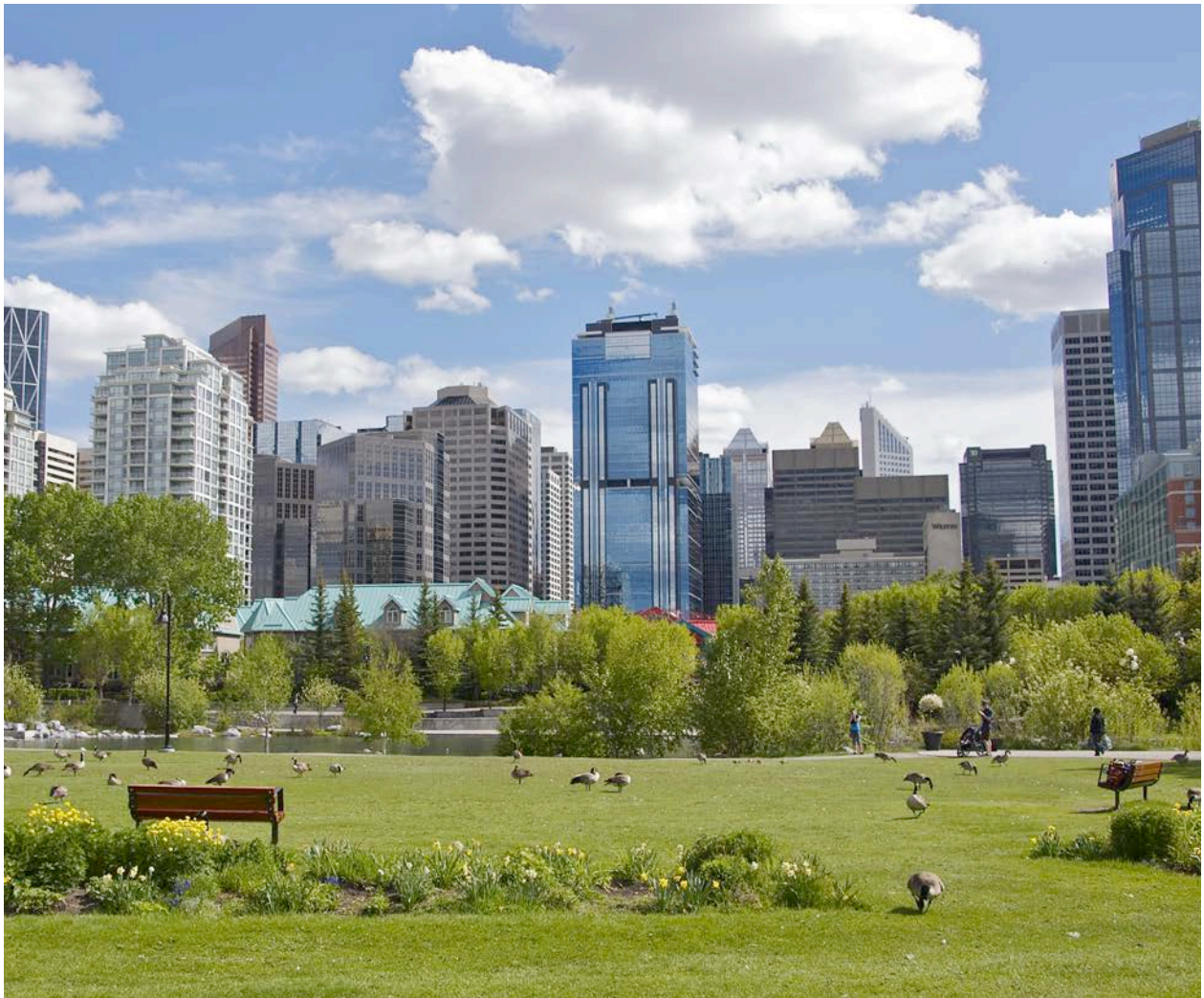




BEE-Cal

Building Energy Efficiency Policy Calculator for Municipalities

Quick Start Manual



Acknowledgments

This is the quick start manual for the BEE-Cal; please see also the [complementary methodology document](#).

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.



The Atmospheric Fund

www.taf.ca

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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1. Introduction

Improving the building stock is a major priority for Canadian municipalities because of the multiple benefits that it can bring – climate change mitigation, city renewal, economic competitiveness, resilience, etc. In recent years, some work has been done on quantifying these benefits. However, no tool existed to assist Canadian municipalities with assessing policy options to improve the energy performance of their building stock, both old and new.

The purpose of the BEE-Cal (Building Energy Efficiency Policy Calculator for Municipalities) is to provide a **preliminary analysis** of the potential local impacts of various municipal energy efficiency policy options for the building sector. The BEE-Cal estimates the potential impact on a diverse set of metrics that contribute to:

- Cost savings,
- Energy savings,
- Emissions reduction,
- Job creation, and
- Social equity.

This calculator aims to provide local policy makers with information that can initiate a dialogue around energy efficiency within their municipalities.



In summary, the BEE-Cal allows users to:

- Customize energy efficiency policies for a number of municipalities across Canada;
- Compare potential impacts of different policies or groups of policies;
- Estimate the potential benefits of energy efficiency policies – job creation, social equity, cost savings, energy savings, and emissions savings;
- Conduct a sensitivity analysis of a single policy using different impact levels, time length a policy is in effect, and building types;
- Assess whether a package of policies is sufficient to meet municipal goals or targets.

1.1. Policy Descriptions

Financing: Loans provided to building owners to reduce energy and water consumption.

This calculator analyzes the impacts of property-assessed financing, e.g. Local Improvement Charges (LICs) and Property Assessed Clean Energy (PACE). The city provides the funding required to complete the retrofit and the building owner will repay the city back through installments on their property tax bill. The cost of the installments is offset by the energy savings. The loan is tied to the property rather than the property owner, so it can be transferred to a new owner if the property is sold. Property-assessed financing is a tool being used in Toronto, Halifax, and multiple U.S. jurisdictions to finance energy efficiency and renewable energy projects.

Incentives: Provision of financial incentives (such as grants, rebates) to qualifying applicants for either retrofits or efficient new construction.

Best practice recommends that a minimum energy reduction threshold is targeted in order for the project to qualify for the incentive. As such, the calculator analyzes the impact of incentive programs that tie the payment of the incentive to performance requirements. An example of this type of incentive is the Toronto Green Standard V2 Tier 2, which refunds part of the development fees to developers that meet or exceed the energy performance requirements.

Reporting and Benchmarking: A mandatory measurement of building energy and water performance over time.

Mandatory energy reporting and benchmarking (ERB) would require building owners to report energy and water use data to the government annually. This policy also includes public disclosure of such data, although the specific level of disclosure can be determined by the regulation. Building energy use is benchmarked against other buildings to provide an understanding of performance within similar building groups and assist with identifying opportunities to reduce energy use. ERB can be implemented at the municipal or provincial levels. Examples include New York City and Ontario.

Home Energy Rating & Disclosure (HERD): The evaluation of a home's energy performance and disclosure of a performance report or rating to a prospective buyer at time of listing/sale.

HERD promotes greater energy transparency by integrating energy efficiency into market activities. HERD programs can motivate homeowners to improve their home's performance to be competitive within the housing market and achieve a higher sales price.

Minimum Performance Standards for New Buildings: Mandatory energy efficiency design standards.

The ability of municipalities to apply energy efficiency design standards that are more stringent than, or supplement, provincial building codes can vary based on provincial policies. For example, Toronto requires compliance with the Toronto Green Standard as part of site plan approval. British Columbia is in the process of introducing “Step Code” legislation that will allow all B.C. municipalities to apply for energy standards beyond provincial code requirements. This calculator bases impacts on the Toronto Green Standard¹ Tier 1, which requires new buildings to be 15% more energy efficient than required under the 2012 Ontario Building Code.

Minimum Performance Standards for Existing Buildings: Mandatory energy efficiency upgrades.



postgreenhomes.com

Cities have multiple options for requiring energy efficiency upgrades for existing buildings. For example, mandatory upgrades can be triggered by poor energy performance (where ERB is in place) and/or permit applications for renovations, additions, and reconstructions. In Canada, the City of Vancouver is the leading example of this type of policy, applying energy efficiency requirements at time of renovation. The authority to apply this type of policy may vary based on provincial legislation.

Auditing and Retrocommissioning: Municipal by-law requiring mandatory energy audits and retrocommissioning for eligible buildings (determined by building size).

An energy audit is a systematic examination of how a building and its systems use energy, to provide building owners and managers with more information about the energy performance of their buildings and identify options for improvement. Retrocommissioning is the process of identifying and implementing operational and maintenance improvements in an existing building to ensure good performance over time. Retrocommissioning is possible for buildings that may have never been properly commissioned. The calculator bases this policy's impact on best practice - that eligible buildings be required to undergo auditing and retrocommissioning once every 10 years (ex. New York City).

Leading by example: Setting an energy reduction target for all municipal buildings.

In addition to setting an energy reduction target for municipal buildings, cities should put in place a program and resources to achieve those targets in order for the impacts of this policy to be realized.

¹ 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.

1.2. Calculator Sections

The BEE-Cal includes three main sections:

1. **Introduction Tab:** Summarizes calculator and steps required to use it. The information provided in this manual is intended to be supplementary information.
2. **Calculator Tab:** Where the user inputs the city and policy details which are used to calculate the impacts. Once a particular policy is defined by the user this tab also shows the energy, financial, and social impacts.
3. **Summary Tab:** Includes a table summarizing all of the policies and user inputs as well as a series of graphs comparing the energy consumption, costs, and GHG emission reductions for each policy. A comparison against business as usual is also shown.

This calculator can be used on any **Windows** operating system. Please note that it cannot be used on a **Mac** operating system.

1.3. Providing User Feedback

Users can share their analyses with TAF! Just click 'Send TAF Your Analysis!' at the bottom of the Calculator Tab. An email will automatically be sent to TAF with screenshots of the Calculator and Summary tabs.

Please note: Once the button is clicked an automatic email will be generated and sent for users that have an Outlook email account. Users with other email accounts can still share their analyses with TAF by manually emailing their excel file to towerwise@taf.ca.

Uses of Your Data

Feedback from users will help TAF assess and improve the utility of the calculator. The specific data generated by the calculator will not be shared.

CALCULATED IMPACTS			View Graphs	Review Policy
Impact Category	Units	Total Impact		
Energy Impact				
Average annual energy reduction	GJ/year			
Cumulative energy reduction (from effective year to 2050)	GJ			
Financial Impact				
Average annual energy cost savings	CAD/year			
Cumulative energy cost savings (from effective year to 2050)	CAD			
Social Impact				
Greenhouse Gas Emissions				
Average annual reduction in CO ₂ eq emissions	tn CO ₂ eq/year			
Cumulative reduction in CO ₂ eq emissions (from effective year to 2050)	tn CO ₂ eq			
Average annual reduction in CO ₂ emissions	tn CO ₂ /year			
Cumulative reduction in CO ₂ emissions (from effective year to 2050)	tn CO ₂			
Average annual reduction in CH ₄ emissions	tn CH ₄ /year			
Cumulative reduction in CH ₄ emissions (from effective year to 2050)	tn CH ₄			
Average annual reduction in N ₂ O emissions	tn N ₂ O/year			
Cumulative reduction in N ₂ O emissions (from effective year to 2050)	tn N ₂ O			
Job Creation				
Average annual job creation	job years/year			
Cumulative job creation	job years			
Energy Poverty				
Annual number of energy poor households in program	average			
Average reduction in household expenditure from energy savings	% reduction in household expenditure			
Funding Requirements				
Average annual program cost per participant	CAD/year			
Cumulative program funding requirement for participants	CAD			

FIGURES

View Graphs

Send TAF Your Analysis!

2. Using the Calculator - FAQ

2.1. How do I calculate the impacts of a policy based on an Existing City?

In the [Calculator Tab](#), use the drop-down list to define a particular scenario:

- **Input #1 - Province/Territory** where the policy will be implemented.
- **Input #2 - City** where the policy will be implemented. The calculator will automatically pull the necessary city-level data to calculate the impacts. If your city is not on the list OR you have accurate data, go to Section 2.2.
- **Input #3 - Type of Policy** you are interested in testing. There are a total of eight policies that can be tested (refer to Section 1.1 in this manual for a description of each policy). The [Policy Descriptions Button](#) in the [Calculator Tab](#) also provides information on all policies.
- **Input #4 - Building Type** this policy is intended to target. Types include commercial, single family residential, multi-unit residential over four storeys, and municipal. Not all policies can be applied to a particular building type. For example, if you choose the *Leading by Example* policy, the only available building type is municipal buildings.
- **Input #5 - Year** the policy will come into effect. An implementation year between 2017 and 2049 can be selected; however, choosing a year close to 2050 will result in a small improvement over the business-as-usual scenario.
- **Input #6 - Impact level** choices are 'low', 'medium', and 'high'. Once the type of policy is selected from the drop-down list, you can click on the [Impact Level Description Button](#) to see how the different impact levels associated with your chosen policy are defined. Note that there is no impact level available for the *Leading by Example* policy. Instead, you will be prompted to enter a reduction target, total municipal floor area in your city, and year to achieve reductions by once you click on the [Calculate and Add Policy Impact Button](#).

Since you selected "Leading by Example" as the policy of interest, you will need to enter some details about your policy plan.

1. Energy reduction target for city-owned buildings.

Please express your reduction target as a decimal value between 0 and 80%.

For example, if you want to reduce building energy consumption by 20%, enter "0.2" below.

2. The energy reduction target year.

Please enter the four digit year between 2018 and 2050 that you would like to achieve your reductions by. Your target year should be later than your implementation year.

For example, if you would like to achieve a 20% energy reduction in municipal buildings by 2035, please enter "2035" below.

3. The total municipal floor area in your city.

Please enter the total municipal floor area of your city in square meters, using numeric digits only.

For example, if you wish to enter 12,000 square meters, enter "12000" below.

Leading by Example data entry form - appears once user selects the [Calculate and Add Policy Impact Button](#).

If you need more information about a particular input, you can hover over the orange triangles which activate dialogue boxes. To calculate the results, click on the **Calculate and Add Policy Impact Button**. Calculation results can be viewed in the **Calculator Tab** and the **Summary Tab**. If you want to clear all calculations, press the **Start Over Button**.

2.2. How do I calculate the impacts of a policy based on a User-Defined City?

In the **Calculator Tab**, use the drop-down list to define a particular scenario:

- Input #1 - **Province/Territory** where the policy will be implemented.
- Input #2 - **City** where the policy will be implemented - choose **Other**. You will be prompted to enter your City's information at a later step. You can also choose this option if you believe you have more up-to-date information on your city.
- Input #3 - **Type of Policy** you are interested in testing. There are a total of eight policies that can be tested (refer to Section 1.1 in this manual for a description of each policy). The **Policy Descriptions Button** in the **Calculator Tab** also provides information on all policies.
- Input #4 - **Building Type** this policy is intended to target. Types include commercial, single family residential, multi-unit residential over four storeys, and municipal. Not all policies can be applied to a particular building type. For example, if you choose the *Leading by Example* policy, the only available building type is municipal buildings.
- Input #5 - **Year** the policy will come into effect. An implementation year between 2017 and 2049 can be selected; however, choosing a year close to 2050 will result in a small improvement over the business-as-usual scenario.
- Input #6 - **Impact level** choices are 'low', 'medium', and 'high'. Once the type of policy is selected from the drop-down list, you can click on the **Impact Level Description Button** to see how the different impact levels associated with your chosen policy are defined. Note that there is no impact level available for the *Leading by Example* policy. Instead, you will be prompted to enter a reduction target, total municipal floor area in your city, and year to achieve reductions by once you click on the **Calculate and Add Policy Impact Button**.

If you need more information about a particular input, you can hover over the orange triangles which activate dialogue boxes. To calculate the results, click on the **Calculate and Add Policy Impact Button**. Calculation results can be viewed in the **Calculator Tab** and the **Summary Tab**. If you want to clear everything, press the **Start Over Button**.

Before the calculations begin, a new window will appear where you populate your city-specific data. This includes **the city name, population, and building-related information** for each type of building you intend to analyse. For example, if you are focusing single family dwellings, you do not need to enter data for commercial or multi-unit dwellings. Once you are finished, press the **Submit and Close Button** at the bottom of the entry data form to automatically start the calculations.

2.3. How do I assess multiple policies?

This calculator can analyze multiple policies, provided they are applied to the same city.

- Follow the instructions in Section 2.1 (calculations based on existing City) or Section 2.2 (calculations based on User-Defined City).
- Once you have entered your first policy and calculated the results, you can go back to the [Calculator Tab](#) to enter additional policies. Inputs #3 (**Type of Policy**), #4 (**Building Type**), #5 (**Year**), #6 (**Impact level**) can be re-populated.

Press the **Calculate and Add Policy Impact Button** to run a new iteration. A new column will appear in the impacts table for every new policy that is entered. The **Total Impacts** column will now contain the *combined* benefits of all the policies that have been entered. The information in the [Summary Tab](#) will be automatically updated as well.

CALCULATED IMPACTS			View Graphs	Review Policy Selections
Impact Category	Units	Total Impact		
Energy Impact				
Average annual energy reduction	GJ/year			
Cumulative energy reduction (from effective year to 2050)	GJ			
Financial Impact				
Average annual energy cost savings	CAD/year			
Cumulative energy cost savings (from effective year to 2050)	CAD			
Social Impact				
Greenhouse Gas Emissions				
Average annual reduction in CO ₂ eq emissions	tn CO ₂ eq/year			
Cumulative reduction in CO ₂ eq emissions (from effective year to 2050)	tn CO ₂ eq			
Average annual reduction in CO ₂ emissions	tn CO ₂ /year			
Cumulative reduction in CO ₂ emissions (from effective year to 2050)	tn CO ₂			
Average annual reduction in CH ₄ emissions	tn CH ₄ /year			
Cumulative reduction in CH ₄ emissions (from effective year to 2050)	tn CH ₄			
Average annual reduction in N ₂ O emissions	tn N ₂ O/year			
Cumulative reduction in N ₂ O emissions (from effective year to 2050)	tn N ₂ O			
Job Creation				
Average annual job creation	job years/year			
Cumulative job creation	job years			
Energy Poverty				
Annual number of energy poor households in program	average			
Average reduction in household expenditure from energy savings	% reduction in household expenditure			
Funding Requirements				
Average annual program cost per participant	CAD/year			
Cumulative program funding requirement for participants	CAD			

A new column will appear here for every new policy that is entered.

Calculator Tab - Impacts summary table.

The **Review Policy Button** in the [Calculator Tab](#) will take you to the [Summary Tab](#). When testing a number of different policies, the summary table will keep a history of all iterations and specific inputs. After each calculation, the graphs will be automatically updated showing individual and cumulative effects.

2.4. How do I conduct a sensitivity analysis on the same policy?

This calculator allows users to undertake a sensitivity analysis of a particular policy.

- Follow the instructions in Section 2.1 (calculations based on existing City) or Section 2.2 (calculations based on User-Defined City).
- Once you have entered your first policy and calculated the results, you can go back to the [Calculator Tab](#) to vary the Input #4 (**Building Type**), #5 (**Year**), #6 (**Impact level**) parameters.

Press the **Calculate and Add Policy Impact Button** to run a new iteration. A new column will appear in the impacts table for every policy variation that is entered. Users can refer to the [Calculator Tab](#) and [Summary Tab](#) to see how sensitive the savings are to a variety of policy parameters.

CALCULATED IMPACTS			View Graphs	Review Policy Selections
Impact Category	Units	Total Impact		
Energy Impact				
Average annual energy reduction	GJ/year			
Cumulative energy reduction (from effective year to 2050)	GJ			
Financial Impact				
Average annual energy cost savings	CAD/year			
Cumulative energy cost savings (from effective year to 2050)	CAD			
Social Impact				
Greenhouse Gas Emissions				
Average annual reduction in CO ₂ eq emissions	tn CO ₂ eq/year			
Cumulative reduction in CO ₂ eq emissions (from effective year to 2050)	tn CO ₂ eq			
Average annual reduction in CO ₂ emissions	tn CO ₂ /year			
Cumulative reduction in CO ₂ emissions (from effective year to 2050)	tn CO ₂			
Average annual reduction in CH ₄ emissions	tn CH ₄ /year			
Cumulative reduction in CH ₄ emissions (from effective year to 2050)	tn CH ₄			
Average annual reduction in N ₂ O emissions	tn N ₂ O/year			
Cumulative reduction in N ₂ O emissions (from effective year to 2050)	tn N ₂ O			
Job Creation				
Average annual job creation	job years/year			
Cumulative job creation	job years			
Energy Poverty				
Annual number of energy poor households in program	average			
Average reduction in household expenditure from energy savings	% reduction in household expenditure			
Funding Requirements				
Average annual program cost per participant	CAD/year			
Cumulative program funding requirement for participants	CAD			

A new column will appear here for every new policy that is entered.

[Calculator Tab](#) - Impacts summary table.

When testing the sensitivity of the same policy, all cumulative calculations need to be ignored, since a particular policy will be implemented only once.

3. Interpreting the Results - FAQ

The policy calculator results are displayed across two tabs:

- **Calculator Tab** summarizes the energy, financial, and social impacts.
- **Summary Tab** displays the policy variables and a series of graphs comparing the potential policy impacts against the business-as-usual scenario. The **View Graphs Button** and **Review Policy Button** automatically take you to the **Summary Tab**.

3.1. What kind of results does the Calculator Tab provide?

Energy and Financial Impacts are expressed as *average annual* reductions/savings and *cumulative* reductions/savings which are based on the time span the policy is in effect (i.e. from user specified implementation year to 2050).

Social Impacts are expressed in terms of emission reductions, job creation and energy poverty reductions.

- Total GHG emissions are provided as a CO₂ equivalent (in bold); a breakdown of the carbon dioxide, methane, and nitrous oxide components is also presented.
- The job creation for each policy is calculated based on multiplying a job creation factor² and expected energy savings. The jobs created are a result of recycling the energy savings in other sectors, not the jobs created from retrofit activity itself.
- Energy poverty occurs when a particular household spends more than 10% of their total expenditure on energy.³ By reducing energy expenditures, households can be brought above the energy poverty line. The policy calculator shows the average number of households in the program that are likely experiencing energy poverty and the reduction in energy spending as a proportion of total household expenditure. The higher the reduction in energy spending, the greater the positive social impact.



Buildings and Health: There's a connection!

Some building energy improvements can result in additional benefits like enhanced occupant comfort, improved indoor air quality, and reduced incidence of moisture problems.

Pollutant reductions stemming from using less energy can also decrease the incidence of mild and severe health conditions, with improvements in acute cases occurring in a matter of days and improvements in chronic conditions occurring over decades.

² Acadia Center. March 2014. *Energy Efficiency: Engine of Economic Growth in Canada*.

³ International Energy Agency. 2014. *Capturing the Multiple Benefits of Energy Efficiency*.

Funding Requirements estimate the amount of funding that should be allocated to policy participants (ex. funding allocated to participants for an incentive program). This estimate does not include operational expenses (e.g. administration, program start-up, etc.) which can vary widely depending on the city and policy design. In some cases where funding is not allocated to policy participants, a particular policy will not have a program cost. This does not mean that there is no cost to implementing the policy – those costs are simply not factored into the calculator.

Two **View Graphs Buttons** are provided in the **Calculator Tab** which take users to the **Summary Tab**. Depending on the policy analyzed, additional notes are provided under the **Policy Comments and Considerations** section.

Funding Requirements		
Average annual program cost per participant	CAD/year	
Cumulative program funding requirement for participants	CAD	

FIGURES

[View Graphs](#)

POLICY COMMENTS AND CONSIDERATIONS

Calculator Tab – Shortcut to graphs and Policy Comments section.

3.2. What kind of results does the Summary Tab provide?

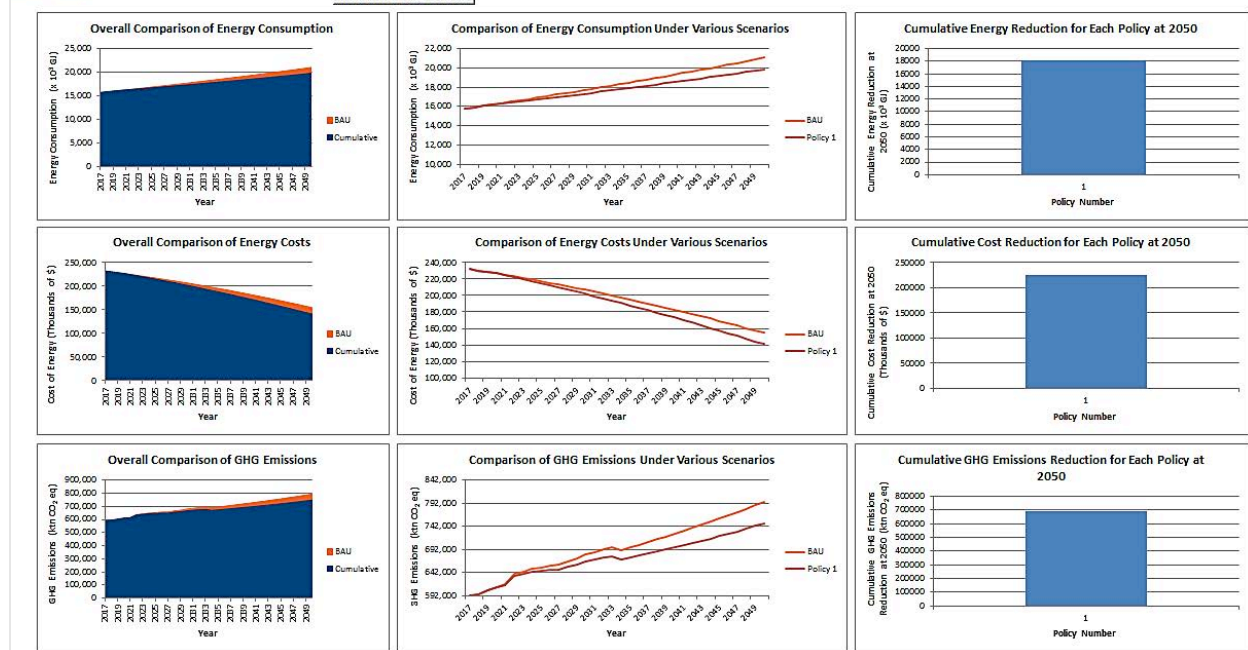
The **Summary Tab** contains all user inputs associated with a particular policy. The Summary of User Inputs table at the top of this sheet is a helpful reference when a number of different policies are tested (see Section 2.3) or when a sensitivity analysis is performed on a particular policy (see Section 2.4). This table also includes emission reductions compared to business-as-usual, expressed as a percentage. **Go Back to Calculator Button** takes users back to the **Calculator Tab**.

The **Summary Tab** also contains a series of graphs showing three types of impacts associated with a particular policy: energy consumption, energy costs and GHG emission reductions.

- The first column of graphs shows the **cumulative impacts** against the business-as-usual scenario, from the policy implementation year to 2050.
- The middle column of line-graphs shows the **performance of individual policy scenarios**. If only one policy is analyzed these graphs will display the same information as the cumulative impacts graphs in column one.
- The third column of graphs compares the **total energy reductions of individual policies**. **Help Interpreting Graphs Button** provides additional information to the user when viewing the graphs.

FIGURES

Help Interpreting Graphs



Summary Tab - Energy consumption, energy costs, and GHG emission reduction graphs.

3.3. How do I modify or delete my policy results?

Once you have clicked the **Calculate and Add Policy Impact Button**, you cannot change the results of that specific policy or delete it from the Results sections of the calculator.

If you try to modify the same policy, it will appear as a “new” policy in a new column rather than replacing the existing policy. The calculator is built this way to allow for sensitivity analyses (see Section 2.4). All calculated policies will also show up in the graphs and summary tables which cannot be edited to remove specific policies.

Users can erase all policies and subsequent calculations by using the **Start Over Button** in the **Calculator Tab**.

3.4. How do I save/export my results?

There are four options for saving results:

1. ‘Save As’ the calculator workbook as a regular excel file (not as a macro-enabled file). This will preserve all inputs and calculations, however, users will not be able to make further modifications or run any new calculations.
2. ‘Save As’ the calculator workbook as a macro-enabled file. This will preserve all of inputs and users will be able to make further modifications to their policies.
3. ‘Save As’ a PDF.
4. Screen capture the inputs and results.



4. Limitations

The limitations associated with this policy calculator are as follows:

- This calculator is intended as a first-cut of potential policy impacts to generate discourse. It does not replace the need to conduct in-depth analyses of the policies that are tested. Please use caution when interpreting the results.
- This calculator cannot be used on a Mac operating system.
- Only one city can be analyzed at any one time. Users need to start over before analyzing a different city.
- A total of 18 policy scenarios can be analyzed at any one time based on the types of policies that can be realistically implemented.
- Interactive effects of implementing a variety of policies can be either positive or negative.
- The cumulative results show everything at a net present value. A social discount factor of 0% is assumed.
- Cumulative impacts are determined by adding the impacts of individual policies. Synergies between complementary policies are not taken into account.
- Emissions factors for each province/territory were taken from the 2016 National Inventory Report which includes data from 2013 (final established year). Electrical emissions factors were determined based on each province/territory's available long-term plans. If plans were not available, emissions factors were assumed to stay constant.

