base their performance requirements in kWh/yr/m^2

[1] Building Performance Index, as it relates to the New Zealand Building Code, Clause H1 for Energy Efficiency equals to the heating energy (kWh) divided by the heating degree days multiplied by the sum of the floor area and total wall area (m^2).

of heated floor area; while the UKBR residential code (L1a for new dwellings) base the performance level as a target CO_2 emission rating (TER). However, in all three of the abovementioned energy standards, minimum requirements for building envelope components are prescribed.

Benefits from performance or hybrid methods of compliance is builder flexibility and innovation in building design. However, the difficulty lies in justifying or proving that the proposed building design is just as good, or better, than the allowable baseline (May, 2003). Therefore, this method requires a comprehensive method for calculating the energy performance of a building such as computer based modelling software, in order to fully integrate the different building components (Laustsen, 2008). The potential drawbacks in these methods include inconsistencies with application rules; decreased predictability in regulatory expectations; and potential increased costs for governmental regulators (May, 2003). One of the major issues observed with performance based compliance methods is validating the proposed design. Both the applicant and the regulator must have to required capabilities to ensure compliance has been achieved when validating an estimated energy consumption or level of emissions of a building (Bowen, Meacham, Moore, & Traw, 2005; May, 2003; Laustsen, 2008).

3.3. Methods for Developing Energy Efficiency Prescriptive Packages for Homes

Studies demonstrate that there is a common framework applied when developing energy standards for buildings; using typical techniques such as experimental and analytical methods, good practice, and building simulation (CISBE, 2004). Based on the studies conducted by Deringer, Iyer, & Huang (2004) (2008), Mund, Sawhney, & Syal (2002), National Research Council of Canada (2011), MMAH (2010), and Radhi & Sharples (2008), it can be said that there are 4 methodological processes that occur when developing standards:

1. A base case building is established, based on characteristics of existing buildings in the defined area.

2. Analytical or experimental methods are used to determine the factors that influence the energy consumption of the building. The individual measures are often established through research, or industry best practices.
3. Building simulations are used to evaluate the impacts of the different measures.
4. The standard is developed and presented as either a prescriptive or performance standard.

The different studies also indicate Steps 3 and 4 to be interchangeable. For example, the development of the Canadian National Building Code, Ontario Building Code and other research studies followed the steps as shown; while the development of Mexican and Egyptian standards interchange them. Additional to those steps, frameworks also often include 2 additional steps in the methodological process:

5. A sensitivity analysis to take into account other factors that will vary between buildings such as the building orientation or the type and location of window placements.
6. A cost analysis to determine the cost benefit of the measures taken.

Figure 5 (pg. 19) is a representation of the methodological framework for developing energy standards, as described above. The framework is often described as the design optimization approach for developing energy standards. The measures identified as the design alternatives are dependent on the criteria to be measured. Some of the criteria that are often measured include: thermal performance, energy benchmarks, thermal comfort, daylight levels, visual comfort, and acoustical comfort. Based on this approach, the higher the energy performance of the design alternatives (i.e. the lower the estimated energy consumption), the more optimum the design choice (Radhi & Sharples, 2008).

The design optimization approach for developing standards is an effective method for developing energy standards for residential buildings as it is direct and simplified; and adheres to the needs and capabilities of the involved parties. The design variables can be determined by industry experts or

practitioners; while the criteria is linked to the health and safety of the homebuyers (the market). The sensitivity analysis, specifically the cost analysis, is an area where all stakeholders are required to be involved to ensure financial stability for all parties.

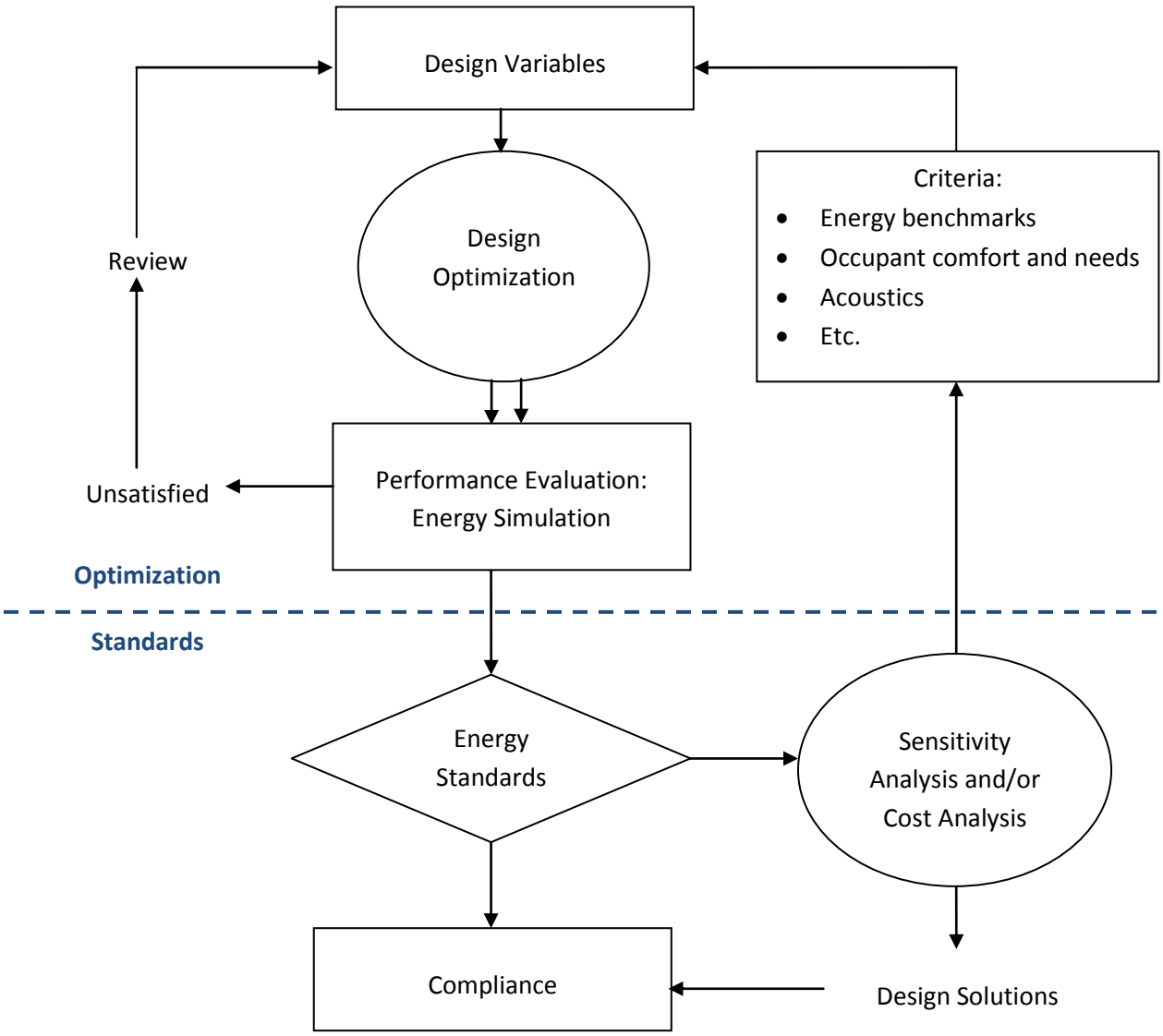


Figure 5: Design Optimization Framework for Developing Energy Standards
Source: Adapted from Radhi & Sharples **(2008)**

The findings from the literature review have indicated that the adoption of EEP within the RCI is mainly dependent on the perspectives of the different stakeholders and the capabilities of the builders; and driven by incentives. Studies also suggest that builders who are uncertain about adopting EEP, or lack innovation, often are not willing to adopt EEP due to the possibility or risks. Consequently, the literature suggests that residential builders usually use the building code as a literal requirement that must be achieved and often resort to standard building practices. Therefore, it can be said the adoption of EEP can be enforced within the RCI through the development of more stringent building codes.

4.0 Research Identification

4.1. Purpose and Significance

Based on the findings from the literature review, the intent if this research study is to demonstrate that it is possible for builders in Ontario to design and build lower energy consuming buildings through the adoption of construction practices and methods that are presently used in the industry. To do so, the goal of this research study is to develop prescriptive compliance packages that will enable builders to achieve a higher energy standard. Based on the SBD program, the packages shall meet a reduction target of 20% compared to existing SB-12 OBC requirements for residential (Part 9) buildings. In order to achieve the research goals, develop the packages, it was required to address the following questions:

1. What are the practices and methods that Ontario builders are able to adopt to build better performing homes, in terms of their energy demand?
2. What are the differences in requirements for the different house archetypes?
3. What are the optimum combination of energy efficiency practices and specifications that will enable a builder to be 20% better than OBC, in terms of energy consumption in GJ?

The important factor in this research is that the specifications in the packages should be indicative of the industry's capabilities. Therefore, the reports generated by the SDP charrettes will be used to address the first research question. The remaining research questions will be directly addressed by the findings from this research study.

The final document is intended to potentially serve as a guide for home builders that will enable them to reduce the energy demand of the homes they build. Additionally, this document can be presented to the Ministry of Municipal Affairs and Housing in Ontario (MMAH) as a reference of possible changes in the OBC requirements that can be made in the near future.

4.2. Scope

This research will focus on the specifications outlined in the SBD reports to reduce the energy demand in space heating, ventilation and water heating for low rise, residential building (Part 9) in the GTA; limited to the proposed changes indicated by the participating builders. The builders that have participated in SBD include mainly production homebuilders from the GTA and Ottawa. Therefore, the total housing constructed by these builders have a large impact on the total housing market in Ontario. Additionally, since the builders have participated in the IDP and have specified the changes themselves, direct costs of the proposed specifications will not be evaluated because it is assumed that the builders are well informed of the incurred costs for the specified changes.

The OBC requirements that have been used as the reference for the study include only the packages outlined in Table 2.1.1.2.A ZONE 1 - Compliance Packages for Space Heating Equipment with AFUE ≥ 90%, of the SB-12 standard. Therefore, the results of this research will not be applicable for homes that are outside of the defined zone or those that use electric baseboards as their primary space heating equipment.

4.3. Study Limitations

The packages will be developed based on energy simulations only. However, simulated predictions do not take into account for compliance and enforcement protocols by regulators or behavioral responses that occur in the construction process. Therefore, the actual performance of a house built to one of the proposed packages is not guaranteed to be equal to the predicted energy performance.

5.0 Methodology

In accordance to the identified research goal, a set a compliance packages have been developed that will enable homebuilders to design and build buildings with a total annual energy consumption 20% lower than current SB-12 OBC requirements. The methodological approach that was taken to develop the packages was adapted from the design optimization approach for developing energy standards by Rahdi & Sharples (2008). Once the packages have been developed, a series of envelope assembly and systems specifications were provided to serve as a reference for builders.

5.1. Research Framework

The adapted framework for this research can be found in Figure 6 (pg. 24). For this research, the criteria for the packages have been adapted from the SBD program. Where the SBD program allows the use of energy credits to reach a reduction target of 25%, this study will only include the use of building envelope upgrades and systems specification to reach a total energy reduction target of 20%. The optimization of design measures was conducted at the SBD charrettes through analytical and experimental methods. However, the performance evaluation has been re-evaluated for the specific scope of this research using HOT 2000. In order to identify the differences between different house types, a reference house was used for a detached house, a row/townhouse, and a semi-detached house. After the packages have been developed, and prior to final recommendations, a sensitivity analyses was conducted to identify other design considerations related to the energy performance of residential buildings.

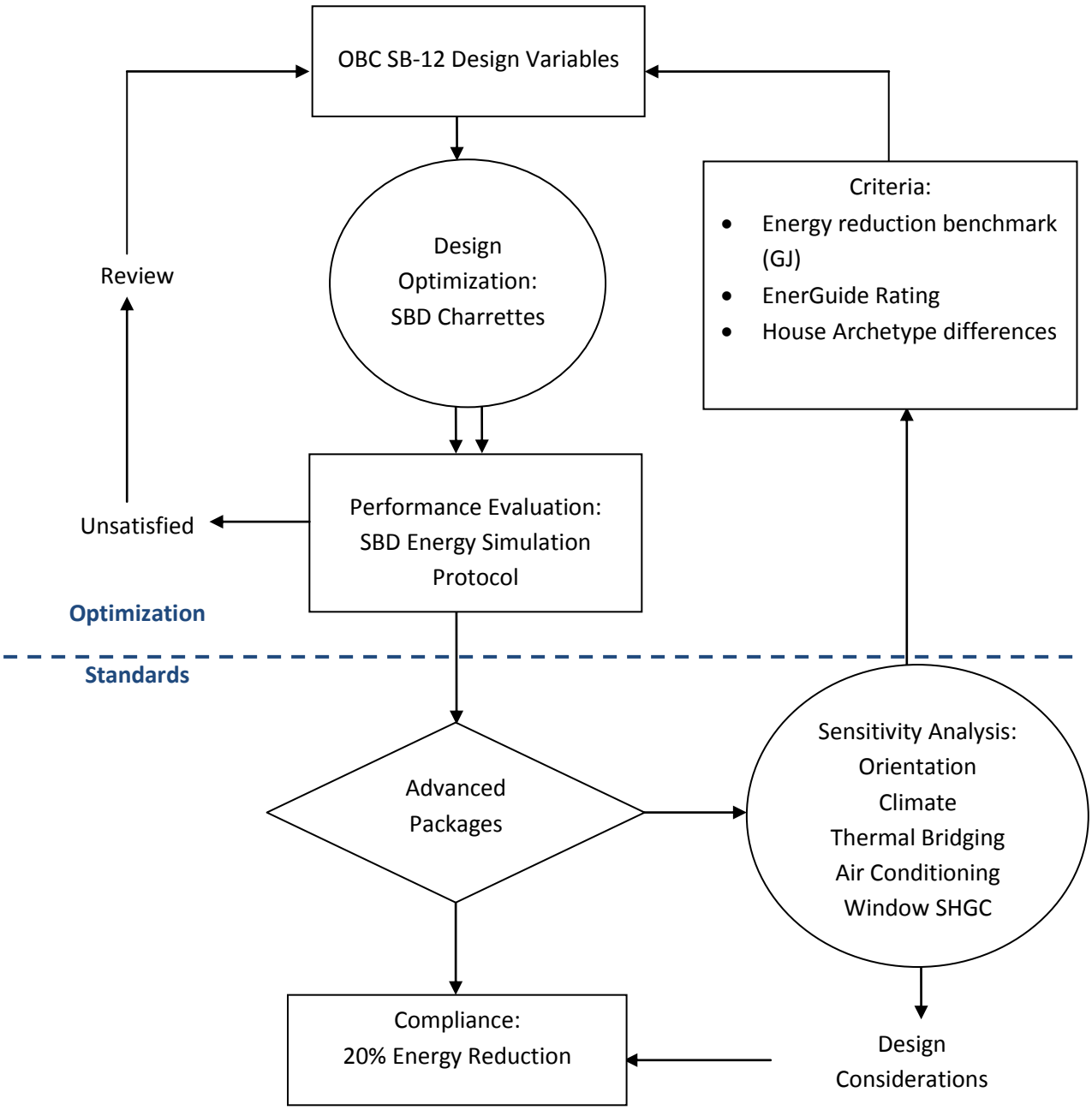


Figure 6: Research Framework- Design Optimization Approach

5.2. Methodological Process

Once the framework for this study was designed, based on the design optimization framework and the SBD simulation protocols, the methodological process that was applied to execute the research includes the following steps:

1. A reference house for each house archetype was established to determine the baseline energy consumption of a typical house, currently built to OBC SB-12 standards.
2. Data collection of inputs and parameters of advanced packages was determined by the SBD summary reports.
3. Energy simulations were modelled for all SBD packages for all house archetypes, as per the simulation protocol outlined in Section 5.4.4.
4. Energy simulation results were collected, in GJ and GJ/m^2, and presented in a table format.
5. The EnerGuide Rating (ER) was calculated for each simulation package; and the results were included in the summary of results table.
6. An analysis of the results was conducted to determine the packages that achieved the reduction target; as well as those that were within 4% of the reduction target.
7. Trends from the packages that meet the reduction target were established; in terms of their input specifications.
8. Findings from Step 7 were used to make modifications and adjustments to the packages that were within 4% of reaching the reduction target; and those that have met the target by more than 5%.
9. Energy simulations were conducted using the modifications to the package specifications; and presented in a table format. The ER was re-calculated for the modified packages.
10. The packages that are suitable for the different house archetypes were established; and trends that are present for each category were determined.

11. Recommendations of building envelope specifications for the packages were developed, based on the information provided in the SBD reports.
12. A sensitivity analysis through energy simulations was conducted to determine the impacts of building orientation; climate; thermal bridging; the effects of window SHGC; and the use of central air conditioning.

5.3. Data Collection

Data collected through SDP charrettes provided the data set for the proposed research study. There has been a total of 24 charrettes conducted for residential houses; 12 in 2012 and 12 in 2013. Of those charrettes, 20 projects were based in the GTA and 4 in Ottawa. Due to the completeness of the reports, only 19 of the reports were eligible for use in this study. The SBD reports indicate the compliance package specifications used to reach the 20% reduction target; plus additional credits that will reach a reduction target of 25% or more. The selection of the specific measures to achieve the reduction are selected based on analytical and experimental methods conducted during the charrettes.

Each project contains it own set of summary reports containing summary tables outlining the components and inputs of the compliance package followed, the project baseline building variable inputs, and the advanced building variable inputs for the following categories: building envelope, mechanical systems and energy credits. The building envelope specifications outlined by the SBD reports are nominal values only. Each of the project reports also contain summary reports of the energy consumption of each model.

5.4. Energy Simulation Modelling

Energy modelling has been conducted to determine the energy consumption of the SBD packages for typical house archetypes. The packages were modelled for a detached house, a row/townhouse, and a semi-detached. The energy simulation models were conducted using HOT 2000 software; the software

used both in the residential industry as per OBC approved assessment tools, and in the SBD charrettes. The simulation protocol in this study has been adapted from the simulation protocol followed in the SBD charrettes.

5.4.1. HOT 2000 Energy Simulation Software

HOT2000 energy simulation software, v9.34C, was used as the energy modelling tool for the purpose of this study. HOT2000 is Canada's leading residential energy analysis and rating software, developed by CanmetENERGY's Housing, Buildings, Communities and Simulation (HBCS) group. The results are calculated from pull-down menus offering variable input options for details on the building design, site information, and climatic zone. The software calculates heat losses and heat gains; total annual electrical usage in kWh; total annual fuel usage in m^3 for natural gas; and total annual energy consumption in MJ. The calculations account for the location and orientation of the building to estimate the contribution of passive solar heating.

Although more robust simulation tools exist in the market, this software has been chosen because it is the software that was used to develop the existing SB-12 packages; it was the software tool used in the energy model for the charrettes; it is the suggested software in the OBC for residential buildings; and thus, it is the most common within the RCI in Ontario. In order to validate the accuracy of the energy simulations and the results, the energy simulation files have been pre-evaluated by the experts who model the energy simulations at the SDP charrettes.

5.4.2. Baseline House Archetypes

In order to conduct the energy models for the advanced packages, baseline reference archetypes have been used for three house typologies; a detached house, a typical row/townhouse and a semi-detached house. The selection of the baseline reference homes are based on the typical house types built in

Ontario; as demonstrated by the background review of the RCI and the SDP reports. Through using a reference house for the different house archetypes, the differences in requirements will be able to be noted. Potential benefits of this include the potential for difference house archetypes, especially the row/townhouse archetype, to have different options as opposed to conforming to the same specifications used on a detached house.

The specifications of the each house archetype have been summarized in Table 2 below. Full detailed dimensions have been included in Appendix A (pg. 80).

Table 2: Baseline House Archetypes Specifications

	Detached	Row/Townhouse	Semi-Detached
GFA[1] (m^2)	265.85	148.57	193.09
Height Above Grade (m)	5.62	6.83	7.98
External Wall Area (m^2)	376.99	99.14	258.13
Above Grade	353.18	85.15	216.13
Below Grade	23.81	13.99	42.00
Window-Wall Ratio[2]	9%	13%	7%
House Volume (m^3)	716.01	398.17	513.47

[1] Gross Floor Area (GFA) includes basement.
[2] Window-Wall Ratio has been calculated using the external wall area only.

Detached House - CCHT Research House

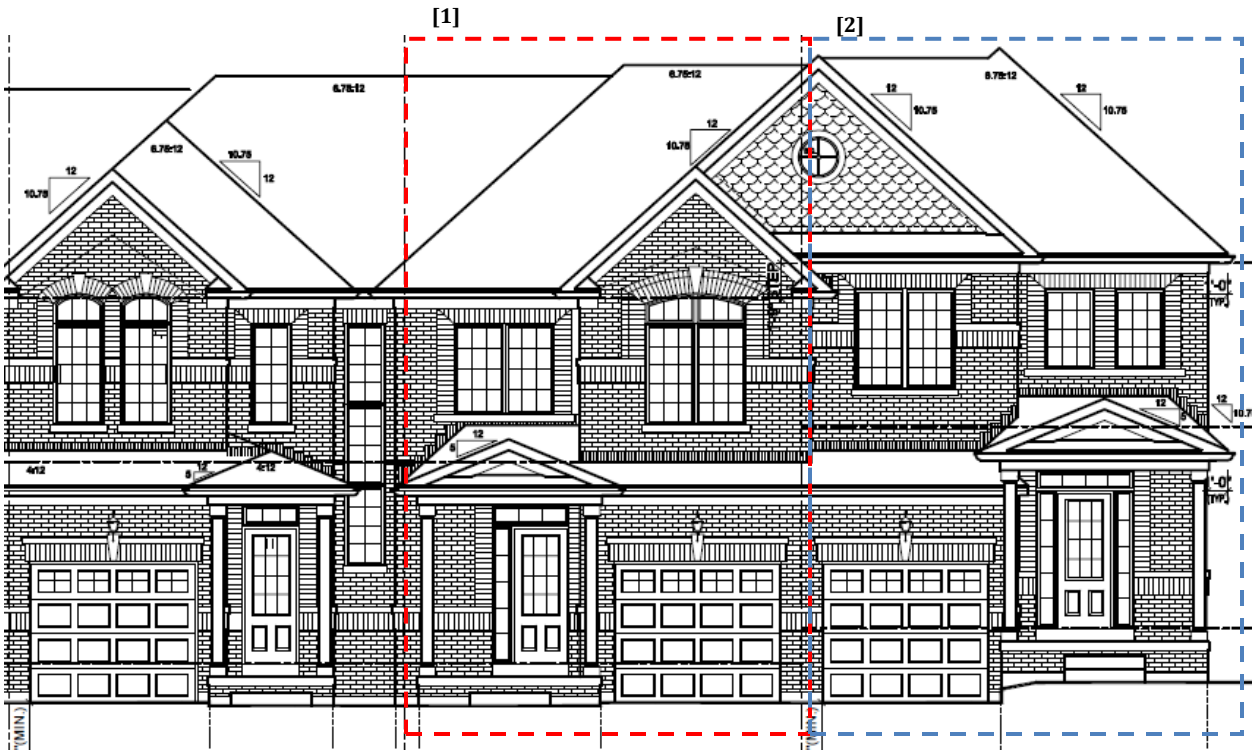
The Canadian Centre for Housing Technology (CCHT) is a full scale facility dedicated for research, evaluating, and demonstrating innovation in products and techniques to accelerate the improvement in quality, affordability, and environmental sustainability for Canadian housing. The site is located on the NRCan Council's Ottawa campus; consisting of two identical detached homes and a three-unit townhouse. The detached house is a two-storey house plus basement with a one-car garage on the main floor. The layout of the house consists of a living room, dining room, family room and kitchen on the main floor; and, four bedrooms, two bathrooms and a laundry room on the second floor. The utilities

are located in the basement. Full dwelling dimensions and layouts have been provided in Appendix A (pg. 81).

Figure 7: CCHT Detached House- Front Elevation (NTS)

Row House- Typical

The row house that has been selected for this research is a typical two-storey house plus a basement with an attached one-car garage on the main floor. The layout of the house consists of a foyer, dining room, great room and kitchen/breakfast area and powder room on the main floor; and three bedrooms, two bathrooms on the second floor. The laundry and utilities in the unfinished basement. Full dwelling dimensions and layouts have been provided in Appendix A (pg.82).



Notes:
[1] Typical Row/Townhouse
[2] Typical Semi-Detached House (row house end unit)

Figure 8: Typical Row/Townhouse and Semi-Detached (End Unit)- Front Elevation (NTS)

Semi-Detached House- Typical

The semi-detached house selected for this research is an end unit of the same row/townhouse complex. It is a two-storey house plus a basement. The layout consists of a foyer, living/dining room, kitchen, breakfast area and a powder room on the main floor; and three bedrooms, two bathrooms and a storage closet on the second floor. The laundry and utilities are located in the basement. Full dwelling dimensions and layouts have been provided in Appendix A (pg. 83).

5.4.3. Modelling Inputs and Outputs Parameters

All of the simulations were conducted in general mode. The general mode in HOT 2000 is used to determine the as-operated house condition and energy consumption based on user identified input values. The simulations were conducted for the Toronto location, with a South front orientation; using

the weather data imbedded in the software. The manual inputs for the simulations include the building envelope thermal resistance values; systems types and efficiencies; interior temperature set-points; and required ventilation based on occupancy and room. Default values were used for systems operating loads such as the energy required to run fans; lighting and appliances loads and usage; and hot water usage based on occupancy. Detailed information of all inputs have been included in Appendix B (pg. 84).

The simulation output data that has been used for analysis includes the total annual energy consumption in GJ for heating, hot water, lights, appliances, exterior, and other; and the total annual heat loss in GJ from the building envelope and ventilation. Cooling has not been included in the baseline simulations; therefore cooling energy is not included in the total annual energy consumption. However, cooling energy has been included in the total annual energy consumption, in GJ, for the simulations that include cooling in the sensitivity analysis section of this study.

5.4.4. Simulation Protocol

The methodology used to simulate the compliance packages has been adapted from the SBD energy modelling protocol. The energy modelling consists of modelling the upgrades one upgrade at a time until the minimum reduction target of 20% has been met; followed by calculating the approved additional NRCan and SBD energy credits. The simulation steps are as follows:

1. Set HOT 2000 in general mode, without adjusting the standard operating conditions.
2. Model the baseline reference building as per SB-12 Package B specifications and requirements; using nominal values for the building envelope components.
3. Use the upgrade function to model the each upgrade component as per the advanced package requirements; beginning with the building envelope components and followed by the systems components. Each component shall be calculated individually to tabulate both the reduction of the

individual component and the cumulative reduction of the components combined, in MJ and as a percentage.

4. The additional credits have been itemized in the table, using the indicated reduction, in MJ, from the SBD packages.

5.5. EnerGuide Rating Calculation

Although the energy reduction target will has been determined based on the total annual energy consumption in GJ, the EnerGuide Rating has been calculated because it serves as a familiar reference for homebuilders. The energy efficiency rating for the upgrade packages was determined using the EnerGuide for Houses energy efficiency rating equation as follows:

$$Energy\ Efficiency\ Rating\ = 100 - \left[\frac{Estimated\ Total\ Energy\ Consumption}{Benchmark\ Total\ Energy\ Consumption}\right]\ x\ 20$$

Note:

i. A negative energy efficiency rating shall be reported to the homeowner as zero; and
ii. A rating for a house cannot exceed 100 and remain within the scope of this procedure.

Where, the *Estimated Total Energy Consumption [ETEC]* is determined by the HOT 2000 energy simulation in *GJ* for the specified advanced compliance package; and, The *Benchmark Total Energy Consumption [BTEC]* is the energy consumption of the reference SB-12 compliance package B, determined by the HOT 2000 energy simulation in *GJ*.

5.6. Sensitivity Analyses

Once the advanced packages have been simulated and final energy consumptions have been identified, the packages that have achieved the reduction target have undergone a sensitivity analyses. The sensitivity analyses will include determining the differences in energy consumption between building orientations; the differences in climate; the effects of thermal bridging; the use of central air conditioning, and the impact of the window SHGC.

Building Orientation

Although the front orientation of the house selected to be analysed is due south, the baseline reference packages were modelled at the different orientations in order to get a sense of how that will influence the energy consumption of the house. The different orientations were modelled by adjusting the orientation of the windows in the simulation models accordingly.

Thermal Bridging

The OBC identifies minimum thermal resistance values for the insulating materials in the wall assembly only. This thermal resistance value is referred as the nominal thermal resistance. However, other building materials with lower thermal resistance values can act as a thermal bridge; allowing for increased heat flow to the outward side of the assembly and thus reducing the total thermal resistance value of the wall assembly. This thermal resistance value is referred to as the effective thermal resistance (Burnett & Straube, 2005).

The nominal thermal resistance values were used for all the simulation models. Therefore, in order to determine the effects of thermal bridging caused by the structural components, the effective thermal resistance value was determined and the simulation models for the final modified packages were re-simulated. The effective thermal resistance values were calculated for two points on the wall assembly; the first through the insulation cavity and the second through the structural components, i.e. the wood studs. The assemblies and selected stud spacing were based on the recommended wall assemblies as indicated in the SDP reports. The interior finishing materials and exterior cladding materials will not be taken into account.

The effective thermal resistance values were calculated using the following formula:

$$R_T = \sum R_{wtd.}$$

Where, R_{wtd} is the area weighted thermal resistance of the individual wall components, in m^2K/W. The area-weighted thermal resistance value was calculated using the parallel path formula, as follows:

$$R_{Wtd.} = \left[R_{T_{P_1}} \times A_{P1}\right] + \left[R_{T_{P_2}} \times A_{P2}\right]$$

Where, P refers to the different points in the wall assembly, and A is the area of the specified points, expressed as a percentage, $\%$ (Burnett & Straube, 2005).

The framing factors used to determine the area of the structural components were based off the recommended factors from the Energy Start for New Homes Technical Specifications for Ontario (ESTS) (NRCan, 2011). The applicable framing factors for the different building envelope assemblies have been identified in Table 3 below.

Table 3: Energy Star Framing Factors

	Framing System	Framing Factor (%)
Above Grade Walls	Standard wood frame wall @ 406mm O.C.	23%
	Standard wood frame wall @ 610mm O.C.	20%
Below Grade Walls	Standard wood frame wall inside concrete @ 406mm O.C.	16%
	Standard wood frame wall inside concrete @ 610mm O.C.	13%
Ceiling	Conventional rafter/joist framing @ 406mm O.C.	13%
	Conventional rafter/joist framing @ 610mm O.C.	10%
Exposed Floor	Standard lumber joist floor @ 406mm O.C.	13%
	Standard lumber joist floor @ 610mm O.C.	10%
	I-joist floors@ 406mm O.C.	9%
	I-joist floors @ 610mm O.C.	6%

Source: Adapted from NRCan, 2011

Air-Conditioning

Given that most of the new homes in Ontario are built including air conditioning, as per homeowner requests, it is necessary to determine how this will affect the final energy consumption of the house. The initial modelling was carried out without including cooling in the energy load for both the baseline and proposed packages. However, to assess the impact cooling can have, the selected packages underwent a new baseline model and upgrade model to include cooling. The air conditioning efficiency for the baseline was SEER 13, as per indications in the HOT 2000 manual of typical SEER values by year built; while the upgrade was SEER 14.5 as indicated by the builders in the SDP reports.

Window SHGC

The SHGC of the window will influence the amount of natural solar heat gains that will transmit through the window; the higher the SHGC, the higher the solar heat gains (Burnett & Straube, 2005). The baseline simulations were conducted using a window SHGC of 0.4, or 40%. The window SHGC will be adjusted, to an SHGC of 0.52 or 52%, in order to determine the effects of increased heat gains through the windows.

6.0 Results and Analysis

6.1. Baseline Energy Consumption and Distribution

The reference homes were simulated to the existing SB-12 prescriptive compliance packages in Table 2.1.1.2.A ZONE 1 - Compliance Packages for Space Heating Equipment with AFUE ≥ 90%. There are 13 packages identified in this table, Compliance Packages (CP) A-M; however only CP A- J are applicable for the type of construction identified in the SBD reports. The results of the simulations, included in Appendix C (pg. 86), found that for all the archetypes, CP-H results in the lowest energy consumption. However, in accordance to the majority of the SBD reports, the reference package that has been used as the baseline is CP- B. In comparison to CP-H, the difference in energy consumption is 0.22% for the detached house; 5.94% for the row/townhouse; and 4.19% for the semi-detached house.

Of the three archetypes, the detached house consumes the most energy, followed by the semi-detached house and row/townhouse; with 115.41 GJ, 93.52 GJ and 87.07 GJ respectively. In terms of energy intensity, the row/townhouse has the highest consumption, followed by the semi-detached and detached house; with 0.59 GJ/m^2, 0.48 GJ/m^2, and 0.43 GJ/m^2 respectively. The differences in consumption between the archetypes have been identified in Table 4 and the distribution of energy use and heat loss have been identified in Figure 9 to Figure 124 (pg. 37).

Table 4: Energy Consumption (GJ) and Heat Loss (GJ) - Baseline Archetype Comparison

SB-12 Package B	Detached	Semi-Detached	Row/Townhouse
Total Energy Use (GJ)	115.41	93.52	87.07
Difference (%)	33%	7%	-
Overall Energy Intensity (GJ/m^2)	0.43	0.48	0.59
Difference (%)	-	12%	35%
Heating Energy Intensity (GJ/m^2)	0.20	0.17	0.18
Difference (%)	15%	-	6%
Total Heat Loss (GJ)	103.27	66.55	58.81
Difference (%)	43%	12%	-

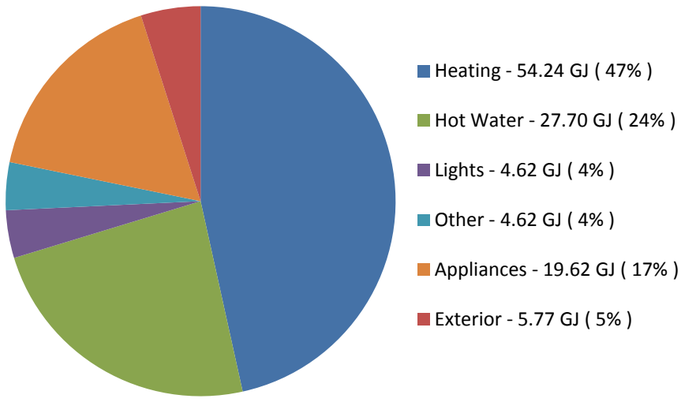


Figure 9: Baseline Annual Energy Consumption- Distribution - Detached House

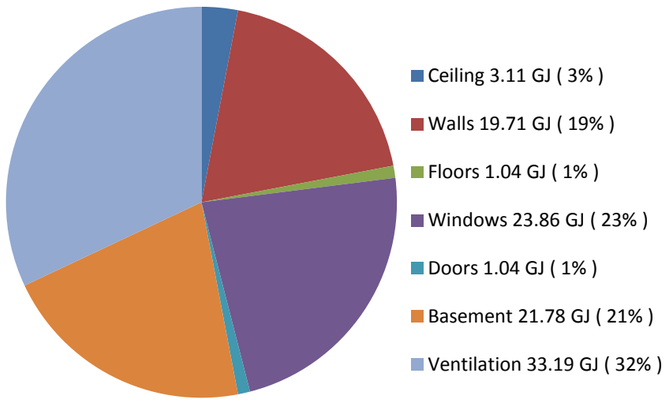


Figure 10: Baseline Annual Heat Loss Distribution - Detached House

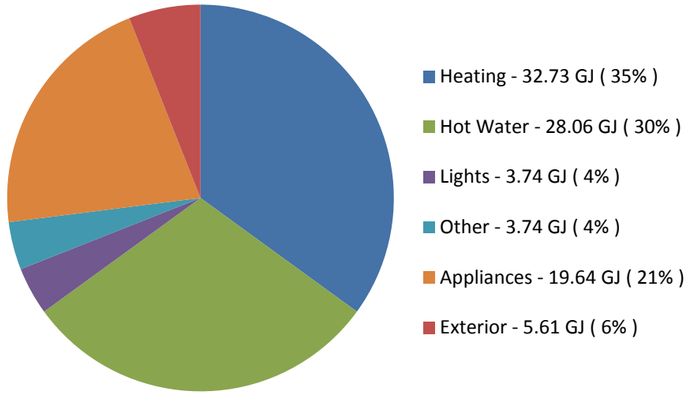


Figure 11: Baseline Annual Energy Consumption Distribution - Semi-Detached House

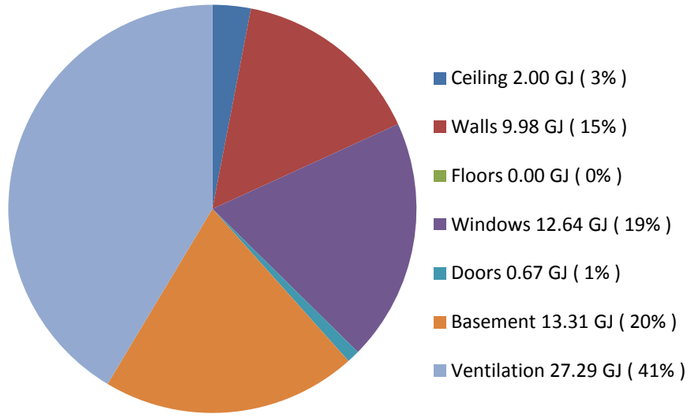


Figure 12: Baseline Annual Heat Loss Distribution - Semi-Detached House

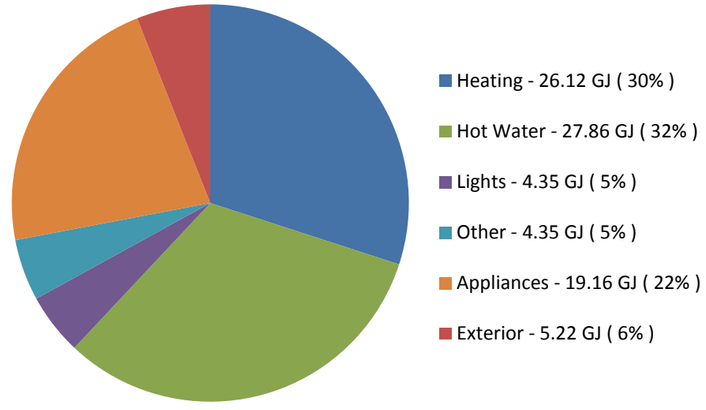


Figure 13: Baseline Annual Energy Consumption Distribution - Row/Townhouse

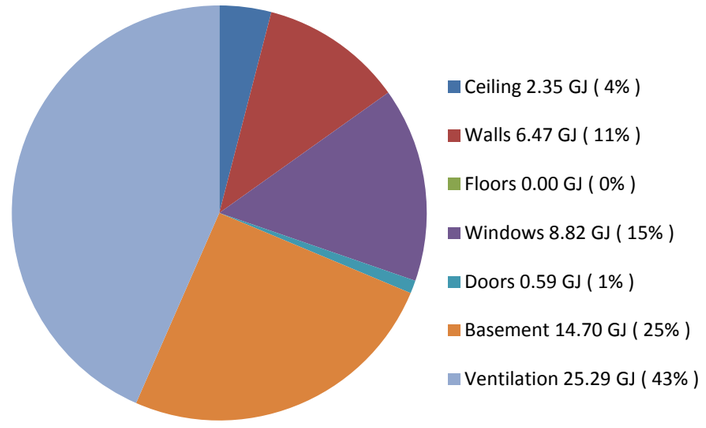


Figure 14: Baseline Annual Heat Loss Distribution - Row/Townhouse

For all three house archetypes, heating, hot water and appliances consume the most energy. In comparison between the three archetypes, the detached home has the highest heating demand in both absolute terms and as a percentage with 54.24 GJ (47%); followed by the semi-detached with 32.73 GJ (35%) and the row/townhouse with 26.12 (30%). The energy demand for hot water is relatively equal for all 3 archetypes with approximately 28 GJ. However, when viewed as a percentage of the total energy demand, the row/townhouse has the highest demand with 32%; followed by the semi -detached house with 30% and the detached house with 24%. It is important to note that cooling was not included in the baseline simulations. However, if included, the total energy consumption of the house would increase; and the energy distribution as a percentage will differ significantly for all house types.

The overall energy intensity is highest for the row/townhouse with 0.59; followed by the semi-detached house with 0.48 and the detached house with 0.43. The fact that it is the highest for the row/townhouse and lowest in the detached house, which is the opposite trend in comparison to the total energy consumption, is due to the total floor area of the house. The higher the floor area, the lower the energy intensity will be for a given energy consumption. When only taking into account the space heating energy intensity however, the detached house has the highest intensity with 0.20; followed by the row/townhouse with 0.18 and the semi-detached house with 0.17. This is so because the space heating requirements in a detached house is higher due to a greater heat loss area from more exposed walls.

The distribution of heat loss can be divided into two categories: the building envelope and ventilation; with ventilation being the most significant. Factors that contribute to the total heat loss of a house include the area of external walls, the WWR, the mechanical systems, and the air tightness. As indicated in Table 4 (pg.36), there is a significant difference in total heat loss between the 3 archetypes. The detached house has the highest total heat loss with 103.27 GJ; followed by the semi-detached house with 66.55 GJ and the row/townhouse with 58.81 GJ. The heat loss trends can be correlated to the heat

loss factors where the house with the highest external wall area exhibits the highest amount of heat loss.

When the expressed as a percentage, the heat loss that is occurring through the building envelope is highest in the detached house with 68%, followed by the semi-detached house and row/townhouse with 57% and 59%. The heat loss through ventilation is highest in the row/townhouse with 43%, followed by the semi-detached house and the detached house with 41% and 32%. However, it is important to keep in mind that in absolute terms, the highest heat loss through ventilation is occurring in the detached house with 33.19 GJ, followed by the semi-detached house and the row/townhouse with 27.29 GJ and 25.29 GJ. The trend in heat loss through ventilation can again be correlated to the before mentioned heat loss factors; as well as to the total volume of the house.

Based on the baseline energy consumption distribution and the heat loss distribution, the following findings can be established for the different archetypes:

- There is a higher heating energy demand in the detached house than in the other archetypes; when expressed in both GJ and as a %.
- All archetypes have a similar energy demand for hot water in GJ; with the row/townhouse having the highest when expressed as a %.
- There is a higher heat loss through the building envelope in the detached house than in the other archetypes; suggesting that the detached house, which has a larger area of building envelope, will reap a higher benefit from a building envelope upgrade.
- The distribution of heat loss through the building envelope suggests that the upgrades in the basement walls, windows, and above grade walls will have the highest impact.

- The high heat loss through ventilation suggests that all the archetypes will require mechanical systems upgrades; such as the use of an HRV and reducing the air infiltration by increasing the air tightness of the house.

6.2. Builder Specifications from SBD Reports

The specifications that have been identified by the builders, as indicated in Figure 15 (pg. 41), include both building envelope changes and systems changes. The building envelope changes include both increases and reductions in thermal resistance values; while most of the systems changes are upgrades. Full specifications of the SBD packages can be found in Appendix D (pg. 89).

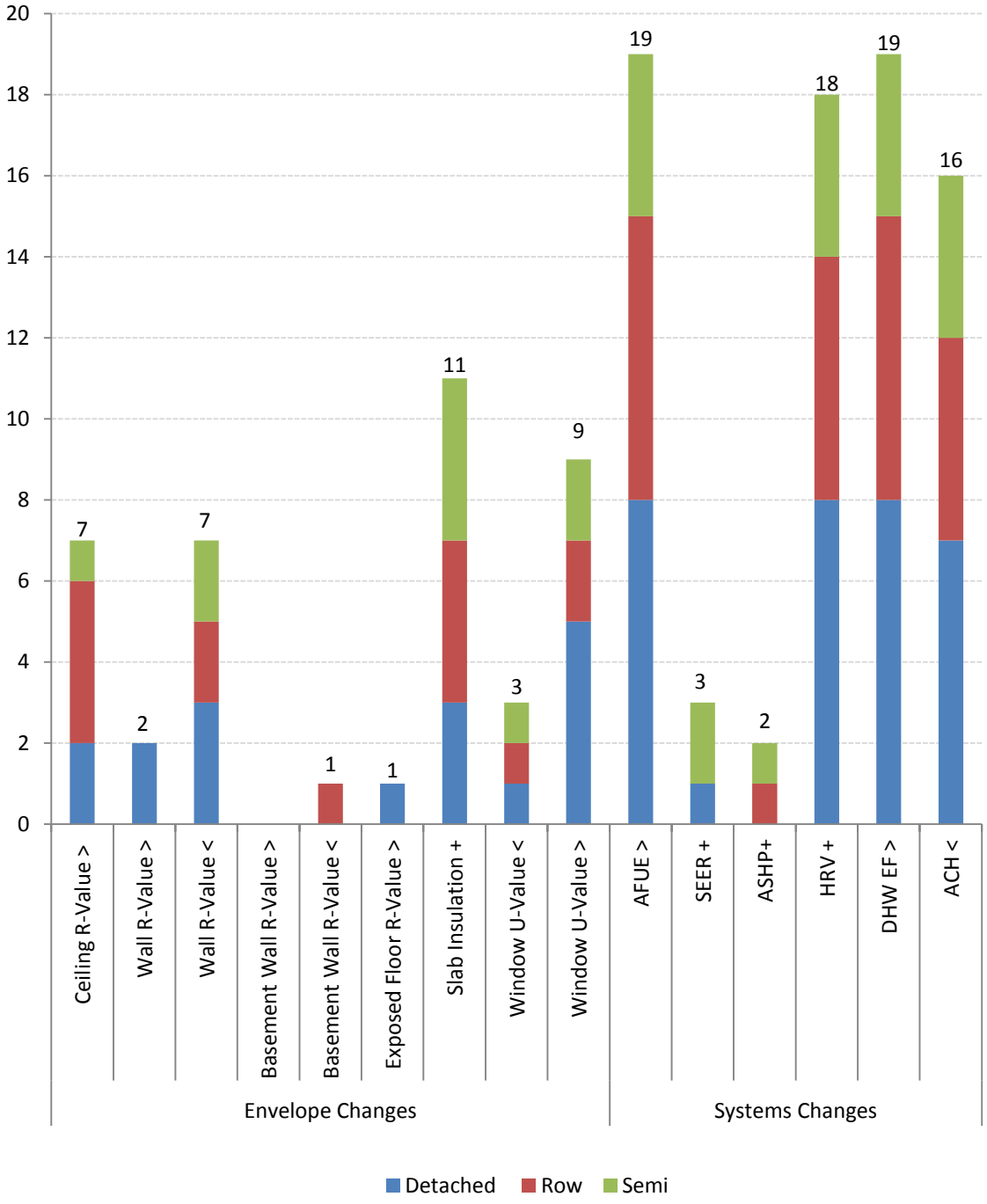


Figure 15: Builder Specified Envelope and Systems Changes

In accordance to findings from the baseline energy and loss distribution, a more in depth observation of the specifications changes has been conducted for the following building components: the above grade wall thermal resistance values, the window thermal transmittance values, the HRV efficiency (maximum); and the specified air infiltration rate (ACH). The distribution of specifications for these components have been identified in Figure 16 to 19 (pgs. 42-44). These figures indicate the percentage of builders who have specified the certain measure and house type that the measure was applied on; and serve as an indication of builder preferences for the different house archetypes.

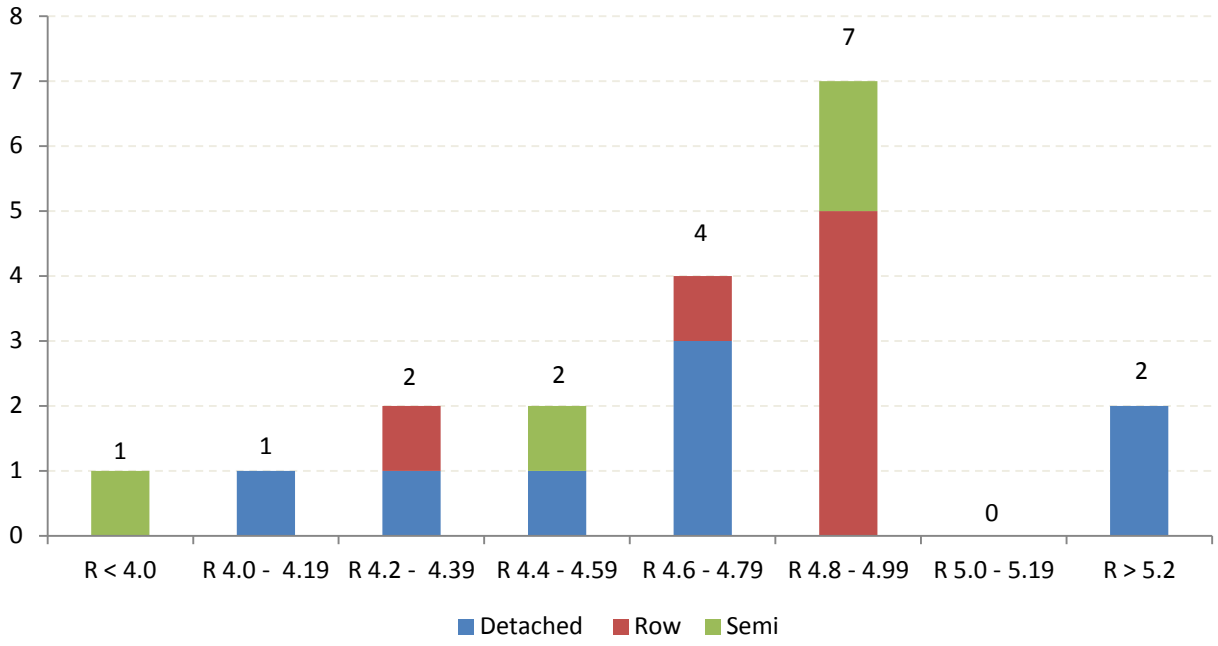


Figure 16: Builder Specified Above Grade Wall Thermal Resistance (RSI) Values [(m²·k)/W]

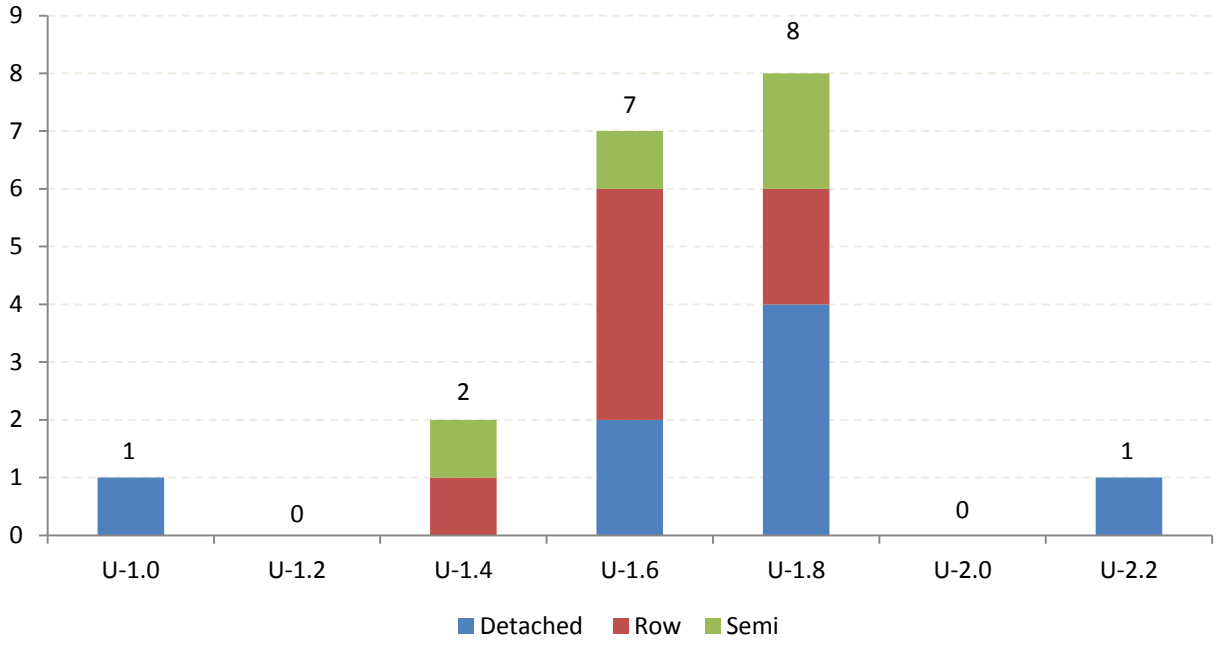


Figure 17: Builder Specified Window Thermal Transmittance (U-Value) [W/ (m²·k)]

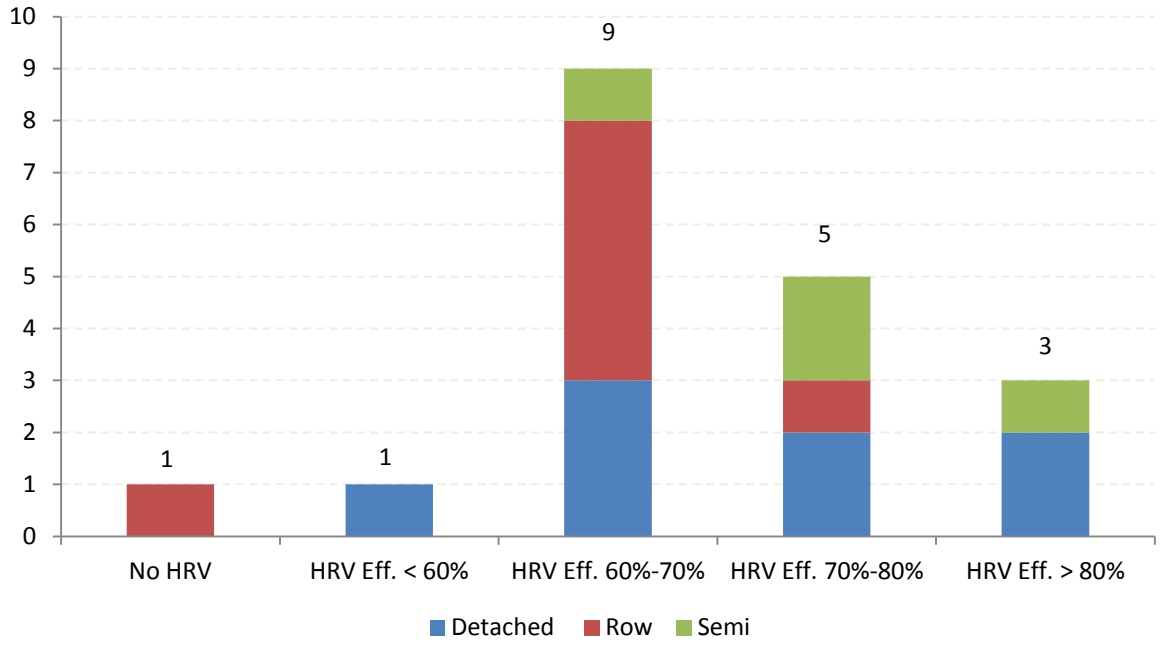


Figure 18: Builder Specified HRV Efficiency [%]

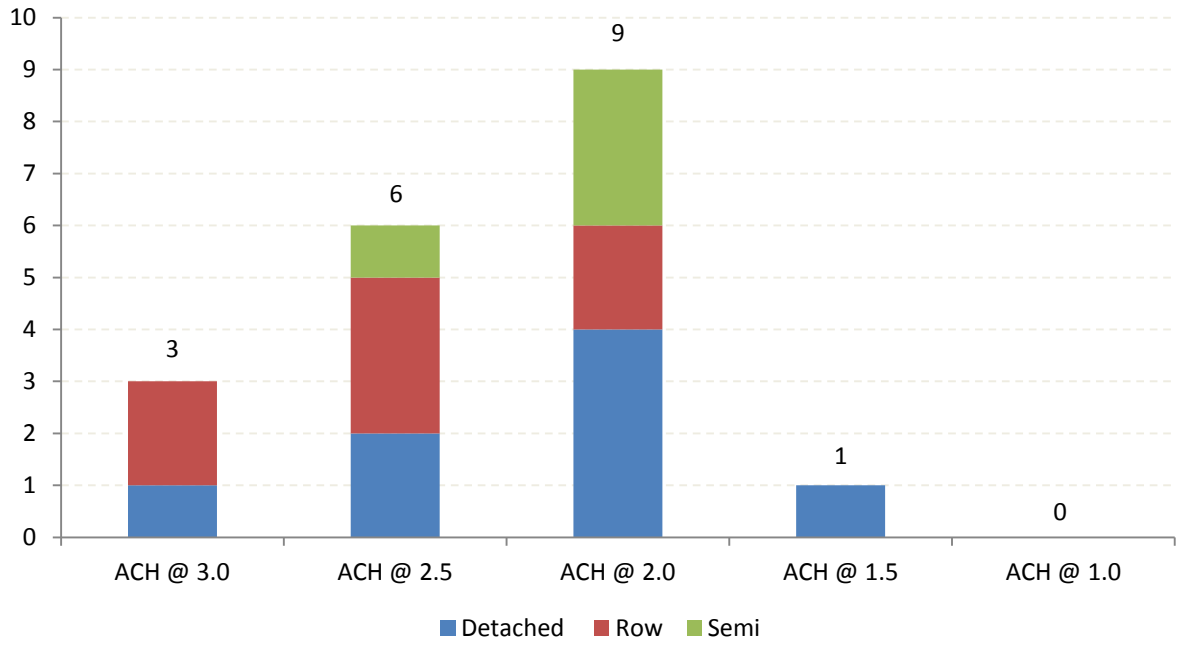


Figure 19: Builder Specified Air Leakage Rate [ACH]

The findings from the builder specified building changes include the following:

- Builders are not comfortable addressing the thermal resistance values in the basement wall assemblies.
- All builders are comfortable specifying a higher AFUE for the furnace and a higher EF for the hot water tank.
- There is a large fluctuation in the specified thermal resistance values for the above grade walls; this suggests that builders are comfortable with a variation of wall assemblies. The most common thermal resistance value specified was between RSI 4.8 to 4.99 [$(m^2 \cdot k)/W$]; and the highest thermal resistance value specified was RSI 5.2 [$(m^2 \cdot k)/W$]. The highest thermal resistance value was only specified for the detached house archetype; and the common thermal resistance values were only specified for the semi-detached house and row/townhouse archetypes.

- Builders are most comfortable using a window with a U-value of 1.8 or 1.6 [W/ (m^2·k)]. Both of these window values are used in the SB-12 requirements; with CP-B requiring a window U-value of 1.6 [W/ (m^2·k)].
- Almost all the builders are comfortable adding an HRV system to the house; with the majority having a maximum efficiency between 60%-70%. The SBD package that did not upgrade the ventilation system with an HRV was for the row/townhouse archetype. Only 16% of the builders specified and HRV with an efficiency of 80% or more; this efficiency was only used for detached house or semi-detached house archetypes.
- Almost half the builders feel comfortable building to an ACH of 2.0. Most of the other half have specified an ACH of either 3.0 (OBC standard) or 2.5 (the typical average for Ontario homebuilders). This suggests that there is a split between the builders and their comfort level in detailing of the homes.

6.3. SBD Advanced Packages Energy Consumption

A total of 19 advanced packages were simulated for each house archetype; resulting in a total of 57 energy simulations. A summary of the simulation results can be found in Table 5 (pg. 47) and full results can be found in Appendix E (pg. 91) and Appendix F(pg. 93). The findings from the energy simulations are as follows:

- Not all of the SDP packages achieved the reduction target for the different house archetypes.
- 4 packages achieved the reduction target for all 3 house archetypes (AP-2, AP-5, AP-13, AP-19).
- 1 package was within 2% of the reduction target for all 3 house archetypes (AP-6); and 1 package was within 2% for only the row-house archetype (AP-15).
- 1 package was within 4% of the reduction target for all 3 house archetypes (AP-12); 1 package was within 4% of the reduction target for both the row-house and semi-detached house

archetype (AP-4); 1 package was within 4% of the reduction target for the semi-detached house archetype only (AP-15); and 1 package was within 4% of the reduction target for the row-house archetype only (AP-1).

From the 4 packages that achieved the reduction target for all house archetypes, the following findings can be made from their package specifications:

- The thermal resistance value for the above grade walls vary between RSI 4.4 to 5.2.
- 4 of the packages have a window thermal transmittance of either at U-1.6 which the same as SB-12 Package B requirement; or U-1.8 which is prescribed in other SB-12 packages. There are also 2 packages that are below U-1.6.
- All 4 of the packages added an HRV, with a minimum efficiency of 60%; 2 of which are above 80%.
- The majority of the packages specify an ACH below building code requirements; 3 of which specifying ACH 2.0, with 1 specifying ACH 1.5.
- 2 of the packages specify an air-source heat pump (ASHP) as the primary heating system; with the total reduction achieved by these 2 packages being significantly higher than the other 2 packages.

Table 5: Relevant SBD Packages Energy Simulation Results- Detached House, Row/Townhouse, and Semi-Detached House

CCHT Detached House										
	SB-12 Package B	**AP-1**	**AP-2**	**AP-4**	**AP-5**	**AP-6**	**AP-12**	**AP-13**[2]	**AP-15**	**AP-19**[2]
Electricity (GJ)	38.29	43.12	42.21	42.21	41.59	41.90	41.90	50.21	42.82	50.21
Natural Gas (GJ)	77.12	59.09	48.69	55.15	41.22	52.62	54.58	26.65	55.95	23.85
Total Energy Use (GJ)	115.41	102.21	90.90	97.36	82.81	94.52	96.48	76.87	98.77	74.06
Overall Energy Intensity (GJ/m²)	0.43	0.38	0.34	0.37	0.31	0.36	0.36	0.29	0.37	0.28
Reduction (%)	-	**11.44%**	**21.24%**	**15.64%**	**28.25%**	**18.10%**	**16.40%**	**33.40%**	**14.42%**	**35.83%**
EnerGuide Rating[3]	80	82	84	83	86	84	83	87	83	87
Total Credits	0.00	11.20	16.60	11.60	25.10	12.20	5.50	5.50	6.50	2.70
Net Energy Use (GJ)	115.41	91.01	74.30	85.76	57.71	82.32	90.98	71.37	92.27	71.36
Net Energy Intensity (GJ/m²)	0.43	0.34	0.28	0.32	0.22	0.31	0.34	0.27	0.35	0.27
Total Reduction (%)	-	21.14%	35.62%	25.70%	49.99%	28.67%	21.16%	38.16%	20.05%	38.17%
Typical Townhouse										
	SB-12 Package B	**AP-1**	**AP-2**	**AP-4**	**AP-5**	**AP-6**	**AP-12**	**AP-13**[2]	**AP-15**	**AP-19**[2]
Electricity (GJ)	35.85	40.07	39.76	39.76	39.46	39.46	39.46	45.24	40.07	44.93
Natural Gas (GJ)	51.23	32.50	27.62	33.12	25.41	31.24	32.33	17.67	30.27	15.46
Total Energy Use (GJ)	87.07	72.57	67.38	72.88	64.87	70.70	71.79	62.90	70.34	60.39
Overall Energy Intensity (GJ/m²)	0.59	0.49	0.45	0.49	0.44	0.48	0.48	0.42	0.47	0.41
Reduction (%)	-	**16.66%**	**22.62%**	**16.30%**	**25.50%**	**18.81%**	**17.56%**	**27.76%**	**19.22%**	**30.65%**
EnerGuide Rating[3]	80	83	85	83	85	84	84	86	84	86
Total Credits	0.00	11.20	16.60	11.60	25.10	12.20	5.50	5.50	6.50	2.70
Net Energy Use (GJ)	87.07	61.37	50.78	61.28	39.77	58.50	66.29	57.40	63.84	57.69
Net Energy Intensity (GJ/m²)	0.59	0.41	0.34	0.41	0.27	0.39	0.45	0.39	0.43	0.39
Total Reduction (%)	-	29.52%	41.68%	29.62%	54.33%	32.82%	23.87%	34.07%	26.69%	33.75%
Typical Semi-Detached										
	SB-12 Package B	**AP-1**	**AP-2**	**AP-4**	**AP-5**	**AP-6**	**AP-12**	**AP-13**[2]	**AP-15**	**AP-19**[2]
Electricity (GJ)	36.46	40.68	40.37	40.37	40.07	40.07	40.07	46.72	40.68	46.40
Natural Gas (GJ)	57.06	38.54	32.30	37.98	28.20	35.84	37.00	18.45	36.32	16.67
Total Energy Use (GJ)	93.52	79.22	72.67	78.35	68.27	75.91	77.07	65.18	77.00	63.07
Overall Energy Intensity (GJ/m²)	0.48	0.41	0.38	0.41	0.35	0.39	0.40	0.34	0.40	0.33
Reduction (%)	-	**15.29%**	**22.29%**	**16.22%**	**27.00%**	**18.83%**	**17.59%**	**30.30%**	**17.67%**	**32.56%**
EnerGuide Rating[3]	80	83	84	83	85	84	84	86	84	87
Total Credits	0.00	11.20	16.60	11.60	25.10	12.20	5.50	5.50	6.50	2.70
Net Energy Use (GJ)	93.52	68.02	56.07	66.75	43.17	63.71	71.57	59.68	70.50	60.37
Net Energy Intensity (GJ/m²)	0.48	0.35	0.29	0.35	0.22	0.33	0.37	0.31	0.37	0.31
Total Reduction (%)	-	27.27%	40.04%	28.62%	53.84%	31.87%	23.47%	36.19%	24.62%	35.44%

Note:
[1] This table only includes the advanced packages that have met the reduction target for at least one of the house archetypes; or are within 2% or 4% of meeting the reduction target. All other advanced packages results are included in Appendix E.
[2] These packages use an air source heat pump as their primary heating system.
[3] The EnerGuide Rating was calculated using the estimated energy consumption, prior to the saving incurred from the credits.

The remaining 5 packages that are within 2% or 4% of the reduction target, or that have surpassed the target by more than 25%, have been modified using the above mentioned findings. The summary of results of the modifications can be found in Table 6 (pg.49). Based on the modified energy simulations, the following findings can be made:

- 6 packages achieved the reduction target for all house archetypes (AP-2, AP-5, AP-6, AP-12, AP-13, AP-19). Package AP-5, AP-13, and AP-19 still achieve a reduction above 25% after the modifications. Of these packages, 2 use an ASHP as the primary heating system (AP-13, AP-19).
- 2 of the packages achieved the reduction target for the row house archetype only (AP-1, AP-4).
- 1 package achieved the reduction target for both the semi-detached house and row house archetype (AP-15).

Table 6: Modified SBD Packages Energy Simulation Results- Detached House, Row/Townhouse, and Semi-Detached House

CCHT Detached House										
	SB-12 Package B	**AP-1$_m$**	**AP-2**	**AP-4$_m$**	**AP-5**	**AP-6$_m$**	**AP-12$_m$**	**AP-13$_m$** [2]	**AP-15$_m$**	**AP-19$_m$** [2]
Electricity (GJ)	38.29	40.98	42.21	40.98	40.68	40.68	40.68	50.71	41.29	50.47
Natural Gas (GJ)	77.12	53.77	48.69	52.35	46.98	50.53	50.51	33.72	52.27	33.43
Total Energy Use (GJ)	115.41	94.75	90.90	93.34	87.66	91.21	91.19	84.43	93.55	83.90
Overall Energy Intensity (GJ/m²)	0.43	0.36	0.34	0.35	0.33	0.34	0.34	0.32	0.35	0.32
Reduction (%)	-	**17.90%**	**21.24%**	**19.13%**	**24.05%**	**20.97%**	**20.99%**	**26.84%**	**18.94%**	**27.31%**
EnerGuide Rating[3]	80	84	84	84	85	84	84	85	84	85
Total Credits	0.00	12.98	16.60	7.58	25.10	8.89	5.50	5.50	1.29	2.70
Net Energy Use (GJ)	115.41	81.77	74.30	85.76	62.56	82.32	85.69	78.93	92.27	81.20
Net Energy Intensity (GJ/m²)	0.43	0.31	0.28	0.32	0.24	0.31	0.32	0.30	0.35	0.31
Total Reduction (%)	-	29.15%	35.62%	25.70%	45.79%	28.67%	25.76%	31.61%	20.05%	29.65%
Typical Townhouse										
	SB-12 Package B	**AP-1$_m$**	**AP-2**	**AP-4$_m$**	**AP-5**	**AP-6$_m$**	**AP-12$_m$**	**AP-13$_m$** [2]	**AP-15$_m$**	**AP-19$_m$** [2]
Electricity (GJ)	35.85	38.84	39.76	38.84	38.84	38.54	38.84	44.62	38.84	43.87
Natural Gas (GJ)	51.23	30.64	27.62	30.69	27.01	29.95	29.76	22.26	29.07	22.13
Total Energy Use (GJ)	87.07	69.49	67.38	69.53	65.85	68.48	68.60	66.88	67.92	66.00
Overall Energy Intensity (GJ/m²)	0.59	0.47	0.45	0.47	0.44	0.46	0.46	0.45	0.46	0.44
Reduction (%)	-	**20.20%**	**22.62%**	**20.14%**	**24.37%**	**21.35%**	**21.22%**	**23.19%**	**22.00%**	**24.20%**
EnerGuide Rating[3]	80	84	85	84	85	84	84	85	84	85
Total Credits	0.00	-8.48	16.60	8.25	25.10	9.99	2.31	5.50	4.08	2.70
Net Energy Use (GJ)	87.07	77.97	50.78	61.28	40.75	58.50	66.29	61.38	63.84	63.30
Net Energy Intensity (GJ/m²)	0.59	0.52	0.34	0.41	0.27	0.39	0.45	0.41	0.43	0.43
Total Reduction (%)	-	10.46%	41.68%	29.62%	53.20%	32.82%	23.87%	29.51%	26.69%	27.30%
Typical Semi-Detached										
	SB-12 Package B	**AP-1$_m$**	**AP-2**	**AP-4$_m$**	**AP-5**	**AP-6$_m$**	**AP-12$_m$**	**AP-13$_m$** [2]	**AP-15$_m$**	**AP-19$_m$** [2]
Electricity (GJ)	36.46	39.46	40.37	39.46	39.15	39.15	39.15	46.48	39.46	46.01
Natural Gas (GJ)	57.06	35.73	32.30	35.48	31.45	34.41	34.18	23.94	34.24	23.33
Total Energy Use (GJ)	93.52	75.19	72.67	74.94	70.60	73.56	73.33	70.42	73.70	69.34
Overall Energy Intensity (GJ/m²)	0.48	0.39	0.38	0.39	0.37	0.38	0.38	0.36	0.38	0.36
Reduction (%)	-	**19.60%**	**22.29%**	**19.87%**	**24.50%**	**21.34%**	**21.59%**	**24.70%**	**21.20%**	**25.86%**
EnerGuide Rating[3]	80	84	84	84	85	84	84	85	84	85
Total Credits	0.00	-9.60	16.60	8.19	25.10	12.20	1.76	5.50	3.20	2.70
Net Energy Use (GJ)	93.52	84.79	56.07	66.75	45.50	61.36	71.57	64.92	70.50	66.64
Net Energy Intensity (GJ/m²)	0.48	0.44	0.29	0.35	0.24	0.32	0.37	0.34	0.37	0.35
Total Reduction (%)	-	9.34%	40.04%	28.62%	51.34%	34.39%	23.47%	30.58%	24.62%	28.75%

Notes:
[1] These packages use an air source heat pump as their primary heating system.
[2]The EnerGuide Rating was calculated using the estimated energy consumption, prior to the saving incurred from the credits.

6.4. Specifications of Advanced Packages

The specifications of the modified advanced packages have been identified in Table 7 below. The specifications indicate that the building envelope components that vary the most between the packages are the above grade wall thermal resistance (RSI) values and window thermal transmittance (U) values; while the ceiling, basement wall, and slab thermal resistance values are almost consistent throughout. However, in the systems specifications, there is greater diversity between the packages.

Table 7: Specifications of Modified Advanced Packages

		AP-1$_m$	AP-2	AP-4$_m$	AP-5	AP-6$_m$	AP-12$_m$	AP-13$_m$	AP-15$_m$	AP-19$_m$
Building Envelope	Ceiling w/ Attic Space Min. RSI -Value[1]	8.8	8.8	8.8	8.8	10.5	8.8	8.8	8.8	8.8
	Ceiling w/out Attic Space Min.RSI Value[1]	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
	Exposed Floor Min. RSI Value[1]	5.5	7.1	5.5	5.5	5.5	5.5	5.5	5.5	5.5
	Walls Above Grade Min. RSI Value[1]	4.8	5.2	4.8	5.1	5.2	4.8	4.8	4.6	4.4
	Basement Walls Min. RSI Value[1]	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4.2	3.5
	Below Grade Slab Entire Surface Min. RSI Value[1]	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
	Windows and Sliding Doors Max. U-Value[2]	1.6	1.6	1.6	1.4	1.6	1.4	1.8	1.6	1.8
	Skylights Maximum U-Value[2]	-	-	-	-	-	-	-	-	-
Systems	Space Heating Equipment Minimum AFUE	95.0	98.0	95.0	97.5	96.0	92.0	9.4 HSPF[3]	97.0	9.4 HSPF[3]
	HRV Min. Efficiency (High Temp./Low Temp)	75/70	84/72	75/65	84/78	60/50	75/65	60/50	78/68	75/65
	Domestic Hot Water Heater Min. EF	0.9	0.9	0.8	0.9	0.9	0.8	0.7	1.0	0.7
	Air Tightness @ 50 Pa	2.0	2.0	2.0	2.0	1.5	1.5	2.5	2.0	2.5

Notes:
[1] The RSI values listed are for the thermal insulation component, expressed in $(m^2 \cdot K)/W$.
[2] The U-value for the window glazing is expressed in $W/(m^2 \cdot K)$.
[3] HSPF refers t the heating seasonal performance factor for an air source heat pump.

6.4.1. Building Envelope Components

The simulation results indicate that the above grade wall thermal resistance and the window thermal transmittance values had a greater impact for the detached house, followed by the semi-detached house and the row/townhouse. That said, the energy savings of the individual upgrades were not significant. The highest thermal resistance value specified (RSI 5.2) only resulted in a reduction of an average of 1.5% for the detached house, and below 1% for the row/townhouse. Similarly, the U-value of the window also had limited impact on the energy use reduction. The upgrades of the increased amount of slab insulation to cover the entire underside of the floor slab saw more consistent reductions at ~1.5% for all 3 archetypes. Reasons for the limited reductions incurred from building envelope upgrades is due to the level of the upgrade itself. In order to see a greater reduction there needs to be a greater increase in thermal performance of the envelope. For example, a window U-value of 1.0 would result in an 7.5% reduction while a U-value of 1.4 only saw a 1.5% reduction, for the detached house and lower for the semi-detached and row/townhouse.

The builder specified building envelope assemblies for the advanced packages have been outlined in Table 8 (pg. 52). The SBD reports indicate that discussions were made during the charrettes of alternative types of assemblies such as applying higher thermal resistance value in the exterior insulation; using structural insulated panels; or advanced framing by spacing the stud wall at 610mm spacing as opposed to 406mm spacing. However, the specified assemblies demonstrate that builders are not comfortable with those changes. Furthermore, some of the packages that did not meet the reduction target specified thermal resistance values that were lower than SB-12 requirements and U-values that were higher than SB-12 requirements.

Table 8: Builder Specified Building Envelope Assemblies and Components

Component	Nominal RSI[1] Value	Effective RSI[2] Value	Assembly Description	#[4]
Ceiling with Attic Space	8.80	8.03	38mm x 140mm @ 610mm o.c. , RSI 8.8 blown insulation (RSI 0.61/25mm for cellulose, RSI 0.44/25mm for fibreglass)	1
	10.50	9.56	38mm x 140mm @ 610mm o.c. , RSI 10.5 blown insulation (RSI 0.61/25mm for cellulose (RSI 0.44/25mm for fibreglass)	2
Ceiling without Attic Space	7.10	6.46	38mm x 286mm @ 610mm o.c. , RSI 7.1 batt insulation (RSI 0.56/25mm for fibreglass)	3
Exposed Floor	5.50	5.17	38mm x 235mm @ 406mm o.c. , engineered joists, RSI 5.5 batt insulation	4
	7.10	6.66	38mm x 286mm @ 406mm o.c. , engineered joists, RSI 7.1 batt insulation	5
Walls Above Grade	5.20	4.48	38mm x 140mm @ 610mm o.c. , RSI 4.23 batt insulation (RSI 0.77/25mm) , RSI 0.88 continuous exterior rigid insulation (25mm)	6
	5.10	4.38	38mm x 140mm @ 406mm o.c. , RSI 4.23 batt insulation(RSI 0.77/25mm), RSI 0.88 continuous exterior rigid insulation (25mm)	7
	4.80	4.19	38mm x 140mm @ 610mm o.c. , RSI 3.87 batt insulation (RSI 0.71/25mm) , RSI 0.88 continuous exterior rigid insulation (25mm)	8
	4.60	4.11	38mm x 140mm @ 406mm o.c. , RSI 3.87 batt insulation(RSI 0.71/25mm), RSI 0.88 continuous exterior rigid insulation (25mm)	9
	4.40	3.84	38mm x 140mm @ 406mm o.c. , RSI 3.52 batt insulation(RSI 0.65/25mm), RSI 0.88 continuous exterior rigid insulation (25mm)	10
	4.30	3.77	38mm x 140mm @ 610mm o.c. , RSI 4.23 batt insulation (RSI 0.77/25mm), RSI 0.17 continuous exterior insulated sheathing (7mm)	11
Walls Below Grade	3.50	3.20	38mm x 140mm @ 610mm o.c. , RSI 3.52 batt insulation(RSI 0.65/25mm), full coverage	12
	4.20	3.82	38mm x 140mm @ 610mm o.c. , RSI 4.23 batt insulation(RSI 0.77/25mm), full coverage	13
Below Grade Slab	1.80	1.80	51mm full coverage, RSI 1.8 rigid insulation	14
Windows and Sliding Doors	U 1.8[3]	-	double glazed IGU, 12mm argon filled, vinyl frame, low e coating, SHGC 0.42	-
	U 1.6[3]	-	double glazed IGU, 13mm argon filled, low e coating, SHGC 0.42	-
	U 1.4[3]	-	triple glazed IGU, argon filled, vinyl frame, low e coating, SHGC 0.42	-

Notes:
[1] The RSI values listed are for the thermal insulation component, expressed in $(m^2 \cdot K)/W$. The nominal value refers to the thermal resistance value of the insulating materials only.
[2] The RSI values listed are for the thermal insulation component, expressed in $(m^2 \cdot K)/W$. The effective value refers to the thermal resistance value taking into account the framing components. Refer to Appendix I (pg. 118) for calculations.
[3] The U-value for the window glazing is for the centre of glass only, expressed in $W/(m^2 \cdot K)$.
[4] The number in this column is the calculation identification number for the effective RSI value calculations in Appendix I (pg.118).

Based on the specifications distribution for the above grade wall thermal resistance values, shown in Figure 20 below, it can be noted that the packages that achieved the reduction target for the row/townhouse and/or semi-detached archetype only do not have specified values greater than SB-12 requirements. For the packages that have achieved the target for the all the house archetypes, values greater than SB-12 requirements, along with values used in the current standard, are in the specifications. When analysing the actual reduction of the packages using a higher thermal resistance value of 5.2 (AP-2, AP-5, and AP-6), it can be noted that the row/townhouse has a higher reduction than the semi-detached and detached archetype. This correlates with the fact that since the detached house and semi-detached house have a greater external wall area and experience higher heat loss through the building envelope, if only taking into account the wall thermal resistance value, the detached and semi-detached house would need a higher value than the row/townhouse.

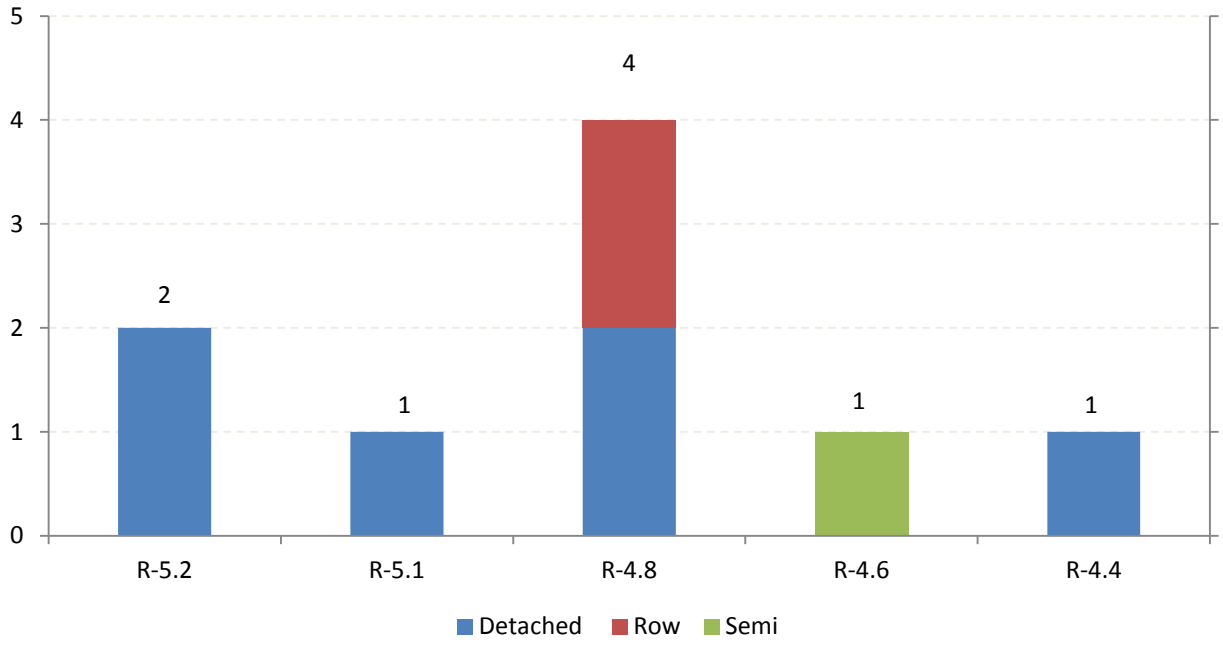


Figure 20: Advanced Packages Specified Above Grade Wall Thermal Resistance (RSI) Values [(m²·K)/W]

The distribution of window U-values indicates that the packages have achieved the reduction target using 3 different U-values; 1.8, 1.6, and 1.4. The charrette reports had indicated that builders were most comfortable using windows with a U-value of either 1.6 or 1.8; both of which are used for compliance in the current standard. In the original packages that had achieved compliance, lower U-values had been used. However, after the modifications, only 1 package remained that specified a U-value of 1.4 Based on the distribution of house archetypes, a window with a U-value of 1.6 was common for all archetypes. The package that was compliant using a U-value of 1.4 was compliant for all 3 archetypes; as were the two packages that used windows with a U-value of 1.8. However, it should be noted that the latter packages used an ASHP as their primary heating system.

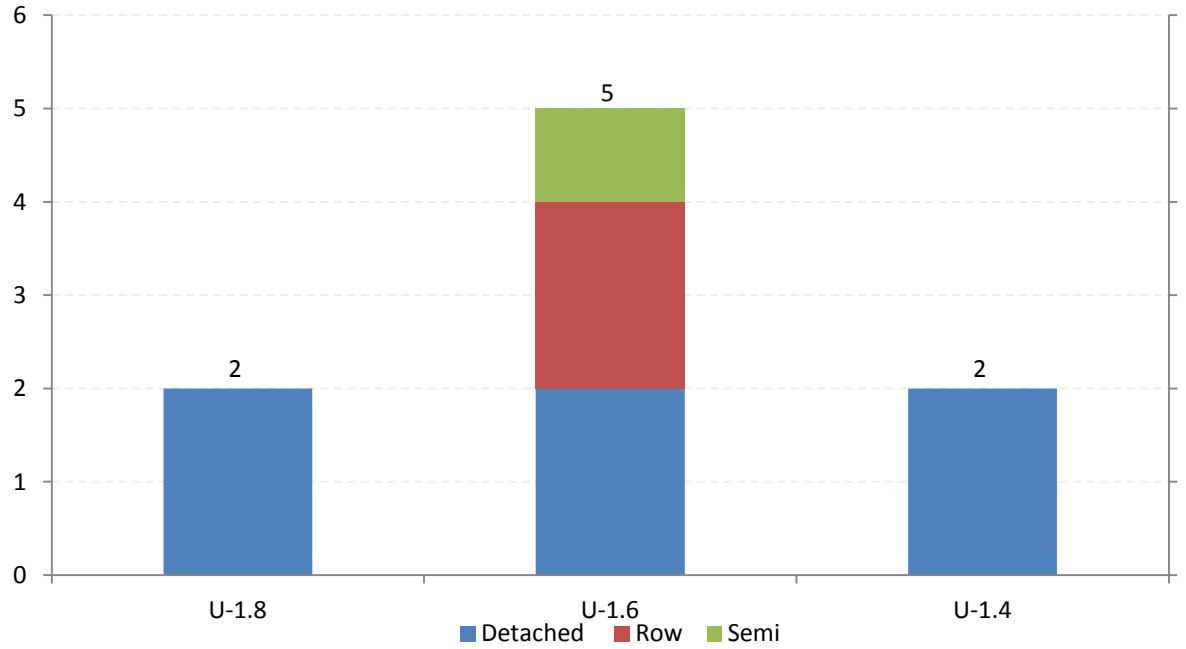


Figure 21: Advanced Packages Specified Window Thermal Transmittance (U) Values [W/(m²·K)]

6.4.2. Systems Components

The simulation results indicated that the building systems upgrades had greater energy reductions than the building envelope upgrades. Typically, the systems with the greatest reduction in all archetypes was the HRV and the water heater efficiency. However, even though space heating was one of the highest energy consumers in all house types, the space heater efficiency upgrades resulted in the lowest reduction in comparison to the other systems components upgrades. For the detached house, the air tightness (ACH) was also a significant measure.

Space Heating Efficiency

The charrette reports indicate that a typical space heating AFUE in Ontario new home constructions is 95%. As shown in Figure 22 (pg.56), all of the packages that have met the reduction target use a space heating AFUE above 90%, most of which are above 95%. Furthermore, only the packages that met the reduction target for the row/townhouse only use an efficiency of 95%, while the others, except for 1, were above 95%. The exception, which had an AFUE of 92%, still met the reduction target for all 3 house archetypes. Both of the packages that used an ASHP as the primary space heating equipment specified a heating seasonal performance factor (HSPF) of 9.4.

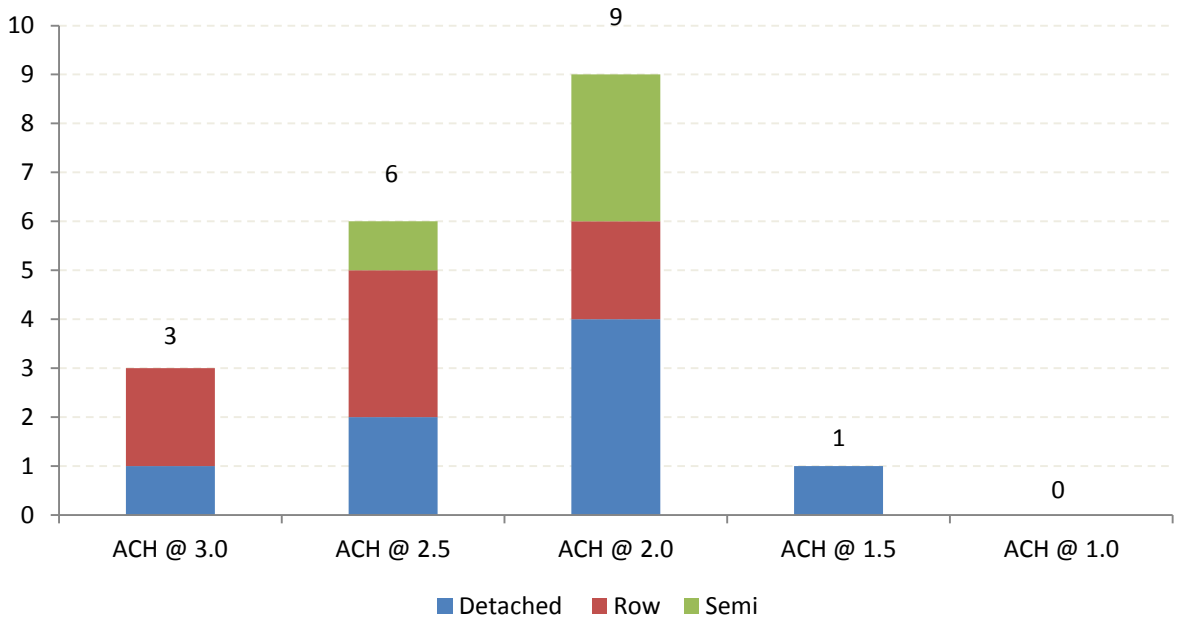


Figure 22: Advanced Packages Specified Space Heating AFUE

In comparing the results of the packages that used an ASHP to those that used a natural gas furnace, the former resulted in reductions much higher than the target. Although a house with an ASHP will use more electricity than one that uses a natural gas furnace, it uses much less natural gas. The individual reduction of using an ASHP alone is approximately 20% for the detached house, 14% for the row/townhouse and 17% for the semi-detached house. Therefore, it can be said that if a ASHP is to be used, lower requirements for the other systems and building envelope components could be used to meet the reduction target. However, it should be noted that the reduction, expressed as a percentage, met for the row/townhouse archetype was lower than the reduction met by both the detached house and semi-detached house archetype; which is the opposite for the packages that do not use an ASHP.

When evaluating the absolute energy reductions, the reduction for the detached house was the highest with approximately 22 GJ; followed by the semi-detached with 14 GJ and the row/townhouse with 11 GJ. Therefore, the results can be correlated to the amount of heating required by each house archetype; where the house with the highest heating demand will reap the highest energy savings in GJ.

That said, there are other factors that may have an influence on the overall performance of an ASHP that have not been conducted in this study such as the efficiency (HSPF) of the system, or the capabilities of the software to model an ASHP accurately. The efficiency specified for the ASHP by the builders in the reports was an HSPF of 9.4. This efficiency is representative of the highest efficiency ASHP available in the market whose HSPF range between 8 and 10 (DOE, 2012); while the lower efficiency systems will have a minimum efficiency of HSPF 7.1 (NRCan, 2004).

Water Heater Efficiency

According the to charrette reports, there is no typical water heater efficiency used by homebuilders in Ontario. The efficiency of the water heater of the packages that met the reduction target varied between 0.7 to 1.0; with the majority specifying an efficiency of either 0.8 or 0.9 and an efficiency of 0.7 only specified in the packages that used an ASHP as their primary heating system. The energy simulation results of the individual components identify that there is significant difference in energy reduction between the efficiencies. A water heater with an efficiency of 0.7 saw an average reduction of 2%-3% while an efficiency of 0.9 saw an average reduction of 4.5% to 6%; with the lower reduction corresponding to the detached house archetype and the higher reduction to the row/townhouse. The fact that the water heater efficiency had a highest impact for the row/townhouse can be correlated to the fact that the row/townhouse has the highest percentage of hot water energy demand.

HRV Efficiency

The HRV efficiency of the packages that achieved the reduction target vary with a maximum (high temperature) efficiency between 60% to 84%. The energy simulation results indicate that a higher HRV efficiency resulted in a higher reduction of the individual component. An efficiency of 60% resulted in an individual reduction of 4% to 6%; while an efficiency of 84% resulted in an individual reduction of 8% to 10%. Furthermore, the results indicate that an HRV has a higher benefit in the row/townhouse and the

least benefit for the detached house in terms of meeting the reduction as a percentage; but a higher benefit for the detached house in terms of actual GJ consumption reduction.

The distribution of efficiencies and their respective compliant archetype, as shown in Figure 23 below, indicates that there is a variation of efficiencies that can be used. The most common efficiencies for all archetypes fall between 70% and 80%.

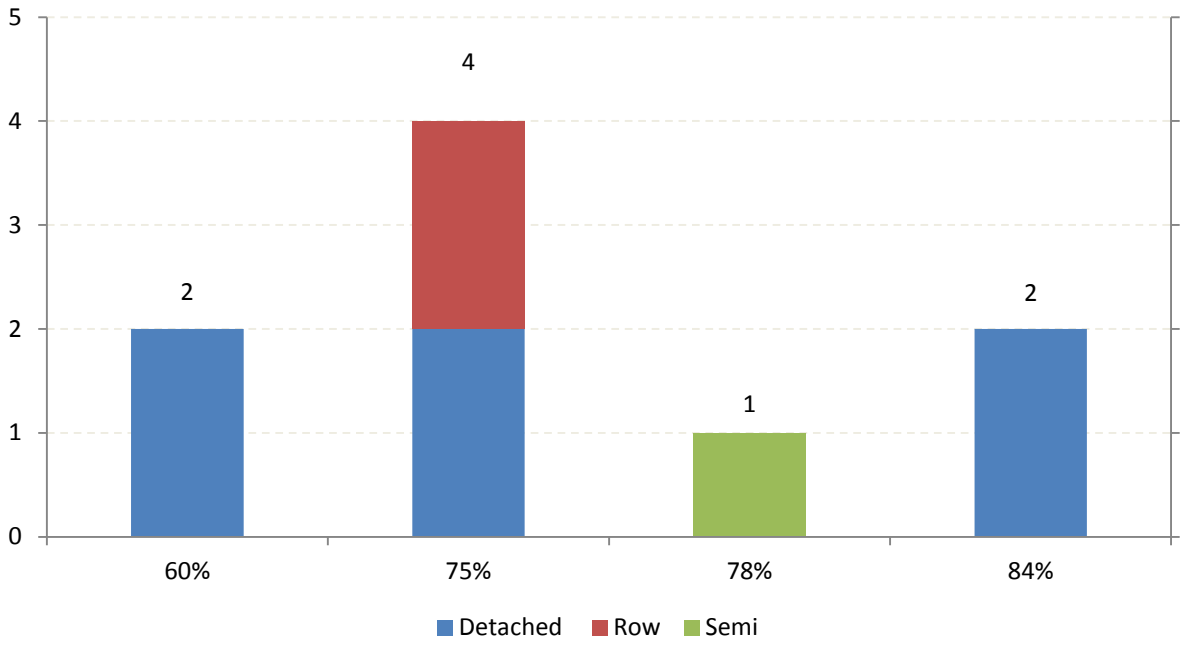


Figure 23: Advanced Packages Specified HRV Efficiency [%]

It should be noted that the 2 packages that met the reduction with the 60% efficiency had significant improvements from the other building components. One of the packages used an ASHP as their primary heating equipment while the other had the highest building envelope upgrades in the above grade walls, the highest water heater efficiency and an ACH of 1.5.

6.5. Sensitivity Analyses

A sensitivity analysis was conducted to determine the effects of building orientation, climate, thermal bridging, the use of air-conditioning, and the SHGC of the windows. The building orientation analysis was conducted on the baseline package for the different house archetypes; with results identified in Figure 24 (pg. 60). The climate analysis was conducted on the 19 SBD packages for all 3 different house archetypes; the summary of results can be found in Appendix G (pg. 116) with full detailed results found in Appendix H (pg.118) . The remaining analyses were conducted on the 9 packages that have achieved the reduction target. The results of these analyses can be found in Table 10 to 12 (pgs. 63-65); with full results of each individual sensitivity measure found in Appendix J (pg. 143).

6.5.1. Building Orientation

The baseline energy consumption at the different orientations indicate a gap in the performance scale, as shown in Figure 24 (pg. 60). However, the differences in performance in the varying front orientations are not significant; with less than 3% difference for the detached house and semi-detached house and less than 2% for the row/townhouse. The detached house indicates the highest energy consumption with an eastern orientation and the lowest with a southern orientation; the row/townhouse indicates the highest with either an eastern or western orientation and the lowest on the northern orientation; and the semi-detached house has the highest with an eastern orientation and the lowest on the northern orientation.

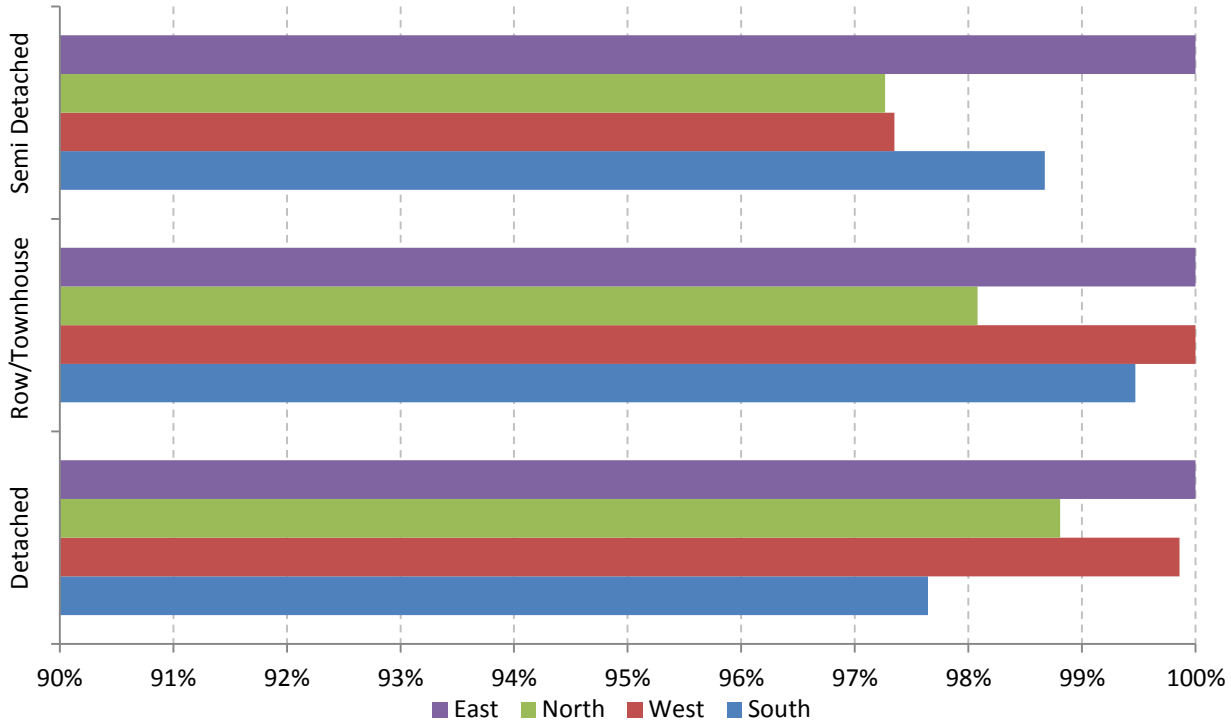


Figure 24: Baseline Energy Consumption- Orientation Percentage Scale

The differences in lowest energy consuming orientation between the archetypes is due to the design and window placements. The WWR for the archetypes are 9%, 7%, and 13% for the detached house, semi-detached house and row/townhouse respectively. The distribution of window glazing varies between the 3 archetypes, but most of the glazing area is located on the front and rear elevations. The distribution of glazing is consistent with most homes. Primarily, homes have the largest window areas on the front and rear elevations, and small window areas on the side. Furthermore, in many homes, the floor layout and design will have common areas at the front of the house where large windows will be required. However, additional to allowing for natural sunlight into those select space, it is important to optimize the building design to take advantage of passive solar opportunities; such as appropriate window glazing location and size and providing appropriate shading devices in order to reduce the energy load requirements through proper storage and distribution of solar heat energy. Therefore, it is

important to note the orientation of the front elevation when designing the house to ensure that windows are being placed accordingly.

The fact that most homes are not design to optimize passive solar opportunities, especially with large scale homebuilders, is due to the limitations incurred by the design of the subdivision. Many times, the option to place the front elevation at the most appropriate orientation is not possible. For these cases, designers and builders should be aware of the window specifications and placement; specifically the window sizes, the sill heights, the window placement along the sill, and the SHGC of the window panes.

6.5.2. Climate

The SBD charrettes were conducted on homes both in the GTA and Ottawa. The baseline energy consumption (GJ) found that the homes in the Ottawa consumed more energy than those using the Toronto; as identified in Table 9 below.

Table 9: Climate Dependent Baseline Energy Consumption (GJ)- Detached House, Row/Townhouse, and Semi-Detached House

	Detached		Row/Townhouse		Semi-Detached	
	Toronto	**Ottawa**	**Toronto**	**Ottawa**	**Toronto**	**Ottawa**
Total Consumption (GJ)	115.41	127.20	87.07	94.91	93.52	102.33
Consumption (GJ/m2)	0.43	0.48	0.59	0.64	0.48	0.53
Difference (%)	-	**9%**	-	**8%**	-	**9%**

The original SBD packages that were simulated using the Ottawa weather found that there were minor differences in the overall reduction. The results from the simulations identified the following findings:

- The same 4 packages achieved the reduction target for all 3 house archetypes (AP-2, AP-5, AP-13, AP-19).
- 1 package achieved the reduction target for the row/townhouse archetype only (AP-10).

- 1 package was within 2% of the reduction target for all 3 archetypes (AP-6); 1 package was within 2% of the target for the semi-detached house and row/townhouse archetypes (AP-12); and 1 package was within 2% of the reduction target for the row/townhouse only (AP-15).
- 1 package was within 4% of the reduction target for the detached house only (AP-12); 1 package was within 4% of the reduction target for the semi-detached and row/townhouse archetypes (AP-15); and 1 package was within 4% of the reduction target for the row/townhouse only (AP-18).

Of the packages identified above, AP-18 is the only package that did not achieve the reduction target for any of the archetypes in the Toronto climate. In comparing between the packages that achieved the reduction target for Ottawa and those that met the reduction target for Toronto, the following findings can be made:

- The building envelope upgrades had higher individual reduction in Ottawa; both when expressed as a percentage of the total energy consumption and in absolute energy savings in GJ.
- The HRV had a lower individual reduction in Ottawa for the detached house as a percentage but higher energy savings in GJ; while the individual component reductions for the semi-detached house and row/townhouse were higher as a percentage but lower in absolute energy savings in GJ.
- The water heater upgrade had a lower individual component reduction on Ottawa for all 3 archetypes; both when expressed as a percentage of the total energy consumption and in absolute energy savings in GJ.
- The air tightness of the house had a higher individual component reduction on Ottawa for all 3 archetypes; both when expressed as a percentage of the total energy consumption and in absolute energy savings in GJ.

Table 10: Summary of Energy Simulation Results for Sensitivity Analyses on Thermal Bridging, Air-Conditioning and SHGC- Detached House

		AP Specifications	TB	A/C[1]	TB+ A/C[1]	SHGC 0.52	SHGC 0.52 + A/C[1]
AP-1$_m$	**Consumption (GJ)**	94.75	98.22	101.32	104.77	91.37	99.83
	Consumption (GJ/m²)	0.36	0.37	0.38	0.39	0.34	0.38
	Reduction (%)	17.90%	14.89%	16.94%	14.11%	20.83%	18.16%
	Reduction Difference (%)	-	**-3.01%**	**-0.97%**	**-3.79%**	**2.93%**	**0.25%**
AP-2	**Consumption (GJ)**	90.90	94.31	97.50	100.89	87.78	96.28
	Consumption (GJ/m²)	0.34	0.35	0.37	0.38	0.33	0.36
	Reduction (%)	21.24%	18.28%	20.07%	17.29%	23.94%	21.07%
	Reduction Difference (%)	-	**-2.96%**	**-1.17%**	**-3.95%**	**2.70%**	**-0.18%**
AP-4$_m$	**Consumption (GJ)**	93.34	96.92	100.08	103.62	90.19	98.81
	Consumption (GJ/m²)	0.35	0.36	0.38	0.39	0.34	0.37
	Reduction (%)	19.13%	16.02%	17.95%	15.05%	21.85%	18.99%
	Reduction Difference (%)	-	**-3.10%**	**-1.17%**	**-4.07%**	**2.72%**	**-0.13%**
AP-5	**Consumption (GJ)**	87.66	91.24	94.47	98.01	84.72	93.44
	Consumption (GJ/m²)	0.33	0.34	0.36	0.37	0.32	0.35
	Reduction (%)	24.05%	20.94%	22.55%	19.65%	26.59%	23.40%
	Reduction Difference (%)	-	**-3.11%**	**-1.50%**	**-4.40%**	**2.54%**	**-0.65%**
AP-6$_m$	**Consumption (GJ)**	91.21	94.74	97.93	101.42	88.02	96.64
	Consumption (GJ/m²)	0.34	0.36	0.37	0.38	0.33	0.36
	Reduction (%)	20.97%	17.91%	19.72%	16.86%	23.73%	20.77%
	Reduction Difference (%)	-	**-3.06%**	**-1.25%**	**-4.11%**	**2.76%**	**-0.20%**
AP-12$_m$	**Consumption (GJ)**	91.19	94.65	97.97	101.40	88.10	96.79
	Consumption (GJ/m²)	0.34	0.36	0.37	0.38	0.33	0.36
	Reduction (%)	20.99%	17.98%	19.68%	16.87%	23.66%	20.65%
	Reduction Difference (%)	-	**-3.01%**	**-1.31%**	**-4.12%**	**2.67%**	**-0.34%**
AP-13$_m$	**Consumption (GJ)**	84.43	87.05	89.77	91.58	82.67	89.13
	Consumption (GJ/m²)	0.32	0.33	0.34	0.34	0.31	0.34
	Reduction (%)	26.84%	24.58%	26.40%	24.92%	28.37%	26.93%
	Reduction Difference (%)	-	**-2.26%**	**-0.44%**	**-1.92%**	**1.53%**	**0.09%**
AP-15$_m$	**Consumption (GJ)**	93.55	96.47	100.13	103.00	90.19	98.66
	Consumption (GJ/m²)	0.35	0.36	0.38	0.39	0.34	0.37
	Reduction (%)	18.94%	16.41%	17.91%	15.56%	21.85%	19.12%
	Reduction Difference (%)	-	**-2.52%**	**-1.02%**	**-3.38%**	**2.92%**	**0.18%**
AP-19$_m$	**Consumption (GJ)**	83.90	86.19	88.46	90.62	81.32	87.75
	Consumption (GJ/m²)	0.32	0.32	0.33	0.34	0.31	0.33
	Reduction (%)	27.31%	25.32%	27.48%	25.71%	29.54%	28.06%
	Reduction Difference (%)	-	**-1.99%**	**0.17%**	**-1.60%**	**2.23%**	**0.75%**

Notes:
[1] The reduction (%) has been calculated with the baseline SB-12 CP-B including A/C with a SEER of 13; at an energy consumption of 121.98 GJ. The reduction difference (%) has been calculated using the baseline energy consumption without A/C.

Table 11: Summary of Energy Simulation Results for Sensitivity Analyses on Thermal Bridging, Air-Conditioning and SHGC- Detached - Row/Townhouse

		AP Specifications	TB	A/C[1]	TB+ A/C[1]	SHGC 0.52	SHGC 0.52 + A/C[1]
AP-1 m	**Consumption (GJ)**	69.49	71.02	73.59	75.13	68.30	73.00
	Consumption (GJ/m²)	0.47	0.48	0.50	0.51	0.46	0.49
	Reduction (%)	20.20%	18.44%	19.17%	17.48%	21.56%	19.82%
	Reduction Difference (%)	-	**-1.76%**	**-1.02%**	**-2.72%**	**1.36%**	**-0.38%**
AP-2	**Consumption (GJ)**	67.38	68.66	71.49	72.75	66.29	71.01
	Consumption (GJ/m²)	0.45	0.46	0.48	0.49	0.45	0.48
	Reduction (%)	22.62%	21.15%	21.48%	20.09%	23.87%	22.01%
	Reduction Difference (%)	-	**-1.47%**	**-1.14%**	**-2.53%**	**1.25%**	**-0.61%**
AP-4 m	**Consumption (GJ)**	69.53	71.02	73.71	75.17	68.44	73.22
	Consumption (GJ/m²)	0.47	0.48	0.50	0.51	0.46	0.49
	Reduction (%)	20.14%	18.44%	19.04%	17.43%	21.40%	19.58%
	Reduction Difference (%)	-	**-1.71%**	**-1.11%**	**-2.71%**	**1.26%**	**-0.56%**
AP-5	**Consumption (GJ)**	65.85	67.19	70.06	71.38	64.84	69.66
	Consumption (GJ/m²)	0.44	0.45	0.47	0.48	0.44	0.47
	Reduction (%)	24.37%	22.84%	23.04%	21.60%	25.53%	23.49%
	Reduction Difference (%)	-	**-1.53%**	**-1.33%**	**-2.77%**	**1.16%**	**-0.88%**
AP-6 m	**Consumption (GJ)**	68.48	70.04	72.64	74.20	67.33	96.64
	Consumption (GJ/m²)	0.46	0.47	0.49	0.50	0.45	0.36
	Reduction (%)	21.35%	19.56%	20.22%	18.50%	22.68%	20.77%
	Reduction Difference (%)	-	**-1.79%**	**-1.13%**	**-2.85%**	**1.33%**	**-0.58%**
AP-12 m	**Consumption (GJ)**	68.60	69.95	72.80	74.13	67.53	96.79
	Consumption (GJ/m²)	0.46	0.47	0.49	0.50	0.45	0.36
	Reduction (%)	21.22%	19.66%	20.03%	18.57%	22.45%	20.65%
	Reduction Difference (%)	-	**-1.55%**	**-1.18%**	**-2.64%**	**1.23%**	**-0.56%**
AP-13 m	**Consumption (GJ)**	66.88	67.57	66.17	70.47	66.50	70.01
	Consumption (GJ/m²)	0.45	0.45	0.45	0.47	0.45	0.47
	Reduction (%)	23.19%	22.41%	27.32%	22.60%	23.63%	23.10%
	Reduction Difference (%)	-	**-0.78%**	**4.13%**	**-0.59%**	**0.44%**	**-0.09%**
AP-15 m	**Consumption (GJ)**	67.92	68.94	71.50	73.05	67.20	98.66
	Consumption (GJ/m²)	0.46	0.46	0.48	0.49	0.45	0.37
	Reduction (%)	22.00%	20.83%	21.47%	19.76%	22.82%	19.12%
	Reduction Difference (%)	-	**-1.17%**	**-0.53%**	**-2.24%**	**0.82%**	**-2.88%**
AP-19 m	**Consumption (GJ)**	66.00	66.59	68.92	69.48	65.56	69.07
	Consumption (GJ/m²)	0.44	0.45	0.46	0.47	0.44	0.46
	Reduction (%)	24.20%	23.53%	24.30%	23.68%	24.70%	24.14%
	Reduction Difference (%)	-	**-0.67%**	**0.10%**	**-0.52%**	**0.50%**	**-0.06%**

Notes:
[1] The reduction (%) has been calculated with the baseline SB-12 CP-B including A/C with a SEER of 13; at an energy consumption of 91.04 GJ. The reduction difference (%) has been calculated using the baseline energy consumption without A/C.

Table 12: Summary of Energy Simulation Results for Sensitivity Analyses on Thermal Bridging, Air-Conditioning and SHGC- Detached - Semi-Detached House

		AP Specifications	TB	A/C[1]	TB+ A/C[1]	SHGC 0.52	SHGC 0.52 + A/C[1]
AP-1 m	Consumption (GJ)	75.19	76.97	80.37	82.13	73.52	79.74
	Consumption (GJ/m²)	0.39	0.40	0.42	0.43	0.38	0.41
	Reduction (%)	19.60%	17.69%	18.49%	16.71%	21.39%	19.13%
	Reduction Difference (%)	-	-1.91%	-1.11%	-2.89%	1.79%	-0.47%
AP-2	Consumption (GJ)	72.67	74.40	77.87	79.57	71.13	77.37
	Consumption (GJ/m²)	0.38	0.39	0.40	0.41	0.37	0.40
	Reduction (%)	22.29%	20.44%	21.03%	19.30%	23.94%	21.53%
	Reduction Difference (%)	-	-1.85%	-1.27%	-2.99%	1.65%	-0.76%
AP-4 m	Consumption (GJ)	74.94	76.76	80.19	81.98	73.38	79.67
	Consumption (GJ/m²)	0.39	0.40	0.42	0.42	0.38	0.41
	Reduction (%)	19.87%	17.92%	18.67%	16.86%	21.54%	19.20%
	Reduction Difference (%)	-	-1.94%	-1.20%	-3.00%	1.67%	-0.67%
AP-5	Consumption (GJ)	70.60	70.76	75.88	76.06	69.15	79.02
	Consumption (GJ/m²)	0.37	0.37	0.39	0.39	0.36	0.41
	Reduction (%)	24.50%	24.33%	23.04%	22.87%	26.06%	19.87%
	Reduction Difference (%)	-	-0.17%	-1.46%	-1.63%	1.56%	-4.63%
AP-6 m	Consumption (GJ)	73.56	75.37	78.79	80.57	71.94	78.22
	Consumption (GJ/m²)	0.38	0.39	0.41	0.42	0.37	0.41
	Reduction (%)	21.34%	19.40%	20.10%	18.29%	23.07%	20.67%
	Reduction Difference (%)	-	-1.94%	-1.25%	-3.05%	1.73%	-0.67%
AP-12 m	Consumption (GJ)	73.33	75.28	78.59	80.54	71.80	78.11
	Consumption (GJ/m²)	0.38	0.39	0.41	0.42	0.37	0.40
	Reduction (%)	21.59%	19.51%	20.30%	18.32%	23.22%	20.79%
	Reduction Difference (%)	-	-2.08%	-1.29%	-3.27%	1.63%	-0.81%
AP-13 m	Consumption (GJ)	70.42	71.20	69.15	74.94	72.03	74.42
	Consumption (GJ/m²)	0.36	0.37	0.36	0.39	0.37	0.39
	Reduction (%)	24.70%	23.86%	28.87%	24.00%	22.98%	24.52%
	Reduction Difference (%)	-	-0.84%	4.17%	-0.70%	-1.72%	-0.18%
AP-15 m	Consumption (GJ)	73.70	74.67	78.87	79.83	72.03	78.24
	Consumption (GJ/m²)	0.38	0.39	0.41	0.41	0.37	0.41
	Reduction (%)	21.20%	20.16%	20.02%	19.04%	22.98%	20.65%
	Reduction Difference (%)	-	-1.04%	-1.18%	-2.16%	1.78%	-0.54%
AP-19 m	Consumption (GJ)	69.34	70.33	73.09	74.05	68.69	73.57
	Consumption (GJ/m²)	0.36	0.36	0.38	0.38	0.36	0.38
	Reduction (%)	25.86%	24.79%	25.88%	24.91%	26.55%	25.39%
	Reduction Difference (%)	-	-1.07%	0.02%	-0.95%	0.69%	-0.47%

Notes:
[1] The reduction (%) has been calculated with the baseline SB-12 CP-B including A/C with a SEER of 13; at an energy consumption of 98.60 GJ. The reduction difference (%) has been calculated using the baseline energy consumption without A/C.

6.5.3. Thermal Bridging

The effective thermal resistance values calculated for this study were based of the recommendations from the ESTS. Different factors were applicable for different assembly types, between 6% to 23%, depending on the framing specifications indicated in the SBD repots. However, it is important to note that these values are solely recommendations, and framing factors in reality can be higher or lower depending on on-site detailing and workmanship; especially when considering the extra framing members used at the building corners and around openings such as doors and windows. Other sources and studies have indicated values that are higher than those stated in the ESTS, such as ASHRAE (1997) and a study conducted by Gorgolewski, Hua & Qasass (2013); the latter having been conducted using homes built within the GTA in recent years. For example, ASHRAE standards recommend framing factors for wall assemblies at 25%; while the study by Gorgolewski, Hua & Rana identify factors between 30% to 39% depending on the house type.

The framing factor is an important consideration because the higher the framing factor, the lower the effective thermal resistance value will be. That said, it is important to note that most of the wall assembly specifications incorporated continuous insulation on the exterior side of the framing members (Refer to Table 8, pg.52). Based on the calculations found in Appendix I (pg.141) which indicates both the effective thermal resistance values before and after adding the exterior insulation, it is evident that the use of exterior insulation significantly reduces the effects of thermal bridging that is occurring through the structural members.

The summary of the energy simulation results taking into account thermal bridging are located in Table 10 to 12 (pgs. 63-65); with full results located in Appendix J (pg.143). From those results, the following findings can be made:

- Not all of the packages achieved the same reduction target for the same house archetype.
- 4 packages did not achieve the reduction target for any of the house archetypes (AP-1, AP-4, AP-6, AP-12).
- 3 packages achieved the reduction target for all house archetypes (AP-5, AP-13, AP-19).
- 4 packages achieved the reduction target for the semi-detached and row/townhouse archetype only (AP-2, AP-15).
- None of the packages achieved the reduction target for the row/townhouse archetype only.

All of the packages resulted in a lower energy consumption reduction; approximately 2% to 3.18%, 0.7% to 1.8%, and 1% to 2.1% for the detached house, row/townhouse and semi-detached house respectively. It can be said that based on those differences, the area of building envelope plays a role in the effect of thermal bridging where the house with the highest envelope saw the highest reduction decrease. Additionally, the packages that had higher building envelope insulation values saw the highest reduction decrease, especially those with 610mm stud spacing in the wall assembly.

Based on the results, it can also be said that the reduction differences can be correlated to the systems specifications. For the detached house and semi-detached house, a package with a lower HRV efficiency were among the packages that saw the highest decrease in reduction; while a package with similar envelope specifications with a higher HRV efficiency saw a lower reduction decrease. However, for the row/townhouse where there is less heat loss to recuperate from the building envelope, the HRV efficiency did not suggest to be a factor in the reduction difference.

6.5.4. Air Conditioning

Typically, homes in Ontario are built to include an air conditioning unit. However, the use of a central air conditioner in a house will increase the total energy consumption. An air conditioner of the condensing type, as used in the simulations, will mainly increase the amount of electricity consumed. The SBD

charrettes indicated that an air conditioning system with an SEER of 14.5 is typically used in Energy Star homes; while the lowest SEER available is 13 and the highest is 18.

The energy simulations results, using SEER 13 for the base case and 14.5 for the upgraded system, found in Appendix JJ (pg.145), identifies the following findings:

- Not all of the packages achieved the same reduction target for the same house archetype.
- 2 packages did not achieve the reduction target for a any of the house archetypes (AP-1, AP-4).
- 4 packages achieved the reduction target for all house archetypes (AP-2, AP-5, AP-13, AP-19).
- 3 packages achieved the reduction target for the semi-detached and row/townhouse archetype only (AP-6, AP-12, AP-15).
- None of the packages achieved the reduction target for the row/townhouse archetype only.

All of the packages, except for those that use an ASHP, resulted in a higher energy consumption (GJ), thus resulting in a lower energy consumption reduction (Refer to Tables 10 to 12, pgs.63-65). For the detached house archetype, the package that had higher building envelope component specifications and a lower ACH resulted in a lower performance reduction. For the row/townhouse, the packages that had a higher water heater efficiency resulted in a lower performance reduction. This result correlates with the amount of heat loss occurring in the archetypes and what factors influence the energy consumption in the respective archetype.

The results in the packages that use an ASHP indicate that the HRV efficiency has the highest influence over the energy performance reduction. For the detached house, the package with a higher HRV efficiency resulted in higher performance (GJ) and a lower performance reduction (%). However, the semi-detached house and row/townhouse found the opposite. This result again is correlated to the heat loss occurring in each archetype. Since the detached house has a higher heat loss, the reduction in

natural gas consumption offsets the increase in electricity used for the higher HRV efficiency and air conditioner. However, for the semi-detached and row/townhouse, the additional electrical energy incurred to run the higher efficiency HRV and the air conditioner is not offset by the reduction in natural gas consumption.

When the simulations account for both air conditioning and thermal bridging, all of the packages resulted in higher performance reductions. The results from those simulations, located in Appendix J (pg. 146), identified the following findings:

- 5 packages did not achieve the reduction target for a any of the house archetypes (AP-1, AP-4, AP-6, AP-12, AP-15).
- 2 packages achieved the reduction target for all house archetypes (AP-13, AP-19).
- 2 packages achieved the reduction target for the semi-detached and row/townhouse archetype only (AP-2, AP-5).
- None of the packages achieved the reduction target for the row/townhouse archetype only.

It is evident that both the effects of thermal bridging will occur through the building envelope and that typically homeowners use air conditioning in the cooling season. Therefore, it can be said that the results considering both factors together are indicative of real life performance. That said, these results indicate that the effects of thermal bridging and the use of air conditioning together have a higher negative effect than when only considered individually; which indicates that these factors must take a higher priority when designing and specifying a new home.

6.5.5. Window SHGC

When designing a house, the ideal solar design strategy is to maximize the amount of heat gains in the heating season and mitigate the heat gains in the cooling season. Since Ontario is a heating dominated

climate, when the window SHGC was adjusted to 0.52 from 0.40 in all the windows, all the packages had a lower energy consumption (GJ) and achieved the reduction target for all house archetypes. The detached house saw an increase in performance between 2% to 3%; the row/townhouse between 0.5% to 1.5%; and the semi-detached house between 1% to 2%.

However, for most of Ontario, especially the southern area around the GTA, the increased solar heat gains will work in reverse during the summer months and cooling will be required; especially around the glazing areas. Therefore, when the simulations were conducted to include air conditioning and the window SHGC change to 0.52, the overall reduction achieved by most of the packages was lower (as shown in Tables 10 to 12, pgs. 63-65). From the full results, located in Appendix JJ (pg. 148) the following findings were identified:

- Not all of the packages achieved the same reduction target for the same house archetype.
- 2 packages did not achieve the reduction target for a any of the house archetypes (AP-1, AP-4).
- 4 packages achieved the reduction target for all house archetypes (AP-2, AP-5, AP-13, AP-19).
- 3 packages achieved the reduction target for the semi-detached and row/townhouse archetype only (AP-6, AP-12, AP-15).
- None of the packages achieved the reduction target for the row/townhouse archetype only.

In terms of the compliancy of the packages, these results are identical to those from the simulation that only take into account air conditioning. This indicates that although the higher SHGC is allowing for more solar heat gains in the cooling season, the reduced heating load incurred in the heating season is still sufficient enough to offset the increased cooling demand. However, there is a lower energy reduction achieved (%) when the SHGC is 0.52 in comparison to the base case with a SHGC of 0.42. Therefore, using a SHGC of 0.52 for all the windows does not result in an improved overall performance. As

indicated by the SBD reports, the best way to optimize solar heat gains is to design for passive solar opportunities and use a higher SHGC on window glazing only where it will optimize the performance.

6.6. Energy Reduction Credits

NRCan and SBD allow the use of energy credits to be deducted from the energy consumption of the house in order to get a larger reduction. An energy credit refers to energy savings induced by building design and components not included in the prescriptions of the SB-12 packages such as high performance appliances, lighting and systems. The SBD program allows for a maximum of 5% of the energy savings to come from the use of credits; after reaching the 20% reduction target to get to the final 25% reduction target. A full list of the applicable credits and respective energy savings can be found in Appendix K K (pg. 149).

The energy credits specified by the builders are illustrated in

Figure 255 (pg. 72). The distribution of credits by house archetype demonstrates that the packages intended for a detached house have specified the most credits; while the packages intended for a row/townhouse have specified the least credits. This can be correlated to the fact that since a row/townhouse consumes less energy than a detached house, the building components upgrades have a greater impact. Thus, the use of additional energy saving credits are not required.

Based on the credits that were specified, it can be said that builders are most comfortable specifying the use of high efficient compact fluorescent (CFL) lighting or Energy Star bulbs; the use of a drain water heat recovery installed in stack with the showers; and specifying a furnace (or HRV) with an electronically commutated (ECM) motor. Surprisingly however, most builders did not specify the use of high efficiency Energy Star appliances for the kitchen and laundry. It can be assumed that this is the case because the builders may not be providing the appliances.

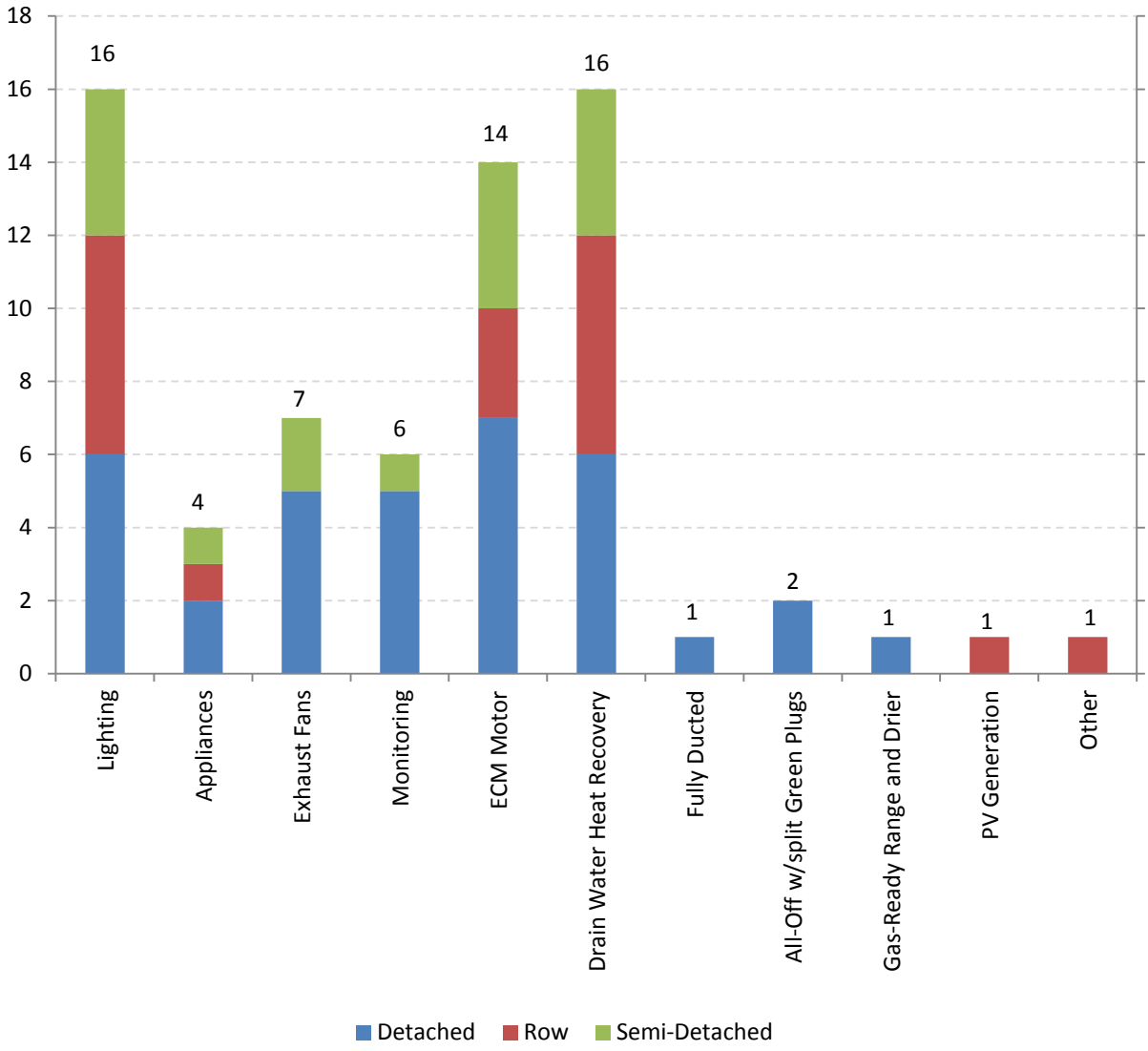


Figure 25: Builder Specified Energy Credits

6.7. Summary of Results

From the initial analysis of the baseline archetypes, it was found that there is a difference in energy consumption (GJ) and energy intensity (GJ/m^2) between the different archetypes. The detached house has the highest energy consumption (GJ) and the lowest energy intensity (GJ/m^2); while the row/townhouse has the lowest energy consumption (GJ) and the highest energy intensity (GJ/m^2). It was also found that there was a difference in the distribution of heat loss between the archetypes. The detached house has the highest space heating energy demand and the highest heat loss (GJ) occurring through the building envelope; specifically the above grade walls, basement walls, and windows. The row/townhouse has the highest energy demand for hot water and the highest heat loss occurring through the ventilation. The semi-detached falls in between the detached house and the row/townhouse in energy consumption (GJ), energy intensity (GJ/m^2) and heat loss (GJ).Based on these findings, it was concluded that the detached house will require higher building envelope upgrades than the row/townhouse and semi-detached house and systems upgrades; while the row/townhouse will benefit the most from systems upgrades as opposed to building envelope upgrades.

From the specifications identified by the SBD charrettes, it can be said Ontario homebuilders are capable and most comfortable providing systems upgrades over building envelope upgrades in order to reach the reduction target. Most builders are willing to improve the furnace efficiency and water heater efficiency to a minimum AFUE 95% and EF between 0.7 - 0.9 respectively; add an HRV with a minimum efficiency of 60%; and increase the air tightness of the house. For the building envelope upgrades, there is a more diverse range of thermal resistance values that builders most commonly specified for the above grade walls and windows; ranging between RSI 4.4 to RSI 5.2 for the walls and U-2.0 to U-1.4 for the windows. Indications of why certain measures were chosen over others were not included in the SBD reports. That said, based on the findings from the literature review, it can be said that cost was a factor during the design optimization that occurred at the charrettes with the homebuilders.

The results of the energy simulations indicated that of the 19 SBD packages, only 9 packages met the 20% reduction target for at least 1 of the archetypes; after some minor adjustments to the specifications. Of the 9 packages, 6 packages met the reduction target for all 3 archetypes; 2 for the row/townhouse only; and 1 for both the semi-detached archetype and row/townhouse. The fact that different packages met the target for different archetypes enables a builder to choose the appropriate package to follow for its respective archetype.

Further analysis demonstrated that there are other design considerations that need to be addressed in order to fully meet the reduction target. The primary considerations that need to be accounted for is the effective thermal resistance value of the building envelope assemblies and the inclusion of air conditioning in the energy simulation of the house. Secondary considerations that should be addressed are the orientation of the house, and the potential for passive solar design through the adjustment of the window SHGC.

The builder specified wall assemblies indicate that due to thermal bridging that occurs through the studs, the effective thermal resistance value of the assembly is significantly reduced where in some cases the packages no longer meet the reduction target. That said, it is recommended for all the assemblies to always be insulated (continuously) on the exterior side of the wood framing in order to reduce heat flow through the structural components. Furthermore, the window U-value should be calculated accordingly to account for the window framing and other components.

The results of the energy simulation that take into account air conditioning illustrate that when air conditioning is considered, there is a lower energy reduction achieved. Therefore, it is recommended to include minimum requirements for the air conditioner efficiency (SEER), should an air condition system be provided by the homebuilder.

7.0 Conclusions and Recommendations

There is a rising concern for energy conservation within the building sector in Canada. Given that the residential building sector is a dominant consumer of energy and emitter of GHG emissions in Ontario, it is imperative for the RCI to design and build with energy efficiency in mind. That said, as indicated in the literature review and speculated through anecdotal references, barriers exist that restrict the adoption of EEP for homebuilders. That said, an effective method for adopting EEP is through building codes and energy standards; especially in the RCI where builders lack the incentives to adopt EEP through their own capabilities.

As a response, this study as set out to identify the energy efficiency practices and measures that could be applied in the Ontario RCI to design and build more efficient homes. The overall objective of the study was to develop prescriptive compliance packages that achieve a reduction target of 20%, in comparison to existing OBC SB-12 requirements. The critical aspect was for the specifications of the packages to be indicative of the potential capabilities of Ontario homebuilders. Therefore, the reports generated by the SBD program were used to identify the specifications and combination of measures. In accordance to the research questions that were outlined in Section 4, the following conclusions can be made.

Firstly, with regard to the practices and methods that Ontario homebuilders are able to adopt to conserve energy in the homes they build; it can be said that the specifications outlined in the SBD reports are a good indication of what the industry is able to adopt with its current capabilities. Additionally, it can be said that builders are more comfortable in upgrading the systems components of a house over the building envelope components to achieve the reduction in energy consumption.

Secondly, it can be determined that there is a difference in requirements of upgrades for the different house archetypes; based on their respective energy consumption and heat loss distribution. The findings have indicated that the detached house archetype has the highest energy demand for space heating; and the most heat loss occurring through the building envelope. Therefore, building envelope upgrades on a detached house would reap a higher energy reduction that on a semi-detached or row/house. The systems upgrades however, although they still reap the highest saving in actual energy savings in the detached house; as a percentage of reduction, a higher benefit is seen for both the row/townhouse and semi-detached house archetypes.

Lastly, not all of the SBD combination of specifications were able to achieve the 20% reduction in energy for the different house archetypes. Of the 19 packages, only 9 of them have met the reduction target. The final recommended packages and their respective specifications have been identified in Table 13 (pg.77); categorized by their applicable house archetype. The packages achieve an average energy reduction of 21% with an EnerGuide rating of 84. The packages that have a higher reduction target of 25% and EnerGuide Rating of 85 have significantly higher specifications such as higher building envelope thermal resistance values or the use of an ASHP.

Table 13: Recommended Advanced Compliance Packages for Natural Gas Space Heating- Zone 1

		AP-A	AP-B	AP-C	AP-D	AP-E	AP-F	AP-G	AP-H	AP-I
Components		**Detached**				**Row**		**Semi**	**ASHP**	
Building Envelope	Ceiling w/ Attic Space Min. RSI -Value[1]	8.8	8.8	10.5	8.8	8.8	8.8	8.8	8.8	8.8
	Ceiling w/out Attic Space Min.RSI Value[1]	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
	Exposed Floor Min. RSI Value[1]	7.1	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
	Walls Above Grade Min. RSI Value[1]	5.2	5.1	5.2	4.8	4.8	4.8	4.6	4.8	4.4
	Basement Walls Min. RSI Value[1]	3.5	3.5	3.5	3.5	3.5	3.5	4.2	3.5	3.5
	Below Grade Slab Entire Surface Min. RSI Value[1]	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
	Windows and Sliding Doors Max. U-Value[2]	1.6	1.4	1.6	1.4	1.6	1.6	1.6	1.8	1.8
	Skylights Maximum U-Value[2]	-	-	-	-	-	-	-	-	-
Systems	Space Heating Equipment Minimum AFUE	98.0	97.5	96.0	92.0	95.0	95.0	97.0	9.4 HSPF	9.4 HSPF
	HRV Min. Efficiency (High Temp./Low Temp)	84/72	84/78	60/50	75/65	75/70	75/65	78/68	60/50	75/60
	Domestic Hot Water Heater Min. EF	0.9	0.9	0.9	0.8	0.9	0.8	1.0	0.7	0.7
	Air Tightness @ 50 Pa	2.0	2.0	1.5	1.5	2.0	2.0	2.0	2.5	2.5
	Reduction (%)	**21%**	**24%**	**21%**	**21%**	**20%**	**20%**	**21%**	**25%**	**25%**
	EnerGuide Rating	**84**	**85**	**84**	**84**	**84**	**84**	**84**	**85**	**85**
#	1	2				3		4	5	

Notes:
[1] The RSI values listed are for the thermal insulation component, expressed in $(m^2 \cdot K)/W$. All assemblies with structural members must be continuously insulated on the exterior to reduce heat flow.
[2] The U-value for the window glazing is expressed in $W/(m^2 \cdot K)$.
[3] Packages in Column 2 are applicable for all house archetypes.
[4] Packages in Column 3 are only applicable for the row/townhouse archetype only.
[5] Packages in Column 4 are applicable for the semi-detached and row/townhouse archetypes only.
[6] Packages in Column 5 are only applicable if an air source heat pump is used for the primary heating (cooling) system.
[7] If air conditioning is to be included by the homebuilders, it must be of the condensing type, and have a minimum SEER of 14.5.

8.0 Future Work

Since the scope of the study was limited to the packages identified in Table 2.1.1.2.A ZONE 1 - Compliance Packages for Space Heating Equipment with AFUE ≥ 90%, of the SB-12 standard, further packages should be developed for the different climate zone (Zone 2) and for dwellings that use electric space heating as their primary heating source. To do so, the same methodological approach can be adapted to include the recommended specifications from homebuilders that fall under the new categories. If reports from the SBD program are not applicable, direct interviews or surveys with homebuilders can be conducted to attain the necessary data set.

Additionally, in accordance to the design optimization approach for developing energy standards, a full cost estimate for the building components upgrades and a cost optimization of the combination of measures for each advanced package should be conducted. The cost estimate for the upgrades should follow the methodology outlined in the MMAH study of Prescriptive Requirements for EnerGuide 80 in Ontario's Building Code (2010) . This method of estimating includes both materials and labour; where costs for materials are determined through consultation with Ontario homebuilders and their respective suppliers. Given that different builders and suppliers will have varying costs, as outlined in the Next Generation Energy Star for New Homes (NRCan, 2011), an effective method for providing the cost analysis would be to identify the average cost for the upgrade, and identify both a lowest cost and highest cost.

Finally, in order to ensure energy conservation, a verification of homes built to one of the established packages should be conducted. This should include a blower door test after construction to ensure the specified air leakage rates have been achieved; and a comparison between the predicted energy saving and the actual energy savings based on the space heating energy consumption only.

Appendices

Appendix A: Reference House Dimensions

Appendix B: HOT2000 Software Inputs

Appendix C: Baseline Reference Energy Consumption-SB-12Compliance Packages, Table 2.1.1.2 (Toronto)

Appendix D: SBD Packages Specifications

Appendix E: SBD Advanced Packages Energy Consumption Results (Toronto)- Summary Table

Appendix F: SBD Advanced Packages Energy Consumption Results (Toronto)- Detailed Breakdown

Appendix G: SBD Advanced Packages Energy Consumption Results (Ottawa)- Summary Table

Appendix H: SBD Advanced Packages Energy Consumption Results (Ottawa)- Detailed Breakdown

Appendix I: Effective Thermal Resistance Value Calculations

Appendix J: Sensitivity Analyses Full Results- Detached House, Row/Townhouse, and Semi-Detached House

Appendix K: NRCan and SBD Energy Credits

Appendix A: Reference House Dimensions

CCHT Detached House Measurements

CCHTT Detached House			
Basement			
Floor Area		88.62	m^2
Wall Area	Above Grade	99.41	m^2
	Below Grade	23.81	m^2
Windows		0.57	m^2
Doors		0.00	m^2
First Floor			
Floor Area		88.62	m^2
Wall Area	Above Grade	125.41	m^2
Windows		18.37	m^2
Doors		1.76	m^2
Second Floor			
Floor Area		88.62	m^2
Wall Area	Above Grade	128.36	m^2
Windows		14.18	m^2
Doors		0.00	m^2
Totals			
Gross Floor Area		265.85	m^2
Total Wall Area		376.99	m^2
	Above Grade	353.18	m^2
	Below Grade	23.81	m^2
House Volume		716.012	m^3
Total Window Area		33.12	m^2
Window to Wall Ratio		9	%
Door Area		1.76	m^2

Note: The walls that attach the garage to the house have been treated as external walls.

Typical Row/Townhouse Measurements

Typical Row/Townhouse				
Basement				
Perimeter			33.42	m
Floor Area			48.62	m^2
Wall Area	Above Grade		15.17	m^2
	Below Grade		13.99	m^2
Attached Wall	Above Grade		28.98	m^2
	Below Grade		26.74	m^2
Windows			0.31	m^2
Doors			0.00	m^2
First Floor				
Perimeter			33.42	m
Floor Area			48.62	m^2
Wall Area	External		34.99	m^2
	Attached		66.87	m^2
Windows			4.92	m^2
Doors			1.76	m^2
Second Floor				
Perimeter			34.33	m
Floor Area			51.33	m^2
Wall Area	External		34.99	m^2
	Attached		69.66	m^2
Windows			7.39	m^2
Doors			0.00	m^2
Totals				
Gross Floor Area			148.57	m^2
Total Wall Area			250.66	m^2
	Above Grade	External	85.15	m^2
		Attached	165.51	m^2
	Below Grade	External	13.99	m^2
		Attached	26.74	m^2
House Volume			398.17	m^3
Total Window Area			13	%
Window to Wall Ratio			12.73	m^2
Total Door Area			1.76	m^2

Note: The walls that attach the garage to the house have been treated as external walls.

Typical Semi-Detached House Measurements

Semi-Detached House- Row House End Unit				
Basement				
Perimeter			37.14	m
Floor Area			56.86	m^2
Wall Area	Above Grade		40.94	m^2
	Below Grade		37.78	m^2
Attached Wall	Above Grade		8.12	m^2
	Below Grade		7.49	m^2
Windows			0.93	m^2
Doors			0.00	m^2
First Floor				
Perimeter			37.14	m
Floor Area			57.17	m^2
Wall Area	Above Grade	External	94.45	m^2
		Attached	18.74	m^2
Windows			8.55	m^2
Doors			1.76	m^2
Second Floor				
Perimeter			38.91	m
Floor Area			79.06	m^2
Wall Area	Above Grade	External	80.74	m^2
		Attached	15.15	m^2
Windows			8.69	m^2
Doors			0.00	m^2
Totals				
Gross Floor Area			193.09	m^2
Total Wall Area			303.40	m^2
	Above Grade	External	216.13	m^2
	Below Grade	External	37.78	m^2
	Above Grade	Attached	42.00	m^2
	Below Grade	Attached	7.49	m^2
House Volume			513.47	m^3
Total Window Area			18.16	m^2
Window to Wall Ratio			7	%
Total Door Area			1.76	m^2

Note: The walls that attach the garage to the house have been treated as external walls.

Appendix B: HOT2000 Software Inputs

Building Dimensions

Building dimensions have been calculated using working drawings for each reference house. For the row/townhouse and semi-detached archetype, the attached walls were considered adiabatic, as per HOT2000's manual protocol.

Building Component Specifications

The thermal resistance values were manual inputs, using the nominal values indicated in the package specifications. All windows had a SHGC of 0.40.

Base Loads

Default Electricity Loads and Hot Water Loads were used for all models, as follows:

Electric Appliances:	14 kWh/day	Hot Water Load:	225 L/day
Lighting:	3 kWh/day	Temperature:	55°C
Other:	3 kWh/day	Occupancy:	4

Natural Air Infiltration

Baseline Input:	3.0 ACH
Advanced Input:	As specified in SBD report

Ventilation

The required ventilation was determine from OBC Part 9, Sentence 9.23.3.3(1), Table 9.23.3.3 Ventilation Capacity.

Ventilation Type	Supply (L/S)	Exhaust (L/S)
Fans w/out heat recovery*	0	37.5
HRV	37.5	37.5

*With a rated fan power of 30 W.

Heating/Cooling System

All baseline systems are heated using a natural gas condensing furnace. For the models that include cooling, a conventional central air conditioning system on the condensing type was selected.

Domestic Hot Water

Default inputs were used for the primary domestic hot water system. The tank capacity is 151.4 L, located in the basement.

Appendix C: Baseline Reference Energy Consumption-SB-12Compliance Packages, Table 2.1.1.2 (Toronto)

Baseline Energy Consumption (Toronto)- Detached House

CCHT-Detached										
	SB-12 Package A	SB-12 Package B	SB-12 Package C	SB-12 Package D	SB-12 Package E	SB-12 Package F	SB-12 Package G	SB-12 Package H	SB-12 Package I	SB-12 Package J
Electricity (kWh)	10637.00	10637.00	10722.00	10722.00	11639.00	11639.00	11639.00	11724.00	11639.00	11724.00
Natural Gas (m3)	2091.10	2069.70	2062.30	2094.90	2003.50	2006.20	1991.70	1957.90	1998.20	1990.40
Total Consumption (GJ)	116.21	115.41	115.44	116.65	116.55	116.65	116.11	115.16	116.35	116.37
Consumption (GJ/m2)	0.44	0.43	0.43	0.44	0.44	0.44	0.44	0.43	0.44	0.44
Difference (%)	0.90%	0.22%	0.25%	1.28%	1.20%	1.28%	0.82%	-	1.03%	1.04%
SB-12 Package B:	**Orientations**									
	South	West	North	East						
Electricity (kWh)	10637.00	10637.00	10637.00	10637.00						
Natural Gas (m3)	2069.70	2140.00	2106.60	2144.50						
Total Consumption (GJ)	115.41	118.03	116.79	118.19						
Consumption (GJ/m2)	0.43	0.44	0.44	0.44						
Difference (%)	-	2.22%	1.18%	2.36%						
Percentage Scale (%)	98%	100%	99%	100%						

Baseline Energy Consumption (Toronto)- Row/Townhouse

Typical- Row House										
	SB-12 Package A	SB-12 Package B	SB-12 Package C	SB-12 Package D	SB-12 Package E	SB-12 Package F	SB-12 Package G	SB-12 Package H	SB-12 Package I	SB-12 Package J
Electricity (kWh)	9957.00	9957.00	10042.00	10042.00	10960.00	10960.00	10960.00	10960.00	10960.00	10960.00
Natural Gas (m3)	1364.30	1374.90	1343.40	1335.30	1209.40	1229.20	1200.30	1139.40	1181.80	1177.50
Total Consumption (GJ)	86.68	87.07	86.21	85.90	84.52	85.25	84.18	81.91	83.49	83.33
Consumption (GJ/m2)	0.58	0.59	0.58	0.58	0.57	0.57	0.57	0.55	0.56	0.56
Difference (%)	5.51%	5.94%	4.99%	4.66%	3.09%	3.92%	2.70%	-	1.90%	1.71%
SB-12 Package B	**Orientations**									
	South	West	North	East						
Electricity (kWh)	9957.00	9957.00	9957.00	9957.00						
Natural Gas (m3)	1374.90	1387.40	1342.30	1387.40						
Total Consumption (GJ)	87.07	87.54	85.86	87.54						
Consumption (GJ/m2)	0.59	0.59	0.58	0.59						
Difference (%)	-	0.53%	-1.42%	0.53%						
Percentage Scale (%)	99%	100%	98%	100%						

Baseline Energy Consumption (Toronto)- Semi-Detached House

Typical- Semi Detached										
	SB-12 Package A	SB-12 Package B	SB-12 Package C	SB-12 Package D	SB-12 Package E	SB-12 Package F	SB-12 Package G	SB-12 Package H	SB-12 Package I	SB-12 Package J
Electricity (kWh)	10127.00	10127.00	10212.00	10212.00	11130.00	11130.00	11130.00	11130.00	11130.00	11130.00
Natural Gas (m3)	1533.70	1531.40	1508.00	1511.60	1396.70	1405.90	1381.10	1329.40	1377.20	1366.00
Total Consumption (GJ)	93.60	93.52	92.95	93.09	92.11	92.45	91.52	89.60	91.38	90.96
Consumption (GJ/m2)	0.48	0.48	0.48	0.48	0.48	0.48	0.47	0.46	0.47	0.47
Difference (%)	4.28%	4.19%	3.61%	3.75%	2.72%	3.08%	2.10%	-	1.95%	1.50%
SB-12 Package B	**Orientations**									
	South	West	North	East						
Electricity (kWh)	10127.00	10127.00	10127.00	10127.00						
Natural Gas (m3)	1531.40	1497.70	1495.60	1565.20						
Total Consumption (GJ)	93.52	92.26	92.18	94.78						
Consumption (GJ/m2)	0.48	0.48	0.48	0.49						
Difference (%)	-	-1.36%	-1.45%	1.33%						
Percentage Scale (%)	99%	97%	97%	100%						

Appendix D: SBD Packages Specifications

SBD Packages Specifications

	Case Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	House Typology	Detached	Detached	Detached	Detached	Detached	Detached	Detached	Detached	Row (Stacked)	Row (back-to-back)	Row	Row	Row	End Unit Row-MURB	Row	Semi-Bungalow	Semi-Bungalow	Semi-detached	Semi-Detached
	Gross Floor Area	332.9	648.0	516.8	232.7	334.8	485.6	139.2	376.0	-	-	183.4	176.9	176.9	167.4	219.8	271.1	271.1	155.3	352.9
	Window-to-Wall Ratio	16.0	16.0	-	-	16.0	14.0	-	11.0	-	-	13.0	15.0	15.0	20.0	17.0	8.0	8.0	15.0	20.0
	Orientation	South	East	-	-	South	West	-	South	-	-	East	-	-	North	-	West	West	-	-
	Baseline Package	B	B	B	D	B	B	D	B	B	B	B	D	D	B	B	B	B	B	D
Building Envelope	Ceiling w/ Attic Space Min. RSI Value[1]	8.8	8.8	8.8	8.8	8.8	10.5	8.8	8.8	8.8	8.8	10.5	7.1	7.1	10.5	8.8	8.8	10.5	8.8	8.8
	Ceiling w/out Attic Space Min. RSI Value[1]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.5	5.5	-	-
	Exposed Floor Min.RSI Value[1]	5.5	7.1	5.5	5.5	5.5	5.5	-	5.5	-	-	5.5	5.5	5.5	-	5.5	5.5	5.5	5.5	5.5
	Walls Above Grade Min. RSI Value[1]	4.3	5.2	4.1	4.8	5.1	4.6	4.8	4.8	4.3	4.8	4.8	4.8	4.8	4.8	4.6	4.8	4.8	3.9	4.4
	Basement Walls Min. RSI Value[1]	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.2	-	-	3.5	-	-	3.5	4.2	3.5	3.5	3.5	3.5
	Below Grade Slab Entire Surface > 600mm below grade Min.RSI Value[1]	None	None	None	None	1.8	1.8	1.8	None	-	-	None	-	-	2.0	-	1.8	1.8	1.8	1.8
	Edge or Below Grade Slab ≤ 600mm below grade Min.RSI Value[1]	-	-	-	-	-	-	-	-	-	1.8	-	1.8	1.8	-	-	-	-	-	-
	Heated Slab or Slab ≤ 600mm below grade Min.RSI Value[1]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Windows and Sliding Doors Max. U-Value[2]	1.8	1.6	1.8	1.8	1.0	1.6	2.2	1.8	1.6	1.8	1.6	1.6	1.6	1.4	1.8	1.8	1.8	1.6	1.4
	Skylights Maximum U-Value[2]	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-
Systems	Space Heating Equipment Minimum AFUE [3]	95.0	98.0	95.0	95.0	97.5	96.0	94.0	95.0	90.0	95.0	96.0	92.0	9.4 HSPF	96.0	97.0	95.0	95.0	95[5]	9.4 HSPF
	Space Cooling SEER	-	-	-	-	-	-	-	14.5	-	-	-	-	-	-	-	14.0	14.0	-	-
	HRV Min. Efficiency (High Temp./Low Temp) [4]	75/70	84/72	65/60	60/50	84/78	60/50	55/45	75/68	60/50	60/50	None	60/50	60/50	60/50	78.0	72/65	84/78	65/55	73/75
	Domestic Hot Water Heater Minimum EF	0.9	0.9	0.9	0.8	0.9	0.8	0.8	0.8	0.9	0.9	0.8	0.8	0.8	0.8	1.0	0.7	0.7	_[5]	0.9
	Air Tightness @ 50 Pa	2.5	2.0	2.0	2.0	2.0	1.5	-	2.5	2.5	2.5	3.0	1.5	1.5	3.0	2.5	2.5	2.0	2.0	2.0
Energy Credits (GJ/year)	Lighting	2.0	1.5	-	2.0	2.0	2.0	-	0.9	2.0	1.1	2.0	2.0	2.0	2.0	-	2.0	2.0	2.0	2.0
	Appliances	1.5	2.0	-	-	-	-	-	-	-	-	-	-	-	4.4	-	-	-	1.5	-
	Exhaust Fans	-	1.1	0.7	-	0.2	0.2	-	0.7	-	-	-	-	-	-	-	0.7	0.7	-	-
	Monitoring	-	2.8	2.9	-	2.9	-	-	2.9	-	-	-	-	-	-	-	-	-	-	-
	ECM Motor	1.5	1.5	2.5	2.5	1.5	1.9	-	1.5	-	-	1.5	-	-	1.5	1.5	1.5	1.5	2.5	0.7
	Drain Water Heat Recovery (dual stack)	6.2	7.7	3.5	7.1	7.7	6.2	-	-	6.2	6.2	6.2	3.5	3.5	7.7	3.5	6.2	7.7	3.5	-
	Fully Ducted	-	-	-	-	2.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All-Off w/split Green Plugs	-	-	-	-	1.1	1.9	-	-	-	-	-	-	-	-	-	-	-	-	-
	Gas-Ready Range and Drier	-	-	-	-	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PV Generation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.6	-	-	-	-
	Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9	-	-	2.2	-
Results	**Total Consumption (GJ)**	**105.9**	**166.8**	**154.6**	**96.1**	**89.2**	**129.1**	**113.4**	**126.8**	**55.4**	**72.0**	**82.2**	**79.4**	**67.5**	**99.3**	**-**	**109.0**	**102.1**	**72.9**	**79.5**
	Total Energy Credits (GJ)	**11.1**	**16.7**	**9.6**	**11.6**	**19.1**	**9.1**	**-**	**6.0**	**8.2**	**7.3**	**9.7**	**5.5**	**5.5**	**15.2**	**-**	**10.4**	**11.9**	**11.7**	**5.8**
	Adjusted Consumption (GJ)	**117.0**	**150.1**	**145.0**	**84.5**	**70.1**	**120.1**	**113.4**	**120.8**	**47.2**	**64.7**	**72.5**	**73.9**	**62.0**	**84.1**	**-**	**98.6**	**90.2**	**61.2**	**73.7**
	Total Energy Consumption (GJ/m2)	**0.4**	**0.2**	**0.3**	**0.4**	**0.2**	**0.2**	**0.8**	**0.3**	**-**	**-**	**0.4**	**0.4**	**0.4**	**0.5**	**0.0**	**0.4**	**0.3**	**0.4**	**0.2**
	Reduction (%)	**26.0**	**26.7**	**27.0**	**26.4**	**55.5**	**32.2**	**24.4**	**28.4**	**27.6**	**26.5**	**25.3**	**25.4**	**37.4**	**26.4**	**34.5**	**29.2**	**35.2**	**28.7**	**47.5**

Notes:
[1] The RSI values listed are for the thermal insulation component, expressed in $(m^2 \cdot K)/W$.
[2] The U-value for the window glazing is expressed in $W/(m^2 \cdot K)$.
[3] The efficiency for the furnace AFUE is expressed as a percentage (%).
[4] The efficiency for the HRV is expressed as a percentage (%).
[5] This package uses a natural gas combo system for the furnace and domestic hot water heater.

Appendix E: SBD Advanced Packages Energy Consumption Results (Toronto)- Summary Table

SBD Advanced Packages Energy Consumption Results (Toronto)- Summary Table

CCHT Detached House																			
	SB-12 CP-B	**AP-1**	**AP-2**	**AP-3**	**AP-4**	**AP-5**	**AP-6**	**AP-7**	**AP-8**	**AP-9**	**AP-10**	**AP-11**	**AP-12**	**AP-13**	**AP-14**	**AP-15**	**AP-16**	**AP-17**	**AP-18**	**AP-19**
Electricity (kWh)	10637	11979	11724	11894	11724	11554	11639	10892	13685	11894	11892	10977	11639	13948	11894	11894	13706	13789	11809	13948
Natural Gas (m3)	2069.70	1879.80	1552.80	1880.80	1743.80	1318.50	1657.10	2239.10	1795.20	1938.60	1856.80	2150.20	1713.90	1012.80	1867.90	1780.20	1868.20	1753.10	1846.00	951.40
Consumption (GJ)	115.41	102.21	90.90	102.38	97.36	82.81	94.52	101.96	99.89	104.00	101.61	108.23	96.48	76.87	101.98	98.77	102.31	99.08	101.25	74.06
Consumption (GJ/m2)	0.43	0.38	0.34	0.39	0.37	0.31	0.36	0.38	0.38	0.39	0.38	0.41	0.36	0.29	0.38	0.37	0.38	0.37	0.38	0.28
Reduction (%)	-	**11.44%**	**21.24%**	**11.29%**	**15.64%**	**28.25%**	**18.10%**	**11.66%**	**13.45%**	**9.89%**	**11.96%**	**6.22%**	**16.40%**	**33.40%**	**11.64%**	**14.42%**	**11.36%**	**14.15%**	**12.27%**	**35.83%**
Total Credits	0.00	11.20	16.60	9.60	11.60	25.10	12.20	0.00	6.00	8.20	7.30	9.70	5.50	5.50	15.60	6.50	10.40	11.90	9.50	2.70
Net Consumption (GJ)	115.41	91.01	74.30	92.78	85.76	57.71	82.32	101.96	93.89	95.80	94.31	98.53	90.98	71.37	86.38	92.27	91.91	87.18	91.75	71.36
Net Consumption (GJ/m2)	0.43	0.34	0.28	0.35	0.32	0.22	0.31	0.38	0.35	0.36	0.35	0.37	0.34	0.27	0.32	0.35	0.35	0.33	0.35	0.27
Total Reduction (%)	-	21.14%	35.62%	19.61%	25.70%	49.99%	28.67%	11.66%	18.65%	16.99%	18.29%	14.63%	21.16%	38.16%	25.15%	20.05%	20.37%	24.46%	20.50%	38.17%
EnerGuide Rating	80	82	84	82	83	86	84	82	83	82	82	81	83	87	82	83	82	83	82	87
Typical Townhouse																				
	SB-12 CP-B	**AP-1**	**AP-2**	**AP-3**	**AP-4**	**AP-5**	**AP-6**	**AP-7**	**AP-8**	**AP-9**	**AP-10**	**AP-11**	**AP-12**	**AP-13**	**AP-14**	**AP-15**	**AP-16**	**AP-17**	**AP-18**	**AP-19**
Electricity (kWh)	9957.00	11130	11045	11045	11045	10960	10960	11215	12161	11045	11045	10212	10960	12566	11045	11130	12169	12170	11045	12481
Natural Gas (m3)	1374.90	1071.2	890	1061.7	1055.2	809.7	985.3	1273.1	1049.3	1122.2	1073.2	1393	1020.8	592.7	1111.1	980.9	1093.5	1038.2	1068.2	527.7
Total Consumption (GJ)	87.07	72.57	67.38	80.09	72.88	64.87	70.70	79.23	73.30	74.86	73.44	81.12	71.79	62.90	74.79	70.34	74.61	72.74	73.42	60.39
Consumption (GJ/m2)	0.59	0.49	0.45	0.54	0.49	0.44	0.48	0.53	0.49	0.50	0.49	0.55	0.48	0.42	0.50	0.47	0.50	0.49	0.49	0.41
Reduction (%)	-	**16.66%**	**22.62%**	**8.02%**	**16.30%**	**25.50%**	**18.81%**	**9.01%**	**15.82%**	**14.02%**	**15.66%**	**6.84%**	**17.56%**	**27.76%**	**14.11%**	**19.22%**	**14.31%**	**16.46%**	**15.69%**	**30.65%**
Total Credits	0.00	11.20	16.60	9.60	11.60	25.10	12.20	0.00	6.00	8.20	7.30	9.70	5.50	5.50	15.60	6.50	10.40	11.90	9.50	2.70
Net Consumption (GJ)	87.07	61.37	50.78	70.49	61.28	39.77	58.50	79.23	67.30	66.66	66.14	71.42	66.29	57.40	59.19	63.84	64.21	60.84	63.92	57.69
Net Consumption (GJ/m2)	0.59	0.41	0.34	0.47	0.41	0.27	0.39	0.53	0.45	0.45	0.45	0.48	0.45	0.39	0.40	0.43	0.43	0.41	0.43	0.39
Total Reduction (%)	-	29.52%	41.68%	19.05%	29.62%	54.33%	32.82%	9.01%	22.71%	23.44%	24.05%	17.98%	23.87%	34.07%	32.02%	26.69%	26.26%	30.13%	26.60%	33.75%
EnerGuide Rating	80	83	85	82	83	85	84	82	83	83	83	81	84	86	83	84	83	83	83	86
Typical Semi-Detached																				
	SB-12 CP-B 10127.0	**AP-1**	**AP-2**	**AP-3**	**AP-4**	**AP-5**	**AP-6**	**AP-7**	**AP-8**	**AP-9**	**AP-10**	**AP-11**	**AP-12**	**AP-13**	**AP-14**	**AP-15**	**AP-16**	**AP-17**	**AP-18**	**AP-19**
Electricity (kWh)	0	11300	11215	11300	11215	11130	11130	11384	12714	11300	11300	10382	11130	12979	11300	11300	12715	12623	11215	12888
Natural Gas (m3)	1531.40	1237.5	1038.9	1249	1208.6	934.8	1136.1	1472	1219.5	1312.9	1261.5	1569.6	1173.5	662.1	1297.8	1171.1	1277.4	1210.7	1252.6	604.7
Total Consumption (GJ)	93.52	79.22	72.67	79.83	78.35	68.27	75.91	87.38	78.91	81.66	80.15	87.39	77.07	65.18	81.42	77.00	81.12	78.78	79.90	63.07
Consumption (GJ/m2)	0.48	0.41	0.38	0.41	0.41	0.35	0.39	0.45	0.41	0.42	0.42	0.45	0.40	0.34	0.42	0.40	0.42	0.41	0.41	0.33
Reduction (%)	-	**15.29%**	**22.29%**	**14.64%**	**16.22%**	**27.00%**	**18.83%**	**6.57%**	**15.62%**	**12.67%**	**14.29%**	**6.55%**	**17.59%**	**30.30%**	**12.94%**	**17.67%**	**13.26%**	**15.76%**	**14.57%**	**32.56%**
Total Credits	0.00	11.20	16.60	9.60	11.60	25.10	12.20	0.00	6.00	8.20	7.30	9.70	5.50	5.50	15.60	6.50	10.40	11.90	9.50	2.70
Net Consumption (GJ)	93.52	68.02	56.07	70.23	66.75	43.17	63.71	87.38	72.91	73.46	72.85	77.69	71.57	59.68	65.82	70.50	70.72	66.88	70.40	60.37
Net Consumption (GJ/m2)	0.48	0.35	0.29	0.36	0.35	0.22	0.33	0.45	0.38	0.38	0.38	0.40	0.37	0.31	0.34	0.37	0.37	0.35	0.36	0.31
Total Reduction (%)	-	27.27%	40.04%	24.91%	28.62%	53.84%	31.87%	6.57%	22.03%	21.44%	22.10%	16.92%	23.47%	36.19%	29.62%	24.62%	24.38%	28.49%	24.72%	35.44%
EnerGuide Rating	80	83	84	83	83	85	84	81	83	83	83	81	84	86	83	84	83	83	83	87

Appendix F: SBD Advanced Packages Energy Consumption Results (Toronto)- Detailed Breakdown

Advanced Package 1- Toronto

Advanced Package 1	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
U-Value Windows 1.8	118.26	-2.85	-2.85	-2.47%	-2.47%
R-Value Wall 4.3	120.23	-4.82	-4.82	-1.66%	-4.17%
HRV Efficiencies 75/60	112.39	5.88	3.02	6.52%	2.62%
AFUE 95%	110.79	1.60	4.62	1.42%	4.00%
Water Heater EF 0.9	104.98	5.81	10.43	5.24%	9.04%
ACH 2.5	102.21	2.77	13.20	2.64%	11.44%
U-Value Windows 1.6	99.65	2.56	15.76	2.50%	13.66%
R-Value Wall 4.4	99.207	0.44	16.20	0.44%	14.04%
R-Value Wall 4.8	97.464	1.74	17.95	1.76%	15.55%
ACH 2.0	94.748	2.72	20.66	2.79%	17.90%
Credits-Lighting	100.21	2.00	15.20	1.96%	13.17%
Credits- Appliances	98.71	1.5	16.70	1.50%	14.47%
Credits- DWHR (dual)	92.51	6.2	22.90	6.28%	19.84%
Credits- ECM Motor	91.01	1.5	24.40	1.62%	21.14%

Advanced Package 1	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
U-Value Windows 1.8	88.20	-1.13	-1.13	-1.30%	-1.30%
R-Value Wall 4.3	88.85	-0.65	-1.78	-0.74%	-2.04%
HRV Efficiencies 75/60	80.95	7.91	6.13	8.90%	7.03%
AFUE 95%	80.40	0.55	6.68	0.68%	7.67%
Water Heater EF 0.9	73.99	6.41	13.09	7.97%	15.03%
ACH 2.5	72.57	1.42	14.50	1.91%	16.66%
U-Value Windows 1.6	71.691	0.88	15.38	1.21%	17.67%
R-Value Wall 4.4	71.551	0.14	15.52	0.20%	17.83%
R-Value Wall 4.8	71.054	0.50	16.02	0.69%	18.40%
ACH 2.0	69.488	1.57	17.59	2.20%	20.20%
Credits-Lighting	70.57	2.00	16.50	2.76%	18.95%
Credits- Appliances	69.07	1.5	18.00	2.13%	20.68%
Credits- DWHR (dual)	62.87	6.2	24.20	8.98%	27.80%
Credits- ECM Motor	61.37	1.5	25.70	2.39%	29.52%

Advanced Package 1	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
U-Value Windows 1.8	94.63	-1.11	-1.11	-1.18%	-1.18%
R-Value Wall 4.3	95.77	-1.15	-2.26	-1.21%	-2.41%
HRV Efficiencies 75/60	88.16	7.61	5.35	7.95%	5.73%
AFUE 95%	87.38	0.79	6.14	0.89%	6.57%
Water Heater EF 0.9	81.26	6.12	12.26	7.00%	13.11%
ACH 2.5	79.22	2.04	14.30	2.51%	15.29%
U-Value Windows 1.6	78.207	1.01	15.31	1.28%	16.37%
R-Value Wall 4.4	77.986	0.22	15.53	0.28%	16.61%
R-Value Wall 4.8	77.199	0.79	16.32	1.01%	17.45%
ACH 2.0	75.189	2.01	18.33	2.60%	19.60%
Credits-Lighting	77.22	2.00	16.30	2.52%	17.43%
Credits- Appliances	75.72	1.5	17.80	1.94%	19.03%
Credits- DWHR (dual)	69.52	6.2	24.00	8.19%	25.66%
Credits- ECM Motor	68.02	1.5	25.50	2.16%	27.27%

Advanced Package 2- Toronto

Advanced Package 2	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
R-Value Walls 5.2	113.80	1.61	1.61	1.40%	1.40%
R-Value Exp. Floors 7.1	113.55	0.25	1.86	0.22%	1.61%
HRV Efficiencies 84/72	104.32	9.23	11.09	8.13%	9.61%
AFUE 98%	102.27	2.06	13.14	1.97%	11.39%
Water Heater EF 0.9	96.19	6.08	19.22	5.94%	16.65%
ACH 2.0	90.90	5.29	24.51	5.50%	21.24%
Credits- Lighting	89.40	1.5	26.01	1.65%	22.54%
Credits- Appliances	87.40	2	28.014	2.24%	24.27%
Credits- Exhaust Fans	86.30	1.1	29.114	1.26%	25.23%
Credits- Monitoring	83.50	2.8	31.914	3.24%	27.65%
Credits- ECM Motor	82.00	1.5	33.414	1.80%	28.95%
Credits- DWHR (dual)	74.30	7.7	41.114	9.39%	35.62%

Advanced Package 2	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
R-Value Walls 5.2	86.54	0.53	0.53	0.61%	0.61%
R-Value Exp. Floors 7.1	86.50	0.04	0.57	0.05%	0.65%
HRV Efficiencies 84/72	77.58	8.93	9.49	10.32%	10.91%
AFUE 98%	76.90	0.67	10.17	0.86%	11.68%
Water Heater EF 0.9	70.21	6.69	16.86	8.70%	19.36%
ACH 2.0	67.38	2.84	19.69	4.04%	22.62%
Credits- Lighting	65.88	1.5	21.19	2.23%	24.34%
Credits- Appliances	63.88	2	23.19	3.04%	26.64%
Credits- Exhaust Fans	62.78	1.1	24.29	1.72%	27.90%
Credits- Monitoring	59.98	2.8	27.09	4.46%	31.12%
Credits- ECM Motor	58.48	1.5	28.59	2.50%	32.84%
Credits- DWHR (dual)	50.78	7.7	36.29	13.17%	41.68%

Advanced Package 2	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
R-Value Walls 5.2	92.69	0.83	0.83	0.89%	0.89%
R-Value Exp. Floors 7.1	92.65	0.04	0.87	0.04%	0.93%
HRV Efficiencies 84/72	83.83	8.82	9.69	9.52%	10.36%
AFUE 98%	82.84	1.00	10.68	1.19%	11.42%
Water Heater EF 0.9	76.39	6.44	17.12	7.78%	18.31%
ACH 2.0	72.67	3.73	20.85	4.88%	22.29%
Credits- Lighting	71.17	1.5	22.35	2.06%	23.90%
Credits- Appliances	69.17	2	24.35	2.81%	26.04%
Credits- Exhaust Fans	68.07	1.1	25.45	1.59%	27.21%
Credits- Monitoring	65.27	2.8	28.25	4.11%	30.21%
Credits- ECM Motor	63.77	1.5	29.75	2.30%	31.81%
Credits- DWHR (dual)	56.07	7.7	37.45	12.07%	40.04%

Advanced Package 3-Toronto

Advanced Package 3	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
U-Value Windows 1.8	118.26	-2.85	-2.85	-2.47%	-2.47%
Above Grade Walls R-4.1	121.24	-2.98	-5.83	-2.52%	-5.05%
HRV Efficiencies 65/60	115.19	6.05	0.22	4.99%	0.19%
AFUE 95%	113.49	1.70	1.92	1.48%	1.66%
Water Heater EF 0.9	107.75	5.75	7.66	5.06%	6.64%
ACH 2.0	102.38	5.37	13.03	4.98%	11.29%
Credits- Exhaust Fans	101.68	0.70	13.73	0.68%	11.90%
Credits- Monitoring	98.78	2.90	16.63	2.85%	14.41%
Credits- DWHR (dual)	95.28	3.50	20.13	3.54%	17.44%
Credits- ECM Motor	92.78	2.5	22.63	2.62%	19.61%

Advanced Package 3	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
U-Value Windows 1.8	88.20	-1.13	-1.13	-1.30%	-1.30%
Above Grade Walls R-4.1	89.19	-0.99	-2.12	-1.12%	-2.43%
HRV Efficiencies 65/60	89.91	-0.72	-2.84	-0.81%	-3.26%
AFUE 95%	88.22	1.69	-1.15	1.88%	-1.32%
Water Heater EF 0.9	82.61	5.61	4.46	6.36%	5.13%
ACH 2.0	80.09	2.52	6.99	3.05%	8.02%
Credits- Exhaust Fans	79.39	0.70	7.69	0.87%	8.83%
Credits- Monitoring	76.49	2.90	10.59	3.65%	12.16%
Credits- DWHR (dual)	72.99	3.50	14.09	4.58%	16.18%
Credits- ECM Motor	70.49	2.5	16.59	3.43%	19.05%

Advanced Package 3	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
U-Value Windows 1.8	95.11	-1.59	-1.59	-1.70%	-1.70%
Above Grade Walls R-4.1	96.64	-1.53	-3.13	-1.61%	-3.34%
HRV Efficiencies 65/60	90.65	5.99	2.86	6.20%	3.06%
AFUE 95%	89.78	0.88	3.74	0.97%	4.00%
Water Heater EF 0.9	83.78	5.99	9.73	6.68%	10.41%
ACH 2.0	79.83	3.96	13.69	4.72%	14.64%
Credits- Exhaust Fans	79.13	0.70	14.39	0.88%	15.39%
Credits- Monitoring	76.23	2.90	17.29	3.67%	18.49%
Credits- DWHR (dual)	72.73	3.50	20.79	4.59%	22.23%
Credits- ECM Motor	70.23	2.5	23.29	3.44%	24.91%

Advanced Package 4- Toronto

Advanced Package 4	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Above Grade Walls R-5.2	113.80	1.61	1.61	1.40%	1.40%
HRV Efficiencies 60/50	108.89	4.91	6.52	4.31%	5.65%
AFUE 95%	107.41	1.48	8.00	1.36%	6.93%
Water Heater EF 0.8	102.80	4.61	12.61	4.29%	10.92%
ACH 2.0	97.36	5.45	18.06	5.30%	15.64%
HRV Efficiencies 75/65	94.714	2.64	20.70	2.71%	17.93%
Slab Insulation 1.8	93.337	1.38	22.07	1.45%	19.13%
Credits-Lighting	95.36	2.00	20.06	2.05%	17.38%
Credits-ECM Motor	92.86	2.50	22.56	2.62%	19.54%
Credits-DWHR	85.76	7.10	29.66	7.65%	25.70%

Advanced Package 4	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Above Grade Walls R-5.2	86.54	0.53	0.53	0.61%	0.61%
HRV Efficiencies 60/50	81.45	5.09	5.62	5.88%	6.45%
AFUE 95%	80.88	0.57	6.19	0.70%	7.11%
Water Heater EF 0.8	75.87	5.01	11.20	6.19%	12.86%
ACH 2.0	72.88	2.99	14.19	3.94%	16.30%
HRV Efficiencies 75/65	70.487	2.40	16.59	3.29%	19.05%
Slab Insulation 1.8	69.534	0.95	17.54	1.35%	20.14%
Credits-Lighting	70.88	2.00	16.19	2.74%	18.60%
Credits-ECM Motor	68.38	2.50	18.69	3.53%	21.47%
Credits-DWHR	61.28	7.10	25.79	10.38%	29.62%

Advanced Package 4	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Above Grade Walls R-5.2	92.69	0.83	0.83	0.89%	0.89%
HRV Efficiencies 60/50	87.82	4.87	-0.74	5.25%	-0.85%
AFUE 95%	87.03	0.78	0.04	0.89%	7.45%
Water Heater EF 0.8	82.23	4.80	4.84	5.51%	12.96%
ACH 2.0	78.35	3.88	8.72	4.72%	17.42%
HRV Efficiencies 75/65	75.88	2.47	11.19	3.15%	20.25%
Slab Insulation 1.8	74.938	0.94	12.14	1.24%	21.34%
Credits-Lighting	76.35	2.00	10.72	2.55%	12.31%
Credits-ECM Motor	73.85	2.50	13.22	3.27%	15.18%
Credits-DWHR	66.75	7.10	20.32	9.61%	23.34%

Advanced Package 5- Toronto

Advanced Package 5	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Window U- 1.0	107.15	8.26	8.26	7.16%	7.16%
Above Grade Walls R-5.1	105.90	1.25	9.51	1.17%	8.24%
Slab Insulation R-1.8	104.30	1.60	11.11	1.51%	9.63%
HRV Efficiencies 84/78	95.70	8.60	19.71	8.24%	17.07%
Water Heater EF 0.9	89.65	6.05	25.76	6.32%	22.32%
AFUE 97.5%	87.95	1.70	27.46	1.90%	23.79%
ACH 2.0	82.81	5.14	32.60	5.85%	28.25%
Window U- 1.4	87.66	-4.85	27.752	-5.85%	24.05%
Credits-Lighting	80.81	6.85	34.60	7.81%	29.98%
Credits-Exhaust Fans	74.61	0.20	40.80	7.67%	35.35%
Credits- Monitoring	71.71	2.9	43.70	3.89%	37.86%
Credits-ECM Motor	70.21	1.5	45.20	2.09%	39.16%
Credits- DWHR (dual)	62.51	7.7	52.90	10.97%	45.84%
Credits- Fully Ducted	59.61	2.9	55.80	4.64%	48.35%
Credits- All-off w. Split	58.51	1.1	56.90	1.85%	49.30%
Credits- Gas Ready Ran and Drier	57.71	0.8	57.70	1.37%	49.99%

Advanced Package 5	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Window U- 1.0	84.90	2.17	2.17	2.49%	2.49%
Above Grade Walls R-5.1	84.49	0.41	2.58	0.49%	2.96%
Slab Insulation R-1.8	83.25	1.24	3.82	1.47%	4.39%
HRV Efficiencies 84/78	74.68	8.57	12.39	10.29%	14.23%
Water Heater EF 0.9	68.06	6.63	19.01	8.87%	21.84%
AFUE 97.5%	67.40	0.65	19.67	0.96%	22.59%
ACH 2.0	64.87	2.53	22.20	3.76%	25.50%
Window U- 1.4	65.85	-0.98	21.22	-1.52%	24.37%
Credits-Lighting	62.87	2.98	24.20	4.53%	27.79%
Credits-Exhaust Fans	56.67	0.20	30.40	9.86%	34.92%
Credits- Monitoring	53.77	2.9	33.30	5.12%	38.25%
Credits-ECM Motor	52.27	1.5	34.80	2.79%	39.97%
Credits- DWHR (dual)	44.57	7.7	42.50	14.73%	48.81%
Credits- Fully Ducted	41.67	2.9	45.40	6.51%	52.14%
Credits- All-off w. Split	40.57	1.1	46.50	2.64%	53.41%
Credits- Gas Ready Ran and Drier	39.77	0.8	47.30	1.97%	54.33%

Advanced Package 5	**Semi-Detached**				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Window U- 1.0	89.15	4.36	4.36	4.67%	4.67%
Above Grade Walls R-5.1	88.51	0.64	5.00	0.72%	5.35%
Slab Insulation R-1.8	87.36	1.16	6.16	1.30%	6.59%
HRV Efficiencies 84/78	79.16	8.20	14.36	9.39%	15.35%
Water Heater EF 0.9	72.71	6.45	20.81	8.14%	22.25%
AFUE 97.5%	71.84	0.87	21.68	1.20%	23.18%
ACH 2.0	68.27	3.57	25.25	4.97%	27.00%
Window U- 1.4	70.60	-2.33	22.92	-3.42%	24.50%
Credits-Lighting	66.27	4.33	27.25	6.14%	29.14%
Credits-Exhaust Fans	60.07	0.20	33.45	9.36%	35.77%
Credits- Monitoring	57.17	2.9	36.35	4.83%	38.87%
Credits-ECM Motor	55.67	1.5	37.85	2.62%	40.47%
Credits- DWHR (dual)	47.97	7.7	45.55	13.83%	48.71%
Credits- Fully Ducted	45.07	2.9	48.45	6.05%	51.81%
Credits- All-off w. Split	43.97	1.1	49.55	2.44%	52.99%
Credits- Gas Ready Ran and Drier	43.17	0.8	50.35	1.82%	53.84%

Advanced Package 6-Toronto

Advanced Package 6	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Celing R-10.5	114.84	0.57	0.57	0.49%	0.49%
Above Grade Walls R-4.6	115.45	-0.61	-0.04	-0.53%	-0.04%
Slab Insulation R-1.8	113.76	1.69	1.65	1.46%	1.43%
HRV Efficiencies 60/50	108.92	4.84	6.49	4.26%	5.62%
Water Heater EF 0.8	104.50	4.42	10.91	4.06%	9.45%
AFUE 96%	102.60	1.90	12.81	1.82%	11.10%
ACH 1.5	94.52	8.08	20.89	7.87%	18.10%
Above Grade Walls R-5.2	92.499	2.03	22.91	2.14%	19.85%
Water Heater EF 0.9	91.212	1.29	24.20	1.39%	20.97%
Credits-Lighting	92.52	2.00	22.89	2.12%	19.83%
Credits- Exhaust Fans	92.32	0.20	23.09	0.22%	20.00%
Credits- ECM Motor	90.42	1.90	24.99	2.06%	21.65%
Credits-DWHR	84.22	6.2	31.19	6.86%	27.02%
Credits- All off w/ split	82.32	1.9	33.09	2.26%	28.67%

Advanced Package 6	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Celing R-10.5	86.67	0.40	0.40	0.46%	0.46%
Above Grade Walls R-4.6	86.88	-0.20	0.20	-0.24%	0.23%
Slab Insulation R-1.8	85.62	1.25	1.45	1.44%	1.67%
HRV Efficiencies 60/50	80.67	4.95	6.40	5.78%	7.35%
Water Heater EF 0.8	75.77	4.91	11.31	6.08%	12.99%
AFUE 96%	75.01	0.76	12.07	1.00%	13.86%
ACH 1.5	70.70	4.31	16.38	5.75%	18.81%
Above Grade Walls R-5.2	69.885	0.81	17.19	1.15%	19.74%
Water Heater EF 0.9	68.483	1.40	18.59	2.01%	21.35%
Credits-Lighting	68.70	2.00	18.38	2.83%	21.11%
Credits- Exhaust Fans	68.50	0.20	18.58	0.29%	21.34%
Credits- ECM Motor	66.60	1.90	20.48	2.77%	23.52%
Credits-DWHR	60.40	6.2	26.68	9.31%	30.64%
Credits- All off w/ split	58.50	1.9	28.58	3.15%	32.82%

Advanced Package 6	**Semi-Detached House**				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Celing R-10.5	93.12	0.40	0.40	0.43%	0.43%
Above Grade Walls R-4.6	93.43	-0.31	0.09	-0.34%	0.09%
Slab Insulation R-1.8	92.20	1.23	1.32	1.32%	1.41%
HRV Efficiencies 60/50	87.43	4.77	6.09	5.17%	6.51%
Water Heater EF 0.8	82.78	4.65	10.74	5.32%	11.48%
AFUE 96%	81.74	1.04	11.78	1.26%	12.60%
ACH 1.5	75.91	5.83	17.61	7.13%	18.83%
Above Grade Walls R-5.2	74.91	1.00	18.61	1.32%	19.90%
Water Heater EF 0.9	73.56	1.35	19.96	1.80%	21.34%
Credits-Lighting	71.56	2.00	21.96	2.72%	23.48%
Credits- Exhaust Fans	71.36	0.20	22.16	0.28%	23.69%
Credits- ECM Motor	69.46	1.90	24.06	2.66%	25.73%
Credits-DWHR	63.26	6.2	30.26	8.93%	32.36%
Credits- All off w/ split	61.36	1.9	32.16	3.00%	34.39%

Advanced Package 7-Toronto

Advanced Package 7	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Window U-2.2	113.34	2.08	2.08	1.80%	1.80%
Slab Insulation R-1.8	111.53	1.81	3.88	1.59%	3.36%
HRV Efficiencies 55/45	107.66	3.87	7.75	3.47%	6.72%
Water Heater EF 0.8	103.21	4.44	12.20	4.13%	10.57%
AFUE 94%	101.96	1.26	13.45	1.22%	11.66%
Credits	101.96	0.00	13.45	0.00%	11.66%

Advanced Package 7	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Window U-2.2	90.27	-3.19	-3.19	-3.67%	-3.67%
Slab Insulation R-1.8	88.92	1.35	-1.84	1.49%	-2.12%
HRV Efficiencies 55/45	84.55	4.37	2.53	4.92%	2.90%
Water Heater EF 0.8	79.86	4.69	7.22	5.55%	8.29%
AFUE 94%	79.23	0.63	7.84	0.78%	9.01%
Credits	79.23	0.00	7.84	0.00%	9.01%

Advanced Package 7	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Window U-2.2	98.17	-4.65	-4.65	-4.97%	-4.97%
Slab Insulation R-1.8	96.89	1.27	-3.38	1.30%	-3.61%
HRV Efficiencies 55/45	92.73	4.16	0.78	4.29%	0.84%
Water Heater EF 0.8	88.23	4.50	5.29	4.85%	5.65%
AFUE 94%	87.38	0.85	6.14	0.97%	6.57%
Credits	87.38	0.00	6.14	0.00%	6.57%

Advanced Package 8-Toronto

Advanced Package 8	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Below Grade Walls R-3.2	115.93	-0.52	-0.52	-0.45%	-0.45%
HRV Eff. 75/68	108.72	7.21	6.69	6.22%	5.79%
Water Heater EF 0.8	104.21	4.52	11.21	4.15%	9.71%
AFUE 95%	102.62	1.58	12.79	1.52%	11.08%
ACH 2.5	99.89	2.73	15.52	2.66%	13.45%
Credits-Lighting	98.99	0.9	16.42	0.90%	14.23%
Credits-Exhaust Fans	98.29	0.7	17.12	0.71%	14.83%
Credits-Monitoring	95.39	2.9	20.02	2.95%	17.35%
Credits- ECM Motor	93.89	1.5	21.52	1.57%	18.65%

Advanced Package 8	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Below Grade Walls R-3.2	87.48	-0.40	-0.40	-0.46%	-0.46%
HRV Eff. 75/68	80.30	7.18	6.77	8.20%	7.78%
Water Heater EF 0.8	75.32	4.98	11.76	6.21%	13.50%
AFUE 95%	74.70	0.62	12.38	0.82%	14.22%
ACH 2.5	73.30	1.39	13.77	1.87%	15.82%
Credits-Lighting	72.40	0.9	14.67	1.23%	16.85%
Credits-Exhaust Fans	71.70	0.7	15.37	0.97%	17.65%
Credits-Monitoring	68.80	2.9	18.27	4.04%	20.98%
Credits- ECM Motor	67.30	1.5	19.77	2.18%	22.71%

Advanced Package 8	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Below Grade Walls R-3.2	93.88	-0.36	-0.36	-0.38%	-0.38%
HRV Eff. 75/68	86.35	7.53	7.17	8.02%	7.67%
Water Heater EF 0.8	81.58	4.77	11.94	5.52%	12.76%
AFUE 95%	80.75	0.83	12.77	1.01%	13.65%
ACH 2.5	78.91	1.84	14.61	2.28%	15.62%
Credits-Lighting	78.01	0.9	15.51	1.14%	16.58%
Credits-Exhaust Fans	77.31	0.7	16.21	0.90%	17.33%
Credits-Monitoring	74.41	2.9	19.11	3.75%	20.43%
Credits- ECM Motor	72.91	1.5	20.61	2.02%	22.03%

Advanced Package 9- Toronto

Advanced Package 9	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Above Grade Walls R-4.3	117.37	-1.96	-1.96	-1.69%	-1.69%
HRV Eff. 60/50	112.36	5.01	3.05	4.27%	2.65%
Water Heater EF 0.9	106.70	5.66	8.71	5.03%	7.55%
ACH 2.5	104.00	2.70	11.41	2.53%	9.89%
Credits-Lighting	102.00	2.00	13.41	1.92%	11.62%
Credits-DWHR	95.80	6.20	19.61	6.08%	16.99%

Advanced Package 9	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Above Grade Walls R-4.3	87.72	-0.65	-0.65	-0.74%	-0.74%
HRV Eff. 60/50	82.49	5.23	4.58	5.96%	5.26%
Water Heater EF 0.9	76.35	6.14	10.72	7.44%	12.31%
ACH 2.5	74.86	1.49	12.21	1.95%	14.02%
Credits-Lighting	72.86	2.00	14.21	2.67%	16.32%
Credits-DWHR	66.66	6.20	20.41	8.51%	23.44%

Advanced Package 9	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Above Grade Walls R-4.3	94.52	-1.01	-1.01	-1.08%	-1.08%
HRV Eff. 60/50	89.53	4.99	3.98	5.28%	4.26%
Water Heater EF 0.9	83.63	5.90	9.89	6.59%	10.57%
ACH 2.5	81.66	1.97	11.85	2.35%	12.67%
Credits-Lighting	79.66	2.00	13.85	2.45%	14.81%
Credits-DWHR	73.46	6.20	20.05	7.78%	21.44%

Advanced Package 10- Toronto

Advanced Package 10	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Window U-1.8	118.26	-2.85	-2.85	-2.47%	-2.47%
Slab Insulation R-1.8	116.42	1.84	-1.01	1.56%	-0.87%
HRV Eff. 60/50	111.50	4.92	3.91	4.23%	3.39%
Water Heater EF 0.9	105.93	5.57	9.49	5.00%	8.22%
AFUE 95%	104.20	1.72	11.21	1.63%	9.71%
ACH 2.5	101.61	2.60	13.80	2.49%	11.96%
Credits-Lighting	100.51	1.10	14.90	1.08%	12.91%
Credits-DWHR	94.31	6.2	21.10	6.17%	18.29%

Advanced Package 10	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Window U-1.8	88.20	-1.13	-1.13	-1.30%	-1.30%
Slab Insulation R-1.8	86.74	1.47	0.34	1.66%	0.39%
HRV Eff. 60/50	81.72	5.01	5.35	5.78%	6.15%
Water Heater EF 0.9	75.57	6.15	11.51	7.53%	13.21%
AFUE 95%	74.86	0.71	12.21	0.94%	14.02%
ACH 2.5	73.44	1.43	13.64	1.90%	15.66%
Credits-Lighting	72.34	1.10	14.74	1.50%	16.93%
Credits-DWHR	66.14	6.2	20.94	8.57%	24.05%

Advanced Package 10	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Window U-1.8	95.11	-1.59	-1.59	-1.70%	-1.70%
Slab Insulation R-1.8	93.73	1.38	-0.21	1.46%	-0.22%
HRV Eff. 60/50	88.85	4.87	4.66	5.20%	4.99%
Water Heater EF 0.9	82.99	5.86	10.52	6.60%	11.25%
AFUE 95%	82.04	0.96	11.48	1.15%	12.28%
ACH 2.5	80.15	1.88	13.36	2.30%	14.29%
Credits-Lighting	79.05	1.10	14.46	1.37%	15.47%
Credits-DWHR	72.85	6.2	20.66	7.84%	22.10%

Advanced Package 11- Toronto

Advanced Package 11	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Ceiling R-10.5	114.84	0.57	0.57	0.49%	0.49%
Water Heater EF 0.8	110.53	4.31	4.88	3.75%	4.23%
AFUE 96%	108.23	2.31	7.18	2.09%	6.22%
Credits-Lighting	106.23	2.00	9.18	1.85%	7.96%
Credits-ECM Motor	104.73	1.50	10.68	1.41%	9.26%
Credits-DWHR	98.53	6.20	16.88	5.92%	14.63%

Advanced Package 11	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Ceiling R-10.5	86.68	0.40	0.40	0.46%	0.46%
Water Heater EF 0.8	82.31	4.37	4.77	5.04%	5.47%
AFUE 96%	81.12	1.19	5.95	1.44%	6.84%
Credits-Lighting	79.12	2.00	7.95	2.47%	9.13%
Credits-ECM Motor	77.62	1.50	9.45	1.90%	10.86%
Credits-DWHR	71.42	6.20	15.65	7.99%	17.98%

Advanced Package 11	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Ceiling R-10.5	93.12	0.40	0.40	0.43%	0.43%
Water Heater EF 0.8	88.84	4.28	4.68	4.60%	5.00%
AFUE 96%	87.39	1.45	6.13	1.63%	6.55%
Credits-Lighting	85.39	2.00	8.13	2.29%	8.69%
Credits-ECM Motor	83.89	1.50	9.63	1.76%	10.29%
Credits-DWHR	77.69	6.20	15.83	7.39%	16.92%

Advanced Package 12- Toronto

Advanced Package 12	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Ceiling R-7.1	116.25	-0.84	-0.84	-0.73%	-0.73%
Slab Insulation R-1.8	114.56	1.69	0.85	1.46%	0.74%
HRV Eff. 60/50	109.70	4.86	5.71	4.24%	4.95%
Water Heater EF 0.8	105.29	4.41	10.12	4.02%	8.77%
AFUE 92%	104.63	0.67	10.78	0.63%	9.34%
ACH 1.5	96.48	8.14	18.93	7.78%	16.40%
Window U-1.4	93.82	2.67	21.59	2.76%	18.71%
HRV Eff. 75/65	91.19	2.63	24.23	2.81%	20.99%
Credits-Lighting	89.19	2.00	26.23	2.19%	22.72%
Credits-DWHR	85.69	3.5	29.73	3.92%	25.76%

Advanced Package 12	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Ceiling R-7.1	87.67	-0.59	-0.59	-0.68%	-0.68%
Slab Insulation R-1.8	86.40	1.27	0.68	1.45%	0.78%
HRV Eff. 60/50	81.38	5.01	5.69	5.80%	6.53%
Water Heater EF 0.8	76.51	4.87	10.56	5.98%	12.13%
AFUE 92%	76.24	0.27	10.83	0.36%	12.44%
ACH 1.5	71.79	4.46	15.29	5.84%	17.56%
Window U-1.4	70.938	0.85	16.14	1.18%	18.53%
HRV Eff. 75/65	68.6	2.34	18.47	3.30%	21.22%
Credits-Lighting	69.79	2.00	17.29	2.79%	19.85%
Credits-DWHR	66.29	3.5	20.79	5.02%	23.87%

Advanced Package 12	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Ceiling R-7.1	94.11	-0.59	-0.59	-0.63%	-0.63%
Slab Insulation R-1.8	92.87	1.24	0.65	1.32%	0.69%
HRV Eff. 60/50	88.06	4.81	5.45	5.17%	5.83%
Water Heater EF 0.8	83.43	4.63	10.08	5.26%	10.78%
AFUE 92%	83.07	0.37	10.45	0.44%	11.17%
ACH 1.5	77.07	6.00	16.45	7.23%	17.59%
Window U-1.4	75.77	1.29	17.74	1.68%	18.97%
HRV Eff. 75/65	73.33	2.45	20.19	3.23%	21.59%
Credits-Lighting	75.07	2.00	18.45	2.60%	19.73%
Credits-DWHR	71.57	3.5	21.95	4.66%	23.47%

Advanced Package 13- Toronto

Advanced Package 13	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Ceiling R-7.1	116.25	-0.84	-0.84	-0.73%	-0.73%
Slab Insulation R-1.8	114.56	1.69	0.85	1.46%	0.74%
HRV Eff. 60/50	109.70	4.86	5.71	4.24%	4.95%
Water Heater EF 0.8	105.29	4.41	10.12	4.02%	8.77%
HSPF 9.4	83.04	22.25	32.37	21.14%	28.05%
ACH 1.5	76.87	6.17	38.55	7.44%	33.40%
Window U-Value 1.8	78.30	-1.43	37.11	-1.86%	32.16%
ACH 2.5	82.16	-3.86	33.25	-4.94%	28.81%
Water Heater EF 0.7	84.43	-2.27	30.98	-2.77%	26.84%
Credits-Lighting	80.16	2.00	35.25	-4.29%	30.54%
Credits-DWHR	76.66	3.5	38.75	4.37%	33.58%

Advanced Package 13	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Ceiling R-7.1	87.67	-0.59	-0.59	-0.68%	-0.68%
Slab Insulation R-1.8	86.40	1.27	0.68	1.45%	0.78%
HRV Eff. 60/50	81.38	5.01	5.69	5.80%	6.53%
Water Heater EF 0.8	76.51	4.87	10.56	5.98%	12.13%
HSPF 9.4	64.93	11.59	22.15	15.15%	25.44%
ACH 1.5	62.90	2.02	24.17	3.11%	27.76%
Window U-Value 1.8	63.18	-0.27	23.90	-0.43%	27.45%
ACH 2.5	64.62	-1.45	22.45	-2.29%	25.79%
Water Heater EF 0.7	66.89	-2.27	20.19	-3.51%	23.18%
Credits-Lighting	64.89	2.00	22.19	2.99%	25.48%
Credits-DWHR	61.39	3.5	25.69	5.39%	29.50%

Advanced Package 13	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Ceiling R-7.1	94.11	-0.59	-0.59	-0.63%	-0.63%
Slab Insulation R-1.8	92.87	1.24	0.65	1.32%	0.69%
HRV Eff. 60/50	88.06	4.81	5.45	5.17%	5.83%
Water Heater EF 0.8	83.43	4.63	10.08	5.26%	10.78%
HSPF 9.4	68.46	14.97	25.05	17.94%	26.79%
ACH 1.5	65.18	3.29	28.34	4.80%	30.30%
Window U-Value 1.8	65.91	-0.73	27.61	-1.12%	29.52%
ACH 2.5	68.24	-2.33	25.28	-3.54%	27.03%
Water Heater EF 0.7	70.42	-2.18	23.10	-3.19%	24.70%
Credits-Lighting	68.42	2.00	25.10	2.84%	26.84%
Credits-DWHR	64.92	3.5	28.60	5.12%	30.58%

Advanced Package 14- Toronto

Advanced Package 14	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Ceiling R-10.5	114.84	0.57	0.57	0.49%	0.49%
Slab Insulation R-2.0	113.10	1.74	2.31	1.52%	2.00%
HRV Eff. 60/50	108.28	4.82	7.13	4.26%	6.18%
Water Heater EF 0.8	103.85	4.43	11.56	4.09%	10.01%
AFUE 96%	101.98	1.87	13.43	1.80%	11.64%
Credits-Lighting	99.98	2.00	15.43	1.96%	13.37%
Credits- Appliances	95.58	4.4	19.83	4.40%	17.18%
Credits- ECM Motor	94.08	1.5	21.33	1.57%	18.48%
Credits-DWHR	86.38	7.7	29.03	8.18%	25.15%

Advanced Package 14	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Ceiling R-10.5	86.68	0.40	0.40	0.46%	0.46%
Slab Insulation R-2.0	85.38	1.30	1.69	1.49%	1.94%
HRV Eff. 60/50	80.46	4.93	6.62	5.77%	7.60%
Water Heater EF 0.8	75.54	4.92	11.54	6.11%	13.25%
AFUE 96%	74.79	0.75	12.29	0.99%	14.11%
Credits-Lighting	72.79	2.00	14.29	2.67%	16.41%
Credits- Appliances	68.39	4.4	18.69	6.04%	21.46%
Credits- ECM Motor	66.89	1.5	20.19	2.19%	23.18%
Credits-DWHR	59.19	7.7	27.89	11.51%	32.02%

Advanced Package 14	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Ceiling R-10.5	93.12	0.40	0.40	0.43%	0.43%
Slab Insulation R-2.0	91.85	1.27	1.67	1.36%	1.78%
HRV Eff. 60/50	87.11	4.74	6.41	5.16%	6.86%
Water Heater EF 0.8	82.44	4.66	11.08	5.35%	11.84%
AFUE 96%	81.42	1.03	12.10	1.24%	12.94%
Credits-Lighting	79.42	2.00	14.10	2.46%	15.08%
Credits- Appliances	75.02	4.4	18.50	5.54%	19.78%
Credits- ECM Motor	73.52	1.5	20.00	2.00%	21.39%
Credits-DWHR	65.82	7.7	27.70	10.47%	29.62%

Advanced Package 15- Toronto

Advanced Package 15	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Window U-1.8	118.26	-2.85	-2.85	-2.47%	-2.47%
Above Grade Walls R-4.6	118.87	-0.61	-3.46	-0.52%	-3.00%
HRV Eff. 78/68	110.51	8.37	4.90	7.04%	4.25%
Water Heater EF 1.0	103.83	6.68	11.58	6.05%	10.04%
AFUE 97%	101.48	2.34	13.93	2.26%	12.07%
ACH 2.5	98.77	2.72	16.64	2.68%	14.42%
Window U-1.6	96.07	2.69	19.34	2.73%	16.76%
ACH 2.0	93.55	2.52	21.86	2.62%	18.94%
Credits- ECM Motor	97.27	1.50	18.14	1.52%	15.72%
Credits-DWHR	93.77	3.5	21.64	3.60%	18.75%
Credits- PV Generation	93.17	0.6	22.24	0.64%	19.27%
Credits-Other	92.27	0.9	23.14	0.97%	20.05%

Advanced Package 15	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Window U-1.8	88.20	-1.13	-1.13	-1.30%	-1.30%
Above Grade Walls R-4.6	88.41	-0.20	-1.33	-0.23%	-1.53%
HRV Eff. 78/68	80.05	8.36	7.02	9.45%	8.07%
Water Heater EF 1.0	72.64	7.41	14.43	9.25%	16.57%
AFUE 97%	71.73	0.91	15.35	1.26%	17.62%
ACH 2.5	70.34	1.39	16.74	1.94%	19.22%
Window U-1.6	69.47	0.87	17.60	1.23%	20.22%
ACH 2.0	67.917	1.55	19.16	2.24%	22.00%
Credits- ECM Motor	68.84	1.50	18.24	2.13%	20.94%
Credits-DWHR	65.34	3.5	21.74	5.08%	24.96%
Credits- PV Generation	64.74	0.6	22.34	0.92%	25.65%
Credits-Other	63.84	0.9	23.24	1.39%	26.69%

Advanced Package 15	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Window U-1.8	95.11	-1.59	-1.59	-1.70%	-1.70%
Above Grade Walls R-4.6	95.42	-0.32	-1.91	-0.33%	-2.04%
HRV Eff. 78/68	87.14	8.28	6.37	8.68%	6.82%
Water Heater EF 1.0	80.10	7.05	13.42	8.09%	14.35%
AFUE 97%	78.84	1.26	14.68	1.57%	15.69%
ACH 2.5	77.00	1.85	16.52	2.34%	17.67%
Window U-1.6	75.689	1.31	17.83	1.70%	19.06%
ACH 2.0	73.696	1.99	19.82	2.63%	21.20%
Credits- ECM Motor	75.50	1.50	18.02	1.95%	19.27%
Credits-DWHR	72.00	3.5	21.52	4.64%	23.01%
Credits- PV Generation	71.40	0.6	22.12	0.83%	23.66%
Credits-Other	70.50	0.9	23.02	1.26%	24.62%

Advanced Package 16- Toronto

Advanced Package 16	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Window U-1.8	118.26	-2.85	-2.85	-2.47%	-2.47%
Slab Insulation R-1.8	116.42	1.84	-1.01	1.56%	-0.87%
HRV Eff. 72/65	109.29	7.13	6.12	6.12%	5.30%
Water Heater EF 0.7	106.44	2.85	8.97	2.61%	7.78%
AFUE 95%	104.87	1.57	10.54	1.47%	9.14%
ACH 2.5	102.31	1.50	13.11	2.44%	11.36%
Credits- Appliances	100.31	2	15.11	1.95%	13.09%
Credits- Exhaust Fans	99.61	0.7	15.81	0.70%	13.69%
Credits- ECM Motor	98.11	1.5	17.31	1.51%	14.99%
Credits-DWHR	91.91	6.2	23.51	6.32%	20.37%

Advanced Package 16	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Window U-1.8	88.20	-1.13	-1.13	-1.30%	-1.30%
Slab Insulation R-1.8	86.74	1.47	0.34	1.66%	0.39%
HRV Eff. 72/65	79.77	6.97	7.31	8.03%	8.39%
Water Heater EF 0.7	76.53	3.24	10.54	4.06%	12.11%
AFUE 95%	75.96	0.57	11.11	0.74%	12.76%
ACH 2.5	74.61	1.50	12.46	1.78%	14.31%
Credits- Appliances	72.61	2	14.46	2.68%	16.61%
Credits- Exhaust Fans	71.91	0.7	15.16	0.96%	17.41%
Credits- ECM Motor	70.41	1.5	16.66	2.09%	19.14%
Credits-DWHR	64.21	6.2	22.86	8.81%	26.26%

Advanced Package 16	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Window U-1.8	95.11	-1.59	-1.59	-1.70%	-1.70%
Slab Insulation R-1.8	93.73	1.38	-0.21	1.46%	-0.22%
HRV Eff. 72/65	86.80	6.93	6.72	7.39%	7.19%
Water Heater EF 0.7	83.76	3.03	9.75	3.50%	10.43%
AFUE 95%	82.95	0.81	10.57	0.97%	11.30%
ACH 2.5	81.12	1.50	12.40	2.21%	13.26%
Credits- Appliances	79.12	2	14.40	2.47%	15.40%
Credits- Exhaust Fans	78.42	0.7	15.10	0.88%	16.14%
Credits- ECM Motor	76.92	1.5	16.60	1.91%	17.75%
Credits-DWHR	70.72	6.2	22.80	8.06%	24.38%

Advanced Package 17- Toronto

Advanced Package 17	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Window U-1.8	118.26	-2.85	-2.85	-2.47%	-2.47%
Ceiling R-10.5	117.56	-2.15	-2.15	-1.86%	-1.86%
Slab Insulation 1.8	115.85	2.41	-0.44	2.04%	-0.38%
HRV Eff. 72/65	108.74	7.11	6.67	6.14%	5.78%
Water Heater EF 0.7	105.88	2.86	9.53	2.63%	8.26%
AFUE 95%	104.33	1.55	11.08	1.46%	9.60%
ACH 2.0	99.08	1.50	16.33	5.03%	14.15%
Credits- Appliances	97.08	2	18.33	2.02%	15.88%
Credits- Exhaust Fans	96.38	0.7	19.03	0.72%	16.49%
Credits- ECM Motor	94.88	1.5	20.53	1.56%	17.79%
Credits-DWHR	87.18	7.7	28.23	8.12%	24.46%

Advanced Package 17	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Window U-1.8	88.20	-1.13	-1.13	-1.30%	-1.30%
Ceiling R-10.5	87.66	-0.59	-0.59	-0.67%	-0.67%
Slab Insulation 1.8	86.34	1.86	0.73	2.11%	0.84%
HRV Eff. 72/65	79.42	6.93	7.65	8.02%	8.79%
Water Heater EF 0.7	76.18	3.23	10.89	4.07%	12.50%
AFUE 95%	75.63	0.56	11.44	0.73%	13.14%
ACH 2.0	72.74	1.50	14.33	3.82%	16.46%
Credits- Appliances	70.74	2	16.33	2.75%	18.76%
Credits- Exhaust Fans	70.04	0.7	17.03	0.99%	19.56%
Credits- ECM Motor	68.54	1.5	18.53	2.14%	21.28%
Credits-DWHR	60.84	7.7	26.23	11.23%	30.13%

Advanced Package 17	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Window U-1.8	95.11	-1.59	-1.59	-1.70%	-1.70%
Ceiling R-10.5	94.57	-1.05	-1.05	-1.13%	-1.13%
Slab Insulation 1.8	93.33	1.78	0.19	1.87%	0.20%
HRV Eff. 72/65	86.43	6.90	7.09	7.39%	7.58%
Water Heater EF 0.7	83.39	3.04	10.13	3.52%	10.83%
AFUE 95%	82.59	0.80	10.93	0.96%	11.69%
ACH 2.0	78.78	1.50	14.74	4.62%	15.76%
Credits- Appliances	76.78	2	16.74	2.54%	17.90%
Credits- Exhaust Fans	76.08	0.7	17.44	0.91%	18.65%
Credits- ECM Motor	74.58	1.5	18.94	1.97%	20.25%
Credits-DWHR	66.88	7.7	26.64	10.33%	28.49%

Advanced Package 18- Toronto

Advanced Package 18	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Above Grade Walls R-3.9	119.63	-4.22	-4.22	-3.65%	-3.65%
Slab Insulation 1.8	117.91	1.72	-2.50	1.44%	-2.16%
HRV Eff. 65/55	112.04	5.87	3.37	4.98%	2.92%
ACH 2.0	106.45	5.59	8.96	4.99%	7.77%
Combo System (Furnace and Water)	101.25	5.19	14.16	4.88%	12.27%
Credits- Lighting	99.25	2.00	16.16	1.98%	14.00%
Credits- Appliances	97.75	1.50	17.66	1.51%	15.30%
Credits- ECM Motor	95.25	2.5	20.16	2.56%	17.46%
Credits-DWHR	91.75	3.5	23.66	3.67%	20.50%

Advanced Package 18	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Above Grade Walls R-3.9	88.57	-1.50	-1.50	-1.72%	-1.72%
Slab Insulation 1.8	87.10	1.47	-0.03	1.66%	-0.03%
HRV Eff. 65/55	81.24	5.86	5.83	6.73%	6.70%
Combo System (Furnace and Water)	76.41	4.83	10.67	5.95%	12.25%
ACH 2.0	73.42	2.99	13.66	3.92%	15.69%
Credits- Lighting	71.42	2.00	15.66	2.72%	17.98%
Credits- Appliances	69.92	1.50	17.16	2.10%	19.71%
Credits- ECM Motor	67.42	2.5	19.66	3.58%	22.58%
Credits-DWHR	63.92	3.5	23.16	5.19%	26.60%

Advanced Package 18	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Above Grade Walls R-3.9	95.76	-2.24	-2.24	-2.39%	-2.39%
Slab Insulation 1.8	94.37	1.39	-0.85	1.45%	-0.91%
HRV Eff. 65/55	88.60	5.77	4.92	6.11%	5.26%
Combo System (Furnace and Water)	83.80	4.80	9.72	5.42%	10.39%
ACH 2.0	79.90	3.90	13.62	4.66%	14.57%
Credits- Lighting	77.90	2.00	15.62	2.50%	16.70%
Credits- Appliances	76.40	1.50	17.12	1.93%	18.31%
Credits- ECM Motor	73.90	2.5	19.62	3.27%	20.98%
Credits-DWHR	70.40	3.5	23.12	4.74%	24.72%

Advanced Package 19- Toronto

Advanced Package 19	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	115.41	-	-	-	-
Window U-1.4	112.60	2.81	2.81	2.43%	2.43%
Above Grade Walls R-4.4	114.22	-1.62	1.19	-1.44%	1.03%
Slab Insulation 1.8	112.54	1.68	2.87	1.47%	2.49%
HRV Eff. 75/65	105.06	7.48	10.35	6.65%	8.97%
Water Heater EF 0.9	99.32	5.74	16.09	5.46%	13.94%
HSPF 9.4	78.75	20.57	36.66	20.71%	31.76%
ACH 2.0	74.06	4.69	41.35	5.95%	35.83%
Window U-1.8	77.78	-3.71	37.63	-5.01%	32.61%
Water Heater EF 0.7	81.23	-3.46	34.18	-4.44%	29.61%
ACH 2.5	83.90	-2.66	31.51	-3.28%	27.31%
Credits- Appliances	81.90	2.00	33.51	2.38%	29.04%
Credits- ECM Motor	81.20	0.70	34.21	0.85%	29.65%

Advanced Package 19	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	87.07	-	-	-	-
Window U-1.4	86.11	0.97	0.97	1.11%	1.11%
Above Grade Walls R-4.4	86.60	-0.49	0.48	-0.57%	0.55%
Slab Insulation 1.8	85.35	1.25	1.72	1.44%	1.98%
HRV Eff. 75/65	78.05	7.30	9.02	8.56%	10.36%
Water Heater EF 0.9	71.64	6.41	15.43	8.21%	17.72%
HSPF 9.4	61.77	9.87	25.30	13.78%	29.06%
ACH 2.0	60.39	1.50	26.69	2.24%	30.65%
Window U-1.8	60.99	1.50	26.09	-0.99%	29.96%
Water Heater EF 0.7	65.22	1.50	21.86	-6.94%	25.10%
ACH 2.5	66.00	1.50	21.07	-1.20%	24.20%
Credits- Appliances	64.00	2.00	23.07	3.03%	26.50%
Credits- ECM Motor	63.30	0.70	23.77	1.09%	27.30%

Advanced Package 19	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	93.52	-	-	-	-
Window U-1.4	92.09	1.43	1.43	1.53%	1.53%
Above Grade Walls R-4.4	92.85	-0.76	0.67	-0.83%	0.71%
Slab Insulation 1.8	91.62	1.23	1.89	1.32%	2.03%
HRV Eff. 75/65	84.47	7.16	9.05	7.81%	9.68%
Water Heater EF 0.9	78.33	6.14	15.19	7.27%	16.24%
HSPF 9.4	65.02	13.31	28.50	16.99%	30.47%
ACH 2.0	63.07	1.50	30.45	3.00%	32.56%
Window U-1.8	64.14	1.50	29.37	-1.70%	31.41%
Water Heater EF 0.7	68.17	1.50	25.34	-6.28%	27.10%
ACH 2.5	69.34	1.50	24.18	-1.70%	25.86%
Credits- Appliances	67.34	2.00	26.18	2.88%	28.00%
Credits- ECM Motor	66.64	0.70	26.88	1.04%	28.75%

Appendix G: SBD Advanced Packages Energy Consumption Results (Ottawa)- Summary Table

SBD Advanced Packages Energy Consumption Results (Ottawa)- Summary Table

CCHT Detached House																			
	SB-12 Package B	**AP-1**	**AP-2**	**AP-3**	**AP-4**	**AP-5**	**AP-6**	**AP-7**	**AP-8**	**AP-9**	**AP-10**	**AP-11**	**AP-12**	**AP-13**	**AP-14**	**AP-15**	**AP-16**	**AP-17**	**AP-18**	**AP-19**
Electricity (kWh)	10977.00																			
Natural Gas (m3)	2353.20																			
Consumption (GJ)	127.20	113.16	100.04	112.86	107.15	90.72	103.64	101.96	116.15	115.02	112.00	119.59	105.76	87.95	112.42	109.12	118.95	114.96	111.29	85.66
Consumption (GJ/m2)	0.48	0.43	0.38	0.42	0.40	0.34	0.39	0.38	0.44	0.43	0.42	0.45	0.40	0.33	0.42	0.41	0.45	0.43	0.42	0.32
Reduction (%)	-	**11.03%**	**21.35%**	**11.27%**	**15.76%**	**28.68%**	**18.52%**	**19.84%**	**8.68%**	**9.58%**	**11.94%**	**5.98%**	**16.85%**	**30.86%**	**11.62%**	**14.21%**	**6.48%**	**9.62%**	**12.50%**	**32.65%**
EnerGuide Rating	80	80	83	80	81	84	82	82	80	80	81	79	82	85	81	81	79	80	81	85
Typical Townhouse																				
	SB-12 Package B	**AP-1**	**AP-2**	**AP-3**	**AP-4**	**AP-5**	**AP-6**	**AP-7**	**AP-8**	**AP-9**	**AP-10**	**AP-11**	**AP-12**	**AP-13**	**AP-14**	**AP-15**	**AP-16**	**AP-17**	**AP-18**	**AP-19**
Electricity (kWh)	10212.00																			
Natural Gas (m3)	1560.60																			
Total Consumption (GJ)	94.91	79.97	72.92	79.91	79.08	69.62	76.17	79.23	82.87	81.57	70.75	88.67	77.49	67.32	81.16	76.61	84.55	82.49	79.56	64.59
Consumption (GJ/m2)	0.64	0.54	0.49	0.54	0.53	0.47	0.51	0.53	0.56	0.55	0.48	0.60	0.52	0.45	0.55	0.52	0.57	0.56	0.54	0.43
Reduction (%)	-	**15.74%**	**23.17%**	**15.80%**	**16.68%**	**26.64%**	**19.75%**	**16.52%**	**12.68%**	**14.05%**	**25.46%**	**6.58%**	**18.35%**	**29.07%**	**14.49%**	**19.28%**	**10.91%**	**13.08%**	**16.17%**	**31.94%**
EnerGuide Rating	80	82	83	82	82	84	83	82	81	81	84	80	82	85	81	82	81	81	82	85
Typical Semi-Detached																				
	SB-12 Package B	**AP-1**	**AP-2**	**AP-3**	**AP-4**	**AP-5**	**AP-6**	**AP-7**	**AP-8**	**AP-9**	**AP-10**	**AP-11**	**AP-12**	**AP-13**	**AP-14**	**AP-15**	**AP-16**	**AP-17**	**AP-18**	**AP-19**
Electricity (kWh)	10382.00																			
Natural Gas (m3)	1743.30																			
Total Consumption (GJ)	102.33	86.79	79.08	87.21	85.40	74.90	82.40	87.38	91.21	89.60	87.68	95.86	83.79	71.39	89.03	84.31	93.37	90.55	87.04	68.93
Consumption (GJ/m2)	0.53	0.45	0.41	0.45	0.44	0.39	0.43	0.45	0.47	0.46	0.45	0.50	0.43	0.37	0.46	0.44	0.48	0.47	0.45	0.36
Reduction (%)	-	**15.19%**	**22.72%**	**14.77%**	**16.54%**	**26.81%**	**19.48%**	**14.61%**	**10.87%**	**12.44%**	**14.31%**	**6.32%**	**18.12%**	**30.23%**	**12.99%**	**17.61%**	**8.76%**	**11.51%**	**14.94%**	**32.64%**
EnerGuide Rating	80	81	83	81	82	84	82	81	80	81	81	79	82	85	81	82	80	81	81	85

Appendix H: SBD Advanced Packages Energy Consumption Results (Ottawa)- Detailed Breakdown

Advanced Package 1- Ottawa

Advanced Package 1	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
U-Value Windows 1.8	129.49	-2.29	-2.29	-1.80%	-1.80%
R-Value Wall 4.3	131.69	-4.49	-4.49	-1.70%	-3.53%
HRV Efficiencies 75/60	124.14	5.35	3.06	5.73%	2.41%
AFUE 95%	122.20	1.94	5.00	1.56%	3.93%
Water Heater EF 0.9	116.40	5.80	10.80	4.75%	8.49%
ACH 2.5	113.16	3.24	14.04	2.78%	11.04%
Credits-Lighting	111.16	2.00	16.04	1.77%	12.61%
Credits- Appliances	109.66	1.5	17.54	1.35%	13.79%
Credits- DWHR (dual)	103.46	6.2	23.74	5.65%	18.66%
Credits- ECM Motor	101.96	1.5	25.24	1.45%	19.84%

Advanced Package 1	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.91	-	-	-	-
U-Value Windows 1.8	96.02	-1.11	-1.11	-1.17%	-1.17%
R-Value Wall 4.3	96.76	-0.74	-9.69	-0.77%	-11.12%
HRV Efficiencies 75/60	88.68	8.08	-1.60	8.35%	-1.84%
AFUE 95%	87.90	0.77	-0.83	0.87%	-0.95%
Water Heater EF 0.9	81.71	6.19	5.36	7.04%	6.16%
ACH 2.5	79.97	1.74	7.10	2.13%	8.16%
Credits-Lighting	77.97	2.00	9.10	2.50%	10.46%
Credits- Appliances	76.47	1.5	10.60	1.92%	12.18%
Credits- DWHR (dual)	70.27	6.2	16.80	8.11%	19.30%
Credits- ECM Motor	68.77	1.5	18.30	2.13%	21.02%

Advanced Package 1	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
U-Value Windows 1.8	103.58	-1.25	-1.25	-1.22%	-1.22%
R-Value Wall 4.3	104.86	-1.28	-11.34	-1.23%	-12.13%
HRV Efficiencies 75/60	96.26	8.60	-2.74	8.20%	-2.93%
AFUE 95%	95.24	1.02	-1.72	1.06%	-1.84%
Water Heater EF 0.9	89.22	6.02	4.30	6.32%	4.60%
ACH 2.5	86.79	2.43	6.73	2.73%	7.20%
Credits-Lighting	84.79	2.00	8.73	2.30%	9.34%
Credits- Appliances	83.29	1.5	10.23	1.77%	10.94%
Credits- DWHR (dual)	77.09	6.2	16.43	7.44%	17.57%
Credits- ECM Motor	75.59	1.5	17.93	1.95%	19.17%

Advanced Package 2- Ottawa

Advanced Package 2	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
R-Value Walls 5.2	124.49	2.71	2.71	2.13%	2.13%
R-Value Exp. Floors 7.1	124.21	0.28	2.99	0.22%	2.59%
HRV Efficiencies 84/72	114.89	9.32	12.31	7.50%	10.67%
AFUE 98%	112.35	2.54	14.85	2.21%	12.87%
Water Heater EF 0.9	106.28	6.08	20.93	5.41%	18.13%
ACH 2.0	100.04	6.24	27.16	5.87%	23.53%
Credits- Lighting	98.54	1.5	28.66	1.50%	24.83%
Credits- Appliances	96.54	2	30.66	2.03%	26.57%
Credits- Exhaust Fans	95.44	1.1	31.76	1.14%	27.52%
Credits- Monitoring	92.64	2.8	34.56	2.93%	29.95%
Credits- ECM Motor	91.14	1.5	36.06	1.62%	31.25%
Credits- DWHR (dual)	83.44	7.7	43.76	8.45%	37.92%

Advanced Package 2	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.91	-	-	-	-
R-Value Walls 5.2	94.30	0.61	0.61	0.64%	0.64%
R-Value Exp. Floors 7.1	94.26	0.04	-7.19	0.05%	-8.26%
HRV Efficiencies 84/72	83.87	10.39	3.20	11.03%	3.68%
AFUE 98%	82.94	0.93	4.13	1.11%	4.75%
Water Heater EF 0.9	76.38	6.56	10.69	7.90%	12.28%
ACH 2.0	72.92	3.46	14.15	4.53%	16.25%
Credits- Lighting	71.42	1.5	15.65	2.06%	17.97%
Credits- Appliances	69.42	2	17.65	2.80%	20.27%
Credits- Exhaust Fans	68.32	1.1	18.75	1.58%	21.53%
Credits- Monitoring	65.52	2.8	21.55	4.10%	24.75%
Credits- ECM Motor	64.02	1.5	23.05	2.29%	26.47%
Credits- DWHR (dual)	56.32	7.7	30.75	12.03%	35.31%

Advanced Package 2	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
R-Value Walls 5.2	101.39	0.94	0.94	0.92%	0.92%
R-Value Exp. Floors 7.1	101.35	0.04	-7.83	0.04%	-8.37%
HRV Efficiencies 84/72	91.18	10.17	2.34	10.04%	2.50%
AFUE 98%	89.86	1.32	3.66	1.45%	3.91%
Water Heater EF 0.9	83.58	6.27	9.93	6.98%	10.62%
ACH 2.0	79.08	4.50	14.44	5.39%	15.44%
Credits- Lighting	77.58	1.5	15.94	1.90%	17.04%
Credits- Appliances	75.58	2	17.94	2.58%	19.18%
Credits- Exhaust Fans	74.48	1.1	19.04	1.46%	20.36%
Credits- Monitoring	71.68	2.8	21.84	3.76%	23.35%
Credits- ECM Motor	70.18	1.5	23.34	2.09%	24.95%
Credits- DWHR (dual)	62.48	7.7	31.04	10.97%	33.19%

Advanced Package 3- Ottawa

Advanced Package 3	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
U-Value Windows 1.8	129.49	-2.29	-2.29	-1.80%	-1.80%
Above Grade Walls R-4.1	132.97	-3.48	-5.77	-2.69%	-4.53%
HRV Efficiencies 65/60	127.13	5.83	0.07	4.38%	0.05%
AFUE 95%	125.09	2.05	2.11	1.61%	1.66%
Water Heater EF 0.9	119.37	5.72	7.84	4.57%	6.16%
ACH 2.0	112.86	6.50	14.34	5.45%	11.27%
Credits- Exhaust Fans	112.16	0.70	15.04	0.62%	11.82%
Credits- Monitoring	109.26	2.90	17.94	2.59%	14.10%
Credits- DWHR (dual)	105.76	3.50	21.44	3.20%	16.85%
Credits- ECM Motor	103.26	2.5	23.94	2.36%	18.82%

Advanced Package 3	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.91	-	-	-	-
U-Value Windows 1.8	96.02	-1.11	-1.11	-1.17%	-1.17%
Above Grade Walls R-4.1	97.14	-1.12	-10.07	-1.16%	-11.56%
HRV Efficiencies 65/60	89.91	7.23	-2.84	7.44%	-3.26%
AFUE 95%	89.09	0.82	-2.02	0.91%	-2.32%
Water Heater EF 0.9	82.97	6.12	4.10	6.87%	4.71%
ACH 2.0	79.91	3.06	7.16	3.69%	8.23%
Credits- Exhaust Fans	79.21	0.70	7.86	0.88%	9.03%
Credits- Monitoring	76.31	2.90	10.76	3.66%	12.36%
Credits- DWHR (dual)	72.81	3.50	14.26	4.59%	16.38%
Credits- ECM Motor	70.31	2.5	16.76	3.43%	19.25%

Advanced Package 3	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
U-Value Windows 1.8	104.11	-1.78	-1.78	-1.74%	-1.74%
Above Grade Walls R-4.1	105.84	-1.73	-12.32	-1.66%	-13.17%
HRV Efficiencies 65/60	98.97	6.86	-5.46	6.48%	-5.83%
AFUE 95%	97.86	1.12	-4.34	1.13%	-4.64%
Water Heater EF 0.9	91.14	6.71	2.38	6.86%	2.54%
ACH 2.0	87.21	3.93	6.30	4.31%	6.74%
Credits- Exhaust Fans	86.51	0.70	7.00	0.80%	7.49%
Credits- Monitoring	83.61	2.90	9.90	3.35%	10.59%
Credits- DWHR (dual)	80.11	3.50	13.40	4.19%	14.33%
Credits- ECM Motor	77.61	2.5	15.90	3.12%	17.01%

Advanced Package 4- Ottawa

Advanced Package 4	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
Above Grade Walls R-5.2	124.49	2.71	2.71	2.13%	2.13%
HRV Efficiencies 60/50	119.99	4.50	-4.58	3.61%	-3.97%
AFUE 95%	118.18	1.81	-2.77	1.51%	-2.40%
Water Heater EF 0.8	113.57	4.61	1.84	3.90%	1.59%
ACH 2.0	107.15	6.42	8.26	5.65%	7.15%
Credits-Lighting	105.15	2.00	10.26	1.87%	8.89%
Credits-ECM Motor	102.65	2.50	12.76	2.38%	11.05%
Credits-DWHR	95.55	7.10	19.86	6.92%	17.21%

Advanced Package 4	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.91	-	-	-	-
Above Grade Walls R-5.2	94.30	0.61	0.61	0.64%	0.64%
HRV Efficiencies 60/50	88.32	5.98	-1.25	6.34%	-1.43%
AFUE 95%	87.56	0.76	-0.49	0.86%	-0.56%
Water Heater EF 0.8	82.69	4.87	4.39	5.57%	5.04%
ACH 2.0	79.08	3.61	8.00	4.37%	9.18%
Credits-Lighting	77.08	2.00	10.00	2.53%	11.48%
Credits-ECM Motor	74.58	2.50	12.50	3.24%	14.35%
Credits-DWHR	67.48	7.10	19.60	9.52%	22.51%

Advanced Package 4	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
Above Grade Walls R-5.2	101.39	0.94	0.94	0.92%	0.92%
HRV Efficiencies 60/50	95.81	5.59	-8.73	5.51%	-10.03%
AFUE 95%	94.79	1.01	-7.72	1.06%	-8.86%
Water Heater EF 0.8	90.07	4.72	-3.00	4.98%	-3.44%
ACH 2.0	85.40	4.67	1.67	5.18%	1.92%
Credits-Lighting	83.40	2.00	3.67	2.34%	4.22%
Credits-ECM Motor	80.90	2.50	6.17	3.00%	7.09%
Credits-DWHR	73.80	7.10	13.27	8.78%	15.24%

Advanced Package 5- Ottawa

Advanced Package 5	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
Above Grade Walls R-5.1	124.86	2.34	2.34	1.84%	1.84%
Window U- 1.0	115.66	9.20	-0.25	7.37%	-0.22%
Slab Insulation R-1.8	113.66	2.00	1.76	1.73%	1.52%
HRV Efficiencies 84/78	104.86	8.80	10.55	7.74%	9.14%
Water Heater EF 0.9	98.85	6.01	16.56	5.73%	14.35%
AFUE 97.5%	96.77	2.08	18.64	2.10%	16.15%
ACH 2.0	90.72	6.05	24.69	6.25%	21.39%
Credits-Lighting	88.72	2.00	26.69	2.20%	23.13%
Credits-Exhaust Fans	82.52	0.20	32.89	6.99%	28.50%
Credits- Monitoring	79.62	2.9	35.79	3.51%	31.01%
Credits-ECM Motor	78.12	1.5	37.29	1.88%	32.31%
Credits- DWHR (dual)	70.42	7.7	44.99	9.86%	38.98%
Credits- Fully Ducted	67.52	2.9	47.89	4.12%	41.49%
Credits- All-off w. Split	66.42	1.1	48.99	1.63%	42.45%
Credits- Gas Ready Ran and Drier	65.62	0.8	49.79	1.20%	43.14%

Advanced Package 5	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.91	-	-	-	-
Above Grade Walls R-5.1	94.43	0.48	0.48	0.51%	0.51%
Window U- 1.0	91.18	3.25	-4.11	3.44%	-4.72%
Slab Insulation R-1.8	90.29	0.89	-3.22	0.98%	-3.70%
HRV Efficiencies 84/78	80.37	9.92	6.70	10.99%	7.69%
Water Heater EF 0.9	73.85	6.52	13.22	8.11%	15.18%
AFUE 97.5%	72.98	0.88	14.09	1.18%	16.19%
ACH 2.0	69.62	3.35	17.45	4.60%	20.04%
Credits-Lighting	67.62	2.00	19.45	2.87%	22.34%
Credits-Exhaust Fans	61.42	0.20	25.65	9.17%	29.46%
Credits- Monitoring	58.52	2.9	28.55	4.72%	32.79%
Credits-ECM Motor	57.02	1.5	30.05	2.56%	34.51%
Credits- DWHR (dual)	49.32	7.7	37.75	13.50%	43.35%
Credits- Fully Ducted	46.42	2.9	40.65	5.88%	46.68%
Credits- All-off w. Split	45.32	1.1	41.75	2.37%	47.95%
Credits- Gas Ready Ran and Drier	44.52	0.8	42.55	1.77%	48.87%

Advanced Package 5	**Semi-Detached**				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
Above Grade Walls R-5.1	101.59	0.74	0.74	0.73%	0.73%
Window U- 1.0	96.67	4.91	-3.16	4.84%	-3.37%
Slab Insulation R-1.8	96.67	0.01	-3.15	0.01%	-3.37%
HRV Efficiencies 84/78	86.80	9.86	6.71	10.20%	7.18%
Water Heater EF 0.9	80.50	6.31	13.02	7.27%	13.92%
AFUE 97.5%	79.30	1.20	14.22	1.49%	15.21%
ACH 2.0	74.90	4.40	18.62	5.55%	19.91%
Credits-Lighting	72.90	2.00	20.62	2.67%	22.05%
Credits-Exhaust Fans	66.70	0.20	26.82	8.51%	28.68%
Credits- Monitoring	63.80	2.9	29.72	4.35%	31.78%
Credits-ECM Motor	62.30	1.5	31.22	2.35%	33.39%
Credits- DWHR (dual)	54.60	7.7	38.92	12.36%	41.62%
Credits- Fully Ducted	51.70	2.9	41.82	5.31%	44.72%
Credits- All-off w. Split	50.60	1.1	42.92	2.13%	45.90%
Credits- Gas Ready Ran and Drier	49.80	0.8	43.72	1.58%	46.75%

Advanced Package 6- Ottawa

Advanced Package 6	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
Celing R-10.5	125.66	1.54	1.54	1.21%	1.21%
Above Grade Walls R-4.6	126.34	-0.68	-10.93	-0.54%	-9.47%
Slab Insulation R-1.8	124.18	2.16	-8.77	1.71%	-7.59%
HRV Efficiencies 60/50	119.81	4.36	-4.40	3.51%	-3.81%
Water Heater EF 0.8	115.39	4.42	0.02	3.69%	0.02%
AFUE 96%	113.10	2.29	2.31	1.98%	2.00%
ACH 1.5	103.64	9.46	11.77	8.36%	10.20%
Credits-Lighting	101.64	2.00	13.77	1.93%	11.93%
Credits- Exhaust Fans	101.44	0.20	13.97	0.20%	12.10%
Credits- ECM Motor	99.54	1.90	15.87	1.87%	13.75%
Credits-DWHR	93.34	6.2	22.07	6.23%	19.12%
Credits- All off w/ split	91.44	1.9	23.97	2.04%	20.77%

Advanced Package 6	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.91	-	-	-	-
Celing R-10.5	94.46	0.45	0.45	0.48%	0.48%
Above Grade Walls R-4.6	94.69	-0.23	-7.61	-0.24%	-8.74%
Slab Insulation R-1.8	93.15	1.53	-6.08	1.62%	-6.98%
HRV Efficiencies 60/50	87.31	5.84	-0.24	6.27%	-0.27%
Water Heater EF 0.8	82.56	4.75	4.51	5.44%	5.18%
AFUE 96%	81.58	0.98	5.50	1.19%	6.31%
ACH 1.5	76.17	5.41	10.91	6.64%	12.53%
Credits-Lighting	74.17	2.00	12.91	2.63%	14.83%
Credits- Exhaust Fans	73.97	0.20	13.11	0.27%	15.06%
Credits- ECM Motor	72.07	1.90	15.01	2.57%	17.24%
Credits-DWHR	65.87	6.2	21.21	8.60%	24.36%
Credits- All off w/ split	63.97	1.9	23.11	2.88%	26.54%

Advanced Package 6	**Semi-Detached House**				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
Celing R-10.5	101.88	0.45	0.45	0.44%	0.44%
Above Grade Walls R-4.6	102.23	-0.35	-8.71	-0.35%	-9.32%
Slab Insulation R-1.8	100.80	1.43	-7.28	1.40%	-7.79%
HRV Efficiencies 60/50	95.27	5.53	-1.76	5.48%	-1.88%
Water Heater EF 0.8	90.70	4.57	2.81	4.79%	3.01%
AFUE 96%	89.39	1.31	4.12	1.44%	4.41%
ACH 1.5	82.40	7.00	11.12	7.83%	11.89%
Credits-Lighting	80.40	2.00	13.12	2.43%	14.03%
Credits- Exhaust Fans	80.20	0.20	13.32	0.25%	14.24%
Credits- ECM Motor	78.30	1.90	15.22	2.37%	16.28%
Credits-DWHR	72.10	6.2	21.42	7.92%	22.90%
Credits- All off w/ split	70.20	1.9	23.32	2.64%	24.94%

Advanced Package 7- Ottawa

Advanced Package 7	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
Slab Insulation R-1.8	125.08	2.12	2.12	1.67%	1.67%
Window U-2.2	134.71	-9.63	-19.30	-7.70%	-16.72%
HRV Efficiencies 55/45	130.02	4.69	-14.61	3.48%	-12.66%
Water Heater EF 0.8	125.94	4.09	-10.53	3.14%	-9.12%
AFUE 94%	122.64	3.30	-7.23	2.62%	-6.26%
Credits	122.64	0.00	-7.23	0.00%	-6.26%

Advanced Package 7	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.91	-	-	-	-
Slab Insulation R-1.8	94.90	0.01	0.01	0.01%	0.01%
Window U-2.2	98.49	-3.59	-11.42	-3.78%	-13.11%
HRV Efficiencies 55/45	93.26	5.23	-6.18	5.31%	-7.10%
Water Heater EF 0.8	88.64	4.62	-1.56	4.95%	-1.80%
AFUE 94%	87.81	0.83	-0.73	0.94%	-0.84%
Credits	87.81	0.00	-0.73	0.00%	-0.84%

Advanced Package 7	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
Slab Insulation R-1.8	100.90	1.43	1.43	1.40%	1.40%
Window U-2.2	106.02	-5.12	-12.50	-5.08%	-13.37%
HRV Efficiencies 55/45	101.32	4.70	-7.81	4.43%	-8.35%
Water Heater EF 0.8	96.89	4.43	-3.37	4.38%	-3.60%
AFUE 94%	95.83	1.06	-2.31	1.09%	-2.47%
Credits	95.83	0.00	-2.31	0.00%	-2.47%

Advanced Package 8- Ottawa

Advanced Package 8	CCHT Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	133.61	-	-	-	-
Below Grade Walls R-3.2	134.20	-0.59	-0.59	-0.44%	-0.44%
HRV Eff. 75/68	126.04	8.16	-10.63	6.08%	-9.21%
AC SEER 14.5	125.78	0.26	-10.37	0.20%	-8.99%
Water Heater EF 0.8	121.25	4.53	-5.84	3.60%	-5.06%
AFUE 95%	119.37	1.89	-3.96	1.56%	-3.43%
ACH 2.5	116.15	3.22	-0.74	2.69%	-0.64%
Credits-Lighting	115.25	0.9	0.16	0.77%	0.14%
Credits-Exhaust Fans	114.55	0.7	0.86	0.61%	0.74%
Credits-Monitoring	111.65	2.9	3.76	2.53%	3.26%
Credits- ECM Motor	110.15	1.5	5.26	1.34%	4.56%

Advanced Package 8	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	98.80	-	-	-	-
Below Grade Walls R-3.2	99.26	-0.46	-0.46	-0.47%	-0.47%
HRV Eff. 75/68	90.60	8.66	-3.53	8.72%	-4.05%
AC SEER 14.5	90.43	0.17	-3.36	0.19%	-3.85%
Water Heater EF 0.8	85.57	4.86	1.51	5.38%	1.73%
AFUE 95%	84.78	0.79	2.29	0.92%	2.63%
ACH 2.5	82.87	1.91	4.20	2.25%	4.82%
Credits-Lighting	81.97	0.9	5.10	1.09%	5.86%
Credits-Exhaust Fans	81.27	0.7	5.80	0.85%	6.66%
Credits-Monitoring	78.37	2.9	8.70	3.57%	9.99%
Credits- ECM Motor	76.87	1.5	10.20	1.91%	11.71%

Advanced Package 8	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	107.31	-	-	-	-
Below Grade Walls R-3.2	107.72	-0.41	-0.41	-0.38%	-0.38%
HRV Eff. 75/68	99.38	8.34	-5.86	7.74%	-6.27%
AC SEER 14.5	99.17	0.20	-5.66	0.21%	-6.05%
Water Heater EF 0.8	94.50	4.67	-0.98	4.71%	-1.05%
AFUE 95%	93.45	1.05	0.07	1.11%	0.07%
ACH 2.5	91.21	2.24	2.31	2.40%	2.47%
Credits-Lighting	90.31	0.9	3.21	0.99%	3.43%
Credits-Exhaust Fans	89.61	0.7	3.91	0.78%	4.18%
Credits-Monitoring	86.71	2.9	6.81	3.24%	7.28%
Credits- ECM Motor	85.21	1.5	8.31	1.73%	8.89%

Advanced Package 9 - Ottawa

Advanced Package 9	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
Above Grade Walls R-4.3	129.57	-2.37	-2.37	-1.87%	-1.87%
HRV Eff. 60/50	124.03	5.54	-8.62	4.28%	-7.47%
Water Heater EF 0.9	118.39	5.64	-2.98	4.55%	-2.58%
ACH 2.5	115.02	3.38	0.39	2.85%	0.34%
Credits-Lighting	113.02	2.00	2.40	1.74%	2.08%
Credits-DWHR	106.82	6.20	8.60	5.49%	7.45%

Advanced Package 9	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.91	-	-	-	-
Above Grade Walls R-4.3	95.64	-0.73	-0.73	-0.77%	-0.77%
HRV Eff. 60/50	89.57	6.08	-2.50	6.35%	-2.87%
Water Heater EF 0.9	83.55	6.02	3.52	6.72%	4.04%
ACH 2.5	81.57	1.98	5.50	2.37%	6.32%
Credits-Lighting	79.57	2.00	7.50	2.45%	8.62%
Credits-DWHR	73.37	6.20	13.70	7.79%	15.74%

Advanced Package 9	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
Above Grade Walls R-4.3	103.47	-1.14	-1.14	-1.11%	-1.11%
HRV Eff. 60/50	97.94	5.53	-4.42	5.34%	-4.73%
Water Heater EF 0.9	92.12	5.82	1.40	5.94%	1.49%
ACH 2.5	89.60	2.52	3.92	2.74%	4.19%
Credits-Lighting	87.60	2.00	5.92	2.23%	6.33%
Credits-DWHR	81.40	6.20	12.12	7.08%	12.96%

Advanced Package 10- Ottawa

Advanced Package 10	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
Slab Insulation R-1.8	125.08	2.12	2.12	1.67%	1.67%
Window U-1.8	128.23	-3.16	-12.82	-2.52%	-11.11%
HRV Eff. 60/50	122.85	5.38	-7.44	4.20%	-6.45%
Water Heater EF 0.9	117.27	5.58	-1.86	4.54%	-1.61%
AFUE 95%	115.22	2.05	0.19	1.75%	0.17%
ACH 2.5	112.00	3.22	3.41	2.79%	2.95%
Credits-Lighting	110.90	1.10	4.51	0.98%	3.91%
Credits-DWHR	104.70	6.2	10.71	5.59%	9.28%

Advanced Package 10	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.91	-	-	-	-
Slab Insulation R-1.8	93.38	1.53	1.53	1.62%	1.62%
Window U-1.8	94.47	-1.10	-7.40	-1.17%	-8.50%
HRV Eff. 60/50	88.54	5.94	-1.46	6.28%	-1.68%
Water Heater EF 0.9	82.56	5.98	4.52	6.75%	5.19%
AFUE 95%	81.66	0.90	5.42	1.09%	6.22%
ACH 2.5	70.75	10.91	16.33	13.36%	18.75%
Credits-Lighting	69.65	1.10	17.43	1.55%	20.02%
Credits-DWHR	63.45	6.2	23.63	8.90%	27.14%

Advanced Package 10	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
Slab Insulation R-1.8	100.90	1.43	1.43	1.40%	1.40%
Window U-1.8	102.47	-1.57	-8.95	-1.56%	-9.57%
HRV Eff. 60/50	96.91	5.56	-3.39	5.43%	-3.63%
Water Heater EF 0.9	91.15	5.76	2.37	5.95%	2.54%
AFUE 95%	89.96	1.19	3.56	1.31%	3.81%
ACH 2.5	87.68	2.27	5.84	2.53%	6.24%
Credits-Lighting	86.58	1.10	6.94	1.25%	7.42%
Credits-DWHR	80.38	6.2	13.14	7.16%	14.05%

Advanced Package 11- Ottawa

Advanced Package 11	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
Ceiling R-10.5	126.60	0.60	0.60	0.47%	0.47%
Water Heater EF 0.8	122.37	4.24	-6.96	3.35%	-6.03%
AFUE 96%	119.59	2.77	-4.18	2.27%	-3.62%
Credits-Lighting	117.59	2.00	-2.18	1.67%	-1.89%
Credits-ECM Motor	116.09	1.50	-0.68	1.28%	-0.59%
Credits-DWHR	109.89	6.20	5.52	5.34%	4.78%

Advanced Package 11	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.91	-	-	-	-
Ceiling R-10.5	94.46	0.45	0.45	0.48%	0.48%
Water Heater EF 0.8	90.12	4.34	-3.05	4.59%	-3.50%
AFUE 96%	88.67	1.45	-1.59	1.61%	-1.83%
Credits-Lighting	86.67	2.00	0.41	2.26%	0.47%
Credits-ECM Motor	85.17	1.50	1.91	1.73%	2.19%
Credits-DWHR	78.97	6.20	8.11	7.28%	9.31%

Advanced Package 11	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
Ceiling R-10.5	101.88	0.45	0.45	0.44%	0.44%
Water Heater EF 0.8	97.61	4.27	-4.09	4.19%	-4.38%
AFUE 96%	95.86	1.75	-2.34	1.80%	-2.50%
Credits-Lighting	93.86	2.00	-0.34	2.09%	-0.36%
Credits-ECM Motor	92.36	1.50	1.16	1.60%	1.24%
Credits-DWHR	86.16	6.20	7.36	6.71%	7.87%

Advanced Package 12- Ottawa

Advanced Package 12	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
Ceiling R-7.1	128.19	-1.00	-1.00	-0.78%	-0.78%
Slab Insulation R-1.8	126.02	2.17	-10.61	1.69%	-9.19%
HRV Eff. 60/50	120.69	5.32	-5.28	4.22%	-4.58%
Water Heater EF 0.8	116.28	4.41	-0.87	3.66%	-0.75%
AFUE 92%	115.48	0.80	-0.07	0.69%	-0.06%
ACH 1.5	105.76	9.72	9.65	8.42%	8.36%
Credits-Lighting	103.76	2.00	11.65	1.89%	10.10%
Credits-DWHR	100.26	3.5	15.15	3.37%	13.13%

Advanced Package 12	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.91	-	-	-	-
Ceiling R-7.1	95.58	-0.67	-0.67	-0.71%	-0.71%
Slab Insulation R-1.8	94.04	1.54	-6.97	1.61%	-8.00%
HRV Eff. 60/50	88.14	5.90	-1.06	6.28%	-1.22%
Water Heater EF 0.8	83.42	4.72	3.65	5.35%	4.20%
AFUE 92%	83.07	0.35	4.00	0.42%	4.60%
ACH 1.5	77.49	5.58	9.58	6.72%	11.01%
Credits-Lighting	75.49	2.00	11.58	2.58%	13.30%
Credits-DWHR	71.99	3.5	15.08	4.64%	17.32%

Advanced Package 12	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
Ceiling R-7.1	103.00	-0.67	-0.67	-0.66%	-0.66%
Slab Insulation R-1.8	101.56	1.44	-8.05	1.40%	-8.60%
HRV Eff. 60/50	96.00	5.56	-2.49	5.47%	-2.66%
Water Heater EF 0.8	91.46	4.55	2.06	4.74%	2.20%
AFUE 92%	91.00	0.46	2.52	0.50%	2.70%
ACH 1.5	83.79	7.21	9.73	7.92%	10.40%
Credits-Lighting	81.79	2.00	11.73	2.39%	12.54%
Credits-DWHR	78.29	3.5	15.23	4.28%	16.28%

Advanced Package 13- Ottawa

Advanced Package 13	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
Ceiling R-7.1	128.19	-1.00	-1.00	-0.78%	-0.78%
Slab Insulation R-1.8	126.02	2.17	-10.61	1.69%	-9.19%
HRV Eff. 60/50	120.69	5.32	-5.28	4.22%	-4.58%
Water Heater EF 0.8	116.28	4.41	-0.87	3.66%	-0.75%
HSPF 9.4	97.15	19.14	18.27	16.46%	15.83%
ACH 1.5	87.95	9.20	27.46	9.47%	23.80%
Credits-Lighting	85.95	2.00	29.46	2.27%	25.53%
Credits-DWHR	82.45	3.5	32.96	4.07%	28.56%

Advanced Package 13	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.91	-	-	-	-
Ceiling R-7.1	95.58	-0.67	-0.67	-0.71%	-0.71%
Slab Insulation R-1.8	94.04	1.54	-6.97	1.61%	-8.00%
HRV Eff. 60/50	88.14	5.90	-1.06	6.28%	-1.22%
Water Heater EF 0.8	83.42	4.72	3.65	5.35%	4.20%
HSPF 9.4	71.13	12.29	15.95	14.73%	18.31%
ACH 1.5	67.32	3.81	19.75	5.36%	22.69%
Credits-Lighting	65.32	2.00	21.75	2.97%	24.98%
Credits-DWHR	61.82	3.5	25.25	5.36%	29.00%

Advanced Package 13	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
Ceiling R-7.1	103.00	-0.67	-0.67	-0.66%	-0.66%
Slab Insulation R-1.8	101.56	1.44	-8.05	1.40%	-8.60%
HRV Eff. 60/50	96.00	5.56	-2.49	5.47%	-2.66%
Water Heater EF 0.8	91.46	4.55	2.06	4.74%	2.20%
HSPF 9.4	77.09	14.36	16.43	15.71%	17.56%
ACH 1.5	71.39	5.70	22.13	7.39%	23.66%
Credits-Lighting	69.39	2.00	24.13	2.80%	25.80%
Credits-DWHR	65.89	3.5	27.63	5.04%	29.54%

Advanced Package 14- Ottawa

Advanced Package 14	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
Ceiling R-10.5	126.60	0.59	0.59	0.47%	0.47%
Slab Insulation R-2.0	124.39	2.21	-8.98	1.75%	-7.78%
HRV Eff. 60/50	119.10	5.29	-3.69	4.25%	-3.20%
Water Heater EF 0.8	114.67	4.43	0.74	3.72%	0.64%
AFUE 96%	112.42	2.26	2.99	1.97%	2.60%
Credits-Lighting	110.42	2.00	4.99	1.78%	4.33%
Credits- Appliances	106.02	4.4	9.40	3.98%	8.14%
Credits- ECM Motor	104.52	1.5	10.90	1.41%	9.44%
Credits-DWHR	96.82	7.7	18.60	7.37%	16.11%

Advanced Package 14	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.10	-	-	-	-
Ceiling R-10.5	94.46	-0.36	-0.36	-0.38%	-0.38%
Slab Insulation R-2.0	92.74	1.72	-5.67	1.82%	-6.51%
HRV Eff. 60/50	86.89	5.85	0.18	6.31%	0.21%
Water Heater EF 0.8	82.13	4.76	4.94	5.47%	5.67%
AFUE 96%	81.16	0.98	5.92	1.19%	6.79%
Credits-Lighting	79.16	2.00	7.92	2.46%	9.09%
Credits- Appliances	74.76	4.4	12.32	5.56%	14.14%
Credits- ECM Motor	73.26	1.5	13.82	2.01%	15.87%
Credits-DWHR	65.56	7.7	21.52	10.51%	24.71%

Advanced Package 14	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
Ceiling R-10.5	101.88	0.45	0.45	0.44%	0.44%
Slab Insulation R-2.0	100.41	1.47	-6.89	1.44%	-7.37%
HRV Eff. 60/50	94.90	5.51	-1.39	5.48%	-1.48%
Water Heater EF 0.8	90.33	4.58	3.19	4.82%	3.41%
AFUE 96%	89.03	1.29	4.48	1.43%	4.79%
Credits-Lighting	87.03	2.00	6.48	2.25%	6.93%
Credits- Appliances	82.63	4.4	10.88	5.06%	11.64%
Credits- ECM Motor	81.13	1.5	12.38	1.82%	13.24%
Credits-DWHR	73.43	7.7	20.08	9.49%	21.48%

Advanced Package 15- Ottawa

Advanced Package 15	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
Above Grade Walls R-4.6	127.93	-0.73	-0.73	-0.57%	-0.57%
Window U-1.8	131.12	-3.19	-15.71	-2.50%	-13.61%
HRV Eff. 78/68	121.82	9.30	-6.41	7.09%	-5.55%
Water Heater EF 1.0	115.14	6.67	0.27	5.48%	0.23%
AFUE 97%	112.33	2.81	3.08	2.44%	2.67%
ACH 2.5	109.12	3.21	6.29	2.86%	5.45%
Credits- ECM Motor	107.62	1.50	7.79	1.37%	6.75%
Credits-DWHR	104.12	3.5	11.29	3.25%	9.78%
Credits- PV Generation	103.52	0.6	11.89	0.58%	10.30%
Credits-Other	102.62	0.9	12.79	0.87%	11.08%

Advanced Package 15	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.91	-	-	-	-
Above Grade Walls R-4.6	95.14	-0.23	-0.23	-0.24%	-0.24%
Window U-1.8	96.25	-1.11	-9.18	-1.17%	-10.54%
HRV Eff. 78/68	86.69	9.56	0.38	9.93%	0.44%
Water Heater EF 1.0	79.48	7.21	7.59	8.31%	8.72%
AFUE 97%	78.31	1.17	8.76	1.48%	10.06%
ACH 2.5	76.61	1.70	10.46	2.17%	12.01%
Credits- ECM Motor	75.11	1.50	11.96	1.96%	13.74%
Credits-DWHR	71.61	3.5	15.46	4.66%	17.76%
Credits- PV Generation	71.01	0.6	16.06	0.84%	18.45%
Credits-Other	70.11	0.9	16.96	1.27%	19.48%

Advanced Package 15	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
Above Grade Walls R-4.6	102.68	-0.35	-0.35	-0.34%	-0.34%
Window U-1.8	104.46	-1.78	-10.95	-1.73%	-11.70%
HRV Eff. 78/68	95.21	9.26	-1.69	8.86%	-1.81%
Water Heater EF 1.0	88.28	6.92	5.23	7.27%	5.60%
AFUE 97%	86.71	1.57	6.80	1.78%	7.27%
ACH 2.5	84.31	2.40	9.20	2.77%	9.84%
Credits- ECM Motor	82.81	1.50	10.70	1.78%	11.45%
Credits-DWHR	79.31	3.5	14.20	4.23%	15.19%
Credits- PV Generation	78.71	0.6	14.80	0.76%	15.83%
Credits-Other	77.81	0.9	15.70	1.14%	16.79%

Advanced Package 16- Ottawa

Advanced Package 16	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	133.61	-	-	-	-
Window U-1.8	136.76	-3.15	-3.15	-2.36%	-2.36%
Slab Insulation R-1.8	134.73	2.03	-19.32	1.48%	-16.74%
HRV Eff. 72/65	127.15	7.58	-11.74	5.63%	-10.17%
Water Heater EF 0.7	124.30	2.85	-8.89	2.24%	-7.70%
AFUE 95%	122.41	1.89	-7.00	1.52%	-6.07%
SEER 14.5	122.16	0.25	-6.75	0.21%	-5.85%
ACH 2.5	118.95	1.50	-3.54	2.63%	-3.07%
Credits- Appliances	116.95	2	-1.54	1.68%	-1.33%
Credits- Exhaust Fans	116.25	0.7	-0.84	0.60%	-0.73%
Credits- ECM Motor	114.75	1.5	0.66	1.29%	0.57%
Credits-DWHR	108.55	6.2	6.86	5.40%	5.94%

Advanced Package 16	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	98.80	-	-	-	-
Window U-1.8	99.87	-1.07	-1.07	-1.09%	-1.09%
Slab Insulation R-1.8	98.40	1.47	-11.32	1.48%	-13.00%
HRV Eff. 72/65	90.47	7.92	-3.40	8.05%	-3.90%
Water Heater EF 0.7	87.36	3.11	-0.29	3.44%	-0.33%
AFUE 95%	86.61	0.75	0.46	0.86%	0.53%
SEER 14.5	86.44	0.17	0.63	0.20%	0.73%
ACH 2.5	84.55	1.50	2.52	2.19%	2.90%
Credits- Appliances	82.55	2	4.52	2.37%	5.19%
Credits- Exhaust Fans	81.85	0.7	5.22	0.85%	6.00%
Credits- ECM Motor	80.35	1.5	6.72	1.83%	7.72%
Credits-DWHR	74.15	6.2	12.92	7.72%	14.84%

Advanced Package 16	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	107.31	-	-	-	-
Window U-1.8	109.05	-1.75	-1.75	-1.63%	-1.63%
Slab Insulation R-1.8	107.46	1.60	-13.94	1.47%	-14.90%
HRV Eff. 72/65	99.82	7.64	-6.30	7.11%	-6.74%
Water Heater EF 0.7	96.84	2.97	-3.33	2.98%	-3.56%
AFUE 95%	95.81	1.03	-2.29	1.07%	-2.45%
SEER 14.5	95.61	0.20	-2.09	0.21%	-2.24%
ACH 2.5	93.37	1.50	0.15	2.34%	0.16%
Credits- Appliances	91.37	2	2.15	2.14%	2.30%
Credits- Exhaust Fans	90.67	0.7	2.85	0.77%	3.05%
Credits- ECM Motor	89.17	1.5	4.35	1.65%	4.65%
Credits-DWHR	82.97	6.2	10.55	6.95%	11.28%

Advanced Package 17- Ottawa

Advanced Package 17	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	133.61	-	-	-	-
Window U-1.8	136.76	-3.15	-3.15	-2.36%	-2.36%
Ceiling R-10.5	136.12	-2.51	-20.71	-1.88%	-17.94%
Slab Insulation 1.8	133.94	2.82	-18.53	2.06%	-16.06%
HRV Eff. 72/65	126.31	7.63	-10.90	5.70%	-9.44%
Water Heater EF 0.7	124.43	1.88	-9.02	1.49%	-7.82%
AFUE 95%	121.60	2.83	-6.19	2.28%	-5.36%
SEER 14.5	121.56	0.04	-6.15	0.03%	-5.33%
ACH 2.0	114.96	1.50	0.45	5.43%	0.39%
Credits- Appliances	112.96	2	2.45	1.74%	2.13%
Credits- Exhaust Fans	112.26	0.7	3.15	0.62%	2.73%
Credits- ECM Motor	110.76	1.5	4.65	1.34%	4.03%
Credits-DWHR	103.06	7.7	12.35	6.95%	10.70%

Advanced Package 17	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	98.80	-	-	-	-
Window U-1.8	99.87	-1.07	-1.07	-1.09%	-1.09%
Ceiling R-10.5	99.42	-0.62	-12.35	-0.63%	-14.18%
Slab Insulation 1.8	97.95	1.92	-10.88	1.92%	-12.49%
HRV Eff. 72/65	90.06	7.89	-2.99	8.05%	-3.44%
Water Heater EF 0.7	86.94	3.12	0.13	3.47%	0.15%
AFUE 95%	86.21	0.73	0.86	0.84%	0.99%
SEER 14.5	86.04	0.17	1.03	0.20%	1.19%
ACH 2.0	82.49	1.50	4.58	4.12%	5.26%
Credits- Appliances	80.49	2	6.58	2.42%	7.55%
Credits- Exhaust Fans	79.79	0.7	7.28	0.87%	8.36%
Credits- ECM Motor	78.29	1.5	8.78	1.88%	10.08%
Credits-DWHR	70.59	7.7	16.48	9.83%	18.92%

Advanced Package 17	**Semi-Detached House**				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	107.31	-	-	-	-
Window U-1.8	109.05	-1.75	-1.75	-1.63%	-1.63%
Ceiling R-10.5	108.44	-1.13	-14.92	-1.06%	-15.96%
Slab Insulation 1.8	107.06	2.00	-13.54	1.83%	-14.48%
HRV Eff. 72/65	99.39	7.66	-5.88	7.16%	-6.28%
Water Heater EF 0.7	96.41	2.98	-2.90	3.00%	-3.10%
AFUE 95%	95.40	1.02	-1.88	1.05%	-2.01%
SEER 14.5	95.19	0.20	-1.68	0.21%	-1.79%
ACH 2.0	90.55	1.50	2.97	4.88%	3.17%
Credits- Appliances	88.55	2	4.97	2.21%	5.31%
Credits- Exhaust Fans	87.85	0.7	5.67	0.79%	6.06%
Credits- ECM Motor	86.35	1.5	7.17	1.71%	7.66%
Credits-DWHR	78.65	7.7	14.87	8.92%	15.90%

Advanced Package 18- Ottawa

Advanced Package 18	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
Above Grade Walls R-3.9	131.96	-4.76	-4.76	-3.74%	-3.74%
Slab Insulation 1.8	129.75	2.21	-14.34	1.68%	-12.42%
HRV Eff. 65/55	123.31	6.44	-7.90	4.96%	-6.84%
ACH 2.0	116.74	6.56	-1.33	5.32%	-1.16%
Combo System (Furnace and Water)	111.29	5.45	4.12	4.67%	3.57%
Credits- Lighting	109.29	2.00	6.12	1.80%	5.30%
Credits- Appliances	107.79	1.50	7.62	1.37%	6.60%
Credits- ECM Motor	105.29	2.5	10.12	2.32%	8.77%
Credits-DWHR	101.79	3.5	13.62	3.32%	11.80%

Advanced Package 18	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.91	-	-	-	-
Above Grade Walls R-3.9	96.44	-1.53	-1.53	-1.61%	-1.61%
Slab Insulation 1.8	94.88	1.56	-7.81	1.62%	-8.97%
HRV Eff. 65/55	87.97	6.91	-0.90	7.28%	-1.03%
Combo System (Furnace and Water)	83.17	4.81	3.91	5.46%	4.48%
ACH 2.0	79.56	3.61	7.51	4.34%	8.63%
Credits- Lighting	77.56	2.00	9.51	2.51%	10.93%
Credits- Appliances	76.06	1.50	11.01	1.93%	12.65%
Credits- ECM Motor	73.56	2.5	13.51	3.29%	15.52%
Credits-DWHR	70.06	3.5	17.01	4.76%	19.54%

Advanced Package 18	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
Above Grade Walls R-3.9	104.84	-2.51	-2.51	-2.45%	-2.45%
Slab Insulation 1.8	103.19	1.64	-9.68	1.57%	-10.35%
HRV Eff. 65/55	96.78	6.42	-3.26	6.22%	-3.48%
Combo System (Furnace and Water)	91.89	4.89	1.63	5.05%	1.74%
ACH 2.0	87.04	4.85	6.48	5.28%	6.92%
Credits- Lighting	85.04	2.00	8.48	2.30%	9.06%
Credits- Appliances	83.54	1.50	9.98	1.76%	10.67%
Credits- ECM Motor	81.04	2.5	12.48	2.99%	13.34%
Credits-DWHR	77.54	3.5	15.98	4.32%	17.08%

Advanced Package 19- Ottawa

Advanced Package 19	Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	127.20	-	-	-	-
Window U-1.4	124.24	2.95	2.95	2.32%	2.32%
Above Grade Walls R-4.4	125.90	-1.66	-10.49	-1.33%	-9.09%
Slab Insulation 1.8	123.75	2.15	-8.34	1.71%	-7.23%
HRV Eff. 75/65	115.48	8.28	-0.07	6.69%	-0.06%
Water Heater EF 0.9	109.75	5.73	5.66	4.96%	4.91%
HSPF 9.4	91.75	17.99	23.66	16.39%	20.50%
ACH 2.0	85.66	6.09	29.75	6.64%	25.78%
Credits- Appliances	83.66	2	31.75	2.33%	27.51%
Credits- ECM Motor	82.96	0.7	32.45	0.84%	28.12%

Advanced Package 19	Row House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	94.91	-	-	-	-
Window U-1.4	93.82	1.10	1.10	1.15%	1.15%
Above Grade Walls R-4.4	94.37	-0.56	-7.30	-0.59%	-8.38%
Slab Insulation 1.8	92.70	1.67	-5.62	1.77%	-6.46%
HRV Eff. 75/65	84.12	8.58	2.95	9.25%	3.39%
Water Heater EF 0.9	77.87	6.26	9.21	7.44%	10.58%
HSPF 9.4	66.87	10.99	20.20	14.12%	23.20%
ACH 2.0	64.59	1.50	22.48	3.41%	25.82%
Credits- Appliances	62.59	2	24.48	3.10%	28.12%
Credits- ECM Motor	61.89	0.7	25.18	1.12%	28.92%

Advanced Package 19	Semi-Detached House				
	Total Consumption (GJ)	Savings (GJ)	Cumulative Savings (GJ)	Reduction (%)	Cumulative Reduction (%)
Reference House (Package B)	102.33	-	-	-	-
Window U-1.4	100.72	1.61	1.61	1.58%	1.58%
Above Grade Walls R-4.4	101.57	-0.86	-8.06	-0.85%	-8.62%
Slab Insulation 1.8	100.15	1.42	-6.64	1.40%	-7.09%
HRV Eff. 75/65	91.79	8.36	1.72	8.35%	1.84%
Water Heater EF 0.9	85.84	5.96	7.68	6.49%	8.21%
HSPF 9.4	72.36	13.47	21.15	15.70%	22.62%
ACH 2.0	68.93	1.50	24.59	4.75%	26.30%
Credits- Appliances	66.93	2	26.59	2.90%	28.43%
Credits- ECM Motor	66.23	0.7	27.29	1.05%	29.18%

Appendix I: Effective Thermal Resistance Value Calculations

Effective Thermal Resistance Value (RSI) Calculations

#	Materials	l	k	R	%	Re	Rt
1	Insulation	0.140	-	8.800	90.0%	7.92	8.028
	Stud	0.140	0.13	1.077	10.0%	0.108	
2	Insulation	0.140	-	10.500	90.0%	9.45	9.558
	Stud	0.140	0.13	1.077	10.0%	0.108	
3	Insulation	0.286	-	7.100	87.0%	6.18	6.463
	Stud	0.286	0.13	2.200	13.0%	0.286	
4	Insulation	0.253	-	5.500	91.0%	5.01	5.168
	Stud	0.235	0.13	1.808	9.0%	0.163	
5	Insulation	0.286	-	7.100	91.0%	6.46	6.659
	Stud	0.286	0.13	2.200	9.0%	0.198	
6	Insulation	0.140	-	4.230	80.0%	3.38	3.599
	Stud	0.140	0.13	1.077	20.0%	0.215	
	Insul. & Stud	0.140	-	3.599	-	-	4.479
	Rigid c.i.	0.025	-	0.88	-	-	
7	Insulation	0.140	-	4.230	77.0%	3.26	3.505
	Stud	0.140	0.13	1.077	23.0%	0.248	
	Insul. & Stud	0.140	-	3.505	-	-	4.385
	Rigid c.i.	0.025	-	0.88	-	-	
8	Insulation	0.140	-	3.870	80.0%	3.10	3.311
	Stud	0.140	0.13	1.077	20.0%	0.215	
	Insul. & Stud	0.140	-	3.311	-	-	4.191
	Rigid c.i.	0.025	-	0.88	-	-	
9	Insulation	0.140	-	3.870	77.0%	2.98	3.228
	Stud	0.140	0.13	1.077	23.0%	0.248	
	Insul. & Stud	0.140	-	3.228	-	-	4.108
	Rigid c.i.	0.025	-	0.88	-	-	
10	Insulation	0.140	-	3.520	77.0%	2.71	2.958
	Stud	0.140	0.13	1.077	23.0%	0.248	
	Insul. & Stud	0.140	-	2.958	-	-	3.838
	Rigid c.i.	0.025	-	0.88	-	-	
11	Insulation	0.140	-	4.230	80.0%	3.38	3.599
	Stud	0.140	0.13	1.077	20.0%	0.215	
	Insul. & Stud	0.140	-	3.599	-	-	3.769
	Rigid c.i.	0.025	-	0.170	-	-	
12	Insulation	0.140	-	3.520	87.0%	3.06	3.202
	Stud	0.140	0.13	1.077	13.0%	0.140	
13	Insulation	0.140	-	4.230	87.0%	3.68	3.820
	Stud	0.140	0.13	1.077	13.0%	0.140	
14	Insulation	0.052	-	1.8	100%	1.8	1.8

Notes:
[1] The material length is expressed in [m].
[2] The material depth is expressed in [m].
[3] The material thermal conductivity is expressed in [W/(m^2·K)].
[4] The thermal resistance value (RSI) is expressed in [(m^2·K)/W].

Appendix J: Sensitivity Analyses Full Results- Detached House, Row/Townhouse, and Semi-Detached House

Sensitivity Analysis- Thermal Bridging

CCHT Detached House

	SB-12 Package B	AP-1	AP-2	AP-4	AP-5	AP-6	AP-12	AP-13	AP-15	AP-19
Electricity (kWh)	10637.00	11469.00	11469.00	11469.00	11384.00	11384.00	11384.00	14128.00	11469.00	14256.00
Natural Gas (m3)	2069.70	1528.10	1423.00	1492.90	1348.90	1442.90	1440.50	971.20	1480.90	935.90
Consumption (GJ)	115.41	98.22	94.31	96.92	91.24	94.74	94.65	87.05	96.47	86.19
Consumption (GJ/m2)	0.43	0.37	0.35	0.36	0.34	0.36	0.36	0.33	0.36	0.32
Reduction (%)	-	**14.89%**	**18.28%**	**16.02%**	**20.94%**	**17.91%**	**17.98%**	**24.58%**	**16.41%**	**25.32%**
Total Credits	0.00	12.98	16.60	7.58	25.10	8.89	5.50	5.50	1.29	2.70
Net Consumption (GJ)	115.41	85.24	77.71	89.34	66.14	85.85	89.15	81.55	95.18	83.49
Net Consumption (GJ/m2)	0.43	0.32	0.29	0.34	0.25	0.32	0.34	0.31	0.36	0.31
Total Reduction (%)	-	26.14%	32.67%	22.59%	42.69%	25.61%	22.75%	29.34%	17.53%	27.66%
EnerGuide Rating	80	83	84	83	84	84	84	85	83	85

Typical Townhouse

	SB-12 Package B	AP-1	AP-2	AP-4	AP-5	AP-6	AP-12	AP-13	AP-15	AP-19
Electricity (kWh)	9957.00	108.75	10790.00	10790.00	10790.00	10790.00	10790.00	12473.00	10875.00	12311.00
Natural Gas (m3)	1374.90	855.40	800.20	863.60	760.70	837.40	834.90	608.20	799.50	597.70
Total Consumption (GJ)	87.07	71.02	68.66	71.02	67.19	70.04	69.95	67.57	68.94	66.59
Consumption (GJ/m2)	0.59	0.48	0.46	0.48	0.45	0.47	0.47	0.45	0.46	0.45
Reduction (%)	-	**18.44%**	**21.15%**	**18.44%**	**22.84%**	**19.56%**	**19.66%**	**22.41%**	**20.83%**	**23.53%**
Total Credits	0.00	12.98	16.60	8.25	25.10	9.99	2.31	5.50	4.08	2.70
Net Consumption (GJ)	87.07	58.04	52.06	62.77	42.09	60.06	67.64	62.07	64.86	63.89
Net Consumption (GJ/m2)	0.59	0.39	0.35	0.42	0.28	0.40	0.46	0.42	0.44	0.43
Total Reduction (%)	-	33.34%	40.22%	27.91%	51.67%	31.03%	22.32%	28.72%	25.52%	26.63%
EnerGuide Rating	80	84	84	84	85	84	84	84	84	85

Typical Semi-Detached

	SB-12 Package B	AP-1	AP-2	AP-4	AP-5	AP-6	AP-12	AP-13	AP-15	AP-19
Electricity (kWh)	10127.00	10960.00	10960.00	10960.00	10875.00	10875.00	10960.00	13029.00	10960.00	12886.00
Natural Gas (m3)	1531.40	1007.00	937.90	1001.10	848.50	972.20	961.40	652.10	945.10	642.60
Total Consumption (GJ)	93.52	76.97	74.40	76.76	70.76	75.37	75.28	71.20	74.67	70.33
Consumption (GJ/m2)	0.48	0.40	0.39	0.40	0.37	0.39	0.39	0.37	0.39	0.36
Reduction (%)	-	**17.69%**	**20.44%**	**17.92%**	**24.33%**	**19.40%**	**19.51%**	**23.86%**	**20.16%**	**24.79%**
Total Credits	0.00	12.98	16.60	8.25	25.10	9.99	2.31	5.50	4.08	2.70
Net Consumption (GJ)	93.52	63.99	57.80	68.50	45.66	65.38	72.96	65.70	70.59	67.63
Net Consumption (GJ/m2)	0.48	0.33	0.30	0.35	0.24	0.34	0.38	0.34	0.37	0.35
Total Reduction (%)	-	31.57%	38.19%	26.75%	51.17%	30.08%	21.98%	29.74%	24.52%	27.68%
EnerGuide Rating	80	84	84	84	85	84	84	85	84	85

Sensitivity Analysis- Air Conditioning

CCHT Detached House										
	SB-12 Package B	**AP-1**	**AP-2**	**AP-4**	**AP-5**	**AP-6**	**AP-12**	**AP-13**	**AP-15**	**AP-19**
Electricity (kWh)	10637.00	12462.00	13222.00	13258.00	13193.00	13166.00	18185.00	15365.00	13296.00	15286.00
Natural Gas (m3)	2069.70	2069.70	1339.60	1405.10	1260.90	1356.30	1355.60	924.80	1402.70	897.20
Consumption (GJ)	121.98	101.32	97.50	100.08	94.47	97.93	97.97	89.77	100.13	88.46
Consumption (GJ/m2)	0.46	0.38	0.37	0.38	0.36	0.37	0.37	0.34	0.38	0.33
Reduction (%)	-	**16.94%**	**20.07%**	**17.95%**	**22.55%**	**19.72%**	**19.68%**	**26.40%**	**17.91%**	**27.48%**
Total Credits	0.00	12.98	16.60	7.58	25.10	8.89	5.50	5.50	1.29	2.70
Net Consumption (GJ)	121.98	88.34	80.90	92.50	69.37	89.04	92.47	84.27	98.84	85.76
Net Consumption (GJ/m2)	0.46	0.33	0.30	0.35	0.26	0.33	0.35	0.32	0.37	0.32
Total Reduction (%)	-	27.58%	33.68%	24.17%	43.13%	27.00%	24.19%	30.91%	18.97%	29.70%
EnerGuide Rating	80	83	84	84	85	84	84	85	84	85
Typical Townhouse										
	SB-12 Package B	**AP-1**	**AP-2**	**AP-4**	**AP-5**	**AP-6**	**AP-12**	**AP-13**	**AP-15**	**AP-19**
Electricity (kWh)	11060.00	11928.00	11931.00	11950.00	11960.00	11858.00	11956.00	13016.00	11926.00	12996.00
Natural Gas (m3)	1374.90	822.50	765.90	823.70	724.90	803.70	798.70	518.40	793.50	593.90
Total Consumption (GJ)	91.04	73.59	71.49	73.71	70.06	72.64	72.80	66.17	71.50	68.92
Consumption (GJ/m2)	0.61	0.50	0.48	0.50	0.47	0.49	0.49	0.45	0.48	0.46
Reduction (%)	-	**19.17%**	**21.48%**	**19.04%**	**23.04%**	**20.22%**	**20.03%**	**27.32%**	**21.47%**	**24.30%**
Total Credits	0.00	12.98	16.60	8.25	25.10	9.99	2.31	5.50	4.08	2.70
Net Consumption (GJ)	87.07	60.61	54.89	65.46	44.96	62.65	70.49	60.67	67.42	66.22
Net Consumption (GJ/m2)	0.59	0.41	0.37	0.44	0.30	0.42	0.47	0.41	0.45	0.45
Total Reduction (%)	-	30.40%	36.96%	24.82%	48.36%	28.05%	19.05%	30.32%	22.58%	23.96%
EnerGuide Rating	80	84	84	84	85	84	84	85	84	85
Typical Semi-Detached										
	SB-12 Package B	**AP-1**	**AP-2**	**AP-4**	**AP-5**	**AP-6**	**AP-12**	**AP-13**	**AP-15**	**AP-19**
Electricity (kWh)	11541.00	12399.00	12405.00	12420.00	12342.00	12327.00	12337.00	13651.00	12396.00	13822.00
Natural Gas (m3)	1531.40	959.10	891.50	952.30	844.20	923.60	917.30	537.00	919.00	626.10
Total Consumption (GJ)	98.60	80.37	77.87	80.19	75.88	78.79	78.59	69.15	78.87	73.09
Consumption (GJ/m2)	0.48	0.42	0.40	0.42	0.39	0.41	0.41	0.36	0.41	0.38
Reduction (%)	-	**18.49%**	**21.03%**	**18.67%**	**23.04%**	**20.10%**	**20.30%**	**29.87%**	**20.02%**	**25.88%**
Total Credits	5.09	12.98	16.60	8.25	25.10	9.99	2.31	5.50	4.08	2.70
Net Consumption (GJ)	93.52	67.39	61.27	71.94	50.78	68.80	76.28	63.65	74.79	70.39
Net Consumption (GJ/m2)	0.48	0.35	0.32	0.37	0.26	0.36	0.40	0.33	0.39	0.36
Total Reduction (%)	-	27.94%	34.48%	23.07%	45.70%	26.43%	18.44%	31.94%	20.03%	24.74%
EnerGuide Rating	80	84	84	84	85	84	84	86	84	85

Sensitivity Analysis- Thermal Bridging and Air Conditioning

CCHT Detached House

	SB-12 Package B	AP-1	AP-2	AP-4	AP-5	AP-6	AP-12	AP-13	AP-15	AP-19
Electricity (kWh)	10637.00	13288.00	13296.00	13331.00	13265.00	13238.00	13259.00	15387.00	13284.00	15485.00
Natural Gas (m3)	2069.70	1528.10	1423.00	1492.90	1348.90	1442.90	1440.50	971.20	1480.90	935.90
Consumption (GJ)	121.98	104.77	100.89	103.62	98.01	101.42	101.40	91.58	103.00	90.62
Consumption (GJ/m2)	0.46	0.39	0.38	0.39	0.37	0.38	0.38	0.34	0.39	0.34
Reduction (%)	-	**14.11%**	**17.29%**	**15.05%**	**19.65%**	**16.86%**	**16.87%**	**24.92%**	**15.56%**	**25.71%**
Total Credits	0.00	12.98	16.60	7.58	25.10	8.89	5.50	5.50	1.29	2.70
Net Consumption (GJ)	121.98	91.79	84.29	96.04	72.91	92.53	95.90	86.08	101.71	87.92
Net Consumption (GJ/m2)	0.46	0.35	0.32	0.36	0.27	0.35	0.36	0.32	0.38	0.33
Total Reduction (%)	-	24.75%	30.90%	21.27%	40.23%	24.14%	21.38%	29.43%	16.62%	27.93%
EnerGuide Rating	80	83	83	83	84	83	83	85	83	85

Typical Townhouse

	SB-12 Package B	AP-1	AP-2	AP-4	AP-5	AP-6	AP-12	AP-13	AP-15	AP-19
Electricity (kWh)	11060.00	12015.00	11927.00	11942.00	11954.00	11944.00	11951.00	13279.00	12017.00	13114.00
Natural Gas (m3)	1374.90	855.40	800.20	863.60	760.70	837.40	834.90	608.20	799.50	597.70
Total Consumption (GJ)	91.04	75.13	72.75	75.17	71.38	74.20	74.13	70.47	73.05	69.48
Consumption (GJ/m2)	0.61	0.51	0.49	0.51	0.48	0.50	0.50	0.47	0.49	0.47
Reduction (%)	-	**17.48%**	**20.09%**	**17.43%**	**21.60%**	**18.50%**	**18.57%**	**22.60%**	**19.76%**	**23.68%**
Total Credits	0.00	12.98	16.60	8.25	25.10	9.99	2.31	5.50	4.08	2.70
Net Consumption (GJ)	87.07	62.15	56.15	66.92	46.28	64.21	71.82	64.97	68.97	66.78
Net Consumption (GJ/m2)	0.59	0.42	0.38	0.45	0.31	0.43	0.48	0.44	0.46	0.45
Total Reduction (%)	-	28.63%	35.51%	23.15%	46.85%	26.26%	17.52%	25.39%	20.79%	23.31%
EnerGuide Rating	80	83	84	83	84	84	84	85	84	85

Typical Semi-Detached

	SB-12 Package B	AP-1	AP-2	AP-4	AP-5	AP-6	AP-12	AP-13	AP-15	AP-19
Electricity (kWh)	11541.00	12393.00	12396.00	12410.00	12346.00	12318.00	12421.00	14067.00	12395.00	13918.00
Natural Gas (m3)	1531.40	1007.00	937.90	1001.10	848.50	972.20	961.40	652.10	945.10	642.60
Total Consumption (GJ)	98.60	82.13	79.57	81.98	76.06	80.57	80.54	74.94	79.83	74.05
Consumption (GJ/m2)	0.48	0.43	0.41	0.42	0.39	0.42	0.42	0.39	0.41	0.38
Reduction (%)	-	**16.71%**	**19.30%**	**16.86%**	**22.87%**	**18.29%**	**18.32%**	**24.00%**	**19.04%**	**24.91%**
Total Credits	5.09	12.98	16.60	8.25	25.10	9.99	2.31	5.50	4.08	2.70
Net Consumption (GJ)	93.52	69.15	62.97	73.73	50.96	70.58	78.22	69.44	75.75	71.35
Net Consumption (GJ/m2)	0.48	0.36	0.33	0.38	0.26	0.37	0.41	0.36	0.39	0.37
Total Reduction (%)	-	26.05%	32.66%	21.16%	45.51%	24.52%	16.36%	25.75%	18.99%	23.71%
EnerGuide Rating	80	83	84	83	85	84	84	85	84	85

Sensitivity Analysis- Window Glazing Solar Heat Gain Coefficient (SHGC) at 0.52

CCHT Detached House										
	SB-12 Package B	**AP-1**	**AP-2**	**AP-4**	**AP-5**	**AP-6**	**AP-12**	**AP-13**	**AP-15**	**AP-19**
Electricity (kWh)	10637.00	11384.00	11384.00	11384.00	11300.00	11300.00	11300.00	13990.00	11469.00	13947.00
Natural Gas (m3)	2069.70	1352.30	1255.90	1320.20	1182.10	1270.70	1272.80	867.10	1312.40	835.00
Consumption (GJ)	115.41	91.37	87.78	90.19	84.72	88.02	88.10	82.67	90.19	81.32
Consumption (GJ/m2)	0.43	0.34	0.33	0.34	0.32	0.33	0.33	0.31	0.34	0.31
Reduction (%)	-	**20.83%**	**23.94%**	**21.85%**	**26.59%**	**23.73%**	**23.66%**	**28.37%**	**21.85%**	**29.54%**
Total Credits	0.00	12.98	16.60	7.58	25.10	8.89	5.50	5.50	1.29	2.70
Net Consumption (GJ)	115.41	78.39	71.18	82.61	59.62	79.14	82.60	77.17	88.90	78.62
Net Consumption (GJ/m2)	0.43	0.29	0.27	0.31	0.22	0.30	0.31	0.29	0.33	0.30
Total Reduction (%)	-	32.08%	38.33%	28.42%	48.34%	31.43%	28.43%	33.13%	22.97%	31.88%
EnerGuide Rating	80	84	85	84	85	85	85	86	84	86
Typical Townhouse										
	SB-12 Package B	**AP-1**	**AP-2**	**AP-4**	**AP-5**	**AP-6**	**AP-12**	**AP-13**	**AP-15**	**AP-19**
Electricity (kWh)	9957.00	10790.00	10790.00	10790.00	10790.00	10705.00	10790.00	12288.00	10790.00	12100.00
Natural Gas (m3)	1374.90	790.60	736.70	794.30	697.80	772.70	769.90	597.40	761.30	590.60
Total Consumption (GJ)	87.07	68.30	66.29	68.44	64.84	67.33	67.53	66.50	67.20	65.56
Consumption (GJ/m2)	0.59	0.46	0.45	0.46	0.44	0.45	0.45	0.45	0.45	0.44
Reduction (%)	-	**21.56%**	**23.87%**	**21.40%**	**25.53%**	**22.68%**	**22.45%**	**23.63%**	**22.82%**	**24.70%**
Total Credits	0.00	12.98	16.60	8.25	25.10	9.99	2.31	5.50	4.08	2.70
Net Consumption (GJ)	87.07	55.32	49.69	60.19	39.74	57.34	65.22	61.00	63.12	62.86
Net Consumption (GJ/m2)	0.59	0.37	0.33	0.41	0.27	0.39	0.44	0.41	0.42	0.42
Total Reduction (%)	-	36.47%	42.93%	30.88%	54.36%	34.15%	25.10%	29.95%	27.51%	27.81%
EnerGuide Rating	80	84	85	84	85	85	84	85	85	85
Typical Semi-Detached										
	SB-12 Package B	**AP-1**	**AP-2**	**AP-4**	**AP-5**	**AP-6**	**AP-12**	**AP-13**	**AP-15**	**AP-19**
Electricity (kWh)	10127.00	10960.00	10960.00	10960.00	10875.00	10875.00	10875.00	12812.00	10960.00	12668.00
Natural Gas (m3)	1531.40	914.20	850.10	910.40	805.10	880.10	876.30	630.80	874.20	619.70
Total Consumption (GJ)	93.52	73.52	71.13	73.38	69.15	71.94	71.80	69.63	72.03	68.69
Consumption (GJ/m2)	0.48	0.38	0.37	0.38	0.36	0.37	0.37	0.36	0.37	0.36
Reduction (%)	-	**21.39%**	**23.94%**	**21.54%**	**26.06%**	**23.07%**	**23.22%**	**25.55%**	**22.98%**	**26.55%**
Total Credits	0.00	12.98	16.60	8.25	25.10	9.99	2.31	5.50	4.08	2.70
Net Consumption (GJ)	93.52	60.54	54.53	65.12	44.05	61.96	69.49	64.13	67.95	65.99
Net Consumption (GJ/m2)	0.48	0.31	0.28	0.34	0.23	0.32	0.36	0.33	0.35	0.34
Total Reduction (%)	-	35.27%	41.69%	30.36%	52.90%	33.75%	25.70%	31.43%	27.34%	29.43%
EnerGuide Rating	80	84	85	84	85	85	85	85	85	85

Sensitivity Analysis- SHGC at 0.52 and Air Conditioning

CCHT Detached House										
	SB-12 Package B	**AP-1**	**AP-2**	**AP-4**	**AP-5**	**AP-6**	**AP-12**	**AP-13**	**AP-15**	**AP-19**
Electricity (kWh)	10637.00	13735.00	13748.00	13784.00	13721.00	13694.00	13712.00	15785.00	13822.00	15733.00
Natural Gas (m3)	2069.70	1352.30	1255.80	1320.20	1182.10	1270.70	1272.80	867.10	1312.40	835.00
Consumption (GJ)	121.98	99.83	96.28	98.81	93.44	96.64	96.79	89.13	98.66	87.75
Consumption (GJ/m2)	0.46	0.38	0.36	0.37	0.35	0.36	0.36	0.34	0.37	0.33
Reduction (%)	-	**18.16%**	**21.07%**	**18.99%**	**23.40%**	**20.77%**	**20.65%**	**26.93%**	**19.12%**	**28.06%**
Total Credits	0.00	12.98	16.60	7.58	25.10	8.89	5.50	5.50	1.29	2.70
Net Consumption (GJ)	121.98	86.85	79.68	91.23	68.34	87.75	91.29	83.63	97.37	85.05
Net Consumption (GJ/m2)	0.46	0.33	0.30	0.34	0.26	0.33	0.34	0.31	0.37	0.32
Total Reduction (%)	-	28.80%	34.67%	25.21%	43.97%	28.06%	25.16%	31.44%	20.18%	30.28%
EnerGuide Rating	80	84	84	84	85	84	84	85	84	86
Typical Townhouse										
	SB-12 Package B	**AP-1**	**AP-2**	**AP-4**	**AP-5**	**AP-6**	**AP-12**	**AP-13**	**AP-15**	**AP-19**
Electricity (kWh)	11060.00	12095.00	12099.00	12117.00	12127.00	12026.00	12124.00	13265.00	12093.00	13073.00
Natural Gas (m3)	1374.90	790.60	736.70	794.30	697.80	772.70	769.90	597.40	761.30	590.60
Total Consumption (GJ)	91.04	73.00	71.01	73.22	69.66	72.08	72.33	70.01	71.90	69.07
Consumption (GJ/m2)	0.61	0.49	0.48	0.49	0.47	0.49	0.49	0.47	0.48	0.46
Reduction (%)	-	**19.82%**	**22.01%**	**19.58%**	**23.49%**	**20.82%**	**20.55%**	**23.10%**	**21.03%**	**24.14%**
Total Credits	0.00	12.98	16.60	8.25	25.10	9.99	2.31	5.50	4.08	2.70
Net Consumption (GJ)	87.07	60.02	54.41	64.96	44.56	62.10	70.02	64.51	67.82	66.37
Net Consumption (GJ/m2)	0.59	0.40	0.37	0.44	0.30	0.42	0.47	0.43	0.46	0.45
Total Reduction (%)	-	31.07%	37.52%	25.39%	48.83%	28.68%	19.59%	25.91%	22.11%	23.78%
EnerGuide Rating	80	84	84	84	85	84	84	85	84	85
Typical Semi-Detached										
	SB-12 Package B	**AP-1**	**AP-2**	**AP-4**	**AP-5**	**AP-6**	**AP-12**	**AP-13**	**AP-15**	**AP-19**
Electricity (kWh)	11541.00	12689.00	12694.00	12709.00	12673.00	12618.00	12627.00	14144.00	12686.00	13996.00
Natural Gas (m3)	1531.40	914.20	850.10	910.40	896.20	880.10	876.30	630.80	874.20	619.70
Total Consumption (GJ)	98.60	79.74	77.37	79.67	79.02	78.22	78.11	74.42	78.24	73.57
Consumption (GJ/m2)	0.48	0.41	0.40	0.41	0.41	0.41	0.40	0.39	0.41	0.38
Reduction (%)	-	**19.13%**	**21.53%**	**19.20%**	**19.87%**	**20.67%**	**20.79%**	**24.52%**	**20.65%**	**25.39%**
Total Credits	5.09	12.98	16.60	8.25	25.10	9.99	2.31	5.50	4.08	2.70
Net Consumption (GJ)	93.52	66.76	60.77	71.42	53.92	68.23	75.80	68.92	74.16	70.87
Net Consumption (GJ/m2)	0.48	0.35	0.31	0.37	0.28	0.35	0.39	0.36	0.38	0.37
Total Reduction (%)	-	28.61%	35.01%	23.63%	42.35%	27.04%	18.95%	26.30%	20.70%	24.21%
EnerGuide Rating	80	84	84	84	84	84	84	85	84	85

Appendix K: NRCan and SBD Energy Credits

Savings by Design/Enbridge Credits

Technology	Eligibility	Energy Savings
Heating Distribution	Furnace or air handler with ECM motor	700 kWh
Ventilation Distribution	HRV with ECM motor	200 kWh
	Conventional PSC motor forced air low tap for ventilation distribution	400 kWh
	Dedicated fully ducted supply and exhaust ventilation system with an HRV or balanced fans, operated without a central forced air furnace or air handler	Conventional HRV: 600 kWh HRV w/ ECM motor: 800 kWh
Air Conditioning	All CFL lighting with eligible A/C	100 kWh
	Air handler with ECM motor w/ eligible A/C	100 kWh
	ERV with eligible A/C	100 kWh
	ENERGY STAR qualified windows with an average SHGC of less than 0.40	300 kWh
Gas Appliances	Gas pre-piped to kitchen range location and/or clothes drier location	100 kWh each
	Gas kitchen range installed	400 kWh
	Gas drier installed	600 kWh
Drainwater Heat Recovery[1]	With electric water heater and DWHR of minimum 48" length:	
	Installed in stack with all showers	800 kWh
	Installed in stack with most showers	500 kWh
Monitoring and Switching	Whole house, in home, real time electricity use monitor	800 kWh
	All-off switch with spot green plugs	800 kWh
	All-off switch with one receptive per room	300 kWh
	All-off lighting switch with minimum one fixture per room	300 kWh
Solar Ready[2]	Non-shaded roof area of a minimum of 100ft, 30-60 degrees slope and within 30 degrees of south, and, 4" pipe leading from roof to basement for future piping or wiring, capped	300 kWh
On-Site Power Production	Solar DHW with electric DHW, PV, wind, fuel cell, micro-combined heat and power, or micro-turbine on-site power production systems	As determined using RetScreen software or other third party performance specification

Notes:
[1] DWHR can be applied to fuel consumption if the water id fuel fired.
[2] Solar ready credit can be applied to fuel consumption if the hot water is fuel fired.
[3] Credits taken for fuel should be listed un a separate table, and may not also be taken for electricity.

NRCan New Housing Programs Energy Credits (April 2011)

Technology	Eligibility	Energy Savings
Electronic Thermostats[1]	Electronic wall-mounted thermostats used in elecric baseboard heating applications; with a temperature swing of 1 degree celcius or less	1% of the estimated annual space heating energy consumption for the house, calculated by HOT 2000 or approved energy software
Ventilation Distribution	HVI Certified HRV	Calculated by HOT 2000 or approved energy software
Lighting	Energy Star qualified, or CFL lighting, or Energy Star qualified bulbs in the following rooms[2]:	
	Kitchen	110 kWh/yr
	Main hallway	70 kWh/yr
	living room	65 kWh/yr
	family room	65 kWh/yr
	finished rooms	17 kWh/yr
	unfinished rooms	9 kWh/yr
	Entire House	Additional 305 kWh/yr (to a maximum of 550 kWh/yr)
Appliances	Energy Star qualified refrigerator	70 kWh/yr
	Energy Star qualified dishwasher	100 kWh/yr
	Energy Star qualified clothes washer	240 kWh/yr
Attached Garage[3]	15% attachment	1.08 RSI adjustment factor
	30% attachment	1.16 RSI adjustment factor
	45% attachement	1.24 RSI adjustment factor
	60% attachment	1.32 RSI adjustment factor
	75% attachement	1.40 RSI adjustment factor
Drainwater Heat Recovery	DWHR installed on all vertical (not exceed 5 degrees within the vertical) plumbing stacks serving two or more showers for full credit, or one shower for half credit	As per NRCan approved elegible systems and teir respective credits (kWh)[4]
Renewable Energy	Wind Energy	As per RetScreen calculations
	Photovoltaic Systems	As per HOT 2000 calculations

Notes:
[1] Only applicable for homes using electric baseboards as primary heating system.
[2] Only 3 rooms can be used for eligibility of credits. If entire house is eligible, credits for 3 additional rooms can be added, up to a maximum of 550 kWh/yr.
[3] Credits for an attached garage are eligible for participants in the Savings by Design program.
[4] Full list of eligible systems and their applicable credits can be found on the NRCan website.

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