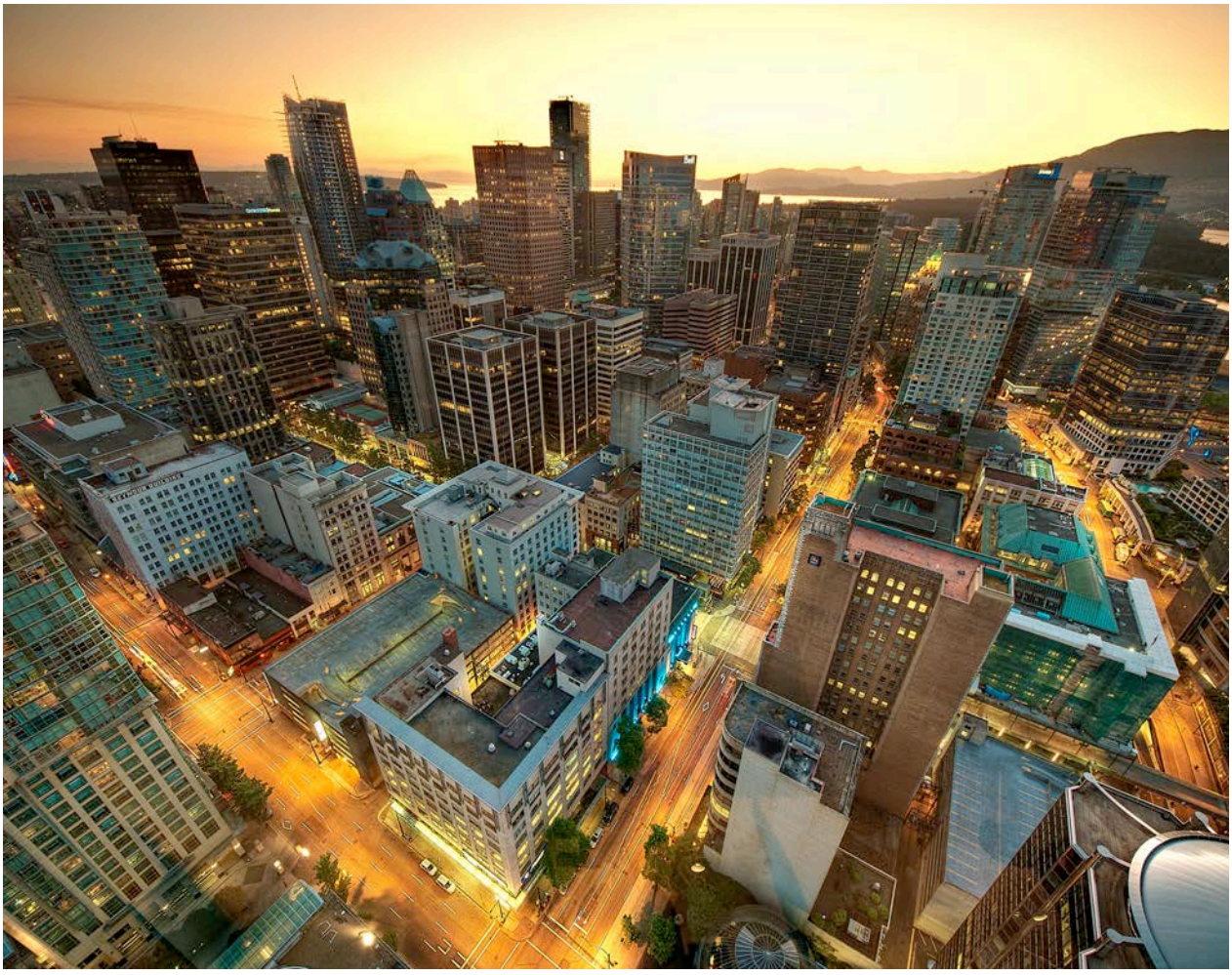
TAF

BEE-Cal

Building Energy Efficiency Policy Calculator for Municipalities

Methodology



Acknowledgments

This is the methodology document for the BEE-Cal; please see also the complementary quick start guide.

This document outlines the methodology behind the BEE-Cal (Building Energy Efficiency Policy Calculator for Municipalities) and the data references, calculation steps, and policy assumptions associated with the calculations

BEE-Cal is a project by The Atmospheric Fund (TAF) that was made possible by the generous support of the J.W. McConnell Family Foundation.

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Founded in 1991 by the City of Toronto, TAF's mission is to invest in urban low-carbon solutions to reduce greenhouse gas emissions and air pollution. To date, TAF has invested more than $50 million, helping Toronto shave more than $60 million from its energy bills, and contributed to a city-wide reduction of GHG emissions to 24% below 1990 levels.

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The Atmospheric Fund
75 Elizabeth Street
Toronto, ON M5G 1P4

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Contents

1. Data References & Methodology

This section provides users with the following information:

- Sources of data;
- Assumptions;
- Areas where data was not available and methods used to estimate these data.

All calculated values were rounded to two significant digits where appropriate.

Floor Space

- Primary source: the Office of Energy Efficiency (OEE) where possible, supplemented by the Survey of Commercial and Institutional Energy Use (SCIEU).
- Commercial floor space: the OEE combines commercial and institutional floor space. SCIEU data provided the split between commercial and institutional floor space. These ratios were applied to OEE data.
- In some instances, OEE combined various provinces and territories together OR did not include province-level data. In those cases the following assumptions were made:
    - British Columbia: floor area was taken from SCIEU because the OEE data combined B.C. with the territories.
    - Where province-level data was unavailable, estimates were made combining OEE and SCIEU sources and scaled using populations.

1.1. Emissions

- Primary source: 2016 National Inventory Report (2013 data).
- Emissions factors (EF) for various energy sources, except for electricity, were assumed to stay constant over time.
- Electricity: The EFs (i.e., CO_2, CH_4, N_2O) refer to electricity generation, not consumption. Although consumption data would have been preferred, it was only presented in CO_2eq form and does not state how transmission and distribution affect CO_2, CH_4, and N_2O consumption EFs. In many cases, consumption and generation were exceptionally similar (identical in some provinces).
- The temporal progression of each province's electricity EFs was determined based on their long-term plans. If no concrete plans were available, the EF was assumed to stay constant.
    - Ontario (ON): Ontario's Long Term Energy Plan
    - Alberta (AB): Trends in GHG Emissions in the Alberta Electricity Market
    - Quebec (QC): 2030 Energy Policy
    - Manitoba (MB): No concrete plans stated
    - Saskatchewan (SK): SaskPower Renewables Roadmap
    - Prince Edward Island (PEI): Prince Edward Island Energy Strategy
    - Newfoundland (NFLD): No concrete plans stated

- Nova Scotia (NS): Nova Scotia's Electricity Plan, 2015-2040
- Nunavut (NVT): No concrete plans stated
- Northwest Territories (NWT): No concrete plans stated
- Yukon (YK): No concrete plans stated
- British Columbia (BC): BC Hydro 2013 Integrated Resource Plan
- New Brunswick (NB): No concrete plans stated

- Error, uncertainty, and methodology associated with the EFs from the National Inventory Report (NIR) 2016: Canada used 2006 IPCC Guidelines for National Greenhouse Gas Inventories to assess emission uncertainties. The energy sector had a low error margin (± 5%).

1.2. Energy Use by Source

- Primary source: Office of Energy Efficiency
- Energy use in the BEE-Cal is not static over time. Fluctuations in energy fuel use were incorporated into the BEE-Cal using an annual change factor. The annual change factor was determined by looking at medium-term changes over the past 10 years. However, it is important to note that the change over time reflects current trends and does not factor in the possibility of major changes in energy fuel use (e.g. accelerated coal phase-out).

Unless an example/existing policy clearly indicates a specific reduction by a particular fuel source, energy reductions are distributed proportionally across the sources used.

1.3. Rates & Costs

- Primary source: actual billing data where possible at the provincial level.
- Household income and energy prices were adjusted with a 1.9% inflation rate. The inflation rate was determined by taking the median of the annual inflation rates from 1990–2015.
- If natural gas prices were not available, the following assumptions were made:
    - Atlantic Provinces: prices were based on NB.
    - YK, NWT, and NVT: prices were based on the Atlantic rate (the energy rates in the Atlantic Provinces and the Territories are often higher than other areas in Canada).
- Energy cost savings were divided proportionally among the various fuel sources based on each amount used.

1.4. Household Expenditure & Energy Poverty

- Primary source: Statistics Canada, Survey of Household Spending, 2014
- Number of households potentially experiencing energy poverty is calculated as the number of households in the program multiplied by the energy poverty prevalence rate in each province.
- YK, NWT, and NVT: Research on energy poverty in Canada has demonstrated that the prevalence of energy poverty is much higher in the north compared to the south. In the absence of specific data, the highest known energy poverty incidence rate (Atlantic Canada) was applied to the Territories.

1.5. Job Creation

- Primary Source: *Energy Efficiency: Engine of Economic Growth in Canada by Acadia Center, 2014.*
- The methodology for estimating job creation is based on the method presented in the Acadia Center report (p. 48). A job creation factor was extracted by running an analysis on the data provided in the report (p. 48).
- Job creation was calculated by multiplying the job creation factor and the expected energy savings.
- YK, NWT, and NVT: In the absence of specific data for the Territories, the average factor of the Atlantic Provinces was used.

2. Policies

A wide range of case studies across Canada and the U.S. were used to inform the policy settings and assumptions. The values incorporated into the calculator are based on a review of multiple case studies. A breakdown of these assumptions is provided below.

- **Impact Level:** within every policy, three impact levels are available to the user for each applicable building type.
- The impact level options are a representation of the following factors:
    - **Participant Compliance:** the percentage of buildings within the adoption rate that comply with the policy. Compliance rates chosen were informed by existing case studies and seek to reflect a realistic balance between participant compliance and non-compliance.
    - **Adoption Rate:** the percentage of buildings that participate in the policy. The adoption rate is applied to the entire building stock of the selected city. The adoption rates chosen were informed by existing case studies and are not recommendations; the most suitable adoption rate should be determined during the policy design process.
    - **Reduction Factor:** the percent by which relevant fuels are reduced as a result of the activities stimulated by the policy.

2.1. Financing (Local Improvement Charges)

Building Type	Impact Level	Participant Compliance	Adoption Rate	Reduction Factor	Participant Funding
Residential single detached	Low	40%	0.1%	25%	Varies. Funding amounts include only the loan amount to the participant, not the cost of program design, launch or administration. Amounts are based on existing case studies and should not be taken as recommendations.
	Medium		0.4%		
	High		0.7%		
Residential MURB[1]	Low	40%	0.05%	28%	
	Medium		0.09%		
	High		0.13%		
Commercial building	Low	40%	0.005%	35.5%	
	Medium		0.01%		
	High		0.015%		

Notes:

- The capital used in financing programs is re-paid with interest back to the loaning party. The outputs in the Participant Funding section of the calculator do not reflect

[1] *Multi-unit Residential Buildings*

this repayment or the revolving fund aspect of financing programs. As such, the Participant Funding output should be interpreted as an estimate of the capital mobilization needs for a financing program.

- Most programs provide financing to participants for a maximum of 15 years. This calculator has adopted that maximum financing term. Participants receive total financing amount up-front and pay the loan back over a 15-year period.
- Energy reductions from implementing energy efficiency measures are carried forward into future years.

2.2. Incentives

Building Type	Impact Level	Participant Compliance	Adoption Rate	Reduction Factor	Participant Funding
Residential single detached	Low	100%	15%	25%	Varies. Amounts include only the incentive paid to the participant, not program design, launch or administration costs.
	Medium			40%	
	High			55%	
Residential MURB	Low	100%	15%	25%	
	Medium			40%	
	High			55%	
Commercial building	Low	100%	15%	25%	Calculation not provided. The incentive is based on the amount of floor area that development fees were paid for.
	Medium			40%	
	High			55%	

Notes:

- All assumptions are based on the Toronto Green Standard V2 Tier 2.[2]
- Compliance is assumed to be 100% since payment of the incentive is tied to verification.

[2] *The Toronto Green Standard has two tiers: Tier 1 and Tier 2. Tier 1 is a performance requirement set by the City for new construction projects. Tier 2 is a higher, voluntary level of performance that provides an incentive to projects that meet the performance requirements.*

2.3. Home Energy Rating and Disclosure

Building Type	Impact Level	Compliance Rate	Adoption Rate	Reduction Factor	Participant Funding
Residential single detached	Low	7.5%	50%	20%	No calculation. This policy does not provide funding to participants.
	Medium	14.5%	51.7%	20%	
	High	21%	53.6%	20%	

Notes:

- The Compliance Rate refers to the number of households that undertake energy improvements as a result of the HERD policy. It does not refer to the number of households that participate in HERD.
- The Adoption Rate is the percent of annual homes sold that would participate in HERD.
- At the time the calculator was built, there was no public source for annual number of homes sold at the city level. As such, this value was determined by:
    - Using provincial sales data where available. Where sales data was not available, the provincial sales data of the most similar province was used.
        - NS: median of other Atlantic provinces
        - BC: use the ON rate
        - MB, SK: use the Alberta rate (prairies)
        - QC: use the ON rate
        - YK, NWT, NVT: use the Atlantic rate
    - A 10-year average of monthly provincial sales was captured to determine an average monthly sales percent. Annual average provincial sales = average monthly sales % * 12.
- The sales rate stays constant over time as the historical data provides no discernable pattern to model a temporal change over time.

2.4. Minimum Performance Standards for New Buildings

Building Type	Impact Level	Compliance Rate	Adoption Rate	Reduction Factor	Participant Funding
Residential single detached	Low	100%	85%	15%	No calculation. This policy does not provide funding to participants.
	Medium			17%	
	High			20%	
Residential MURB	Low	100%	85%	15%	
	Medium			17%	
	High			20%	
Commercial building	Low	100%	85%	15%	
	Medium			17%	
	High			20%	

Notes:

- The values are based on the Toronto Green Standard V2 Tier 1.[3]
- Adoption rate is based on research indicating that, in the Toronto case, 85% of new buildings are likely to achieve this level of performance. The Toronto case is used as the basis for other cities.
- Compliance rate is assumed to be 100% because this policy should be designed to require performance verification.
- The calculations apply to new floor area for a particular year only to avoid double counting and to reflect the fact that this policy applies to new buildings only.

[3] *See Footnote 2.*

2.5. Minimum Performance Standards for Existing Buildings

Building Type	Impact Level	Compliance Rate	Adoption Rate	Reduction Factor	Participant Funding
Residential single detached	Low	60–75%	5%	10%	No calculation. This policy does not provide funding to participants.
	Medium			20%	
	High			30%	
Residential MURB	Low	60–75%	5%	10%	
	Medium			20%	
	High			30%	
Commercial building	Low	60–75%	5%	10%	
	Medium			20%	
	High			30%	

Notes:

- The compliance rate scales over time to reflect increases in compliance the longer a reporting policy is in place. Compliance starts at 60% in Year 1 of the policy and increases to a maximum of 75%.
- The calculations are re-applied to the floor area of each year to accommodate for growth of a city's total floor area and the continuous addition of floor area to the "existing buildings" stock.

2.6. Reporting and Benchmarking

Building Type	Impact Level	Compliance Rate	Adoption Rate	Reduction Factor	Participant Funding
Residential MURB	Low	75-99%	85%	2%	No calculation. This policy does not provide funding to participants.
	Medium		95%		
	High		99%		
Commercial building	Low	75-99%	35%	2%	
	Medium		45%		
	High		53%		

Notes:

- A key component of this policy is the percentage of floor area separated into three common categories:
    - Small buildings: 25,000 – 49,999 sq.ft.
    - Medium buildings: 50,000 – 99,999 sq.ft.
    - Large buildings: 100,000+ sq.ft.

The adoption and compliance rates are applied to the category (above), not to the total floor area of the city.

- Due to a lack of available information with regards to floor space breakdown in many cities, the following coverage rates were applied to all cities:
    - Commercial
        - >=25,000 sqft (53% floor area)
        - >=50,000 sqft (45% floor area)
        - >=100,000 sqft (35% floor area)
    - Multi-unit residential >4 storeys
        - >=25,000 sqft (89% floor area)
        - >=50,000 sqft (82% floor area)
        - >=100,000 sqft (72% floor area)
- This policy assumes that the energy savings decrease over time as buildings become more efficient and the potential of marginal improvements decreases.
    - First 10 years: energy savings are 100%.
    - Subsequent 15 years: energy savings are reduced by 40%.

2.7. Auditing and Retro-commissioning

Building Type	Impact Level	Compliance Rate	Adoption Rate	Reduction Factor	Participant Funding
Residential MURB	Low	65-99%	85%	3.2%	No calculation. This policy does not provide funding to participants.
	Medium		95%		
	High		99%		
Commercial building	Low	65-99%	35%	3.2%	
	Medium		45%		
	High		53%		

Notes:

- Coverage rates for Low/Medium/High scenarios are multiplied by 10% to account for the 10 year frequency for each building.
- At present, there is a lack of data on the cumulative impacts of auditing and retro-commissioning. As such, the average annual improvement of 3.2% was adopted from San Francisco's program, which requires audits only.
- This policy assumes that the energy savings will decrease over time as buildings become more efficient and the potential of marginal improvement decreases.
    - First 20 years: savings are 100%.
    - Subsequent 20 years: savings are reduced by 40%.

2.8. Leading by Example

Building Type	Impact Level	Compliance Rate	Adoption Rate	Reduction Factor	Participant Funding	Goal Year
Municipal buildings	User selected	100%	100%	20%	No calculation. This policy does not provide funding to participants.	User selected

Notes:

- The calculator assumes the reduction will occur between the start of the year of the policy and the goal year. This is visualized by a consistent linear reduction towards the goal year.

Commercial provincial data from the Office of Energy Efficiency was used to inform energy use intensity (EUI) for municipal buildings.


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