The Economics of Low Carbon Development:

Calgary, Canada

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Centre for Climate Change Economics and Policy

UNIVERSITY OF CALGARY

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Calgary

The Economics of Low Carbon Development

Calgary, Canada

Today

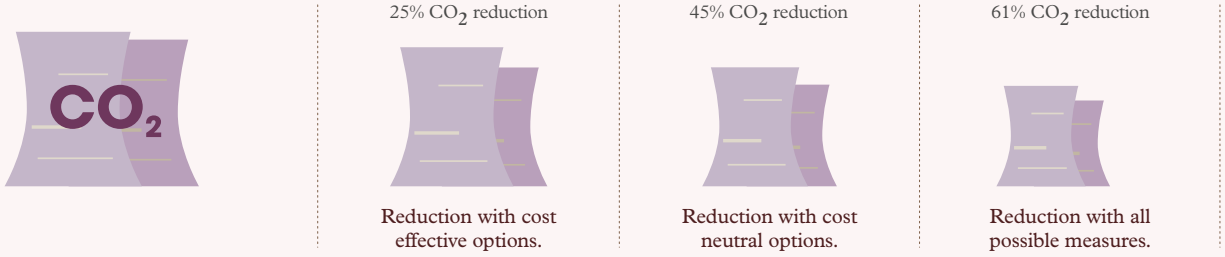
3% of Calgary's GVA goes to energy expenditure each year.

Tomorrow

0.6% of GDP could be profitably invested every year through to 2030, or approximately $1 billion CND, to exploit economically attractive low carbon opportunities.

- **Energy**
  2030 annual energy bill could be cut by $1.7 billion, or $1100 per person
- **Employment**
  more than 70,000 job-years could be generated
- **Wider economic benefits**
  more energy security, improved resource efficiency, increased competitiveness
- **Wider social benefits**
  reductions in fuel poverty, improvements in health, and mobility

Potential to reduce CO_2 emissions



Reduction with cost effective options.

Reduction with cost neutral options.

Reduction with all possible measures.

Executive Summary

The Economics of Low Carbon Development in Calgary

Calgary is a city of more than one million people, with a GDP of more than $100 billion1 a year and total annual expenditure on energy of $2.6 billion a year. As a city, Calgary is committed to significantly reduce its level of carbon emissions, with a goal of 80% reduction as compared to 2005 emissions by 2050. This report examines the economics of Calgary switching to a more energy efficient, lower carbon development path. The report provides both economic and broader evaluations on the desirability of different options and pathways capable of leading Calgary towards its goals. The evidence base generated is intended to provide policymakers, businesses, and individuals in the city with reliable, locally relevant information that can be used to make informed decisions on how best to shift toward a lower carbon development path.

This report highlights both the opportunity presented to Calgary and the challenges that need to be overcome if the opportunity is to be taken. Low carbon measures can require large investments, coordination between policymakers, businesses, and individuals, and changes to the ways in which Calgarians live and work. The analysis shows that the benefits of many actions far outweigh the costs; a low carbon future for Calgary will not just improve the global climate, but bring economic and social benefits to the lives of Calgarians.

Our Approach

Drawing on data from a wide range of sources and technical expertise at the University of Leeds and the University of Calgary, our approach is to develop a robust model of the energy use and emissions of the different sectors across the city. Taking into account planned investments and policies, including at the national and provincial levels, our focus is on the opportunity for action based on currently available technologies within the city. Our work is focused on small scale renewables and energy efficiency measures that could be adopted across the residential, commercial, transportation, waste, and industrial sectors. Our mitigation estimates are made using established emissions protocols that consider only energy-use within Calgary – including both fuels and electricity consumed. Technically, these emissions are known as 'scope 1' and 'scope 2' emissions; 'scope 3' emissions that are embedded in the goods and services that are imported into or exported from the city are excluded from our analysis.

[1] Note on the scenarios or pathways:
Cost effective: The set of all measures that generate a positive economic return
Cost neutral: The set of measures that generates the largest savings in GHG emissions while maintaining an indicated rate of return across all measures greater than zero
Technical potential: The set of measures that generates the largest savings in GHG emissions

Executive Summary

The Potential for Reducing Carbon Emissions and Generating Economic Returns

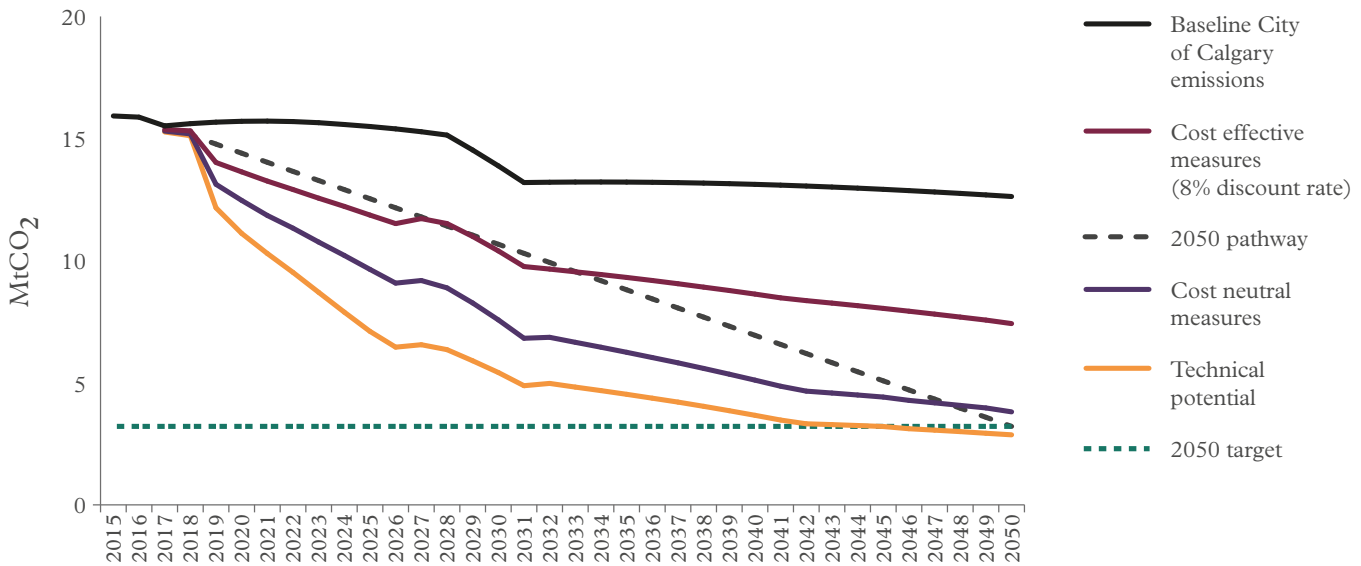
When comparing low carbon development options with business as usual trends, the results of the analysis show that Calgary could substantially reduce energy use, energy costs and emissions. As shown in Figure 1, between 2017 and 2050 we predict that Calgary could reduce its baseline emissions by:

— 41% through cost effective investments that would pay for themselves (at an 8% real interest or discount rate) quickly before providing further profits over their lifetime. This would require cumulative investment of $12.4 billion and generate average savings of up to $4.2 billion per year. Using net present values, the investment is paid back in three years.

— 70% through cost neutral investments[2] that could be adopted at no net cost to the city's economy if the benefits from cost effective measures were captured and re-invested in further low carbon measures. This would require cumulative investment of $100.4 billion, generating savings of up to $5.7 billion per year. Using net present values, the investment is paid back in 17 years with savings continuing over the lifetime of the measures still in place.

— 77% with the exploitation of all of the realistic potential of the different measures considered. This would require cumulative investment of $177 billion, generating savings of up to $7.2 billion per year. Using net present values, the investment is paid back in 24 years with savings continuing over the lifetime of the measures still in place.

Figure 1: Calgary's potential future emissions under the baseline and carbon reduction scenarios



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Impact on Energy Bills

We find that Calgary currently spends $2.6 billion on energy each year, equating to 3% of all money earned in the city. By 2030 this could rise to $6 billion and 4% of all money earned in the city through expected increases in energy prices and the growth of economic activity. Reducing carbon emissions directly translates to reduced energy use and energy bills across the city[3].

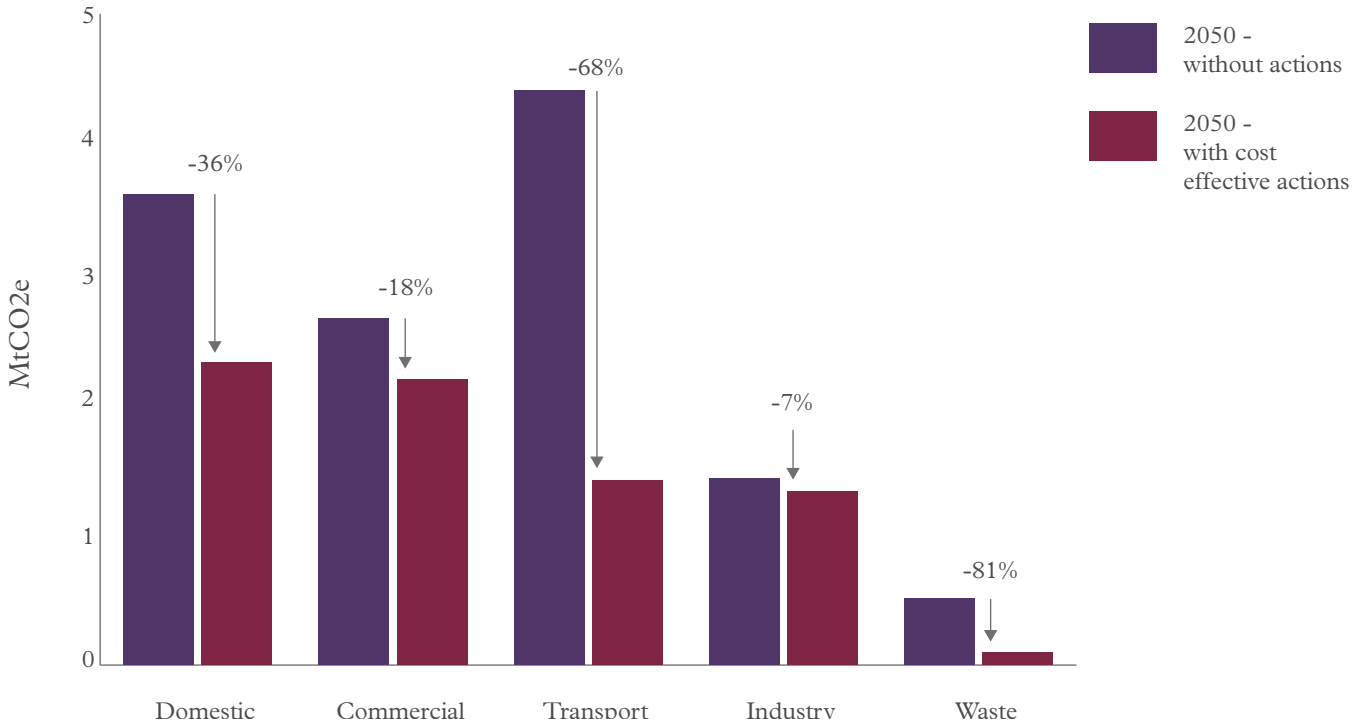
— With cumulative investment in cost effective measures of $12.4 billion through to 2050, the 2030 annual energy bill could be cut by $1.7 billion (29%), or $1100 per person per year.

— With cumulative investment in cost neutral measures of $100.4 billion through 2050, the 2030 energy bill could be cut by $2.55 billion (42%), or $1600 per person per year.

— With cumulative investment to exploit all of the realistic potential of $177 billion through 2050 the 2030 energy bill could be cut by $3.1 billion (54%), or $2100 per person per year.

Residents and businesses within the city of Calgary will therefore significantly enhance their energy security through investments in energy efficiency and low carbon options.

Figure 2: Emission reductions in 2050 by sector



[3] For a small number of actions in the waste sector, energy use increases when carbon emissions decline. Across the other sectors and actions within this report, energy use reductions lead directly to GHG emissions savings.

Executive Summary

The Most Cost and Carbon Effective Options

Targetted actions can generate substantial impacts on future carbon emissions. Table 1 shows the most carbon effective actions – those actions that save the most tonnes of emissions over their lifetime. For sectors that could adopt different levels of action, the results are presented in a range from the minimum to maximum impact. For example, replacing only heavy vehicles with electric vehicles would save 7 Mt CO2, but replacing the entire fleet of vehicles in Calgary saves 65 Mt CO2.

A number of actions reduce carbon emissions while generating net economic returns at an 8% real discount rate. Table 2 presents the top 10 actions ranked by the cost per tonne of emissions reduction. Note, negative figures (in brackets) mean that a measure incurs a negative cost – or in other words generates a positive economic return – for every tonne of carbon saved. Only measures that save more than 1Mt of CO2 are presented.

A number of measures are found in both Tables 1 and 2, indicating that they are both cost and carbon effective. These include land-use measures that result in modest increases in urban density, hybrid and electric cars, and low level retrofits across the commercial and residential sectors.

Table 1: The most carbon effective options

Rank	Sector	Subsector	Intervention (s)	Carbon savings (Mt CO2 over lifetime)
1	Residential	Single family homes (existing)	Zero Energy building, High Performance-Based Standard, Upgrade to Mid Performance-Based Standard, Upgrade to code.	11-86Mt
2	Transport	Private vehicles (light, medium and heavy)	Electric vehicles	7-65Mt
3	Residential	Single family homes (new)	Zero Energy building, High Performance-Based Standard, Upgrade to Mid Performance-Based Standard, Code plus efficient lights and appliances	22-57Mt
4	Commercial	Retail (new)	New 1 (AEDG 30), New 2 (AEDG 50)	16-26Mt
5	Transport		Biofuel (B20)	17Mt
6	Waste		Energy from waste (CHP and electricity), incineration, landfill gas utilization	13-15Mt
7	Land-use	Buildings and transportation	MDP and MDP+	7-12Mt
8	Transport		Increased parking levies	12Mt
9	Transport		Reduced car ownership	8Mt
10	Residential	Townhouses (existing)	Zero Energy building, High Performance-Based Standard, Upgrade to Mid Performance-Based Standard, Code plus efficient lights and appliances	2-22Mt

Table 2: The most cost effective options

Rank	Sector	Subsector	Intervention (s)	Cost savings ($ over lifetime)
1	Land-use		MDP and MDP+	$300-325
2	Transport	Private vehicles	Increasing parking levies	$270
3	Transport	Goods transport	Electric goods vehicles (light, medium and heavy)	$225-245
4	Transport	Private vehicles	Hybrid private vehicles	$70 to $140
5	Transport	Private vehicles	Electric private vehicles	$50-110
6	Residential	Existing apartments, townhouses and single family homes	Retrofit 1: Efficient lights and appliances	$60-80
7	Commercial	Retail/Offices/Warehouses	Shallow retrofit	$40-60
8	Residential	New apartments, townhomes, and single family homes	Code + Efficient lights and appliances	$30 to $40
9	Commercial	Existing retail	Moderate-Deep Retrofit	$20
10	Commercial	New offices	AEDG 30%-50%	$10-20

Executive Summary

Impacts on Employment

The analysis indicates that investments in low carbon actions in Calgary could generate substantial employment opportunites. Results are calculated using employment intensity multipliers that relate every $1 million of investment to a number of jobs created. For example, in the residential sector it is assumed that every $1 million in investment generates 13 job-years of employment[4].

In summary, we find that:

- More than 70,000 job-years could be generated by investment in cost-effective low carbon actions.
- Nearly 860,000 job-years could be generated by investing in cost neutral options.
- Almost 2 million job-years could be generated by investing in all of the options at their maximum potential in this report.

Conclusions

A low carbon future for Calgary can also be a prosperous future. This analysis shows that there is a strong economic case for Calgary to pursue an ambitious and cost-effective low carbon development path that is consistent with its 2050 target for decarbonisation until the early 2030s (see the cost-effective pathway in Figure 1). This would require total investments of over $12 billion and the analysis shows that in aggregate these investments would pay for themselves within three years before generating net returns of $1.7 billion per year across the city. These investments would also create 71,000 years of extra employment in the city. The opportunity for cost-effective forms of low carbon development should therefore be seen as an opportunity to secure a very significant economic benefit for the city.

A significant proportion of the investment required to enable a switch to this lower carbon development path could occur autonomously – for example where organisations or individuals invest in reducing their own energy use and carbon emissions in order to realise the associated benefits. A further proportion could be stimulated through new forms of policy such as improved building standards or requirements for decentralised energy to be integrated into new developments. More still could be realised by 'nudging' developments that would have happened anyway towards a more energy efficient and lower carbon path, and some investment could be raised from investors. Innovative ways of securing and deploying such investments – such as green bonds or revolving funds – could make this level of investment more appealing and ensure that more of the benefits of the investments are retained by actors within the city.

The results therefore demonstrate that Calgary can meet and exceed its contribution to national carbon reduction targets. At a national scale, Canada has committed to cutting emissions by 30% by 2030 from 2005 levels. Calgary can reduce its emissions by 35% below its 2005 levels by 2030 by applying only cost-effective actions, and by 53% if the returns from cost effective actions were reinvested[5]. Climate action is therefore not just an opportunity for economic, social and environmental returns, but an opportunity for Calgary to showcase itself as a leader in the low carbon economy – one of the fastest growing sectors in OECD countries.

The analysis in this report makes a case for Calgary to be a leader in the low carbon economy. It also offers some guidance on the most cost and carbon effective and publically acceptable ways of assuming this leadership position. However, it is important to emphasize that the economic lens through which much of this analysis has been conducted provides only a limited perspective on the rationale for climate action in Calgary. Clearly the case for action must be viewed in the context of a much wider set of criteria that consider the future of the city in broader terms. But the main conclusion of the report is that the shift towards a lower carbon development path for Calgary cannot be dismissed on technical or economic grounds – an economically and technologically viable transition to a low carbon Calgary is entirely possible.

[4] Employment generation numbers should be treated with a high degree of caution. While a substantial body of research in North America and Europe establishes that investments in energy efficiency and low carbon development can generate increased employment – even after considering the jobs lost in other industries from diverted investment – the impacts of many types of investments are uncertain, especially for the cost neutral and technical potential scenarios

[5] This analysis assumes that Calgary's contribution to national emissions reduction targets should be the same proportion of current emissions. In reality, land-use change in Canada is likely to significantly reduce the emissions reductions required from urban centres.

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Lima-Callao, Peru

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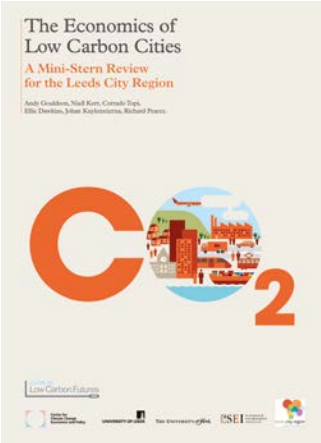
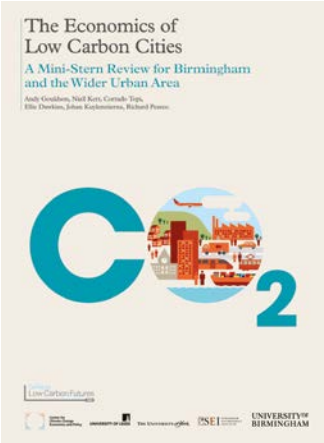
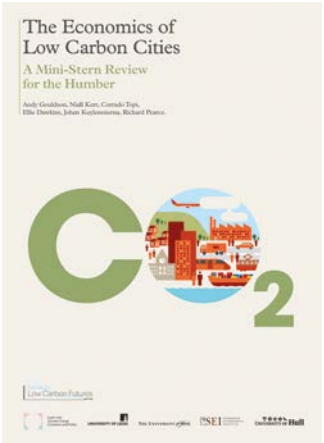


Leeds City Region



Birmingham and the Wider Urban Area



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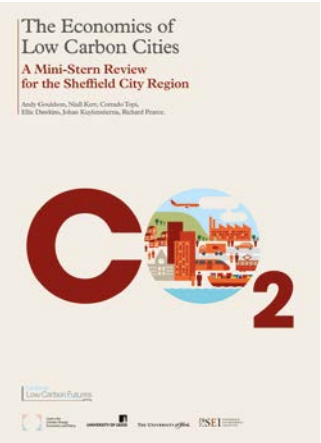

Sheffield City Region