Cost-Benefit Analysis of Implementing the 2011 National Energy Code for Buildings in Newfoundland and Labrador

Prepared for:
Office of Climate Change and Energy Efficiency
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Executive Summary

To gain an understanding of the feasibility of adopting the National Energy Code of Canada for Buildings 2011 (NECB) in Newfoundland and Labrador, a cost benefit analysis was completed. Stantec Consulting Ltd. (Stantec) was contracted by the Government of Newfoundland & Labrador's Office of Climate Change and Energy Efficiency (CCEE) to complete this analysis for commercial buildings.

The NECB details minimum energy performance requirements for new buildings and new additions. The most recent version, published in 2011, significantly updates the original Model National Energy Code for Buildings (MNECB) which was released in 1997. All provinces and two territories are considering adopting the 2011 NECB, but provincial approaches vary significantly

Like the 1997 MNECB, the 2011 NECB defines requirements for the performance of five building elements: (1) the building envelope; (2) lighting systems; (3) heating, ventilation, and air-conditioning (HVAC) systems and equipment; (4) service water heating systems; and (5) electrical systems and motors. Within these categories of building systems, specific design requirements are established based on the climate zone in which the proposed building will be constructed.

In order to assess the benefits and costs of adopting the code, it is necessary to understand the current energy performance of buildings and to assess this against the new requirements of the NECB. However, there is no information available for the existing stock of buildings in the province, with the exception of new public buildings, such as schools and medical facilities, and new private sector buildings that are registered for the Leadership in Energy and Environmental Design (LEED), a certification program for high performance green buildings. Given this, this study was limited to selecting those buildings for which energy models are available. Seven buildings were included in the study. These were selected to reflect as much diversity as possible, including different building and construction categories and regional representation. Of note, the buildings range in size from about 3,800 m^2 to 16,000 m^2, some have ground source heat pumps, and most are multi-story with complex mechanical and lighting systems. The seven buildings are summarized below.

Building No.	Category	Building	Town
1	Office	Office	St John's
2		Office	St John's
3	Education	School	Torbay
4		College Campus	Labrador City
5	Health	Long-Term Care Facility	Corner Brook
6	MURB[1]	Residential	St John's
7	Warehouse	-	Mount Pearl

[1] Multi-Unit Residential Building

The results of the study determined that:

- From a technology and construction practices perspective, it is possible to achieve the overall level of energy efficiency required for all four of the NECB climate zones (6, 7a, 7b and 8) in Newfoundland and Labrador.
- Beyond a certain point, the most cost-effective way of meeting the NECB, is through efficient mechanical and lighting systems rather than extra insulation (i.e. once a certain amount of insulation is installed, there are diminishing returns as the energy saved per dollar spent from extra insulation declines).
- New buildings built to LEED standards already exceeded the level of energy efficiency required by the NECB, with one exception (the College Campus in Labrador City).
- Building to the NECB is less expensive than building to the standard of the base buildings included in this study (which are all LEED registered), but building to the level of NECB also generates less energy savings. There was one exception to this (the College Campus).
- The College Campus is located in a remote northern region (climate zone 8) where construction costs are high, the NECB requirements are more stringent, and electricity rates are low relative to other regions of the province (climate zones 6 and 7). This means it is less cost-effective to invest in energy efficiency in this region up to the same point that it would be in other regions (where construction costs are lower, NECB requirements are less stringent (zones 6 and 7), and electricity rates are higher).

The study also identified three additional factors which must also be considered in adopting NECB.

- First, there are higher costs for building materials in Labrador, due to transportation and distribution issues.
- Second, almost one-half of the province's population lives in municipalities, local service districts or unincorporated areas with a population of less than 2,500 people. It is reasonable to expect that there will be a limited number of commercial buildings being constructed in these areas.
- Third, skills training of all groups (such as designers, construction workers and building inspectors), as well as the means to ensure compliance, require further consideration. These factors, while not examined within the parameters of this study, should be considered in a broader dialogue with stakeholders in considering next steps.

Abbreviations

ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers
BBB: Build Better Buildings policy
CaGBC Canada Green Building Council
CCEE: Office of Climate Change and Energy Efficiency
HDD: Heating Degree Day
LEED: Leadership in Energy and Environmental Design
NECB: National Energy Code for Buildings
MBC: Manitoba Building Code
MNECB: Model National Energy Code for Buildings
NBC: National Building Code
NFC: National Fire Code
NPC: National Plumbing Code

Limits of Liability

Every effort has been made to ensure the accuracy of the results in this report. Variations in assumptions and building variables will affect the actual energy that the modelled building may consume. These variables may include variations in occupancy, building design, operations schedules, weather, energy use for equipment not included in the simulations or not covered by the applicable energy code, changes in energy costs from the design of the building to occupancy, and the precision of the simulation and calculation tools used.

1.0 Introduction

Stantec Consulting Ltd. was engaged by the Government of Newfoundland & Labrador's Office of Climate Change and Energy Efficiency (CCEE) to evaluate the costs and benefits of building to the standards in the National Energy Code of Canada for Buildings 2011 (NECB) for Newfoundland and Labrador.

Energy resource depletion, rising global energy demands, and growing awareness of environmental issues, all suggest that energy costs will continue to rise. At today's prices, energy typically represents more than half of the cost of owning and operating a building. Energy efficiency is about using less energy to provide the same or better level of service. Improvements in building energy efficiency can result in significant cost savings over the building's lifetime and that retrofits and improvements to existing building systems can also produce substantial savings.

A building's overall energy efficiency is determined by how well the building is designed, constructed, maintained, and operated. The benefits of an energy efficient building extend beyond the obvious utility cost reductions. Other benefits can include: improved occupant comfort (which is proven to result in more productive occupants and fewer absentee days) and reduced carbon dioxide emissions and local pollutants. In addition energy exports are an important pillar of economic activity and employment in Newfoundland and Labrador. By using energy more wisely, energy exporters like Newfoundland and Labrador will have additional power to sell into global markets and the resulting revenue can be invested in our schools, hospitals and infrastructure.

1.1 BACKGROUND

In its 2007 Energy Plan, the Government of Newfoundland and Labrador set energy efficiency at the heart of the province's energy policy. Recognizing that energy efficiency is fundamental to long-term economic growth and environmental sustainability, government committed to developing a detailed plan for energy conservation and efficiency, including priorities and targets. In 2011, government released *Moving Forward: Energy Efficiency Action Plan*. The Action Plan set out the province's vision and goals alongside 40 commitments for action. It also reaffirmed government's commitment to pursue the Conference of New England Governors and Eastern Canadian Premiers target of reducing energy consumption by 20 per cent by 2020 from business-as-usual projections. In the Action Plan, government committed to *"examine the case for adopting new national energy codes for buildings in Newfoundland and Labrador in collaboration with key stakeholders"* given the pending release of the NECB.

In order to better understand the NECB and the potential opportunities and challenges associated with it for Newfoundland and Labrador, the provincial government commissioned this study. It is intended as a foundational piece to understand the issues and develop the evidence base to inform future discussions with interested stakeholders and decision-makers on the case for adopting the NECB in the province.

1.2 OBJECTIVES OF PROJECT

The scope of analysis that Stantec was asked to complete includes the following:

1. Determine the **baseline energy performance** level of new commercial buildings being built in Newfoundland and Labrador by analyzing the results of existing energy models for a selection of buildings.
2. **Compare** the current construction practice and performance levels to those achieved if the buildings were designed to meet the requirements of the NECB.
3. **Identify any barriers** to meeting the minimum performance requirements of the NECB.
4. Quantify the **expenditure and energy savings** that would result by implementing the NECB as a minimum building energy standard.
5. Conduct **life-cycle economic analysis** on the measures required to comply with the performance level required by the NECB.
6. Comment on the **appropriateness** of the NECB for Newfoundland and Labrador and, if necessary, identify which provisions may need adapting to local circumstances.

1.3 REPORT STRUCTURE

The remainder of this report is structured into the following sections:

- **Section 2.0: Context** – A summary of contextual analysis is provided including the magnitude and attributes of the local commercial building sector and the local design environment.
- **Section 3.0: 2011 NECB Code Overview** – A summary of the NECB.
- **Section 4.0: Methodology -** The methodology used to complete the study is described.
- **Section 5.0: Results** – This section summarizes the results of Stantec's analysis of the seven (7) buildings including baseline and NECB building energy consumption and the results of the life cycle analysis.
- **Section 6.0: Discussion** – This section comments on the appropriateness of the NECB for Newfoundland and Labrador given local circumstances.
- **Section 7.0: Conclusion** – The key findings of the study are summarized.
- **Appendices**: Supporting appendices provide more detailed documentation of the inputs and results of the analysis.

2.0 Context

This section summarizes the policy context at a national and provincial level, including the advantages of adopting energy codes, and the magnitude and attributes of the local commercial building sector and design environment in Newfoundland and Labrador.

2.1 NATIONAL MODEL CONSTRUCTION CODES

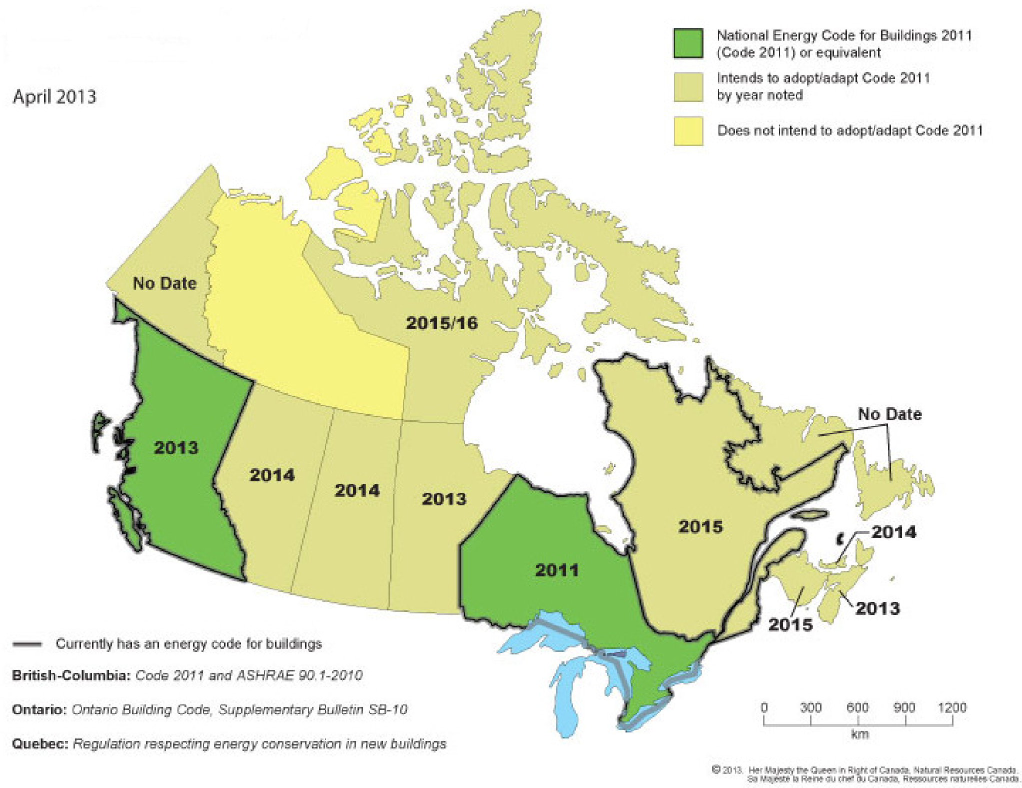
The National Model Construction Codes comprise the National Building Code of Canada 2010, National Fire Code of Canada 2010, National Plumbing Code of Canada 2010 and National Energy Code of Canada for Buildings 2011. They also include the Model National Energy Code of Canada for Houses (which was last published in 1997 and has now been updated and incorporated in the National Building Code of Canada 2010) and the National Farm Building Code (last published in 1995).

The Codes are developed and maintained by the Canadian Commission on Building and Fire Codes, an independent committee of volunteers established by the National Research Council of Canada (NRC). They are published by the NRC as models for provincial and territorial building and fire regulations. The development of codes on a national level helps to facilitate the harmonization of construction standards across Canada, but these codes have no legal status until they are adopted by the province or territory having jurisdiction. This is because provinces and territories have the responsibility to regulate the construction of houses and buildings under the Canadian Constitution. Provinces and territories have the option of adopting these codes as a whole, with province-specific amendments, or they may develop their own codes.

2.2 PROVINCIAL AND TERRITORIAL REGULATOR AND POLICY FRAMEWORKS

As shown in Figure 1, all provinces and two territories are considering adopting the NECB, but provincial approaches vary significantly. British Columbia, Ontario and Quebec have building codes that already include energy requirements. Quebec's energy requirements have not been updated since 1983, and they are doing an analysis to determine whether they should amend the NECB to add more stringent requirements. British Columbia adopted the code in May 2013 and will implement it in December 2013. Ontario intends to adopt the NECB as a possible compliance option under their existing energy requirements. Nova Scotia has adopted the code and will implement it in two stages at the end of 2013 and 2014 and Manitoba is poised to adopt it at the end of this year. This level of preparedness for code adoption differs from a number of other provinces, who intend to explore the adoption of the NECB. Table 1 summarizes the position of Ontario, Quebec, British Columbia, Nova Scotia and Manitoba.

Figure 1: Status of NECB Adoption/Adaption in Canada



Source: Government of Canada, 2013.

Table 2-1: Summary of Provincial Energy Codes

Provincial Energy Codes	
Quebec	The Code de construction du Quebec has contained energy requirements since 1983, but they are not based on a specific standard. The requirements are currently out of date and are being revised.
Ontario	To achieve the energy requirements for buildings contained in the Ontario Building Code, there are three possible compliance options: • Achieving MNECB (1997) + 25% • Achieving ASHRAE 90.1 (2010) +5% • Achieving ASHRAE 90.1 (2010) + additions and substitutions contained in the Supplementary Bulletin 10 of the Ontario Building Code

Provincial Energy Codes	
British Columbia	To achieve the energy requirements for buildings contained in the British Columbia Building Code, there are two possible compliance options: • Achieving ASHRAE 90.1 (2010) • Achieving NECB (2011)
Nova Scotia	Nova Scotia has adopted the NECB 2011, which will become effective on December 31, 2013 for Houses and Small Buildings and on December 31, 2014 for all buildings.
Manitoba	Manitoba is poised to adopt NECB-2011 at the end of 2013.

2.2.1 Comparison of ASHRAE 90.1 and the NECB

As with the NECB, ASHRAE 90.1 places a set of minimum basic requirements for a building system that must be complied with. Stipulations cover building envelope; heating ventilation and air conditioning (HVAC) and service hot water systems; electrical power and lighting.

The ASHRAE 90.1 standard offers two methods of compliance: the Prescriptive Method or the Building Energy Cost Budget Method. Under the Prescriptive Method, ASHRAE 90.1 provides the prescriptive requirements for HVAC and service hot water SWH systems, lighting and building envelope. For building envelope, the standard provides, for each climatic zone, tables of maximum thermal transmittance U-values for the below grade surfaces, floors, external walls, and roof. There is little flexibility available to the designer using this approach.

With the Energy Cost Budget Method, there is more flexibility. This method is similar to the performance method in the NECB code. This method allows for the use of a computer program to undertake calculations and allows for the use of improved or poorer values than each prescriptive requirement, as long as the overall calculations meet the code requirements.

The following are the major differences in approach between the NECB 2011 and ASHRAE 90.1:

- The NECB differs from the ASHRAE standard in that there is a greater focus on improvements to the building envelope rather than relying mainly on improvements to the building's mechanical equipment and operations,
- The NECB does not have different requirements for different energy sources whereas ASHRAE does,
- The NECB does not have different requirements for different constructs, e.g. different U-values for different wall and roof constructions,

- The NECB applies to new construction and additions, ASHRAE requirements also apply to alterations to existing buildings.

The table below shows the overall impact of the NECB 2011 on performance improvement (more efficient) for energy used in buildings in Canada1.

NECB 2011 All-Canada energy savings relative to:

MNECB 1997	ASHRAE 90.1 2004	ASHRAE 90.1 2007	ASHRAE 90.1 2010
26.2%	26.8%	20.7%	18.0%

2.3 NEWFOUNDLAND AND LABRADOR SITUATION OVERVIEW

The Government of Newfoundland and Labrador is committed to supporting a major shift in the uptake of energy efficiency across the economy given the board spectrum of benefits energy efficiency generates, including reduced energy costs and enhanced business competitiveness. In its 2011 Energy Efficiency Action Plan, government identified four main ways in which energy efficiency could be improved in Newfoundland and Labrador, one of which was building new buildings to higher energy efficiency standards, thereby reducing the amount of energy needed to operate them. Commercial and institutional sector buildings account for 9% of provincial energy consumption and approximately 3% of provincial greenhouse gas emissions, when electricity purchases are included.

Currently, within Newfoundland and Labrador there are energy efficiency requirements for homes and smaller commercial buildings (less than 600 m^2 or less than 3 stories). These requirements are laid out in section 9.36 of the most recent addition to the National Building Code of Canada. However, Newfoundland and Labrador has no current energy code requirement for large commercial buildings (greater than 600 m^2 or 3 stories).

In November 2011, the Canadian Commission on Building and Fire Codes released the NECB. This enhanced the minimum requirements for the design and construction of energy-efficient buildings contained in the 1997 Model National Energy Code for Buildings (MNECB). Mindful of this, the untapped potential for energy efficiency in the province and the new materials and practices in the construction industry, government committed to "examine the case for adopting new national energy codes for buildings in Newfoundland and Labrador, in collaboration with key stakeholders including Municipalities Newfoundland and Labrador, the construction industry, and the design consulting and business communities".

[1] Adaptation Guidelines for the National Energy Code of Canada for Buildings 2011: http://www.nationalcodes.nrc.gc.ca/eng/necb/necb_adaptation_guidelines.html

2.4 TRENDS AND OPPORTUNITIES

2.4.1 Current Building Practices in Newfoundland and Labrador

Statistics Canada is the main source for data on non-residential construction. There is limited data available regarding the construction of commercial sector and government buildings. This is a function of three main factors: (i) these data are primarily used to inform projections in economic activity and therefore focus on investment levels only; (ii) these data can only be captured by examining municipal building permits, and there is no standardized permitting process across all municipalities in Canada; and (iii) municipalities capture a limited amount of information for commercial buildings, given their municipal regulatory needs, and most construction level detail is contained in separate engineering design documents that may be submitted with permit requests.

Data is available on the value of building permits for the commercial sector (e.g., office buildings, restaurants and retail outlets) and the institutional and government sector (e.g., schools, long-term care facilities) in Newfoundland and Labrador. Over the 2010 to 2012 period, these data show that $2.14 billion in building permits have been issued. The data also indicate that:

- The commercial sector accounted for 70% of the value of building permits, and the institutional and government sector accounted for 30%;
- Within the province, the St. John's Census Metropolitan Area (CMA) (i.e., the Northeast Avalon area) accounted for 67% of the value of building permits, large rural service centres (i.e. Corner Brook, Bay Roberts, and Grand Falls-Windsor) accounted for 12%, and all other rural areas accounted for 21%.
- Within the commercial sector, the St. John's CMA accounted for 71% of the value of building permits. However, for the institutional and government sector, the CMA accounted for 57%. This difference is, in large part, a function of recent investments in school and health care construction in rural areas.
- Corner Brook, Grand Falls-Windsor and the Bay Roberts area (i.e., the three largest areas outside the St. John's CMA) accounted for 11% of commercial sector buildings permit value, and 13% of institutional and government sector investment.
- All other towns (which include Gander, Labrador City, Happy Valley-Goose Bay, Carbonear and Clarenville, as well as all other municipalities) accounted for 18% of commercial sector buildings permit value, and 29% of institutional and government sector investment.

2.4.2 Build Better Buildings Policy in Newfoundland and Labrador

In 2007 Energy Plan, government recognized that, as buildings have an expected lifespan of several decades, energy efficiency investments at the time of construction can affect energy use for a long time. In view of this and the impact that buildings can have on the environment, government committed to lead by example and undertook that "starting in 2008, where appropriate, all new buildings and major renovations receiving funding from the Provincial Government or built by Provincial Government corporations or agencies exceed the current Model National Energy Code by 25 per cent and, where possible, also qualify for a minimum Silver standard in the Leadership in Energy and Environmental Design (LEED) program". In August 2011, government reiterated this commitment in its Energy Efficiency Action Plan and, separately, released a detailed policy in support of this undertaking.

The Build Better Buildings (BBB) policy, released in 2011, formalizes the Energy Plan commitment and a guide to implementation is available at www.turnbackthetide.ca. It applies to the construction of new buildings and major renovations and extensions that receive capital construction funding from the Provincial Government where:

- The area of a new building or extension to an existing building is 600 sq. m. (6,458 sq. ft.) or more; or
- The cost of renovations and/or extensions to an existing building (600 sq. m. or more) exceeds 50 per cent of the cost of a new building of equivalent size and function.

Projects within the scope of BBB must register with LEED Canada and strive to achieve a minimum of LEED Silver certification under the appropriate LEED rating system. Established in 1999 by the US Green Building Council and adapted for use in Canada in 2003, LEED is a rating tool to assess the environmental performance of buildings across a spectrum of environmental aspects including:

- Sustainable Sites
- Water efficiency
- Energy and atmosphere
- Materials and resources
- Indoor environmental quality
- Innovation in design
- Regional Priorities

LEED Certification is based on the total point score achieved in these seven areas, following an independent review. There are four possible levels of certification; certified, silver, gold and platinum. Under the LEED 2009 'New Construction' rating system, the project must score between 50-59 points from 100 base points and 10 exceptional/innovative/regional points to achieve a LEED silver designation.

There are five core building types which dictate the type of LEED tool or rating system a project can choose from, including:

- Homes
- Neighbourhood Development
- Commercial Interiors
- Existing Buildings Operations and Maintenance
- New Construction

- Core and Shell
- New construction and Major Renovation

There are a number of LEED Canada Rating systems available to meet the needs of different building types, which include:

- LEED Canada NC 2009- New Construction and Major Renovations
- LEED Canada 2009 –Core and Shell LEED Canada for Commercial Interiors – LEED Canada CI
- LEED Canada EB: O&M 2009 – Existing Buildings Operation and Maintenance
- LEED Canada for Homes
- LEED ND 2009 with Canadian Alternative Compliance Path – Neighborhood Development

LEED continues to dominate the market of green building assessment methodologies. As such, the degree of adoption of LEED is one measure of the degree of market transformation toward more sustainable building design and construction practices. However, LEED is neither an energy code nor an energy standard. It does not provide designers with information on how buildings should be designed; rather it references other bodies' energy standards.

There are currently two LEED-certified project in Newfoundland and Labrador[2]; however, there are an additional 54 registered projects. Of the 56 total projects as shown in Table 2-2, 27 are located in the St. John's Census Metropolitan Area, 21 are located elsewhere on the island of Newfoundland and five in Labrador (three projects do not have an identified location). Registration is only an indication that a building is striving to attain a LEED certification, not that it has achieved it.

[2] Canada Green Building Council, Project Profiles and Stats, Updated April, 2013, duplicate project registration removed. Excludes the St. John's Target store that is registered by the parent company in Ontario.

Table 2-2: Summary of LEED Registered Projects

LEED Registered Projects					
		Number of Projects			
Project Type[1]	Share of Floor Space	Private Sector[2]	Provincial Government[3]	Federal Government	Municipal Government[4]
Health care and related[5]	23%		9		
Neighbourhood re-development	19%			1	
Office Building	14%	5	1	1	2
K-12 Education	12%		12		
Public safety[6]	8%			2	1
Post-secondary Education	7%	1	4		
Sports facilities	6%				5
Retail	5	3			
Public transit	2%				1
Other[7]	3%	7	1		
Total	100%	16	27	4	9

1. Project types do not align with the categories assigned by the Canada Green Building Council.
2. Private sector includes non-profit organizations.
3. Provincial Government includes crown corporations and the post-secondary system.
4. Municipal Government includes municipal commissions.
5. Health care and related includes hospitals, clinics, nursing homes, health laboratories and youth treatment centres.
6. Public safety includes national defense.
7. Other includes industrial and manufacturing, hotels/motels, residential and mixed use developments, conservation centres and unidentified projects. .

2.4.3 Advantages of Adopting an Energy Code

Although several provinces have conducted studies and have announced intentions, as of yet only British Columbia, Ontario and Nova Scotia has currently adopted the NECB, although Manitoba is poised to adopt the code at the end of 2013. Understanding the challenges of adopting a new code is critical to designing an approach that will achieve the expected outcomes.

Adopting an energy code brings many benefits to building tenants and owners and at a provincial level. Whether the code adopted in NECB, ASHRAE or any other code, the advantages include:

- **Economic Savings:** A reduction in energy use results in energy cost savings. Over the lifetime of a building this reduction can be significant.
- **Job Creation:** The use of improved technology in buildings and the increasing need for energy code experts will create employment opportunities. New jobs will become available such as technical experts, duct and air leakage professionals, quality control assessors, building and system commissioning agents, energy auditors, and compliance officers. In addition, completing project retrofits and building weatherization will create new employment opportunities as well.
- **Improved Grid Reliability:** By decreasing the impact and peak loads of buildings, energy codes help reduce strain on utility electricity transmission and distribution systems.
- **Reduced Emissions:** Newfoundland and Labrador's electricity is mostly generated by hydroelectricity, however on the island interconnected grid there is also a thermal oil facility and several emergency gas facilities, and isolated communities operate using diesel generators. The burning of carbon-containing fuels (oil and gas) contributes to the greenhouse effect and climate change. By reducing the energy consumed by buildings, greenhouse gas emissions will be reduced.

Adopting a new code will also require that potential barriers be addressed:

- **Availability of Current Technology and Skills**: One area where availability may be a challenge is in terms of the capacity of the local design industry. The first LEED project was registered in 2008; the year after the Energy Plan was released. The policy on LEED will have helped to build capacity. In addition, enhancing capacity of the local industry may be achieved through implementation of a grace period wherein designs voluntarily meet the code, before enforcement comes into effect at a later date.
- **Availability of Products:** Fabricators and other manufacturers tend to stock the product that is most demanded by designers. The ability for these market agents to respond to codes or standards requiring components with improved performance characteristics may require some lead time. Whilst this is not expected to be a major barrier in the major centres of population, such as St. John's, building material and product availability could be an issue in remote areas where the additional shipping costs could increase payback timelines.
- **Affordability:** Affordability addresses the financial barriers related to technologies and processes required to raise the energy standards for commercial buildings relative to current (baseline) levels. Affordability can be defined on both a first cost and a life cycle cost basis. The tendency of the design community to base decisions on first cost rather than payback or life cycle costing poses a significant barrier to the adoption of higher performance requirements.
- **Split Incentives**: This barrier is particularly evident for building owners / developers that do not intend to retain ownership of the property beyond completion or intend to cover the building's operational costs via its tenants' lease arrangements. Both situations effectively achieve the same outcome – the operational costs of the property once completed are not borne by the principal developer of the property.

3.0 NECB Overview

Canada's National Energy Code for Buildings details minimum energy performance requirements for new buildings and additions to existing buildings. The most recent version, published in 2011, significantly updates the original MNECB which was released in 1997. The NECB is applicable to all new buildings and additions:

a) Classified as post-disaster buildings,
b) Used for major occupancies classified as
   i. Assembly occupancies,
   ii. Care, treatment or detention occupancies, or
   iii. High-hazard industrial occupancies, or
c) Exceeding 600m^2 in building area or exceeding 3 storeys in building height used for major occupancies classified as
   i. Residential occupancies,
   ii. Business and personal services occupancies,
   iii. Mercantile occupancies, or
   iv. Medium and low-hazard industrial occupancies.

The code also applies the alteration, reconstruction, demolition, removal, relocation and occupancy of existing buildings. The code does not apply to farm buildings.

MNECB was intended to provide a comprehensive standard for building energy efficiency for adoption by provinces and territories. Since the release of MNECB, only one jurisdiction -- Ontario -- has adopted the energy standard as a part of its building code. The MNECB adopted a life cycle cost approach to energy efficiency, evaluating energy efficiency in terms of assumptions about relative energy prices for various fuels across the provinces and territories. This regional adjustment to the energy cost budget methodology for evaluating energy efficiency in buildings, caused the MNECB to be considered out of date within a year or two, as the economic assumptions built into the were not reflective of real-world conditions over time. The NECB is therefore based on energy performance and energy consumption only, without regard for fuel type or jurisdiction beyond climate zones. However, MNECB continues to be extensively used for incentive and green building rating programs such as LEED. The 'New Construction' and 'Core and Shell' rating systems within LEED requires, as a prerequisite, that the building demonstrates a 25% reduction in design energy consumption when compared to MNECB[3].

The development of MNECB was heavily influenced by the 1975 and 1989 versions of ASHRAE Standard 90.1: Energy Standard for Buildings Except Low-Rise Residential Buildings. ASHRAE 90.1 is a widely recognized energy code developed by the American Society of Heating, Refrigeration, and Air-Conditioning Engineers, which provides mandatory and prescriptive requirements for building designs

[3] LEED Canada requires projects to demonstrate a 25% reduction in design energy consumption when compared to MNECB or an 18% reduction in design energy cost of compliance when compared with ASHRAE/IESNA Standard 90.1-1999.

which minimize energy consumption. It has been adopted in jurisdictions across Canada and North America, including the province of British Columbia.

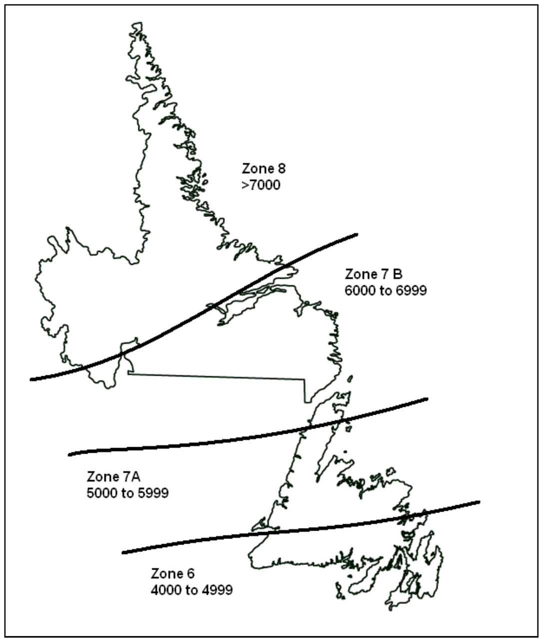
Construction practices, building technologies and materials have evolved significantly since the release of the MNECB and have informed the development of the NECB. Major developments include the use of improved insulation in building envelopes and double or triple glazed windows along with improved glazing coatings which reflect the sun. In addition compact fluorescent lights have replaced incandescent fixtures and LED lighting has started to be used, particularly in exterior lighting. Mechanical equipment has become generally more efficient with the extensive use of heat recovery. The next update to the NECB is anticipated in 2015

Like ASHRAE 90.1 and MNECB, the NECB defines requirements for the performance of five building elements: (1) the building envelope; (2) lighting systems; (3) heating, ventilation, and air-conditioning (HVAC) systems and equipment; (4) service water heating systems; and (5) electrical systems and motors. Also like ASHRAE 90.1, other energy end uses, such as process equipment (e.g. server rooms, commercial refrigeration systems other than those found in ice areas, or equipment used for industrial production) and renewable energy systems are not addressed. Within these categories of building systems, specific design requirements are established based on the climate zone in which the proposed building will be constructed. For instance, limits on thermal transmittance through walls are more stringent in climates with a higher number of heating degree days. A heating degree day (HDD) is a technical measure used to evaluate energy demand and consumption for heating buildings[4]. Degree days are based on how far the average daily temperature departs from a human comfort level of a base temperature. The NBC uses a base temperature of 18°C. Each degree of temperature below 18°C is counted as one heating degree day. For example, a day with an average temperature of 6 °C will have 12 heating degree days. HDD are added over periods of time to provide a rough estimate of seasonal heating requirements

There are four climate zones represented in the province; zone 6 (HDDs of between 4,000 and 4,999 based on a 1981-2006 average), 7A (HDDs between 5,000 and 5,999), 7B (HDDs between 6,000 and 6,999) and 8 (HDDs of at least 7,000). Due to climate variances, there are substantive differences in the requirements of the NECB between zones 6 and 8. For example Wabush, which is in zone 8, has an average annual temperature of -3.5°C, whilst the average temperature is 4.7°C in St John's which is in zone 6. It is therefore reasonable that the NECB code demands that the thermal transmittance through walls is more stringent in zone 8. HDD zones cut across the province as shown in Figure 1. Based on this delineation, 60% of the population lives in Zone 4% in Zone 7B and 3% in Zone 8.

[4] The reciprocal of HDD is CDD which are used to evaluate energy demand and consumption for cooling buildings.

Figure 2: Climate Zones and Average Annual Heating Degree Days in Newfoundland and Labrador, 25 Year Average 1981-2006[5]



It should be noted that according to the NECB map delineation, Corner Brook is located in zone 7A, with annual HDD between 5000 and 5999. However, the NBC contradicts that and states that Corner Brook has annual HDD of 4760, placing it in zone 6.

The NECB states that the climatic values required for building design should be in conformance with the values for the location nearest to the building site. The NECB also notes that climate is not static and at any location, weather and climatic conditions vary from season-to-season and year-to-year. Evidence is mounting that the climates of Canada are changing and will continue to change significantly into the future. Past and ongoing modifications to atmospheric chemistry (from greenhouse gas emissions and land use changes) are expected to alter most climatic regions in the future. Consequently many buildings will need to be designed, maintained and operated to adequately withstand changing climatic loads[6]. A possible outcome to a changing climate is that Zone 6 may cover the entire island in the future, rather than the NECB delineation of it being a mix of Zone 6, 7A & 7B. For example, Table 3-1 shows the heating degree days and climate zones for communities in Newfoundland and Labrador based on 2011 climate data, as well as climate zones for the 1981-2006 average.

[5] Source: NRC, based on weather observations collected by the Atmospheric Environment Service, Environment Canada.

[6] National Building Code of Canada 2010

Table 3-1: Heating Degree Days in Newfoundland and Labrador, 2011

Community	Heating Degree Days (2011)	Climate Zone (2011)	Climate Zone (NECB based on 1981-2006 average HDDs)
St. John's	4,542	6	6
St. Lawrence	4,459	6	6
Bonavista	4,488	6	6
Gander	4,851	6	7A
Badger	5,145	7A	7A
Corner Brook	4,416	6	7A
Stephenville	4,391	6	7A
Port aux Basques	4,288	6	6
Daniel's Harbour	4,989	6	7A
St. Anthony	5,333	7A	7B
Cartwright	6,203	7B	7B
Happy Valley-Goose Bay	6,236	7B	7B
Wabush	7,413	8	8
Nain	7,290	8	8

Source: Environment Canada

3.1 CODE COMPLIANCE

There are two possible compliance paths that may be selected in order to demonstrate that their building design complies with the NECB:

- The Prescriptive Path requirements laid out in the code for each of the five building systems (envelope, HVAC, lighting, service water heating, and electrical systems) may be adopted, ensuring that the overall system design meets the all of the mandatory efficiency requirements defined in the code.
    - A sub component of the Prescriptive Path is the Tradeoff Path. This option affords some flexibility in the application of the prescriptive path. The trade-off option presents an easy way to make small adjustments to the prescriptive path without having to follow the

whole-building performance path. For example the thermal characteristics of one or more components of the building envelope can be changed, provided it can be shown that the resultant building envelope will not transfer more energy than it would if all of its components complied with that section.

- The Performance Path uses the calculation methodologies provided in the NECB to trade off a limited number of mandatory requirements while still demonstrating that the overall energy efficiency of the system has not been compromised. Whole building simulation is used for this compliance path.

Regardless of the compliance path chosen, the NECB establishes a consistent building energy performance requirement, based on U-value and fenestration-to-wall ratio limits for each climate zone. In general, a building designed to comply with NECB will need to be 26.2% more efficient than an MNECB-compliant building.

4.0 Methodology

4.1 APPROACH

In order to assess the benefits and costs of adopting the NECB, it was necessary to understand the current energy performance of buildings and to assess this against the requirements of the NECB. However, as explained in Section 2.2.1 there is no information available for the existing stock of buildings in the province, with the exception of new public buildings, such as schools and medical facilities, and new private sector buildings that are registered for LEED. Given this, this study was limited to selecting those buildings for which energy models are available.

4.2 CHOOSING STUDY BUILDINGS

Seven buildings were assessed in this project. The selection of buildings for the project was limited by three factors.

- First, there was a need to establish a representative sample of buildings. The study includes buildings with varying construction materials across multiple sectors such as education, office buildings and warehousing, and across different regions and climate zones in the province. There were a limited number of buildings that meet this criteria in Climate Zones 7a, 7b and 8 when considered in combination with the remaining selection factors.
- Second, in order to assess the impacts of the NECB, it was necessary to include buildings for which an energy model had previously been completed and was available for analysis, as it was outside the scope of this project to develop a baseline energy model for any building.
- Third, a regional representation of buildings was sought. As there were a limited number of buildings that had energy models in the province, this was challenging. However, buildings in Labrador City and Corner Brook were included.

A list of potential buildings was developed by the provincial government in consultation with Stantec for consideration in the study. Of the seven buildings selected for the project, only two have been operational for at least one year (i.e., the Torbay School and the Corner Brook Long-term Care Facility).

The owners of the buildings identified were contacted to request permission to use the existing energy models that had previously been built and release facility information such as building drawings and specifications. A list of the buildings included in the study is provided in Table 4-1 below.

Table 4-1: Summary of Buildings by Category, Type, Location and Climate Zone

Building No.	Category	Building Type	Town	Climate Zone (NECB)
1	Office	Office	St John's	6
2		Office	St John's	6
3	Education	School	Torbay	6
4		College Campus	Labrador City	8
5	Health	Long-Term Care Facility	Corner Brook	7a
6	Multi-Unit Residential Building	Residential	St John's	6
7	Warehouse	Warehouse	Mount Pearl	6

4.3 DATA COLLECTION

Detailed data was obtained for each of the seven buildings analyzed in this study in order to characterize each building and collect the necessary information for the energy models updates. The information described below was included for each building.

- Drawings: For each building "issued for tender", "issued for construction" or "as-built" drawings were obtained for architectural, mechanical, and electrical systems.
- Specifications: Where available, project specifications for architectural, mechanical, and electrical systems were obtained.
- Shop Drawings: On some projects shop drawings of installed equipment were available and obtained to provide the equipment performance values for the modeling process.

4.4 ENERGY MODELING

This section describes the energy modeling methodology, including modeling each building to meet NECB requirements.

Part of the criteria for selecting buildings for the analysis was that the study building must have an existing energy model. The buildings selected were built in two different software, EE4 and eQUEST.

4.4.1 EE4

The EE4 computer software was developed by Natural Resources Canada (NRCan) and was designed to demonstrate a building's compliance to the requirements of the Commercial Building Incentive Program (CBIP) performance path approach. A CBIP incentive was offered to building owners and developers for the design and construction of new commercial and institutional buildings that used 25% less energy than similar buildings built to the requirements of the MNECB. Although the CBIP program ended in 2007, EE4 continues to be frequently used due to the software being approved energy simulation software for LEED Canada. It strengths are that it automatically generates a reference building to verify compliance to MNECB requirements using the performance path approach. It has a user-friendly interface and has a detailed help guide. It also includes default libraries of common building plants, systems, construction assemblies and materials, lighting elements, fenestration and operating schedules, and is available in English and French.

A limitation of EE4 is that not all HVAC systems and plant configurations can be modeled directly with the software and more detailed simulation software should be selected in complex cases.

4.4.2 eQUEST

eQUEST is a U.S. Department of Energy (DOE) energy simulation software package initially developed jointly by Lawrence Berkeley National laboratory and J.J. Hirsch and Associates, under funding from the UDOE and the Electric Power Research Institute. Although eQUEST was developed in the United States and uses Imperial units as its model inputs, it has become one of the industry standards in Canada as well. One of the major strengths of eQUEST is that there are two levels of model inputs, design development and detailed mode. Its 'wizard' interface allows the user to input high level detail including the capability of auto size equipment capacities that gives a reasonable estimation of energy use. Its detailed interface allows detailed building analysis using design or actual building drawings/documentation.

Although not as limited as EE4, again not all HVAC systems and plant configurations can be modelled directly with the software. In addition, the user is required to build both the proposed design model and the reference model when simulations for compliance are being built. An additional limitation to eQUEST is that the modeller is able to automatically model the effects of framing in the building envelope. A common method used to overcome this drawback, is to use alternative software to model the framing effects and then apply them to the eQUEST model.

It should be noted, that NRCan has recently developed CanQUEST which is a derivative of the eQUEST energy simulation software. The current version of CanQUEST automatically generates the reference building defined by the MNECB for compliance analysis; however subsequent CanQUEST versions will also generate the reference building for the NECB.

4.4.3 NECB Energy Models

For each building, the original models were altered to match the relevant components of the performance path requirements of the NECB, regardless of whether the code would result in better or worse energy consumption performance. The NECB building is architecturally identical to the original, having the same wall orientations, areas, windows, number of occupants, indoor set-point temperatures, fan schedule, and process equipment.

The study was completed in two phases. In phase one, the Torbay School and the long-term care facility were chosen to be the subject of multiple scenarios to better understand the effects of the different envelope requirements and mechanical/lighting systems and their related costing. These buildings were selected because they were representative of two different types of construction that are commonly used in the province. The school used brick facing concrete block, whilst the long-term care facility used a combination of brick and curtain wall. The scenarios that were run on these two buildings were as follows:

- The baseline building compared against the NECB equivalent building that has the NECB performance path applied to the mechanical systems, but with air source heat pumps (carried out for the School analysis only).
- The baseline building compared against the NECB equivalent building.
- The baseline building compared against the NECB equivalent building with Zone 7A (instead of Zone 6) applied.
- The baseline building is compared against a building that has the baseline envelope and NECB applied to the mechanical systems and lighting.
- The baseline building is compared against the baseline building with an NECB envelope.

Note that, one building was located in climate zone 6 and one in climate zone 7. Each building was modeled for each of zone 6 and zone 7 to highlight the difference in impact between the zones. As discussed previously, specific design requirements are established based on the climate zone in which the proposed building will be constructed. It was felt that zone 6 building envelope requirements could be met at present and it would be beneficial to study the impacts of a more stringent zone.

The results from the first phase of work informed the second phase in which the performance of the remaining buildings was assessed against the NECB's prescriptive requirements. As phase one of the study had already answered questions concerning the constructability, costs and benefits of building in zone 7A, four of the remaining buildings were only assessed for climate zone 7A except the college campus which was assessed at zone 8, Table 4-2 depicts the zones used within the study.

Table 4-2: Climate Zones used for the cost benefit analysis

Building No.	Category	Town	Heating Degree Days (HDD) 2011	NECB Zones	Zones used for Study
1, 2	Office Buildings	St. John's	4800	6	7A
3	Education	Torbay	4800	6	6, 7A
4	Education	Labrador City	7710	8	6, 7A, 8
5	Health	Corner Brook	4760	6	6, 7A
6	MURB	St. John's	4800	6	7A
7	Warehouse	Mount Pearl	4800	6	7A

4.4.4 Building Envelope

The NECB includes a section dedicated to building envelope requirements. Part 3 of the NECB deals with the transfer of heat and air flow throughout building materials, components and assemblies, as well as the interfaces between building materials, components and assemblies forming part of the building envelope and interfaces between building materials.

Part 5, Environmental Separation, applies to heating, ventilating and air-conditioning systems and equipment. In terms of the building envelope, it deals with air leakage and heat transfer.

The different envelope requirements include the following:

- Continuity of Insulation
- Thermal Characteristics of Above-ground Opaque Building Assemblies
- Thermal Characteristics of Fenestration
- Thermal Characteristics of Doors and Access Hatches
- Building Assemblies in contact with the Ground.
- Heat Transfer
- Air Leakage

Flooring was not changed to NECB requirements due to the limitations of the existing energy models used within this study.

4.4.5 Mechanical Systems

The NECB building's heating and cooling plant (if applicable) was dependent on the original building's function. In this study, one of seven HVAC building system types were assigned to NECB building depending on the space types located in the baseline building. A table detailing the HVAC system selection and description is located in Appendix B, whilst each building summarized model inputs are detailed in Appendix C.

4.4.6 Lighting

Lighting requirements were covered under Part 4 of the NECB which define the minimum lighting power density[7] (LPD) requirements, which for this study were calculated on a whole building basis. In cases where there were two distinctive space types within one building, for example the warehouse building had a well-defined warehouse area and office area, the relevant LPD for each building type was applied.

A comparison table detailing the differences between the lighting power density requirements for both the MNECB and NECB by building types is located in Appendix B, whilst each building's summarized model inputs are detailed in located in Appendix C.

4.5 FINANCIAL IMPACT OF CODE ADOPTION

4.5.1 Baseline Costs

To evaluate the financial impact of adopting NECB in Newfoundland and Labrador, costs for current construction practice had first to be established. Costs were developed using the RS Means CostWorks estimating software. This cost estimating software is updated quarterly to reflect the latest market trends in construction material and labour costs and costs for Q1, 2013 were therefore used. Building type, construction and floor area were inputted into CostWorks for each archetype to get the basic construction costs. Please note that CostWorks does not contain a Labrador City location where one of the study buildings was located, therefore the St John's location was used and the costs multiplied by 50%, as a crude estimate, to reflect the increase in construction materials and labour cost. A detailed breakdown of these costs is available in Appendix E.

4.5.2 NECB Costs

The baseline costs were adjusted to take into account the changes to comply with the NECB. A percentage increase in the cost of the various envelopes, mechanical and lighting elements was calculated using a combination of CostWorks and local knowledge.

[7] Lighting Power Density (LPD) is a measure of the installed lighting power (wattage) per unit area (typical units are W/m^2 and W/ft^2).

4.5.3 Operating Cost Savings

Energy savings are combined with energy price data to estimate annual savings. Electricity rates are assumed to increase by 3.78% per year to 2016 and then 2.65% per year thereafter[8], whilst fuel oil rates are assumed to rise by 3.75% per year.

To simplify the financial analysis, electricity price forecasts have been "levelized" – in other words, an average energy price was developed over the study period of 25 years, accounting for inflation. The levelized electricity and fuel oil prices are summarized in Table 4-3.

Table 4-3: Levelized Cost of Electricity and Fuel Oil

Fuel	Levelized Cost
Electricity (Newfoundland)	$0.1452/kWh
Electricity (Labrador)	$0.0365/kWh
Fuel Oil	$0.1814/equivalent kWh

4.5.4 Project Life

In general, upgrades were assumed to have the same expected life as the baseline assembly. As such, changes to maintenance and replacement costs were not considered for this study.

4.6 LIMITATIONS

It is important to recognize the limitations of the study to inform how results are interpreted and used in decision-making. Table 4-4 summarizes some of the key limitations.

Table 4-4: Summary of Study Limitations

Issue	Discussion of Limitations
Sample Size	This is a case study approach. Seven buildings were analyzed, but it must be recognized that there is a wide variation in building design and associated energy performance across buildings. Some of the factors attributed to this variation include, but are not limited to: size, design team, specific space uses and staff who operate the building.
Sample Group	There is a narrow profile of buildings recently constructed and expected to be constructed. The most popular building types include schools, hospitals, large retail stores and warehouses, with some new

[8] Escalation rates calculated from projected rates sited in 'Electricity Rates Forecasting: Muskrat Falls Will Stabilize Rates for Consumers' report, released in November 2012: http://www.powerinourhands.ca/pdf/TB_ElectricityRates.pdf

Issue	Discussion of Limitations
	office building and hotel construction. Most of these buildings are low rise, typically five stories or less.
Size of Buildings	The study is based on large buildings only. The smallest building in the study is about 3,800 m^2, and four buildings are over 10,000 m^2.
Modelling	Due to time and budget limitations, the study included buildings for which energy models already existed. As there is currently no energy code adopted in the Province, the available energy models have been primarily constructed as part of a LEED project. It should therefore be noted that the sample of buildings on the whole reflects buildings which will likely have been built to higher efficiency standards.
Costing	The financial analysis is sensitive to the estimates of the cost to building new construction to meet the requirements of NECB relative to current practise. Multiple costing sources were consulted in order to cross-reference the results; however, it should be noted that actual costs are highly dependent on a variety of factors including the overall building design strategy and fluctuations in materials and resource prices.

5.0 Results

The study was approached in phases to understand the impact in terms of energy and cost of the three elements of the NECB as well as the overall impact.

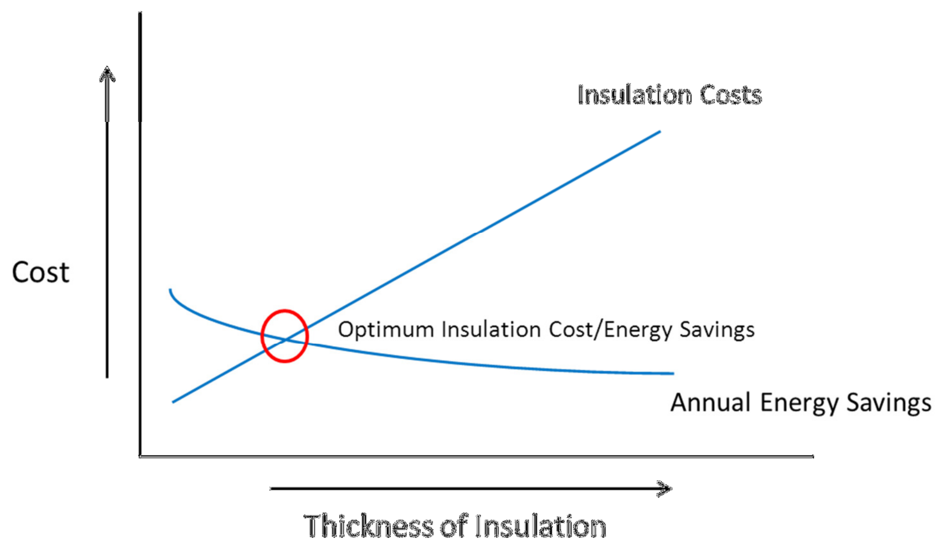
5.1 SCHOOL AND LONG-TERM CARE FACILITY

The first step of the study was to assess the impact of the different elements of the NECB. The NECB was divided into three different study areas;

- Envelope
- Lighting
- Mechanical

Considering the envelope, an investment in improved thermal performance of the building envelope can result in lower building energy costs. However the extra cost of the addition insulation must be balanced against the energy cost savings. A graphic illustration of this can be seen in Figure 8 below. Please note that this illustration is not representative of a specific study building.

Figure 3: Optimum Cost/Energy Savings



Equally a more efficient HVAC system will have additional design and installation costs and a balance must be reached on these additional costs and the energy savings. It is important to evaluate how combined strategies interact together with their associated cost savings for each building design.

An integrated building design must consider the envelope, HVAC system and the lighting system as a whole.

In the first phase of work, two buildings were chosen from the seven study buildings; the school and long-term care facility. These two buildings were chosen due to each having different wall construction types which are detailed in Table 5-1, both of which are commonly used in the province. One of the main differences in construction between the two buildings is the inclusion of curtain wall in the long-term care facility whilst the school is mainly brick wall.

Table 5-1: School and Long-Term Care Facilities Constructions

Constructions	School	Long-Term Care Facility
Roof	**Common Roof:** 2 ply modified membrane, RSI 4.0 Continuous Rigid Insulation, Steel Deck. **Metal Batten Roof:** Metal Covering, 13mm Gypsum Board, W/Steel Girts, Steel Deck.	**Roof construction:** Cap Sheet, 3mm Recovery Board, 6mm Glass Mat Gypsum Board, Tapered Insulation as Required, 100mm Polyisocyanurate Insulation, Vapour Barrier, 13mm Glass Mat Gypsum Board, Metal Deck, Structural Steel.
Wall	**Brick Wall:** Brick Facing, 190mm Concrete Block, 64mm Rigid Insulation, Brick Facing. **Steel Wall:** 190mm Concrete Block, 100mm Rigid Insulation W/Z Bars, Steel Siding.	**Brick Wall:** 90mm Concrete Block, Air Space, 50mm Semi Rigid Insulation, Masonry Ties, Air Barrier, 13mm Glass Mat Gypsum Board, 152mm Structural Studs(600mm O.C.), RSI 3.5 Mineral Fiber Insulation, 0.15mm Polyethylene Vapor Barrier, 13mm Gypsum Board. **Curtain Wall:** Extruded Aluminum, Thermally Broken, Double Glazed Curtain Wall Assembly OR Single Glazed Spandrel Panel;150mm Semi Rigid Insulation and Metal Back Pan,64mm Structural Studs (600 O.C.), 2-13mm Gypsum Board.

To study the impact of the different elements of the NECB, multiple scenarios were studied for both the school and long-term care facility. The scenarios are detailed in Table 5-2. This approach has two benefits. First, the comparison between the scenarios allows for a detailed breakdown that is not possible to achieve with doing one simulation where all of the NECB requirements (envelope, mechanical and lighting system changes) are made. Second, it allows for a comparison between multiple approaches which highlights the various trade-offs across policy approaches.

Table 5-2: School and Long-Term Care Facility Scenarios

Building No.	Building	Study	Envelope	Mechanical	Lighting	Description
3	Education: School	NECB, ASHPs	NECB-2011	NECB-2011 (ASHP)	NECB-2011	Baseline building compared against the NECB performance path applied to the mechanical systems but with air source heat pumps (ASHP).
		NECB	NECB-2011	NECB-2011	NECB-2011	Baseline building compared against the NECB performance path applied to in its entirety.
		NECB, 7A	NECB-2011 (7A)	NECB-2011 (7A)	NECB-2011 (7A)	Baseline building compared against the NECB performance path with Zone 7A (instead of Zone 6) applied in its entirety.
		NECB, Base. Envelope	No Change	NECB-2011	NECB-2011	Baseline building compared against the NECB performance path applied to the mechanical systems and lighting.
		NECB Envelope	NECB-2011	No Change	No Change	Baseline building compared against the baseline building with an NECB envelope.
5	Health: Long-Term Care Facility	NECB	NECB-2011	NECB-2011	NECB-2011	Baseline building compared against the NECB performance path applied to it in its entirety.
		NECB, 7A	NECB-2011 (7A)	NECB-2011 (7A)	NECB-2011 (7A)	Baseline building compared against the NECB performance path with Zone 7A (instead of Zone 6) applied in its entirety.
		NECB, Base. Envelope	No Change	NECB-2011	NECB-2011	Baseline building compared against the baseline envelope and the NECB performance path applied to the mechanical systems and lighting.
		NECB Envelope	NECB-2011	No Change	No Change	Baseline building is compared against the baseline building with an NECB envelope.

5.1.1 School Results

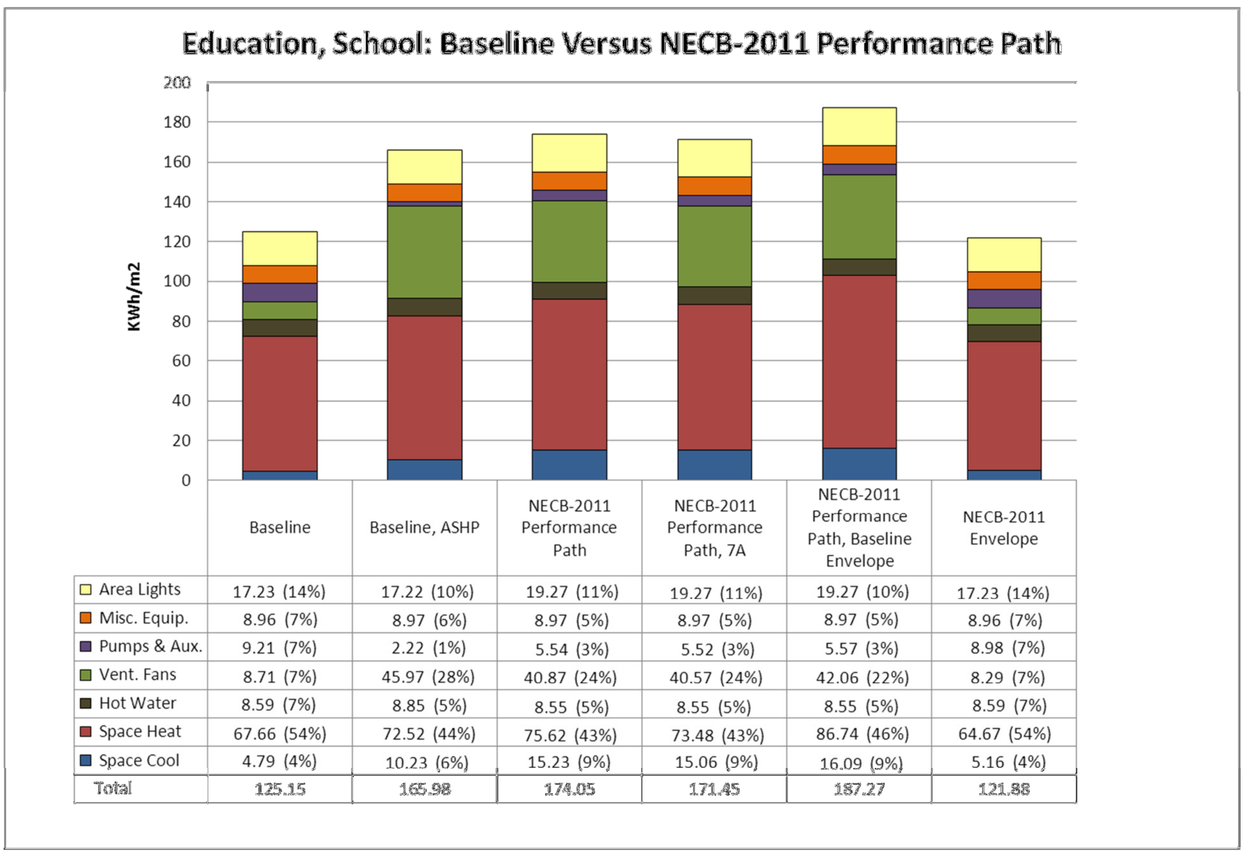
Table 5-3 gives the construction cost per m2 for each study scenario, whilst Figure 4 gives the energy use in kWh/m2. An assessment of payback periods is contained later in Section 5.1.3.

Table 5-3: School: Construction Cost per m²

Building No.	Category	Building	Study	Cost per m²
3	Education	School	Baseline	$2,101.7
			NECB, ASHPs	$1,974.2
			NECB	$1,962.2
			NECB, 7A	$1,981.1
			NECB, Base. Envelope	$1,945.9
			NECB Envelope*	$2,118.0

* The cost per m² for the NECB envelope is more expensive than the baseline building as more insulation was required for the NECB envelope. Although other NECB buildings also had more expensive envelopes the overall costs were balanced by the less costly mechanical and electrical systems.

Figure 4: School: Scenario Results in kWh/m²



The following conclusions can be drawn:

- In four of the five scenarios, the capital construction cost is lower than for the base case. That is, it would have been less expensive to build the school to meet NECB requirements.
- In four of the five scenarios, however, building to NECB requirements would also have meant higher annual energy costs than the base building. That is, while capital costs would have been lower in four scenarios, energy costs on an ongoing basis would have been higher.
- Installing air-source heat pumps (ASHPs) instead of the regular rooftop packaged units as per the NECB scenario is more expensive overall (total construction costs are $1,974.2/m2 for the ASHP pathway compared to $1,962.2/m2 for the NECB pathway) but gives more energy savings (it uses 165.98 kwh/m2 compared to 174.05/m2).
- The factor which is having the least impact is changing only the envelope. It is the only scenario that has reduced energy use relative to the base building but is also the most expensive to construct. The energy savings are relatively marginal at 2.6% per year per m².

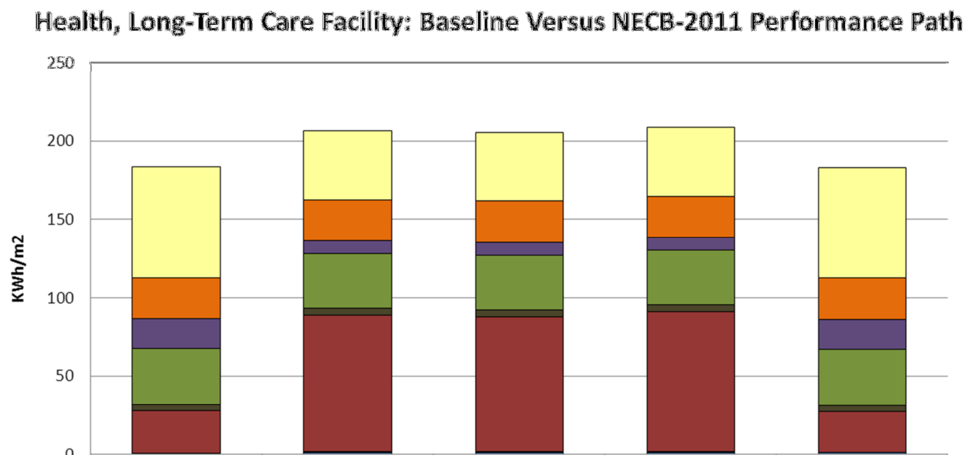
5.1.2 Long-Term Care Facility Results

Table 5-4 gives the construction cost per m² for each study scenario, whilst Figure 6 gives the energy use in kWh/m².

Table 5-4: Long-Term Care Facility: Cost per m²

Building No.	Category	Building	Study	Cost per m²
5	Health	Long-Term Care Facility	Baseline	$2,572
			NECB	$2,442
			NECB, 7A	$2,453
			NECB, Base. Envelope	$2,424
			NECB Envelope	$2,590

Figure 5: Long-Term Care Facility: Scenario Results in kWh/m²



	Baseline	NECB-2011 Performance Path	NECB-2011 Performance Path, 7A	NECB-2011 Performance Path, Baseline Envelope	NECB-2011 Envelope
Area Lights	70.14 (38%)	43.83 (21%)	43.83 (21%)	43.83 (21%)	70.14 (38%)
Misc. Equip.	26.29 (14%)	26.29 (13%)	26.29 (13%)	26.29 (12%)	26.29 (14%)
Pumps & Aux.	19.40 (11%)	8.21 (4%)	8.25 (4%)	8.16 (4%)	19.47 (11%)
Vent. Fans	35.45 (19%)	34.83 (17%)	34.84 (17%)	34.82 (17%)	35.47 (20%)
Hot Water	4.22 (2%)	4.22 (2%)	4.22 (2%)	4.22 (2%)	4.22 (2%)
Space Heat	26.53 (15%)	87.24 (42%)	86.31 (42%)	89.47 (43%)	26.04 (14%)
Heat Reject.	0.00 (0%)	0.45 (0%)	0.45 (0%)	0.45 (0%)	0.00 (0%)
Space Cool	1.05 (1%)	1.25 (1%)	1.25 (1%)	1.25 (1%)	1.05 (1%)
Total	183.07	206.32	205.45	208.50	182.67

The Long-Term Care Facility had similar results to the school. That is, to meet NECB requirements, capital construction costs would decrease in most cases but energy use would increase. The only exception to this relates to the NECB Envelope scenario in which construction cost increases and energy use decreases (for the long-term care facility, there is a marginal decline of 0.2% in energy consumption per year per m²).

In looking at the nine scenarios for both the school and the long-term care facility, the main findings are that it is less expensive to build to NECB requirements (seven of nine scenarios) but energy use is higher (seven of nine scenarios).

5.2 OVERALL BUILDING RESULTS

As both the school and long-term care facility gave similar results, the second phase of the study was to assess the overall impact of the NECB. The school and long-term care facility detailed studies assessed the impacts of both zone 6 and 7A NECB envelope thermal characteristics (zone 7A has more stringent requirements). As the study buildings chosen met the requirements of zone 6 and the difference between Zone 6 and 7A in terms of the savings ratio was minimal, the remaining buildings the remaining buildings were assessed using Zone 7A requirements to see if they still met the NECB requirements.

The one exception to this was the college campus building. This building is located in Labrador City which is in NECB climate zone 8. As well as being located in the most stringent climate zone for envelope requirements, the construction costs are also more expensive due to the remote location. In order to study the effects of the differing thermal transmittance requirements (see Table 5-5 below)of NECB zone 6, 7A and 8 as well as the associated construction costs, three college campus building studies were carried out.

Table 5-5: Zone Envelope Thermal Transmittance Requirements

Building Assembly	Zone 6	Zone 7A	Zone 8
	Thermal Transmittance (W/(m²·K)		
Roofs	0.183	0.162	0.142
Walls	0.247	0.210	0.183
Glazing	2.2	2.2	1.6

Table 5-6 below details each study that was carried out.

Table 5-6: Building Studies

Building No.	Building	Study	Envelope	Mechanical	Lighting	Description
1	Office	NECB, 7A	NECB-2011 (7A)	NECB-2011 (7A)	NECB-2011 (7A)	Baseline building compared against the NECB performance path with Zone 7A (instead of Zone 6) applied in its entirety.
2	Office	NECB, 7A	NECB-2011 (7A)	NECB-2011 (7A)	NECB-2011 (7A)	Baseline building compared against the NECB performance path with Zone 7A (instead of Zone 6) applied in its entirety.
4	College Campus	NECB	NECB-2011 (6)	NECB-2011 (6)	NECB-2011 (6)	Baseline building compared against the NECB performance path applied to in its entirety using Zone 6.
			NECB-2011 (7A)	NECB-2011 (7A)	NECB-2011 (7A)	Baseline building compared against the NECB performance path applied to in its entirety using Zone 7A.
			NECB-2011 (8)	NECB-2011 (8)	NECB-2011 (8)	Baseline building compared against the NECB performance path applied to in its entirety using Zone 8.

Building No.	Building	Study	Envelope	Mechanical	Lighting	Description
6	MURB	NECB, 7A	NECB-2011 (7A)	NECB-2011 (7A)	NECB-2011 (7A)	Baseline building compared against the NECB performance path with Zone 7A (instead of Zone 6) applied in its entirety.
7	Warehouse	NECB, 7A	NECB-2011 (7A)	NECB-2011 (7A)	NECB-2011 (7A)	Baseline building compared against the NECB performance path with Zone 7A (instead of Zone 6) applied in its entirety.

5.2.1 Baseline Energy Results

Current practice energy use intensity by study building is presented in Table 5-7. Results are reported in equivalent kilowatt hours per square meter per year (kWh/m2/year), a common set of units when reporting energy intensity.

Table 5-7: Baseline Energy Utilization

			kWh/m2/Year							
Building No.	Category	Building	Cooling	Heating	Service Hot Water	Ventilation	Pumps	Misc. Equip.	Lights	Total
1	Office	-	16	21	7	5	42	31	11	134
2		-	28	33	0	23	34	25	36	179
3	Education	School	5	68	9	9	9	9	17	125
4		College Campus	19	192	53	70	38	38	37	447
5	Health	Long-term Care Facility	1	27	4	35	19	26	70	183
6	MURB	-	0	76	21	96	0	7	15	216
7	Warehouse	-	1	58	1	4	0	21	11	97

The college campus, multi-unit residential building and long-term care facility buildings are the most energy intensive buildings, while the warehouse, school and office buildings are the least energy intensive. The college campus is a somewhat unique building within the buildings selected, given its location (climate zone 8) and the fact that, as a post-secondary training campus, it requires ventilation systems and specialized equipment not normally required in other buildings.

5.2.2 NECB Energy Results

Based on the upgrades, Table 5-8 summarizes the NECB scenario energy utilization intensity. A heat rejection (heat rejected from a cooling tower) column has been added to the NECB results table which was not featured in the baseline results. This is due to none of the baseline buildings having a cooling tower.

Table 5-8: NECB Energy Utilization

				kWh/m2/Year								
Building No.	Category	Building	Study	Cooling	Heat Reject	Heating	Service Hot Water	Ventilation	Pumps	Misc. Equip	Lights	Total
1	Office	-	NECB, 7A	6	3	86	6	5	11	31	25	176
2		-	NECB, 7A	15	0	129	0	33	37	25	28	268
3	Education	School	NECB, ASHPs	10	0	73	9	46	2	9	17	166
4			NECB	15	0	76	9	41	6	9	19	174
			NECB, 7A	15	0	73	9	41	6	9	19	171
			NECB, Base. Envelope	16	0	87	9	42	6	9	19	187
			NECB Envelope	5	0	65	9	8	9	9	17	122
		College Campus	NECB, 6	2	0	204	53	71	35	38	29	432
			NECB, 7A	2	0	197	53	70	35	38	29	424
			NECB, 8	2	0	191	53	69	35	38	29	416
5	Health	Long-term Care Facility	NECB	1	0	87	4	35	8	26	44	206
			NECB, 7A	1	0	86	4	35	8	26	44	205
			NECB, Base. Envelope	1	0	89	4	35	8	26	44	208
			NECB Envelope	1	0	26	4	35	19	26	70	183
6	MURB	-	NECB, 7A	0	0	138	21	52	0	7	16	235
7	Warehous	-	NECB, 7A	1	0	47	1	12	1	21	16	98

				kWh/m2/Year								
Building No.	Category	Building	Study	Cooling	Heat Reject	Heating	Service Hot Water	Ventilation	Pumps	Misc. Equip	Lights	Total
	e											

Table 5-9 summarizes the energy savings or increase between the baseline and NECB scenarios. The table also shows the breakdown between mechanical and lighting. Further detail is provided in Section 5.2 below.

Table 5-9: Energy Utilization Intensity Savings and Increases from NECB

Building No.	Category	Building	Study	Mechanical		Lighting		Total[9]	
				% Savings from NECB[10]	% Increase from NECB	% Savings from NECB	% Increase from NECB	% Savings from NECB	% Increase from NECB
1	Office	-	NECB, 7A	30%	-	34%	-	31%	-
2		-	NECB, 7A	81%	-	-	13%	49%	-
3	Education	School	NECB, ASHPs	41%	-	0%	-	33%	-
			NECB	47%	-	8%	-	39%	-
			NECB, 7A	45%	-	8%	-	37%	-
			NECB, Base. Envelope	61%	-	8%	-	50%	-
			NECB Envelope	-	3%	0%	-	-	3%
4		College Campus	NECB, 6	-	2%	-	10%	-	3%
			NECB, 7A	-	4%	-	10%	-	5%

[9] Total includes mechanical, electrical and envelope savings.
[10] Savings from NECB" represents signifies that the baseline building is performing better, and "increase from NECB" signifies that the baseline building is performing worse than NECB.

Building No.	Category	Building	Study	Mechanical		Lighting		Total[9]	
				% Savings from NECB[10]	% Increase from NECB	% Savings from NECB	% Increase from NECB	% Savings from NECB	% Increase from NECB
			NECB, 8	-	6%	-	10%	-	7%
5	Health	Long-Term Care Facility	NECB	57%	-	-	27%	13%	-
			NECB, 7A	56%	-	-	27%	12%	-
			NECB, Base. Envelope	60%	-	-	27%	14%	-
			NECB Envelope	0%	-	0%	-	0%	-
6	MURB	-	NECB, 7A	9%	-	5%	-	9%	-
7	Warehouse	-	NECB, 7A	-	4%	13%	-	1%	-

The key points are:

- For the school, the baseline building performed better in four of the five identified scenario, that is, the energy intensity in the baseline building is lower in four of the five scenarios. The exception was the NECB envelope scenario.
- For the long-term care facility, the baseline building performed better in three of four scenarios, and performed equally as well in the remaining scenario (i.e., the NECB Envelope scenario).
- For four of the remaining five buildings, that is, the office buildings, MURB and warehouse, the baseline building performed better than the NECB-7A scenario. In the case of the warehouse, however, the difference is marginal at 1 ekWh/m^2/year.
- For the remaining building, the college campus, the NECB scenario performed better than the baseline building. The main drivers of the improvement for the NECB scenario were cooling and lighting.
- From a component perspective, the baseline buildings perform generally perform better in terms of mechanical systems and lighting. In 11 of the 16 total scenarios in this study, the mechanical systems in the base building were better than in the policy scenario. For lighting, the base building performed as well or better in 9 of 16 scenarios.

As discussed previously in section 4.1, the building selection was limited to those buildings for which energy models are available. Additionally, a prerequisite of LEED is that the building has to perform at minimum, 25% better than the MNECB reference building. Buildings striving to achieve LEED Silver, as required by the Build Better Buildings Policy, would typically be targeting energy savings greater than the LEED requirements.

Most of the study baseline buildings are showing to be performing better than NECB, as they typically incorporate a relatively good thermal building envelope, heat recovery ventilation, efficient lighting and controls.

The percentage savings or increases in Table 5-9 differ from building -to -building. It is important to remember that the NECB performance path building's heating and cooling plant (if applicable) and lighting are dependent on the original building's function, therefore it is not a one-size-fits-all analysis. For example, building 1 has mostly office areas and is over two storeys in height; therefore as per the NECB performance path, system 6 is chosen for the NECB building. This is a multi-zone built up system with variable volume fan controls, a water cooled screw chiller, electric coils in AHU's and electric resistance baseboard. This is different to building 7 which has an office area which is less than 2 storeys and a non-refrigerated warehouse area. As per the NECB performance path, system 3 is chosen for the NECB building in the office area, which is a single zone packaged rooftop unit with electric baseboard heating. System 4 is chosen for the warehouse area, which is a single zone constant volume make-up air unit with electric baseboard heating. Further details on NECB HVAC System Selection and the system chosen for each building in this study can be found in Appendix B and C.

5.2.3 Impact by Building

Table 5-10 summarizes the construction cost increase/decrease between the baseline and NECB scenarios as well as the energy cost difference and, where appropriate, the discounted payback which takes into account the discount and escalation rates and the savings to ratio investment.

The concept of a payback period is that higher incremental construction costs to achieve an objective are offset by lower incremental operational costs on an annual basis. At some future point, cumulative incremental operational savings will exceed incremental construction costs, meaning that the building owner will be better off after an initial payback period.

A simple payback period is defined as the number of years it would take to recover a project's costs in todays' value of money. It does not incorporate aspects such as the time value of money and the cost of borrowing money. A discounted payback period is defined as the number of years it would take to recover a project's costs taking into account the time value of money and the cost of borrowing money (escalation and the discount rate). This is expressed in Table 5-10. The discount rate is an investors cost of borrowing money, and the escalation rate is the annual rate of increase in the price of a specific commodity such as electricity or fuel oil. Also included in the table is the net present value (NPV) at 25 years for each scenario and for each respective baseline building. The NPV at 25 years is the present value of total cash inflows from a project over 25 years, less cash outflows over that period, accounting for inflation and interest.

Table 5-10: Summary of Impacts

Study	Change in Energy Costs	Change in Construction Costs	Discount Payback Period	Discount Payback Period at which time building owner will be worse off	NPV At 25 Years Baseline Building	NPV At 25 years Scenario Building	Change in NPV
	Using base building as starting point		*Years*				*Relative to Baseline building*
Office Building 1, NECB 7A	$84,332	-$508,464		6.9	$34,652,697	$35,429,261	$776,564
Office Building 2 , NECB 7A	$206,039	-$962,345		4.5	$35,590,660	$37,767,703	$2,177,043
School, NECB, ASHPs	$35,770	-$769,808		34.2	$14,536,365	$14,371,549	-$164,816
School, NECB	$42,843	-$885,652		7.0	$14,536,365	$14,375,299	-$161,066
School , NECB 7A	$40,563	-$816,637		32.5	$14,536,365	$14,405,759	-$130,606
School, NECB Baseline Envelope	$54,430	-$940,370		19.8	$14,536,365	$14,516,549	-$19,816
School, NECB Envelope	-$2,866	$54,717	29.4		$14,536,365	$14,542,606	$6,241
College Campus, NECB 6	-$2,491	-$29,639	14.5		$22,452,687	$22,380,924	-$71,763

Study	Change in Energy Costs	Change in Construction Costs	Discount Payback Period	Discount Payback Period at which time building owner will be worse off	NPV At 25 Years Baseline Building	NPV At 25 years Scenario Building	Change in NPV
	Using base building as starting point		*Years*				*Relative to Baseline building*
College Campus, NECB 7A	-$3,780	$73,322	30.7		$22,452,687	$22,462,082	$9,395
College Campus, NECB 8	-$5,074	$300,108	100+		$22,452,687	$22,666,942	$214,255
Long Term Care Facility, NECB	$101,379	-$1,444,549		14.8	$46,304,534	$47,121,995	$817,461
Long Term Care Facility, NECB 7A	$98,883	-$1,267,036		11.9	$46,304,534	$47,251,470	$946,936
Long Term Care Facility, NECB Baseline Envelope	$107,543	-$1,726,574		16.3	$46,304,534	$46,958,253	$653,719
Long Term Care Facility, NECB Envelope	-$900	$859,022	100+		$46,304,534	$47,148,333	$843,799
MURB, NECB	$42,544	-$303,708		5.8	$51,358,905	$51,703,479	$344,574

Study	Change in Energy Costs	Change in Construction Costs	Discount Payback Period	Discount Payback Period at which time building owner will be worse off	NPV At 25 Years Baseline Building	NPV At 25 years Scenario Building	Change in NPV
	Using base building as starting point		*Years*				*Relative to Baseline building*
Warehouse, NECB 7A	$799	-$32,000		100+	$4,949,591	$4,929,760	-$19,831

In this study, the payback period concept applies in five scenarios only; School NECB Envelope, College Campus NECB 6, 7A & 8, and Long term Care Facility NECB Envelope. For the remaining 11 scenarios, lower incremental construction costs to meet NECB requirements will result in higher annual energy costs. This means that the building owners will realize the benefits of the lower construction costs for only 6.9 years before the effect of higher utility costs will start to take over. For example, for building 1, there will be a positive return for the first 6.9 years only, that is, cumulative incremental energy cost increases ($84,337 per year before escalation) will not offset incremental construction costs savings ($508,464 before discounting) for the first 6.9 years. Therefore, for years 1 to 6.9, the building owner will be better off, but from year 7 forward, the building owner will be worse off under the NECB policy scenario.

For 12 of the 16 scenarios, the baseline building is more expensive than the policy scenario. This means that capital construction costs would be lower to construct a building that met the NECB requirements.

These findings show that, generally, while it is less expensive to build to NECB requirements, energy use is higher.

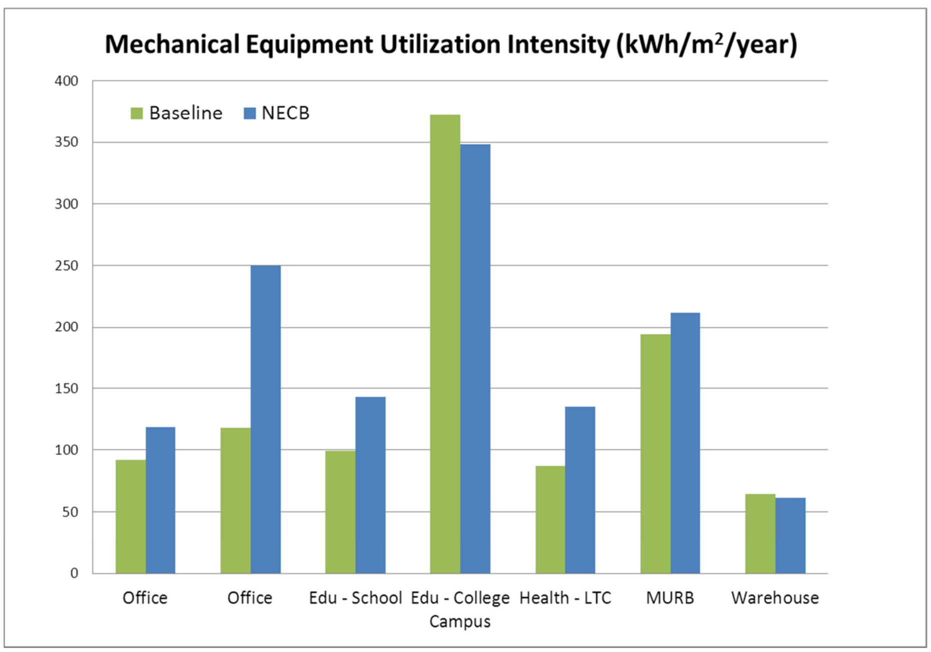
The college campus is located in Labrador City and for which the NECB climate zones 6, 7A and 8 were studied. It can be seen that by using the reduced thermal transmittance values of zones 6 and 7A, it does reduce the discount payback period, however the baseline building is never better in energy or construction costs than the NECB building, although by using the less stringent climate zones, it is closer to meeting the NECB standard. This does not mean that no building built in Labrador City will meet the NECB standard, as due to the study limitations, only one existing building model was available. However, further investigation is advised, as the increased construction costs (because of the remote location) will have a greater bearing on the discount payback period than if the building was in a populated area, such as St. John's.

5.3 MECHANICAL AND LIGHTING SYSTEMS

The buildings targeted in this study incorporate a wide range of energy efficient HVAC systems. Several facilities utilize heat recovery to extract heat exhausted from the building from washrooms and kitchens. In addition, some facilities also incorporate demand control ventilation into their HVAC systems through the use of CO_2 sensors.

Several facilities also incorporate the use of geothermal heat pumps[11] to supply heating and cooling to the building. Some facilities, through the use of heat exchangers, use the heat extracted from the ground source heat pumps to supply hydronic fluid to infloor heating systems. Other systems use the heat pumps to supply heating and cooling capabilities to heating coils in the air handling units. In addition, one building took advantage of the geographical location by using sea water to provide cooling for packaged Chillers/Heat Pumps via Shell & Tube Exchangers. Summarized model inputs are detailed in located in Appendix C.

Figure 6: Mechanical Systems Utilization Intensity



The graph above details the energy utilization intensity for the mechanical equipment. Each scenario depicts the baseline building against the same building that has had the NECB performance path using Zone 7A (instead of Zone 6) applied to it in its entirety. The lower the utilization intensity in kwh/m²/year, the better the building is performing. Due to the wide range of energy efficient HVAC measures described above it can be seen from the above Figure 9, that five of the seven buildings featured

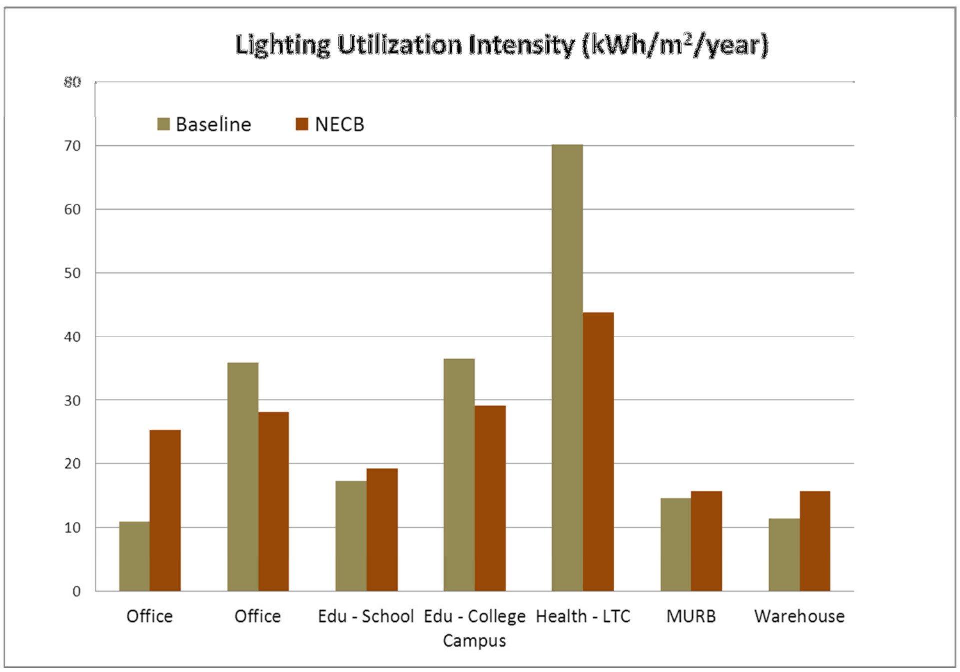
[11] A geothermal heat pump or ground source heat pump (GSHP) is a heating and/or cooling system that pumps heat to or from the ground.

in the study are surpassing the requirements of the NECB. That is, in five of seven cases, the utilization of the baseline building is lower than that for the NECB.

5.3.1 Lighting Systems

The graph below details the energy utilization intensity for the lighting. Each scenario depicts the baseline building against the same building that has had the NECB performance path using Zone 7A (instead of Zone 6) applied to it in its entirety. As with the mechanical utilization intensity graph, the lower the utilization intensity in kwh/m²/year, the better the building is performing. However as Figure 10 shows, four of the seven buildings featured in the study are surpassing the requirements of the NECB. That is, in four of seven cases, the lighting utilization of the baseline building is lower than that for the NECB.

Figure 7: Lighting Utilization Intensity



6.0 Discussion

6.1 LOCAL CONTEXT

Within the province, there are challenges to be addressed with regards to adopting the NECB:

There are high costs for building materials. Almost all building materials have to be transported to the province by ship with local distribution by road freight. Given the transportation network in the province, as well as long distances between towns, particularly in Labrador, building developers in rural areas often incur higher building costs. Crude estimates suggest, for example, that construction costs in Labrador City tend to be about 50% higher than for the St. John's area.

Within the province, about 42% of the population lives in St. John's and 6 other cities and towns with a population of 10,000 or more. Conversely, 47% of the population lives in municipalities or unincorporated areas with a population of less than 2,500 people. It is reasonable to expect that there will be greater challenges in adopting the NECB faced by these areas of Newfoundland and Labrador with less densely populated areas because there are a limited number of commercial buildings being constructed in these areas, and municipal councils may not have sufficient financial capacity to invest in skills training and active compliance measures.

Newfoundland and Labrador has no current energy code requirement for large commercial buildings (greater than 600 m^2 or 3 stories). Although for the most part, the study buildings had good mechanical and lighting systems, none of the buildings surpassed the NECB envelope thermal characteristic requirements under the prescriptive route even though all buildings have been built as part of the LEED initiative which typically calls for a better performing envelope. If the Province were to adopt the envelope requirements of the NECB under the prescriptive route only, there would be a leap from very little thermal requirements in the external wall assemblies to the stringent requirements of the NECB code. However, the flexibility inherent in the NECB allows the designer to achieve energy savings from an overall building perspective.

6.2 MECHANICAL AND LIGHTING SYSTEMS AND BUILDING ENVELOPE

The buildings used in this study have been registered with LEED and are therefore typically built to have good overall energy efficiency due to the LEED energy performance requirements. The buildings are shown to be mostly performing better than NECB, as the baseline buildings typically incorporate a relatively good thermal building envelope, heat recovery ventilation, efficient lighting and controls. Additionally, some buildings have a ground source or air source heat pump, further reducing demand on the building's electrical system. However the study can draw conclusions on what elements of the NECB have the biggest impact in terms of energy and cost reduction and payback, that is, it allows for trade-offs among various policy options to be identified.

It should be noted that LEED does not have prescriptive envelope requirements, however due the overall building performance criteria, architects are steered towards designing a better performing envelope.

As discussed in the results, section 5, the factors which have the largest impact include the mechanical and lighting systems. Upgrading these systems can be more expensive overall than upgrading the envelope; however, it has the potential to have a greater impact on energy reduction.

It must also be understood that having too little insulation will also reach a point that is economical unviable, i.e. the cost of additional energy needed to heat and cool a space will outweigh the advantages of the original construction cost savings of reducing the building insulation. However envelope design is not just about the thermal characteristics. Attention should be paid to building siting and orientation, the use of shading, solar reflectance, air infiltration and the window to wall ratio. These design elements are important in reducing energy consumption and an integrated building design must consider the envelope, HVAC system and the lighting system as a whole.

It is important to understand that a building can still meet the NECB energy requirements by using the calculation methodologies provided in the NECB to trade off a limited number of mandatory requirements while still demonstrating that the overall energy efficiency of the system has not been compromised. For example if it was found that it very costly to install insulation to the NECB standards, by installing mechanical equipment and lighting that performs considerably better than NECB, the overall energy efficiency of the building can still meet the NECB requirements. In order to demonstrate compliance, whole building simulation is used.

7.0 Conclusions

In its 2011 Energy Efficiency Action Plan, the provincial government committed to examine the case for adopting the 2011 National Energy Code for Buildings in Newfoundland and Labrador. The NECB applies to larger buildings (those over 600m^2 in size) which are typically commercial premises or multi-unit apartment blocks. The rationale for looking at the case for adopting the NECB for the province is that better energy efficiency can generate multiple benefits, including lowering energy costs.

In order to assess the appropriateness of the NECB for the province, analysis was needed to determine if it was technically feasible to build to the levels required in the NECB and what the costs and benefits would be. This study was focused on these issues. It did not explore in detail what training might be needed to support adoption of the NECB or issues associated with enforcement including capacity constraints and cost; these important matters are being separately examined.

Given resource constraints, the buildings selected needed to have energy models already developed on them. These models determine how the energy efficiency buildings are and allowed this study to compare their actual level of energy efficiency to that required by the NECB. Efforts were made to try and ensure the selection of building was as diverse as possible in terms of their function, size and location. One of the limitations is of this study is that there are only a limited number of buildings in the province that have energy models and the ones that do are usually striving to achieve LEED certification, which means that they are already incorporating energy efficient features into their design.

The study concluded that:

- It is possible to build to the standard required by the NECB for the four different climate zones (6, 7a, 7b, and 8) in Newfoundland and Labrador using the 'performance' path for compliance. In other words, the overall performance of the building in terms of energy use is at least as good as the standard required by the NECB but it is up to the building owner to determine how to achieve this standard. For example, the owner could choose from a better building envelope, more efficient mechanical and operating systems, more efficient lighting, or a blend of these measures.
- It would be challenging to build to the standard required by the NECB using the prescriptive path because of the NECB envelope requirements. The prescriptive path is an alternative means of compliance to the performance path and involves following the requirements laid out in the code for each of the five building systems (envelope, HVAC, lighting, service water heating and electrical systems). The study shows that most buildings would have no problem meeting the HVAC, lighting, service water heating and electrical systems requirements. However given the commonly used methods of envelope construction in the province, namely concrete block with rigid insulation and the use of curtain wall, the challenges of meeting the NECB envelope requirements, especially in the most stringent zones of 7B and 8 would be difficult. The challenges of complying with the prescriptive path would be to dispense with the aesthetically pleasing curtain wall and also to persuade the building owners to spend the additional capital required for

greater insulation requirements without perhaps seeing the equivalent cost savings in reduced energy costs.

- Evidence from NR Can suggests that building more energy efficient buildings in accordance with the NECB lowers energy costs. However, as shown by the baseline used in this study, it usually does not lower energy costs as much as building to the standard required to receive Leadership in Energy and Environmental Design certification. LEED does not have prescriptive architectural, mechanical and electrical requirements, however, it does have an overall building energy performance criteria and therefore it is not surprising that LEED buildings are better than an average building built in the Province.
- This analysis showed that, in almost all scenarios used, the capital construction cost is lower than for the base buildings which were striving to attain for LEED certification. However, building to NECB requirements would also have meant higher annual energy costs than the base building. That is, while capital costs would have been lower in four scenarios, energy costs on an ongoing basis would have been higher. The analysis also found that installing air-source heat pumps instead of the regular rooftop packaged units as per the NECB is more expensive to construct but gives more energy savings. Last, the analysis found that changing only the envelope is having the least impact.
- Improving the building envelope is an important way to cost-effectively reduce energy use in a building. However, improvements to the insulation have diminishing returns beyond a certain point. After this point, it becomes more cost effective to focus on improved mechanical and operating systems.

Other points to note are:

- There are higher costs for building materials in Labrador due to transportation and distribution challenges.
- Almost one-half of the province's population lives in municipalities or unincorporated areas with a population of less than 2,500 people. It is reasonable to expect that there will be a limited number of commercial buildings being constructed in these areas.
- The issues of skills training for all groups (designers, construction workers, building inspectors, etc.) and how to ensure compliance, require further consideration. These factors were not examined within the parameters of this study and should be considered in a broader dialogue with stakeholders when considering next steps.

APPENDIX A

MNECB versus NECB Comparison

Key Code Changes			
Component	**Description**	**Proposed Design Relative Influence**	**NECB-2011 Reference**
General	**Climate Zones and Heating Degree Days**		As per 1.1.4.1, the climatic values shall be in accordance with the values in the NBC-2010, Appendix C.
Exterior Surfaces	**Wall R-Value**	Weather	Select appropriate R value based on NEBC-2011 -Table 3.2.2.2. & 3.2.3.1.
	Wall Construction		Same construction as the proposed, Insulation thickness as required to make wall U value equal to prescriptive requirements.
	Roof R-Value	Weather	Select appropriate R value based on NEBC-2011 -Table 3.2.2.2. & 3.2.3.1.
	Roof Construction		Same construction as the proposed, Insulation thickness as required to make wall U value equal to prescriptive requirements.
	Infiltration	Same as Reference.	3.3.4.9 (6) Air leakage shall be set at a constant value of 0.25L/(s.m2) or (0.05 cfm/ft2) of gross above-ground wall and roof area (see A-8.4.3.4.(3) in Appendix A). Same as Proposed
	Glazing Percentage	Glazing Percentage	Table A3.2.1.4(1) Max glazing based on HDD, up to a max of 40%. Max. of 5% skylight area to gross roof area ratio on all above-ground roofs
	Window U-value	Weather	Select appropriate U value based on applicable region found in Table 3.2.2.3
	Window Shading Coefficient		No requirement.
	Shading Devices (Overhangs and Fins)		No requirement.
Electrical - Lighting & Equipment	**Lighting**		Lighting power allowance based on building type or space function, from Tables 4.2.1.5 or 4.2.1.6 respectively.
	Lighting Control - Occupancy Sensors		Where occupant sensors are required by subsection 4.2.2., the installed interior lighting power shall be multiplied by an adjustment factor of 0.9.
	Lighting Control - Daylight Sensors		Daylight Sensors required in enclosed space where primary side lighted area > 1,076 sq.ft. Also required in enclosed space where daylight area under skylights plus daylight area under rooftop monitors > 4,300 sq.ft
	Equipment Density	Same as reference.	Equipment power density based on building type or space function (NECB tables A-8.4.3.3.(1)A)
HVAC System Type	**Air Handling, Heating Fuel Type - Principal Heating Source & Cooling Source**	Building or Space Type	Reference HVAC type will one of 7 different types based on building use type as found in Table 8.4.4.8.A with descriptions of HVAC types found in Table 8.4.4.8.B
Fan System	**Fan Power**		Same as proposed
	Outside Air		Same as proposed
	Heat Recovery	Percent outside air.	Minimum of 50% when sensible heat content of exhaust exceeds 150 kW.
HVAC Control	**Economizer**	Proposed building and HVAC System	If proposed requires an economizer, reference economizer dependent on Reference HVAC system type (table 8.4.4.13(1))
	Demand Control Ventilation		No requirement
Heating Plant	**Boiler**	Gas/Oil principal heating source with hydronic heating.	8.4.4.10.(6) Fuel source same proposed. If proposed Hydronic system >176kW, single-stage boiler. Capacity >176kW but less than 352kW then 2 boilers equal size or 2 staged boiler that operates in stages with a 1:2 ratio. Capacity > 352kW mode a fully modulating boiler down to 25% of its capacity. 83% thermal efficiency.
	Furnace	Natural gas or fuel oil principal heating source without hydronic heating.	If capacity <66kW, the furnace has two stages of equal capacity, if capacity >66kW, divide the capacity by 66kW and round up. AFUE ≥ 92.4% for ≤ 400,000 Btu/h, 81% Thermal Efficiency for > 400,000 Btu/h
	Heat Pumps	Principal heating source as heat pump, cooling capacity and heating mode.	If the proposed HVAC system includes a WATER LOOP heat pump, the reference HVAC will be selected from Table 8.4.4.8.A. If Proposed HVAC includes air/water or ground source heat pump, reference HVAC will be air source heat pump as per Table 8.4.4.14
Cooling	**Chiller**	Hydronic cooling.	Capacity <2100kW model one water chiller. When capacity is >2100kW model two water chillers of equal capacity. Efficiency as per appropriate table 5.2.12.1.
	Cooling Tower	If hydronic cooling applies	Capacity <1750kW shall be modeled with one cell. > 1750kW capacity shall be modeled equals proposed capacity divided by 1750kW, rounded up.
	Direct Expansion (DX) Cooling	Cooling source (i.e.,. If DX).	If capacity <66kW, the furnace shall be modeled with two stages of equal capacity, and when capacity >66kW, divide the capacity by 66kW and round up. Efficiency as per appropriate table 5.2.12.1.
	Heat Pumps	Principal heating source as heat pump.	If proposed HVAC system includes a water loop heat pump, the reference HVAC will be selected from Table 8.4.4.8.A. If Proposed HVAC includes air/water or ground source heat pump, reference HVAC will be air-source heat pump as per Table 8.4.4.14. Efficiency as per appropriate table 5.2.12.1.
DHW	**Heating Fuel Source**	Electric	Electric resistance at 100% heating efficiency.
		Fossil (Natural Gas, Fuel Oil).	Varies from 77% - 80% (NECB table 6.2.2.1)
		Heat Pump	EF ≥ 2.1 (EF=energy factor, in %/h)

APPENDIX B

NECB Mechanical and Lighting Systems

The type of HVAC system assigned to each thermal block of the NECB performance path building is determined based on each thermal blocks building space type using table 8.4.4.8.A. with the corresponding descriptions in Table 8.4.4.8.B.

Table 8.4.4.8.A
HVAC System Selection for the Reference Building

Building or Space Type of the Proposed Building	Size of Building or Space(1)(2)	Type of HVAC System Required(3)
Assembly Area: exhibit space, conference/meeting/multi-purpose room, performing arts/motion picture theatre, courtroom classroom/lecture/training room, place of worship, fellowship hall, sports centre, arena and swimming pool seating area, waiting room	Maximum 4 storeys	System - 3
	More than 4 storeys	System - 6
Automotive Area: repair garage or parking garage, fire engine room, indoor truck dock, indoor bus or train platform	All sizes	System - 4
Data Processing Area: control room, data centre	All sizes	Where the proposed building or space has a cooling capacity exceeding 20 kW, the reference building or space shall use System - 2; otherwise, the reference building or space shall use System - 1.
General Area: office, banking, health care clinic, library, retail/mall concourse, gymnasium, athletic play area, swimming pool, exercise centre, dressing room, lighting control room, atrium	Maximum 2 storeys	System - 3
	More than 2 storeys	System - 6
Historical Collections Area: archival library, museum and gallery archives	All sizes	System - 2
Hospital Area: operating theatre, emergency room, patient/recovery room, clean room, hospital laboratories, forensics laboratory	All sizes	System - 3

Building or Space Type of the Proposed Building	Size of Building or Space(1)(2)	Type of HVAC System Required(3)
Indoor Arena: ice rinks, curling rinks	All sizes	System – 7
Industrial Area: industrial manufacturing and workshop without dust exhausting hood	All sizes	System - 3 Where the reference building or space is a single zone, it can be divided into multiple units as long as it matches the proposed building or space's units.
Residential/Accommodation Area: multi-unit residential, hotel/motel guest room	All sizes	Where the proposed building or space is room heated only, the reference building or space shall use System - 1. Where the proposed building or space is heated as well as being cooled with an air-cooled unitary, packaged terminal or room air-conditioner (or heat pumps), or fan coils, the reference building or space's HVAC system shall be modeled as being identical to that of the proposed building or space; otherwise, the reference building or space shall use through-the-wall systems.
Sleeping Area: dormitory, detention cell, sleeping quarters	All sizes	System - 3
Supermarket/Food Service Area: grocery store, bar lounge/leisure, cafeteria, fast food, family dining food preparation without kitchen hood or vented appliance(4) food preparation with kitchen hood or vented appliance(4)	All sizes All sizes	System - 3 System - 4
Warehouse Area: fine, medium and	All sizes of non-	System - 4

Building or Space Type of the Proposed Building	Size of Building or Space(1)(2)	Type of HVAC System Required(3)
bulky material storage, self-storage, material handling/sorting/baggage areas	refrigerated space	
	All sizes of refrigerated space	System - 5

Notes to Table 8.4.4.8.A.:
(1) Spaces generally located in the same vicinity shall be grouped together for the purpose of selecting the reference building's type of HVAC system.
(2) Small individual spaces in the proposed building that are located among larger spaces of another space type shall be considered ancillary to that larger space: for example, a conference room serving office spaces would be grouped with the office spaces as one space type. The HVAC system serving that space in the reference building shall be the same as the one for the larger space type.
(3) See Table 8.4.4.8.9. for descriptions of HVAC Systems 1 - 7.
(4) Vented appliances include, for example, steam dishwashers.

Table 8.4.4.8.B
Descriptions of HVAC Systems 1 - 7

System Number	Type of HVAC System	Fan Control Type	Type of Cooling System	Type of Heating System(1)
System-1	Unitary air-conditioner with baseboard heating	Constant-volume	Air-cooled direct-expansion with remote condenser	Hot water with fuel-fired water boiler or electric resistance baseboard.
System-2	Four-pipe fan-coil	Constant-volume	Water-cooled water chiller	Fuel-fired or electric resistance water boiler.
System-3	Single-zone packaged rooftop	Constant-volume	Air-cooled direct-expansion	Fuel-fired or electric resistance furnace for rooftop, hot water with fuel-fired boiler, or electric resistance for baseboards.
System-4	Single-zone make-up air unit	Constant-volume	Air-cooled direct-expansion	Make-up air unit: electric or indirect fuel-fired furnace.
				Baseboards: electric resistance or hydronic with fuel-fired boiler.
System-5	Two-pipe fan-coil(2)	Constant-volume	Water-cooled water chiller	None
System-6	Multi-zone built-up system with baseboard	Variable-volume	Water-cooled water chiller	Baseboards: electric resistance or hydronic with

	heating			fuel-fired boiler
System-7	Four-pipe fan-coil[2]	Constant-volume	Water-cooled water chiller	Hydronic with electric resistance or fuel-fired Boiler

Notes to Table 8.4.4.8.B:
(1) Where present, humidification systems shall use the same energy source as the heating system.
(2) Except for HVAC systems serving dwelling units, outside air requirements for the thermal blocks served by those systems shall be met by a single ventilation system able to meet all the required outside and exhaust air rates. For HVAC systems serving dwelling units, outside air requirements shall be met by a ventilation system identical to that of the proposed building.

The following table presents a comparison between the lighting power density requirements for both the MNECB and NECB by building type. For building types not listed in table 4.32.1 of the MNECB, the space function method lighting power densities from table 4.3.3.4 were used.

	Lighting Power Density (W/m²)		
Building Type	**MNECB 1997**	**NECB 2011**	**% decrease**
Automotive facility	3.2 [1]	8.8	-175%
Convention centre	19.4 [2]	11.6	40%
Courthouse	19.4 [2]	11.3	42%
Dining:			
bar lounge/leisure	15.1	10.7	29%
cafeteria/fast food	14	9.7	31%
family	15.1	9.6	36%
Dormitory	15.1 [3]	6.6	56%
Exercise centre	10.8 [4]	9.5	12%
Fire station	7.5 [5]	7.6	-1%
Gymnasium	10.8 [4]	10.8	0%
Health-care clinic	22.6	9.4	58%
Hospital	22.6	13	42%
Hotel	15.1 [7]	10.8	28%
Library	17.2 [8]	12.7	26%
Manufacturing facility	26.9 [9]	11.9	56%
Motel	15.1 [7]	9.5	37%
Motion picture theatre	16.2	8.9	45%
Multi-unit residential building	15.1 [7]	6.5	57%
Museum	20.4	11.4	44%
Office	16.2	9.7	40%
Parking garage	3.2 [10]	2.7	16%
Penitentiary	8.6	10.4	-21%
Performing arts theatre	16.2	15	7%
Police station	8.6	10.3	-20%
Post office	11.8	9.4	20%
Religious building	26.9	11.3	58%
Retail area	22.6	15.1	33%
School/university	18.3	10.7	42%
Sports arena	14	8.4	40%

	Lighting Power Density (W/m²)		
Building Type	**MNECB 1997**	**NECB 2011**	**% decrease**
Town hall	16.2 [11]	9.9	39%
Transportation	9.7 [12]	8.3	14%
Warehouse	4.3	7.1	-65%
Workshop	24.8 [13]	12.9	48%

1. Service station/Auto repair
2. Conference, meeting rooms
3. Bedroom with study
4. Gymnasium – General exercising and recreation
5. Fire engine room
6. Occupational therapy/physical therapy
7. Guest Rooms
8. Card file and cataloguing
9. Shop – Machinery
10. Inactive storage, general
11. Offices
12. Passenger stations and depots, concourse/main thruway
13. Shop – Carpentry

The building types with the largest percentage decrease include manufacturing facilities and dormitories with a 56% decrease, Multi-unit residential buildings with a 57% decrease and religious buildings and health-care clinics with a 58% decrease. There were five building types with an increase in lighting power density from the MNECB to the NECB. These include automotive facilities, warehouses, penitentiaries, and police and fire stations. The required lighting power density for gymnasiums is the same in both the MNECB and NECB.

APPENDIX C

Model Inputs

1. Office

Baseline versus NECB Performance Pathway, Zone 7A

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path with Zone 7A (instead of Zone 6) applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (7A)
Mechanical	NECB-2011 (7A)
Lighting	NECB-2011 (7A)

Description of Archetype: St. John's, Avalon, Newfoundland. This facility includes a 12 storey office tower and adjoining parking garage. The parking garage has not been included in the analysis.

Modelling Software: EE4

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 7A, 5000-5999 HDD	
Net Floor Area	13,970 m²	
Floors	12 above grade 1 below grade	
Roof construction	**Office Roof Construction:** Roofing Membranes, 2 Layers 3mm Protection Board, 100mm Rigid Insulation, Vapour Retarder, Sloped Concrete Roof Topping, Concrete Roof Deck. **Mechanical Penthouse Roof Construction:** Roofing Membranes, 2 Layers 3mm Protection Board, 100mm Rigid Insulation, Vapour Retarder, 12.5mm Exterior Grade Gypsum Board Sheathing, Metal Deck And Roof Framing.	
Roof U-value	**Office Roof Construction:** 0.218 W/m²K **Mechanical Penthouse Construction:** 0.226 W/m²K	U= 0.162 W/m²K
Wall construction	**Office Wall:** Insulated Aluminum Curtain Wall, Minimum 64 kg/m³ Density Mineral Wool Insulation. **Office & Mechanical Penthouse Wall Construction (W5):**	

1. Office

Baseline versus NECB Performance Pathway, Zone 7A

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path with Zone 7A (instead of Zone 6) applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (7A)
Mechanical	NECB-2011 (7A)
Lighting	NECB-2011 (7A)

Description of Archetype: St. John's, Avalon, Newfoundland. This facility includes a 12 storey office tower and adjoining parking garage. The parking garage has not been included in the analysis.

Modelling Software: EE4

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 7A, 5000-5999 HDD	
Net Floor Area	13,970 m²	
Floors	12 above grade 1 below grade	
Roof construction	**Office Roof Construction:** Roofing Membranes, 2 Layers 3mm Protection Board, 100mm Rigid Insulation, Vapour Retarder, Sloped Concrete Roof Topping, Concrete Roof Deck. **Mechanical Penthouse Roof Construction:** Roofing Membranes, 2 Layers 3mm Protection Board, 100mm Rigid Insulation, Vapour Retarder, 12.5mm Exterior Grade Gypsum Board Sheathing, Metal Deck And Roof Framing.	
Roof U-value	**Office Roof Construction:** 0.218 W/m^2K **Mechanical Penthouse Construction:** 0.226 W/m^2K	U= 0.162 W/m^2K
Wall construction	**Office Wall:** Insulated Aluminum Curtain Wall, Minimum 64 kg/m^3 Density Mineral Wool Insulation. **Office & Mechanical Penthouse Wall Construction (W5):** Horizontal Metal Siding, 125mm Metal Z-Bars @ 1220mm OC, 100mm Rigid Mineral Wool Insulation, Air Barrier Membrane, 190mm Concrete Block with Cores Filled.	

	Office & Mechanical Penthouse Wall Construction (W6A&B): Composite Wood Panel, 25mm U-Shape, 100mm Adjustable Metal Z-Bars @ 1220mm OC, 100mm Rigid Mineral Wool Insulation, Air Membrane, 190mm Concrete Block with Cores Filled. **Office Exterior Brick Wall:** 90mm Face Brick, 25mm Air Space, 100mm Rigid Mineral Wool Insulation, Air/Vapour Barrier, 12.5mm Exterior Grade Gypsum Board, 152mm Metal Stud Framing (405mm O.C.), 12.5mm Gypsum Board.	
Wall U-value	**Office Wall:** 0.223 W/m²K **Office & Mechanical Penthouse Wall Construction (W5):** 0.293 W/m²K **Office & Mechanical Penthouse Wall Construction (W6A&B):** 0.302 W/m²K **Office Exterior Brick Wall:** 0.274 W/m²K	U= 0.210 W/m²K
Glazing construction	Double Glazing with Thermally Broken Aluminium Frames.	
Glazing Properties	U-value: 1.41 W/m m²K Shading Coefficient: 0.32	U-value: 2.2 W/m m²K Shading Coefficient: 0.32
Shading	No shading (overhangs).	
Glazing Percentage	39%	
Lighting Power Density	3.7 W/m²	9.7 W/m²
Lighting Controls	Occupancy Sensors and Daylight Sensors in some Areas.	Occupancy Sensors in Office Areas, Conference, Meeting and Training Rooms, Employee Break Rooms, Storage Rooms up to , 100m², Enclosed Office Space up to 25m² and Washrooms/Locker Rooms.
Plug Loads	7.1 W/m²	
Ventilation System	AHU #1 (Serves all Levels): Multi-Zone, Variable Air Volume Unit	System - 6: Multi-Zone Built Up System with Variable Volume Fan Control
Fan Power	AHU #1: 1.12 W/l/s	
Minimum Outside Air	Per ASHRAE 62.1-2001	Per ASHRAE 62.1-2007

Heat Recovery	AHU #1: 0%	AHU #1: 50%
Economizers	None	AHU #1: Dual Enthalpy Economizer
Demand Control Ventilation	None	No Requirement
Heating System	Ground Source Water Cooled Chiller/Heat Pumps with two electric boilers sized for peak heating.	Electric Coils in AHU's and Electric Resistance Baseboard.
Heating efficiency	COP: 3.4	100%
Cooling System	Ground Source Water Cooled Chiller/Heat Pumps	Water Cooled Screw Chiller (modelled as Centrifugal in EE4 due to software limitations)
Cooling efficiency	COP: 4.6	COP: 6.1
Domestic Hot Water System	1 Electric Heater, 100% efficient	

2. Office

Baseline versus NECB Performance Pathway, Zone 7A

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path with Zone 7A (instead of Zone 6) applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (7A)
Mechanical	NECB-2011 (7A)
Lighting	NECB-2011 (7A)

Description of archetype: St. John's, Avalon, Newfoundland. The building consists of six (6) office floors and six (6) parking levels, with a restaurant and various retail spaces located on the main street level. The parking levels have not been included in the analysis. The domestic hot water has also not been included, as there was no domestic hot water modelled in the baseline building.

Modelling Software: eQUEST

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 7A, 5000-5999 HDD	
Net Floor Area	16,096m²	
Floors	7 above grade	
Roof construction	**Roof Construction:** 2 Ply SBS Modified Bituminous Membrane Roofing, 2 Layers of Mineral Wool Board Roof Insulation With RSI 0.65/25.4mm, Vapour Retardant, 1 Layer Substrate Board, Structural Metal Deck on Structural Support Framing.	
Roof U-value	**Roof Construction:** 0.183 W/m²K	U= 0.162 W/m²K
Wall construction	**Office Wall Construction:** Unitized Curtain Wall System – 60mm Air Space, 92mm metal studs @406mm OC Max, 13mm Gypsum Board.	
Wall U-value	**Wall Construction:** 0.187 W/m²K	U = 0.210 W/m²K
Glazing construction	Double Glazing with Thermally Broken Aluminium Frames.	

Glazing Properties	U-value: 1.39 W/m m²K Shading Coefficient: 0.45	U-value: 2.2 W/m m²K Shading Coefficient: 0.45
Shading	No shading (overhangs)	
Glazing Percentage	34%	
Lighting Power Density	11.80 W/m²	9.7 W/m²
Lighting Controls	Occupancy Sensors and Daylight Sensors in some areas.	Occupancy Sensors in Office Areas, Conference, Meeting and Training Rooms, Employee Break Rooms, Storage Rooms up to , 100m², Enclosed Office Space up to 25m² and Washrooms/Locker Rooms.
Plug Loads	8.93 W/m²	
Ventilation System	AHU #1-3 (Level 1, Retail, Lobby & Misc Areas): Multi-Zone Constant Volume Units. AHU #5-16 (Two per Office Level, Interior & Perimeter): Multi-Zone Variable Air Volume Units. AHU #17 (Fresh Air Unit for Office Levels): Multi-Zone Constant Volume Units.	System - 6: Multi-Zone Built Up Systems with Variable Volume Fan Control.
Fan Power	AHU #1: 2.43 W/l/s AHU #2: 1.91 W/l/s AHU #3: 2.56 W/l/s AHU #5-16 (Interior): 2.63 W/l/s AHU #5-16 (Exterior): 2.82 W/l/s AHU #17: 2.24 W/l/s	
Minimum Outside Air	Per ASHRAE 62.1-2001	Per ASHRAE 62.1-2007
Heat Recovery	AHU #1: 0% AHU #2: 0% AHU #3: 0% AHU #5-16 (Interior): 70% AHU #5-16 (Exterior): 70%	AHU #1: 0% AHU #2 : 0% AHU #3 : 0% AHU #5-16 (Interior): 50% AHU #5-16 (Exterior): 50%
Economizers	All AHU's: Outside Air Temperature Economizer	All AHU's: Dual Enthalpy Economizer
Demand Control Ventilation	CO_2 Sensors	No Requirement

Heating System	Packaged Chiller/Heat Pump connected to Seawater Loop via Shell & Tube Exchangers. Two electric boilers sized for peak heating.	Electric Coils in AHU's and Electric Resistance Baseboard.
Heating efficiency	COP: 4.35	100%
Cooling System	Packaged Chiller/Heat Pump connected to Seawater Loop via Shell & Tube Exchangers.	Water Cooled Screw Chiller
Cooling efficiency	COP: 4.35	COP: 5.67

3: Education – School

Baseline versus Baseline with Air Source Heat Pump (ASHP)

Description of Analysis: The baseline building is compared against the baseline building that has the NECB-2011 performance path applied to the mechanical systems but with air source heat pumps.

Parameter	Comparison
Envelope	No Change
Mechanical	NECB-2011 (ASHP)
Lighting	No Change

Description of Archetype: Torbay School, Avalon, Newfoundland. This facility includes classrooms, a library, and a gymnasium/theatre.

Modelling Software: eQUEST

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 6, 4800 HDD	
Net Floor Area	6,034 m^2	
Floors	2 above grade 0 below grade	
Roof construction	**Common Roof:** 2 ply modified membrane, RSI 4.0 Continuous Rigid Insulation, Steel Deck. **Metal Batten Roof:** Metal Covering, 13mm Gypsum Board, W/Steel Girts, Steel Deck.	
Roof U-value	**Common Roof:** U= 0.22 W/m^2K **Metal Batten Roof:** U= 0.58 W/m^2K	
Wall construction	**Brick Wall:** Brick Facing, 190mm Concrete Block, 64mm Rigid Insulation, Brick Facing. **Steel Wall:** 190mm Concrete Block, 100mm Rigid Insulation W/Z Bars, Steel Siding.	
Wall U-value	**Brick Wall:** U= 0.33 W/m^2K **Steel Wall:** U= 0.33 W/m^2K	
Glazing construction	Double Glazing with Thermally Broken Aluminium Frames.	

Glazing Properties	U-value: 1.65 W/m m^2K Shading Coefficient: 0.44	
Shading	No shading (overhangs)	
Glazing Percentage	9%	
Lighting Power Density	9.02 W/m^2	
Lighting Controls	Occupancy Sensors and Daylight Sensors in some areas.	
Plug Loads	9.0 W/m^2	
Ventilation System	AHU #1(Gym Unit): Multi-Zone, Constant Volume Unit AHU #2(Admin Unit): Multi-Zone, Variable Air Volume Unit AHU #3(Classroom Unit): Multi-Zone, Variable Air Volume Unit Terminal Units	Air Source Heat Pumps
Fan Power	AHU #1: 1.12 W/l/s AHU #2: 1.35 W/l/s (supply), 1.1 W/l/s (return) AHU #3: 1.58 W/l/s (supply), 1.26 W/l/s (return) Terminal Units: 0.49 W/l/s	
Minimum Outside Air	Per ASHRAE 62.1-2001	Per ASHRAE 62.1-2007
Heat Recovery	AHU #2: 50% AHU #3: 50%	AHU #1: 50% AHU #2: 50% AHU #3: 50%
Economizers	AHU-1: Outside Air Temperature Economizer	AHU-1: Dual Enthalpy Economizer
Demand Control Ventilation	CO_2 sensors	No Requirement
Heating System	Ground Source Heat Pumps	Electric Resistance Baseboard
Heating efficiency	COP: 4.3	100%
Cooling System	Ground Source Heat Pumps	Air Cooled Direct-Expansion
Cooling efficiency	EER 13.8	EER 9.7
Domestic Hot Water System	1 Electric Heater, 100% efficient	

3: Education – School

Baseline versus NECB Performance Pathway

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011
Mechanical	NECB-2011
Lighting	NECB-2011

Description of Archetype: Torbay School, Avalon, Newfoundland. This facility includes classrooms, a library, and a gymnasium/theatre.

Modelling Software: eQUEST

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 6, 4800 HDD	
Net Floor Area	6,034 m²	
Floors	2 above grade 0 below grade	
Roof construction	**Common Roof:** 2 ply modified membrane, RSI 4.0 Continuous Rigid Insulation, Steel Deck. **Metal Batten Roof:** Metal Covering, 13mm Gypsum Board, W/Steel Girts, Steel Deck.	
Roof U-value	**Common Roof:** U= 0.22 W/m²K **Metal Batten Roof:** U= 0.58 W/m²K	U= 0.183 W/m²K
Wall construction	**Brick Wall:** Brick Facing, 190mm Concrete Block, 64mm Rigid Insulation, Brick Facing. **Steel Wall:** 190mm Concrete Block, 100mm Rigid Insulation W/Z Bars, Steel Siding.	
Wall U-value	**Brick Wall:** U= 0.33 W/m²K **Steel Wall:** U= 0.33 W/m²K	U= 0.247 W/m²K
Glazing construction	Double Glazing with Thermally Broken Aluminium Frames.	
Glazing Properties	U-value: 1.65 W/m m²K Shading Coefficient: 0.44	U-value: 2.2 W/m m²K Shading Coefficient: 0.44

Shading	No shading (overhangs)	
Glazing Percentage	9%	
Lighting Power Density	9.02 W/m²	10.7 W/m²
Lighting Controls	Occupancy Sensors and Daylight Sensors in some areas.	Occupancy Sensors in Classrooms, Employee Break Rooms, Storage Rooms up to , 100m², Office Space up to 25m² and Washrooms/Locker Rooms.
Plug Loads	9.0 W/m²	
Ventilation System	AHU #1(Gym Unit): Multi-Zone, Constant Volume Unit AHU #2(Admin Unit): Multi-Zone, Variable Air Volume Unit AHU #3(Classroom Unit): Multi-Zone, Variable Air Volume Unit Terminal Units	System - 3: Single Zone Packaged Rooftop Units
Fan Power	AHU #1: 1.12 W/l/s AHU #2: 1.35 W/l/s (supply), 1.1 W/l/s (return) AHU #3: 1.58 W/l/s (supply), 1.26 W/l/s (return) Terminal Units: 0.49 W/l/s	
Minimum Outside Air	Per ASHRAE 62.1-2001	Per ASHRAE 62.1-2007
Heat Recovery	AHU #2: 50% AHU #3: 50%	AHU #1: 50% AHU #2: 50% AHU #3: 50%
Economizers	AHU #1: Outside Air Temperature Economizer	AHU #1: Dual Enthalpy Economizer
Demand Control Ventilation	CO_2 sensors	No Requirement
Heating System	Ground Source Heat Pumps	Electric Coils in Rooftop Units and Electric Resistance Baseboard
Heating efficiency	COP: 4.3	100%
Cooling System	Ground Source Heat Pumps	Air Cooled Direct-Expansion
Cooling efficiency	EER 13.8	EER 9.7
Domestic Hot Water System	1 Electric Heater, 100% efficient	

3: Education – School

Baseline versus NECB Performance Pathway, Zone 7A

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path with Zone 7A (instead of Zone 6) applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (7A)
Mechanical	NECB-2011 (7A)
Lighting	NECB-2011 (7A)

Description of Archetype: Torbay School, Avalon, Newfoundland. This facility includes classrooms, a library, and a gymnasium/theatre.

Modelling Software: eQUEST

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 6, 4800 HDD	
Net Floor Area	6,034 m²	
Floors	2 above grade 0 below grade	
Roof construction	**Common Roof:** 2 ply modified membrane, RSI 4.0 Continuous Rigid Insulation, Steel Deck. **Metal Batten Roof:** Metal Covering, 13mm Gypsum Board, W/Steel Girts, Steel Deck.	
Roof U-value	**Common Roof:** U= 0.22 W/m²K **Metal Batten Roof:** U= 0.58 W/m²K	U= 0.162 W/m²K
Wall construction	**Brick Wall:** Brick Facing, 190mm Concrete Block, 64mm Rigid Insulation, Brick Facing. **Steel Wall:** 190mm Concrete Block, 100mm Rigid Insulation W/Z Bars, Steel Siding.	
Wall U-value	**Brick Wall:** U= 0.33 W/m²K **Steel Wall:** U= 0.33 W/m²K	U= 0.210 W/m²K
Glazing construction	Double Glazing with Thermally Broken Aluminium Frames.	
Glazing Properties	U-value: 1.65 W/m m²K Shading Coefficient: 0.44	U-value: 2.2 W/m m²K Shading Coefficient: 0.44

Shading	No shading (overhangs)	
Glazing Percentage	9%	
Lighting Power Density	9.02 W/m^2	10.7 W/m^2
Lighting Controls	Occupancy Sensors and Daylight Sensors in some areas.	Occupancy Sensors in Classrooms, Employee Break Rooms, Storage Rooms up to , 100m^2, Office Space up to 25m^2 and Washrooms/Locker Rooms.
Plug Loads	9.0 W/m^2	
Ventilation System	AHU #1(Gym Unit): Multi-Zone, Constant Volume Unit AHU #2(Admin Unit): Multi-Zone, Variable Air Volume Unit AHU #3(Classroom Unit): Multi-Zone, Variable Air Volume Unit Terminal Units	System - 3: Single Zone Packaged Rooftop Units
Fan Power	AHU #1: 1.12 W/l/s AHU #2: 1.35 W/l/s (supply), 1.1 W/l/s (return) AHU #3: 1.58 W/l/s (supply), 1.26 W/l/s (return) Terminal Units: 0.49 W/l/s	
Minimum Outside Air	Per ASHRAE 62.1-2001	Per ASHRAE 62.1-2007
Heat Recovery	AHU #2: 50% AHU #3: 50%	AHU #1: 50% AHU #2: 50% AHU #3: 50%
Economizers	AHU-1: Outside Air Temperature Economizer	AHU-1: Dual Enthalpy Economizer
Demand Control Ventilation	CO_2 sensors	No Requirement
Heating System	Ground Source Heat Pumps	Electric Coils in Rooftop Units and Electric Resistance Baseboard
Heating efficiency	COP: 4.3	100%
Cooling System	Ground Source Heat Pumps	Air Cooled Direct-Expansion
Cooling efficiency	EER 13.8	EER 9.7
Domestic Hot Water System	1 Electric Heater, 100% efficient	

3: Education – School

<u>Baseline versus NECB Performance Pathway with Baseline Envelope</u>

Description of Analysis: The baseline building is compared against a building that has the baseline envelope and the NECB performance path applied to the mechanical systems and lighting.

Parameter	Comparison
Envelope	No Change
Mechanical	NECB-2011
Lighting	NECB-2011

Description of Archetype: Torbay School, Avalon, Newfoundland. This facility includes classrooms, a library, and a gymnasium/theatre.

Modelling Software: eQUEST

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 6, 4800 HDD	
Net Floor Area	6,034 m²	
Floors	2 above grade 0 below grade	
Roof construction	**Common Roof:** 2 ply modified membrane, RSI 4.0 Continuous Rigid Insulation, Steel Deck. **Metal Batten Roof:** Metal Covering, 13mm Gypsum Board, W/Steel Girts, Steel Deck.	
Roof U-value	**Common Roof:** U= 0.22 W/m²K **Metal Batten Roof:** U= 0.58 W/m²K	
Wall construction	**Brick Wall:** Brick Facing, 190mm Concrete Block, 64mm Rigid Insulation, Brick Facing. **Steel Wall:** 190mm Concrete Block, 100mm Rigid Insulation W/Z Bars, Steel Siding.	
Wall U-value	**Brick Wall:** U= 0.33 W/m²K **Steel Wall:** U= 0.33 W/m²K	
Glazing construction	Double Glazing with Thermally Broken Aluminium Frames.	

Glazing Properties	U-value: 1.65 W/m m²K Shading Coefficient: 0.44	
Shading	No shading (overhangs)	
Glazing Percentage	9%	
Lighting Power Density	9.02 W/m²	10.7 W/m²
Lighting Controls	Occupancy Sensors and Daylight Sensors in some areas.	Occupancy Sensors in Classrooms, Employee Break Rooms, Storage Rooms up to , 100m², Office Space up to 25m² and Washrooms/Locker Rooms.
Plug Loads	9.0 W/m²	
Ventilation System	AHU #1(Gym Unit): Multi-Zone, Constant Volume Unit AHU #2(Admin Unit): Multi-Zone, Variable Air Volume Unit AHU #3(Classroom Unit): Multi-Zone, Variable Air Volume Unit Terminal Units	System - 3: Single Zone Packaged Rooftop Units
Fan Power	AHU #1: 1.12 W/l/s AHU #2: 1.35 W/l/s (supply), 1.1 W/l/s (return) AHU #3: 1.58 W/l/s (supply), 1.26 W/l/s (return) Terminal Units: 0.49 W/l/s	
Minimum Outside Air	Per ASHRAE 62.1-2001	Per ASHRAE 62.1-2007
Heat Recovery	AHU #2: 50% AHU #3: 50%	AHU #1: 50% AHU #2: 50% AHU #3: 50%
Economizers	AHU #1: Outside Air Temperature Economizer	AHU #1: Dual Enthalpy Economizer
Demand Control Ventilation	CO_2 sensors	No Requirement
Heating System	Ground Source Heat Pumps	Electric Coils in Rooftop Units and Electric Resistance Baseboard
Heating efficiency	COP: 4.3	100%
Cooling System	Ground Source Heat Pumps	Air Cooled Direct-Expansion
Cooling efficiency	EER 13.8	EER 9.7
Domestic Hot Water System	1 Electric Heater, 100% efficient	

3: Education – School

Baseline versus Baseline with NECB Envelope

Description of Analysis: The baseline building is compared against the baseline building with an NECB envelope.

Parameter	Comparison
Envelope	NECB-2011
Mechanical	No Change
Lighting	No Change

Description of Archetype: Torbay School, Avalon, Newfoundland. This facility includes classrooms, a library, and a gymnasium/theatre.

Modelling Software: eQUEST

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 6, 4800 HDD	
Net Floor Area	6,034 m²	
Floors	2 above grade 0 below grade	
Roof construction	**Common Roof:** 2 ply modified membrane, RSI 4.0 Continuous Rigid Insulation, Steel Deck. **Metal Batten Roof:** Metal Covering, 13mm Gypsum Board, W/Steel Girts, Steel Deck.	
Roof U-value	**Common Roof:** U= 0.22 W/m²K **Metal Batten Roof:** U= 0.58 W/m²K	U= 0.183 W/m²K
Wall construction	**Brick Wall:** Brick Facing, 190mm Concrete Block, 64mm Rigid Insulation, Brick Facing. **Steel Wall:** 190mm Concrete Block, 100mm Rigid Insulation W/Z Bars, Steel Siding.	
Wall U-value	**Brick Wall:** U= 0.33 W/m²K **Steel Wall:** U= 0.33 W/m²K	U= 0.247 W/m²K
Glazing construction	Double Glazing with Thermally Broken Aluminium Frames.	
Glazing Properties	U-value: 1.65 W/m m²K Shading Coefficient: 0.44	U-value: 2.2 W/m m²K Shading Coefficient: 0.44

Shading	No shading (overhangs)	
Glazing Percentage	9%	
Lighting Power Density	9.02 W/m²	
Lighting Controls	Occupancy Sensors and Daylight Sensors in some areas.	
Plug Loads	9.0 W/m²	
Ventilation System	AHU #1(Gym Unit): Multi-Zone, Constant Volume Unit AHU #2(Admin Unit): Multi-Zone, Variable Air Volume Unit AHU #3(Classroom Unit): Multi-Zone, Variable Air Volume Unit Terminal Units	
Fan Power	AHU #1: 1.12 W/l/s AHU #2: 1.35 W/l/s (supply), 1.1 W/l/s (return) AHU #3: 1.58 W/l/s (supply), 1.26 W/l/s (return) Terminal Units: 0.49 W/l/s	
Minimum Outside Air	Per ASHRAE 62.1-2001	Per ASHRAE 62.1-2007
Heat Recovery	AHU #2: 50% AHU #3: 50%	
Economizers	AHU #1: Outside Air Temperature Economizer	
Demand Control Ventilation	CO_2 sensors	
Heating System	Ground Source Heat Pumps	
Heating efficiency	COP: 4.3	
Cooling System	Ground Source Heat Pumps	
Cooling efficiency	EER 13.8	
Domestic Hot Water System	1 Electric Heater, 100% efficient	

4. Education – College Campus

Baseline versus NECB Performance Pathway

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path with Zone 6 (instead of Zone 8) applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (6)
Mechanical	NECB-2011
Lighting	NECB-2011

Description of archetype: Labrador City, Newfoundland. This facility includes classrooms, a library, electrical, mechanical and welding shops, and a computer lab.

Modelling Software: eQUEST

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 6, 4760 HDD	
Net Floor Area	4,515 m2	
Floors	1 above grade 0 below grade	
Roof construction	**Roof Construction:** 2 Ply Modified Roofing System, 2 Layers of 3mm Thick Asphalt Recovery Board, Tapered Insulation as Required, Rigid Polyisocyanurate Insulation, Vapour Retarder, 12.7mm Gypsum Board, Metal Deck	
Roof U-value	**Roof Construction:** U= 0.153 W/m²K	U= 0.183 W/m²K
Wall construction	**Main Area & Lobby Wall:** 12.7 Gypsum Board, 152mm Structural Metal Studs @ 400mm O.C, 16mm Cement Board, Air Barrier, RSI 3.8 Polyisocyanurate Insulation, 25mm Air Space, Composite Wall Panels on Supporting Z-Bars @ 1200mm O.C. **Workshop Wall:** 190mm Concrete Block, Preformed Insulated Metal siding RSI 4.0.	
Wall U-value	**Main Area & Lobby Wall:** U= 0.273 W/m²K **Workshop Wall:** U= 0.289 W/m²K	U= 0.247 W/m²K
Glazing construction	Triple Glazing with Thermally Broken Aluminium Frames.	

Glazing Properties	**Windows: U-value:** 2.2 W/m m^2K Shading Coefficient: 0.37 **Skylight: U-value:** 5.7 W/m m^2K Shading Coefficient: 0.37	U-value: 2.2 W/m m^2K Shading Coefficient: 0.37
Shading	No shading (overhangs)	
Glazing Percentage	Windows: 10% Skylight: 0.4%	
Lighting Power Density	School: 9.4 W/m^2 Shop: 6.8 W/m^2	School: 10.7 W/m^2 Shop: 12.9 W/m^2
Lighting Controls	Occupancy Sensors and Daylight Sensors in some Areas.	Occupancy Sensors in Classrooms, Employee Break Rooms, Storage Rooms up to , 100m^2, Office Space up to 25m^2 and Washrooms/Locker Rooms. Daylight Sensors in Skylight Area.
Plug Loads	School: 10.3 W/m^2 Shop: 4.8 W/m^2	
Ventilation System	AHU #1(General Area): Variable Air Volume AHU #2(Shop): Constant Volume AHU #3(Fresh Air Unit for Shop): Supply & Exhaust	School: System - 3: Single Zone Packaged Rooftop Units with Baseboard Heating Shop: System - 4: Single Zone Constant Volume Make-Up Air Unit with Baseboard Heating
Fan Power	AHU #1: 1.39 W/l/s AHU #2: 1.36 W/l/s AHU #3: 1.39 W/l/s (supply), 1.26 W/l/s (exhaust)	
Minimum Outside Air	Per ASHRAE 62.1-2001	Per ASHRAE 62.1-2007
Heat Recovery	AHU #1: 68% AHU #2: 68%	PSZ's: 50%
Economizers	Dual Enthalpy Economizer	
Demand Control Ventilation	CO_2 sensors (except shop areas)	No requirement
Heating System	School: Electric preheat and reheat and electric resistance baseboard. Shop: Electric coils and reheat and electric resistance baseboard.	System - 3: Electric Resistance for Rooftop and Baseboards System - 4: Electric Coil Make-up Air Unit
Heating efficiency	100%	100%

Cooling System	Air Cooled Direct-Expansion	Air Cooled Direct-Expansion
Cooling efficiency	COP: 2.9	EER: 13/10.6 Dependent on capacity of NECB-2011 Unit
Domestic Hot Water System	2 Electric Heaters	

4. Education – College Campus

Baseline versus NECB Performance Pathway

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path with Zone 7A (instead of Zone 8) applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (7A)
Mechanical	NECB-2011
Lighting	NECB-2011

Description of archetype: Labrador City, Newfoundland. This facility includes classrooms, a library, electrical, mechanical and welding shops, and a computer lab.

Modelling Software: eQUEST

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 7A, 5000-5999 HDD	
Net Floor Area	4,515 m2	
Floors	1 above grade 0 below grade	
Roof construction	**Roof Construction:** 2 Ply Modified Roofing System, 2 Layers of 3mm Thick Asphalt Recovery Board, Tapered Insulation as Required, Rigid Polyisocyanurate Insulation, Vapour Retarder, 12.7mm Gypsum Board, Metal Deck	
Roof U-value	**Roof Construction:** U= 0.153 W/m²K	U= 0.162 W/m²K
Wall construction	**Main Area & Lobby Wall:** 12.7 Gypsum Board, 152mm Structural Metal Studs @ 400mm O.C, 16mm Cement Board, Air Barrier, RSI 3.8 Polyisocyanurate Insulation, 25mm Air Space, Composite Wall Panels on Supporting Z-Bars @ 1200mm O.C. **Workshop Wall:** 190mm Concrete Block, Preformed Insulated Metal siding RSI 4.0.	
Wall U-value	**Main Area & Lobby Wall:** U= 0.273 W/m²K **Workshop Wall:** U= 0.289 W/m²K	U= 0.210 W/m²K
Glazing construction	Triple Glazing with Thermally Broken Aluminium Frames.	

Glazing Properties	**Windows: U-value:** 2.2W/m m^2K Shading Coefficient: 0.37 **Skylight: U-value:** 5.7 W/m m^2K Shading Coefficient: 0.37	U-value: 2.2 W/m m^2K Shading Coefficient: 0.37
Shading	No shading (overhangs)	
Glazing Percentage	Windows: 10% Skylight: 0.4%	
Lighting Power Density	School: 9.4 W/m² Shop: 6.8 W/m²	School: 10.7 W/m² Shop: 12.9 W/m²
Lighting Controls	Occupancy Sensors and Daylight Sensors in some Areas.	Occupancy Sensors in Classrooms, Employee Break Rooms, Storage Rooms up to , 100m², Office Space up to 25m² and Washrooms/Locker Rooms. Daylight Sensors in Skylight Area.
Plug Loads	School: 10.3 W/m² Shop: 4.8 W/m²	
Ventilation System	AHU #1(General Area): Variable Air Volume AHU #2(Shop): Constant Volume AHU #3(Fresh Air Unit for Shop): Supply & Exhaust	School: System - 3: Single Zone Packaged Rooftop Units with Baseboard Heating Shop: System - 4: Single Zone Constant Volume Make-Up Air Unit with Baseboard Heating
Fan Power	AHU #1: 1.39 W/l/s AHU #2: 1.36 W/l/s AHU #3: 1.39 W/l/s (supply), 1.26 W/l/s (exhaust)	
Minimum Outside Air	Per ASHRAE 62.1-2001	Per ASHRAE 62.1-2007
Heat Recovery	AHU #1: 68% AHU #2: 68%	PSZ's: 50%
Economizers	Dual Enthalpy Economizer	
Demand Control Ventilation	CO_2 sensors (except shop areas)	No requirement
Heating System	School: Electric preheat and reheat and electric resistance baseboard. Shop: Electric coils and reheat and electric resistance baseboard.	System - 3: Electric Resistance for Rooftop and Baseboards System - 4: Electric Coil Make-up Air Unit
Heating efficiency	100%	

Cooling System	Air Cooled Direct-Expansion	
Cooling efficiency	COP: 2.9	EER: 13/10.6 Dependent on capacity of NECB-2011 Unit.
Domestic Hot Water System	2 Electric Heaters	

4. Education – College Campus

Baseline versus NECB Performance Pathway

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011
Mechanical	NECB-2011
Lighting	NECB-2011

Description of archetype: Labrador City, Newfoundland. This facility includes classrooms, a library, electrical, mechanical and welding shops, and a computer lab.

Modelling Software: eQUEST

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 8, 7710 HDD	
Net Floor Area	4,515 m2	
Floors	1 above grade 0 below grade	
Roof construction	**Roof Construction:** 2 Ply Modified Roofing System, 2 Layers of 3mm Thick Asphalt Recovery Board, Tapered Insulation as Required, Rigid Polyisocyanurate Insulation, Vapour Retarder, 12.7mm Gypsum Board, Metal Deck	
Roof U-value	**Roof Construction:** U= 0.153 W/m²K	U= 0.142 W/m²K
Wall construction	**Main Area & Lobby Wall:** 12.7 Gypsum Board, 152mm Structural Metal Studs @ 400mm O.C, 16mm Cement Board, Air Barrier, RSI 3.8 Polyisocyanurate Insulation, 25mm Air Space, Composite Wall Panels on Supporting Z-Bars @ 1200mm O.C. **Workshop Wall:** 190mm Concrete Block, Preformed Insulated Metal siding RSI 4.0.	
Wall U-value	**Main Area & Lobby Wall:** U= 0.273 W/m²K **Workshop Wall:** U= 0.289 W/m²K	U= 0.183 W/m²K
Glazing construction	Triple Glazing with Thermally Broken Aluminium Frames.	

Glazing Properties	**Windows: U-value:** 2.2W/m m²K Shading Coefficient: 0.37 **Skylight: U-value:** 5.7 W/m m²K Shading Coefficient: 0.37	U-value: 1.6 W/m m²K Shading Coefficient: 0.37
Shading	No shading (overhangs)	
Glazing Percentage	Windows: 10% Skylight: 0.4%	
Lighting Power Density	School: 9.4 W/m² Shop: 6.8 W/m²	School: 10.7 W/m² Shop: 12.9 W/m²
Lighting Controls	Occupancy Sensors and Daylight Sensors in some Areas.	Occupancy Sensors in Classrooms, Employee Break Rooms, Storage Rooms up to , 100m², Office Space up to 25m² and Washrooms/Locker Rooms. Daylight Sensors in Skylight Area.
Plug Loads	School: 10.3 W/m² Shop: 4.8 W/m²	
Ventilation System	AHU #1(General Area): Variable Air Volume AHU #2(Shop): Constant Volume AHU #3(Fresh Air Unit for Shop): Supply & Exhaust	School: System - 3: Single Zone Packaged Rooftop Units with Baseboard Heating Shop: System - 4: Single Zone Constant Volume Make-Up Air Unit with Baseboard Heating
Fan Power	AHU #1: 1.39 W/l/s AHU #2: 1.36 W/l/s AHU #3: 1.39 W/l/s (supply), 1.26 W/l/s (exhaust)	
Minimum Outside Air	Per ASHRAE 62.1-2001	Per ASHRAE 62.1-2007
Heat Recovery	AHU #1: 68% AHU #2: 68%	PSZ's: 50%
Economizers	Dual Enthalpy Economizer	
Demand Control Ventilation	CO_2 sensors (except shop areas)	No requirement
Heating System	School: Electric preheat and reheat and electric resistance baseboard. Shop: Electric coils and reheat and electric resistance baseboard.	System - 3: Electric Resistance for Rooftop and Baseboards System - 4: Electric Coil Make-up Air Unit
Heating efficiency	100%	100%

Cooling System	Air Cooled Direct-Expansion	Air Cooled Direct-Expansion
Cooling efficiency	COP: 2.9	EER: 13/10.6 Dependent on capacity of NECB-2011 Unit
Domestic Hot Water System	2 Electric Heaters	

5. Health - Long-Term Care Home Facility

Baseline versus NECB Performance Pathway

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011
Mechanical	NECB-2011
Lighting	NECB-2011

Description of archetype: Corner Brook, Western, Newfoundland. This facility includes patient rooms, kitchens, a recreation room, lounges, and a gift shop

Modelling Software: EE4

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 6, 4760 HDD	
Net Floor Area	15,515 m²	
Floors	4 above grade 1 below grade	
Roof construction	**Roof construction:** Cap Sheet, 3mm Recovery Board, 6mm Glass Mat Gypsum Board, Tapered Insulation as Required, 100mm Polyisocyanurate Insulation, Vapour Barrier, 13mm Glass Mat Gypsum Board, Metal Deck, Structural Steel.	
Roof U-value	**Roof construction:** 0.219 W/m²K	U= 0.183 W/m²K
Wall construction	**Brick Wall:** 90mm Concrete Block, Air Space, 50mm Semi Rigid Insulation, Masonry Ties, Air Barrier, 13mm Glass Mat Gypsum Board, 152mm Structural Studs(600mm O.C.), RSI 3.5 Mineral Fiber Insulation, 0.15mm Polyethylene Vapor Barrier, 13mm Gypsum Board. **Curtain Wall:** Extruded Aluminum, Thermally Broken, Double Glazed Curtain Wall Assembly OR Single Glazed Spandrel Panel;150mm Semi Rigid Insulation and Metal Back Pan,64mm Structural Studs (600 O.C.), 2-13mm Gypsum Board.	
Wall U-value	**Brick Wall:** U= 0.257 W/m²K **Curtain Wall:** U= 0.643 W/m²K	U= 0.247 W/m²K
Glazing construction	Double Glazing with Thermally Broken Aluminium Frames.	

Glazing Properties	Operable: U-value: 2.97 W/m m²K Fixed: U-value: 2.15 W/m m²K Shading Coefficient: 0.3	U-value: 2.2 W/m m²K Shading Coefficient: 0.3
Shading	Shading Over Main Entrance, Loading Area	
Glazing Percentage	10%	
Lighting Power Density	13.7 W/m²	9.4 W/m²
Lighting Controls	Occupancy Sensors and Daylight Sensors in some Areas.	Occupancy Sensors in Storage Rooms up to 100m², Office Space up to 25m² and Washrooms/Locker Rooms. No occupancy sensors are required where patient care is rendered.
Plug Loads	26.3 W/m²	
Ventilation System	AHU #3(Core 1st): Supply & Return AHU #4(Core 2nd-4th): Supply & Return AHU #5/6(Kitchen Hood): Supply & Return only AHU #7(Laundry): Supply only Fan Coils: North & South Wings	Core Areas: System - 6: Multi-Zone Built Up Systems with Fuel Fired Oil Boiler and Hot Water Baseboard Heating. Residential Wings: Equal to baseline.
Fan Power	AHU #3: 1.57 W/l/s (supply), 0.85 W/l/s (return) AHU #4: 1.42 W/l/s (supply), 0.87 W/l/s (return) AHU #5/6: 1.70 W/l/s (supply) & 1.71 W/l/s (return)	
Minimum Outside Air	Per ASHRAE 62.1-2001	Per ASHRAE 62.1-2007
Heat Recovery	AHU #3: 0% AHU #4: 0% AHU #5/6: 40% AHU #7: 40% Fan Coils: 67% (North), 59% (South)	AHU #3: 50% AHU #4: 50% AHU #5/6: 50% AHU #7: 0% Fan Coils: 67% (North), 59% (South)
Economizers	AHU #3: Dual Enthalpy Economizer AHU #4: Dual Enthalpy Economizer AHU #5/6: Fixed Enthalpy Economizer AHU #7: Fixed Enthalpy Economizer	AHU #3: Dual Enthalpy Economizer AHU #4: Dual Enthalpy Economizer AHU #5/6: Dual Enthalpy Economizer AHU #7: Dual Enthalpy Economizer
Demand Control Ventilation	None	No Requirement

Heating System	Ground Source Heat Pumps with in-floor radiant heating	Two Oil Fuel Fired boilers
Heating efficiency	COP: 3.1	83.4%
Cooling System	Ground Source Heat Pumps	One Water Cooled Chiller
Cooling efficiency	COP: 5.7	COP: 4.509 IPLV: 5.582
Domestic Hot Water System	2 Electric Heaters, 75kW each.	

5. Health - Long-Term Care Home Facility

Baseline versus NECB Performance Pathway, Zone 7A

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path with Zone 7A (instead of Zone 6) applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (7A)
Mechanical	NECB-2011 (7A)
Lighting	NECB-2011 (7A)

Description of archetype: Corner Brook, Western, Newfoundland. This facility includes patient rooms, kitchens, a recreation room, lounges, and a gift shop

Modelling Software: EE4

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 7A, 5000-5999 HDD	
Net Floor Area	15,515 m²	
Floors	4 above grade 1 below grade	
Roof construction	**Roof construction:** Cap Sheet, 3mm Recovery Board, 6mm Glass Mat Gypsum Board, Tapered Insulation as Required, 100mm Polyisocyanurate Insulation, Vapour Barrier, 13mm Glass Mat Gypsum Board, Metal Deck, Structural Steel.	
Roof U-value	**Roof construction:** 0.219 W/m²K	U= 0.162 W/m²K
Wall construction	**Brick Wall:** 90mm Concrete Block, Air Space, 50mm Semi Rigid Insulation, Masonry Ties, Air Barrier, 13mm Glass Mat Gypsum Board, 152mm Structural Studs(600mm O.C.), RSI 3.5 Mineral Fiber Insulation, 0.15mm Polyethylene Vapor Barrier, 13mm Gypsum Board. **Curtain Wall:** Extruded Aluminum, Thermally Broken, Double Glazed Curtain Wall Assembly OR Single Glazed Spandrel Panel;150mm Semi Rigid Insulation and Metal Back Pan,64mm Structural Studs (600 O.C.), 2-13mm Gypsum Board.	
Wall U-value	**Brick Wall:** U= 0.257 W/m²K **Curtain Wall:** U= 0.643 W/m²K	U= 0.210 W/m²K
Glazing construction	Double Glazing with Thermally Broken Aluminium Frames.	

Glazing Properties	Operable: U-value: 2.97 W/m m²K Fixed: U-value: 2.15 W/m m²K Shading Coefficient: 0.3	U-value: 2.2 W/m m²K Shading Coefficient: 0.3
Shading	Shading Over Main Entrance, Loading Area	
Glazing Percentage	10%	
Lighting Power Density	13.7 W/m²	9.4 W/m²
Lighting Controls	Occupancy Sensors and Daylight Sensors in some Areas.	Occupancy Sensors in Storage Rooms up to 100m², Office Space up to 25m² and Washrooms/Locker Rooms. No occupancy sensors are required where patient care is rendered.
Plug Loads	26.3 W/m²	
Ventilation System	AHU #3(Core 1st): Supply & Return AHU #4(Core 2nd-4th): Supply & Return AHU #5/6(Kitchen Hood): Supply & Return only AHU #7(Laundry): Supply only Fan Coils: North & South Wings	Core Areas: System - 6: Multi-Zone Built Up Systems with Fuel Fired Oil Boiler and Hot Water Baseboard Heating. Residential Wings: Equal to baseline.
Fan Power	AHU #3: 1.57 W/l/s (supply), 0.85 W/l/s (return) AHU #4: 1.42 W/l/s (supply), 0.87 W/l/s (return) AHU #5/6: 1.70 W/l/s (supply) & 1.71 W/l/s (return)	
Minimum Outside Air	Per ASHRAE 62.1-2001	Per ASHRAE 62.1-2007
Heat Recovery	AHU #3: 0% AHU #4: 0% AHU #5/6: 40% AHU #7: 40% Fan Coils: 67% (North), 59% (South)	AHU #3: 50% AHU #4: 50% AHU #5/6: 50% AHU #7: 0% Fan Coils: 67% (North), 59% (South)
Economizers	AHU #3: Dual Enthalpy Economizer AHU #4: Dual Enthalpy Economizer AHU #5/6: Fixed Enthalpy Economizer AHU #7: Fixed Enthalpy Economizer	AHU #3: Dual Enthalpy Economizer AHU #4: Dual Enthalpy Economizer AHU #5/6: Dual Enthalpy Economizer AHU #7: Dual Enthalpy Economizer
Demand Control Ventilation	None	No Requirement

Heating System	Ground Source Heat Pumps with in-floor radiant heating	Two Oil Fuel Fired boilers
Heating efficiency	COP: 3.1	83.4%
Cooling System	Ground Source Heat Pumps	One Water Cooled Chiller
Cooling efficiency	COP: 5.7	COP: 4.509 IPLV: 5.582
Domestic Hot Water System	2 Electric Heaters, 75kW each.	

5. Health - Long-Term Care Home Facility

Baseline versus Performance Pathway with Baseline Envelope

Description of Analysis: The baseline building is compared against a building that has the baseline envelope and the NECB performance path applied to the mechanical systems and lighting.

Parameter	Comparison
Envelope	No Change
Mechanical	NECB-2011
Lighting	NECB-2011

Description of archetype: Corner Brook, Western, Newfoundland. This facility includes patient rooms, kitchens, a recreation room, lounges, and a gift shop

Modelling Software: EE4

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 6, 4760 HDD	
Net Floor Area	15,515 m²	
Floors	4 above grade 1 below grade	
Roof construction	**Roof construction:** Cap Sheet, 3mm Recovery Board, 6mm Glass Mat Gypsum Board, Tapered Insulation as Required, 100mm Polyisocyanurate Insulation, Vapour Barrier, 13mm Glass Mat Gypsum Board, Metal Deck, Structural Steel.	
Roof U-value	**Roof construction:** 0.219 W/m²K	
Wall construction	**Brick Wall:** 90mm Concrete Block, Air Space, 50mm Semi Rigid Insulation, Masonry Ties, Air Barrier, 13mm Glass Mat Gypsum Board, 152mm Structural Studs(600mm O.C.), RSI 3.5 Mineral Fiber Insulation, 0.15mm Polyethylene Vapor Barrier, 13mm Gypsum Board. **Curtain Wall:** Extruded Aluminum, Thermally Broken, Double Glazed Curtain Wall Assembly OR Single Glazed Spandrel Panel;150mm Semi Rigid Insulation and Metal Back Pan,64mm Structural Studs (600 O.C.), 2-13mm Gypsum Board.	
Wall U-value	**Brick Wall:** U= 0.257 W/m²K **Curtain Wall:** U= 0.643 W/m²K	

Glazing construction	Double Glazing with Thermally Broken Aluminium Frames.	
Glazing Properties	Operable: U-value: 2.97 W/m m²K Fixed: U-value: 2.15 W/m m²K Shading Coefficient: 0.3	
Shading	Shading Over Main Entrance, Loading Area	
Glazing Percentage	10%	
Lighting Power Density	13.7 W/m²	9.4 W/m²
Lighting Controls	Occupancy Sensors and Daylight Sensors in some Areas.	Occupancy Sensors in Storage Rooms up to 100m², Office Space up to 25m² and Washrooms/Locker Rooms. No occupancy sensors are required where patient care is rendered.
Plug Loads	26.3 W/m²	
Ventilation System	AHU #3(Core 1st): Supply & Return AHU #4(Core 2nd-4th): Supply & Return AHU #5/6(Kitchen Hood): Supply & Return only AHU #7(Laundry): Supply only Fan Coils: North & South Wings	Core Areas: System - 6: Multi-Zone Built Up Systems with Fuel Fired Oil Boiler and Hot Water Baseboard Heating. Residential Wings: Equal to baseline.
Fan Power	AHU #3: 1.57 W/l/s (supply), 0.85 W/l/s (return) AHU #4: 1.42 W/l/s (supply), 0.87 W/l/s (return) AHU #5/6: 1.70 W/l/s (supply) & 1.71 W/l/s (return)	
Minimum Outside Air	Per ASHRAE 62.1-2001	Per ASHRAE 62.1-2007
Heat Recovery	AHU #3: 0% AHU #4: 0% AHU #5/6: 40% AHU #7: 40% Fan Coils: 67% (North), 59% (South)	AHU #3: 50% AHU #4: 50% AHU #5/6: 50% AHU #7: 0% Fan Coils: 67% (North), 59% (South)
Economizers	AHU #3: Dual Enthalpy Economizer AHU #4: Dual Enthalpy Economizer AHU #5/6: Fixed Enthalpy Economizer AHU #7: Fixed Enthalpy Economizer	AHU #3: Dual Enthalpy Economizer AHU #4: Dual Enthalpy Economizer AHU #5/6: Dual Enthalpy Economizer AHU #7: Dual Enthalpy Economizer

Demand Control Ventilation	None	No Requirement
Heating System	Ground Source Heat Pumps with in-floor radiant heating	Two Oil Fuel Fired boilers
Heating efficiency	COP: 3.1	83.4%
Cooling System	Ground Source Heat Pumps	One Water Cooled Chiller
Cooling efficiency	COP: 5.7	COP: 4.509 IPLV: 5.582
Domestic Hot Water System	2 Electric Heaters, 75kW each	

5. Health - Long-Term Care Home Facility

Baseline versus Baseline with NECB Envelope

Description of Analysis: The baseline building is compared against the baseline building with an NECB envelope.

Parameter	Comparison
Envelope	NECB-2011
Mechanical	No Change
Lighting	No Change

Description of archetype: Corner Brook, Western, Newfoundland. This facility includes patient rooms, kitchens, a recreation room, lounges, and a gift shop

Modelling Software: EE4

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 6, 4760 HDD	
Net Floor Area	15,515 m²	
Floors	4 above grade 1 below grade	
Roof construction	**Roof construction:** Cap Sheet, 3mm Recovery Board, 6mm Glass Mat Gypsum Board, Tapered Insulation as Required, 100mm Polyisocyanurate Insulation, Vapour Barrier, 13mm Glass Mat Gypsum Board, Metal Deck, Structural Steel.	
Roof U-value	**Roof construction:** 0.219 W/m²K	U= 0.183 W/m²K
Wall construction	**Brick Wall:** 90mm Concrete Block, Air Space, 50mm Semi Rigid Insulation, Masonry Ties, Air Barrier, 13mm Glass Mat Gypsum Board, 152mm Structural Studs(600mm O.C.), RSI 3.5 Mineral Fiber Insulation, 0.15mm Polyethylene Vapor Barrier, 13mm Gypsum Board. **Curtain Wall:** Extruded Aluminum, Thermally Broken, Double Glazed Curtain Wall Assembly OR Single Glazed Spandrel Panel;150mm Semi Rigid Insulation and Metal Back Pan,64mm Structural Studs (600 O.C.), 2-13mm Gypsum Board.	
Wall U-value	**Brick Wall:** U= 0.257 W/m²K **Curtain Wall:** U= 0.643 W/m²K	U= 0.247 W/m²K
Glazing construction	Double Glazing with Thermally Broken Aluminium Frames.	

Glazing Properties	Operable: U-value: 2.97 W/m m²K Fixed: U-value: 2.15 W/m m²K Shading Coefficient: 0.3	U-value: 2.2 W/m m²K Shading Coefficient: 0.3
Shading	Shading Over Main Entrance, Loading Area	
Glazing Percentage	10%	
Lighting Power Density	13.7 W/m²	
Lighting Controls	Occupancy Sensors and Daylight Sensors in some Areas.	
Plug Loads	26.3 W/m²	
Ventilation System	AHU #3(Core 1st): Supply & Return AHU #4(Core 2nd-4th): Supply & Return AHU #5/6(Kitchen Hood): Supply & Return AHU #7(Laundry): Supply only Fan Coils: North & South Wings	
Fan Power	AHU #3: 1.57 W/l/s (supply), 0.85 W/l/s (return) AHU #4: 1.42 W/l/s (supply), 0.87 W/l/s (return) AHU #5/6: 1.70 W/l/s (supply) & 1.71 W/l/s (return)	
Minimum Outside Air	Per ASHRAE 62.1-2001	
Heat Recovery	AHU #3: 0% AHU #4: 0% AHU #5/6: 40% AHU #7: 40% Fan Coils: 67% (North), 59% (South)	
Economizers	AHU #3: Dual Enthalpy Economizer AHU #4: Dual Enthalpy Economizer AHU #5/6: Fixed Enthalpy Economizer AHU #7: Fixed Enthalpy Economizer	
Demand Control Ventilation	None	
Heating System	Ground Source Heat Pumps with in-floor radiant heating	
Heating efficiency	COP: 3.1	
Cooling System	Ground Source Heat Pumps	

Cooling efficiency	COP: 5.7
Domestic Hot Water System	2 Electric Heaters, 75kW each

6. Multi-Unit Residential Building

Baseline versus NECB Performance Pathway, Zone 7A

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path with Zone 7A (instead of Zone 6) applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (7A)
Mechanical	NECB-2011 (7A)
Lighting	NECB-2011 (7A)

Description of archetype: St. John's, Avalon, Newfoundland. The Memorial University Residences (MUN Residences) at the St. John's Campus comprises of two 7-storey wings and a 2-storey central hub.

Modelling Software: EE4

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 7A, 5000-5999 HDD	
Net Floor Area	15,694m²	
Floors	7 above grade	
Roof construction	**Common Roof:** Cap Sheet, Base Sheet, 3mm Recover Board, 6mm Glass Mat Gypsum board, Tapered EPS, 100mm Polyiso Rigid Insulation, Vapour Barrier Membrane, Metal deck. **Penthouse & Hub Roof:** Cap Sheet, Base Sheet, 3mm Recover Board, 6mm Glass Mat Gypsum board, 100mm Polyiso Rigid Insulation, Vapour Barrier Membrane, 13mm Glass Mat Board, Metal deck.	
Roof U-value	**Common Roof:** 0.183 W/m²K **Penthouse & Hub Roof::** 0.225 W/m²K	U= 0.162 W/m²K
Wall construction	**Common Wall:** 90mm CMU, 25mm Air Space, 50mm Semi-Rigid Fibrous Rock Insulation, Masonry Ties, Air Barrier Membrane, 13mm Glass Mat Gypsum Board, 152mm Structural Metal Studs @ 600mm O.C, RSI 3.5 Batt Insulation, 0.15mm Polyethylene Vapour Barrier, 16mm VHI Gypsum Board. **Stairwell Wall:** 90mm CMU, 25mm Air Space, 75mm Semi-Rigid Fibrous Rock Insulation, Masonry Ties, Air Barrier Membrane, Reinforced Concrete Wall. **Penthouse Wall:** Standing Seam Metal Roof, 75mm Z-Bars @ 600mm	

	O.C, 50mm semi-rigid Fibrous Rock Insulation, 13mm Glass Mat Gypsum board, 152mm Structural Metal Studs @ 600mm O.C, RSI 3.5 Batt Insulation, 0.15mm Polyethylene Vapour Barrier, Metal Liner Panel. **First Floor, Lower Wall:** Existing Reinforced Concrete, 50mm XPS Rigid Insulation, 0.15mm Polyethylene Vapour Barrier, 150mm Reinforced Concrete. **Curtain Wall (Spandrel):** Insulated Spandrel Panel, 152 Structural Metal Studs @ 600mm O.C, 16mm VHI Gypsum Board.	
Wall U-value	**Common Wall:** 0.275 W/m^{2}K **Stairwell Wall:** 0.390 W/m^{2}K **Penthouse Wall:** 0.283 W/m^{2}K **First Floor, Lower Wall:** 0.481 W/m^{2}K **Curtain Wall (Spandrel):** 0.729 W/m^{2}K	U=0.210 W/m^{2}K
Glazing construction	Double Glazing with Thermally Broken Aluminium Frames.	
Glazing Properties	U-value: 1.76 W/m m^{2}K Shading Coefficient: 0.44	U-value: 2.2 W/m m^{2}K Shading Coefficient: 0.44
Shading	No shading (overhangs)	
Glazing Percentage	17%	
Lighting Power Density	Common Areas: 6.9 W/m^2 Bedrooms: 7.4 W/m^2	Common Areas: 6.9 W/m^2 Bedrooms: 7.4 W/m^2
Lighting Controls	Occupancy Sensors and Daylight Sensors in some areas.	Occupancy Sensors in Conference, Meeting and Training Rooms, Storage Rooms up to 100m^2 and Washrooms.
Plug Loads	Common Areas: 1.1 W/m^2 Bedrooms: 2.5 W/m^2	
Ventilation System	HRV #1 & 2, East & West, HRV #3, East & West: Heat recovery ventilators, 100% fresh air. Electric Baseboard heating.	System - 6 (Common Areas): Multi-Zone Built Up Systems with Variable Volume Fan Control, Water Cooled Chiller, and Electric Resistance Baseboard Heating. System 1 (Bedrooms): Unitary Air Conditioner with Electric Resistance Baseboard.
Fan Power	HRV #1 & 2, East & West: 2.96 W/l/s HRV #3, East & West: 3.16 W/l/s	
Minimum Outside Air	Per ASHRAE 62.1-2001	Per ASHRAE 62.1-2007

Heat Recovery	HRV #1 & 2, East & West: 54% HRV #3, East & West: 71%	Common Areas, AHU #1 & 2: 50% Bedrooms, Unitary A/C Units: 0%
Economizers	N/A (100% OA)	All AHU's: Dual Enthalpy Economizer
Demand Control Ventilation	None	No Requirement
Heating System	Electric Resistance in HRVs and baseboards.	Electric Coils in AHU's and Electric Resistance Baseboard.
Heating efficiency	100%	100%
Cooling System	No Cooling	No Cooling
Cooling efficiency	N/A	N/A
Domestic Hot Water System	1 Electric Heater, 100% efficient	

7. Warehouse

Baseline versus NECB Performance Pathway, Zone 7A

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path with Zone 7A (instead of Zone 6) applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (7A)
Mechanical	NECB-2011 (7A)
Lighting	NECB-2011 (7A)

Description of archetype: Mount Pearl, Avalon, Newfoundland. This facility includes a Warehouse, with an Electrical Room, Storage room and Sprinkler room.

Modelling Software: eQUEST

Key parameters of archetype:

Model Parameter	Archetype value (Baseline)	Archetype Value (NECB-2011)
Climate Zone and Heating Degree Days (HDD 18°C)	Zone 7A, 5000-5999 HDD	
Net Floor Area	3,808 m²	
Floors	1 above grade	
Roof construction	**Roof Construction:** 2 Ply Modified Roofing membrane, 5mm Semi Rigid Protection Board, R40 (7") Polyiso Insulation, Self-Adhered Roof Membrane, Metal Roof Deck, O.W.S.J.	
Roof U-value	**Roof Construction:** 0.142 W/m²K	U= 0.162 W/m²K
Wall construction	**Wall Construction:** 13mm GWB, 64mm Steel Stud (406mm O.C), 13mm Air Space, Vapour Barrier, 100mm Insulation, 152mm Tilt Up Wall	
Wall U-value	**Wall Construction:** 0.284 W/m²K	U= 0.210 W/m²K
Glazing construction	Double Glazing with Thermally Broken Aluminium Frames. Aluminium framed skylight	

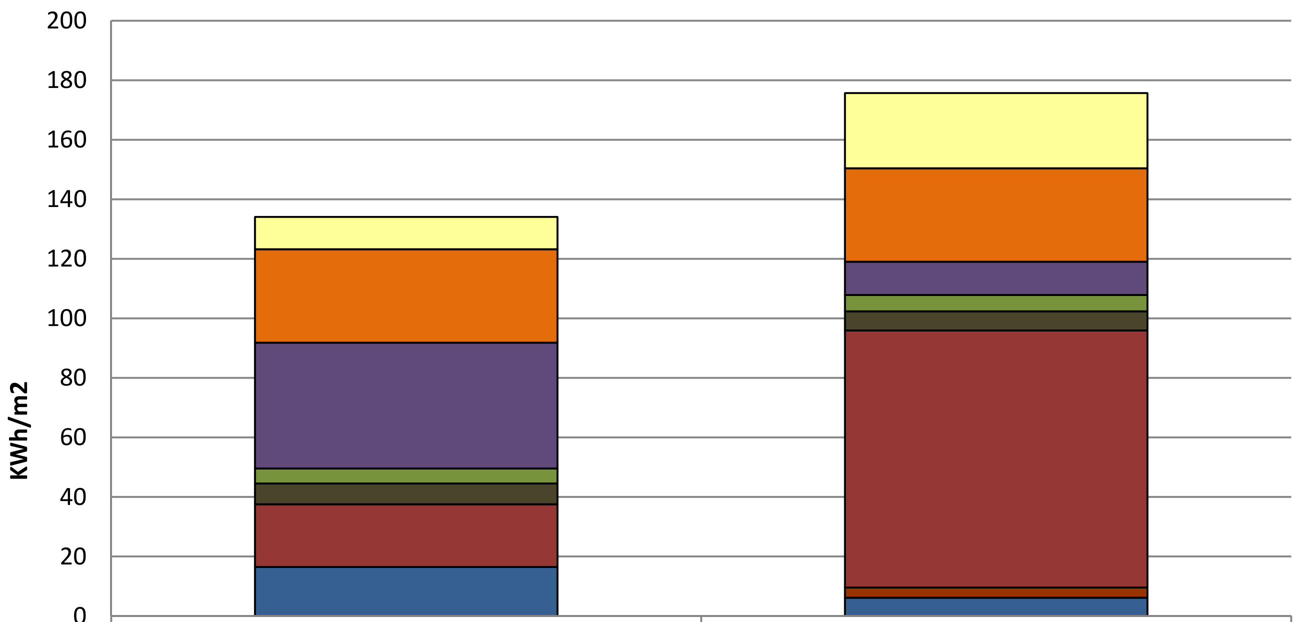
Glazing Properties	Windows: U-value: 2.6 W/m m²K Shading Coefficient: 0.42 Skylight: U-value: 2.2 W/m m²K Shading Coefficient: 0.42	U-value: 2.2 W/m m²K Shading Coefficient: 0.42
Shading	No shading (overhangs)	
Glazing Percentage	Windows: 0.9% Skylight: 1.5%	
Lighting Power Density	Office: 5.8 W/m² Warehouse: 5.8 W/m²	Office: 9.7 W/m² Warehouse: 7.1 W/m²
Lighting Controls	Toggle Switches, Occupancy Sensors in Smaller Rooms	Occupancy Sensors in Office Areas and Washrooms/Locker Rooms. Daylight Sensors in Skylight Area.
Plug Loads	Office: 7.0 W/m² Warehouse: 16.1 W/m²	
Ventilation System	Five Identical HRV units	Office: System - 3: Single Zone Packaged Rooftop Units with Baseboard Heating System - 4: Single Zone Constant Volume Make-Up Air Unit with Baseboard Heating
Fan Power	0.877 W/l/s (5 identical units)	
Minimum Outside Air	Per ASHRAE 62.1-2001	Per ASHRAE 62.1-2007
Heat Recovery	HRV's: 70%	PSZ: 50%
Economizers	HRV's: Outside Air Temperature Economizer	PSZ: Dual Enthalpy Economizer
Demand Control Ventilation	CO_2 sensors	No Requirement
Heating System	Electric Heaters	System - 3: Electric Resistance for Rooftop and Baseboards System - 4: Electric Coil Make-up Air Unit
Heating efficiency	100%	
Cooling System	Air Cooled Direct-Expansion	

Cooling efficiency	COP: 2.9	EER: 13/10.7/10.6 Dependent on capacity of NECB-2011 Unit
Domestic Hot Water System	1 Electric Heater, 100% efficient	

APPENDIX D

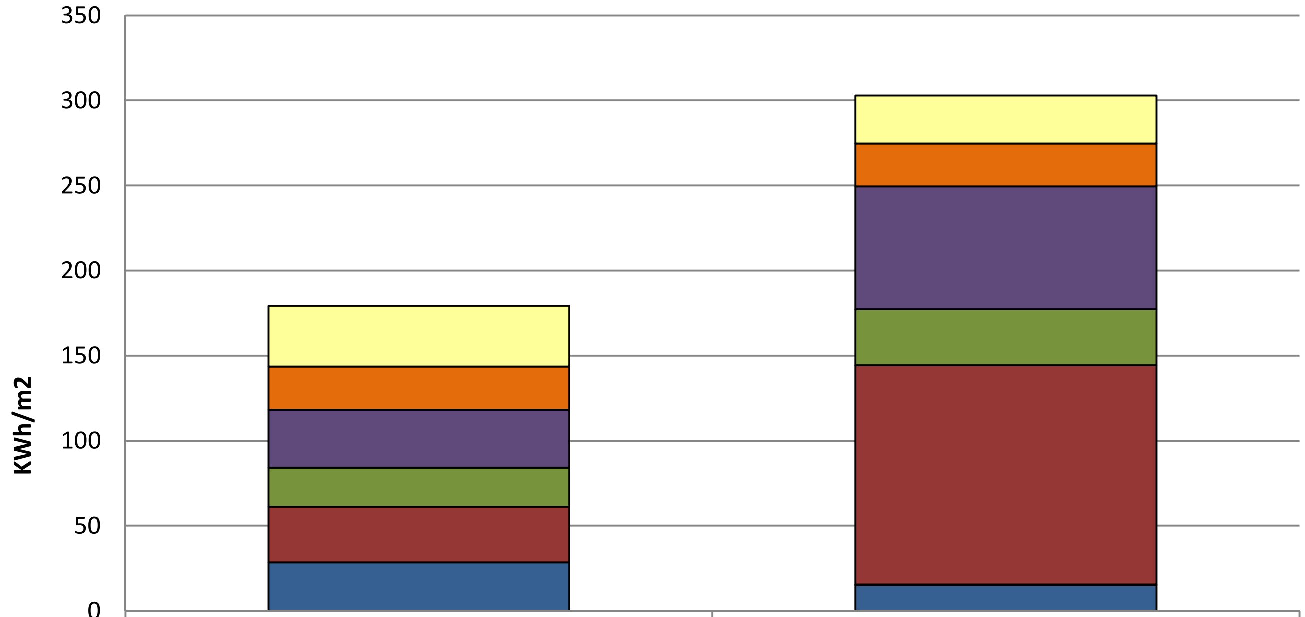
Energy Results

Baseline Versus NECB-2011 Performance Path (7A)



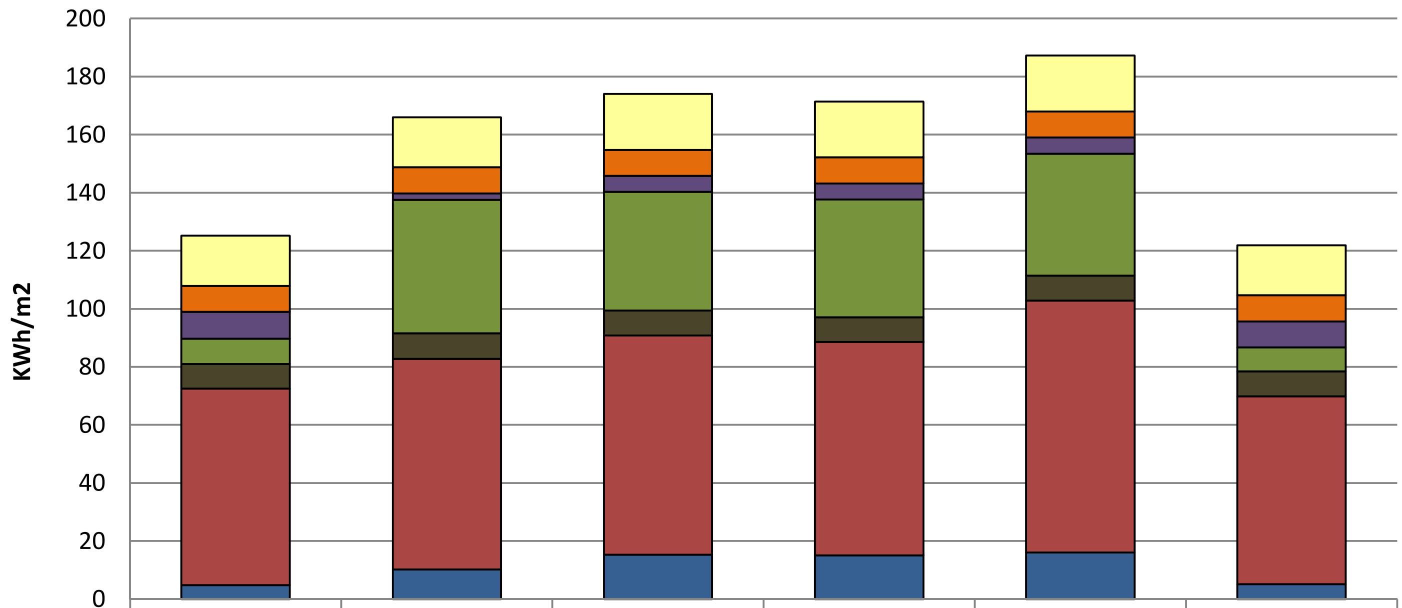
	Baseline	NECB-2011 Performance Path (7A)
Area Lights	10.92	25.29
Misc. Equip.	31.40	31.40
Pumps & Aux.	42.17	11.19
Vent. Fans	5.06	5.50
Hot Water	7.04	6.37
Space Heat	21.03	86.39
Heat Reject.	0.00	3.42
Space Cool	16.49	6.12
Total	134.11	175.68

Baseline Versus NECB-2011 Performance Path (7A)



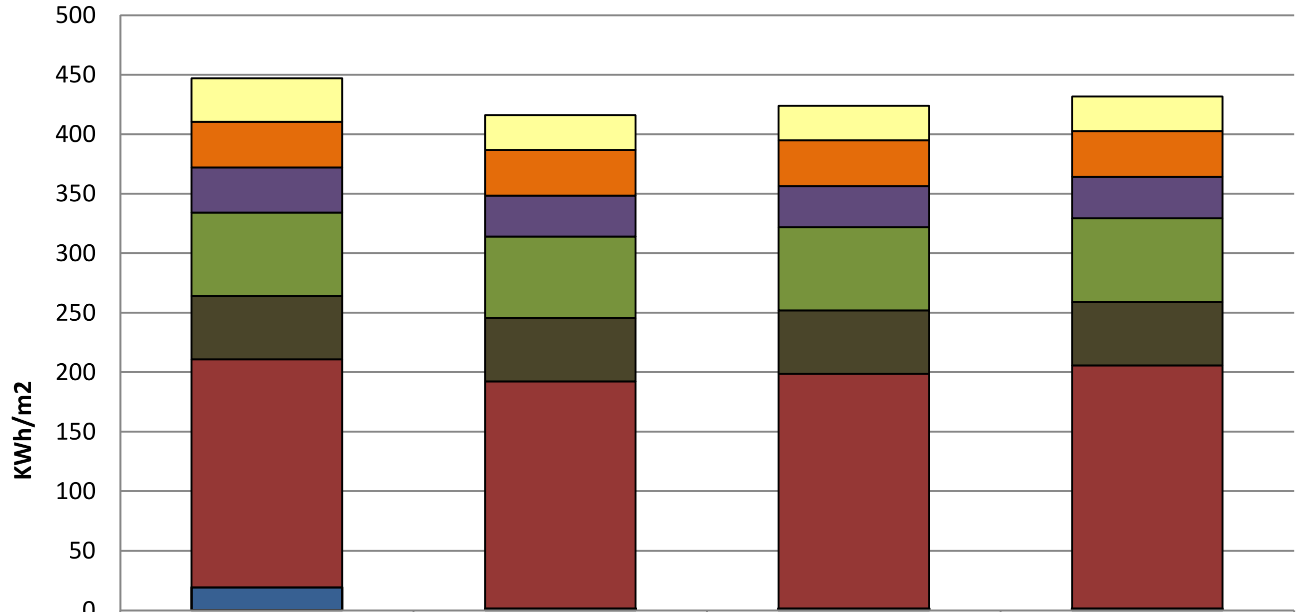
	Baseline	NECB-2011 Performance Path (7A)
Area Lights	35.87	28.21
Misc. Equip.	25.24	25.24
Pumps & Aux.	34.12	72.17
Vent. Fans	22.99	33.05
Space Heat	32.70	128.86
Heat Reject.	0.00	0.28
Space Cool	28.45	15.13
Total	179.37	302.93

Baseline Versus NECB-2011 Performance Path



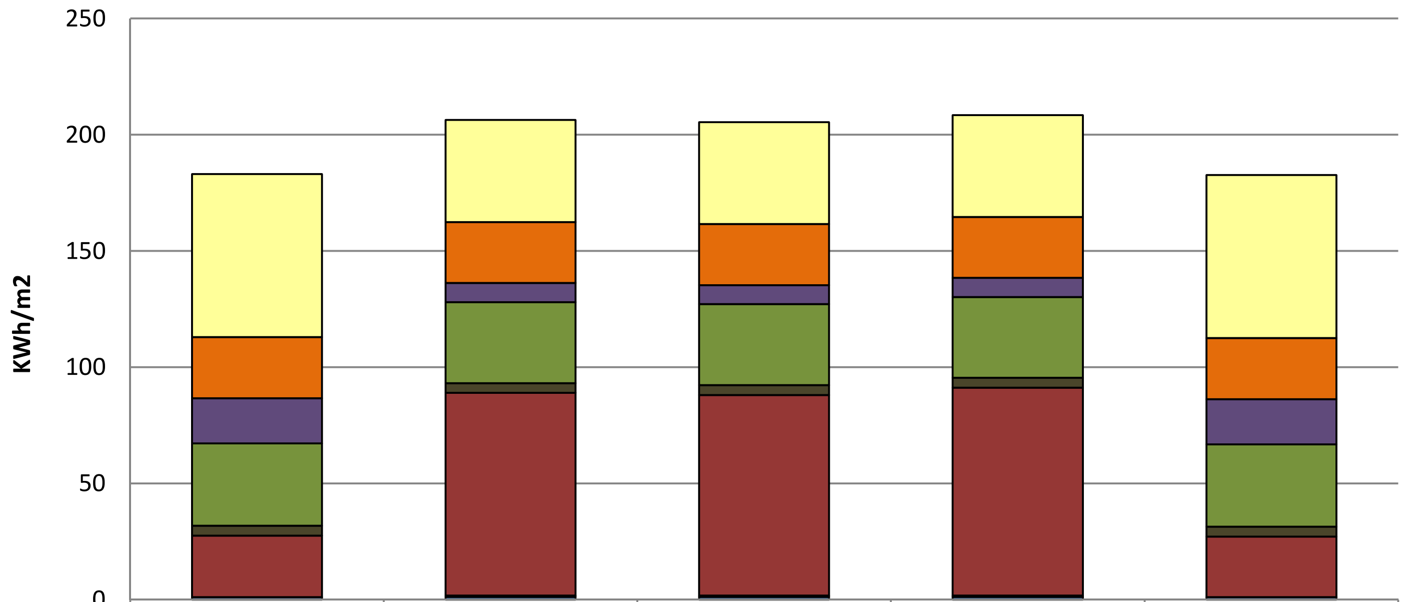
	Baseline	Baseline, ASHP	NECB-2011 Performance Path	NECB-2011 Performance Path, 7A	NECB-2011 Performance Path, Baseline Envelope	NECB-2011 Envelope
Area Lights	17.23	17.22	19.27	19.27	19.27	17.23
Misc. Equip.	8.96	8.97	8.97	8.97	8.97	8.96
Pumps & Aux.	9.21	2.22	5.54	5.52	5.57	8.98
Vent. Fans	8.71	45.97	40.87	40.57	42.06	8.29
Hot Water	8.59	8.85	8.55	8.55	8.55	8.59
Space Heat	67.66	72.52	75.62	73.48	86.74	64.67
Space Cool	4.79	10.23	15.23	15.06	16.09	5.16
Total	125.15	165.98	174.05	171.45	187.27	121.88

Education, College Campus: Baseline Versus NECB-2011 Performance Path



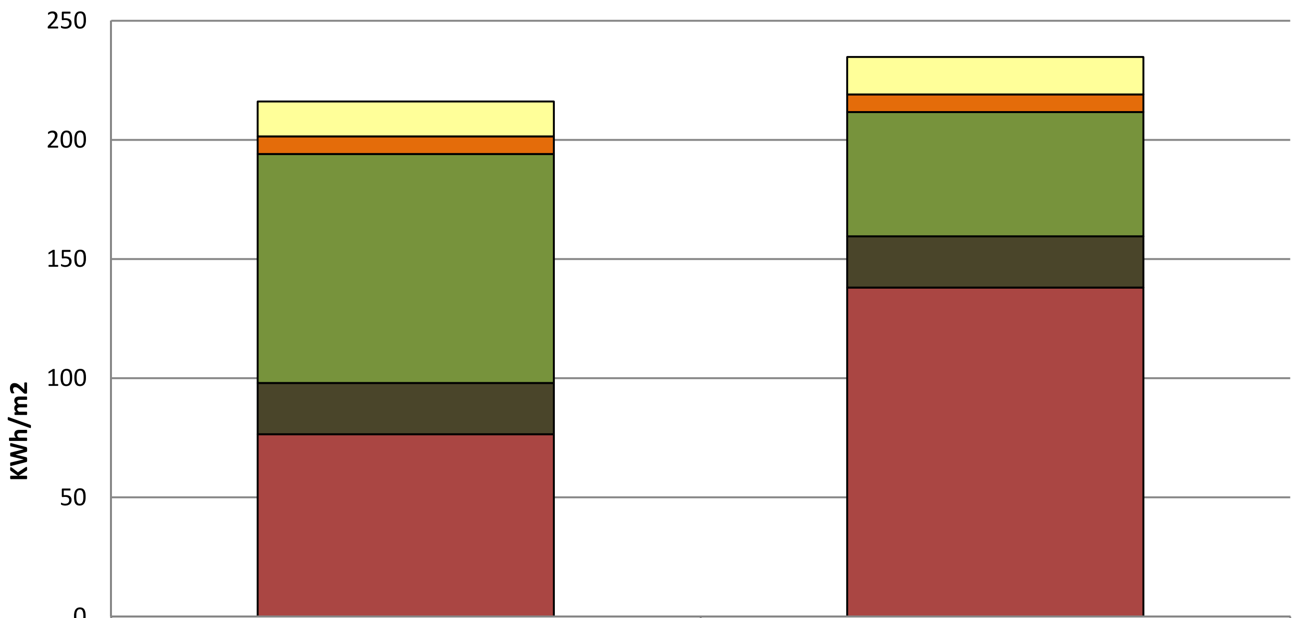
	Baseline	NECB-2011 Performance Path (Zone 8)	NECB-2011 Performance Path (Zone 7A)	NECB-2011 Performance Path (Zone 6)
Area Lights	36.50 (8%)	29.13 (7%)	29.13 (7%)	29.13 (7%)
Misc. Equip.	38.45 (9%)	38.45 (9%)	38.45 (9%)	38.45 (9%)
Pumps & Aux.	37.76 (8%)	34.51 (8%)	34.62 (8%)	34.75 (8%)
Vent. Fans	70.17 (16%)	68.62 (16%)	69.81 (16%)	70.65 (16%)
Hot Water	53.11 (12%)	53.09 (13%)	53.09 (13%)	53.09 (12%)
Space Heat	191.76 (43%)	190.79 (46%)	197.34 (47%)	204.21 (47%)
Space Cool	19.16 (4%)	1.51 (0%)	1.51 (0%)	1.51 (0%)
Total	446.91	416.10	423.96	431.78

Baseline Versus NECB-2011 Performance Path



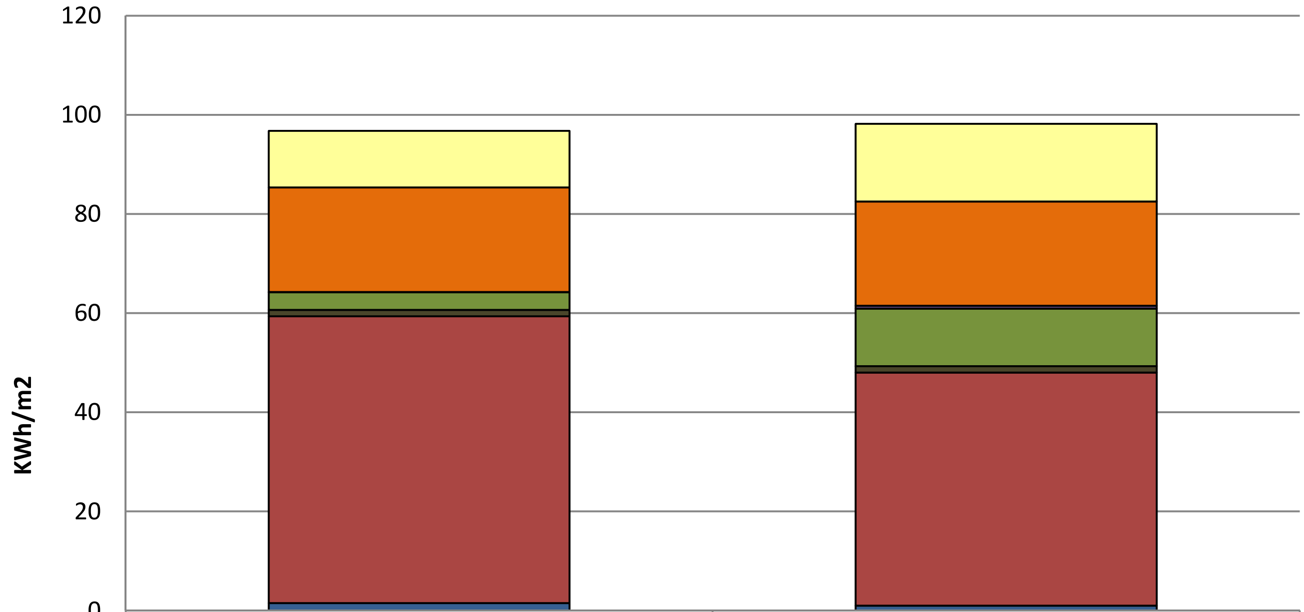
	Baseline	NECB-2011 Performance Path	NECB-2011 Performance Path, 7A	NECB-2011 Performance Path, Baseline Envelope	NECB-2011 Envelope
Area Lights	70.14	43.83	43.83	43.83	70.14
Misc. Equip.	26.29	26.29	26.29	26.29	26.29
Pumps & Aux.	19.40	8.21	8.25	8.16	19.47
Vent. Fans	35.45	34.83	34.84	34.82	35.47
Hot Water	4.22	4.22	4.22	4.22	4.22
Space Heat	26.53	87.24	86.31	89.47	26.04
Heat Reject.	0.00	0.45	0.45	0.45	0.00
Space Cool	1.05	1.25	1.25	1.25	1.05
Total	183.07	206.32	205.45	208.50	182.67

Baseline Versus NECB-2011 Performance Path (7A)



	Baseline	NECB-2011 Performance Path (7A)
Area Lights	14.62	15.63
Misc. Equip.	7.39	7.39
Vent. Fans	96.00	52.13
Hot Water	21.47	21.47
Space Heat	76.49	138.07
Space Cool	0.06	0.01
Total	216.03	234.70

Baseline Versus NECB-2011 Performance Path(7A)



	Baseline	NECB-2011 Performance Path (7A)
Area Lights	11.40	15.68
Misc. Equip.	21.05	21.05
Pumps & Aux.	0.08	0.58
Vent. Fans	3.56	11.61
Hot Water	1.26	1.26
Space Heat	57.87	47.04
Space Cool	1.50	0.97
Total	96.73	98.18

APPENDIX E

Costings

1: Office

2013 Q1 Costs

Baseline versus NECB Performance Pathway, Zone 7A

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path using Zone 7A (instead of Zone 6) applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (Zone 7A)
Mechanical	NECB-2011 (Zone 7A)
Lighting	NECB-2011 (Zone 7A)

Model Type: Office, Floors: 12 above grade, 1 below grade, various wall types.
Stories (Ea.): 12
Floor Area (S.F.): 150,370 ft^2
Perimeter (L.F.): 525 ft
No of Stories (E.A.): 12
Story Height (L.F.): 12 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
St. John's, Newfoundland

		Baseline			NECB-2011			
		Baseline Value	**$Cost/ Per S.F.**	**$ Total Cost**	**NECB-2011 Value**	**$Cost/ Per S.F.**	**$ Total Cost**	**% Increase/ Decrease**
A Substructure								
A1010	Standard Foundations		0.80	120,000.00		0.80	120,000.00	
A1020	Special Foundations		6.34	953,000.00		6.34	953,000.00	
A1030	Slab on Grade		0.43	64,000.00		0.43	64,000.00	
A2010	Basement Excavation		0.02	3,275.00		0.02	3,275.00	
A2020	Basement Walls		0.63	94,000.00		0.63	94,000.00	
B Shell								
B1010	Floor Construction		16.75	2,518,500.00		16.75	2,518,500.00	
B1020	Roof Construction	U-0.218 W/m^{2}K, U-0.226 W/m^{2}K	**1.20**	**181,000.00**	U-0.162 W/m^{2}K	**1.42**	**213,580.00**	**118%**
B2010	Exterior Walls	U-0.223 W/m^{2}K, U-0.293 W/m^{2}K, U-0.302 W/m^{2}K, U-0.274 W/m^{2}K,	**12.36**	**1,859,000.00**	U-0.210 W/m^{2}K	**12.98**	**1,951,950.00**	**105%**
B2020	Exterior Windows	U-2.6 W/m^{2}K, U-2.2 W/m^{2}K SC-0.30	**5.24**	**788,000.00**	U-2.2 W/m^{2}K SC-0.44	**5.61**	**843,160.00**	**107%**
B2030	Exterior Doors		0.72	109,000.00		0.72	109,000.00	
B3010	Roof Coverings		0.50	75,000.00		0.50	75,000.00	
B3020	Roof Openings		0.00	0.00		0.00	0.00	
C Interiors								
C1010	Partitions		3.17	476,000.00		3.17	476,000.00	
C1020	Interior Doors		3.47	522,000.00		3.47	522,000.00	
C1030	Fittings		0.45	67,000.00		0.45	67,000.00	
C2010	Stair Construction		3.80	571,500.00		3.80	571,500.00	
C3010	Wall Finishes		0.77	115,500.00		0.77	115,500.00	
C3020	Floor Finishes		5.32	799,500.00		5.32	799,500.00	
C3030	Ceiling Finishes		6.69	1,006,500.00		6.69	1,006,500.00	
D Services								
D1010	Elevators and Lifts		8.34	1,253,500.00		8.34	1,253,500.00	
D2010	Plumbing Fixtures		29.64	4,457,500.00		29.64	4,457,500.00	
D2020	Domestic Water Distribution		0.38	56,500.00		0.38	56,500.00	
D2040	Rain Water Drainage		0.18	27,500.00		0.18	27,500.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Multi-Zone Air Handling Unit, Ground Source Water Cooled Chiller/Ground Source Heat Pumps.	**21.91**	**3,294,700.00**	Multi-Zone Air Handling Unit with Heat Recovery, Water Cooled Chiller & Electric Baseboard Heating.	**19.26**	**2,896,000.00**	**88%**
D4010	Sprinklers		2.64	397,000.00		2.64	397,000.00	
D4020	Standpipes		0.66	98,500.00		0.66	98,500.00	
D5010	Electrical Service/Distribution		1.77	265,500.00		1.77	265,500.00	
D5020	Lighting and Branch Wiring	3.7 W/m2	**11.86**	**1,783,650.00**	9.7 W/m2	**10.78**	**1,621,500.00**	**91%**
D5030	Communications and Security		5.06	760,500.00		5.06	760,500.00	
D5090	Other Electrical Systems		0.61	92,000.00		0.61	92,000.00	
		Sub-Total	151.71	22,809,625.00		149.1808	22,429,465.00	
	GENERAL CONDITIONS (Overhead & Profit)	25%	37.93	5,702,406.25		37.30	5,607,366.25	
	ARCHITECTURAL FEES	7%	13.27	1,995,842.19		13.05	1,962,578.19	
	TOTAL BUILDING COST		**202.91**	**30,507,873.44**		**199.53**	**29,999,409.44**	**98%**
	COST PER SQ FT($)			**203**			**200**	

2: Office
2013 Q1 Costs

Baseline versus NECB Performance Pathway, Zone 7A

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path using Zone 7A (instead of Zone 6) applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (Zone 7A)
Mechanical	NECB-2011 (Zone 7A)
Lighting	NECB-2011 (Zone 7A)

Model Type: Office, Floors: 7 above grade, unitized curtain wall system (this building has 6 levels of parking below the office levels which are not included in the costing below)
Stories (Ea.): 7
Floor Area (S.F.): 173,256 ft²
Perimeter (L.F.): 709 ft
No of Stories (E.A.): 7
Story Height (L.F.): 13 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
St. John's, Newfoundland

		Baseline			NECB-2011			
		Baseline Value	**$Cost/ Per S.F.**	**$ Total Cost**	**NECB-2011 Value**	**$Cost/ Per S.F.**	**$ Total Cost**	**% Increase/ Decrease**
A Substructure								
A1010	Standard Foundations		1.95	337,500.00		1.95	337,500.00	
A1030	Slab on Grade		0.73	126,500.00		0.73	126,500.00	
A2010	Basement Excavation		0.04	6,475.00		0.04	6,475.00	
A2020	Basement Walls		0.39	67,500.00		0.39	67,500.00	
B Shell								
B1010	Floor Construction		16.90	2,928,500.00		16.90	2,928,500.00	
B1020	Roof Construction	U-0.183 W/m²K	**2.02**	**350,500.00**	U-0.162 W/m²K	**2.32**	**403,075.00**	**115%**
B2010	Exterior Walls	U-0.187 W/m²K	**9.16**	**1,586,500.00**	U-0.210 W/m²K	**8.98**	**1,554,770.00**	**98%**
B2020	Exterior Windows	U-1.39 W/m²K SC-0.30	**3.21**	**557,000.00**	U-2.2 W/m²K SC-0.44	**3.02**	**523,580.00**	**94%**
B2030	Exterior Doors		0.28	48,800.00		0.28	48,800.00	
B3010	Roof Coverings		0.81	140,500.00		0.81	140,500.00	
B3020	Roof Openings		0.00	0.00		0.00	0.00	
C Interiors								
C1010	Partitions		2.51	435,000.00		2.51	435,000.00	
C1020	Interior Doors		3.47	601,500.00		3.47	601,500.00	
C1030	Fittings		0.77	133,500.00		0.77	133,500.00	
C2010	Stair Construction		3.47	601,000.00		3.47	601,000.00	
C3010	Wall Finishes		0.96	166,500.00		0.96	166,500.00	
C3020	Floor Finishes		9.68	1,677,500.00		9.68	1,677,500.00	
C3030	Ceiling Finishes		6.69	1,159,500.00		6.69	1,159,500.00	
D Services								
D1010	Elevators and Lifts		16.79	2,908,500.00		16.79	2,908,500.00	
D2010	Plumbing Fixtures		2.89	500,000.00		2.89	500,000.00	
D2020	Domestic Water Distribution		0.63	109,500.00		0.63	109,500.00	
D2040	Rain Water Drainage		0.30	51,500.00		0.30	51,500.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Multi-Zone Air Handling Units with Packaged Chiller/Heat Pump connected to Seawater Loop.	**23.75**	**4,114,905.22**	Multi-Zone Air Handling Units with Water Cooled Chiller & Electric Baseboard Heating.	**17.73**	**3,072,000.00**	**75%**
D4010	Sprinklers		2.75	476,000.00		2.75	476,000.00	
D4020	Standpipes		0.86	148,500.00		0.86	148,500.00	
D5010	Electrical Service/Distribution		0.78	136,000.00		0.78	136,000.00	
D5020	Lighting and Branch Wiring	11.8 W/m2	**8.83**	**1,530,530.00**	9.7 W/m2	**10.77**	**1,866,500.00**	**122%**
D5030	Communications and Security		4.20	727,500.00		4.20	727,500.00	
D5090	Other Electrical Systems		1.19	207,000.00		1.19	207,000.00	
E Equipment & Furnishings								
E1020	Institutional Equipment		0	0.00		0	0.00	
E1090	Other Equipment		0.00	0.00		0.00	0.00	
		Sub-Total	126.01	21,834,210.22		121.8572	21,114,700.00	
	GENERAL CONDITIONS (Overhead & Profit)	25%	31.50	5,458,552.56		30.46	5,278,675.00	
	ARCHITECTURAL FEES	7%	11.03	1,910,493.39		10.66	1,847,536.25	
	TOTAL BUILDING COST		**168.54**	**29,203,256.17**		**162.98**	**28,240,911.25**	**97%**
	COST PER SQ FT($)			**169**			**163**	

3: Education -School
2013 Q1 Costs

NECB versus NECB with Air Source Heat Pump (ASHP)

Description of Analysis: The NECB building is compared against the NECB building with air source heat pumps.

Parameter	Comparison
Envelope	NECB-2011
Mechanical	ASHP
Lighting	NECB-2011

Model Type: School, High, 2-3 Story, Face Brick with Concrete Block Back-up / Steel Frame
Stories (Ea.): 2
Floor Area (S.F.): 64,950 ft²
Perimeter (L.F.): 1,273 ft
No of Stories (E.A.): 2
Story Height (L.F.): 14.2 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
St. John's, Newfoundland

		Baseline			NECB-2011			
		Baseline Value	**$Cost/ Per S.F.**	**$ Total Cost**	**NECB-2011 Value**	**$Cost/ Per S.F.**	**$ Total Cost**	**% Increase/ Decrease**
A Substructure								
A1010	Standard Foundations		1.37	89,000.00		1.37	89,000.00	
A1030	Slab on Grade		2.56	166,000.00		2.56	166,000.00	
A2010	Basement Excavation		0.07	4,775.00		0.07	4,775.00	
A2020	Basement Walls		1.46	95,000.00		1.46	95,000.00	
B Shell								
B1010	Floor Construction		15.39	999,500.00		15.39	999,500.00	
B1020	Roof Construction	U-0.22 W/m²K, U-0.58 W/m²K	**6.62**	**430,000.00**	U-0.22 W/m²K, U-0.58 W/m²K	**6.62**	**430,000.00**	
B2010	Exterior Walls	U-0.33 W/m²K	**12.83**	**833,500.00**	U-0.33 W/m²K	**12.83**	**833,500.00**	
B2020	Exterior Windows	U-1.65 W/m²K SC-0.44	**7.85**	**510,000.00**	U-1.65 W/m²K SC-0.44	**7.85**	**510,000.00**	
B2030	Exterior Doors		0.71	46,200.00		0.71	46,200.00	
B3010	Roof Coverings		6.05	393,000.00		6.05	393,000.00	
B3020	Roof Openings		0.03	1,975.00		0.03	1,975.00	
C Interiors								
C1010	Partitions		5.15	334,500.00		5.15	334,500.00	
C1020	Interior Doors		1.86	120,500.00		1.86	120,500.00	
C1030	Fittings		1.51	98,000.00		1.51	98,000.00	
C2010	Stair Construction		0.89	58,000.00		0.89	58,000.00	
C3010	Wall Finishes		4.75	308,500.00		4.75	308,500.00	
C3020	Floor Finishes		7.96	517,000.00		7.96	517,000.00	
C3030	Ceiling Finishes		6.69	434,500.00		6.69	434,500.00	
D Services								
D1010	Elevators and Lifts		0.85	55,000.00		0.85	55,000.00	
D2010	Plumbing Fixtures		5.89	382,500.00		5.89	382,500.00	
D2020	Domestic Water Distribution		1.25	81,000.00		1.25	81,000.00	
D2040	Rain Water Drainage		1.24	80,500.00		1.24	80,500.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Multi-Zone Air Handling Units with Zone Heat Pumps, Ground Source Heat Pump System.	**30.56**	**1,984,680.00**	Single-Zone Air Source Heat Pumps, Electric Baseboard Heating.	**21.70**	**1,409,122.80**	71%
D4010	Sprinklers		2.41	156,500.00		2.41	156,500.00	
D4020	Standpipes		0.39	25,400.00		0.39	25,400.00	
D5010	Electrical Service/Distribution		1.17	76,000.00		1.17	76,000.00	
D5020	Lighting and Branch Wiring	9.0 W/m²	**10.07**	**653,400.00**	9.0 W/m²	**10.07**	**653,400.00**	
D5030	Communications and Security		4.15	269,500.00		4.15	269,500.00	
D5090	Other Electrical Systems		0.44	28,900.00		0.44	28,900.00	
E Equipment & Furnishings								
E1020	Institutional Equipment		2.59	168,000.00		2.59	168,000.00	
E1090	Other Equipment		1.24	80,500.00		1.24	80,500.00	
		Sub-Total	146.00	9,481,830.00		137.13402	8,906,272.80	
	GENERAL CONDITIONS (Overhead & Profit)	25%	36.50	2,370,457.50		34.28	2,226,568.20	
	ARCHITECTURAL FEES	7%	12.77	829,660.13		12.00	779,298.87	
	TOTAL BUILDING COST		**195.27**	**12,681,947.63**		**183.42**	**11,912,139.87**	**94%**
	COST PER SQ FT($)			**195**			**183**	

3: Education -School
2013 Q1 Costs

Baseline versus NECB Performance Pathway

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011
Mechanical	NECB-2011
Lighting	NECB-2011

Model Type: School, High, 2-3 Story, Face Brick with Concrete Block Back-up / Steel Frame
Stories (Ea.): 2
Floor Area (S.F.): 64,950 ft²
Perimeter (L.F.): 1,273 ft
No of Stories (E.A.): 2
Story Height (L.F.): 14.2 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
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		Baseline			NECB-2011			
		Baseline Value	**$Cost/ Per S.F.**	**$ Total Cost**	**NECB-2011 Value**	**$Cost/ Per S.F.**	**$ Total Cost**	**% Increase/ Decrease**
A Substructure								
A1010	Standard Foundations		1.37	89,000.00		1.37	89,000.00	
A1030	Slab on Grade		2.56	166,000.00		2.56	166,000.00	
A2010	Basement Excavation		0.07	4,775.00		0.07	4,775.00	
A2020	Basement Walls		1.46	95,000.00		1.46	95,000.00	
B Shell								
B1010	Floor Construction		15.39	999,500.00		15.39	999,500.00	
B1020	Roof Construction	U-0.22 W/m²K, U-0.58 W/m²K	**6.62**	**430,000.00**	U-0.183 W/m²K	**6.95**	**451,500.00**	**105%**
B2010	Exterior Walls	U-0.33 W/m²K	**12.83**	**833,500.00**	U-0.247 W/m²K	**13.60**	**883,510.00**	**106%**
B2020	Exterior Windows	U-1.65 W/m²K SC-0.44	**7.85**	**510,000.00**	U-2.2 W/m²K SC-0.44	**7.38**	**479,400.00**	**94%**
B2030	Exterior Doors		0.71	46,200.00		0.71	46,200.00	
B3010	Roof Coverings		6.05	393,000.00		6.05	393,000.00	
B3020	Roof Openings		0.03	1,975.00		0.03	1,975.00	
C Interiors								
C1010	Partitions		5.15	334,500.00		5.15	334,500.00	
C1020	Interior Doors		1.86	120,500.00		1.86	120,500.00	
C1030	Fittings		1.51	98,000.00		1.51	98,000.00	
C2010	Stair Construction		0.89	58,000.00		0.89	58,000.00	
C3010	Wall Finishes		4.75	308,500.00		4.75	308,500.00	
C3020	Floor Finishes		7.96	517,000.00		7.96	517,000.00	
C3030	Ceiling Finishes		6.69	434,500.00		6.69	434,500.00	
D Services								
D1010	Elevators and Lifts		0.85	55,000.00		0.85	55,000.00	
D2010	Plumbing Fixtures		5.89	382,500.00		5.89	382,500.00	
D2020	Domestic Water Distribution		1.25	81,000.00		1.25	81,000.00	
D2040	Rain Water Drainage		1.24	80,500.00		1.24	80,500.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Multi-Zone Air Handling Units, Ground Source Heat Pump System.	**30.56**	**1,984,680.00**	Single-Zone Packaged Rooftop Units, Electric Baseboard Heating.	**20.65**	**1,341,000.00**	**67%**
D4010	Sprinklers		2.41	156,500.00		2.41	156,500.00	
D4020	Standpipes		0.39	25,400.00		0.39	25,400.00	
D5010	Electrical Service/Distribution		1.17	76,000.00		1.17	76,000.00	
D5020	Lighting and Branch Wiring	9.0 W/m²	**10.07**	**653,400.00**	10.7 W/m²	**9.15**	**594,000.00**	**91%**
D5030	Communications and Security		4.15	269,500.00		4.15	269,500.00	
D5090	Other Electrical Systems		0.44	28,900.00		0.44	28,900.00	
E Equipment & Furnishings								
E1020	Institutional Equipment		2.59	168,000.00		2.59	168,000.00	
E1090	Other Equipment		1.24	80,500.00		1.24	80,500.00	
		Sub-Total	146.00	9,481,830.00		135.7998	8,819,660.00	
	GENERAL CONDITIONS (Overhead & Profit)	25%	36.50	2,370,457.50		33.95	2,204,915.00	
	ARCHITECTURAL FEES	7%	12.77	829,660.13		11.88	771,720.25	
	TOTAL BUILDING COST		**195.27**	**12,681,947.63**		**181.63**	**11,796,295.25**	**93%**
	COST PER SQ FT($)			**195**			**182**	

3: Education -School

2013 Q1 Costs

Baseline versus NECB Performance Pathway, Zone 7A

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path using Zone 7A (instead of Zone 6) applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (7A)
Mechanical	NECB-2011 (7A)
Lighting	NECB-2011 (7A)

Model Type: School, High, 2-3 Story, Face Brick with Concrete Block Back-up / Steel Frame
Stories (Ea.): 2
Floor Area (S.F.): 64,950 ft²
Perimeter (L.F.): 1,273 ft
No of Stories (E.A.): 2
Story Height (L.F.): 14.2 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
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		Baseline				NECB-2011		
		Baseline Value	**$Cost/ Per S.F.**	**$ Total Cost**	**NECB-2011 Value**	**$Cost/ Per S.F.**	**$ Total Cost**	**% Increase/ Decrease**
A Substructure								
A1010	Standard Foundations		1.37	89,000.00		1.37	89,000.00	
A1030	Slab on Grade		2.56	166,000.00		2.56	166,000.00	
A2010	Basement Excavation		0.07	4,775.00		0.07	4,775.00	
A2020	Basement Walls		1.46	95,000.00		1.46	95,000.00	
B Shell								
B1010	Floor Construction		15.39	999,500.00		15.39	999,500.00	
B1020	Roof Construction	U-0.22 W/m²K, U-0.58 W/m²K	**6.62**	**430,000.00**	U-0.162 W/m²K	**7.75**	**503,100.00**	**117%**
B2010	Exterior Walls	U-0.33 W/m²K	**12.83**	**833,500.00**	U-0.210 W/m²K	**13.60**	**883,510.00**	**106%**
B2020	Exterior Windows	U-1.65 W/m²K SC-0.44	**7.85**	**510,000.00**	U-2.2 W/m²K SC-0.44	**7.38**	**479,400.00**	**94%**
B2030	Exterior Doors		0.71	46,200.00		0.71	46,200.00	
B3010	Roof Coverings		6.05	393,000.00		6.05	393,000.00	
B3020	Roof Openings		0.03	1,975.00		0.03	1,975.00	
C Interiors								
C1010	Partitions		5.15	334,500.00		5.15	334,500.00	
C1020	Interior Doors		1.86	120,500.00		1.86	120,500.00	
C1030	Fittings		1.51	98,000.00		1.51	98,000.00	
C2010	Stair Construction		0.89	58,000.00		0.89	58,000.00	
C3010	Wall Finishes		4.75	308,500.00		4.75	308,500.00	
C3020	Floor Finishes		7.96	517,000.00		7.96	517,000.00	
C3030	Ceiling Finishes		6.69	434,500.00		6.69	434,500.00	
D Services								
D1010	Elevators and Lifts		0.85	55,000.00		0.85	55,000.00	
D2010	Plumbing Fixtures		5.89	382,500.00		5.89	382,500.00	
D2020	Domestic Water Distribution		1.25	81,000.00		1.25	81,000.00	
D2040	Rain Water Drainage		1.24	80,500.00		1.24	80,500.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Multi-Zone Air Handling Units, Ground Source Heat Pump System.	**30.56**	**1,984,680.00**	Single-Zone Packaged Rooftop Units, Electric Baseboard Heating.	**20.65**	**1,341,000.00**	**67%**
D4010	Sprinklers		2.41	156,500.00		2.41	156,500.00	
D4020	Standpipes		0.39	25,400.00		0.39	25,400.00	
D5010	Electrical Service/Distribution		1.17	76,000.00		1.17	76,000.00	
D5020	Lighting and Branch Wiring	9.0 W/m²	**10.07**	**653,400.00**	10.7 W/m²	**9.15**	**594,000.00**	**91%**
D5030	Communications and Security		4.15	269,500.00		4.15	269,500.00	
D5090	Other Electrical Systems		0.44	28,900.00		0.44	28,900.00	
E Equipment & Furnishings								
E1020	Institutional Equipment		2.59	168,000.00		2.59	168,000.00	
E1090	Other Equipment		1.24	80,500.00		1.24	80,500.00	
		Sub-Total	146.00	9,481,830.00		136.5942	8,871,260.00	
	GENERAL CONDITIONS (Overhead & Profit)	25%	36.50	2,370,457.50		34.15	2,217,815.00	
	ARCHITECTURAL FEES	7%	12.77	829,660.13		11.95	776,235.25	
	TOTAL BUILDING COST		**195.27**	**12,681,947.63**		**182.69**	**11,865,310.25**	**94%**
	COST PER SQ FT($)			**195**			**183**	

3: Education -School

2013 Q1 Costs

Baseline versus NECB Performance Pathway with Baseline Envelope

Description of Analysis: The baseline building is compared against a building that has the baseline envelope and the NECB performance path applied to the mechanical systems and lighting.

Parameter	Comparison
Envelope	No Change
Mechanical	NECB-2011
Lighting	NECB-2011

Model Type: School, High, 2-3 Story, Face Brick with Concrete Block Back-up / Steel Frame
Stories (Ea.): 2
Floor Area (S.F.): 64,950 ft^2
Perimeter (L.F.): 1,273 ft
No of Stories (E.A.): 2
Story Height (L.F.): 14.2 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
St. John's, Newfoundland

		Baseline			NECB-2011			
		Baseline Value	**$Cost/ Per S.F.**	**$ Total Cost**	**NECB-2011 Value**	**$Cost/ Per S.F.**	**$ Total Cost**	**% Increase/ Decrease**
A Substructure								
A1010	Standard Foundations		1.37	89,000.00		1.37	89,000.00	
A1030	Slab on Grade		2.56	166,000.00		2.56	166,000.00	
A2010	Basement Excavation		0.07	4,775.00		0.07	4,775.00	
A2020	Basement Walls		1.46	95,000.00		1.46	95,000.00	
B Shell								
B1010	Floor Construction		15.39	999,500.00		15.39	999,500.00	
B1020	Roof Construction	U-0.22 W/m^{2}K, U-0.58 W/m^{2}K	**6.62**	**430,000.00**	U-0.22 W/m^{2}K, U-0.58 W/m^{2}K	**6.62**	**430,000.00**	
B2010	Exterior Walls	U-0.33 W/m^{2}K	**12.83**	**833,500.00**	U-0.33 W/m^{2}K	**12.83**	**833,500.00**	
B2020	Exterior Windows	U-1.65 W/m^{2}K SC-0.44	**7.85**	**510,000.00**	U-1.65 W/m^{2}K SC-0.44	**7.85**	**510,000.00**	
B2030	Exterior Doors		0.71	46,200.00		0.71	46,200.00	
B3010	Roof Coverings		6.05	393,000.00		6.05	393,000.00	
B3020	Roof Openings		0.03	1,975.00		0.03	1,975.00	
C Interiors								
C1010	Partitions		5.15	334,500.00		5.15	334,500.00	
C1020	Interior Doors		1.86	120,500.00		1.86	120,500.00	
C1030	Fittings		1.51	98,000.00		1.51	98,000.00	
C2010	Stair Construction		0.89	58,000.00		0.89	58,000.00	
C3010	Wall Finishes		4.75	308,500.00		4.75	308,500.00	
C3020	Floor Finishes		7.96	517,000.00		7.96	517,000.00	
C3030	Ceiling Finishes		6.69	434,500.00		6.69	434,500.00	
D Services								
D1010	Elevators and Lifts		0.85	55,000.00		0.85	55,000.00	
D2010	Plumbing Fixtures		5.89	382,500.00		5.89	382,500.00	
D2020	Domestic Water Distribution		1.25	81,000.00		1.25	81,000.00	
D2040	Rain Water Drainage		1.24	80,500.00		1.24	80,500.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Multi-Zone Air Handling Units, Ground Source Heat Pump System.	**30.56**	**1,984,680.00**	Single-Zone Packaged Rooftop Units, Electric Baseboard Heating.	**20.65**	**1,341,000.00**	**67%**
D4010	Sprinklers		2.41	156,500.00		2.41	156,500.00	
D4020	Standpipes		0.39	25,400.00		0.39	25,400.00	
D5010	Electrical Service/Distribution		1.17	76,000.00		1.17	76,000.00	
D5020	Lighting and Branch Wiring	9.0 W/m^2	**10.07**	**653,400.00**	10.7 W/m^2	**9.15**	**594,000.00**	**91%**
D5030	Communications and Security		4.15	269,500.00		4.15	269,500.00	
D5090	Other Electrical Systems		0.44	28,900.00		0.44	28,900.00	
E Equipment & Furnishings								
E1020	Institutional Equipment		2.59	168,000.00		2.59	168,000.00	
E1090	Other Equipment		1.24	80,500.00		1.24	80,500.00	
		Sub-Total	146.00	9,481,830.00		135.17	8,778,750.00	
	GENERAL CONDITIONS (Overhead & Profit)	25%	36.50	2,370,457.50		33.79	2,194,687.50	
	ARCHITECTURAL FEES	7%	12.77	829,660.13		11.83	768,140.63	
	TOTAL BUILDING COST		**195.27**	**12,681,947.63**		**180.79**	**11,741,578.13**	**93%**
	COST PER SQ FT($)			**195**			**181**	

3: Education -School
2013 Q1 Costs

Baseline versus Baseline with NECB Envelope

Description of Analysis: The baseline building is compared against the baseline building with an NECB envelope.

Parameter	Comparison
Envelope	NECB-2011
Mechanical	No Change
Lighting	No Change

Model Type: School, High, 2-3 Story, Face Brick with Concrete Block Back-up / Steel Frame
Stories (Ea.): 2
Floor Area (S.F.): 64,950 ft²
Perimeter (L.F.): 1,273 ft
No of Stories (E.A.): 2
Story Height (L.F.): 14.2 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
St. John's, Newfoundland

		Baseline			NECB-2011			
		Baseline Value	$Cost/ Per S.F.	$ Total Cost	NECB-2011 Value	$Cost/ Per S.F.	$ Total Cost	% Increase/ Decrease
A Substructure								
A1010	Standard Foundations		1.37	89,000.00		1.37	89,000.00	
A1030	Slab on Grade		2.56	166,000.00		2.56	166,000.00	
A2010	Basement Excavation		0.07	4,775.00		0.07	4,775.00	
A2020	Basement Walls		1.46	95,000.00		1.46	95,000.00	
B Shell								
B1010	Floor Construction		15.39	999,500.00		15.39	999,500.00	
B1020	Roof Construction	U-0.22 W/m²K, U-0.58 W/m²K	**6.62**	**430,000.00**	U-0.183 W/m²K	**6.95**	**451,500.00**	**105%**
B2010	Exterior Walls	U-0.33 W/m²K	**12.83**	**833,500.00**	U-0.247 W/m²K	**13.60**	**883,510.00**	**106%**
B2020	Exterior Windows	U-1.65 W/m²K SC-0.44	**7.85**	**510,000.00**	U-2.2 W/m²K SC-0.44	**7.38**	**479,400.00**	**94%**
B2030	Exterior Doors		0.71	46,200.00		0.71	46,200.00	
B3010	Roof Coverings		6.05	393,000.00		6.05	393,000.00	
B3020	Roof Openings		0.03	1,975.00		0.03	1,975.00	
C Interiors								
C1010	Partitions		5.15	334,500.00		5.15	334,500.00	
C1020	Interior Doors		1.86	120,500.00		1.86	120,500.00	
C1030	Fittings		1.51	98,000.00		1.51	98,000.00	
C2010	Stair Construction		0.89	58,000.00		0.89	58,000.00	
C3010	Wall Finishes		4.75	308,500.00		4.75	308,500.00	
C3020	Floor Finishes		7.96	517,000.00		7.96	517,000.00	
C3030	Ceiling Finishes		6.69	434,500.00		6.69	434,500.00	
D Services								
D1010	Elevators and Lifts		0.85	55,000.00		0.85	55,000.00	
D2010	Plumbing Fixtures		5.89	382,500.00		5.89	382,500.00	
D2020	Domestic Water Distribution		1.25	81,000.00		1.25	81,000.00	
D2040	Rain Water Drainage		1.24	80,500.00		1.24	80,500.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Multi-Zone Air Handling Units, Ground Source Heat Pump System.	**30.56**	**1,984,680.00**	Multi-Zone Air Handling Units, Ground Source Heat Pump System.	**30.56**	**1,984,680.00**	
D4010	Sprinklers		2.41	156,500.00		2.41	156,500.00	
D4020	Standpipes		0.39	25,400.00		0.39	25,400.00	
D5010	Electrical Service/Distribution		1.17	76,000.00		1.17	76,000.00	
D5020	Lighting and Branch Wiring	9.0 W/m²	**10.07**	**653,400.00**	9.0 W/m²	**10.07**	**653,400.00**	
D5030	Communications and Security		4.15	269,500.00		4.15	269,500.00	
D5090	Other Electrical Systems		0.44	28,900.00		0.44	28,900.00	
E Equipment & Furnishings								
E1020	Institutional Equipment		2.59	168,000.00		2.59	168,000.00	
E1090	Other Equipment		1.24	80,500.00		1.24	80,500.00	
		Sub-Total	146.00	9,481,830.00		146.6268	9,522,740.00	
	GENERAL CONDITIONS (Overhead & Profit)	25%	36.50	2,370,457.50		36.66	2,380,685.00	
	ARCHITECTURAL FEES	7%	12.77	829,660.13		12.83	833,239.75	
	TOTAL BUILDING COST		**195.27**	**12,681,947.63**		**196.11**	**12,736,664.75**	**100%**
	COST PER SQ FT($)			**195**			**196**	

4: Education – College Campus

2013 Q1 Costs

Baseline versus NECB Performance Pathway

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path, zone 6 applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (Zone 6)
Mechanical	NECB-2011 (Zone 6)
Lighting	NECB-2011 (Zone 6)

Model Type: Education – College Campus, Floors: 1 above grade, 0 below grade, composite wall panels with structural metal studs.
Stories (Ea.): 1
Floor Area (S.F.): 48,600 ft²
Perimeter (L.F.): 1076 ft
No of Stories (E.A.): 1
Story Height (L.F.): 24 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
Costworks does not have Labrador City as a location. As such 50% was added to St. John's costs.
Labrador City, Newfoundland

		Baseline			NECB-2011			
		Baseline Value	**$Cost/ Per S.F.**	**$ Total Cost**	**NECB-2011 Value**	**$Cost/ Per S.F.**	**$ Total Cost**	**% Increase/ Decrease**
A Substructure								
A1010	Standard Foundations		0.88	43,000.00		0.88	43,000.00	
A1030	Slab on Grade		10.20	496,000.00		10.20	496,000.00	
A2010	Basement Excavation		0.48	23,800.00		0.48	23,800.00	
A2020	Basement Walls		4.98	242,000.00		4.98	242,000.00	
B Shell								
B1010	Floor Construction		8.44	410,000.00		8.44	410,000.00	
B1020	Roof Construction	U-0.153 W/m²K	**24.48**	**1,190,000.00**	U-0.183 W/m²K	**23.26**	**1,130,500.00**	**95%**
B2010	Exterior Walls	U-0.273 W/m²K, U-0.289 W/m²K	**21.24**	**1,032,000.00**	U-0.247 W/m²K	**21.66**	**1,052,640.00**	**102%**
B2020	Exterior Windows	U-2.2 W/m²K, U-5.7 W/m²K SC-0.37	**15.06**	**732,000.00**	U-2.2 W/m²K SC-0.37	**15.06**	**732,000.00**	**0%**
B2030	Exterior Doors		1.46	70,600.00		1.46	70,600.00	
B3010	Roof Coverings		11.48	558,000.00		11.48	558,000.00	
C Interiors								
C1010	Partitions		8.58	417,000.00		8.58	417,000.00	
C1020	Interior Doors		13.88	675,000.00		13.88	675,000.00	
C1030	Fittings		14.26	693,000.00		14.26	693,000.00	
C2010	Stair Construction		7.84	381,000.00		7.84	381,000.00	
C3010	Wall Finishes		8.12	395,000.00		8.12	395,000.00	
C3020	Floor Finishes		10.86	528,000.00		10.86	528,000.00	
C3030	Ceiling Finishes		13.40	651,000.00		13.40	651,000.00	
D Services			0			0		
D1010	Elevators and Lifts		7.42	361,000.00		7.42	361,000.00	
D2010	Plumbing Fixtures		39.34	1,912,000.00		39.34	1,912,000.00	
D2020	Domestic Water Distribution		6.46	314,000.00		6.46	314,000.00	
D2040	Rain Water Drainage		1.38	66,800.00		1.38	66,800.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Multi-Zone Air Handling Units with Reheat.	**40.47**	**1,966,860.00**	Single Zone Package Units	**41.30**	**2,007,000.00**	**106%**
D4010	Sprinklers		6.02	293,000.00		6.02	293,000.00	
D4020	Standpipes		0.68	32,600.00		0.68	32,600.00	
D5010	Electrical Service/Distribution		9.06	440,000.00		9.06	440,000.00	
D5020	Lighting and Branch Wiring	School: 9.4 W/m² Shop: 6.8 W/m²	**24.60**	**1,195,440.00**	School: 10.7 W/m² Shop: 8.8 W/m²	**24.12**	**1,172,000.00**	**98%**
D5030	Communications and Security		13.44	653,000.00		13.44	653,000.00	
D5090	Other Electrical Systems		1.72	83,200.00		1.72	83,200.00	
		Sub-Total	326.24	15,855,300.00		325.7808	15,833,140.00	
	GENERAL CONDITIONS (Overhead & Profit)	25%	81.56	3,963,825.00		81.45	3,958,285.00	
	ARCHITECTURAL FEES	7%	28.55	1,387,338.75		28.51	1,385,399.75	
	TOTAL BUILDING COST		**436.34**	**21,206,463.75**		**435.73**	**21,176,824.75**	**100%**
	COST PER SQ FT($)			**436**			**436**	

4: Education – College Campus

2013 Q1 Costs

Baseline versus NECB Performance Pathway

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path, zone 7A applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (Zone 7A)
Mechanical	NECB-2011 (Zone 7A)
Lighting	NECB-2011 (Zone 7A)

Model Type: Education – College Campus, Floors: 1 above grade, 0 below grade, composite wall panels with structural metal studs.
Stories (Ea.): 1
Floor Area (S.F.): 48,600 ft^2
Perimeter (L.F.): 1076 ft
No of Stories (E.A.): 1
Story Height (L.F.): 24 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
Costworks does not have Labrador City as a location. As such 50% was added to St. John's costs.
Labrador City, Newfoundland

		Baseline			NECB-2011			
		Baseline Value	**$Cost/ Per S.F.**	**$ Total Cost**	**NECB-2011 Value**	**$Cost/ Per S.F.**	**$ Total Cost**	**% Increase/ Decrease**
A Substructure								
A1010	Standard Foundations		0.88	43,000.00		0.88	43,000.00	
A1030	Slab on Grade		10.20	496,000.00		10.20	496,000.00	
A2010	Basement Excavation		0.48	23,800.00		0.48	23,800.00	
A2020	Basement Walls		4.98	242,000.00		4.98	242,000.00	
B Shell								
B1010	Floor Construction		8.44	410,000.00		8.44	410,000.00	
B1020	Roof Construction	U-0.153 W/m^{2}K	**24.48**	**1,190,000.00**	U-0.162 W/m^{2}K	**23.99**	**1,166,200.00**	**98%**
B2010	Exterior Walls	U-0.273 W/m^{2}K, U-0.289 W/m^{2}K	**21.24**	**1,032,000.00**	U-0.210 W/m^{2}K	**22.51**	**1,093,920.00**	**106%**
B2020	Exterior Windows	U-2.2 W/m^{2}K, U-5.7 W/m^{2}K SC-0.37	**15.06**	**732,000.00**	U-2.2 W/m^{2}K SC-0.37	**15.06**	**732,000.00**	**0%**
B2030	Exterior Doors		1.46	70,600.00		1.46	70,600.00	
B3010	Roof Coverings		11.48	558,000.00		11.48	558,000.00	
C Interiors								
C1010	Partitions		8.58	417,000.00		8.58	417,000.00	
C1020	Interior Doors		13.88	675,000.00		13.88	675,000.00	
C1030	Fittings		14.26	693,000.00		14.26	693,000.00	
C2010	Stair Construction		7.84	381,000.00		7.84	381,000.00	
C3010	Wall Finishes		8.12	395,000.00		8.12	395,000.00	
C3020	Floor Finishes		10.86	528,000.00		10.86	528,000.00	
C3030	Ceiling Finishes		13.40	651,000.00		13.40	651,000.00	
D Services			0			0		
D1010	Elevators and Lifts		7.42	361,000.00		7.42	361,000.00	
D2010	Plumbing Fixtures		39.34	1,912,000.00		39.34	1,912,000.00	
D2020	Domestic Water Distribution		6.46	314,000.00		6.46	314,000.00	
D2040	Rain Water Drainage		1.38	66,800.00		1.38	66,800.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Multi-Zone Air Handling Units with Reheat.	**40.47**	**1,966,860.00**	Single Zone Package Units	**41.30**	**2,007,000.00**	**106%**
D4010	Sprinklers		6.02	293,000.00		6.02	293,000.00	
D4020	Standpipes		0.68	32,600.00		0.68	32,600.00	
D5010	Electrical Service/Distribution		9.06	440,000.00		9.06	440,000.00	
D5020	Lighting and Branch Wiring	School: 9.4 W/m^2 Shop: 6.8 W/m^2	**24.60**	**1,195,440.00**	School: 10.7 W/m^2 Shop: 8.8 W/m^2	**24.12**	**1,172,000.00**	**98%**
D5030	Communications and Security		13.44	653,000.00		13.44	653,000.00	
D5090	Other Electrical Systems		1.72	83,200.00		1.72	83,200.00	
		Sub-Total	326.24	15,855,300.00		327.3648	15,910,120.00	
	GENERAL CONDITIONS (Overhead & Profit)	25%	81.56	3,963,825.00		81.84	3,977,530.00	
	ARCHITECTURAL FEES	7%	28.55	1,387,338.75		28.64	1,392,135.50	
	TOTAL BUILDING COST		**436.34**	**21,206,463.75**		**437.85**	**21,279,785.50**	**100%**
	COST PER SQ FT($)			**436**			**438**	

4: Education – College Campus

2013 Q1 Costs

Baseline versus NECB Performance Pathway

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path (Zone 8) applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (Zone 8)
Mechanical	NECB-2011 (Zone 8)
Lighting	NECB-2011 (Zone 8)

Model Type: Education – College Campus, Floors: 1 above grade, 0 below grade, composite wall panels with structural metal studs.
Stories (Ea.): 1
Floor Area (S.F.): 48,600 ft²
Perimeter (L.F.): 1076 ft
No of Stories (E.A.): 1
Story Height (L.F.): 24 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
Costworks does not have Labrador City as a location. As such 50% was added to St. John's costs.
Labrador City, Newfoundland

		Baseline			NECB-2011			
		Baseline Value	$Cost/ Per S.F.	$ Total Cost	NECB-2011 Value	$Cost/ Per S.F.	$ Total Cost	% Increase/ Decrease
A Substructure								
A1010	Standard Foundations		0.88	43,000.00		0.88	43,000.00	
A1030	Slab on Grade		10.20	496,000.00		10.20	496,000.00	
A2010	Basement Excavation		0.48	23,800.00		0.48	23,800.00	
A2020	Basement Walls		4.98	242,000.00		4.98	242,000.00	
B Shell								
B1010	Floor Construction		8.44	410,000.00		8.44	410,000.00	
B1020	Roof Construction	U-0.153 W/m²K	**24.48**	**1,190,000.00**	U-0.142 W/m²K	**25.46**	**1,237,600.00**	**104%**
B2010	Exterior Walls	U-0.273 W/m²K, U-0.289 W/m²K	**21.24**	**1,032,000.00**	U-0.183 W/m²K	**22.73**	**1,104,240.00**	**107%**
B2020	Exterior Windows	U-2.2 W/m²K, U-5.7 W/m²K SC-0.37	**15.06**	**732,000.00**	U-1.6 W/m²K SC-0.37	**16.87**	**819,840.00**	**112%**
B2030	Exterior Doors		1.46	70,600.00		1.46	70,600.00	
B3010	Roof Coverings		11.48	558,000.00		11.48	558,000.00	
C Interiors								
C1010	Partitions		8.58	417,000.00		8.58	417,000.00	
C1020	Interior Doors		13.88	675,000.00		13.88	675,000.00	
C1030	Fittings		14.26	693,000.00		14.26	693,000.00	
C2010	Stair Construction		7.84	381,000.00		7.84	381,000.00	
C3010	Wall Finishes		8.12	395,000.00		8.12	395,000.00	
C3020	Floor Finishes		10.86	528,000.00		10.86	528,000.00	
C3030	Ceiling Finishes		13.40	651,000.00		13.40	651,000.00	
D Services			0			0		
D1010	Elevators and Lifts		7.42	361,000.00		7.42	361,000.00	
D2010	Plumbing Fixtures		39.34	1,912,000.00		39.34	1,912,000.00	
D2020	Domestic Water Distribution		6.46	314,000.00		6.46	314,000.00	
D2040	Rain Water Drainage		1.38	66,800.00		1.38	66,800.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Multi-Zone Air Handling Units with Reheat.	**40.47**	**1,966,860.00**	Single Zone Package Units	**41.30**	**2,007,000.00**	**106%**
D4010	Sprinklers		6.02	293,000.00		6.02	293,000.00	
D4020	Standpipes		0.68	32,600.00		0.68	32,600.00	
D5010	Electrical Service/Distribution		9.06	440,000.00		9.06	440,000.00	
D5020	Lighting and Branch Wiring	School: 9.4 W/m² Shop: 6.8 W/m²	**24.60**	**1,195,440.00**	School: 10.7 W/m² Shop: 8.8 W/m²	**24.12**	**1,172,000.00**	**98%**
D5030	Communications and Security		13.44	653,000.00		13.44	653,000.00	
D5090	Other Electrical Systems		1.72	83,200.00		1.72	83,200.00	
		Sub-Total	326.24	15,855,300.00		330.8532	16,079,680.00	
	GENERAL CONDITIONS (Overhead & Profit)	25%	81.56	3,963,825.00		82.71	4,019,920.00	
	ARCHITECTURAL FEES	7%	28.55	1,387,338.75		28.95	1,406,972.00	
	TOTAL BUILDING COST		**436.34**	**21,206,463.75**		**442.52**	**21,506,572.00**	**101%**
	COST PER SQ FT($)			**436**			**443**	

5: Health,Long-Term Care Facility
2013 Q1 Costs

Baseline versus NECB Performance Pathway

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path applied to it in it's entirety.

Parameter	Comparison
Envelope	NECB-2011
Mechanical	NECB-2011
Lighting	NECB-2011

Model Type: Health - Long-Term Care Facility, Floors: 4 above grade, 1 below grade, Concrete Block with Steel Frame
Stories (Ea.): 4
Floor Area (S.F.): 167,002 ft²
Perimeter (L.F.): 1,684 ft
No of Stories (E.A.): 5
Story Height (L.F.): 13.5 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
Corner Brook, Newfoundland

		Baseline				NECB-2011		
		Baseline Value	**$Cost/ Per S.F.**	**$ Total Cost**	**NECB-2011 Value**	**$Cost/ Per S.F.**	**$ Total Cost**	**% Increase/ Decrease**
A Substructure								
A1010	Standard Foundations		3.78	631,500.00		3.78	631,500.00	
A1030	Slab on Grade		1.16	194,500.00		1.16	194,500.00	
A2010	Basement Excavation		0.66	110,500.00		0.66	110,500.00	
A2020	Basement Walls		2.09	349,000.00		2.09	349,000.00	
B Shell								
B1010	Floor Construction		22.89	3,822,500.00		22.89	3,822,500.00	
B1020	Roof Construction	U-0.22 W/m²K	2.60	**435,000.00**	U-0.183 W/m²K	2.89	**482,850.00**	**111%**
B2010	Exterior Walls	U-0.257 W/m²K, U-0.643 W/m²K,	24.75	**4,134,000.00**	U-0.247 W/m²K	25.49	**4,258,020.00**	**103%**
B2020	Exterior Windows	U-2.15 W/m²K, U-2.97 W/m²K SC-0.30	3.34	**557,000.00**	U-2.2 W/m²K SC-0.30	3.57	**595,990.00**	**107%**
B2030	Exterior Doors		0.47	79,000.00		0.47	79,000.00	
B3010	Roof Coverings		1.57	261,500.00		1.57	261,500.00	
B3020	Roof Openings		0.01	985.00		0.01	985.00	
C Interiors								
C1010	Partitions		6.39	1,066,500.00		6.39	1,066,500.00	
C1020	Interior Doors		7.93	1,324,000.00		7.93	1,324,000.00	
C2010	Stair Construction		3.75	626,500.00		3.75	626,500.00	
C3010	Wall Finishes		2.96	494,000.00		2.96	494,000.00	
C3020	Floor Finishes		2.36	394,500.00		2.36	394,500.00	
C3030	Ceiling Finishes		3.09	516,500.00		3.09	516,500.00	
D Services								
D1010	Elevators and Lifts		4.30	717,500.00		4.30	717,500.00	
D2010	Plumbing Fixtures		41.74	6,971,000.00		41.74	6,971,000.00	
D2020	Domestic Water Distribution		1.41	235,500.00		1.41	235,500.00	
D2040	Rain Water Drainage		0.54	89,500.00		0.54	89,500.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Multi-Zone Air Handling Units in Core Areas, Fan Coil Units in Residential Areas, Ground Source Heat Pump System.	**19.99**	**3,338,125.00**	Multi-Zone Air Handling Units in Core Areas, Fan Coil Units in Residential Areas, Oil Fired Boilers with Hot Water Baseboard.	**15.99**	**2,670,500.00**	**71%**
D4010	Sprinklers		2.74	458,000.00		2.74	458,000.00	
D4020	Standpipes		0.41	68,000.00		0.41	68,000.00	
D5010	Electrical Service/Distribution		0.26	43,800.00		0.26	43,800.00	
D5020	Lighting and Branch Wiring	13.7 W/m²	**11.89**	**1,985,771.28**	9.4 W/m²	**8.16**	**1,362,500.00**	**69%**
D5030	Communications and Security		0.90	149,500.00		0.90	149,500.00	
D5090	Other Electrical Systems		0.61	102,500.00		0.61	102,500.00	
E Equipment & Furnishings								
E1020	Institutional Equipment		2.59	168,000.00		2.59	168,000.00	
E1090	Other Equipment		1.24	80,500.00		1.24	80,500.00	
		Sub-Total	178.42	29,405,181.28		171.9523	28,325,145.00	
	GENERAL CONDITIONS (Overhead & Profit)	25%	44.61	7,351,295.32		42.99	7,081,286.25	
	ARCHITECTURAL FEES	7%	15.61	2,572,953.36		15.05	2,478,450.19	
	TOTAL BUILDING COST		**238.64**	**39,329,429.96**		**229.99**	**37,884,881.44**	**96%**
	COST PER SQ FT($)			**236**			**227**	

5: Health,Long-Term Care Facility
2013 Q1 Costs

Baseline versus NECB Performance Pathway, Zone 7A

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path using 7A (instead of Zone 6) applied to it in it's entirety.

Parameter	Comparison
Envelope	NECB-2011 (7A)
Mechanical	NECB-2011 (7A)
Lighting	NECB-2011 (7A)

Model Type: Health - Long-Term Care Facility, Floors: 4 above grade, 1 below grade, Concrete Block with Steel Frame
Stories (Ea.): 4
Floor Area (S.F.): 167,002 ft^2
Perimeter (L.F.): 1,684 ft
No of Stories (E.A.): 5
Story Height (L.F.): 13.5 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
Corner Brook, Newfoundland

		Baseline			NECB-2011			
		Baseline Value	**$Cost/ Per S.F.**	**$ Total Cost**	**NECB-2011 Value**	**$Cost/ Per S.F.**	**$ Total Cost**	**% Increase/ Decrease**
A Substructure								
A1010	Standard Foundations		3.78	631,500.00		3.78	631,500.00	
A1030	Slab on Grade		1.16	194,500.00		1.16	194,500.00	
A2010	Basement Excavation		0.66	110,500.00		0.66	110,500.00	
A2020	Basement Walls		2.09	349,000.00		2.09	349,000.00	
B Shell								
B1010	Floor Construction		22.89	3,822,500.00		22.89	3,822,500.00	
B1020	Roof Construction	U-0.22 W/m^2K	2.60	**435,000.00**	U-0.162 W/m^2K	2.94	**491,550.00**	**113%**
B2010	Exterior Walls	U-0.257 W/m^2K, U-0.643 W/m^2K,	24.75	**4,134,000.00**	U-0.210 W/m^2K	26.24	**4,382,040.00**	**106%**
B2020	Exterior Windows	U-2.15 W/m^2K, U-2.97 W/m^2K SC-0.30	3.34	**557,000.00**	U-2.2 W/m^2K SC-0.30	3.57	**595,990.00**	**107%**
B2030	Exterior Doors		0.47	79,000.00		0.47	79,000.00	
B3010	Roof Coverings		1.57	261,500.00		1.57	261,500.00	
B3020	Roof Openings		0.01	985.00		0.01	985.00	
C Interiors								
C1010	Partitions		6.39	1,066,500.00		6.39	1,066,500.00	
C1020	Interior Doors		7.93	1,324,000.00		7.93	1,324,000.00	
C2010	Stair Construction		3.75	626,500.00		3.75	626,500.00	
C3010	Wall Finishes		2.96	494,000.00		2.96	494,000.00	
C3020	Floor Finishes		2.36	394,500.00		2.36	394,500.00	
C3030	Ceiling Finishes		3.09	516,500.00		3.09	516,500.00	
D Services								
D1010	Elevators and Lifts		4.30	717,500.00		4.30	717,500.00	
D2010	Plumbing Fixtures		41.74	6,971,000.00		41.74	6,971,000.00	
D2020	Domestic Water Distribution		1.41	235,500.00		1.41	235,500.00	
D2040	Rain Water Drainage		0.54	89,500.00		0.54	89,500.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Multi-Zone Air Handling Units in Core Areas, Fan Coil Units in Residential Areas, Ground Source Heat Pump System.	**19.99**	**3,338,125.00**	Multi-Zone Air Handling Units in Core Areas, Fan Coil Units in Residential Areas, Oil Fired Boilers with Hot Water Baseboard.	**15.99**	**2,670,500.00**	**71%**
D4010	Sprinklers		2.74	458,000.00		2.74	458,000.00	
D4020	Standpipes		0.41	68,000.00		0.41	68,000.00	
D5010	Electrical Service/Distribution		0.26	43,800.00		0.26	43,800.00	
D5020	Lighting and Branch Wiring	13.7 W/m^2	**11.89**	**1,985,771.28**	9.4 W/m^2	**8.16**	**1,362,500.00**	**69%**
D5030	Communications and Security		0.90	149,500.00		0.90	149,500.00	
D5090	Other Electrical Systems		0.61	102,500.00		0.61	102,500.00	
E Equipment & Furnishings								
E1020	Institutional Equipment		2.59	168,000.00		2.59	168,000.00	
E1090	Other Equipment		1.24	80,500.00		1.24	80,500.00	
		Sub-Total	178.42	29,405,181.28		172.7468	28,457,865.00	
	GENERAL CONDITIONS (Overhead & Profit)	25%	44.61	7,351,295.32		43.19	7,114,466.25	
	ARCHITECTURAL FEES	7%	15.61	2,572,953.36		15.12	2,490,063.19	
	TOTAL BUILDING COST		**238.64**	**39,329,429.96**		**231.05**	**38,062,394.44**	**97%**
	COST PER SQ FT($)			**236**			**228**	

5: Health,Long-Term Care Facility
2013 Q1 Costs

Baseline versus NECB Performance Pathway with Baseline Envelope

Description of Analysis: The baseline building is compared against a building that has had the baseline envelope and the NECB performance path applied to the mechanical systems and lighting.

Parameter	Comparison
Envelope	No Change
Mechanical	NECB-2011
Lighting	NECB-2011

Model Type: Health - Long-Term Care Facility, Floors: 4 above grade, 1 below grade, Concrete Block with Steel Frame
Stories (Ea.): 4
Floor Area (S.F.): 167,002 ft²
Perimeter (L.F.): 1,684 ft
No of Stories (E.A.): 5
Story Height (L.F.): 13.5 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
Corner Brook, Newfoundland

		Baseline				NECB-2011		
		Baseline Value	$Cost/ Per S.F.	$ Total Cost	NECB-2011 Value	$Cost/ Per S.F.	$ Total Cost	% Increase/ Decrease
A Substructure								
A1010	Standard Foundations		3.78	631,500.00		3.78	631,500.00	
A1030	Slab on Grade		1.16	194,500.00		1.16	194,500.00	
A2010	Basement Excavation		0.66	110,500.00		0.66	110,500.00	
A2020	Basement Walls		2.09	349,000.00		2.09	349,000.00	
B Shell								
B1010	Floor Construction		22.89	3,822,500.00		22.89	3,822,500.00	
B1020	Roof Construction	U-0.22 W/m²K	2.60	**435,000.00**	U-0.22 W/m²K	2.60	**435,000.00**	
B2010	Exterior Walls	U-0.257 W/m²K, U-0.643 W/m²K,	24.75	**4,134,000.00**	U-0.257 W/m²K, U-0.643 W/m²K,	24.75	**4,134,000.00**	
B2020	Exterior Windows	U-2.15 W/m²K, U-2.97 W/m²K SC-0.30	3.34	**557,000.00**	U-2.15 W/m²K, U-2.97 W/m²K SC-0.30	3.34	**557,000.00**	
B2030	Exterior Doors		0.47	79,000.00		0.47	79,000.00	
B3010	Roof Coverings		1.57	261,500.00		1.57	261,500.00	
B3020	Roof Openings		0.01	985.00		0.01	985.00	
C Interiors								
C1010	Partitions		6.39	1,066,500.00		6.39	1,066,500.00	
C1020	Interior Doors		7.93	1,324,000.00		7.93	1,324,000.00	
C2010	Stair Construction		3.75	626,500.00		3.75	626,500.00	
C3010	Wall Finishes		2.96	494,000.00		2.96	494,000.00	
C3020	Floor Finishes		2.36	394,500.00		2.36	394,500.00	
C3030	Ceiling Finishes		3.09	516,500.00		3.09	516,500.00	
D Services								
D1010	Elevators and Lifts		4.30	717,500.00		4.30	717,500.00	
D2010	Plumbing Fixtures		41.74	6,971,000.00		41.74	6,971,000.00	
D2020	Domestic Water Distribution		1.41	235,500.00		1.41	235,500.00	
D2040	Rain Water Drainage		0.54	89,500.00		0.54	89,500.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Multi-Zone Air Handling Units in Core Areas, Fan Coil Units in Residential Areas, Ground Source Heat Pump System.	**19.99**	**3,338,125.00**	Multi-Zone Air Handling Units in Core Areas, Fan Coil Units in Residential Areas, Oil Fired Boilers with Hot Water Baseboard.	**15.99**	**2,670,500.00**	**71%**
D4010	Sprinklers		2.74	458,000.00		2.74	458,000.00	
D4020	Standpipes		0.41	68,000.00		0.41	68,000.00	
D5010	Electrical Service/Distribution		0.26	43,800.00		0.26	43,800.00	
D5020	Lighting and Branch Wiring	13.7 W/m²	**11.89**	**1,985,771.28**	9.4 W/m²	**8.16**	**1,362,500.00**	**69%**
D5030	Communications and Security		0.90	149,500.00		0.90	149,500.00	
D5090	Other Electrical Systems		0.61	102,500.00		0.61	102,500.00	
E Equipment & Furnishings								
E1020	Institutional Equipment		2.59	168,000.00		2.59	168,000.00	
E1090	Other Equipment		1.24	80,500.00		1.24	80,500.00	
		Sub-Total	178.42	29,405,181.28		170.69	28,114,285.00	
	GENERAL CONDITIONS (Overhead & Profit)	25%	44.61	7,351,295.32		42.67	7,028,571.25	
	ARCHITECTURAL FEES	7%	15.61	2,572,953.36		14.94	2,459,999.94	
	TOTAL BUILDING COST		**238.64**	**39,329,429.96**		**228.30**	**37,602,856.19**	**96%**
	COST PER SQ FT($)			**236**			**225**	

5: Health,Long-Term Care Facility
2013 Q1 Costs

Baseline versus Baseline with NECB Envelope

Description of Analysis: The baseline building is compared against the baseline building with an NECB envelope.

Parameter	Comparison
Envelope	NECB-2011
Mechanical	No Change
Lighting	No Change

Model Type: Health - Long-Term Care Facility, Floors: 4 above grade, 1 below grade, Concrete Block with Steel Frame
Stories (Ea.): 4
Floor Area (S.F.): 167,002 ft²
Perimeter (L.F.): 1,684 ft
No of Stories (E.A.): 5
Story Height (L.F.): 13.5 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
Corner Brook, Newfoundland

		Baseline			NECB-2011			
		Baseline Value	**$Cost/ Per S.F.**	**$ Total Cost**	**NECB-2011 Value**	**$Cost/ Per S.F.**	**$ Total Cost**	**% Increase/ Decrease**
A Substructure								
A1010	Standard Foundations		3.78	631,500.00		3.78	631,500.00	
A1030	Slab on Grade		1.16	194,500.00		1.16	194,500.00	
A2010	Basement Excavation		0.66	110,500.00		0.66	110,500.00	
A2020	Basement Walls		2.09	349,000.00		2.09	349,000.00	
B Shell								
B1010	Floor Construction		22.89	3,822,500.00		22.89	3,822,500.00	
B1020	Roof Construction	U-0.22 W/m²K	2.60	**435,000.00**	U-0.183 W/m²K	2.89	**482,850.00**	**111%**
B2010	Exterior Walls	U-0.257 W/m²K, U-0.643 W/m²K,	24.75	**4,134,000.00**	U-0.247 W/m²K	25.49	**4,258,020.00**	**103%**
B2020	Exterior Windows	U-2.15 W/m²K, U-2.97 W/m²K SC-0.30	3.34	**557,000.00**	U-2.2 W/m²K SC-0.30	3.57	**595,990.00**	**107%**
B2030	Exterior Doors		0.47	79,000.00		0.47	79,000.00	
B3010	Roof Coverings		1.57	261,500.00		1.57	261,500.00	
B3020	Roof Openings		0.01	985.00		0.01	985.00	
C Interiors								
C1010	Partitions		6.39	1,066,500.00		6.39	1,066,500.00	
C1020	Interior Doors		7.93	1,324,000.00		7.93	1,324,000.00	
C2010	Stair Construction		3.75	626,500.00		3.75	626,500.00	
C3010	Wall Finishes		2.96	494,000.00		2.96	494,000.00	
C3020	Floor Finishes		2.36	394,500.00		2.36	394,500.00	
C3030	Ceiling Finishes		3.09	516,500.00		3.09	516,500.00	
D Services								
D1010	Elevators and Lifts		4.30	717,500.00		4.30	717,500.00	
D2010	Plumbing Fixtures		41.74	6,971,000.00		41.74	6,971,000.00	
D2020	Domestic Water Distribution		1.41	235,500.00		1.41	235,500.00	
D2040	Rain Water Drainage		0.54	89,500.00		0.54	89,500.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Multi-Zone Air Handling Units in Core Areas, Fan Coil Units in Residential Areas, Ground Source Heat Pump System.	**22.57**	**3,769,524.08**	Multi-Zone Air Handling Units in Core Areas, Fan Coil Units in Residential Areas, Ground Source Heat Pump System.	**22.57**	**3,769,524.08**	
D4010	Sprinklers		2.74	458,000.00		2.74	458,000.00	
D4020	Standpipes		0.41	68,000.00		0.41	68,000.00	
D5010	Electrical Service/Distribution		0.26	43,800.00		0.26	43,800.00	
D5020	Lighting and Branch Wiring	13.7 W/m²	**11.89**	**1,985,771.28**	13.7 W/m²	**11.89**	**1,985,771.28**	
D5030	Communications and Security		0.90	149,500.00		0.90	149,500.00	
D5090	Other Electrical Systems		0.61	102,500.00		0.61	102,500.00	
E Equipment & Furnishings								
E1020	Institutional Equipment		2.59	168,000.00		2.59	168,000.00	
E1090	Other Equipment		1.24	80,500.00		1.24	80,500.00	
		Sub-Total	181.00	29,836,580.36		182.26563	30,047,440.36	
	GENERAL CONDITIONS (Overhead & Profit)	25%	45.25	7,459,145.09		45.57	7,511,860.09	
	ARCHITECTURAL FEES	7%	15.84	2,610,700.78		15.95	2,629,151.03	
	TOTAL BUILDING COST		**242.09**	**39,906,426.23**		**243.78**	**40,188,451.48**	**101%**
	COST PER SQ FT($)			**239**			**241**	

6: Multi-Unit Residence Building (MURB)

2013 Q1 Costs

Baseline versus NECB Performance Pathway, Zone 7A

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path using Zone 7A (instead of Zone 6) applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (Zone 7A)
Mechanical	NECB-2011 (Zone 7A)
Lighting	NECB-2011 (Zone 7A)

Model Type: MURB, Floors: 7 above grade, 0 below, various wall types
Stories (Ea.): 7
Floor Area (S.F.): 168,930 ft²
Perimeter (L.F.): 3617 ft
No of Stories (E.A.): 7
Story Height (L.F.): 11 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
St. John's, Newfoundland

		Baseline			NECB-2011			
		Baseline Value	**$Cost/ Per S.F.**	**$ Total Cost**	**NECB-2011 Value**	**$Cost/ Per S.F.**	**$ Total Cost**	**% Increase/ Decrease**
A Substructure								
A1010	Standard Foundations		2.26	381,500.00		2.26	381,500.00	
A1030	Slab on Grade		0.73	123,000.00		0.73	123,000.00	
A2010	Basement Excavation		0.04	5,925.00		0.04	5,925.00	
A2020	Basement Walls		2.22	374,500.00		2.22	374,500.00	
B Shell								
B1010	Floor Construction		27.25	4,602,500.00		27.25	4,602,500.00	
B1020	Roof Construction	U-0.183 W/m²K,	**3.35**	**566,500.00**	U-0.162 W/m²K	**3.72**	**628,815.00**	**111%**
B2010	Exterior Walls	U-0.225 W/m²K, U-0.275 W/m²K, U-0.390 W/m²K, U-0.238 W/m²K, U-0.481 W/m²K, U-0.729 W/m²K,	**22.31**	**3,769,500.00**	U-0.210 W/m²K	**23.43**	**3,957,975.00**	**105%**
B2020	Exterior Windows	U-1.76 W/m²K SC-0.44	**12.63**	**2,133,000.00**	U-2.2 W/m²K SC-0.44	**11.87**	**2,005,020.00**	**94%**
B2030	Exterior Doors		0.37	62,000.00		0.37	62,000.00	
B3010	Roof Coverings		1.44	242,500.00		1.44	242,500.00	
B3020	Roof Openings		0.00	0.00		0.00	0.00	
C Interiors								
C1010	Partitions		10.71	1,809,500.00		10.71	1,809,500.00	
C1020	Interior Doors		7.49	1,266,000.00		7.49	1,266,000.00	
C1030	Fittings		1.80	303,500.00		1.80	303,500.00	
C2010	Stair Construction		4.14	700,000.00		4.14	700,000.00	
C3010	Wall Finishes		7.97	1,347,000.00		7.97	1,347,000.00	
C3020	Floor Finishes		11.90	2,009,500.00		11.90	2,009,500.00	
C3030	Ceiling Finishes		0.96	162,000.00		0.96	162,000.00	
D Services								
D1010	Elevators and Lifts		12.80	2,161,500.00		12.80	2,161,500.00	
D2010	Plumbing Fixtures		23.15	3,910,500.00		23.15	3,910,500.00	
D2020	Domestic Water Distribution		2.11	357,000.00		2.11	357,000.00	
D2040	Rain Water Drainage		0.16	27,700.00		0.16	27,700.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Multi-Zone, Heat Recovery Air Handling Units in Common Areas & Bedroom Areas, Electric Baseboard Heating.	**15.56**	**2,629,186.78**	Multi-Zone Air Handling Units in Common Areas, Water Cooled Chiller & Electric Baseboard Heating, Unitary Units in Bedroom Areas, Electric Baseboard Heating.	**14.45**	**2,441,500.00**	**93%**
D4010	Sprinklers		2.76	466,000.00		2.76	466,000.00	
D4020	Standpipes		0.67	113,000.00		0.67	113,000.00	
D5010	Electrical Service/Distribution		0.57	97,000.00		0.57	97,000.00	
D5020	Lighting and Branch Wiring	Common Area: 6.9 W/m² Bedrooms: 7.4 W/m²	**9.69**	**1,636,695.00**	Common Area: 10.7 W/m² Bedrooms: 6.5 W/m²	**8.73**	**1,474,500.00**	**90%**
D5030	Communications and Security		5.87	991,500.00		5.87	991,500.00	
D5090	Other Electrical Systems		0.27	45,000.00		0.27	45,000.00	
E Equipment & Furnishings								
E1090	Other Equipment		2.95	497,500.00		2.95	497,500.00	
		Sub-Total	194.13	32,791,006.78		192.7862	32,563,935.00	
	GENERAL CONDITIONS (Overhead & Profit)	25%	48.53	8,197,751.69		48.20	8,140,983.75	
	ARCHITECTURAL FEES	7%	16.99	2,869,213.09		16.87	2,849,344.31	
	TOTAL BUILDING COST		**259.65**	**43,857,971.56**		**257.85**	**43,554,263.06**	**99%**

7: Warehouse
2013 Q1 Costs

Baseline versus NECB Performance Pathway, Zone 7A

Description of Analysis: The baseline building is compared against a building that has had the NECB performance path using Zone 7A (instead of Zone 6) applied to it in its entirety.

Parameter	Comparison
Envelope	NECB-2011 (Zone 7A)
Mechanical	NECB-2011 (Zone 7A)
Lighting	NECB-2011 (Zone 7A)

Model Type: Warehouse, Floors: 1 above grade, 0 below grade, Tilt-up Wall with Steel Frame
Stories (Ea.): 1
Floor Area (S.F.): 41,000 ft²
Perimeter (L.F.): 862 ft
No of Stories (E.A.): 1
Story Height (L.F.): 24 ft
Costs are derived from a building model with basic components. Scope differences and local market conditions can cause costs to vary significantly.
St. John's, Newfoundland

		Baseline			NECB-2011			% Increase/ Decrease
		Baseline Value	$Cost/ Per S.F.	$ Total Cost	NECB-2011 Value	$Cost/ Per S.F.	$ Total Cost	
A Substructure								
A1010	Standard Foundations		1.27	52,000.00		1.27	52,000.00	
A1030	Slab on Grade		12.22	501,000.00		12.22	501,000.00	
A2010	Basement Excavation		0.15	6,050.00		0.15	6,050.00	
A2020	Basement Walls		2.04	83,500.00		2.04	83,500.00	
B Shell								
B1010	Floor Construction		2.30	94,500.00		2.30	94,500.00	
B1020	Roof Construction	U-0.142 W/m²K	**8.08**	**331,500.00**	U-0.162 W/m²K	**7.11**	**291,720.00**	**88%**
B2010	Exterior Walls	U-0.284 W/m²K	**5.69**	**233,500.00**	U-0.210 W/m²K	**6.15**	**252,180.00**	**108%**
B2020	Exterior Windows	U-2.6 W/m²K, U-2.2 W/m²K SC-0.42	**3.74**	**153,500.00**	U-2.2 W/m²K SC-0.42	**3.89**	**159,640.00**	**104%**
B2030	Exterior Doors		1.27	52,000.00		1.27	52,000.00	
B3010	Roof Coverings		5.60	229,500.00		5.60	229,500.00	
B3020	Roof Openings		0.27	11,100.00		0.27	11,100.00	
C Interiors								
C1010	Partitions		0.69	28,100.00		0.69	28,100.00	
C1020	Interior Doors		0.28	11,400.00		0.28	11,400.00	
C1030	Fittings		0	0.00		0	0.00	
C2010	Stair Construction		0.75	30,600.00		0.75	30,600.00	
C3010	Wall Finishes		1.84	75,500.00		1.84	75,500.00	
C3020	Floor Finishes		1.96	80,500.00		1.96	80,500.00	
C3030	Ceiling Finishes		0.67	27,400.00		0.67	27,400.00	
D Services								
D1010	Elevators and Lifts		0.00	0.00		0.00	0.00	
D2010	Plumbing Fixtures		1.56	64,000.00		1.56	64,000.00	
D2020	Domestic Water Distribution		0.43	17,500.00		0.43	17,500.00	
D2040	Rain Water Drainage		1.83	75,000.00		1.83	75,000.00	
D3010	Base Heating and Cooling Generating Systems (Including all piping etc.)	Single Zone Heat Recovery Units	**5.35**	**181,815.00**	Single Zone Package Units	**5.75**	**195,500.00**	**108%**
D4010	Sprinklers		3.85	158,000.00		3.85	158,000.00	
D4020	Standpipes		2.18	89,500.00		2.18	89,500.00	
D5010	Electrical Service/Distribution		0.44	18,200.00		0.44	18,200.00	
D5020	Lighting and Branch Wiring	Office: 5.8 W/m² Warehouse: 5.8 W/m²	**6.07**	**249,150.00**	Office: 9.7 W/m² Warehouse: 7.1W/m²	**5.52**	**226,500.00**	**91%**
D5030	Communications and Security		2.69	110,500.00		2.69	110,500.00	
D5090	Other Electrical Systems		0.00	0.00		0.00	0.00	
E Equipment & Furnishings								
E1020	Institutional Equipment		0	0.00		0	0.00	
E1090	Other Equipment		3.07	126,000.00		3.07	126,000.00	
		Sub-Total	76.29	3,091,315.00		75.7752	3,067,390.00	
	GENERAL CONDITIONS (Overhead & Profit)	25%	19.07	772,828.75		18.94	766,847.50	
	ARCHITECTURAL FEES	7%	6.68	270,490.06		6.63	268,396.63	
	TOTAL BUILDING COST		**102.04**	**4,134,633.81**		**101.35**	**4,102,634.13**	**99%**
	COST PER SQ FT($)			**101**			**100**	

APPENDIX F

Contributors

This appendix provides contact information for the various contributors to the study.

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