

## Information Brief: Carbon Budget and Accounting



**November 2019**

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# CARBON BUDGET AND ACCOUNTING BRIEF

\*Informed by the “Carbon Budget” document prepared for the City of Edmonton by the Sustainable Solutions Group.

## *Issue Identification*

*What is Edmonton’s carbon budget, and how can the integration of this budget and a carbon accounting process contribute to the city’s progress reducing greenhouse gas emissions?*

## *Introduction*

In 2017, [C40 Cities](#) published a report<sup>1</sup> in which they assessed the contribution of the C40 cities to the COP21 Paris Agreement’s aspirations of limiting climate change to 1.5 and 2 degrees respectively. Specific GHG emissions reduction trajectories were identified for each of the C40 cities, as well as potential actions to achieve those trajectories. Since then, the same methodology has been used to calculate carbon budgets for other cities. These city-specific carbon budgets are an effective way of communicating the urgency of the required emission reductions.

Once the urgency of the need is realized, cities need tools that allow them to incorporate GHG emissions implications into their administrative decision-making. One such tool is a carbon accounting framework. This framework allows administrators to estimate the GHG emissions associated with their projects, and to provide that information to decision-makers. This will ensure that the decision-makers are aware that approving projects that increase emissions will mean they must deduct those emissions from the city’s carbon budget.

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<sup>1</sup> C40. “deadline-2020.” C40 Cities. <https://www.c40.org/researches/deadline-2020> (accessed November 4, 2019).

As part of the update to Edmonton's Community Energy Transition Strategy [the Strategy], City Council has directed administration to:

"bring back a revised Community Energy Transition Strategy that... aligns the emissions targets and actions with the local carbon budget for City Council's approval. This is to include... implementation of a carbon accounting system for municipal operating and capital budgeting decisions and priorities."

This paper presents Edmonton's carbon budget, explains how it was calculated, and outlines how aligning the Strategy with it and implementing a carbon accounting system can contribute to the city's progress in reducing greenhouse gas emissions.

## ***Analysis***

### *History*

"Greenhouse gases" (GHGs) is the name given to a number of gases which, when released into the atmosphere, trap heat and cause the average temperature on earth to rise. As increasing quantities of greenhouse gases are released from anthropogenic sources, sinks such as forests and oceans are able to absorb some of these emissions. However due to the significant amounts of GHGs released primarily from the combustion of coal, oil and gas in recent decades, the overall concentration of these gases in the atmosphere has also increased significantly. This in turn has trapped more heat within earth's atmosphere which is causing average temperatures to rise significantly.

The figure below illustrates how dramatically atmospheric GHG concentrations have increased since coal, oil and gas became the fuels driving an increasingly industrialized world beginning in approximately 1870.

## CO<sub>2</sub> emissions by fuel type, World

Annual carbon dioxide (CO<sub>2</sub>) emissions from different fuel types, measured in tonnes per year.

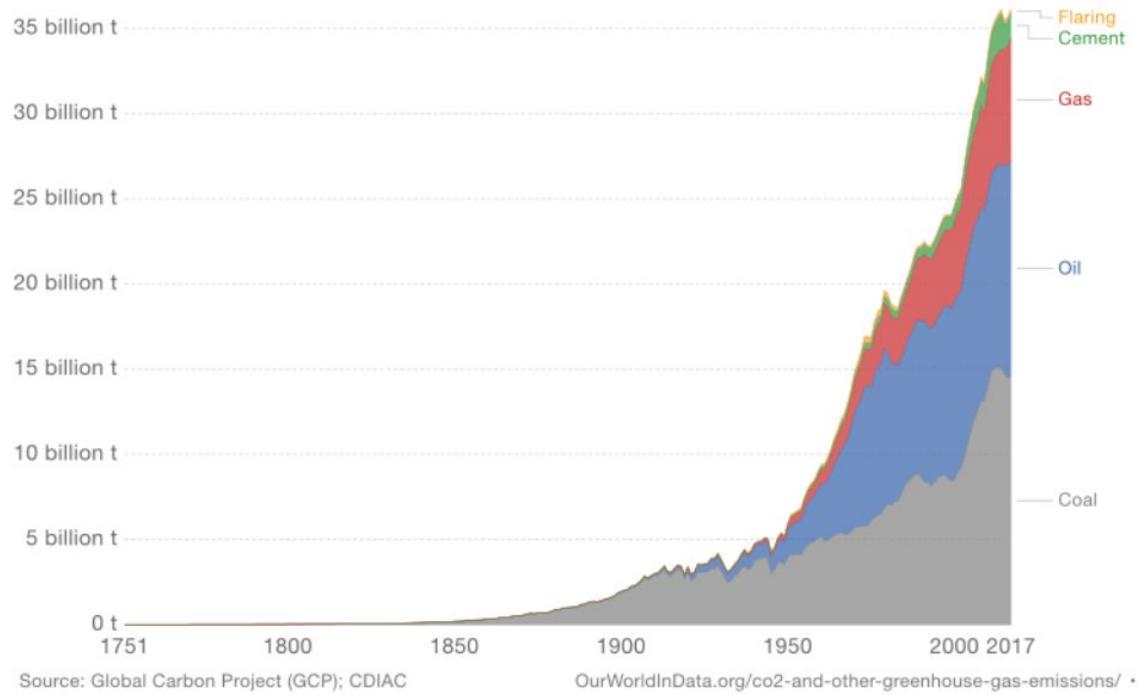


Figure 1: World-wide CO<sub>2</sub> emissions by fuel type over time<sup>2</sup>

### Global Carbon Budgets

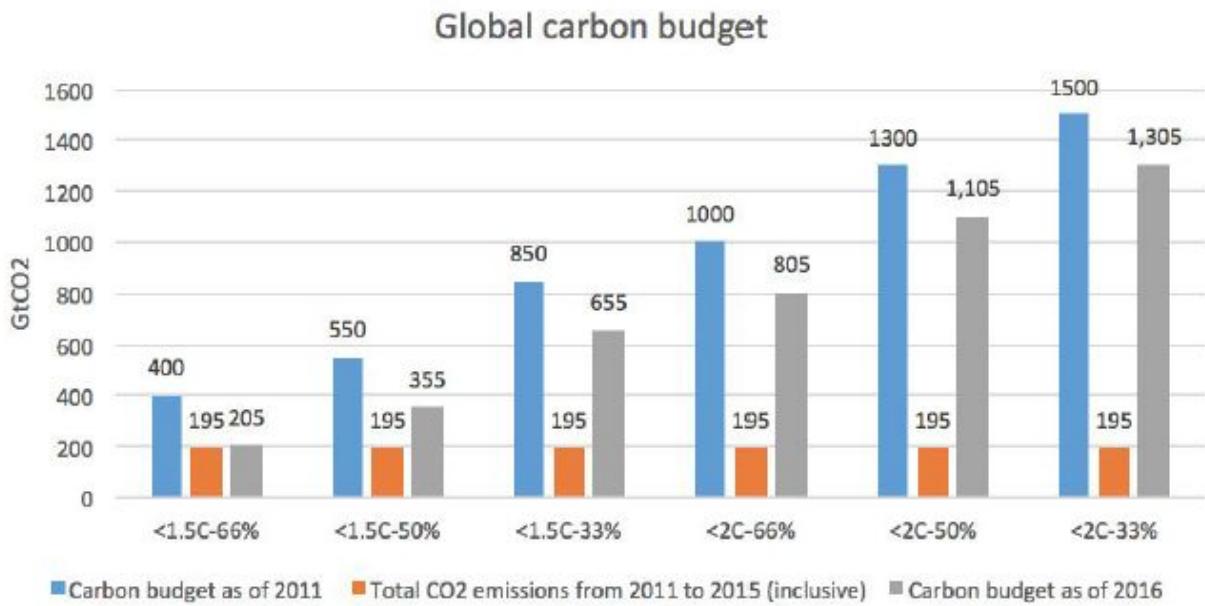
In order to prevent dangerous levels of climate change, scientists working through the Intergovernmental Panel on Climate Change have identified that humanity needs to restrict global warming due to GHG emissions to less than 2°C. They have further quantified that this translates to emitting no more than approximately 2,900 Gtonnes of GHGs. This is effectively the earth's total global <2°C carbon budget. Between 1870 and 2011, it is estimated that humanity emitted about 1,900 Gtonnes of GHGs, leaving the world a remaining budget of approximately 1,000 Gtonnes from 2011 on.<sup>3</sup> Restricting temperature increase to a maximum of 1.5°C results in an even smaller global budget of 400 Gtonnes.<sup>4</sup>

<sup>2</sup> Ritchie, Hannah and Roser, Max. *CO<sub>2</sub> and Greenhouse Gas Emissions*. Our World in Data.

<https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions#co2-emissions-by-fuel>. Accessed November 4, 2019.

<sup>3</sup> Allen, M. R., Barros, V. R., Broome, J., Cramer, W., Christ, R., Church, J. A., ... & Edenhofer, O. (2014). IPCC fifth assessment synthesis report-climate change 2014 synthesis report.

<sup>4</sup> Carbon Brief. "Analysis: Only five years left before 1.5C carbon budget is blown. Retrieved from: <https://www.carbonbrief.org/analysis-only-five-years-left-before-one-point-five-c-budget-is-blown>



*Figure 2: Global carbon budgets for different temperature limits and degrees of certainty.*

### C40 Cities Approach to Creating City Carbon Budgets

C40 Cities used a three step approach to identify carbon budgets for its member cities:

1. Determine the global carbon budgets for safe levels of warming of below 1.5 and 2 degrees as of 2016.

C40 Cities used the global carbon budgets with a 66% chance of limiting global temperature rises to 1.5 and 2 degrees respectively. Data from IPCC was used to estimate that these global carbon budgets were 387 and 1,037 Gtonnes of CO<sub>2</sub>e respectively.

2. Identify an approach to allocate a fair portion of this budget to the C40 cities.

Allocating a portion of the global carbon budgets to the C40 Cities was based on an approach called “Convergence and Contraction”. This was considered a fair approach because it takes into account responsibility, capacity and equality.

Using Convergence and Contraction, cities were assigned to one of four groups depending on whether they have high or low emissions, and high or low GDP. Those with high emissions and high GDP are required to reduce their emissions fastest while cities with low emissions and low GDP are permitted to increase their emissions slightly before ultimately reducing them. All cities are required to converge on a per capita emissions rate of 3.2 tonnes per person by 2030, and then to decrease until 2050 when the per capita emissions rate for all cities would need to reach 0 tonnes per person.

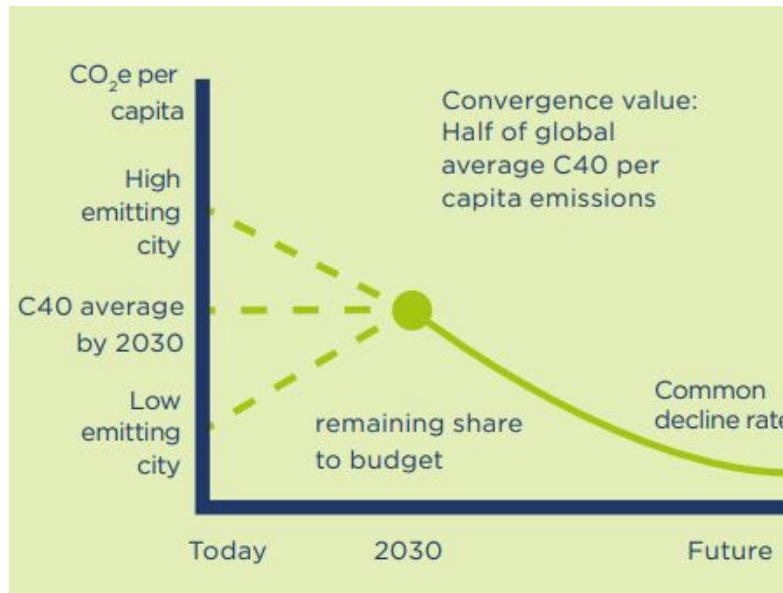


Figure 3: Emissions Reduction Trajectories using Convergence and Contraction<sup>5</sup>

A carbon budget was then calculated for each C40 city using the following formula:

- Multiply the city's forecast 2030 population by 3.2 tonnes to determine the city's maximum, total GHG emissions in 2030.
- Document the city's maximum, total GHG emissions in 2050 as 0.
- Document the city's actual, total GHG emissions in 2016.
- Place the values for all three of these dates on a graph where the X-axis represents time and the Y-axis represents the city's total GHG emissions.
- Connect the 2016 total emissions point to the 2030 total emissions point using a curve. Do the same to connect the 2030 to the 2050 total emissions point.
- Calculate the area under the resulting line. This is the city's carbon budget from 2016 to 2050. (Note that all cities must continue to emit 0 greenhouse gases after 2050.)

3. Calculate the total C40 carbon budget using the approach in step 2 and compare it to the global carbon budget identified in step 1 to ensure that it is realistic relative to current patterns.

The process described above resulted in the C40 Cities being granted a total of 22 Gtonnes of CO<sub>2</sub>e (or 6% of the remaining global budget). In 2016, the C40 Cities emitted a total of 2.4 Gtonnes of CO<sub>2</sub>e, or 5% of the total global emissions (47 Gtonnes of CO<sub>2</sub>e) for that year.

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<sup>5</sup> Deadline 2020. *Deadline 2020 - How cities will get the job done*. C40 Cities. <http://www.c40.org/researches/deadline-2020>. Accessed November 4, 2019.

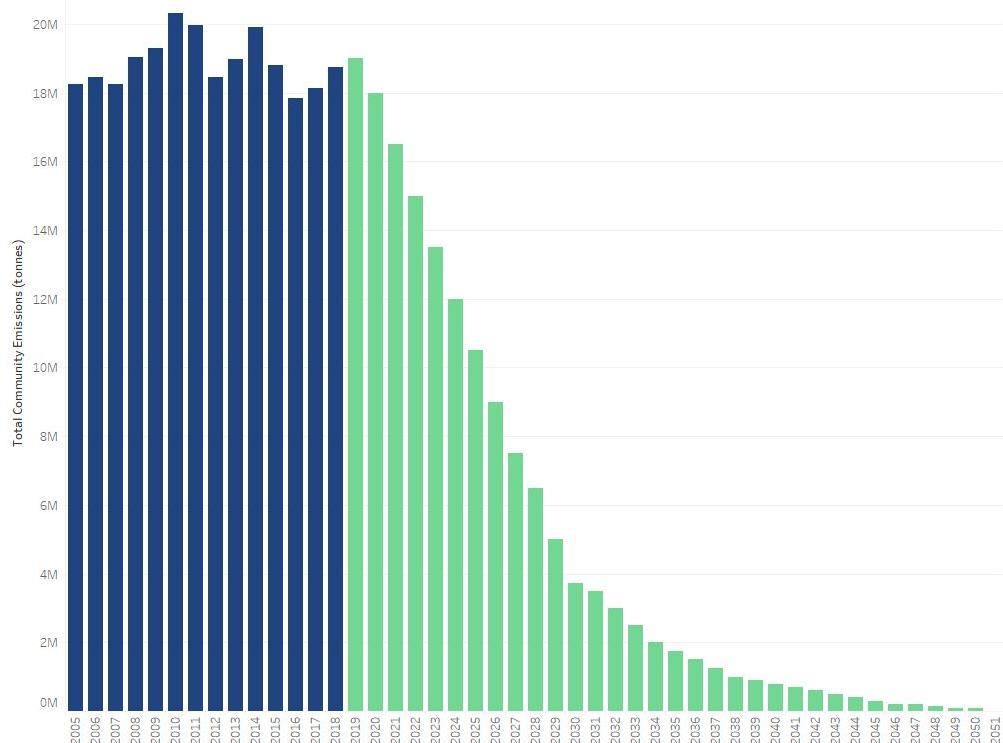
These proportions are similar, suggesting that assigning this portion of the total remaining global carbon budget to C40 cities will not be unreasonable.

### *Edmonton's Carbon Budget*

A carbon budget for Edmonton was developed using a similar approach to that used for the C40 Cities. Employing a 1.5°C global budget with 50% probability, the 2030 target of 3.2 tonnes per person and the 2050 target of 0 tonnes per person, a logistic function was used to extrapolate per capita GHG emissions for the period between 2019 and 2030, and the period 2031 to the end of 2050. Future population projections were then multiplied against the per capita GHG emissions factor to generate total GHG emissions year over year.<sup>6</sup>

The resulting trajectory indicates that the total carbon budget between the beginning of 2019 and the end of 2050 for the City of Edmonton is 155 Mtonnes. This means that for Edmonton to align with the Paris Accord and with the Edmonton Declaration, it cannot emit more than 155 Mtonnes of emissions before 2050.

History and Required 1.5 Degree Trajectory staying w/i 1.5 Degree Carbon Budget



*Figure 4: The City of Edmonton's Historical Emissions and Trajectory to stay within a 1.5°C Carbon Budget*

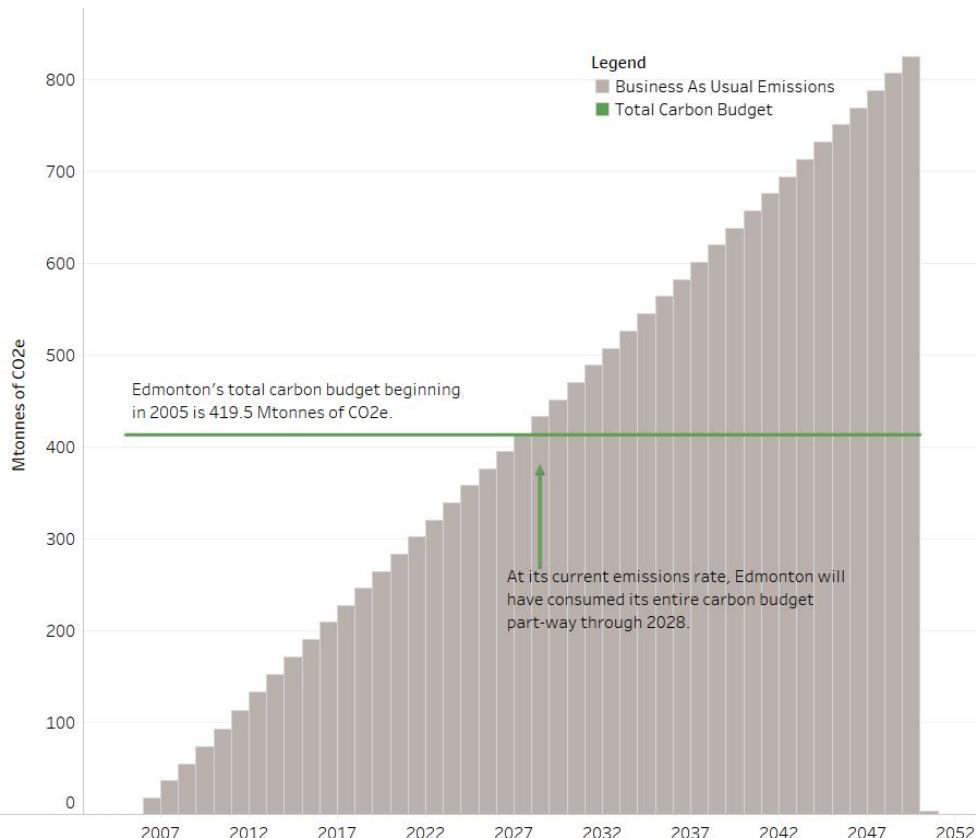
<sup>6</sup> Sustainability Solutions Group. "City of Edmonton Community Energy Transition Strategy Update: Carbon Budget". April 24, 2018.

Year	Population	Required Maximum Emissions to stay within 1.5°C Carbon Budget (tonnes CO2e)
2020	1,000,000	18,000,000
2030	1,167,000	3,734,000
2040	1,308,000	800,000
2050	1,504,800	100,000

*Table 1: Summary Required Emissions Trajectory*

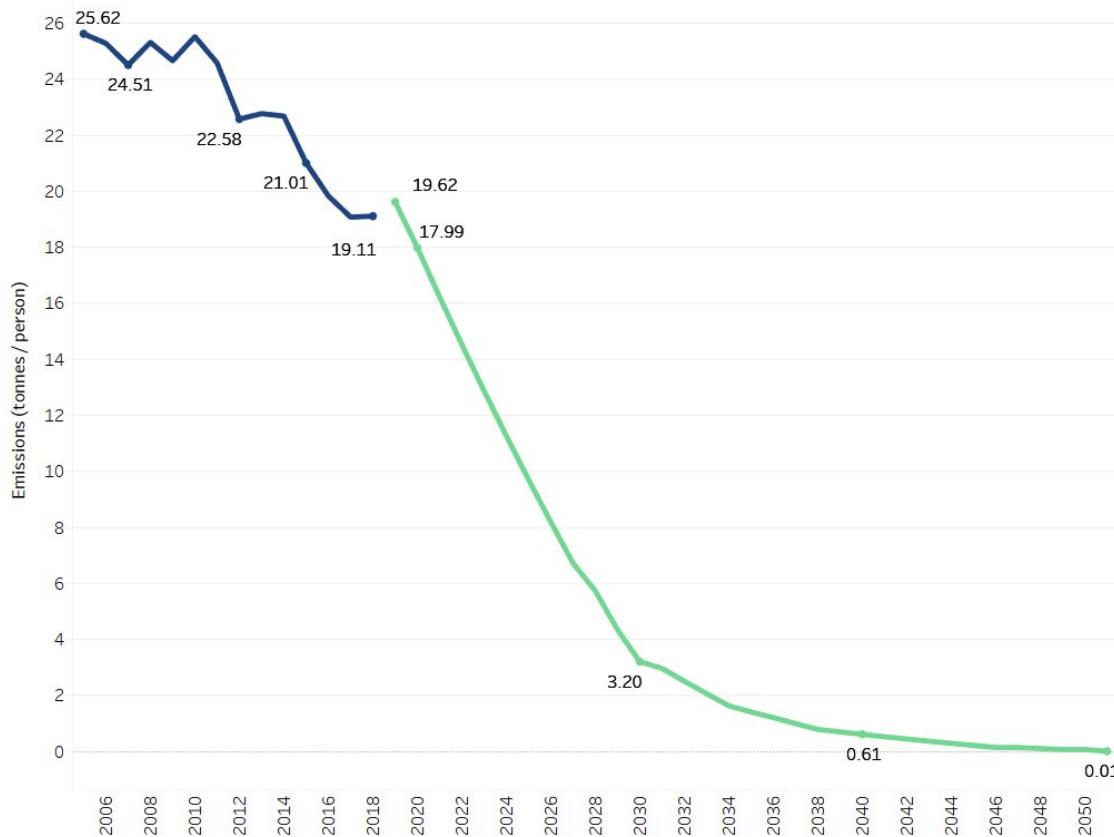
### *Analysis*

Since 2005, Edmonton's total community GHG emissions have ranged from approximately 18 to 20 Mtonnes per year, with the current trend being just slightly down. In fact, if the trajectory is projected out, the city will still be emitting more than 18 Mtonnes per year in 2050. If Edmonton continues on this trajectory, the city will exhaust its carbon budget of 155 Mtonnes in 2028.



*Figure 6: Edmonton's Historical Emissions and Trajectory*

On a per capita basis, Edmonton's historical emissions have been decreasing more notably. However, in 2018, Edmonton's emissions were 19.11 tonnes per person. To stay within its carbon budget, this will need to drop to 3.2 by 2030, and to 0 by 2050. To accomplish this, per capita emission rates need to fall faster, particularly in the next 10 years.



*Figure 6: Edmonton's Historical Per Capita Emissions and Required Trajectory to stay within a 1.5 Degree Carbon Budget*

### *Carbon Accounting Framework*

In order to reduce emissions this dramatically, the City of Edmonton needs to begin considering the implications of each of its decisions on the city's remaining carbon budget. Any project, strategy or initiative that will result in an increase in emissions - whether in the short or long-term - must be recognized as using up some of the remaining carbon budget. Those who make the decision as to whether or not a project is approved must have a clear understanding of the emission implications, much as they need to understand the financial costs of a project relative to a financial budget.

For this to be possible, city administration needs what is called a "carbon accounting framework". This is a set of tools that will provide city staff with the ability to:

- Estimate GHG emissions or reductions that will result from proposed projects, programs, initiatives or operating processes;
- Do so using consistent formulas, factors and assumptions that are aligned with international best practices; and
- Incorporate these estimates into initial proposals and ongoing status reporting, and project completion reports for projects in the city.

## ***Conclusion***

Adding a carbon budget into the City of Edmonton's greenhouse gas reduction targets is an effective way of communicating the urgent need to reduce emissions. With a carbon budget superimposed over a city's projected emissions, the impact of delaying reductions in emissions becomes very clear. This makes a carbon budget a useful tool for encouraging municipal governments, which are often more agile in deploying programs than other levels of government, to act quickly.

Edmonton's carbon budget between 2019 and 2050 is 155 Mtonnes. If the city continues to operate as it does currently, this budget will be exhausted in 2028. In order to make the reductions required to stay within this budget, a carbon accounting framework must be developed. This framework will allow administration and City Council to understand the emissions "costs" associated with any project all the way through the project's lifecycle. Based on this understanding, projects that are approved will need to have their GHG emissions entered against the carbon budget. In this way, the city should be constantly aware of how their decisions are reducing or increasing their carbon budget. This knowledge will provide city staff with the knowledge they require to ensure they become and remain aligned with the Paris Accord and the Edmonton Declaration.