GEARED FOR CHANGE

ENERGY EFFICIENCY IN CANADA'S COMMERCIAL BUILDING SECTOR

ANNEX

MODELLING SCENARIO ASSUMPTIONS FOR POLICY DESIGN

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Policy and program design will be a required next step for implementing the energy efficiency measures contained in this report. Various scenarios that considered the effectiveness of selected policy measures in reducing carbon emissions from commercial and institutional buildings were modelled in the research for this work, and recommendations were derived from the results. The assumptions implicit in the scenarios were based on input from stakeholder consultations and the project's advisory committee, a literature review, and secondary research conducted by ICF International and J&C Nyboer. Assumptions for the scenarios are outlined in detail in this Annex in order to help guide program designers in policy development for increasing energy efficiency in the commercial building sector.

BASELINE AND REFERENCE SCENARIOS

The main analysis in this report builds on previous modelling work that ICF International conducted for the federal government using the Energy 2020 model to assess the impact of the *Turning the Corner* plan, the *Regulatory Framework for Air Emissions*, and select provincial policies.[1] This combined impact is referred to as the reference scenario.

The baseline scenario is the "do nothing" option; that is, where no policies, regulations, prices, or incentives are implemented, and greenhouse gas emissions and energy use follow historic growth patterns.

Under all scenarios, economic growth is assumed at a rate of 2.1% per year.

CARBON PRICE SCENARIO

As noted on page 59 of the report, the carbon price scenario assumes the "Fast and Deep" pricing scheme published by the NRTEE in its 2007 report *Getting to 2050: Canada's Transition to a Low-emission Future*.[2]

COMPLEMENTARY POLICIES SCENARIO

The complementary policies scenario contains eight policy measures. Assumptions about their impacts on carbon emission reductions were conservative, due to difficulties in making precise forecasts and a desire to identify the sector's achievable potential for emissions reductions.

This scenario does not analyze the use of building-integrated renewable energy technologies and does not explicitly encourage greater use of district heating systems.

1

Incorporate energy efficiency into Canada's National Building Code

This policy assumes that as of 2011 the updated (due to be released in 2011[3]) Model National Energy Code for Buildings (MNECB) will be integrated into the National Building Code and adopted by all provinces and territories. The updated MNECB was assumed to require a building efficiency increase of 20% in the energy performance of buildings built under current rules. Current energy performance is expected to be 10% greater than the 1997 MNECB by 2010.[4,5,6]

This regulated increase in efficiency was expected to result in a 4.2% capital cost increase for new buildings.[7,8] For modelling purposes, 85% of new building stock was assumed to comply with this policy.[9] The increased regulations apply to the construction of any new building as well as building refits, which are assumed to occur at a rate 2.2% per annum.[10] This policy applies to all building sectors, except Government.

In addition, the requirements of the MNECB become more stringent over time, increasing the minimum efficiency levels by 5% every five years until the end of the period, as shown in the table below. Please note that the efficiency gains in the table were specified by the NRTEE.

Year	Percentage Improvement over current practice
2016	25%
2021	30%
2026	35%
2031	40%
2036	45%
2041	50%
2046	55%

2 Establish higher efficiency standards for building equipment

Under this policy, the minimum efficiency standards for building appliances and equipment are increased by regulation. The average equipment and appliance efficiency increases over time and is driven by the replacement rate, starting between 2009 and 2015. An incremental change is applied in 2035 (again as specified by the NRTEE), further increasing the minimum equipment standards for energy efficiency.

The efficiency of heating, ventilation, and air conditioning (HVAC) equipment is increased by 8.5%,[11,12] while chillers are increased by 9%[13,14] over current levels. In 2035, the minimum efficiency of HVAC equipment is increased by a further 12%, while the minimum efficiency of chillers is increased by another 13%.

Starting in 2015, regulation increases minimum furnace efficiency by 15%, with a 10% increase in capital costs.[15] A further 21% incremental increase occurs in 2035, with an identical cost increase.

Boilers with a capacity of less than 5 million Btu per hour increase their efficiency by 5% in 2015[16,17] and a further 7% in 2035, while larger boilers increase their minimum efficiency by 10% in 2015, with an incremental increase of 14% in 2035. Regulated changes in boiler efficiencies result in an increased capital cost of 10% for each incremental increase.[18]

In addition, plug-load efficiency increases by 25% over current levels,[19] with no increase in cost.[20] In 2035, minimum plug-load efficiency is increased a further 35% over the levels established in 2015.

This policy assumes that starting in 2009, standard fluorescent lighting efficiency increases by 30%, regular high-intensity discharge (HID) efficiency increases by 8%, and existing high-bay lighting supplied by HID fixtures increases by 40%. The policy also assumes that lighting controls are applied to all standard fluorescent lighting systems, over a period of 10 years, following the increases to the lighting efficiency regulation. Lighting efficiency is further increased in the same manner in 2035, with increases of 42% from current T12 lighting energy use; 11% for HID bulbs, and 56% for high-bay HID lighting.

3 Apply accelerated capital cost allowance rates to equipment

Beginning in 2010, this policy sets the capital cost allowance rate for Class 1 equipment to 20%, and for Class 8 equipment to 35%.[21, 22] All building sectors were considered eligible for this incentive.

4 Establish and regulate building commissioning standards

This policy requires that 70% of the existing building stock in all sub-sectors except Government undertake a commissioning process, resulting in building energy savings of 15%.[23] The policy was applied over a 20-year period beginning in 2010.

Estimated commissioning costs of 1% and 4% for new and existing buildings respectively were translated into an increased annual operating cost of 0.4% per building.[24] Buildings were assumed to incur the cost of commissioning every five years in order to maintain the level of initially realized energy savings.

5 Apply mandatory performance standards to public buildings

New government buildings are assumed to perform at LEED® Gold efficiency (34% higher than current practice),[25] with a monitoring program that ensures this level of performance is maintained. This policy requires a capital cost increase of 9.9%.[26,27] It assumes that 60%[28] of existing buildings in the Government sector increase their energy efficiency by 11%[29] over a 10-year period, beginning in 2010.

A 25% increase in plug-load efficiency is assumed due to the mandatory use of, at minimum, ENERGY STAR® rated equipment, with no cost increase.[30]

6 Provide resources to expedite the building permit process

This policy was quantified in modelling terms through a discounted capital cost, using the analogue of decreased building permit fees.[31] Average commercial building permitting costs were estimated as $167,000 per building.[32,33,34] Beginning in 2011, this policy assumes that at efficiency levels of 30%, 40%, and 50% above current practice, discounts of 10%, 20%, and 30%, respectively, would be offered from the building permit cost.[35]

7 Provide resources to increase skills development

Research determined that with an investment of $1,400 per trainee for skills development, decreases in energy intensity could be achieved in terms of electricity and fuel consumption. Electricity savings of 0.18 kWh per square foot (equivalent to 0.614 thousand Btu) could be achieved, as well as energy fuel savings of 0.71 Btu per square foot.[36] Based on the energy intensity of the average commercial building (approximately 135 MBtu per square foot),[37] the above amounts to approximately 1% reduction in energy use per building.

This policy assumes a 70% compliance rate and is incrementally implemented over a 20-year period, beginning in 2015.

8 Use capital and fiscal incentives to overcome financial risks

A tax incentive policy was modelled where, to qualify, the building must have an optimal performance that meets or exceeds the MNECB guidelines by 20%. The required improvement would rise along with the MNECB over time maintaining a 20% greater efficiency level. This policy provides a tax credit equal to the value of 7% of the capital cost of the building, credited over five years,[38] with a cap of $40 million per annum.[39] This policy, which excludes the Government sector, is implemented starting in 2015.

The policy assumes that an investment of 7% of the capital cost of the building will increase the efficiency of the existing building to 20% greater than MNECB guidelines, and that the average commercial building construction cost is equal to $188 per square foot ($2,023 per m^2).[40] Seven per cent of the average cost yields $142 per square metre. Therefore, accounting for the fact that the assumed program spending cap is $40 million per annum, 281,690 square metres of the 217,649,622 m^2 total floor area in Canada (minus the Government sector) is eligible annually.[41]

COMBINED SCENARIO

The combined scenario results from implementing the carbon price *and* complementary policies scenarios. The assumptions are consistent with the modelling work conducted for each scenario on its own. The total reduction is not equal to the combined total of the carbon price and complementary policy scenarios due to the fact that there is some overlap between them.

REGULATORY SCENARIO

The regulatory scenario was the result of modelling work conducted by J&C Nyboer with the hybrid CIMS model. The effects of the "Fast and Deep" carbon pricing scenario were assessed, including all direct combustion and its system-wide effect on relative electricity and fossil fuel prices for the commercial and institutional buildings sector, with the addition of the basic LEED® standard as a regulation for all new buildings.

The carbon pricing scenario used for the regulatory scenario (shown below) is in 2005 dollars. The prices are slightly higher than those used in the previous modelling work, as outlined below:

Fast and deep pricing path	
2011-2015	18
2016-2020	115
2021-2025	215
2026-2030	300
2031-2035	300
2036-2040	300
2041-2045	300
2046-2050	300

According to research that accompanies this scenario, without complementary regulations in Canada, an emissions pricing system would likely fail in the commercial and institutional buildings sector. Regulations that eliminate a subset of equipment choices may be justified where information or search costs are particularly high. Research has found that application of this type of regulation in certain situations can lead to net societal benefits.[42]

[1] Environment Canada (2008). *Turning the Corner: Regulatory Framework for Industrial Greenhouse Gas Emissions*. Ottawa: Government of Canada. Accessed at http://www.ec.gc.ca/doc/virage-corner/2008-03/541_eng.htm.

[2] NRTEE (2007). *Getting to 2050: Canada's Transition to a Low-emission Future*. Ottawa: NRTEE.

[3] National Research Council of Canada. Model National Energy Code for Buildings. "Updating of 1997 Model National Energy Code for Buildings of Canada." Accessed at http://www.nationalcodes.ca/mnecb/call_for_nominations_e.shtml. Note: The original MNECB was published in 1997; this will be the first update of the code.

[4] National Climate Change Process, Analysis and Modelling Group (1999). *Canada's Emissions Outlook: An Update.* pp.13–14. Accessed at http://www.nrcan.gc.ca/es/ceo/outlook.pdf.

[5] PWGSC (2007). "Sustainable Development Strategy 2007–2009," ch. 3. Accessed at http://www.tpsgc-pwgsc.gc.ca/sd-env/sds2007/strategy/sdd-sds2007-ch3-e.html. The PWGSC will, at a minimum, construct buildings that are 30% more efficient than MNECB (which equates 20% based on current practice, according to endnote 1).

[6] Fraser Basin Council; and Community Energy Association (2007). *Energy Efficiency & Buildings – A Resource for BC's Local Governments*. Fraser Basin Council: Vancouver. Accessed at http://www.fraserbasin.bc.ca/publications/documents/caee_manual_2007.pdf. For the Canadian version of LEED-NC, the energy requirements are based on either MNECB or ASHRAE 90.1-1999, with a minimum efficiency of 25% higher than MNECB for LEED® certification.

[7] Life-Cycle Economic Assessment of Energy Performance Standards Applied to British Columbia (2004). Phase II – Cost Effectiveness of Achieving CBIP in Vancouver. BC Government.

[8] The American Chemistry Council (April 16, 2003). *Analyzing the Cost of Obtaining LEED Certification*. Accessed at http://www.cleanair-coolplanet.org/for_communities/LEED_links/AnalyzingtheCostofLEED.pdf.] This report estimates the cost premium for a LEED Certified building at 4.5% to 11%.

[9] NRCan, Personal Communication with ICF (2008). It is estimated that 15-20% of buildings are not complying with the code due to lack of enforcement.

[10] NRCan, Analysis and Modelling Division (2006). *Canada's Energy Outlook: The Reference Case 2006.* Ottawa: Government of Canada.

[11] NRCan, ENERGY STAR® (Undated). "Energy Star® for Light Commercial HVAC, Fact Sheet for Building Owners and Property Managers." Accessed at http://www.energystar.gov/ia/partners/manuf_res/LCHVACFS3.pdf.

[12] NRCan, ENERGY STAR® (2008). "Light Commercial Heating & Cooling for Consumers." Accessed at http://www.energystar.gov/index.cfm?c=lchvac.pr_lchvac.

[13] New Buildings Institute, Inc. (2003). *Energy Benchmark for High Performance Buildings, version 1.0.* White Salmon, WA: NBI

[14] U.S. Department of Energy, Federal Energy Management Program (FEMP). "How to Buy an Energy-Efficient Water-Cooled Chiller." Accessed at http://www1.eere.energy.gov/femp/procurement/eep_wc_chillers.html. The average value between the chiller that just meets the ASHRAE 90.1 standard and the recommended efficiency was assumed to be the current practice.

[15] United States Environmental Protection Agency (2008). "Clean Energy Strategies for Local Government, Section 6.6 Energy-Efficient Product Procurement." Accessed at http://www.epa.gov/cleanrgy/documents/webcasts/section_6_6_procurement_2-22.pdf.

[16] Energy Information Administration (1995). *Commercial Buildings Energy Consumption Survey*. Accessed at http://www.eia.doe.gov/emeu/cbecs/. US Government.

[17] American Council for an Energy Efficient Economy (2008). "Energy-Efficient Lighting and Lighting Design." *Online Guide to Energy-Efficient Commercial Equipment*. Accessed at http://www.aceee.org/ogeece/ch2_index.htm.

[18] United States Environmental Protection Agency (2008). "Clean Energy Strategies for Local Government, Section 6.6 Energy-Efficient Product Procurement." Accessed at http://www.epa.gov/cleanrgy/documents/webcasts/section_6_6_procurement_2-22.pdf.

[19] NRCan, ENERGY STAR® (2008). Accessed at http://www.energystar.gov/index.cfm?c=home.index. ENERGY STAR products in the commercial sector are on average 30% more efficient than conventional models. On recommendation from Mike Butters, we are using 25%.

[20] NRCan, ENERGY STAR® (2005). *Guide to an Energy-Smart Office.* Ottawa: Government of Canada. Accessed at http://oee.nrcan.gc.ca/publications/equipment/m144-63-2004e.cfm. "The cost premium for all types of ENERGY STAR labelled equipment compared with conventional equipment is $0."

[21] Library of Canada, Parliament Information and Research Service (2006). “Appendix A, Common Capital Cost Allowance Classes.” *En Brief, April 3, 2006.* Accessed at http://www.parl.gc.ca/information/library/PRBpubs/prb0606-e.htm#appendixa.

[22] Alberta Innovative Manufacturing Works (2008). Accessed at http://www.manufacturinginnovation.ca.

[23] Mills, E., N. Bourassa, M. Piette, H. Friedman, T. Haasl, T. Powell, and D. Claridge (2004). “The Cost-Effectiveness of Commissioning New and Existing Commercial Buildings: Lessons from 224 Buildings.” *National Conference on Building Commissioning: May 4–6, 2005*.

[24] Building Commissioning (2008). “Commissioning Costs and Budgets”. Accessed at http://buildingcommissioning.wordpress.com/ .Values used on recommendation of NRTEE.

[25] Turner, C.. and M. Frankel (2008). *Energy Performance of LEED® for New Construction Buildings – Final Report*. Prepared for U.S. Green Building Council. p. 16. Accessed at https://www.usgbc.org/ShowFile.aspx?DocumentID=3930. This assumes that the buildings in the United States are also being built at 10% above the MNECB level. Silver would represent a 22% increase from current practice.

[26] The American Chemistry Council (2003). *Analyzing the Cost of Obtaining LEED Certification*. This report concludes that the cost premium for a LEED Certified building is between 4.5% and 11%.

[27] This calculation assumes a 25% federal, 25% provincial, and 50% municipal split in floor area.

[28] Building Owners and Management Association (BOMA), Personal Communication with ICF (2008).

[29] BOMA Toronto news. (2007). Accessed at http://www.naylornetwork.com/bto-nwl/printFriendly.asp?projID=525.

[30] NRCan, ENERGY STAR® (2005). *Guide to an Energy-Smart Office.* Ottawa: Government of Canada. Accessed at http://oee.nrcan.gc.ca/publications/equipment/m144-63-2004e.cfm. “The cost premium for all types of ENERGY STAR® labelled equipment compared with conventional equipment is $0.”

[31] It was assumed that an expedited green building permitting process would result in reduced financing costs during building planning and construction, which ultimately reduce capital costs.

[32] NRCan, Office of Energy Efficiency (2002). *Commercial and Institutional Building Energy Use Survey 2000* - Detailed Statistical Report 2002. Ottawa: Government of Canada.

[33] Statistics Canada (2007). “Value of Building Permits.” CANSIM, table (for fee) 026-0008 and Catalogue no 64-001-X. Accessed at http://www40.statcan.gc.ca/l01/cst01/manuf15a-eng.htm.

[34] City of Toronto (2008). “Toronto 2008 Building Fee Schedule,” Note: This calculation estimates the total number of meters squared of new building floor area built each year, and applies an averaged building permit cost from the City of Toronto.

[35] Goodland, H. (2007). “Builders save on City of Calgary Permits for BuiltGreen Homes.” Accessed at http://www.sustainablebuildingcentre.com/blog/helen_goodland_30.

[36] Mills, E., N. Bourassa, M. Piette, H. Friedman, T. Haasl, T. Powell, and D. Claridge (2004). “The Cost-Effectiveness of Commissioning New and Existing Commercial Buildings: Lessons from 224 Buildings.” *National Conference on Building Commissioning: May 4–6, 2005.*

[37] NRCan. Office of Energy Efficiency (2007). *Commercial and Institutional Consumption of Energy Survey* - Summary Report, June 2007. Ottawa: Government of Canada.

[38] New York State Department of Environment Conservation. (2008). “New York State Green Building Tax Credit.” Accessed at http://www.dec.ny.gov/energy/1540.html.

[39] NRTEE, Personal communication with ICF (2008).

[40] Carrik, A. (2008). *Reed Construction Data*. “Cost Increases for Four Institutional Building Categories.” Accessed at http://www.reedconstructiondata.com/news/2008/04/cost-increases-for-four-institutional-building-categories/.

[41] NRCan, Office of Energy Efficiency (2002). *Commercial and Institutional Building Energy Use Survey 2000* - Detailed Statistical Report 2002. Ottawa: Government of Canada.

[42] Moxnes, E. (2004). “Estimating customer costs or benefits of energy efficiency standards,” *Journal of Economic Psychology*, 25(6), 707–724.