SUSTAINABLE BUILDINGS CANADA

Development of Energy Efficiency Requirements for the Toronto Green Standard: Final Report

SUSTAINABLE BUILDINGS CANADA
33 LONGBOAT AVENUE
TORONTO • ON • M5A 4C9

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Project team:
Bob Bach, Energy Profiles Limited
Marjorie Lamb, Writer in Residence Inc.

For additional information about this document, please contact:

Bob Bach
Energy Profiles Limited
295 The West Mall, Ste. 503
Toronto, ON, M9C 4Z4
Phone: 416 440-1323 ext. 4
Fax: 416 440-0301

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1.0 Executive Summary

The purpose of this project was to provide City of Toronto Planning with recommendations for changing the energy efficiency requirements of the Toronto Green Standard (TGS) so that requirements for buildings constructed in Toronto would continue to exceed those required by the Ontario Building Code (OBC).

Effective January 1, 2012, OBC 2006 will incorporate the same requirements for energy efficiency in buildings and housing as the TGS. When the next edition of OBC is published, currently expected in 2012, it will state what the requirements will be in the OBC that follows, likely to be published in 2017.

The project consisted of a review of energy efficiency for buildings and houses over the past two decades, research undertaken for buildings by the Ministry of Municipal Affairs and Housing (MMAH) for the 2006 and 2012 building codes, and a review of the plans being currently finalized by Natural Resources Canada for their new *EnerGuide Rating System* and *ENERGY STAR® for New Homes* programs.

A significant factor in establishing the requirements has been the unexpected delay in publishing the new building code. While MMAH has put regulations in place to ensure that the requirements stated in OBC 2006 to take effect after Dec. 31, 2011 will take effect, they have not yet established the requirements that will be stated in OBC 2012 as applying when the next Building Code is issued, likely in 2017.

The requirements for buildings that take effect at the start of 2012 will require that design teams and municipal building officials learn one or two highly advanced versions of energy codes, for which there will be a significant learning curve. Similarly for low-rise housing, the Building Code has fully adopted the *EnerGuide for New Houses* rating scale, albeit using either a prescriptive or a performance approach, and this will also require a new understanding of advanced housing design and construction.

It seems reasonable for the TGS Tier 1 to move the market forward in a manner that anticipates the next edition of the Building Code, and to then raise the bar as the Building Code is released. This has been the practice followed in the current TGS.

The recommendations for housing are based on a reasonable increment over the OBC for Tier 1 requirements that will be consistent with the new ESNH when it is released in 2012, while maintaining the same stringent requirement that have been in place for Tier 2 up to the present time.

The recommendations for buildings follow a phased-in approach over the next Building Code cycle for buildings for both Tier 1 and Tier 2 to permit the industry to become familiar with the more stringent and detailed energy codes in the near term, with a ramping up to the level anticipated in OBC 2017 later in the code cycle. There is also an option proposed for Part 9 non-residential buildings and for Part 3 buildings up to 2,000 m^3 in floor area.

The proposed requirements are presented in Table 1.0-1.

Table 1.0-1: Proposed Requirements for Toronto Green Standard

Implementation Date	01-Jan-12		01-Jan-14		2017 - New OBC	
Category	**Tier 1**	**Tier 2**	**Tier 1**	**Tier 2**	**Tier 1**	**Tier 2**
Part 9 Residential Buildings	ERS 83; Accept New-ESNH by mid-2012	ERS 85: Accept New ESNH Zone 2 by mid-2012	Possible change to New-ERS		To be determined upon release of OBC 2012 (expected mid-2012)	
Part 9 Non-Residential Buildings	Exceed OBC by 5%	Exceed OBC by 15%	Exceed OBC by 15%	Exceed OBC by 25%	To be determined upon release of OBC 2012 (expected mid-2012)	
Part 3 Buildings $\leq$ 2000 m^2	Exceed OBC by 5%	Exceed OBC by 15%	Exceed OBC by 15%	Exceed OBC by 25%	To be determined upon release of OBC 2012 (expected mid-2012)	
Part 3 Buildings > 2000 m^3	Exceed OBC by 5%	Exceed OBC by 15%	Exceed OBC by 15%	Exceed OBC by 25%	To be determined upon release of OBC 2012 (expected mid-2012)	

2.0 Energy Efficiency Requirements for the Toronto Green Standard

The Toronto Green Standard (TGS) sets out requirements for buildings and houses in a number of sustainable performance topic areas that exceed those found in the current Ontario Building Code (OBC). These are organized into mandatory requirements under Tier I, and optional requirements under Tier II for which a rebate is offered on a portion of development charges as an incentive. One of the key topic areas in terms of environmental impact is energy efficiency.

Commencing on January 1, 2012, there will be more stringent energy efficiency requirements introduced through the OBC that will match those required in the current TGS Tier I. In addition, the next edition of the OBC, now expected to be released in mid-2012, will state the requirements for energy efficiency that will be included in the edition to follow, usually in a further 5 years.

The Phase I report described in detail the development of energy efficiency in the OBC, the research undertaken in order to set those requirements, and information on the building stock that is used to determine projected energy savings and greenhouse gas (GHG) emissions reductions.

This Phase II final report provides additional background and recommendations for the revisions to the TGS that could take effect in order for Toronto to maintain its position as a sustainable city.

3.0 Overview of Building Types and Energy Performance

Buildings, other than low-rise residential, vary widely by their construction and their use of energy. This section provides an overview of the delineation of buildings from an energy use perspective.

3.1. Building Categorizations

Buildings are generally categorized by the type of occupancy. The Energy Information Agency (EIA), an arm of the Department of Energy (DOE) in the US, has been conducting the Commercial Building Energy Consumption Survey (CBECS) since 1978. EIA uses the following building types (designated as “Principal Building Activity”):

- Education
- Food Sales
- Food Service
- Health Care
- Inpatient
- Outpatient
- Lodging
- Mercantile
- Retail (Other Than Mall)
- Enclosed and Strip Malls
- Office
- Public Assembly
- Public Order and Safety
- Religious Worship
- Service
- Warehouse and Storage
- Other
- Vacant

Residential buildings, including both low and high rise, are the subject of a separate survey, the Residential Energy Consumption Survey (RECS), in which buildings are defined as Single Family Units or Apartment Buildings.

Natural Resources Canada (NRCan) began collecting energy consumption data in 2000, and has undertaken two further surveys since that time. NRCan uses the following building types (designated as "Activity Type"):

- Wholesale Trade
- Retail Trade
- Transportation and Warehousing
- Information and Cultural Industries
- Offices
- Educational Services
- Health Care and Social Assistance
- Arts, Entertainment and Recreation
- Accommodation and Food Services
- Other Services

NRCan also places residential buildings in a separate part of their survey report, in which buildings are defined as Single Detached, Single Attached, Apartment, and Mobile Home.

Toronto uses a list that has its roots in the property assessment system, and includes the following building types:

- Res-Low
- Industrial
- Res-High
- Com-Retail
- Edu-Ele&Sec
- Com-Office-High
- Com-Office-Med
- Other
- Rec
- Res-Med
- Church
- Med-Hos
- Edu-Post
- Trans-Util
- Com-Retail-Other
- Com-Accom-High
- Med-Other
- Institu-Other
- Edu-Other
- Com-Office-Low
- EMS
- Com-Retail-Food
- Church-Other
- Com-Accom-Low

The full assessment list contains over 120 building types, and these have been grouped together in this shorter list by the City for planning and other purposes.

3.2. Floor Space Share by Building Type

The share of floor space for each building type is significant when it is necessary to ascribe a single number to the energy efficiency gain that would result from the implementation of an energy code into a building code or a civic standard, and also to assess greenhouse gas (GHG) emissions reductions. In the absence of other information, the makeup of the existing stock is used as a proxy for the distribution of new floor space additions by building type.

For Ontario, the latest Comprehensive Energy Use Database from NRCan provides information on share of floor space, as shown in Table 3.2-1.

Table 3.2-1: Ontario Share of Floor space by Building Type – 2008

Market Segment	millions of m^2	millions of ft^2	Share, %
Offices	116.31	1251.95	30.7%
Apartment	110.73	1191.98	29.3%
Retail Trade	43.68	470.22	11.5%
Educational Services	33.24	357.83	8.8%
Health Care & Social Assistance	17.91	192.84	4.7%
Wholesale Trade	16.25	174.92	4.3%
Accommodation & Food Services	12.00	129.19	3.2%
Transportation & Warehousing	11.37	122.43	3.0%
Information & Cultural	5.76	61.96	1.5%
Arts, Entertainment & Recreation	5.67	61.07	1.5%
Other Services	5.38	57.91	1.4%
Total	378.32	4,072.30	100%

The City of Toronto has assembled information on floor space by building type that was prepared for the Flash Forward report in 2006. The building categories have been re-arranged to approximately match the NRCan categories. This is presented in Table 3.2-2.

Table 3.2-2: Toronto Share of Floor space by Building Type – 2006

AQ Classification	Sub-category Total Of GFA, millions of ft^2	% of Total	Category Total Of GFA, millions of ft^2	% of Total
Com-Office-High	278.000	11.8%		
Com-Office-Med	61.989	2.6%		
Com-Office-Low	5.973	0.3%	345.962	14.7%
Res-High	697.750	29.7%		
Res-Med	43.233	1.8%	740.982	31.5%
Com-Retail	173.935	7.4%		
Com-Retail-Food	2.255	0.1%		
Com-Retail-Other	14.245	0.6%	190.435	8.1%
Edu-Ele&Sec	135.868	5.8%		
Edu-Post	46.294	2.0%		
Edu-Other	19.257	0.8%	201.418	8.6%
Med-Hos	58.878	2.5%		
Med-Other	21.926	0.9%	80.803	3.4%
Com-Accom-High	50.355	2.1%		
Com-Accom-Low	2.899	0.1%	53.254	2.3%
Industrial	565.749	24.1%		
Trans-Util	27.152	1.2%	592.902	25.2%
Institu-Other	14.397	0.6%		
Church	29.306	1.2%		
Church-Other	2.336	0.1%	46.039	2.0%
Rec	40.013	1.7%	40.013	1.7%
Other	54.391	2.3%		
EMS	4.880	0.2%	59.271	2.5%
Total	**2,351.080**	100.0%	**2,351.080**	100.0%

While the categories do not line up exactly, some differences are noteworthy. In particular, Office is 30.7% for NRCan and 14.7% for Toronto, while Apartment is much closer at 30.7% and 31.5%, respectively. Retail trade is 11.5% versus 8.1%, while education is also much closer at 8.8% and 8.6%. Toronto has a very large Industrial sector, which could be part of the issue since this is not usually included in a commercial building sector analysis. There may also be an issue with the definition of “Industrial” between the two surveys. Finally, Industrial is not usually considered for energy consumption purposes on a floor space basis due to the wide variation in energy used for process, but rather is broken out by industry segment.

3.3. Energy End-use by Building Type

Energy is used in a building for a range of end uses, and these have been assigned to specific categories. The methodology for determining this is to collect energy utility data and other building characteristics from a statistically valid sample, and then to allocate the total energy to the end uses by using known data from sample buildings and applying it in proportion to the building characteristics. Information from the NRCan Comprehensive Energy Use Database for Ontario using 2008 data is presented in Table 3.3-1.

Table 3.3-1: Energy End-Use Intensity by Building Type, ekWh/ft^2/yr - 2008

Market Segment / Energy End-Use	Offices	Apartment	Retail Trade	Educational Services	Health Care & Social Assistance	Wholesale Trade	Accommodation & Food Services	Transportation & Warehousing	Information & Cultural	Arts, Entertainment & Recreation	Other Services
Space Heating	19.7	9.9	22.6	21.6	32.4	22.2	31.9	23.1	21.3	24.0	21.5
Water Heating	2.8	6.4	3.4	3.2	6.3	3.3	6.0	1.1	3.2	3.6	3.1
Auxiliary Equip.	8.7	4.0	11.0	11.1	16.5	11.2	15.2	4.5	10.8	12.3	10.3
Auxiliary Motors	3.4		4.0	3.8	5.7	3.9	5.3	4.2	3.7	4.2	3.6
Lighting	4.1	0.5	4.9	4.6	7.0	4.7	6.7	5.0	4.5	5.1	4.5
Space Cooling	2.7	0.5	3.7	3.2	5.2	3.3	4.8	2.5	3.4	3.4	3.1
Total	41.4	21.3	49.5	47.5	73.1	48.6	70.0	40.4	46.9	52.6	45.9

Note that there are wide variations in both the total energy required for each building type and the way it is consumed for each end-use. In the Ontario climate, space heating is almost always the major end-use, but the proportion varies widely.

A high internal load such as found in offices and retail buildings, offsets the requirement for space heating, but also increases the energy used for space cooling. Furthermore, the internal loads, including lighting, receptacle load, and occupant density, provide the greatest opportunities for improving energy efficiency. For lighting, newer technologies including efficient light sources such as fluorescent and LEDs, and better controls such as occupancy sensors and daylight sensing, are widely available. For plug load, equipment efficiencies have improved significantly and built-in idle controls and reduced standby power have added to an overall reduction in energy end-use consumption. For occupant density, demand-controlled ventilation and ventilation heat recovery can significantly reduce energy use.

Where a building has relatively low internal loads, such as apartments and accommodation, the efficiencies come mainly from improving the building envelope to reduce space heating and cooling loads, and reducing service water heating by reducing hot water consumption and improving heating and cooling plant efficiencies.

3.4. Summary of Building Types and Energy Performance

Building types or categories are selected for specific purposes. In the case of EIA and NRCan, these have been selected for energy consumption homogeneity in order to keep the number of categories to a manageable level. Toronto, on the other hand, has developed their list for assessment and planning purposes.

The breakdown of energy by end use is useful when considering how energy can be conserved or reduced for a particular building type.

For both floor space and energy end use data, it is important to recognize that the information has a wide margin of error. For instance, an analysis of three or four of the sequential EIA CBECS results shows significant differences between each survey for any single building type, with results rising, then falling, then rising again, an unlikely event given the addition of new more efficient buildings and the overall trend toward operational and retrofit efficiencies.

4.0 Background to Energy Efficiency in the Ontario Building Code

Ontario has established energy efficiency requirements in the OBC for houses since 1991 and for buildings since 1993. The code categorizes buildings by size and by type, as follows:

- Part 3 applies to all buildings,
  (a) used for major occupancies classified as,
  - (i) Group A, assembly occupancies,
  - (ii) Group B, care or detention occupancies,
  - (iii) Group F, Division 1, high hazard industrial occupancies, or

  (b) exceeding 600 m^2 in building area or exceeding three storeys in building height and used for major occupancies classified as,
  - (i) Group C, residential occupancies,
  - (ii) Group D, business and personal services occupancies,
  - (iii) Group E, mercantile occupancies, or
  - (iv) Group F, Divisions 2 and 3, medium and low hazard industrial occupancies.

- Part 9 applies to all buildings,
  (a) of three or fewer storeys in building height,
  (b) having a building area not exceeding 600 m^2, and
  (c) used for major occupancies classified as,
  - (i) Group C, residential occupancies,
  - (ii) Group D, business and personal services occupancies,
  - (iii) Group E, mercantile occupancies, or
  - (iv) Group F, Divisions 2 and 3, medium hazard industrial occupancies and low hazard industrial occupancies.

Note that Part 9 includes both residential <u>and</u> non-residential buildings, and also that Part 3 includes larger residential buildings. Two key requirements are stated elsewhere in the code: Part 9 buildings can be designed by non-professionals while Part 3 buildings must be designed by architects and/or engineers, and while Part 9 buildings can be of combustible construction, Part 3 buildings must be of non-combustible construction.

In OBC 2006, the province included a new objective on Resource Conservation, and a new Part 12 that set forth the requirements to meet that objective. Ontario has been the only province to have this objective in the building code.

OBC 2006 also included for the first time a statement about the energy efficiency levels that will be required for Part 9 housing and all other buildings effective after December 31, 2011.

While it has been widely anticipated that a new building code would be issued in 2011, it is possible that this will not take place until 2012. Nevertheless, the following subsection in OBC 2006 will ensure that energy efficiency requirements will change in 2012:

> ***12.2.1.2. Energy Efficiency Design After December 31, 2011***
> *(2) Except as provided in Sentences (3) and (5), the energy efficiency of all buildings shall be designed to exceed by not less than 25% the energy efficiency levels attained by conforming to the Model National Energy Code for Buildings.*
> *(3) The energy efficiency of a building or part of a building of residential occupancy that is within the scope of Part 9 and is intended for occupancy on a continuing basis during the winter months shall meet the performance level that is equal to a rating of 80 or more when evaluated in accordance with NRCan "EnerGuide for New Houses: Administrative and Technical Procedures".*[1]

4.1. Low-Rise Housing

4.1.1 Activities at the Federal Level

Energy efficiency standards in low-rise housing were developed in Canada during the decade from 1980 to 1990 through the R2000 program. This program focused on building a well-insulated and airtight envelope, and this necessitated the installation of a controlled mechanical ventilation system, complete with heat recovery for even greater energy efficiency. Energy Mines and Resources Canada (predecessor to NRCan) worked with the associations representing homebuilders and heating contractors to ensure the training of trades across the country.

Existing EnerGuide Rating System: In the latter 1990s, Natural Resources Canada (NRCan) introduced the EnerGuide for Houses program as an evaluation and program tool to provide guidance to homeowners for energy retrofits. It featured a rating scale, and is identified as the EnerGuide Rating System (ERS). This was then expanded to apply to new houses in the early 2000s.

The EnerGuide for New Houses program requires the following steps:

[1] Note that this statement has been modified in SB-12, revised Dec. 5, 2011, to read as follows: *Achieve a rating of 80 or more when evaluated in accordance with the technical requirements of NRCan "EnerGuide for New Houses: Administrative and Technical Procedures*.

a) An NRCan certified energy adviser reviews the plans, develops an energy model using HOT2000 software, and advises the designer, homebuilder, and/or the homeowner on improvements that could be made to increase energy efficiency.

b) The energy adviser conducts inspections during construction to ensure that building envelope design details are being completed correctly.

c) Following substantial completion of the house, a blower door test is conducted to determine the rate of air infiltration.

d) Following submission of the energy advisor report to NRCan, a label showing the EnerGuide Rating is issued and is applied to the electrical panel.

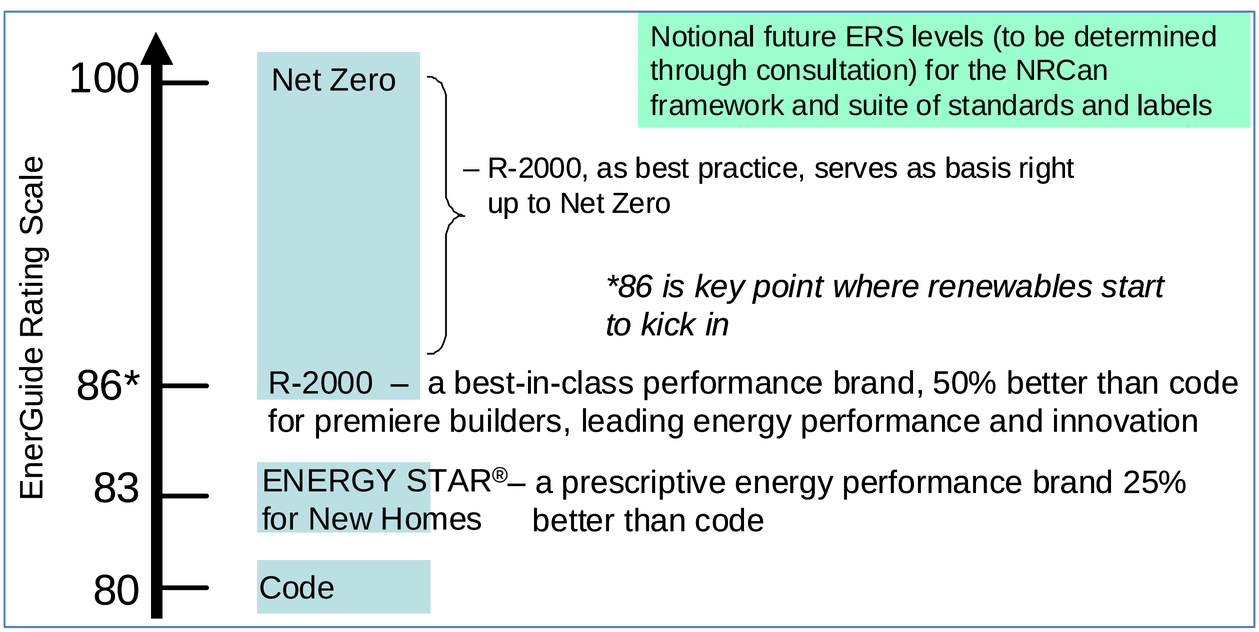
The EnerGuide Rating is determined by the following formula:

$$\text{EnerGuide Rating} = 100 - \left(\frac{\text{Estimated Total Energy Consumption}}{\text{Benchmark Total Energy Consumption}} \right) \times 20$$

The benchmark consumption is determined consistent with normal design practice, typically designed to the building code, and has been adjusted over the period in which EnerGuide has been in the marketplace. The net effect is that the EnerGuide rating is not an absolute energy efficiency number, but will vary as the benchmark is adjusted.

Use of the formula means that the rating for a house that has an estimated total energy consumption equal to the benchmark will be 80. This and other aspects of the EnerGuide rating are shown in Figure 4.1-1

Figure 4.1-1: EnerGuide Rating Scale



Note that the scale is not linear, as evidenced by the fact that a rating of 83 is 25% better than a rating of 80, and a rating of 86 is 50% better. The reference to ENERGY STAR® and R2000 describes projected EnerGuide rating levels that had been anticipated for those two programs commencing in 2012, and may now be superseded by the new labeling system described below.

In order to understand the statements in the figure above, it is necessary to understand the methodology behind the ERS. The system defines the Benchmark Total Energy Consumption as comprising 3 separate loads: Space Heating Consumption, Appliance Energy Consumption, and Domestic Hot Water Consumption. The latter two are also referred to as the Occupancy Consumption.

The Benchmark Total Energy Consumption is specified for each load, and then adjusted as follows:

- Space Heating Consumption is adjusted for climate and house volume.
- Appliance Energy Consumption is fixed at 24 kWh/day or 31,536 MJ/yr.
- Domestic Hot Water Consumption is adjusted for source water temperature.

The ERS has been calculated for a 2000 ft^2 (186 m^2) Toronto house based on achieving ratings of 80, 83, and 85. The incremental improvement required for each of the three loads and for the total load to achieve each ERS is shown at the bottom of Table 4.1-1.

Table 4.1-1: EnerGuide Rating System Calculations

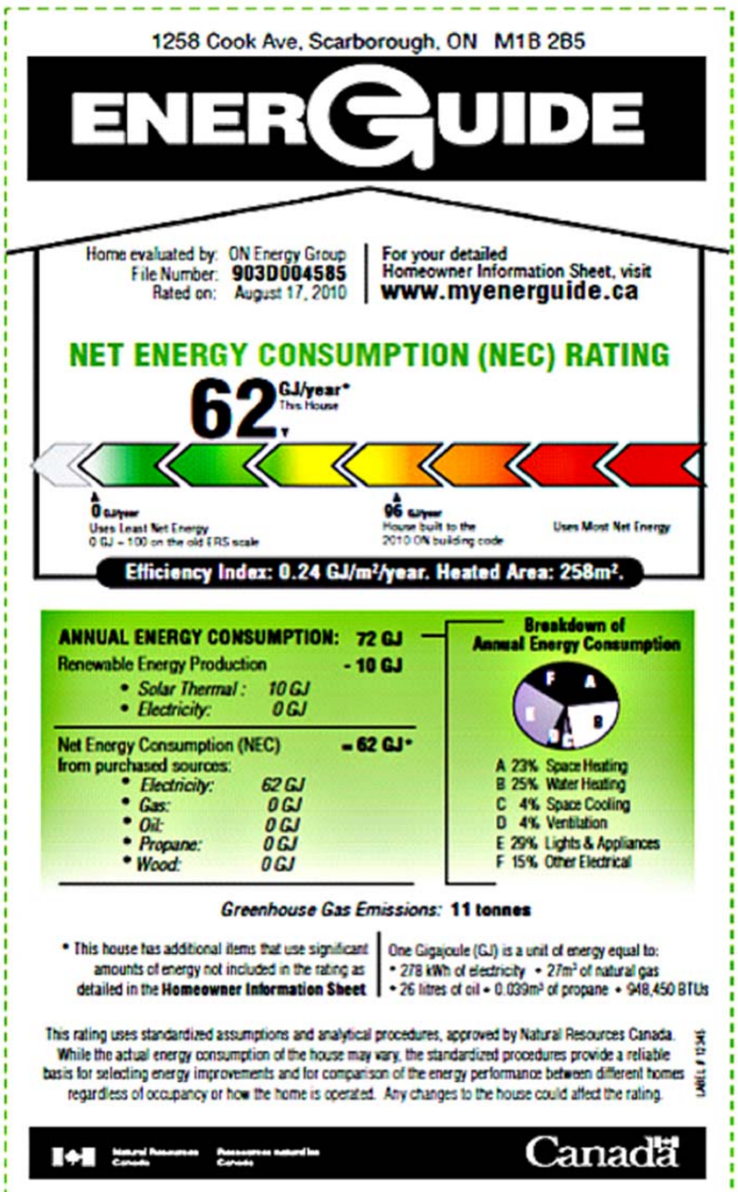
Energy End-Use	EnerGuide Rating System Benchmark	OBC, EnerGuide 80 Design	TGS Tier 1, EnerGuide 83 Design	TGS Tier 2, EnerGuide 85 Design
Space Heating Consumption, MJ	35,280	35,280	26,460	17,640
Appliance Energy Consumption, MJ	31,536	31,536	29,959	28,382
Domestic Hot Water Consumption, MJ	27,758	27,758	24,982	24,982
Total Annual Consumption, MJ	94,574	94,574	81,401	71,004
Improvement over Benchmark - Heating		0%	25%	50%
Improvement over Benchmark - Appliance		0%	5%	10%
Improvement over Benchmark - DHW		0%	10%	10%
Improvement over Benchmark - Total		0%	14%	25%
EnerGuide Rating		80	83	85

In order to achieve an ERS of 83, the space-heating load must be reduced by 25%, along with incremental improvements of 5% and 10% for the other two loads. The overall improvement is 14%. In order to achieve an ERS of 85, the space-heating load must be reduced by 50%, along with incremental improvements of 10% for the other two loads, resulting in an overall improvement of 25%. Since the rating number is always expressed as a whole number, there is some flexibility available in the three individual loads to achieve a specific rating.

Since the publication of the original manual in 2003, NRCan has lowered the Benchmark Total Energy Consumption as part of issuing newer versions of the HOT2000 energy performance software in response to improved energy performance of new houses. This has changed the absolute energy consumption of EnerGuide 80, so that a house designed to Version 9.34c and achieving a rating of 80 would only achieve a rating of approximately 78 or 79 using the current Version 10.51.

Proposed New EnerGuide Rating System: NRCan has also been evaluating the best method of presenting the energy efficiency of houses over the past three years, and is moving towards a label that will provide the Net Energy Consumption Rating (NEC), defined as “the amount of purchased energy (expressed in gigajoules) the house requires, for a year, determined using the ERS Standard Operating Conditions”. It may also show the Efficiency Index (EI), defined as the NEC divided by the total heated area of the house, in gigajoules per square metre (GJ/m^2). One version of the proposed label is shown in Figure 4.1-2.

Figure 4.1-2: Proposed EnerGuide Label



It would be a simple option to adopt a requirement to achieve a defined Efficiency Index, or energy utilization intensity, for each separate housing type, *e.g.* fully detached, semi-detached, fully attached, stacked, *etc.* However, research undertaken by NRCan demonstrated that the Efficiency Index does not vary directly with house size, but correlates more closely with the number of bedrooms. Furthermore, larger houses can more easily achieve a lower Efficiency

Index than smaller houses. In the absence of having access to this research, it is difficult to reach a more definitive conclusion about this approach.

The launch date for the new rating system is expected to be the end of 2012.

Proposed Next Generation ENERGY STAR® for New Homes Standard: The ERS development team has been researching approaches to continuing with the ENERGY STAR® for New Homes (ESNH) Initiative. NRCan released a draft version of the next generation standard in October for a public review period that closed on November 4th. This standard offers both a prescriptive and a performance path, with the requirement that the design achieve a rating of at least EnerGuide 83 using the current ERS scale. Because this standard is based on the current ERS, and NRCan is planning to revise this after the new ERS is released at the end of 2012, this version will be deemed ESNH Next Generation Phase 1. The Phase 2 ESNH will likely be launched in 2014 and will be based on the new ERS.

For the prescriptive path, the standard offers a core builder option package (BOP) for each climate zone in Ontario. Climate Zone 1 includes locations in the province having less than 5,000 heating degree-days (HDD), and Climate Zone 2 includes locations having 5,000 HDD or more. A summary of the core BOPs is presented in Table 4.1-2.

Table 4.1-2: Phase I ENERGY STAR® Core BOP for Ontario

ENERGY STARCore Builder Option Packages for Ontario		
Item	Climate Zone 1 (0 - 4999 HDD) RSI (R)	Climate Zone 2 (> 5000 HDD) RSI (R)
Ceilings below attic	8.66 (49.2)	10.43 (59.2)
Cathedral ceilings	4.87 (27.7)	25.07 (28.8)
Walls above grade	5.14 (29.2)	5.14 (29.2)
Floors over unheated spaces	1.96 (11.1)	1.96 (11.1)
Rim Joists	3.46 (19.6)	3.46 (19.6)
Foundation Walls	3.17 (18.0)	3.57 (20.3)
Unheated floors – above frost line	1.96 (11.1)	1.96 (11.1)
Unheated floors – on permafrost	n/a	4.44 (25.2)
Heated floors	2.32 (13.2)	2.85 (16.2)
Slab on grade	1.76 (10.0)	3.52 (20.0)
Fenestration	ENERGY STAR Zone B	
Space Heating	95% AFUE ENERGY STAR	
Water Heating	EF 0.67	
Ventilation	60% SRE @ 0°C; 55% SRE @ -25°C	

The ESNH standard then requires that the designer select additional options from a table of BOP Upgrade Points for Ontario having separate lists for Zones 1 and 2. The total number of points must equal at least 2.8 in order to meet the ESNH rating. While these points are approximately equivalent to increments on the current ERS scale, the 13 alternative packages in *Supplementary Standard SB-12: Energy Efficiency for Housing* to meet ERS 80 do not line up exactly with the ESNH core BOP.

The requirements for Zone 2 are more stringent in some key building envelope areas than for Zone 2, and this could offer a prescriptive approach for use as a Tier 2 requirement.

The rules for the next generation ESNH Phase 1 will state that a builder cannot register a house until the plan approval stage has been completed. Once the house is registered, the builder will have two years to complete construction and testing and submit the results for certification.

4.1.2 Activities at the Provincial Level

In OBC 1990 Ontario incorporated many of the R2000 design features, including improved insulation and greater air tightness, but not to the full extent of the R2000 program. Continuous mechanical ventilation was not deemed a requirement except under specified conditions, mainly related to the number and capacity of exhaust fans and the use of natural draft space and water heating appliances including fireplaces. Further requirements were incorporated in OBC 1997.

In OBC 2006 the province implemented an objective-based format for the building code. For the first time, the code included a new objective on Resource Conservation, and a new Part 12, *Resource Conservation*, which specified the requirements that would meet the objective. Three options were provided for housing:

a) Prescriptive statements that specified the minimum thermal resistance of insulation for envelope components including wall, roof, floor, and foundation, and the minimum thermal resistance of windows and doors (Subsection 12.3.2).
b) Performance specification for the overall thermal resistance of wall, roof, floor, and foundation assemblies, in addition to the thermal resistance of windows and doors (Subsection 12.3.3).
c) Providing a rating of 80 or more when evaluated in accordance with the EnerGuide for New Houses standard as published by NRCan.

As noted in Section 2, Part 12 further states in Article 12.2.1.2 that after December 31, 2011, the energy efficiency of Part 9 residential buildings "shall meet the performance level that is equal to a rating of 80 or more when evaluated in accordance with NRCan, "EnerGuide for New Houses: Administrative and Technical Procedures".

A companion document to OBC 2006, entitled *Supplementary Standard SB-12: Energy Efficiency for Housing*, was issued with the code. This was updated on November 30, 2009 to provide a set of optional prescriptive compliance paths that can be followed to achieve an EnerGuide rating of 80 or above, and a performance path. This was further updated on December 5, 2011 to clarify some details, including the fact that a label is not required to demonstrate compliance with the Building Code, and a blower door test is not required for the prescriptive and performance paths.

When this takes effect in January 2012, the applicant will have two options to meet the energy efficiency requirement:

a) Follow the prescriptive path of Supplementary Standard SB-12, or
b) Achieve a rating of 80 or more when evaluated in accordance with technical requirements of NRCan, "EnerGuide for New Houses: Administrative and Technical Procedures", January 2005[2].

[2] Supplementary Standard SB-12, *Energy Efficiency of Housing*, December 5, 2011

A label will only be issued by NRCan if Option b) is followed, the services of a certified EnerGuide energy advisor are utilized, and the house is registered with the NRCan "EnerGuide for New Houses" program.

SB-12 offers three compliance options to achieve energy efficiency:

- Select an applicable prescriptive compliance package from Subsection 2.1.1. of this Supplementary Standard,
- Design to the performance compliance method in Subsection 2.1.2. of this Supplementary Standard, or
- Design to ENERGY STAR® requirements as specified in Subsection 2.1.3. of this Supplementary Standard.

The latest edition of SB-12 cites the following software as acceptable for the performance path of Subsection 2.1.3:

- HOT2000 version 9.34c or newer versions
- Other software referenced by the EnerGuide Rating System
- RESNET accredited Home Energy Rating System (HERS) software, such as:
    - OptiMiser
    - EnergyGauge
    - EnergyInsights
    - REM/Rate

The Ontario Ministry of Municipal Affairs and Housing has advised that the Building Code will retain the current EnerGuide rating system through the next code cycle using either version of HOT2000, and NRCan will support this rating system throughout the period.

4.1.3 Activities at the International Level – Passivhaus

Passivhaus was launched in Germany in 1991, and built on ideas developed in Canada with the original Saskatchewan House in 1977 and its further development in the R-2000 program. The word "*haus*" translates as "building", and the principles are applied to both low-rise and high-rise residential buildings. The program has spread to a number of other European countries with about 20,000 homes constructed thus far, and at least two houses have been constructed and certified in Canada.

The approach taken by *Passivhaus* (PH) is to limit the energy for space heating to 15 kWh/m^2/yr, the peak demand for space heating to 10 W/m^2, and the overall air leakage to 0.6 air changes/hr (ACH). The result is that the house can be heated by installing electric duct heaters in the low air flow delivered by the ventilation system with no other heating source except the internal gains. These requirements apply without consideration of climate or any aspect of the house design. The overall energy consumption is generally less than 120 kWh/ m^2/yr – this is approximately ten percent of the energy consumption of a typical house in Toronto.

The keys to a *Passivhaus* are a very energy efficient envelope with high levels of insulation and the elimination of thermal bridges, PH certified windows and doors, careful attention to air sealing, incorporation of passive solar energy including site orientation, and very energy efficient hot water heater, appliances, and lighting.

In Germany and other EU countries, there are many examples of single- and multi-family housing, both new and retrofit built to PH standard. A significant industry has developed that can provide factory assembled components that meet PH standards, including entire wall sections for multi-family building retrofits that can be installed without requiring occupants to move out while construction proceeds.

While this program has only just begun in Canada, where it is known as Passive House[3], there is considerable interest and activity. One house in Oakville was recently renovated in an effort to achieve PH standards, and while it fell a little short, it demonstrated both the barriers and solutions that apply to local construction practice.

4.2. Part 9 Non-residential Buildings

Prior to OBC 2006, Part 9 non-residential buildings followed the same compliance path as Part 3 buildings, requiring the use of an energy code. In OBC 2006 Part 12, prescriptive requirements were provided for the following components and systems:

1.0 Thermal resistance of building envelope components
2.0 Air infiltration
3.0 Heating, ventilating and air conditioning systems and equipment
4.0 Ducts, plenums and piping
5.0 Service water heating
6.0 Lighting, including interior and exterior lighting, and their respective controls
7.0 Electric motors.

This has significantly simplified the level of effort by the applicant to demonstrate compliance with the energy efficiency requirements of Part 12.

The latest version of Supplementary Standard SB-10, identified as the July 1, 2011 update, includes a new Division 4 that sets forth the requirements for Part 9 non-residential buildings. Section 1.1 includes a set of revised tables that will take effect after December 31, 2011, and will replace those currently found in OBC 2006, Section 12.3.

4.3. Part 3 Buildings

In building codes across North America, the standard approach to regulating energy efficiency in new building design has been to cite a separate document called an Energy Code. The two energy codes that have been cited in the Building Code to date are the Canadian Model National Energy Code for Buildings 1997, and the ASHRAE 90.1 series.

4.3.1 How Energy Codes Work

Energy Codes offer both a prescriptive path and a performance path, and typically address the following building components and/or systems in the prescriptive portion:

- Building Envelope
- Lighting
- Heating, Ventilating, and Air Conditioning (HVAC)
- Service Water Heating (SWH)
- Electrical Power

[3] www.passivehouse.ca and www.passivebuildings.ca/

One further section/part sets forth the requirements for the Performance Path, which operates as follows:

(i) An energy performance model of the proposed design is created using a computer program that meets the requirements of the energy code, and this produces a result that is either annual energy use (MNECB), or annual energy cost based on local published rates (ASHRAE 90.1).

(ii) A benchmark or reference building is created that is the proposed design modified to meet the prescriptive requirements of the Envelope, Lighting, HVAC, and SWH sections. An energy performance model of the benchmark building is created using the same computer program, climate, orientation, and energy sources as the proposed design. The result is as described in (i).

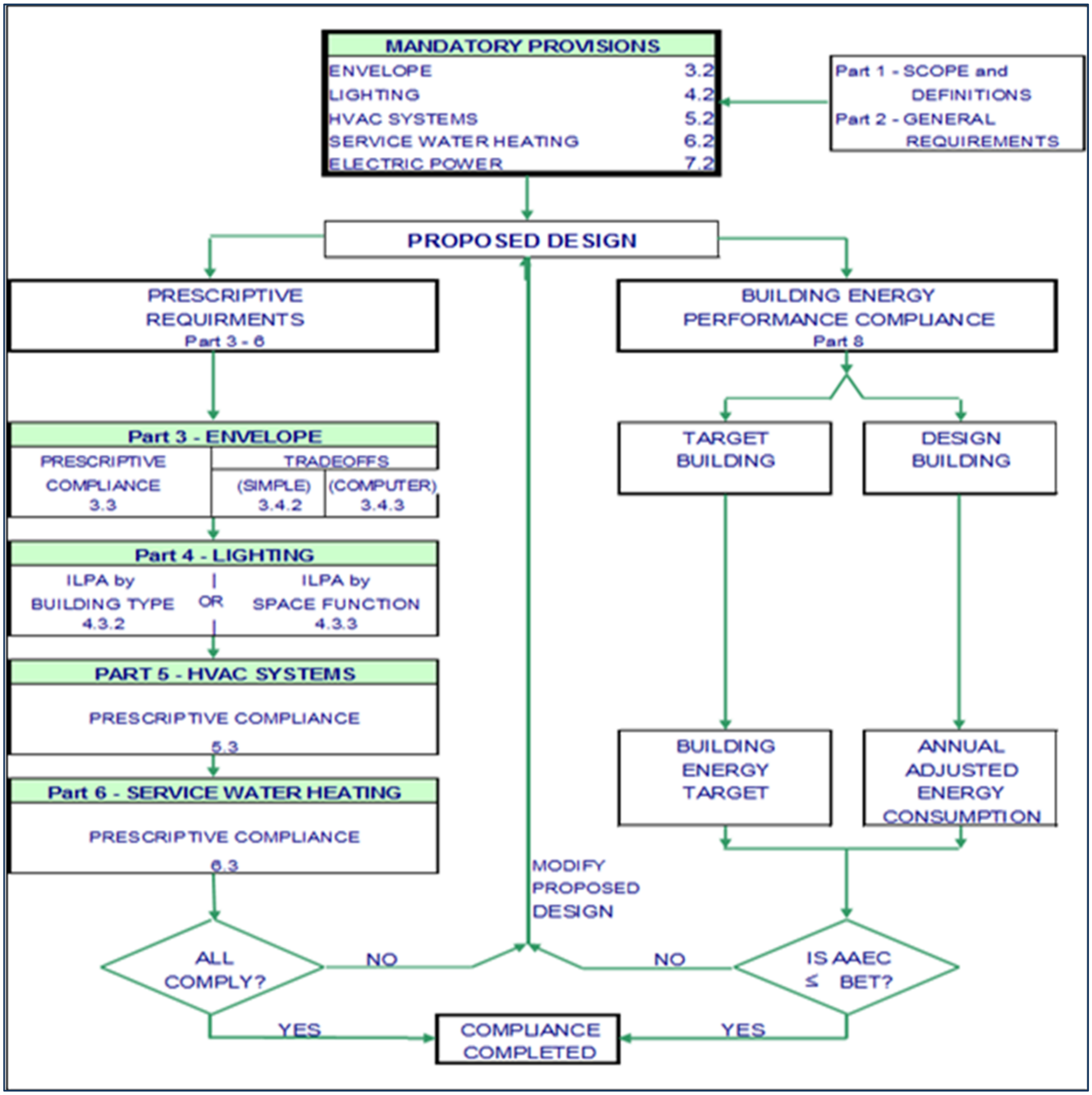
(iii) Provided the annual energy consumption of the proposed design is equal to or less than the annual energy consumption of the benchmark building, the building has complied (MNECB).

or

Provided the annual energy cost of the proposed design is equal to or less than the annual energy cost of the benchmark building, the building has complied (ASHRAE 90.1).

The compliance chart for the MNECB is shown in Figure 4.3-1.

Figure 4.3-1: Compliance Chart for MNECB



The compliance chart for ASHRAE 90.1 operates the same in principle, with only small differences in numbering and nomenclature, and the use of energy cost rather than adjusted energy consumption for compliance in the performance path.

4.3.2 Activities in the US.

In 1972, the U.S. National Bureau of Standards commenced the development of a document entitled *Design and Evaluation Criteria for Energy Conservation in New Buildings.* The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) published the first version of a new building design standard based on the NBS document, and from its inception has collaborated with the Illuminating Engineering Society of North America who provide the Lighting section. The complete series is as follows:

- Standard 90-75, *Energy Conservation in New Building Design.*
- Standard 90A-1980, *Energy Conservation in New Building Design* – first American National Standards Institute (ANSI) national standard.
- Standard 90.1-1989, *Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings* – incorporated a performance path requiring energy performance modeling.
- Standard 90.1-1999, *Energy Standard for Buildings Except Low-Rise Residential Buildings* – the first version to use life-cycle cost analysis to evaluate all measures.
- Standard 90.1-2001, *Energy Standard for Buildings Except Low-Rise Residential Buildings* – the first version developed under continuous maintenance whereby the standard is developed continuously and revised through addenda, and published every three years as a new version by incorporating all addenda and errata, as well as other advances.
- Standard 90.1-2004, *Energy Standard for Buildings Except Low-Rise Residential Buildings* – reformatted for ease of use, climate zones reduced from 26 to 8.
- Standard 90.1-2007, *Energy Standard for Buildings Except Low-Rise Residential Buildings* – includes changes resulting from the continuous maintenance proposals from the public, including all of the Addenda to Standard 90.1-2004.
- Standard 90.1-2010, *Energy Standard for Buildings Except Low-Rise Residential Buildings* – committee objective was to reduce energy cost by 30% over Standard 90.1-2004.
- Standard 90.1-2013, *Energy Standard for Buildings Except Low-Rise Residential Buildings* (currently under development) – committee objective is to be 50% more energy efficient than Standard 90.1-2004.

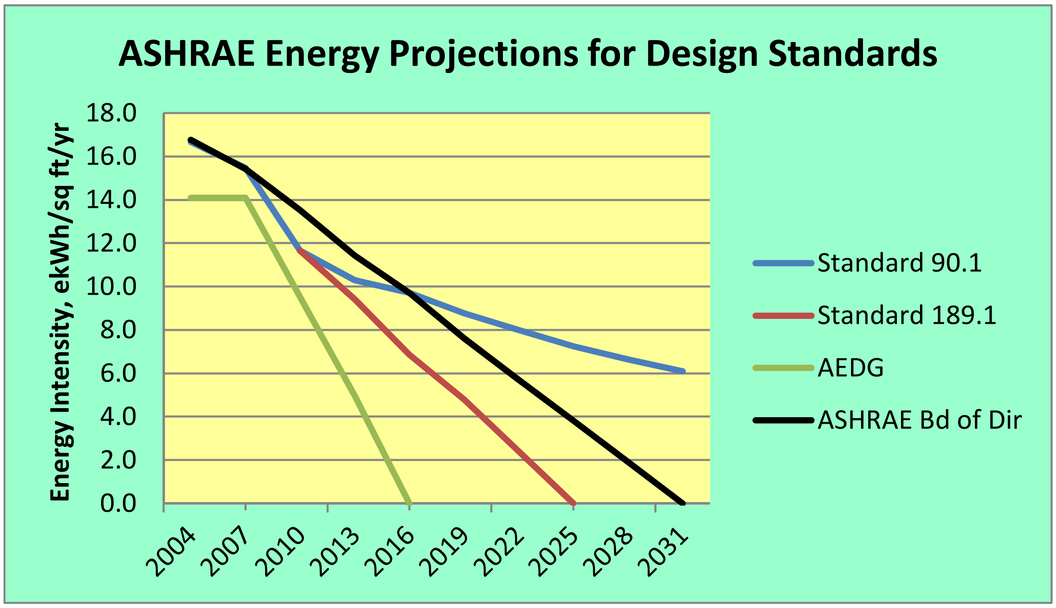
ASHRAE has projected overall levels of energy efficiency for their publications that affect energy efficiency in buildings, including:

- ASHRAE 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*.
- *Advanced Energy Design Guides - 30%* (AEDG-30)) – set of six written to exceed ASHRAE 90.1-1999 by 30%, for the following building types:
    - Small Hospitals and Healthcare Facilities
    - Highway Lodging
    - Small Warehouses and Self-Storage Buildings
    - K-12 School Buildings
    - Small Retail Buildings
    - Small Office Buildings
- *Advanced Energy Design Guides - 50%* - three written to date, based on delivering an incremental improvement of 50% over ASHRAE 90.1-2004, for the following building types:
    - Small Office Buildings
    - K-12 School Buildings
    - Medium to Big Box Retail Buildings
- ASHRAE 189.1, *Standard for the Design of High-Performance Green Buildings*. This standard builds on parts of ASHRAE 90.1-201, but also expands the scope beyond energy efficiency to include Site Sustainability, Water Use Efficiency, Indoor Environmental Quality, The Buildings Impact on the Atmosphere, Materials and Resources, and Construction and Plans for Operation. ASHRAE based the standard on meeting a performance level equivalent to LEED Silver.

The ASHRAE Board of Directors has provided a separate projection for the energy efficiency of buildings (black line in chart below) that would result from the use of current and future ASHRAE standards.

All of these projections are summarized in Chart 4.3-1.

Chart 4.3-1: ASHRAE Projections for Energy Intensity by Standard



In general, Standard 90.1 focuses more attention on the cooling load, driven by the life-cycle cost analysis which is based on the construction activity across the country, where the southern region represents a larger share due to the greater level of construction activity in recent years. In addition, commencing with the 2013 edition, ASHRAE 90.1 will include receptacle load as part of the design whereas this has been excluded in the past, and this is expected to slow the rate of improvement in overall energy efficiency. Standard 189.1 and the Advanced Energy Design Guides are projected to achieve net zero energy use for new buildings by 2031 and 2025, respectively.

It should be noted that any analysis of the overall energy efficiency gain of one edition over another has to be viewed in the context of the US climate, construction practices and costs, energy costs, *etc.*, and therefore these projections are not directly transferable to Toronto, or Ontario or Canada.

The 2030 Challenge[4], launched by Architecture 2030 in January 2006, calls for the global architecture and building community to adopt the following targets:

- All new buildings and major renovations to immediately reduce their fossil-fuel GHG-emitting energy consumption to 50% of the regional average for that building type.

[4] http://www.architecture2030.org/2030_challenge/index.html

- At a minimum, an equal amount of existing building area shall be renovated annually to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 60% of the regional (or country) average for that building type.
- Fossil fuel reduction standard shall be increased to 60% in 2010, 70% in 2015, 80% in 2020, 90% in 2025, and all new buildings and major renovations to be carbon neutral by the year 2030 (using no fossil fuel GHG-emitting energy to operate).

The 2030 Challenge has been widely adopted by a number of organizations including AIA, RAIC, OAA, USGBC, ASHRAE, Architecture 2030, the U.S. Conference of Mayors, and individual cities and counties, endorsed by ICLEI and EPA, and promoted by the National Wildlife Federation and others. A significant number of design firms have also signed on and are obligated to provide regular reports on their progress towards meeting this challenge.

Viewed in the context of this challenge, ASHRAE has clearly committed to meeting this challenge with some of their documents.

The Living Building Challenge[5] **i**s a philosophy, advocacy tool and certification program that promotes the most advanced measurement of sustainability in the built environment possible today. It can be applied to development at all scales, from buildings – both new construction and renovation, to infrastructure, landscapes and neighborhoods. Living Building Challenge comprises seven performance areas: site, water, energy, health, materials, equity and beauty. These are subdivided into a total of twenty Imperatives, each of which focuses on a specific sphere of influence. Certification is based on actual, rather than modeled or anticipated, performance, requiring that, projects must be operational for at least twelve consecutive months prior to evaluation and must meet all assigned imperatives. To date, more than 100 project teams are pursuing this challenge.

4.3.3 Activities in Canada

In 1978 National Research Council (NRC) formed a committee to consider how energy efficiency could be incorporated into the National Building Code (NBC). From this, and following a first published attempt, a set of recommendations was incorporated into the NBC in 1983. The only province to adopt this was Quebec by a separate energy efficiency regulation rather than through the building code, due mainly to the fact that there was not a single province-wide code but rather a patchwork of municipal building codes.

In 1990 NRC began developing a comprehensive energy code for buildings. This was substantially based on ASHRAE 90.1-1989, especially for Lighting, Service Water Heating, and Electrical Power. The Building Envelope Section was developed on a life-cycle cost basis using parameters provided by each province and was more focused on space heating energy. This code was issued as the *Model National Energy Code for Buildings 1997* (MNECB).

In 1999 NRCan released, as a companion to this code, a computer program identified as EE4-CODE that would be used by the applicant to undertake the energy performance modeling for the proposed design required for the performance path, and would also create the benchmark building, model its energy performance, and determine if the building complied. This was a more useful tool for building regulatory officials to accept as proof of compliance with the building code.

[5] https://ilbi.org/lbc

In 2005 NRCan began to lobby the Canadian Commission on Building and Fire Codes (CCBFC) to update the MNECB. NRCan invited provincial and territorial representatives from the departments responsible for building codes and energy, and formed the Building Energy Code Collaborative. This group unanimously committed to adoption of an updated energy code, which led directly to the decision by the CCBFC to undertake the update.

Now renamed the National Energy Code for Buildings (NECB), this code has passed through public review, received final approval from CCBFC, and was released on November 18, 2011.

Based on an analysis using an earlier version, CCBFC has stated that the NECB is 26% more energy efficient that the MNECB, using the building stock for Canada.

4.3.4 Activities in Ontario

In 1993, by an amendment to OBC 1990, Ontario adopted a requirement for all buildings (with limited exceptions), except Part 9 residential buildings, to be energy efficient in accordance with ASHRAE 90.1-1989, as modified by a document entitled *Guideline for the Interpretation of ASHRAE/IES 90.1-1989*. This was the first instance of a province adopting an energy code in its building code.

In OBC 1997, the code included an option to use either ASHRAE 90.1-1989 or MNECB to demonstrate compliance with the requirement to be energy efficient. Ontario was the only province to adopt MNECB in its building code at that time. The applicant could select either energy code for the project, even though ASHRAE 90.1-1989 had a much better thermal performance for the Envelope, the same Lighting requirements, and similar HVAC and Service Water Heating Requirements,

In OBC 2006, the province opted for a hybrid approach, while still offering the option of either MNECB or ASHRAE 90.1, but for the latter, the version was updated to 90.1-2004. The details were included in a document entitled Supplementary Standard SB-10. For either option, the Envelope requirements came from ASHRAE 90.1-1989, evidence of the fact that this earlier version was written without any cost/benefit assessment of the measures adopted. Table 4.3-1 shows the components of two optional hybrids and their source.

Table 4.3-1: OBC 2006 Energy Efficiency Requirements for Part 3 Buildings

Component/System	All Administrative/Climate Zones	
	MNECB 1997	ASHRAE 90.1-2004
Building Envelope	Supplementary Standard SB-10 (ASHRAE 90.1-1989)	Supplementary Standard SB-10 (ASHRAE 90.1-1989)
Lighting	Supplementary Standard SB-10 (ASHRAE 90.1-2004-9)	ASHRAE 90.1-2004 Section 9
Heating, Ventilating & Air Conditioning	Equipment - ASHRAE 90.1-2004-6; Systems - MNECB 1997 Part 5	ASHRAE 90.1-2004 Section 6
Service Water Heating	Equipment - ASHRAE 90.1-2004-7; Systems - MNECB 1997 Part 6	ASHRAE 90.1-2004 Section 7
Electrical Power	MNECB 1997 Part 7	ASHRAE 90.1-2004 Section 10
Performance Path	EE4-OBC SB-10 software (from NRCan)	ASHRAE 90.1-2004 Section 11

For the performance path, upon the introduction of OBC 2006, NRCan did not make available for more than two years the energy performance simulation software that could generate the benchmark building, if the applicant chose the MNECB. This placed an additional burden on applicants, and also on regulatory officials and program managers. Furthermore the quality of the energy modeling in the submissions varied widely, as seen in the results of an expert review. The new energy modeling program, designated EE4-OBC, was eventually released in 2009.

As noted in Section 2, Part 12 further states in Subsection 12.2.1.2 that after December 31, 2011, "the energy efficiency of all buildings shall be designed to exceed by not less than 25% the energy efficiency levels attained by conforming to the Model National Energy Code for Buildings".

In order to meet this requirement, the province has updated SB-10 to permit an applicant to use any one of the four options, as shown in Table 4.3-2.

Table 4.3-2: OBC 2006 Energy Efficiency Requirements for Part 3 Buildings after December 31, 2011

Component/System	All Administrative/Climate Zones			
	MNECB Plus 25%	ASHRAE 90.1-2010 Plus 5%	ASHRAE 90.1-2010 Hybrid	NECB 2011 (when published)
Building Envelope	MNECB Part 3+	ASHRAE 90.1-2010 Sect 5+	Supplementary Std SB-10 (ASHRAE 189.1-2009)	NECB 2012 Part 3
Lighting	MNECB Part 4+	ASHRAE 90.1-2010 Sect 9 +	ASHRAE 90.1-2010 Sect 9	NECB 2012 Part 4
Heating, Ventilating & Air Conditioning	MNECB Part 5+	ASHRAE 90.1-2010 Sect 6+	ASHRAE 90.1-2010 Sect 6	NECB 2012 Part 5
Service Water Heating	MNECB Part 6+	ASHRAE 90.1-2010 Sect 7+	ASHRAE 90.1-2010 Sect 7	NECB 2012 Part 6
Electrical Power	MNECB Part 7+	ASHRAE 90.1-2010 Sect 8+	ASHRAE 90.1-2010 Sect 8	NECB 2012 Part 7
Performance Path	MNECB Part 8	ASHRAE 90.1-2010 Sect 11	ASHRAE 90.1-2010 Sect 11	NECB 2012 Part 8

In research undertaken by the Ministry (summarized in Section 5 of this report), it was found that ASHRAE 90.1-2010 exceeded the MNECB by about 20% on a weighted average basis, mainly due to the performance of the building envelope. Applicants are therefore permitted to use Standard 90.1-2010 as published, provided they demonstrate that they have exceeded the performance level by 5%.

The research found that by taking the building envelope specifications from ASHRAE 189.1-2009, *Standard for the Design of High Performance Green Buildings,* a hybrid version of Standard 90.1-2010 would meet the performance requirement. The same research project demonstrated that the weighted average efficiency for the new NECB would meet the performance requirement, and it is anticipated that the NECB will be included in a new version of SB-10 now that the NECB has been published.

As of this writing, ASHRAE has advised that there is not yet available a small calculation program for performing the building envelope tradeoffs for ASHRAE 90.1-2010, as was the case for OBC 2006 through the use of ENVSTD 23 or 24 (Envelope Standard Version 23 or 24. In any case this would not function correctly for the Ontario Hybrid. The ministry is investigating a possible solution by having a custom program developed specifically for Ontario.

Similarly, it is not yet clear whether there will be a building envelope tradeoff program for the NECB, similar to BILDTRAD (Building Envelope Tradeoffs) that was supplied for the MNECB.

For the performance path, NRCan has proposed the development of an energy performance simulation program with a compliance front end for the NECB that would be similar to EE4-OBC and would be based on EQuest, but the timing of this release has not yet been announced.

ASHRAE 90.1 has always required that compliance through the performance path would require the development of two energy models, one for the benchmark building, and one for the proposed design. Experience in Ontario and elsewhere has demonstrated that this practice offers wide latitude for “gaming” the system, either intentionally or unintentionally.

5.0 Summary of Research for Energy Efficiency of Buildings

In preparation for the introduction of OBC 2006, and again for the requirements that will take effect in 2012, the Ministry commissioned studies to evaluate the impact on overall energy efficiency of specific building archetypes.

5.1. Research for 2006 Building Code

The study addressed six building archetypes, and evaluated energy savings against what would be achieved using MNECB by modeling the energy performance using computer simulation software that evaluates building performance on an hourly basis.

The comparative energy codes were ASHRAE 90.1-1989, ASHRAE 90.1-2004, and a hybrid comprising the Building Envelope from ASHRAE 90.1-1989 and all other sections from ASHRAE 90.1-2004. The results for buildings located in Toronto, and therefore using Toronto-climate data, are summarized in Table 5.1-1.

Table 5.1-1: OBC 2006 Research Results for Toronto Buildings

Building Type	OBC Part	Floor Area, m^2	Energy Savings By Energy Code Over MNECB			Building Archetype Features
			ASHRAE 90.1-1989	ASHRAE 90.1-2004	Hybrid: Envelope - 90.1-1989; Balance - 90.1-2004	
High Rise Office	3	13,380	10.4%	5.3%	16.3%	HVAC - VAV
Low Rise Office	3	2,974	12.1%	15.9%	19.4%	Rooftop VAV c/w hydronic reheat
High Rise MURB	3	13,611	12.7%	-1.5%	16.0%	Water loop HP, central corridor vent.
Low Rise MURB	3	3,900	10.6%	-0.5%	12.9%	Gas hydronic & PAC
Office	9	485	N/A	N/A	16.9%	Rooftop Gas/Electric
Retail	9	485	N/A	N/A	26.2%	Rooftop Gas/Electric

The results are due to the following factors:

- ASHRAE 90.1-1989 has the most stringent Envelope requirements, and this is more beneficial to buildings with lower internal loads such as multi-unit residential.
- ASHRAE 90.1-2004 has the most stringent Lighting requirements, and this is more beneficial to buildings with higher Lighting loads such as office and retail.
- For larger mechanical equipment, ASHRAE 90.1 has the most stringent minimum efficiency requirements.

As noted earlier, the hybrid energy code was introduced into OBC 2006, and could be used with either MNECB or ASHRAE 90.1-2004 as the base energy code – the results are essentially the same because so little of MNECB is retained.

5.2. Research for the 2012 Building Code Requirements for Part 3 Buildings

This study was conducted on seven building types, for which details of the archetypes used for Toronto are presented in Table 5.2-1.

Table 5.2-1: Research Building Archetypes for Toronto

Building Type	OBC Part	Gross Floor Area, m^2	No. of Storeys	Space Heating Fuel	Window-to-Wall Ratio	Other
High Rise Office	3	13,380	10	NG	40.0%	6 - VAV systems
Low Rise Office	3	2,974	2	NG	33.0%	Rooftop VAV with hydronic reheat
High Rise MURB	3	13,611	20	NG	50.0%	2-pipe FC, central corridor ventilation
Low Rise MURB	3	3,900	3	NG	29.0%	Pckge A/C, central HW htg, central corridor ventilaion
Retail	3	17,662	1	NG	18.2%	One large anchor store of 8279 m^2, 45 stores of 56 to 223 m^2. Rooftop HVAC systems
School	3	6,475	2	NG	16.3%	3 - Packaged VAV systems plus gym
Warehouse	3	3,891	1	NG	3.5%	10% Office area with rooftop HVAC. Warehouse htg by unit htrs, no A/C

MNECB was used as the base case, and all other options were compared to this energy code. The energy codes assessed were the hybrid used in OBC 2006, ASHRAE 90.1-2010, the final version of NECB (although not yet published), and a hybrid comprising the Envelope requirements from ASHRAE 189.1-2009, and the balance of the requirements ASHRAE 90.1-2010. The results are summarized in Table 5.2-2.

Table 5.2-2: Research Results for the Building Code after December 31, 2011 – Toronto Buildings

Building Category	Energy Savings By Energy Code Over MNECB			
	OBC 2006	ASHRAE 90.1-2010	NECB 2011 (final)	Hybrid 1: Envelope - 189.1-2009; Balance - 90.1-2010
High Rise Office	19.4%	20.6%	29.6%	27.1%
Low Rise Office	14.4%	20.1%	29.7%	25.2%
High Rise MURB	12.1%	15.4%	23.7%	22.4%
Low Rise MURB	10.3%	11.7%	21.8%	17.3%
Retail	17.7%	27.7%	35.1%	34.0%
School	5.3%	22.9%	33.8%	28.5%
Warehouse	15.7%	16.1%	30.3%	25.7%

The summary of the energy end-use intensities from the research for each building archetype type is shown in Table 5.2-3.

Table 5.2-3: Research Results for the Building Code after December 31, 2011 - Energy End-Uses for Toronto Building Archetypes

Energy End-Use Intensity by Segment, $ekWh/ft^2/yr$ - OBC Research							
Market Segment / Energy End-Use	Toronto High-rise Office	Toronto Low-rise Office	Toronto High-Rise Apartment	Toronto Low-Rise Apartment	Toronto Retail Trade	Toronto School	Toronto Warehouse
Space Heating	6.3	9.4	6.7	8.0	6.5	8.4	12.5
Space Cooling	0.8	4.0	0.6	0.6	0.8	1.0	0.0
Lighting	1.6	0.9	5.1	8.7	1.0	3.3	0.8
Water Heating	3.4	3.4	1.8	1.8	5.5	2.7	1.9
Auxiliary Equip.	3.3	3.8	1.2	1.3	0.8	1.3	0.3
Auxiliary Motors	1.7	2.5	2.1	1.4	1.9	1.9	0.9
Total	17.1	24.1	17.6	21.7	16.5	18.7	16.4

These results show the following:

- The hybrid used in OBC 2006 moved the energy efficiency level up significantly over MNECB, especially for buildings with higher internal loads such as office and retail.
- ASHRAE 90.1-2010 delivered a relatively small incremental improvement over OBC 2006 in all cases except retail and school, and this is mainly due to not requiring a more energy efficient envelope.
- The NECB produced a significant improvement over OBC 2006 for all building types, and is somewhat better than ASHRAE 90.1-2010.
- Hybrid 1 provides results that are somewhat comparable to NECB, with some variability by building type.
- Lighting loads have decreased significantly with the introduction of more modern requirements in the latest energy codes.

The research project also looked at other options for even better performance for 2012, and also reviewed possible improvements for 2017. These included:

- An enhanced Hybrid 2 based on ASHRAE 90.1-2010 with higher minimum efficiencies for HVAC equipment.
- OBC 2017 A, based on Hybrid 1 but with lighting power densities reduced by 10%, and boilers used for space heating and service water heating having a minimum thermal efficiency of 92%.
- OBC 2017 B, based on OBC 2017 A with the addition of heat recovery provisions from ASHRAE 189.1-2009 and building envelope requirements for maximum thermal transmittance of opaque wall assemblies from NECB.

The same building archetypes were used, and the evaluation used MNECB as the base case. The results are summarized in Table 5.2-4.

Table 5.2-4: Further Research Results for 2012 and 2017 Building Codes – Toronto Building Archetypes

Building Category	Energy Savings By Energy Code Over MNECB		
	Hybrid 2: 90.1-2010 with enhanced HVAC equipment efficiency	OBC 2017 A: Same as Hybrid 1, but with enhanced Lighting, HVAC & SWH efficiency	OBC 2017 B: OBC Level A, with 189.1-2009 heat recovery & NECB wall U-value
High Rise Office	28.8%	35.7%	36.6%
Low Rise Office	27.9%	33.3%	34.6%
High Rise MURB	20.8%	29.6%	29.8%
Low Rise MURB	19.7%	29.0%	29.9%
Retail	27.7%	37.1%	40.9%
School	33.6%	38.3%	41.1%
Warehouse	16.1%	26.8%	28.7%

These results confirm that a building of any type that has a better envelope, lighting, HVAC system, and service water heating system, can achieve savings of 29% or more over the MNECB using good design and currently available technologies.

5.3. Comparison of Energy Performance in Codes and Programs

The performance increment that is projected to occur when a code, standard, or program, changes is often expressed as a percentage reduction when compared to the former performance level. While this is satisfactory when the baseline is an absolute number, it can become confusing when comparing percent increments over a succession of changes using different baselines.

Table 5.3-1 presents information on the following:

- OBC 2006 up to December 31, 2011
- After December 31, 2011 as specified in Supplementary Standard SB-10, revised June 27, 2011 (identified in the table as OBC 2012)
- The current Toronto Green Standard
- The current High Performance New Construction Program (HPNC) and the Toronto Better Buildings Partnership New Construction program (BBP-NC) (which share the tiered structure although the incentives differ).
- The proposed next edition of the HPNC/BBP-NC

Note that the baseline is either the Model National Energy Code for Buildings (MNECB) or the Ontario Building Code, 2006, depending on the particular standard or program..

Table 5.3-1: Analysis of Impact of OBC and HPNC/BBP-NC on Energy Utilization Intensity

Code, Standard, or Program	Floorspace & Occupancy Type Weighted Average Performance Increment	Typical EUI, ekWh/ft^2/yr
MNECB	0% (baseline)	25.0
Ontario Building Code		
OBC 2006 (above MNECB)	17%	20.8
OBC 2012 (above MNECB)	25%	18.8
Toronto Green Standard		
TGS Tier 1 (above MNECB)	25%	18.8
TGS Tier 2 (above MNECB)	35%	16.3
Current Incentive Program - HPNC/BBP-NC		
Tier 1 (maximum performance level above OBC 2006 within tier)	25%	15.6
Tier 2 (maximum performance level above OBC 2006 within tier)	50%	10.4
Tier 3 (minimum performance level above OBC 2006 within tier)	50%+	< 10.4
Proposed Incentive Program - HPNC/BBP-NC (2012)		
Tier 1 (maximum performance level above OBC 2012 within tier)	25%	14.1
Tier 2 (maximum performance level above OBC 2012 within tier)	50%	9.4
Tier 3 (minimum performance level above OBC 2012 within tier)	50%+	< 9.4

The absolute energy utilization intensity (EUI) that has been assumed as approximately equal to the MNECB on average, but not necessarily for any single building occupancy type, is 25 equivalent kilowatt hours per square foot per year (25 ekWh/ft^2/yr).

The increment between MNECB and OBC was taken from the research contracted by the Ministry of Municipal Affairs and Housing (MMAH) where it was found to be in the range of 13% to 26%, depending upon the building occupancy type. We have used 17% as an average increment, although the research did not carry the analysis forward to more accurately develop this figure.

Effective after Dec. 31, 2011, the increment between SB-10 and MNECB has been stated as meeting or exceeding 25%. Research conducted for the Ministry confirmed that the energy codes selected for inclusion in Supplementary Standard SB-10 (edition issued in May 2011) met this criterion on the basis of an occupancy type and floor space weighted average.

The current Toronto Green Standard expresses the increment for both Tiers 1 and 2 by using the MNECB as the baseline. This places the actual increment over OBC 2006 for Tier 1 as 9.6% (2.0/20.8), and for Tier 2 as 21.6% (4.5/20.8).

The current HPNC/BBP-NC expresses the increment for Tiers 1, 2, and 3 using OBC 2006 as the baseline.

For the new HPNC/BBP-NC, the percent increments for each Tier will remain the same as those in the current program, but due to the change in baseline that will take effect on January 1, 2012, will result in an incremental reduction in EUI of approximately 10% for each Tier.

5.4. Experience with the HPNC & BBP-NC Programs

Using data provided by Enbridge and the City of Toronto Energy Efficiency Office, an analysis of the combined results of the two programs was prepared to better understand the breadth participation across all building sectors, and the performance level they achieved. This is presented in Tables 5.4-1, showing the geographic diversity across Ontario, and 5.4-2, which shows the relative program tiers in which the projects were placed.

Table 5.4-1: HPNC & BBP-NC Participation by Building Type and Region

Region	Total Number of Buildings	Eastern Ontario	Greater Toronto Area	Toronto	Southwest Ontario	Northern Ontario
Postal Code Zone	Ontario	K	L	M	N	P
College/University	30	7	9	7	5	2
Government	28	2	14	6	5	1
Healthcare	11	2	2	2	1	4
Hotel/Motel	1	1	0	0	0	0
Multi-Residential	108	3	22	81	2	0
Office	68	5	22	33	8	0
Other Commercial	13	4	7	0	1	1
Recreation	23	6	9	7	1	0
Retail	60	7	18	33	2	0
School	42	12	19	2	6	3
Warehouse	5	1	4	0	0	0
Other Industrial	13	0	5	7	0	1
Transportation	1	0	1	0	0	0
Total	403	50	132	178	31	12

Of the 403 projects accepted into the programs, 178 were in the City of Toronto, and of these, 108 were in the Multi-unit residential segment.

Table 5.4-2: HPNC & BBP-NC Participation by Building Type and Performance

Building Type	Total Number of Buildings	Benchmark Efficiency Level			Size Range, ft²	
		1	2	3	Min	Max
College/University	30	17%	61%	22%	6,000	300,000
Government	28	17%	50%	33%	10,000	300,000
Healthcare	11	40%	50%	10%	45,000	970,000
Hotel/Motel	1	100%	0%	0%	N/A	N/A
Multi-Residential	108	41%	41%	17%	37,000	280,000
Office	68	16%	70%	14%	5,300	600,000
Other Commercial	13	38%	31%	25%	5,400	364,000
Recreation	23	19%	75%	6%	7,000	185,000
Retail	60	61%	32%	7%	25,000	417,000
School	42	10%	56%	34%	15,000	209,000
Warehouse	5	50%	50%	0%	125,000	508,000
Other Industrial	13	33%	67%	0%	20,000	375,000
Transportation	1	0%	100%	0%		227,664
Total	403					

Across the province, there was strong participation in the Multi-unit residential, Office, Retail and School segments, and a significant number of participants in most of the other categories. The benchmark efficiency level for Tier 1 is up to 25% better than OBC 2006, Tier 2 is 26% to 50%, and Tier 3 is over 50% better. A significant proportion or projects within each category achieved a performance level above Tier 1, and a number achieved Tier 3. This suggests that applicants for almost every building type were able to meet these relatively stringent requirements during the term of the program.

6.0 Recommendations for Energy Efficiency

It is apparent that the references used in the current edition of the Building Code and those scheduled to commence on January 1, 2012 are going to change no later than the end of next building code cycle and possibly before then. These could include:

- For Part 9 residential buildings, the current ERS will end either before, or coincident with, the end of the next code cycle, generally expected to be in 2017. In addition, the ENERGY STAR® for New Homes program will be updated to Phase 1 in 2012, and to Phase 2 in 2014 when it will be based on the new ERS in 2014.
- For Part 3 Buildings, ASHRAE 90.1-2010 and the Ontario Hybrid, both cited in SB-10, may be updated to ASHRAE 90.1-2013, or possibly ASHRAE 90.1-2016, depending on further research. For the NECB, there is a discussion underway to plan for an update this document within a defined time frame, as otherwise it will fall behind quickly as the pace to achieve higher efficiency levels increases.

Against this backdrop, recommendations to be stated in OBC 2012 for OBC 2017 are being developed based on the background information, research undertaken for the Building Code, current and future directions already defined for the Building Code, the current approach for the TGS, and the influence of other activities for sustainable buildings in the marketplace. They are not yet available, as the decisions have not been made.

6.1. Part 9 Residential Buildings

The Building Code has committed to retain the traditional *EnerGuide for New Houses* rating system through the next five-year code cycle, even though the new ERS is expected to be implemented at the end of 2012. This decision has been based on receiving a commitment from NRCan to support this system throughout that period.

NRCan is continuing the development of the new *EnerGuide for New Houses* rating system that will be based on a Net Energy Consumption Rating (GJ), and which will likely also include the Efficiency Index (GJ/m^2). The launch of the new program is presently scheduled for the end of 2012.

If the new ERS system were in place, the Efficiency Index might be used to establish a maximum energy consumption intensity (GJ/m^2) that would have to be met. Different housing types such as fully detached, semi-detached, or townhomes (row-housing) might have different intensity limits, or even ranges. There might also be a modifier required that adjusts for the number of bedrooms.

The proposed ENERGY STAR® for New Homes program could be used for Tier 1 subject to a review of the completed program, but it is understood that this program will not be available until mid-2012. This would also leave open the question of how to address Tier 2, for which the proposal would be to require the building envelope to meet the requirements of ESNH for Zone 2.

One key issue is whether the Building Code will remain with its stated intention to use the traditional ERS, or will choose to adopt the new ERS midway through the code cycle. This will only take place if the new ERS rating system is fully operational. In the event that a change occurs, the TGS would almost certainly have to meet such a change in the Building Code by using an Efficiency Index.

Recommendations for Part 9 Residential Buildings:

January 1, 2012: Advance the requirement for Tier 1 from ERS 80 to 83, and retain ERS 85 for Tier 2, as long as the Building Code continues to use this system. Offer the Phase 1 ENERGY STAR® as an alternative path for Tier 1 when it is available (expected July 2012), and offer ESNH Zone 2 as an alternative path for Tier 2.

Mid-Cycle of the Building Code: In the event that the Building Code adopts the new ERS, City Planning should obtain and review the research, and consider adopting a requirement that is consistent with the current ERS 83 and 85, but is based on this research.

Next Edition of the Building Code (2017): It is a reasonable assumption that the Building Code will base the energy efficiency for houses on the new ERS system, and that the energy efficiency levels will be substantially more demanding than the current levels. These should be stated in OBC 2012**,** but at the time of writing, this has not been determined.

January 1, 2021: The 2017 Building Code should include a statement about what the requirements for energy efficiency would be for the 2022 Building Code. This will form the basis for the higher requirements in the Toronto Green Standard.

Justification: The Tier 1 requirement will be consistent with the new ESNH program, and in addition many builders are already meeting this performance level, or are very close to doing so. The Tier 2 requirement will be unchanged, but remains challenging for applicants.

A detailed description of the three proposals considered can be found in Appendix A.

6.2. Small and Mid-size Buildings

The Building Code defines small buildings as Part 9 non-residential buildings, covering those of three or fewer storeys above grade and 600 m^2 or less, for which the applicant can use either the prescriptive measures found in SB-12, Section 1.1, or one of the specified energy codes.

The current Toronto Green Standard includes a provision for buildings of 2,000 m^2 or less. The application of this provision is dependent on the use of an online Screening Tool[6] maintained by NRCan that uses the MNECB as the base, requires a minimum of data to be entered, and provides an estimate of the percent by which the building will exceed the MNECB. While the intent of NRCan to continue supporting this tool is not yet clear, it provides the simplest and most readily accessible method of determining compliance with a specified increment over MNECB.

Recommendations for Buildings Less Than 2,000 m^2 Floor Area:

January 1, 2012: Advance the requirement for Tier 1 and Tier 2 to match the percentage increment for large buildings and continue to permit the use of the NRCan Screening Tool as long as it is available.

Next Edition of the Building Code (2017): The 2012 Building Code is expected to specify the level of energy efficiency to be required in the 2017 Building Code, and this is currently projected at 12% to 13% above current levels. Both the TGS level and the method of determining compliance will be reviewed in advance of the release of OBC 2017, and a final determination made at that time.

A detailed summary of this proposal is included in Appendix B.

6.3. Large Buildings (Part 3)

It is now clear that, effective January 1, 2012, the design and construction industry is going to have to become familiar with two new energy codes, ASHRAE 90.1-2010 and NECB, and these are significantly more complex and detailed than earlier versions. For this reason, it is proposed that the energy efficiency increment of the TGS over the OBC should be phased in during the next code cycle, with a two-year implementation period for Phase 1, and the balance of the code cycle for Phase 2. The proposal for the final increment for Tier 1 is based on the

[6] http://screen.nrcan.gc.ca/cgi-bin/facilities1.cgi

assumption that OBC 2012 will include a requirement that the energy efficiency of buildings for OBC 2017 will be 13% better than OBC 2012.

Recommendations for Buildings Equal to or Greater Than 2,000 m^2 Floor Area:

January 1, 2012: Advance the requirement for Tier 1 to exceed either the NECB or the ASHRAE 90-2010 Hybrid A by 5% immediately, and 15% after December 31, 2013. It is expected that the OBC will use the same increment for OBC 2017. Since it is likely that the MNECB and ASHRAE 90.1-2010 as published, may be dropped from the Building Code, the only references are to the two complete energy codes.

For Tier 2, the Phase 1 increment will be to exceed either the NECB or the ASHRAE 90-2010 Hybrid A by 15% immediately, and 25% after December 31, 2013.

Next Edition of the Building Code (expected in 2017): The next edition of the Building Code will reference other energy codes, likely an updated ASHRAE 90.1, and perhaps an updated NECB. A stepped increment, similar in timing and value to the proposal for January 1, 2012, would appear to be appropriate at this time, but a further review, as the implementation of OBC 2017 date approaches, will be necessary.

Building Occupancy Type Consideration: An option for adjusting the overall energy efficiency by building occupancy type could be considered; however, by using a phased approach to achieve increasing levels of efficiency, applicants will find innovative ways to meet the requirement during the code cycle.

Justification: The analysis presented in Sections 5.3 and 5.4 demonstrates that:

- Buildings of all types are moving towards a comparable level of improvement over the MNECB or OBC 2012 benchmarks, due to more stringent envelope requirements, and the adoption of more efficient lighting, HVAC, and service water heating systems and equipment.
- The HPNC/BBP-NC programs have demonstrated that new building design has advanced to the point where building performance is regularly exceeding the OBC in all building categories.

For comparison purposes, Table 5.3-1 is repeated here as Table 6.3-1 to show only OBC 2006 up until December 31, 2011 and after that date (identified as OBC 2012 in the table), and the current TGS Tier 1 and 2 and the proposed changes to the TGS Tier 1 and 2, showing the average weighted energy utilization intensity on a comparative basis.

Table 6.3-1: Analysis of Impact of OBC, HPNC/BBP-NC, and TGS on Absolute Energy Utilization Intensity

Code, Standard, or Program	Floorspace & Occupancy Type Weighted Average Performance Increment	Typical EUI, ekWh/ft^2/yr
MNECB	0%	25.0
Ontario Building Code		
OBC 2006 (above MNECB)	17%	20.8
OBC 2012 (above MNECB)	25%	18.8
Current Toronto Green Standard		
TGS Tier 1 (above MNECB)	25%	18.8
TGS Tier 2 (aboveMNECB)	35%	16.3
TGS Tier 1 (above OBC 2006)	10%	18.8
TGS Tier 2 (above OBC 2006)	22%	16.3
Proposed Toronto Green Standard (2012)		
TGS Tier 1 Phase I (above OBC 2012)	5%	17.8
TGS Tier 1 Phase 2 (above OBC 2012)	15%	15.9
TGS Tier 2 Phase 1(above OBC 2012)	15%	15.9
TGS Tier 2 Phase 2 (above OBC 2012)	25%	14.1

In this table it can be seen that the proposed increment for TGS Tier 1 in the first phase will be 5% better than the 2012 code requirements, equivalent to 5% better than the previous version of the TGS Tier 1, and will rise to 15% better than the 2012 code requirements in the second phase, equivalent to 15% better than the previous version of the TGS Tier 1.

The proposed increment for TGS Tier 2 in the first phase will be 18% better than the 2012 code requirements, equivalent to 5% better than the previous version of the TGS Tier 1, and will rise to 25% better than the 2012 requirements in the second phase, equivalent to 13% better than the previous version of the TGS Tier 2.

6.4. Summary of Proposals for the Toronto Green Standard

The proposal for each building category is summarized in Table 6.4-1, complete with the method of demonstrating compliance.

Table 6.4-1: Summary of Energy Efficiency Proposals for the Toronto Green Standard

Toronto Green Standard - Commencing January 1, 2012 (or when implemented)						
	Requirement					
Project Category	**Tier 1**	**Option 1**	**Option 2**	**Tier 2**	**Option 1**	**Option 2**
Low-Rise Residetnial Development	Design building(s) to achieve at least EnerGuide 83 energy efficiency rating	Proof of registration with NRCan Authorized Service Organization	EnerGuide Label with an EGNH83 rating or better or ENERGY STAR label	Design and construct building(s) to achieve at least EnerGuide 85 energy efficiency rating	Proof of registration with NRCan Authorized Service Organization	EnerGuide Label with an EGNH85 rating or better, or ENERGY STAR label based on
Small (Part 9) Building Non-Residential	Building designed to exceed the Building Code by at least 5% until December 31, 2013, and at least 15% after that date.	Final Design Stage Energy Model Report	Small Buildings Checklist plus NRCan Screening Tool	Building designed to exceed the Building Code by at least 15% until December 31, 2013, and by at least 25% after that date.	As Constructed Energy Model Report	Small Buildings Checklist plus NRCan Screening Tool
Mid - High Rise Part 3 Building (any use) < 2000 m^2	Building designed to exceed the Building Code by at least 5% until December 31, 2013, and at least 15% after that date.	Final Design Stage Energy Model Report	Small Buildings Checklist plus NRCan Screening Tool	Building designed to exceed the Building Code by at least 15% until December 31, 2013, by at least 25% after that date.	As Constructed Energy Model Report	Small Buildings Checklist plus NRCan Screening Tool
Mid - High Rise Part 3 Building (any use) $\geq$ 2000 m^2	Building designed to exceed the Building Code by at least 5% until December 31, 2013, and at least 15% after that date.	Final Design Stage Energy Model Report	(None)	Building designed to exceed the Building Code by at least 15% until December 31, 2013, by at least 25% after that date.	As Constructed Energy Model Report	(None)

7.0 City of Toronto Emissions Reduction

In this section, the projected avoided GHG emissions have been estimated use data for Toronto from a variety of sources. In addition, proposals have been suggested for achieving net zero carbon new building designs, and for methods to develop performance targets for existing buildings.

7.1. Estimate of GHG Emissions Reductions for the Toronto Green Standard

An estimate of annual GHG emissions depends on a wide variety of factors, including an estimate of new building additions, incremental improvements in energy efficiency due to building code changes, and changes in the electricity generation mix. In order to quantify these reductions attributable to the enhanced energy efficiency requirements recommended for the TGS, estimates of annual GHG emissions reductions have been prepared for 2017 and 2022 that will result from new buildings constructed during the previous 5 year period, and therefore having to meet the higher efficiency requirements recommended in this report for the first period, and projected for the second period. The projection is based on the anticipated energy efficiency requirements for the next edition of the OBC listed in Section 6.2 of this report and the maintenance of a similar incremental improvement of the TGS over the OBC.

It should be noted that these projections have been limited to the reductions that would be achieved by following the Tier I requirements.

An estimate of the annual emissions reductions has been prepared for 2017 and 2022 based on the end of the period for which the OBC and the TGS will have been in effect. Implementation of the proposed higher energy efficiency requirements in the TGS over the OBC will reduce GHG emissions resulting from the consumption of both electricity and natural gas. This has been projected using the following sources:

- Buildings constructed during the period from 2011 to 2016 and from 2017 to 2021 using projections for dwelling units (residential) and floorspace (commercial/institutional) from the Background Report on the Energy Plan for Toronto, Appendix C Figures C-1 and C-6.
- Electricity supply mix projections for 2010 and 2030 from Ontario's Long Term Energy Plan, 2010.
- Projected GHG emissions factors developed using the methodology from SBTool developed by the International Initiative for a Sustainable Built Environment (iiSBE), and interpolated for 2017 and 2022.
- Current and projected natural gas and electricity utilization for low-rise residential dwelling units for electricity and natural gas from Table 4.1-1 of this report. These data were adjusted for the range of residential building types to account for factors such as the propensity for larger occupied space in single family versus multi-family, more occupants per dwelling unit for single family, larger appliances in single family, in-suite laundry facilities in single family and in condos versus central laundry in rental, more electronic devices in single family, etc. This breakdown is shown in Table 7.1-5.

- Energy utilization intensity for electricity and natural gas for office and retail from Table 5.2-3 of this report, and for other building types from the information developed for the Background Report on the Energy Plan for Toronto, Appendix C Figures C-7 and C-8, respectively.
- For non-residential buildings, projected energy consumption avoided for natural gas and electricity due to the implementation of the proposed or projected TGS requirements has been allocated evenly between natural gas and electricity, based on a review of energy end-uses presented in Table 5.2-3 and Table 3.3-1 of this report, which shows that the ratio of natural gas and electricity in the current building stock ranges from approximately 40:60 for buildings with high internal loads such as office and retail, to 60:40 for buildings with low internal loads such as long term healthcare and accommodation.

Residential Building Dwelling Unit Additions: From information provided in Appendix Table C-1[7], the number of residential dwelling unit additions during the two periods is summarized in Table 7.1-1. Note that they have been subdivided into Part 9 and Part 3 buildings.

Table 7.1-1: Projected Residential Dwelling Unit Additions by Building Type

Houising Unit Type	No. of Dwelling Units Added From 2011 to 2016	No. of Dwelling Units Added From 2016 to 2021
Single Detached	8,874	7,858
Semi-detached	2,244	1,742
Row House	671	302
Apts in duplex	197	72
Apts < 5 storeys	1,028	588
Apts > 5 stoerys	6,240	5,674
Other	53	35
Part 9 Subtotal	11,986	9,974
Part 3 Subtotal	7,321	6,297
Total	19,307	16,271

Commercial/Institutional Building Floorspace Additions: From information provided in Appendix Table C6[8], the amount of floorspace additions during the two periods is shown in Table 7.1-2. It is interesting to note that other building types had negative floorspace additions in one or both of the periods and were therefore not included.

[7] Background Report on the Energy Plan for Toronto
[8] Ibid.

Table 7.1-2: Projected Commercial/Institutional Floorspace Additions by Building Type

Building Type	Amount of Floorspace Added From 2011 - 2016, ft^2	Amount of Florspace Added from 2016 to 2021, ft^2
Office	59,432,302	65,740,543
Retail	8,067,013	7,061,250
Accommodation Total	4,566,671	4,568,805
Recreation	3,431,495	3,433,098
Healthcare	3,365,887	3,500,523
Transmission/Utility	972,609	880,629
Food Retail	193,406	193,497
Emergency Measures Services	48,423	21,795

Emissions Factors: SBTool uses a spreadsheet calculation methodology for the determination of GHG emissions factors resulting in the generation of electricity that considers the mix of fuels and renewable sources used to generate electricity, as well as adjustments for the transportation of fossil fuels to the generation site and the transmission losses from that site to the region of use.

The following tables summarize these calculations for the supply mix for 2010 and 2030 presented in the Long term Electricity Plan based on consumption for buildings in Toronto.

Table 7.1-3: 2010 GHG Emissions Factors for Electricity Used in Toronto

Electricity power generation base load mix for 2010	Generation mix by source	Calculations for electricty GHGs		
natural gas	**15.00%**	Fuel type	GHG fuels as % of all GJ	kg. GHG per GJ primary
oil-fired	0.00%			
coal-fired	**8.00%**			
nuclear	**52.00%**	Nat. gas	15.0%	19.71
hydro, with high-methane emission reservoir	0.00%	Oil	0.0%	0.00
ydro, with moderate-methane emission reservoir	**19.00%**	Coal	8.0%	19.29
ydro, with low- or no-methane emission reservoir	0.00%	Biom/Oth	4.0%	0.00
wind	**2.00%**	**kg. GHG / GJ for elec.**		**39.00**
solar	0.00%	Note: Only emissions from non-renewables are included. Emissions for biomass and other fuels are assumed to be zero, as per IPCC.		
geothermal	0.00%			
biomass	**1.00%**			
other	**3.00%**			

Table 7.1-4: 2030 GHG Emissions Factors for Electricity Used in Toronto

Electricity power generation base load mix for 2030	Generation mix by source	Calculations for electricty GHGs		
natural gas	**7.00%**	Fuel type	GHG fuels as % of all GJ	kg. GHG per GJ primary
oil-fired	0.00%			
coal-fired	0.00%			
nuclear	**46.00%**	Nat. gas	7.0%	9.20
hydro, with high-methane emission reservoir	0.00%	Oil	0.0%	0.00
ydro, with moderate-methane emission reservoir	**20.00%**	Coal	0.0%	0.00
ydro, with low- or no-methane emission reservoir	0.00%	Biom/Oth	15.3%	0.00
wind	**10.00%**	**kg. GHG / GJ for elec.**		**9.20**
solar	**1.50%**	Note: Only emissions from non-renewables are included. Emissions for biomass and other fuels are assumed to be zero, as per IPCC.		
geothermal	0.00%			
biomass	**1.30%**			
other	**14.00%**			

A simple interpolation was used to develop emissions factors for 2017 and 2022, as shown in Table 7.1-3.

Table 7.1-5: GHG Emissions Factors for Electricity, 2017 and 2021

Year	2010	2017	2022	2030
GHG Emissions, kg/GJ	39.0	28.6	21.1	9.2
GHG Emissions, g/kWh	140	103	76	33

Residential Buildings – Avoided GHG Emissions: Energy consumption proportional savings have been estimated using the information on EnerGuide for New Houses presented in Table 4.1-1 on a per dwelling unit basis, converted to units as measured at the utility meter. It has been assumed that the energy efficiency requirements in the OBC for the 2016 to 2021 period will be equivalent to EnerGuide 83, and for the TGS, EnerGuide 85.

Table 7.1-4: Energy Consumption Proportional Savings for Low-rise Residential Buildings

New low-rise Housing	Design Reference	Electricity Use/Dwelling Unit, kWh/yr	Natural Gas Use/Dwelling Unit, m^3/yr
OBC Effective 2012	EnerGuide 80	8,760	1,542
TGS Tier 1 - 2012 and OBC 2017	EnerGuide 83	8,322	1,264
Projected TGS Tier 2 - 2017	EnerGuide 85	7,884	1,104
Net Savings - 2011 - 2016	Electricity Use/DU	5.0%	18.0%
Net Savings - 2017 - 2021	Natural Gas Use/DU	5.3%	12.7%

Table 7.1-5 shows the avoided GHG emissions for residential dwelling units that could have been constructed to the OBC requirements that came into force on January 1, 2012 in the absence of the TGS but are projected to follow the proposed requirements for the TGS, for the period from 2012 to 2016 inclusive, and projected GHG emissions avoided in 2022 for the same

buildings using the projected emissions factor for electricity for that year. Note in this table that energy use per dwelling unit has been adjusted based on the type of residential building.

Table 7.1-5: Avoided GHG Emissions for Residential Buildings Constructed from 2012 to 2016, for the Years 2017 and 2022

Housing Unit Type	No. of Dwelling Units Added From 2012 to 2016	Energy Use per Dwelling Unit for Residential Buildings Designed to OBC 2012		Annual Avoided GHG Emissions by Dwelling Units Designed to TGS 2012, for 2017, tonnes CO_{2e}			Annual Avoided GHG Emissions by Dwelling Units Designed to TGS 2012, for 2022, tonnes CO_{2e}		
		Electricity, kWh/yr	Natural Gas, m^3/yr	Electr-icity	Natural Gas	Total	Electr-icity	Natural Gas	Total
CO_{2e} Factor				103	1879		76	1879	
Single Detached	8,874	8760	1542	400	4,628	5,028	295	4,628	4924
Semi-detached	2,244	8760	1388	101	1,053	1,155	75	1,053	1128
Row House	671	8760	1311	30	297	328	22	297	320
Apts in duplex	197	8760	1388	9	92	101	7	92	99
Apts < 5 storeys	1,028	7884	1388	42	483	524	31	483	513
Apts > 5 stoerys	6,240	7884	1388	253	2,929	3,182	187	2,929	3116
Other	53	7884	1388	2	25	27	2	25	26
Total	19,307		Total	838	9,508	10,346	618	9,508	10,126

Table 7.1-6 shows the projected GHG emissions avoided for residential buildings constructed during the period from 2017 to 2021 that would be designed to meet the revised TGS requirements following the introduction of a new OBC 2017.

Table 7.1-6: Avoided GHG Emissions for Residential Buildings Constructed from 2017 to 2021, for the Year 2022

Housing Unit Type	No. of Dwelling Units Added From 2017 to 2021	Energy Use per Dwelling Unit for Residential Buildings Designed to OBC 2017		Annual Avoided GHG Emissions by Dwelling Units Designed to TGS 2017, for 2022, tonnes CO_{2e}		
		Electricity, kWh/yr	Natural Gas, m^3/yr	Electr-icity	Natural Gas	Total
CO_{2e} Factor				76	1879	
Single Detached	7,858	8,322	1,264	263	2,296	2,560
Semi-detached	1,742	8,322	1,138	58	458	517
Row House	302	8,322	1,075	10	75	85
Apts in duplex	72	8,322	1,138	2	19	21
Apts < 5 storeys	588	7,490	1,138	18	155	172
Apts > 5 stoerys	5,674	7,490	1,138	171	1,492	1,663
Other	35	7,490	1,138	1	9	10
Total	16,271		Total	524	4,505	5,029

Commercial/Institutional Buildings – Avoided GHG Emissions: Table 7.1-7 shows the avoided GHG emissions for commercial/institutional buildings that could have been constructed to the OBC requirements that came into force on January 1, 2012 in the absence of the TGS but are projected to follow the proposed requirements for the TGS, for the period from 2012 to 2016 inclusive, and projected GHG emissions avoided in 2022 for the same buildings using the projected emissions factor for electricity for that year.

Table 7.1-7: Avoided GHG Emissions for Commercial/Institutional Buildings Constructed from 2012 to 2016, for the Years 2017 and 2022

Building Type	Amount of Floorspace Added From 2012 - 2016, ft^2	Energy Intensity for Buildings Designed to OBC 2012, $ekWh/ft^2/yr$		Annual Avoided GHG Emissons by Buildings Designed to TGS 2012, for 2017, tonnes CO_{2e}			Annual Avoided GHG Emissons from Buildings Deisgned to TGS 2017 for 2022, tonnes CO_{2e}		
		Electr-icity	Natural Gas	Electr-icity	Natural Gas	Total	Electr-icity	Natural Gas	Total
CO_{2e} Factor				103	1879		76	1879	
Office	59,432,302	9.4	11.3	5,724	11,687	17,410	4,223	11,687	15,910
Retail	8,067,013	4.5	12.0	374	1,692	2,066	276	1,692	1,968
Accommodation Total	4,566,671	10.9	11.8	510	946	1,456	377	946	1,322
Recreation	3,431,495	11.7	13.5	412	812	1,224	304	812	1,116
Healthcare	3,365,887	14.1	15.3	487	903	1,390	359	903	1,262
Transmission/Utility	972,609	15.7	18.8	157	320	477	116	320	436
Food Retail	193,406	23.7	10.1	47	34	81	35	34	69
Emergency Measures Services	48,423	16.2	19.5	8	16	25	6	16	22
			Total	7,720	16,410	**24,130**	5,696	16,410	**22,106**

Table 7.1-7 shows the projected GHG emissions avoided for commercial/institutional buildings constructed during the period from 2017 to 2021 that would be designed to meet the revised TGS requirements following the introduction of a new OBC 2017.

Table 7.1-8: Avoided GHG Emissions for Commercial/Institutional Buildings Constructed from 2017 to 2021, for the Year 2022

Building Type	Amount of Floorspace Added From 2017 - 2021, ft^2	Energy Intensity for Buildings Designed to OBC 2017		Annual Avoided GHG Emissons by Buildings Designed to TGS 2012, for 2017, tonnes CO_{2e}		
		Electr-icity	Natural Gas	Electr-icity	Natural Gas	Total
CO_{2e} Factor				76	1879	
Office	65,740,543	8.2	9.8	4,088	11,311	15,399
Retail	7,061,250	3.9	10.5	211	1,296	1,507
Accommodation Total	4,568,805	9.5	10.4	330	828	1,158
Recreation	3,433,098	10.2	11.8	266	711	977
Healthcare	3,500,523	12.3	13.4	327	822	1,149
Transmission/Utility	880,629	13.7	16.5	92	253	345
Food Retail	193,497	20.7	8.9	30	30	60
Emergency Measures Services	21,795	14.2	17.0	2	6	9
			Total	5,347	15,257	**20,604**

Summary of GHG Emissions Avoided: Table 7.1-9 shows the summary of GHG emission that would be avoided through the implementation of the TGS incorporating the recommendations included in this report, followed by a revised TGS having the same incremental improvement over OBC 2017.

Table 7.1-9: Summary of Avoided GHG Emissions for the Years 2017 and 2022

Building Type	Period of Construction	Annual GHG Emissions Avoided, tonnes CO_{2e}	
		2017	2022
Residential	2012 - 2016	10,346	10,126
	2017 - 2021		5,029
Commercial/ Institutional	2012 - 2016	24,130	22,106
	2017 - 2021		20,604
	Total	**34,476**	**57,865**

7.2. Achieving Carbon Neutral New Building Designs

There are a number of initiatives that have set the objective of achieving carbon neutral, or net zero carbon buildings. These have been described in Section 4.3.2 of this report, and include the following programs and standards:

- The 2030 Challenge
- The Living Building Challenge
- The ASHRAE Advanced Energy Design Guides
- ASHRAE Standard 189.1, *Standard for the Design of High-Performance Green Buildings*

The 2030 Challenge in Canada has been adopted by Architecture Canada, part of the Royal Architectural Institute of Canada (RAIC).[9] It is a challenge issued to design professional calls for design activities that will significantly reduce the greenhouse gas emissions of new and renovated Canadian buildings. While it may be appropriate for Toronto to cite this challenge as an aspirational goal, there is not mechanism for ensuring that the goal will be achieved.
The Living Building Challenge has requirements that include not only energy and emissions but all aspects of a building that impact the environment. It does have a performance requirement that is the demonstration of satisfactory operation for one year with no environmental impact, however, it is an open question as to whether a building in an urban setting can achieve such objectives as net zero water, ecological water flow, or rights to nature.

The ASHRAE Advanced Energy Design Guides have been designated by ASHRAE to achieve net zero energy by 2016, as shown in Chart 4.3-1 of this report. To date, however, their scope has been limited to smaller buildings within specific categories, and many building types have not been included. In addition, these are design guides, and are not written in code language. Finally, the most recent series has been written on the basis of achieving 50% less than ASHRAE 90.1-2004, and the target date of 2016 is not very far in the future.

ASHRAE Standard 189.1-2009 is project to achieve net zero energy by 2025, and has the advantage of being written in code language and is therefore more easily enforceable by a municipal building department. The first edition has been written to achieve an overall environmental performance level equivalent to LEED Silver, as defined in 2009. ASHRAE has defined the energy efficiency level as being approximately 10% better than Standard 80.1-2010.

[9] http://www.raic.org/architecture_architects/green_architecture/2030_about_e.htm

On the topic of energy efficiency, this document will be very familiar to designers who follow the use of Standard 90.1 in the Building Code, as the format and energy efficiency requirements are very similar.

Of these examples, Toronto could most readily adopt Standard 189.1 with the possible potential to achieve net zero carbon by 2025. There are some caveats that should be noted:

- Standard 189.1 is written in code language and is therefore readily enforceable.
- Standard 189.1 has only been issued once, and will undoubtedly benefit from some extensive review and revision based on real world experience. To date, only a very few municipalities in the US have chosen to adopt this standard. ASHRAE plans to follow the same practice as Standard 90.1 by placing Standard 189.1 on continuous maintenance resulting in regular updates being issued with a new version published every three years, but this will require that the document be used and feedback provided. It remains to be seen whether ASHRAE will be able to follow through with their plans.
- Standard 189.1 covers topics that are currently covered by the Toronto Green Standard, but a comparison would have to be made to see how they compare in their application and stringency. It is likely that the TGS places more emphasis on some topic areas and less on others, so the City would have to decide on whether to replace the TGS, reinforce Standard 189.1, or simply adopt the energy efficiency requirements.
- As noted in Section 4.3, a statement by ASHRAE with respect to projecting the date for the achieving of net zero energy building design will be based on US building stock and climate, and may not directly apply to Toronto.

7.3. Establishing Performance Targets for Existing Buildings

There are several initiatives underway to rate buildings on the basis of their energy performance as well as on other green or sustainable topic areas. These can be generally categorized as either building energy labels or performance rating systems.

Building Energy Labels/Ratings: Building Energy Labels have been widely used in other jurisdictions, especially Europe, but have not been widely adopted in North America. Two key

Natural Resources Canada began an initiative in 2006, and after some research, settled on a label similar to the European Union that was identified under the EnerGuide banner. After significant consultation, they undertook a pilot is the institutional sector, the results of which were not made public, except for their report that more than 300 labels were issued to pilot program participants. This initiative has now focussed on adopting the US-EPA ENERGY STAR for Buildings program. At the April 2012 Green Real Estate Forum, NRCan and EPA announced that they had reached an agreement to “Canadianize” the US program by including benchmark data developed by NRCan for a statistically valid sample of Canadian buildings, weather normalizing Canadian buildings using their postal codes and Environment Canada weather data, GHG emissions based on provincial data, metrification of the data, and the use of their Portfolio Manager tool on the same basis as US-based users, which includes recommendations fro improving building performance. This system will include baseline performance comparisons for all building types, and is expected to be operational in 2013. The basic output is a rating that compares the energy performance of the building to a benchmark for similar buildings, but the output can also be presented in a variety of forms. NRCan is also discussing a basis on which BOMA BESt and their program can cooperate.

ASHRAE has recently developed a building labelling program called Building Energy Quotient that compares the performance of a building with similar buildings. Certification requires the use of an ASHRAE-certified individual who will conduct an ASHRAE Level 1 Energy Audit, and submit the results to ASHRAE, who will review and then issues the rating and the label. This label uses many of the same features as the EU label.

The 20 by 15 challenge was launched In September 2009 by the Real Property Association of Canada (REALpac), in collaboration with the Canada Green Building Council and BOMA Canada, as an energy consumption target for office buildings of 20 equivalent kilowatt-hours of energy use per square foot of building area per year (20 ekWh/ft^2/year), to be achieved by 2015. It includes a normalization of building energy consumption to ensure the comparability between office buildings regardless of tenant mix or climactic zone. In 2011, the program converted to an online database to streamline data entry and offer a higher degree of user-friendliness. The only report issued in April 2011 was for 2010 and listed 261 office buildings as participants.

It should also be noted that some cities in the US now require that buildings be rated for their energy efficiency and publish the results. In general they have adopted the ENERGY STAR program for its simplicity of use and applicability to a wide variety of building types. Examples include New York, Seattle and San Francisco.

Environmental Performance Rating Systems: Green Globes for Existing Buildings, developed by ECD Energy and Environment, Canada Ltd., began as BREEAM Canada for Existing Buildings, published as a CSA standard in 1996. In 2000, it became an online assessment and rating tool, and has continued to be developed and used across North America. In 2010, Green Globes for New Buildings was approved as an ANSI standard.

In 2004, Green Globes for Existing Buildings was adopted by the Building Owners and Managers Association of Canada, and with some modifications was renamed BOMA BESt. It is Canada's largest environmental assessment and certification program for existing buildings. This assessment provides a consistent framework for owners and managers to critically assess six key areas of environmental performance and management including energy, water, waste diversion and site enhancement, emissions and effluents, indoor environment, and environmental management system. To date, the program has offered certification or recertification to over 2900 buildings in Canada, and now includes five assessment modules covering office and light industrial buildings, retail plazas, shopping centres, and, a new module for multi-unit residential buildings. The energy component makes up a significant portion of the BOMA BESt assessment, and is a key basis on which the certification levels are determined (Level 2 – 6% better than benchmark; Level 3 – 18% better; Level 4 – 46% better). All data on which the certification rating is based is independently verified. The most recent report was issued on April 27, 2012.

Proposals for Toronto: The two systems that offer the breadth of buildings types are BOMA BESt and ENERGY STAR for Buildings. Some pros and cons to the use of either system include the following:

BOMA BESt:

Pros:

- The system has been in use since 2004, and has been modified and updated based on user experience.
- It is industry managed and supported.
- Many of the buildings already in the database are in Toronto.

- It incorporates recommendations for performance improvement.

Cons:

- Some building types have only recently been included, e.g. multi-unit residential, and others are not yet included.
- The system covers a broader range of topics than energy
- It could be difficult to require an industry association to require participation

ENERGY STAR for Buildings

Pros:

- The system covers all building types.
- The system is widely used and understood.
- The system is energy focussed only.
- It incorporates recommendations for performance improvement.

Cons:

- The data which forms the foundation is still under development, and will require seasoning through subsequent surveys to improve the accuracy.
- The timetable for release may be optimistic.

What may prove to be the best program for the City to adopt will be the collaboration between BOMA BESt and ENERGY STAR for Buildings as adapted for Canada. It is expected that a BOMA BESt applicant will provide their data and will receive both ratings. For this reason, the City should commence discussions with both BOMA Canada and NRCan, and continue to monitor developments. In the meantime, the City will need to establish a basis on which they could require all buildings in the City to establish and report their energy performance rating.

8.0 Acronyms and Abbreviations used in this Document

AEDG	Advanced Energy Design Guide (ASHRAE)
AIA	American Institute of Architects
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
BBP-NC	Better Buildings Partnership New Construction program
BILDTRAD	Building Envelope Tradeoffs (Calculation Tool for MNECB)
BOP	Builder Option Package
CCBFC	Canadian Commission on Building and Fire Codes
CBECS	Commercial Building Energy Consumption Survey
DOE	Department of Energy
EI	Efficiency Index
EIA	The Energy Information Agency
ENVSTD 23/24	Envelope Standard (Building Envelope Tradeoff Calculation Tool for ASHRAE 90.1-1989)
EPA	Environmental Protection Agency
ERS	EnerGuide Rating System
ESNH	ENERGY STAR® for New Homes
EUI	Energy utilization intensity
GHG	Greenhouse gas
GJ	Gigajoules
HPNC	High Performance New Construction Program
HVAC	Heating, Ventilating, and Air Conditioning
ICLEI	International Council for Local Environmental Initiatives (now called ICLEI–Local Governments for Sustainability)
LED	Light-emitting diode
MMAH	Ministry of Municipal Affairs and Housing (Ontario)
MNECB	Model National Energy Code for Buildings
MURB	Multi-unit Residential Building
NBC	National Building Code
NEC	Net Energy Consumption Rating
NECB	National Energy Code for Buildings
NRC	National Research Council
NRCan	Natural Resources Canada
OAA	Ontario Association of Architects
OBC	Ontario Building Code
RAIC	Royal Architectural Institute of Canada
RECS	Residential Energy Consumption Survey
SB-10	Supplementary Standard SB-10: Energy Efficiency Supplement (Part 3 Buildings and Part 9 Non-Residential Buildings)
SB-12	Supplementary Standard SB-12: Energy Efficiency for Housing (Part 9 Residential Buildings)
SWH	Service Water Heating
TGS	Toronto Green Standard
USGBC	U.S. Green Building Council

Appendix A: Recommendations for Part 9 Residential Buildings

OPTION 1: Use Current EnerGuide Rating System to establish TGS requirements for Tier 1 and Tier 2.

Ontario Building Code requirement (from Supplementary Standard SB-12): After December 31, 2011, Sentence 12.2.1.2(3) will require the energy efficient design of a building or part of a building of residential occupancy within the scope of Part 9 that is intended to be occupied on a continuing basis during the winter months to comply with:

- Supplementary Standard SB-12; or
- Achieve a rating of 80 or more when evaluated in accordance with the technical requirements of NRCan, "EnerGuide for New Houses: Administrative and Technical Procedures", January 2005.

Proposal for TGS:

- Tier 1: Achieve a rating of 83 or more when evaluated in accordance with NRCan, "EnerGuide for New Houses: Administrative and Technical Procedures", January 2005, or by using the method specified in SB-12, Subsection 2.1.2. Performance Compliance.
- Tier 2: Achieve a rating of 85 or more when evaluated in accordance with NRCan, "EnerGuide for New Houses: Administrative and Technical Procedures", January 2005,
- Or by using the method specified in SB-12, Subsection 2.1.2. Performance Compliance.

Advantages

- Based on the EnerGuide Rating System specified in the OBC.
- OBC Baseline can be achieved using either a prescriptive or a performance option.
- ERS rating system is well understood by homebuilders.

Disadvantages

- Compliance requires builders to follow the NRCan process, resulting in the issuance of a label.

Supplementary Notes:

1. **Article A-2.1.2.1 Application of Performance Compliance Path.**
For the purpose of calculating the annual energy use of a proposed design and a design based on a selected compliance package, the following software may be used:
• HOT2000 version 9.34c or newer versions
• Other software referenced by the EnerGuide Rating System
• RESNET accredited Home Energy Rating System (HERS) software, such as:
  • OptiMiser
  • EnergyGauge
  • EnergyInsights
  • REM/Rate

2. The EnerGuide Rating System establishes a baseline energy use comprising three categories: Space Heating Consumption; Appliance Energy Consumption; and Domestic Hot Water Consumption. The following table shows the probable impact on each in order to achieve the proposed Tier 1 and 2 requirements of ERS 83 and 85, respectively.

Energy End-Use	EnerGuide Rating System Benchmark	OBC, EnerGuide 80 Design	TGS Tier 1, EnerGuide 83 Design	TGS Tier 2, EnerGuide 85 Design
Space Heating Consumption, MJ	35,280	35,280	26,460	17,640
Appliance Energy Consumption, MJ	31,536	31,536	29,959	28,382
Domestic Hot Water Consumption, MJ	27,758	27,758	24,982	24,982
Total Annual Consumption, MJ	94,574	94,574	81,401	71,004
Improvement over Benchmark - Heating		0%	25%	50%
Improvement over Benchmark - Appliance		0%	5%	10%
Improvement over Benchmark - DHW		0%	10%	10%
Improvement over Benchmark - Total		0%	14%	25%
EnerGuide Rating		80	83	85

Based on the examples in the table, the space heating consumption would have to be reduced by 25% to achieve ERS 83, and 50% to achieve ERS 85. In addition, the appliance energy consumption would have to be reduced by 5% and the domestic hot water energy consumption by 10% to meet ERS 83, while the equivalent reductions to achieve ERS 85 would be 50%, 10%, and 10%.

Space heating consumption is driven by the thermal performance of the envelope, the air tightness of the envelope, which affects the air infiltration (estimated as the number of air changes per hour), and the efficiency of the space-heating unit. The minimum performance required for natural gas or propane furnaces is 90% Annual Fuel Utilization Efficiency (AFUE), and for other fuels or heating units, it can be less. Some furnaces and hot water boilers are available with an AFUE of 95% or more. The efficiency of electric heating is 100%.

Appliance energy consumption is driven by the efficiency of all appliances and the frequency of use, as well as the amount of standby power consumed by almost all electrical devices.

Domestic hot water energy consumption is driven by the amount of hot water used, the efficiency of the hot water heater, and the use of heat recovery devices. Low flow showerheads and faucets can reduce hot water consumption. The baseline efficiency of a gas hot water heater is considered to be a storage tank type with an energy factor of 0.57, and this can be easily improved to 0.80 for both storage water heaters and instantaneous types. The energy efficiency of electric hot water tanks is considered to be 100% minus the storage loss.

In all cases, energy consumption can be reduced significantly by selecting ENERGY STAR® products.

OPTION 2: Use Proposed New ENERGY STAR® for New Homes Standard to establish TGS requirements for Tier 1 and Tier 2

NRCan has prepared a new ENERGY STAR® for New Homes Standard for Ontario that has completed a public review period. This Phase I version will be based on the current EnerGuide Rating System (ERS) and is expected to be released by July 1, 2012. The Phase 2 version will be based on the new ERS and is expected to be released in 2014. The system has both a prescriptive and a performance option. The prescriptive path offers significant flexibility to homebuilders through a selection of options that are evaluated using a points system. Under the prescriptive path of this proposed program, builders would select a Builder Option Package (BOP) that will result in an EnerGuide Rating of 83 or higher. Under the performance path, builders must achieve an ERS of 83. This would be consistent with the current TGS and the proposal in Option 1 to require an ERS of 83.

A more stringent requirement for Tier 2 could be achieved by requiring the selection of a BOP that would be applicable to Ontario Climate Zone 2 (applies to parts of the province having 5000 heating degree days or more - approximately north of a line running between Sudbury and North Bay).

Proposal for TGS:

- Tier 1: Design buildings to achieve at least ENERGY STAR®.
- Tier 2: Design buildings to achieve at least ENERGY STAR® for Ontario Climate Zone 2.

Advantages

- Homebuilders and consumers are familiar with current ENERGY STAR® brand & program.
- ENERGY STAR® will offer flexible prescriptive & performance approaches.
- ES Ontario performance requirement for Climate Zone 1 is (current) ERS 83
- Offers homebuilders flexibility to achieve performance level
- ESNH will apply to Part 9:
  a) detached houses,
  b) attached houses, which includes semi-detached houses and row houses, and
  c) multi-unit residential buildings (MURBs), which include stacked townhouses, duplexes, triplexes, and apartment buildings.

Disadvantages

- ES does not have two tiers; propose creating Tier 2 by using Ontario Climate Zone 2 requirements.
- ENERGY STAR® Phase I will not be launched until July 1, 2012.
- ENERGY STAR® Phase 2 will be launched in 2014, after release of new ERS.
- It is unclear whether the OBC will adopt the new ERS before the start of the next code cycle, expected in 2017.

Supplementary Notes:

1. The new ESNH system is under development but is not yet finalized. Information presented in this report is based on the public review draft issued in October with a closing date of Nov. 4, 2011.

2. An analysis of SB-12 compared to the proposed ES Core BOP[10] combined with the BOP Upgrade Points[11] for Ontario that must total 2.8 or more for the specific climate zone, suggests that using the core BOP and the options for Climate Zone 2 as the requirement for Tier 2 would result in a current ERS rating that would meet or exceed 85.

3. The rules for the new-ESNH will require that builders register their project after site plan approval, and they then have 24 months to completion.

4. The existing ESNH – Ontario has been accepted in the latest edition of SB-12 as an acceptable option for demonstrating compliance after Dec. 31, 2011.

[10] 2012 ENERGY STAR® for New Homes Standard Draft for Public Review October 2011, Pg. 20 Table 8
[11] 2012 ENERGY STAR® for New Homes Standard Draft for Public Review October 2011, Pg. 21 Table 9

OPTION 3: Use Proposed New EnerGuide Rating System to establish TGS requirements for Tier 1 and Tier 2.

NRCan will be moving to a new residential energy rating system that will use Net Energy Consumption in GJ/yr, and may also provide an Efficiency Index in GJ/m2/yr.

Proposal for TGS:

- Tier 1: Achieve a Net Energy Consumption (NEC) of 85 GJ/yr or less when evaluated in accordance with NRCan, “New EnerGuide Rating System for New Houses”, expected to be released by January 2013.
- Tier 2: Achieve an energy consumption of 75 or less when evaluated in accordance with NRCan, “New EnerGuide Rating System for New Houses”.

Advantages

- Based on the proposed next generation NRCan EnerGuide Rating System
- Simple metric
- Offers homebuilders flexibility to achieve performance level
- May anticipate adoption of this new system by the market, and the OBC

Disadvantages

- System is not yet available or “market tested”
- Relationship between floor space and EUI is not linear
- Requires different targets for other housing types
- Consumers are unfamiliar with this version of ERS

Supplementary Notes:

1. The new ERS is under development but is not yet finalized
2. Methods of adoption in a program are not yet defined.

Justification for Part 9 Residential Buildings: The Tier 1 requirement will be consistent with the new ESNH program, and many builders will elect to follow this program thereby meeting this performance level. The Tier 2 requirement will be unchanged, but remains challenging for applicants.

Appendix B: Recommendations for Part 9 Non-Residential Buildings and Part 3 Buildings

Summary of Recommendations for the Toronto Green Standard Part 9 Buildings of Non-Residential Occupancy

OPTION 1: Specify incremental improvement above code to establish TGS requirements for Tier 1 and Tier 2.

Ontario Building Code requirement (from Supplementary Standard SB-10):

Article 1.1.1.3 Energy Efficiency Design after December 31, 2011

(2) The energy efficiency of a *building* or part of a *building* may conform to the design requirements of Division 4 of this Supplementary Standard, if the *building* or part of the *building*,

(a) is within the scope of Part 9 of Division B of the Building Code,
(b) does not contain a *residential occupancy*,
(c) does not use *electric space heating*, and
(d) is intended for *occupancy* on a continuing basis during the winter months.

SB-10 Division 4, Section 1.1, Article 1.1.1.1 Application

(1) Except as provided in Sentences 2 and (3), this Division applies to the energy efficiency of *buildings* or parts of *buildings* where the *building*

(a) is within the scope of Part 9 of Division B of the Building Code,
(b) does not contain a *residential occupancy*,
(c) does not use *electric space heating*, and
(d) is intended for *occupancy* on a continuing basis during the winter months.

(2) Where the ratio of the gross area of fenestration to the gross area of peripheral wall measured from grade to the top of the most upper ceiling exceeds 40%, or the ratio of the gross skylight areas to gross ceiling area exceeds 5%, the *building* envelope shall comply with Article 1.1.2.1 of Chapter 1 of Division 3. (The design must follow one of the energy code options of Division 3).

(3) *Buildings* are exempt from compliance with this Division where they meet the exemptions described in Article 1.2.1.1 of Chapter 1 of Division 3. (Heritage buildings, buildings using very little energy or that are unheated or only heated enough to prevent freezing).

Proposal for the Toronto Green Standard (TGS):

Phase 1: For the period up until December 31, 2013:

Tier 1: Exceed by not less than 5% the energy efficiency levels attained by:

- conforming to SB-10 Division 4, as confirmed by use of the NRCan online screening tool, or;
- conforming to SB-10 Division 3, using the prescriptive path of either ASHRAE 90.1-2010 and SB-10 or the National Energy Code for Buildings (when adopted by the OBC), as selected by the applicant, with compliance confirmed by use of the NRCan online screening tool.

Tier 2: Exceed by not less than 15% the energy efficiency levels attained by:

- conforming to SB-10 Division 4, as confirmed by use of the NRCan online screening tool, or;
- conforming to SB-10 Division 3, using the prescriptive path of either ASHRAE 90.1-2010 and SB-10 or the National Energy Code for Buildings (when adopted by the OBC), as selected by the applicant, with compliance confirmed by use of the NRCan online screening tool.

Phase 2: For the period after December 31, 2013:

Tier 1: Exceed by not less than 15% the energy efficiency levels attained by:

- conforming to SB-10 Division 4, as confirmed by use of the NRCan online screening tool, or;
- conforming to SB-10 Division 3, as confirmed by use of the NRCan online screening tool or by following the prescriptive path of the energy code selected by the applicant.

Tier 2: Exceed by not less than 25% the energy efficiency levels attained by:

- conforming to SB-10 Division 4, as confirmed by use of the NRCan online screening tool, or;
- conforming to SB-10 Division 3, as confirmed by use of the NRCan online screening tool or by following the prescriptive path of the energy code selected by the applicant.

Advantages

- By citing the two energy codes specified in the OBC that do not require the exclusive use of the performance path, the OBC Baseline can be achieved using either a prescriptive or a performance option.
- The phased timing will permit designers and energy modelers to become familiar with the new energy codes.
- The Phase 1 energy performance is expected to be consistent with the statement in the next Building Code (2012) that will state the energy efficiency requirement for the edition to follow (2017).
- An applicant who has been accepted for inclusion in either the HPNC or the Toronto Hydro incentive programs will have their energy models reviewed by an expert.
- The timing of the phased approach could be adjusted to suit the needs of the City or the date of release of the OBC and the anticipated date of the OBC edition to follow (usually 5 years).

Disadvantages

- Confirmation of compliance requires that the applicant use the online screening tool accurately to compare the OBC base case and the proposed design, although the life of this tool is as yet undetermined.
- The use of a single increment that applies to all buildings may prejudice proponents applying for specific building types, particularly those having lower internal loads.
- This option does offer an alternative path for buildings under 2000 m^2, although this would mean that the TGS would vary from the OBC in the determination of the OBC base case.

Supplementary Notes:

1. The requirements of SB-10 Division 4, Article 1.1.1.2, *Building Envelope*, are summarized in this table:

Opaque Elements	Zone 1 Less Than 5000 Degree-Days		Zone 2 5000 or More Degree-Days	
	Assembly Max. U-Value(1)	**Insulation Min. RSI-Value**	**Assembly Max. U-Value(1)**	**Insulation Min. RSI-Value**
Roofs				
Without Attic Space-Insulation Above Deck	U-0.181	5.28 ci	U-0.158	6.16 ci
With Attic Space and Other	U-0.119	8.8	U-0.096	10.56
Walls, Above Grade	U-0.312	2.28 + 1.76 ci	U-0.312	2.28 + 1.76 ci
Wall, Below Grade	C-0.522	1.76 ci	C-0.522	1.76 ci
Exposed Floors, Lightweight framing	U-0.181	6.69	U-0.181	6.69
Mass	U-0.323	2.57 ci	U-0.244	3.52 ci
Slab-On-Grade Floors (perimeter+below slab)				
Unheated		2.64 for 600 mm		2.64 for 600 mm + 0.88 ci below
Heated		2.64 for 900 mm + 0.88 ci below		3.52 for 900 mm + 0.88 ci below
Fenestration	**Assembly Max. U-Value**	**Assembly Max. SHGC**	**Assembly Max. U-Value**	**Assembly Max. SHGC**
Vertical Fenestration, 0% - 40% of Wall	U-1.987	0.4	U-1.703	0.45
Skylight with Curb, % of Roof 0% to 5%	U-3.917	0.49	U-3.917	0.50
Skylight without curb, % of Roof 0% to 5%	U-2.555	0.46	U-2.555	0.46

There are other requirements in Articles 1.1.1.3 through 1.1.1.12, for *Air Sealing*, *Heating, Ventilating and Air Conditioning, Ducts, Plenums and Piping, Service Water Heating, Lighting, Interior Lighting, Interior Lighting Controls, Exterior Lighting, Exterior Lighting Controls, and Electric Motors.*

Note that this is a simplified prescriptive option that is only available for Part 9 non-residential buildings.

It should be noted that the Online Screening Tool does not assess Air Sealing; Ducts, Plenums, and Piping; Exterior Lighting Controls; and Electric Motors.

Summary of Recommendations for the Toronto Green Standard Part 3 Buildings Less Than 2,000 m^2 Floor Area:

January 1, 2012: Advance the requirement for Tier 1 and Tier 2 to match the percentage increment for large buildings and continue to permit the use of the NRCan Screening Tool as long as it is available.

Next Edition of the Building Code (2017): The 2012 Building Code is expected to specify the level of energy efficiency to be required in the 2017 Building Code, and this is currently projected at 12% to 13% above current levels. Both the TGS level and the method of determining compliance will be reviewed in advance of the release of OBC 2017, and a final determination made at that time.

Summary of Recommendations for the Toronto Green Standard Part 3 Buildings

OPTION 1a: Specify incremental improvement above the Building Code to establish TGS requirements for Tier 1 and Tier 2.

Ontario Building Code requirement (from Supplementary Standard SB-10):

Article 1.1.1.3 Energy Efficiency Design after December 31, 2011
(1) Except as permitted in Sentence (2), the energy efficiency design and construction of buildings required to comply with Sentence 12.2.1.2.(2) of Division B of the Building Code shall comply with Division 3 of this Standard.

SB-10 Division 3, Chapter 1: 1.1.2.1 Energy Efficiency Design
(1) Except as provided in Sentence (2) and Article 1.2.1.1. and except as permitted in Sentence (3), the energy efficiency of all *buildings* shall be designed to

(a) exceed by not less than 25% the energy efficiency levels attained by conforming to the CCBFC, "Model National Energy Code for Buildings."
(b) exceed by not less than 5% the energy efficiency levels attained by conforming to the ANSI/ASHRAE/IESNA 90.1, "Energy Standard for Buildings Except Low-Rise Residential Buildings", or
(c) achieve the energy efficiency levels attained by conforming to the ANSI/ASHRAE/IESNA 90.1, "Energy Standard for Buildings Except Low-Rise Residential Buildings" and Chapter 2.

In addition, it is contemplated that the National Energy Code for Buildings (NECB), once published, will be added as an additional option. This energy code was released on November 18, 2011.

Proposal for Toronto Green Standard (TGS):
Phase 1: For the period up until December 31, 2013:
Tier 1: Exceed by not less than 5% the energy efficiency levels attained by:

- conforming to ANSI/ASHRAE/IESNA 90.1-2010 and SB-10 Chapter 2; or
- conforming to the National Energy Code for Buildings, 2011

Tier 2: Exceed by not less than 15% the energy efficiency levels attained by:

- conforming to ANSI/ASHRAE/IESNA 90.1-2010 and SB-10 Chapter 2; or
- conforming to the National Energy Code for Buildings, 2011

Phase 2: For the period after December 31, 2013:
Tier 1: Exceed by not less than 15% the energy efficiency levels attained by:

- conforming to ANSI/ASHRAE/IESNA 90.1-2010 and SB-10 Chapter 2; or
- conforming to the National Energy Code for Buildings, 2011

Tier 2: Exceed by not less than 25% the energy efficiency levels attained by:

- conforming to ANSI/ASHRAE/IESNA 90.1-2010 and SB-10 Chapter 2; or
- conforming to the National Energy Code for Buildings, 2011

Advantages	Disadvantages
• By citing the two energy codes specified in the OBC that do not require the exclusive use of the performance path, the OBC Baseline can be achieved using either a prescriptive or a performance option. • The phased energy performance requirement will permit designers and energy modelers to become familiar with the new energy codes. • The Phase 2 energy performance is expected to be consistent with the statement in the next Building Code (2012) that will state the energy efficiency requirement for the edition to follow (2017). • An applicant who has been accepted for inclusion in either the HPNC or the Toronto Hydro incentive programs will have their energy models reviewed by an expert. • The timing of the phased approach could be adjusted to suit the needs of the City, the final date of release of the next edition of the OBC, and the anticipated date of the OBC edition to follow (usually 5 years).	• Tier 1 and 2 require that the applicant follow the performance path to determine compliance. • Confirmation of compliance requires the services of a firm that has energy modeling expertise, due to the inconsistent quality of energy modeling capabilities. • The use of a single increment that applies to all buildings may somewhat prejudice proponents applying for specific building types, particularly those having lower internal loads.

Supplementary Notes:
1. The options for compliance in SB-10 Division 3 are summarized in this table:

Component/System	All Administrative/Climate Zones				
	MNECB Plus 25%	ASHRAE 90.1-2010 Plus 5%	ASHRAE 90.1-2010 Hybrid		NECB 2011 (when published)
Building Envelope	MNECB Part 3	ASHRAE 90.1-2010 Section 5	Supplementary Standard SB-10 (ASHRAE 189.1-2009)		NECB 2012 Part 3
Lighting	MNECB Part 4	ASHRAE 90.1-2010 Section 9	ASHRAE 90.1-2010 Section 9		NECB 2012 Part 4
Heating, Ventilating & Air Conditioning	MNECB Part 5	ASHRAE 90.1-2010 Section 5	ASHRAE 90.1-2010 Section 5		NECB 2012 Part 5
Service Water Heating	MNECB Part 6	ASHRAE 90.1-2010 Section 7	ASHRAE 90.1-2010 Section 7		NECB 2012 Part 6
Electrical Power	MNECB Part 7	ASHRAE 90.1-2010 Section 8	ASHRAE 90.1-2010 Section 8		NECB 2012 Part 7
Performance Path	MNECB Part 8	ASHRAE 90.1-2010 Section 11	ASHRAE 90.1-2010 Section 11		NECB 2012 Part 8

Note that compliance with *MNECB plus 25%* and *ASHRAE 90.1-2010 plus 5%* can only be determined by following a performance path to determine the OBC base case. The other two options, *ASHRAE 90.1-2010 Hybrid* and *NECB 2011* offer both a prescriptive and a performance path.

Justification for all Part 9 Non-Residential Buildings and Part 3 Buildings: The analysis presented in Sections 5.3 and 5.4 demonstrates that:

- Buildings of all types are moving towards a comparable level of improvement over the MNECB or OBC 2012 benchmarks, due to more stringent envelope requirements, and the adoption of more efficient lighting, HVAC and service water heating systems and equipment.
- The HPNC/BBP-NC programs have demonstrated that new building design has advanced to the point where building performance is regularly exceeding the OBC in all building categories.