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Adaptation Guidelines for the **National Energy Code** of Canada for Buildings






CANADIAN COMMISSION ON BUILDING AND FIRE CODES

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Canada

Adaptation Guideline for the National Energy Code for Buildings 2011

Introduction

The content of the National Energy Code for Buildings 2011 (NECB) was approved by the Canadian Commission on Building and Fire Codes (CCBFC) at its April 2011 meeting. During the development of the material, some jurisdictions commented that they had specific policy directives regarding energy efficiency in buildings that they needed to address. It was agreed that a document would be developed to provide guidance on how the NECB 2011 can be modified to address those directives. As a result, this document was developed by a Joint Task Group of the CCBFC and the Provincial/Territorial Policy Advisory Committee on Codes (PTPACC).

The document is targeted to the Provinces and Territories, however it can also be used as a reference document by designers and owners in order to see the effects of varying certain components. It must be remembered that no section of the document can stand alone and therefore the document must be used in its entirety.

Mandate

Ultimately the Joint Task Group was to draft a guideline document that would provide specific details on how the NECB 2011 can be modified to address the following specific issues:

1. *change in the overall building performance (increase or decrease)*

   The ±5% and ±10% variation in overall building performance can be addressed through modification of the various prescriptive requirements for such systems and components as U-values for building envelope, fenestration and door-to-wall ratios, HVAC and service water heating (SWH) efficiencies, and lighting power densities etc.

2. *treatment of renewable energy*

   While updating the Model National Energy Code for Buildings 1997 (MNECB), the Standing Committee on Energy Efficiency in Buildings (SCEEB) spent a lot of time discussing renewable energy, but had such difficulty coming to terms with its definition that they made a conscious effort not to expressly address the use of renewable energy (allowing the building authorities to determine how to deal with it) and not impose or create barriers to its use. It was felt that considerable care needed to be exercised to not impose barriers.

3. *energy source specific requirements*

   The NECB 2011 was developed to be energy source neutral and, as such, its structure is not biased towards any particular energy type or source provider. The NECB 2011 was not intended to deal with policies or incentives.

   In order to establish the cost impact of any Code changes, the fuel costs used in those analyses were derived by using a blended rate and weighted average based on population. The explanation of those analyses can be found in the cost report undertaken during Code development.

The NECB 2011 can be modified to prioritize a particular energy source. This prioritization can be addressed through modification of the various prescriptive requirements, resulting in incenting or penalizing the use of targeted energy source(s).

4. *reduction of greenhouse gases*

   Provinces and territories may wish to identify their greenhouse gas mandates or preferences through adjustments in prescriptive values based upon either the site or source fuels, by requiring more or less stringent regulations than currently exist in the NECB 2011. However, the availability of sources of fuels within the provinces, equivalent greenhouse gas emissions from the electricity generation, social climate and current government policies are not all alike throughout the country. Each provincial and territorial jurisdiction may have guidelines and policies on this topic that need to be considered prior to amending the Code for their particular needs.

5. *promotion of specific technologies/assemblies*

   Provinces and territories may wish to penalize or incent the use of specific technologies and/or assemblies through adjustments in prescriptive values, by requiring more or less stringent regulations than currently exist in the NECB 2011. Each provincial and territorial jurisdiction may have guidelines and policies on this topic that need to be considered prior to amending the Code for their particular needs.

6. *occupancy specific requirements*

   As with most of the other policy areas, occupancy specific requirements can be addressed through modification of the various prescriptive provisions, resulting in incenting or penalizing the use of specific occupancy(s).

In order to carry out the task of drafting the Guideline, the Joint Task Group was instructed to:

- review the policy directives from the CCBFC on the NECB 2011
- review the technical content of the NECB 2011
- review the NECB 2011 presentation related to its flexible framework
- review correspondence received from the provinces and territories on desired modifications to the NECB 2011

The Guideline sets out details for achieving energy performance deviation from the NECB 2011 for ±5% and ±10% levels for all of the above policy areas. The jurisdictions can alter their requirements to meet their local ones. Cost implications were not part of the mandate of the Joint Task Group.

Background Summary

The drafting of the NECB 2011 was based on several principles, among them that the document would be energy source neutral, would not differentiate requirements based on building construction type and occupancy, and would not codify economics. As a national model code, these principles served the purpose of establishing a set of energy efficiency requirements that could be generally accepted by the provincial and territorial regulatory authorities who have the legal authority to enact and enforce building construction regulations in Canada. However, it was noted

that many of these regulators had specific policy directives and goals that they would need to address in order to realize construction requirements for energy efficiency in their jurisdictions. As such, it was decided that the CCBFC would develop a guideline document that would provide guidance on how the NECB 2011 can be modified to address those directives and goals.

Approach Used to Creating Document

A Joint Task Group of the CCBFC and PTPACC was formed to develop the Guideline. The Joint Task Group selected prescriptive areas of the NECB 2011 that would be altered to achieve the performance variations. These prescriptive areas are shown in the table below and are designated as primary areas that are broken down into secondary areas, and then further divided into tertiary areas in some cases. The ±5% and ±10% performance change in each of the secondary adjustment areas was achieved by using an appropriate mix of the tertiary adjustment areas where given and where possible. Where it was not possible to achieve the performance variation in a primary adjustment area through any single secondary adjustment area noted, an appropriate mix of the secondary adjustment areas was used.

Primary Adjustment Area	Secondary Adjustment Area	Tertiary Adjustment Area
Adjust U-values	window	—
	wall	above grade
		below grade
	roof	above grade
		below grade
FDWR	adjust equation	—
	set one level	—
HVAC and SHW	revise minimum efficiencies	—
	require HRVs and ERVs	—
	automatic controls – expand or reduce	—

Primary Adjustment Area	Secondary Adjustment Area	Tertiary Adjustment Area
Lighting	controls	occupancy sensors – auto-on
		occupancy sensor controls in parking garages
		continuous dimming in daylighted areas
	luminous efficacy	increase minimum efficiencies
		new technologies
		revise LPDs

A consultant was hired to perform energy modeling (i.e. simulations) of the adjustment areas for the six archetype buildings used for the validation of the NECB 2011 performance level (see Table 1) and for the same seven Canadian cities used in that validation – Victoria, Windsor, Montreal, Ottawa, Edmonton, Fort McMurray and Yellowknife. These cities were selected based on their location at roughly midpoint in each climate zone.

The modeling used levels of adjustment area variations from the NECB 2011 prescriptive requirements that were constructible and technically feasible as of Spring 2012.

As the results are only meant to provide guidance on how to achieve performance variations from the NECB 2011 levels, no analysis of cost or benefit was performed. Users of this Guideline should be aware that variations to increase the performance level (i.e. use less energy) may be more costly than a strict implementation of the NECB 2011 requirements.

Table 1
Building Archetypes

Building Type	Building Description
Large Office	The large office archetype represents a 13,380 m² (144,000 ft²) square, 10-storey building with a wall-to-roof area ratio of 4.3 and window-to-wall ratio of 0.4. The zoning includes 5 uniformly loaded zones per floor, with a 146 m² (1,570 ft²) perimeter zone on each of the four major orientations and a core zone that accounts for 57% of the floor space. The HVAC system is a single built-up variable air volume (VAV) system serving the entire building. A single natural gas boiler provides heating. A water-cooled electric compression chiller and cooling tower provides cooling. Walls are 75% curtain wall and 25% concrete block with exterior finish and interior insulation and drywall.
Secondary School	The secondary school archetype has 3 storeys, a wall-to-roof area ratio of 0.57, window-to-wall ratio of 0.26 and a total floor area of 17,320 m^2 (186,436 ft^2). Six built-up VAV systems serve the classrooms. The administrative area, library, cafeteria, and two gymnasiums each have dedicated built-up AHUs. Hydronic heating and cooling are provided by a single natural gas boiler and water-cooled chiller.
Mid-Rise Apartment	The mid-rise apartment archetype represents a 3,900 m² (42,000ft²) square, 3-storey building with a wall-to-roof area ratio of 1.1 and a window-to-wall ratio of 0.29. There are 15 apartments and 1 core zone per floor. The HVAC system consists of packaged air conditioners (PACs) and hydronic baseboards serving each apartment with a hydronic heated, DX-cooled make-up air unit (MAU) providing fresh air to the core zones. Fresh air to the suites enters from the core zone via door undercuts. A single natural gas boiler provides heating. Walls are concrete block with exterior finish and interior insulation and drywall.
Strip Mall	The strip mall archetype consists of a number of retail outlets with a total ground floor area of 3,995 m^2 (42,980ft²). Retail store areas range from 56 m^2 (600 ft^2) to 223 m^2 (2400 ft^2). The window-to-wall area ratio is 0.20 and the wall-to-roof area ratio is 0.95. Walls are brick, with air gap and insulation applied over 12-inch concrete block with drywall inside. The HVAC system in each building is a roof-top packaged constant volume system. The packaged system has a natural gas furnace section and a DX cooling section. No zone re-heat is provided.
Box Store	The box store archetype has a floor area of 8,279 m^2 (89,115 ft^2). The building has a wall-to-roof area ratio of 0.3 and a window-to-wall ratio of 7.6%. Walls are a precast construction containing rigid insulation. The building is cooled and heated by 9 roof-top units with heating provided by natural gas. The majority of the floor area is dedicated to sales, but there are small sections for an office, storage, receiving, and a greenhouse.
Warehouse	The warehouse archetype represents a 3,891 m^2 (41,883 ft^2), 1-storey building. The building contains an office area that is 10% of the total area of the building. The building has a wall-to-roof area ratio of 0.72 and a window-to-wall ratio of 3.5%; the FDWR (fenestration and door-to-wall ratio) is 6.5%. Walls are tilt-up precast construction containing rigid insulation. The office area is served by a packaged constant volume system with a natural gas furnace and DX cooling section. The warehouse area contains natural gas-fired unit heaters, but no cooling systems.

How to Use this Document

Variables by Part

In reviewing the variables available for adjustment to achieve ±5% and ±10% in the prescriptive requirements of the NECB 2011, a series of simulations were done to determine the effects of increasing and decreasing the requirements in applicable Sections of the NECB 2011 (i.e. Parts 3, 4, 5 and 6). The variables included window, wall and roof U-values and FDWR in Part 3, occupancy sensors, continuous dimming and lighting power densities in Part 4, demand control ventilation, and equipment efficiencies in Parts 5 and 6 and the inclusion or exclusion of heat recovery ventilators. Variables were chosen based on whether they could achieve a varying performance and then each variable in each section was modeled to determine their effect on performance change.

If the adjusted variable resulted in an appropriate increase or decrease in total performance it was noted as such and no further work was done with that variable. If, however, the adjusted variable did not result in an appropriate increase or decrease in total performance it was noted as such, and then possibly used in combination with another variable to achieve the overall effect in a later simulation. (See section, Combinations, for notes on applying these combinations.)

Tables 2 to 5 of Appendix A indicate in column 1, the Primary Area of the measure studied, in column 2, the Individual (Secondary) Measures that were analyzed at four different efficiency levels (High, Mid-High, Mid-low, and Low) under each of the primary categories, in column 3, the NECB 2011 Prescribed Levels and in column 4, the Explanatory Notes. These tables summarize the inputs varied and what the inputs were for each measure.

The results of these simulations are summarized in Tables 6 to 12 Appendix A. The full Modeling of Adaptation to the National Energy Code for Buildings (NECB) 2011 report prepared by Caneta Research Inc., referred to as the Caneta Report, is available here. Several things, however, should be noted when applying these individual variable results.

The tables must be applied on a measure-by-measure basis and the results should not be combined unless it is specifically addressed in the combined measures section of the Caneta Report. The unintended consequences of doing so are difficult to predict without specific modeling of the combination and may result in related effects such as double counting or double discounting certain aspects. An example of this can result by combining the following:

- Decreasing the lighting loads, which increases the demand on the heating system and decreases the demand on the cooling system, and
- Increasing the FDWR, which increases the amount of daylighting, and increases the demands on the heating and cooling systems.

As can be seen, the increase on the demand on the heating systems is double counted. The total effect on the cooling system depends on the magnitude of the change to the lighting loads and the FDWR, but will not be equal to the sum of the values from the individual tables.

Combinations

The measures indicated in the Combined Measures Tables 13 to 16 of Appendix A can be applied as ways to achieve the specific increase or decrease in energy performance indicated. Trying to utilize

combinations not provided should not be undertaken unless modeling is done specifically for that combination.

6 Mandated Issues

change in the overall building performance (increase or decrease)

To vary the overall performance results of the NECB any of the adjustments indicated in the Combined Measures Tables 13 to 16 of Appendix A can be used to achieve the ±5% and ±10% performance change indicated for prescriptive requirements of the NECB 2011. The specific construction details for the individual and combined measures in Tables 13 to 16 can be found in Tables 2 to 5 of Appendix A. For example, in Table 13, to achieve a 5% performance improvement for secondary schools in Victoria, either "high" performance requirements for U-values for windows and roofs can be implemented, or "high" boilers can be prescribed. Additional tables of revised requirements can be produced by the user to reflect the various levels of performance required or desired.

treatment of renewable energy

Renewable energy is energy which comes from natural resources such as sunlight, wind, tides, geothermal heat, hydroelectricity, biomass and biofuel, which are renewable (naturally replenished).

Dealing with renewable energy will require some policy work by the jurisdictions as difficulties with this issue were identified during the development of the NECB 2011. Some of these difficulties include the following:

1. Should credit be given for providing renewable energy by reducing the building requirements? Should building envelope requirements be relaxed because some solar energy is utilized, etc?
2. How will the renewable energy be accounted for? If solar photovoltaics are used, will the building sell the power back to the utility but receive a relaxed building envelope requirement because they used photovoltaics.
3. Where is the boundary for the generation of renewable energy that is available for credit to the building? on the building? on the property? community based?

These are some of the difficult questions that need to be answered prior to deciding to offer building energy performance credits for the incorporation of renewables. Some organizations have policies whereby the utilization of renewables is encouraged, but not at the expense of allowing building performance credits for using them.

Incentives for using renewable energy or penalties for using non-renewable sources can be addressed through modification of the various prescriptive requirements for such systems and components as U-values for building envelope, fenestration and door-to-wall ratios, HVAC and SWH efficiencies, and lighting power densities, etc., all of which can be found in Tables 6 to 16 of Appendix A.

energy source specific requirements

Measures to favour or deter the use of a specific energy source can be implemented by modifying any prescriptive requirement or set of prescriptive measures in the NECB 2011.

For example, one way of incorporating requirements specific to energy source is to introduce different envelope insulation requirements depending on the fuel source used (have a set of tables for gas fired heat and another set of tables for electric resistance heat).

One problem with setting different performance levels for electricity versus energy derived from fossil fuels is how to deal with the high COP (coefficient of performance) available from electric heat pump heat vs. both electric resistance heat and gas fired heat. To resolve the problem additional tables could be developed by the user to deal with heat pump heat.

The approach that the use of any energy source can be incented or penalized by using a set of tables or specific requirements that are specific to a particular energy source is appropriate here. Again, any prescriptive measure or set of prescriptive measures described in Tables 2 to 16 of Appendix A can be used to incent or penalize the use of a specific energy source.

reduction of greenhouse gases

To reduce greenhouse gas (GHG) emissions, the source of the greenhouse gases needs to be identified before any action can be taken. Once the energy source is identified, the section above on favouring energy source could be referenced to incent the use of energy sources that do not produce as much GHG emissions and/or penalize the use of the ones that do.

Electricity generation sources and the associated relevant GHG emissions change from province to province. The mix or blend of fossil fuels and hydro generation will also change from year to year and therefore cause a moving baseline or reference point when considering what impact electricity usage has in each region of the country.

For information to assist in assessing the impact of an increase or decrease in building energy consumption and its overall effect on GHG emissions, refer to the most recent emission factor data available through the National Inventory Report at Environment Canada under Climate Change at http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/6598.php. Other valuable references that compare fuel types to equivalent CO_2 coefficients can also be found in the latest emission trends and annual summaries on the Environment Canada website http://www.ec.gc.ca/ges-ghg/.

promotion of specific technologies/assemblies

The use of any specific technology/assembly can be incented or penalized by using the same methodology as described above, i.e. modify the prescriptive requirements as per Tables 2 to 5 of Appendix A.

occupancy specific requirements

The NECB 2011 is not occupancy specific by policy decision. There are no specific occupancy requirements (except lighting requirements) anywhere in the NECB 2011.

The approach that any occupancy can be incented or penalized by using a set of tables or specific requirements that are specific to a particular occupancy is appropriate here. In particular, Tables 6 to 16 of Appendix A have detailed performance entries for each of the 6 archetype buildings in each of the 6 climate zones.

Results

Summary Tables in Appendix A

Tables 2 to 5 give the specific construction details for each secondary measure.

Tables 6 to 12 provide a breakdown of the performance level changes for each of the secondary measures applied individually by archetype and by climate zone.

Tables 13 to 16 provide the individual and combined measures used to achieve the ±5% and ±10% performance change indicated for prescriptive requirements of the NECB 2011.

"-" in the tables indicates that a measure was not evaluated because either the target was achieved with a lesser measure or it was not possible to achieve the target with an extreme measure.

In Tables 13 to 16, the magnitude of the measure modifies the measures connected by the "&". For example in Table 14 for big box stores in Victoria, the combined measure that achieves the 10% energy savings is the "High" U-value for windows and walls, the "Mid-High" U-value for the roof, and the "Mid-High" efficiency for the furnace.

Table 17 provides the effects of including or excluding the use of heat recovery ventilators in self-contained residential dwelling units.

Comparison of MNECB 1997, NECB 2011 and ASHRAE 90.1

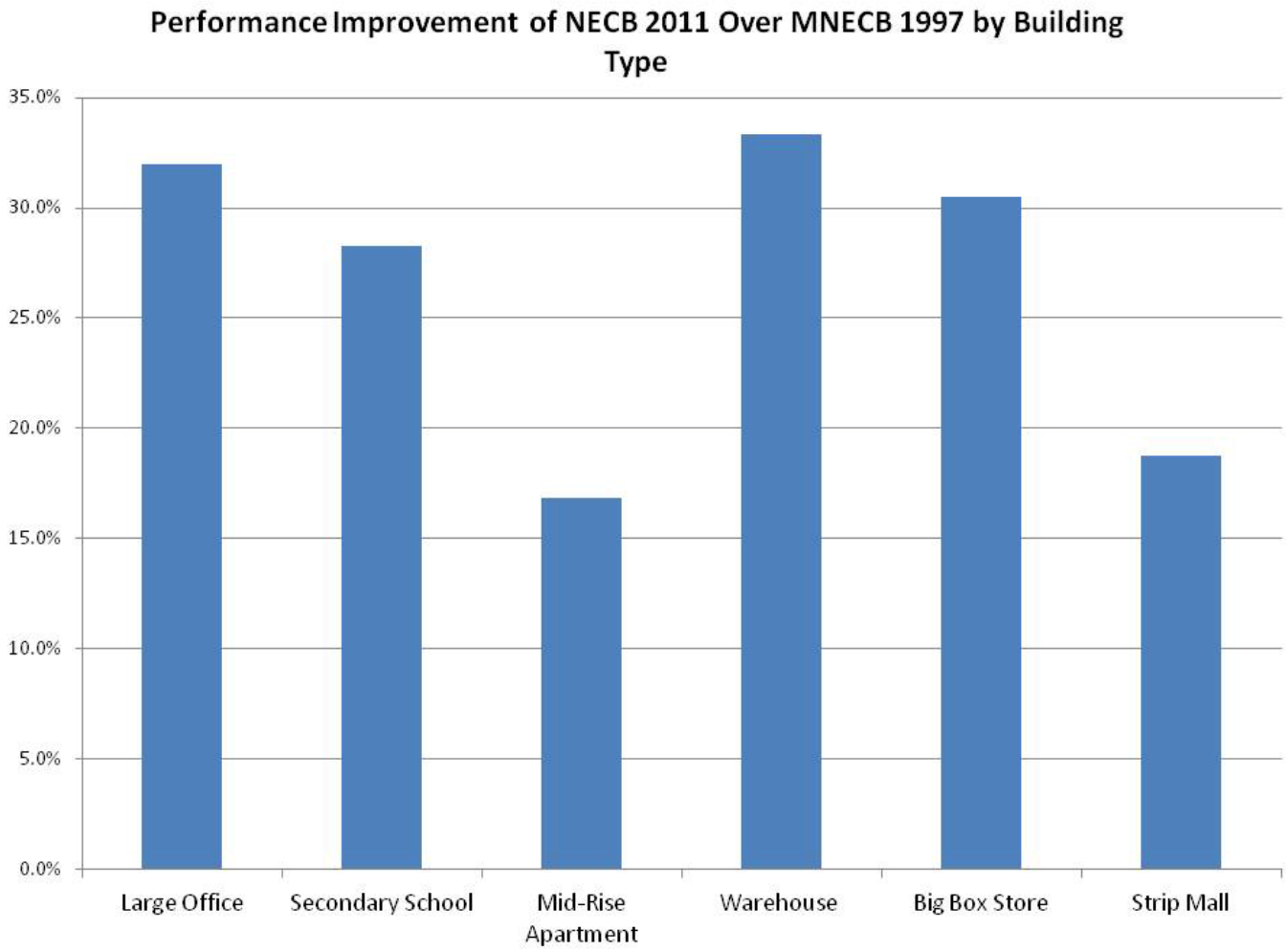
Both the NECB 2011 and ASHRAE 90.1 have set the minimum benchmarks for new building construction in Canada and the United States respectively.

While there are many similarities between the NECB 2011 and ASHRAE 90.1 2010 there are also differences in the way each code/standard describes building types or technologies. This comparison uses a broad based approach in comparing the efficiency of one to the other. The baselines for different parts and technologies of the code/standard will sometimes differ throughout the documents themselves. This comparison addresses only the Prescriptive Paths in each document over the broad range of climate zones and building types.

Model National Energy Code for Buildings (MNECB) 1997

The MNECB 1997 was developed in the mid-90's, but was not widely adopted. There was a strong emphasis on the building envelope and equipment requirements relative to energy source and economics related to the escalation rate of energy costs.

The figure below provides a high level comparison of the difference in the efficiency improvement (reduction in overall energy use) by building type of the NECB 2011 when compared to MNECB 1997 as a baseline:



ASHRAE 90.1

ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings, is drafted by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). The purpose of this standard is to provide minimum requirements for the energy efficient design of buildings except low-rise residential.

Its scope is to provide minimum efficiency requirements for the design and construction of new buildings and their systems, new portions of buildings and their systems, and new systems and equipment in existing buildings.

The Standard has undergone several revisions, with its first release in 1975 followed by updates in 1980, 1989, 1999, 2001, 2004, 2007 and 2010. The next scheduled release is 2013. In 1999, ASHRAE 90.1 was converted to code language and adopted a continuous maintenance practice, whereby ASHRAE publishes approved addenda between versions.

NECB and ASHRAE 90.1

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

- The NECB uses incremental capital cost of construction and incremental annual energy savings for cost/benefit analysis, ASHRAE uses total life cycle costing in the form of a scalar ratio.
- The NECB does not codify economics/social policy by having different requirements for different energy sources, ASHRAE does by establishing an Energy Cost Budget Method (performance path).
- The NECB does not have different requirements for different constructs, e.g. different U-values for different wall and roof constructions, ASHRAE does.
- The NECB applies to new construction and additions, ASHRAE requirements also apply to alterations to existing buildings.
- The NECB has a trade-off route within lighting, HVAC and service water heating (e.g. day lighting controls), ASHRAE does not.
- The NECB has a simple and detailed trade-off for building envelope, ASHRAE has one trade-off path.

Historically, ASHRAE 90.1 has been referenced or adopted with amendments in many of the 50 states in the U.S. The 2007 version of ASHRAE 90.1 was adopted by 31 states, with 10 others having adopted earlier versions.

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

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%

Detailed information on the breakdown of the end use energy usage for the different building components in the above table was based on reference (1).

References

1. Addendum to Performance Simulation of Proposed Changes to NECB Relative to MNECB, ASHRAE 90.1 2007, and ASHRAE 90.1 2004, Caneta Research Inc., January 26th, 2011

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