Policy Makers or Policy Takers: How can cities contribute to reducing greenhouse gas emissions?

by

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Ethics Statement

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Abstract

This study explores the implementation of community energy policy to reduce greenhouse gas emissions in Canada. There are two components to this study. The first is a modeling exercise which uses an energy-economy model to evaluate policies in terms of their greenhouse gas emissions reductions for the city of Victoria, British Columbia. While there is significant potential for Victoria to reduce emissions and fossil fuel use in some sectors, additional policy from the federal and provincial government will be needed to drive deep emissions reductions and fuel switching. The second component is a survey directed at community energy practitioners in Canada. It explores the use of tools such as the model used in this study to help inform the implementation of community energy policy. The preliminary findings suggest that while policy makers are open to the use of analytical tools for policy evaluation, significant barriers to executing these analyses and implementing their recommendations exist at the local level.

Keywords: urban GHG policy; community energy; energy-economy model; implementation gap; Victoria, BC

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List of Acronyms

BAU	Business as Usual
BC	British Columbia
CEEI	Community Energy & Emissions Inventory
CEKAP	Community Energy Knowledge Action Partnership
CEP	Community Energy Planning
CO_2e	Carbon Dioxide Equivalents
E85	Fuel blend of 85% ethanol and 15% gasoline
EMRG	Energy and Material Research Group
EV	Electric Vehicle
GHG	Greenhouse Gas
GIS	Geographic Information System
GJ	Gigajoules
HDRD	Hydrogenation Derived Renewable Diesel
HOV	High Occupancy Vehicle
LCFS	Low carbon Fuel Standard
IPCC	Intergovernmental Panel on Climate Change
PEV	Plug-in Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
RNG	Renewable Natural Gas

Chapter 1: Introduction

Climate change is a well-established threat to our planet, with human-driven increases in greenhouse gas (GHG) emissions being the leading cause. With GHG emissions linked to human energy use, the world's most densely populated areas – cities – become an attractive focus point for GHG reduction policy. 54% of the 2015 world population was concentrated in cities, and the World Bank (2018) projects this number to grow to 66% by 2050. However, given cities' limited legislative authority and jurisdiction, they may not be the most effective policy makers for GHG reductions as their ability to implement effective emissions reduction policy faces significant challenges.

Dozens of cities around the world representing millions of people have adopted targets related to greater renewable energy use (Renewables 100 Policy Institute, 2018). However, the majority of them only have partial renewable energy goals, meaning that they plan to move to renewables in only one or two areas of energy use (e.g. electricity provision, heating and cooling, or transportation). Only a handful of cities have adopted the bold and aggressive goal of using 100% renewable energy for all energy use. Several of these cities are Canadian, and have committed to 100% renewable energy use by the year 2050.

The city of Victoria (Victoria) is one of three cities in British Columbia (BC) to have adopted the target of 100% renewable energy by 2050. Additionally, Victoria is required by the BC government to achieve GHG emissions reductions of 50% by 2030 and 80% by 2050, compared to 2007 levels. As Victoria develops its policy pathway to meeting these objectives, it will need to navigate the complex and challenging limits to its jurisdictional authority to regulate emissions-producing activities.

In this paper, I explore the challenges facing Canadian communities that are interested in pursuing ambitious energy and GHG policies. To this end, I have designed this study to comprise two related yet distinct components: a modeling exercise that evaluates the effect of various policy options for Victoria, and a survey of community energy practitioners in communities in different parts of Canada that focuses on the use of analytical tools – such as the model used in the first part – in community energy planning, and how such tools may assist policy implementation.

In Chapter 2, I provide a brief overview of the policy and legislative context for urban GHG policy in BC specifically and Canada-wide. In Chapter 3, I focus on the modeling study for Victoria. I start by briefly providing some context to Victoria's 100% renewables objective. I then describe the model and methods used, and conclude by reviewing the results and discussing their significance for Victoria's efforts to move to 100% renewable energy. I then focus on the survey for community energy practitioners in Chapter 4. I begin by briefly establishing context for the survey. I then explain the methods and provide an overview of the results, followed by some concluding thoughts on the relevance of the results for policy makers and modelers. In Chapter 5, I conclude by summarizing the findings of these two studies, commenting on their combined potential for providing insights into city-level GHG reductions efforts, and identifying opportunities for future work.

Chapter 2: Background

2.1 Climate Targets in Canada

Climate change is a classic global public good problem. GHGs are emitted to a shared global atmosphere, and actions to reduce emissions are non-exclusive in that the entire world can benefit from the actions of one or a few actors. As a result, the response to this problem is most effective if it involves a united international effort. However, decades of failure point to the challenges inherent in coordinating GHG policy between national governments on a global scale. Humanity has limited success with global governance institutions and efforts.

Canada has a dismal track record of its own when it comes to GHG policy. Although Canadian governments have made numerous commitments to reduce emissions over the past three decades, very little progress towards these goals has been made. In response, sub-national governments have shown a willingness to set their own GHG reductions targets and policies. Notably, at the provincial level, BC introduced a carbon tax years before the nationally-mandated price on carbon was announced as well as other regulations on electricity and fuel related emissions. However, none of these policies has, thus far, been strong enough to put any jurisdiction on a path to achieve deep GHG emissions reductions.

More recently, cities around the world have started to establish their own ambitious targets. Canadian cities have emerged as leaders in this area, at least in terms of aspirations, with four cities (Vancouver, Victoria, and Saanich, BC as well as Oxford County, Ontario) having pledged to achieve 100% renewable energy use by 2050 while also reducing their GHG emissions to meet comparably ambitious targets (a reduction of 80% by 2050 compared to 2007 levels, in the BC cities' cases). However, they have yet to make significant progress towards meeting these targets. The limited legislative authority of cities within a multi-level government framework raises the question as to whether cities can really be policy-makers rather than policy takers when it comes to ambitious GHG reduction. Research on policy action that is both possible and effective at the local level is needed to support these cities' ambitions to transition to 100% renewable energy use.

2.2 What Can Cities Do? Establishing Local Governments' Legislative Authority

The legal authority of local governments to enact GHG and energy policy is limited. Whereas national and provincial governments have the legal authority to regulate or price virtually all GHG emissions, local governments only have an indirect and limited ability to regulate or control activities that produce emissions. Additionally, cities' ability to regulate these activities is complicated by the scope of their authority and competing jurisdiction of more senior levels of government. More specifically, only provincial and national governments have the ability to implement multi-sectoral, price-based policies such as a carbon tax or cap-and-trade system.

Figure 1 summarizes key pieces of legislation at the federal, provincial, and local level in BC and shows how these relate to the creation of GHG emissions. As these key emissions sectors suggest, the core actions to reduce emissions in Canada will involve ways of generating electricity, heating and cooling buildings, providing energy for industrial processes, and moving people and goods without emissions. To do so, governments must implement policy that leads to actions resulting in less energy use, fuel switching to near-zero-GHG or zero-GHG forms of energy, and the capture and storage of remaining GHG emissions. To prompt these actions, policy must be compulsory and have a high level of stringency. Such policies are typically in the form of carbon pricing or regulations that govern the use of technologies and/or energy forms.

In Canada, local governments derive their power from the provinces. Provinces may choose to grant local governments any powers that they possess under the Canadian constitution. In BC, the *Local Government Act* (2015) and *Community Charter* (2003) are the key pieces of legislation delegating authority to local governments. Figure 1 demonstrates that, legislatively, local governments have some authority to create policy in buildings, transportation, and waste management. Local governments have been delegated considerable control over waste within their jurisdictions through the *Local Government Act* and the *Community Charter*. However, their jurisdiction over transportation and buildings is more constrained as all three levels of government have some influence in these areas, with specific responsibilities outlined in multiple pieces of legislation. Additionally, they do not have the ability to implement key policy instruments such as carbon pricing. So, though local governments have some ability to enforce policies in some sectors, they may not be able to enact policies that lead to the actions required to reduce emissions and switch to renewable energy.

Above all, this figure depicts a complex policy environment in which cities have limited jurisdiction to control activities that results in GHG emissions. Local governments must therefore be both creative and jurisdictionally aggressive if they are serious about achieving their ambitious energy and GHG targets, and even this may be insufficient.

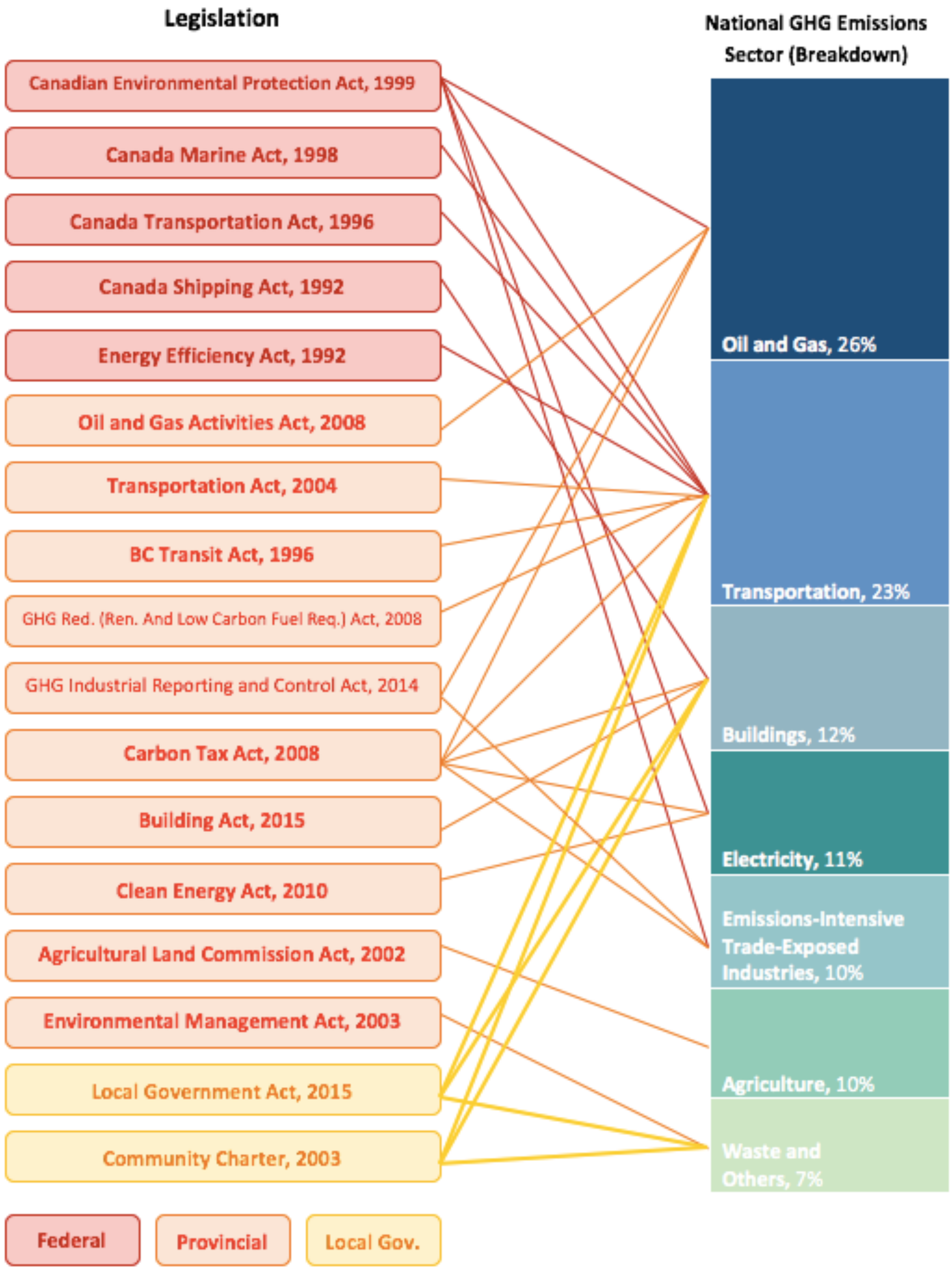

Figure 1: Key pieces of existing legislation and corresponding emissions sector

2.3 Exploring Effective GHG Reducing Policy Options

The policy and planning tools available to municipalities in Canada include land-use planning and zoning, issuing building and development permits, controlling parking access and prices, managing local roads, and public transit. These powers are exercised by cities in their typical planning and development processes. As cities such as Victoria pursue aggressive GHG reduction objectives, they will need to find ways to apply these powers in a new context to influence emission-producing activities, land-uses and energy choices of individuals, institutions and businesses.

Thus far, city-level policy discussions have often emphasized policies that might influence energy efficiency and energy demand through modified building and site designs, urban form changes, encouragement of energy efficient technologies, and a mode shift away from personal vehicles to transit and active mobility through cycling and walking (Corfee-Morlot *et al*., 2009). However, there is conflicting evidence on the ability of some of these actions to reduce GHG emissions through reduced energy use or a shift from fossil fuels to renewable energy. Some studies suggest that policy approaches such as higher density, alternative neighbourhood designs, and a greater mix of land uses can impact vehicle ownership and use, whereas other studies find the link between these actions and car use to be quite limited (Badoe & Miller, 2000). Additionally, the widely-accepted urban planning notion that rezoning for higher density land-use is a key policy pathway to less private vehicle use has been challenged by studies that suggest that densification in itself may have only a modest impact on transportation mode choice for most mobility needs (Hachem, 2016). Therefore, cities that are considering ambitious targets must better understand the likely effect of these types of policies if they are to honestly assess what policies are most likely to help them achieve significant emissions reductions and a greater uptake of renewable energy.

GHG reduction policy can be evaluated based on standard criteria, including effectiveness at achieving environmental targets, economic efficiency, political feasibility, and administrative feasibility. Often, selecting policies involves trade-offs between these criteria (Jaccard, 2006; Goulder & Parry, 2008). Specifically, policies that are non-voluntary or compulsory can be very effective in reducing emissions, but are often politically unattractive (Jaccard, 2006). Many policies that have been implemented by cities to date (e.g. incentives for energy efficiency, reliance on voluntary mode shifting) fall into the category of being politically feasible, but having little effect because of their non-compulsory nature or low stringency. At a minimum, cities will need to move beyond the politically attractive policies that have been employed to date and wield all of their legislative powers in land use planning, transportation, and buildings to enact and enforce stringent, compulsory policies that cause dramatic emissions reductions and fuel switching to renewable energy. However, they will face significant social, political, and economic barriers in doing so.

Chapter 3: Modeling Victoria's Goal of 100% Renewable Energy

3.1 Modeling Context

In August 2016, Victoria pledged to move to 100% renewable energy by 2050 and to lower emissions by 80% (compared to 2007 emissions) by the same year. It also committed to an interim target of reducing emissions 50% by 2030. This commitment to renewable energy use covers community based energy and emissions, which refers to energy use in buildings and transportation within the city's geographic limits, as well as emissions from waste generated within Victoria (City of Victoria, 2018).

For the purposes of this target, Victoria has defined renewable energy as "energy that is generated from naturally occurring processes that is replenished over a single human timescale." (p. iii, City of Victoria, 2018). Under this definition, the city includes biofuels such as renewable natural gas, ethanol, biodiesel, and wood for home heating, as well as electricity. Provincially generated and distributed electricity is at least 96% renewably-generated in BC (Province of BC, 2010), so Victoria considers the vast majority of electricity consumed in the city to be renewable with a very small proportion of electricity use considered non-renewable to correspond to these upstream sources of non-renewable energy (City of Victoria, 2018). However, Victoria does not give the same consideration to upstream energy use for the provision of biofuels. The BC Low Carbon Fuel Standard (LCFS)[1] does include a requirement that fuel suppliers achieve a marginal improvement in the lifecycle carbon intensity of all fuels (Province of BC, 2008), but

[1] The Low Carbon Fuel Standard is a flexible regulation that both BC and California apply to require the sellers of transport fuels (which includes electricity and hydrogen) to have a declining carbon intensity (through the whole chain of energy production to consumption) for the average of all energy they sell. If, in a given year, a fuel seller's average carbon intensity is less than the standard, it earns surplus credits which it can sell to those fuel sellers who fail to meet the standard. The selling price of these credits provides an implicit carbon price signal.

beyond this measure there is no requirement that the production of biofuels is achieved through the use of renewable fuels.

For this study, I adopt the same definition of renewable energy as Victoria. However, given the negligible amount of electricity that is generated from non-renewable sources in BC, I will consider electricity as a whole to be a renewable fuel. For simplicity, I will also consider biofuels to be renewable. While this definition can be problematic both in terms of tailpipe emissions and lifecycle emissions and energy use, I will include them as renewable fuels to get a sense of what role they could play in a shift to renewable energy. However, it is important to note that without policy that requires that biofuels are renewably produced with little or no lifecycle emissions, such fuels would not be truly renewable. This is due to the practice of consuming fossil fuels, usually natural gas, in biofuel production plants, as well as gasoline and diesel in farm equipment when producing the crop feedstocks that are converted into biofuels and then in transporting the biofuels to end consumers.

The most significant source of renewable energy currently used in Victoria is electricity from BC Hydro. However, electricity only accounted for about 33% of the energy used in Victoria in 2015 (City of Victoria, 2018). Fossil fuels accounted for 62%, mostly through gasoline, heating oil, and natural gas. The remaining 5% came from other renewable sources, such as renewable natural gas, biofuels, and wood for home heating.

In 2015, 51% of Victoria's end-use GHG emissions were generated from buildings, 39% from on-road transportation, and 10% from waste (City of Victoria, 2018). In the buildings sector, most of Victoria's emissions come from burning natural gas and heating oil. In transportation, gasoline and diesel account for almost all energy used. Victoria's waste is diverted to the Hartland Landfill facility, which captures and combusts over 60% of its landfill gas (City of Victoria, 2018).

In this modeling study, I evaluate the extent to which Victoria can implement policies within its jurisdictional authority that make progress towards meeting its ambitious energy and emissions targets. I explore the following research questions:

1. Can Victoria achieve its goal of transitioning to 100% renewable energy and reducing GHG emissions 80% by 2050 through municipal policies alone?
2. In which areas of energy use can these policies have the most impact in terms of GHG reductions and increased use of renewables?
3. What is the incremental effect of additional policy action that is compulsory and has a high-level of stringency by the provincial and/or federal governments compared to urban-oriented policies?

To explore these questions, I conduct an analysis of three policy scenarios using an energy-economy model to evaluate their performance in terms of GHG emissions and energy use. In the following section, I describe the model and modeling method that I use and describe the policy scenarios and assumptions. I then review the model results and conclude with a discussion of the key policy outcomes.

3.2 Modelling Methods and Assumptions

3.2.1 Modeling Overview

For this study I use a modified version of CIMS, an energy-economy model used by the Energy and Materials Research Group at Simon Fraser University. The model simulates how stocks of energy-using technologies evolve over time, making it a technology rich bottom-up model (Jaccard, 2009). It also includes several key parameters that describe consumer and business preferences with respect to technologies, technology attributes, and time in order to present a more behaviourally-realistic depiction of technology use (Jaccard, 2009). For instance, the intangible costs parameter (*i*) captures non-financial costs and benefits, such as those related to the quality of service and convenience provided by a specific technology choice. This technological richness and behavioural realism are captured through the model's market share algorithm (see Equation 1), which uses cost (*CC, MC, EC*) and behavioural (*i, v, r*) parameters to estimate the proportion of the market (*MS*) that competing technologies capture. The model produces output in five-year increments from 2005 to 2050, and uses a base year of 2000.

$$MS_j = \frac{\left[CC_j * \frac{r}{1-(1+r)^{-n_j}} + MC_j + EC_j + i_j \right]^{-v}}{\sum_{k=1}^{K} \left\{ \left[CC_k * \frac{r}{1-(1+r)^{-n_k}} + MC_k + EC_k + i_k \right]^{-v} \right\}},$$

Equation 1: CIMS market share algorithm

As CIMS has typically been used for analysis at the national or provincial scale, applying CIMS at a city-level for this analysis is exploratory at this stage. A modified version of CIMS adapted for use at the municipal-level in BC, called CIMS Community, has previously been used for city-level analyses (e.g. Baji, 2015; Moorhouse, 2014; Wollinetz & Goldberg, 2012; Zuehlke, 2017). However, as limitations in using this tool have been identified in some of these previous studies, I elected to use a version of CIMS that is modified specifically for Victoria. In the following section, I describe how I have adapted the model for this purpose.

3.2.2 CIMS Victoria

In order to perform my analysis at a city scale, I developed a modified version of CIMS for Victoria. The sectors included in the model are residential buildings, commercial buildings, personal transportation, freight transportation, and waste. These sectors correspond to the key GHG emissions sectors for Victoria. I scaled down the BC module of CIMS to reflect Victoria's stocks of technologies in each of these sectors in the base year of 2000. Table 1 summarizes the key sources I consulted to estimate Victoria's stocks for each sector in the model.

To reflect the fact that economic activity and energy use in Victoria have a very limited impact on trends at the provincial or national scale, I removed energy supply/demand and macro-economic feedbacks within the model. As Victoria's energy consumption has little to no effect on overall energy demand and energy prices, I turned off the energy supply/demand feedbacks in the model. Thus, energy prices in my simulations are set exogenously (or 'fixed') based on the National Energy Board's (NEB) *Our Energy Futures* 2016 reference case for BC using their sector-specific projections (NEB, 2016). I also turned off the macro-economic feedbacks in the model as the effects of Victoria's local-level policies on the national or provincial economy would be negligible. As a result, the full macro-economic effect of economy-wide policies modeled in this study, such as the carbon tax policy I test, is likely under-represented. However, given that this study focuses primarily on the potential impact of local-level policies, this trade-off appears to be reasonable.

Table 1: Key sources consulted to estimate technology stocks for Victoria, BC

	Residential Buildings	**Commercial Buildings**	**Personal Transportation**	**Freight Transportation**	**Waste**
BC Stats, *Sub-Provincial Population Estimates* and *Population Projections* (2018)	✓	✓	✓	✓	✓
Province of BC, *Community Energy and Emissions Inventory* (2007, 2010, 2012)	✓	✓	✓	✓	✓
Natural Resources Canada, *Canadian Energy End-Use Database* (2009)	✓	✓			
Statistics Canada, *Canadian Census* (2001, 2006, 2011, 2016) and *National Household Survey* (2011)	✓		✓		
Navius, *CIMS Community* (2012)	✓	✓	✓	✓	✓
Capital Regional District, *Hartland Landfill Reporting* (2010, 2015)					✓

I calibrated CIMS Victoria based on data from the Community Energy and Emissions Inventory (CEEI) developed by the Province of BC (2014). Emissions data for all sectors is available for 2007, and data for residential buildings, commercial buildings, and waste are available for 2007, 2010, and 2012. For these sectors, CIMS output is calibrated to within 5% of CEEI data for 2010 and within 15% for 2007 and 2012. The freight and personal transportation sectors are calibrated to within 15% of CEEI data for 2007. Overall emissions for 2007 are within 2% of total emissions calculated by the CEEI for the same year.

3.3 Modeling Scenarios

I developed three policy scenarios to model: Business as Usual (BAU), Urban Policy (Urban), and Urban Policy + Senior Government Policy (Urban + Senior). BAU represents the emissions trajectory in Victoria based on current and almost-enacted policies (the latter are policies to which governments have made a major political commitment and are in the process of implementing). The Urban Policy scenario builds on BAU policies with a range of policies across all sectors, and is intended to capture an aggressive but realistic suite of policies that can be implemented at the local level. The Urban + Senior scenario includes all policies in the Urban scenario, but also adopts a more aggressive carbon pricing policy to represent additional climate policy at the provincial and/or federal level. Each policy scenario is described in more detail in the sections below.

3.3.1 Business as Usual

This policy scenario represents Victoria's current emissions trajectory. It includes key municipal, provincial, and federal policies that are in place as well as policies that have been clearly articulated, have the potential for direct and measurable impacts on emissions, and have a publicly announced implementation date or schedule. In this section I briefly summarize some of the key policies, but this is not an exhaustive description of all policies included in BAU. The BC LCFS is included based on the implementation schedule as of February 2018. The provincial carbon tax is assumed to increase from $30/tonne of carbon dioxide equivalents (CO_2e) by $5 a year starting in 2018 until it reaches $50/tonne in 2021. It then remains constant at $50 until 2050. The provincial oil heating to air source heat pump incentive program is included. Key local policies are also included in the scenario, such as Victoria’s waste diversion strategy.

3.3.2 Urban Policy

The Urban Policy scenario is an aggressive but legally plausible package of policies that can be implemented by Victoria. The scenario is intended to be aggressive in that it includes compulsory policies at a strong level of stringency, with early implementation dates. The scenario is realistic in that the limited jurisdiction of cities to influence emissions reductions in some sectors is acknowledged in the scope and impact of the policies. Some of the policies, particularly in personal transportation, would require cooperation from other agencies (e.g. BC Transit), so this scenario is not based exclusively on policies that Victoria can enact completely independently. However, reliance on other jurisdictions and institutions is minimal and clearly articulated in the detailed policy descriptions below. Given the waste diversion policies already captured in the BAU scenario, no additional policies for the waste sector are included in the Urban Policy scenario.

Key policies in the residential buildings sector are a densification policy and adoption of the BC Step Code (explained below). The residential densification policy simulates the effect of changing zoning bylaws to require an increased proportion of higher density residential building types from 2020 to 2050. Specific policies could include changes to the type of buildings permitted (e.g. changing zoning for single-family detached homes to single-family attached or apartments) or allowing infill development such as laneway homes.

Introduced in 2017, the BC Step Code is an optional extension of the BC Building Code that allows local governments to voluntarily apply increasingly limited energy use standards for new buildings in the form of “steps.” It includes five steps, with each step representing increasing stringency in airtightness, building envelope, and amount of energy used for space heating/cooling and water heating. Step 5 is the highest tier, with the most stringent requirements in each of these categories.[2] In the Urban scenario, the BC Step Code adoption follows an aggressive implementation schedule. Steps 3, 4 and then 5 are gradually phased-in for single family detached and attached homes (Part 9 buildings). Steps 3 and 4 are required for apartment buildings (Part 3 buildings). This implementation strategy requires that all new residential buildings are regulated to the highest step possible under the current Step Code (Province of BC, 2017). The adoption schedule simulated under this policy is summarized in Table 2.

Commercial buildings are also regulated based on the adoption of the Step Code. Based on their classification as Part 3 Buildings under the BC Building Code, Step 3 is currently the highest Step that can be required for commercial buildings (Province of BC, 2017). As is the case for residential buildings, the Step Code only applies to new commercial

[2] Some advocates use the term “Net Zero” to describe the requirements for Step 5. Use of this term suggests that Step 5 could reduce space heating and cooling demand of a given building to a low enough level that this demand could be met, on an average annual basis, from on-site energy supply technologies such as solar photovoltaic electricity and/or solar thermal. However, as the Step Code is a performance-based standard with no energy supply requirements, it does not explicitly require that Step 5 buildings meet these Net Zero standards. Additionally, neither of these concepts account for post-construction changes to building or site design, or actual energy use.

buildings. The adoption schedule for commercial buildings under this policy is summarized in Table 2.

Table 2: Step Code Adoption Schedule

	2020	**2025**	**2032**
Single Family Detached, Single Family Attached	Step 3	Step 4	Step 5
Apartments	Step 3	Step 4	
Commercial Buildings	Step 2	Step 3	

Policy for personal transportation in this scenario includes upgrades to transit infrastructure, incentives for high-occupancy vehicles (HOVs), and parking restrictions. Transit policy includes the addition of a light rail line to the regional transit network after 2030. I assume that 15% of all transit travel in Victoria is by light rail starting in 2030. The implementation of this policy would require the cooperation of BC Transit, as it is responsible for public transit planning, investment and operation in Victoria. It would also likely require cooperation with other municipalities in the Capital Regional District (e.g. Saanich, Esquimalt, Langford). I also include the addition of electric trolleys to Victoria's bus system by 2030. I have assumed that a maximum of 50% of all bus travel can be replaced by electric trolleys to allow for bus routes that may not be suitable for conversion to electric trolleys (e.g. bus routes that run across municipal boundaries). The implementation of this policy would also require the cooperation of BC Transit.

Incentives for HOVs, defined as vehicles with three or more occupants, are included after 2020. Specific policy actions could include designation of lanes reserved for HOVs at peak hours and parking incentives for HOVs (e.g. preferred parking spots, lower parking costs).

A parking restriction policy is a key feature of the personal transportation policy package. Under this policy, the Victoria would gradually convert city-owned parking spots to include electric vehicle (EV) charging infrastructure access between 2020 and 2050. These spots would only be available for use by renewably-powered vehicles, including both pure electric vehicles (PEVs) and plug-in hybrid electric vehicles (PHEVs). Ethanol and ethanol-hybrid vehicles would also be allowed to use these parking spots, but would not benefit from the same improvement in fuel supply infrastructure. The share of parking spots available for each type would gradually change over time, with the number of spots reserved exclusively for PEVs increasing. This policy therefore functions as both an incentive for EVs and a disincentive for gasoline vehicles. By design, this policy would favour EVs over other types of alternative fuel vehicles such as ethanol vehicles (which can burn E85 – a mix of 15% gasoline and 85% ethanol) and hydrogen fuel-cell vehicles. Given challenges facing Victoria's ability to affect biofuel and hydrogen supply, this limitation is reasonable for this policy scenario.

Because of the trans-boundary nature of freight transportation, it is extremely challenging for cities to regulate emissions from freight. In the Urban Policy scenario, the freight policy I have included is a requirement that businesses demonstrate the use of renewably powered vehicles for their local operations (e.g. local deliveries, local transportation services) after 2030 in order to qualify for a business license. This policy would not apply to through-freight or to deliveries made by businesses located outside of Victoria. For the purposes of this modelling exercise, I have assumed that the freight vehicles impacted by such a policy would primarily be light-medium duty trucks. Furthermore, I have limited "renewably powered vehicles" to include electric, hydrogen, and plug-in hybrid vehicles. Given the challenge of verifying the type of fuel used in flexfuel motors capable of using drop-in fuels such as hydrogenation derived renewable diesel (HDRD), I have excluded all vehicles that could fall in this category. As a result, HDRD trucks are effectively excluded through this policy by design. Due to the policy focus on light-medium duty freight and exclusion of HDRD vehicles, the scope of this policy to cause fuel switching is quite limited. However, given cities' restricted power to regulate freight without assistance from policy at a more senior level of government, the policy design and stringency is appropriate for this policy scenario.

3.3.3 Urban Policy + Senior Government Policy

The Urban + Senior scenario includes all of the policies described in the Urban Policy scenario, and introduces a rising carbon price. In this scenario, the carbon price rises from $30/tonne in 2015 to $50/tonne in 2020 and $200/tone by 2030. The price then increases by $10 a year until it reaches $400/tonne in 2050. I developed this pricing scenario based on recent work that found that a carbon tax would need to be roughly in this range for Canada to meet its 2030 and 2050 GHG reduction commitments through a carbon tax (Jaccard, Hein & Vass, 2016). This scenario is intended to represent the potential effects of policy intervention by the provincial and/or federal government. While these governments may consider an alternative policy, this scenario captures the additional impact on GHG emissions from senior government policy.

3.4 Model Results and Discussion

3.4.1 Emissions Summary

Figure 2 shows Victoria's GHG emissions pathways for the BAU, Urban, and Urban + Senior policy scenarios, as well as the 2030 and 2050 emissions reductions targets. The

BAU scenario shows a slight increase in emissions by 2050 after an initial dip. The Urban scenario shows a steady decline in emissions followed by a levelling off and slight increase, leading to a decrease of 40% by 2050 (compared to 2007 levels), widely missing the 2050 target. Emissions under the Urban + Senior scenario also decline steadily before starting to level off out around 2040, narrowly missing the interim 2030 target and resulting in a decrease of 65% by 2050.

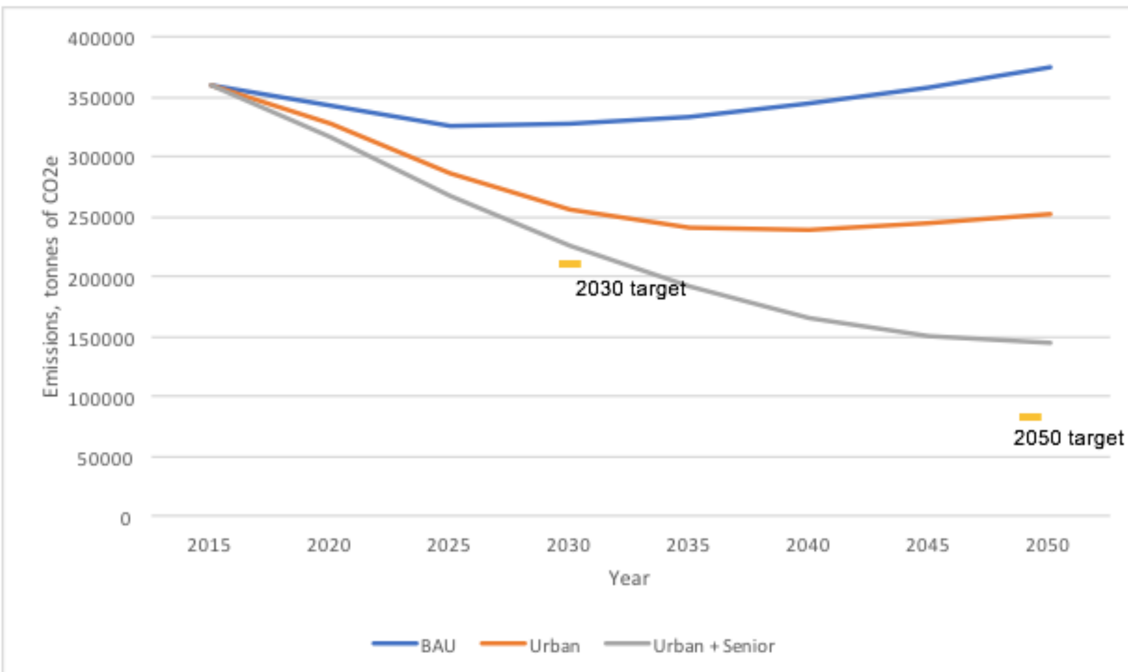

Figure 2: Victoria greenhouse gas emissions trajectories for each policy scenario

Figure 3 also depicts reductions in emissions for each scenario, as well as the level of renewable energy use for each scenario. In terms of both emissions and renewable energy, the Urban scenario results in improvements over BAU. However, Urban + Senior pushes emissions and energy closer to their respective targets. In the following sections, I explain these trends through a sectoral analysis and review of energy use for each scenario.

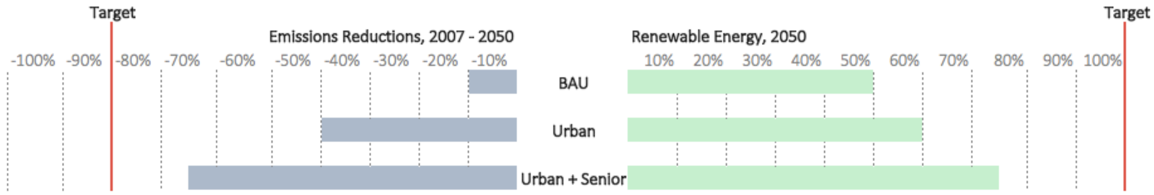

Figure 3: Victoria greenhouse gas emissions reductions and renewable energy use for each policy scenario

3.4.2 Emissions by Sector

Figure 4 shows emissions by sector for the BAU scenario. An initial decline in emissions is caused by a decline in emissions from waste, commercial buildings, and personal transportation. Emissions reductions from waste are likely due to the waste diversion strategy included in this scenario as they decline up to 2025 before gradually levelling off. Emissions from personal transportation and commercial buildings decline initially before slowly increasing. Residential buildings and freight gradually increase to 2050. Overall, these results suggest that some early policies that stop increasing in stringency in BAU (such as the waste diversion strategy, carbon tax and LCFS) drive this trend of an initial decline. These initial reductions are eventually offset by increases in population and economic activity that drive increased commercial and residential floor space, demand for personal transportation, and freight transportation.

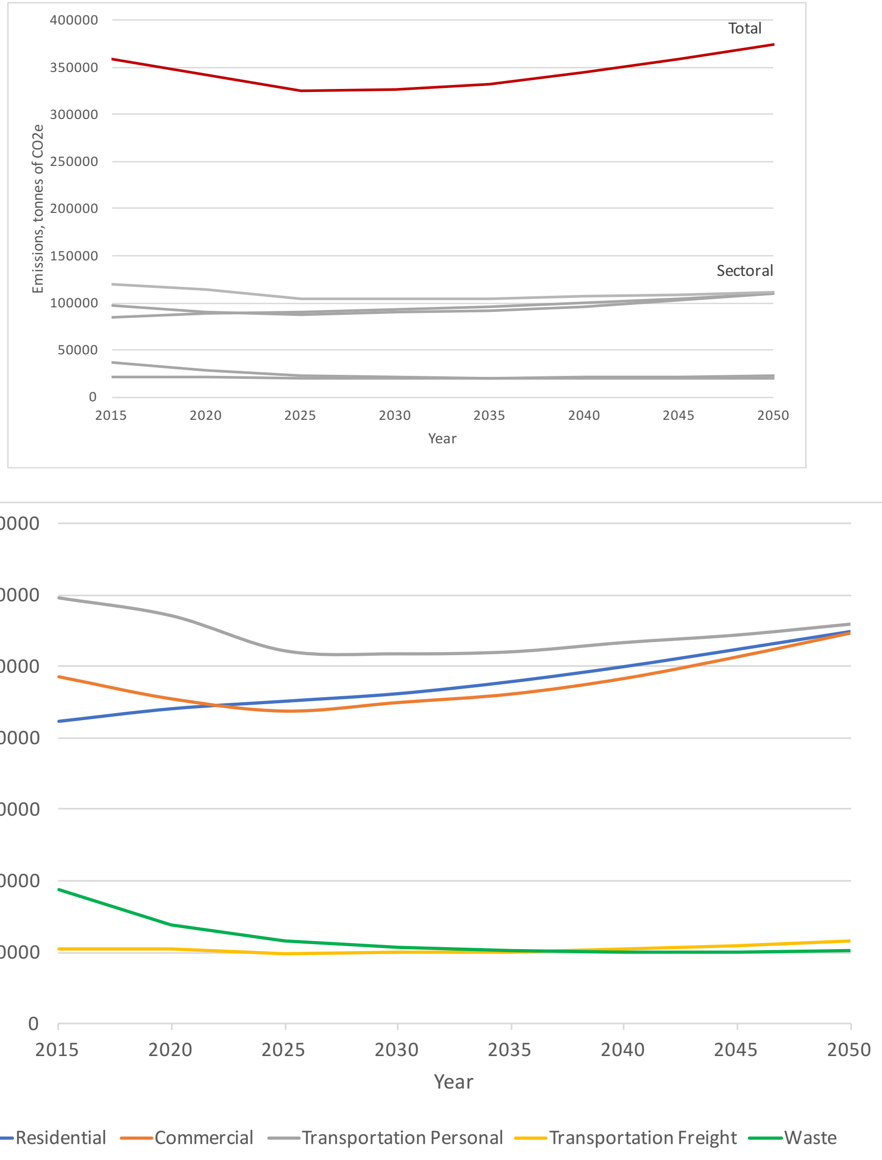

Figure 4: Victoria's greenhouse gas emissions by sector, Business as Usual scenario

In contrast, emissions under the Urban scenario decline to 2035 before leveling off and slightly increasing (Figure 5). Emissions in the residential buildings sector decline sharply until 2035 before levelling off. Emissions decline consistently in the personal transportation sector to 2050. Emissions reductions occurring after 2035 in this sector are likely due to the parking policy, as this policy increases in stringency to 2050 whereas the other policies are fully in place by 2035. The urban freight policy modeled in this scenario has a small but noticeable effect, as emissions from this sector fluctuate but remain relatively stable to 2050 instead of increasing as they do in BAU. By 2050, commercial buildings are the most significant source of emissions and are the only sector that increases in emissions to 2050. These results suggest that the Step Code implementation in this sector has limited impact.

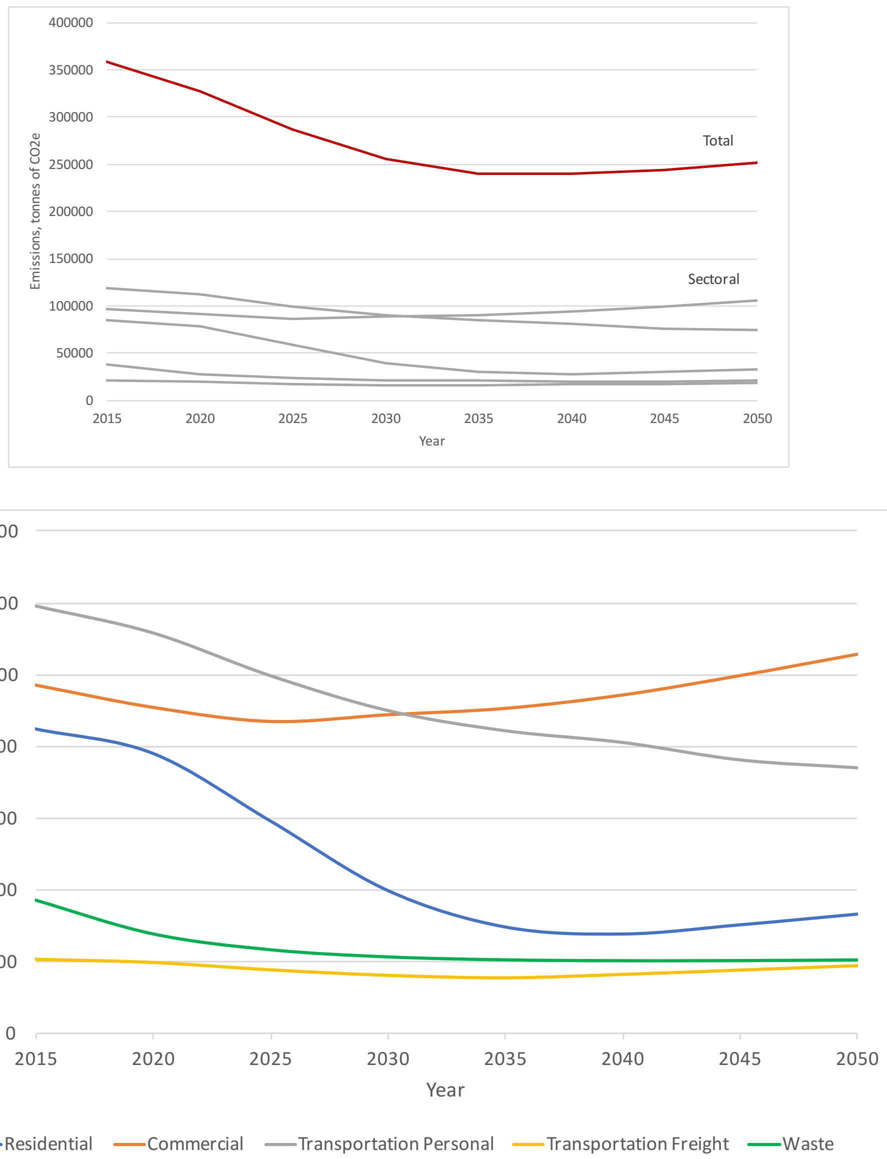

Figure 5: Victoria's greenhouse gas emissions by sector, Urban Policy scenario

There are sharp declines in emissions across all sectors in the Urban + Senior scenario (Figure 6). The higher carbon price modeled in this scenario results in lowered emissions from all sectors compared to the Urban scenario, except for waste (which is the same across all three scenarios). Notably, emissions from commercial buildings decline by about 35% in 2050 compared to 2015. Freight emissions also decline much more dramatically than they do in the Urban scenario. By 2050, emissions from commercial buildings and personal transportation account for the vast majority of emissions, with commercial buildings contributing 44% of total emissions and personal transportation 37%.

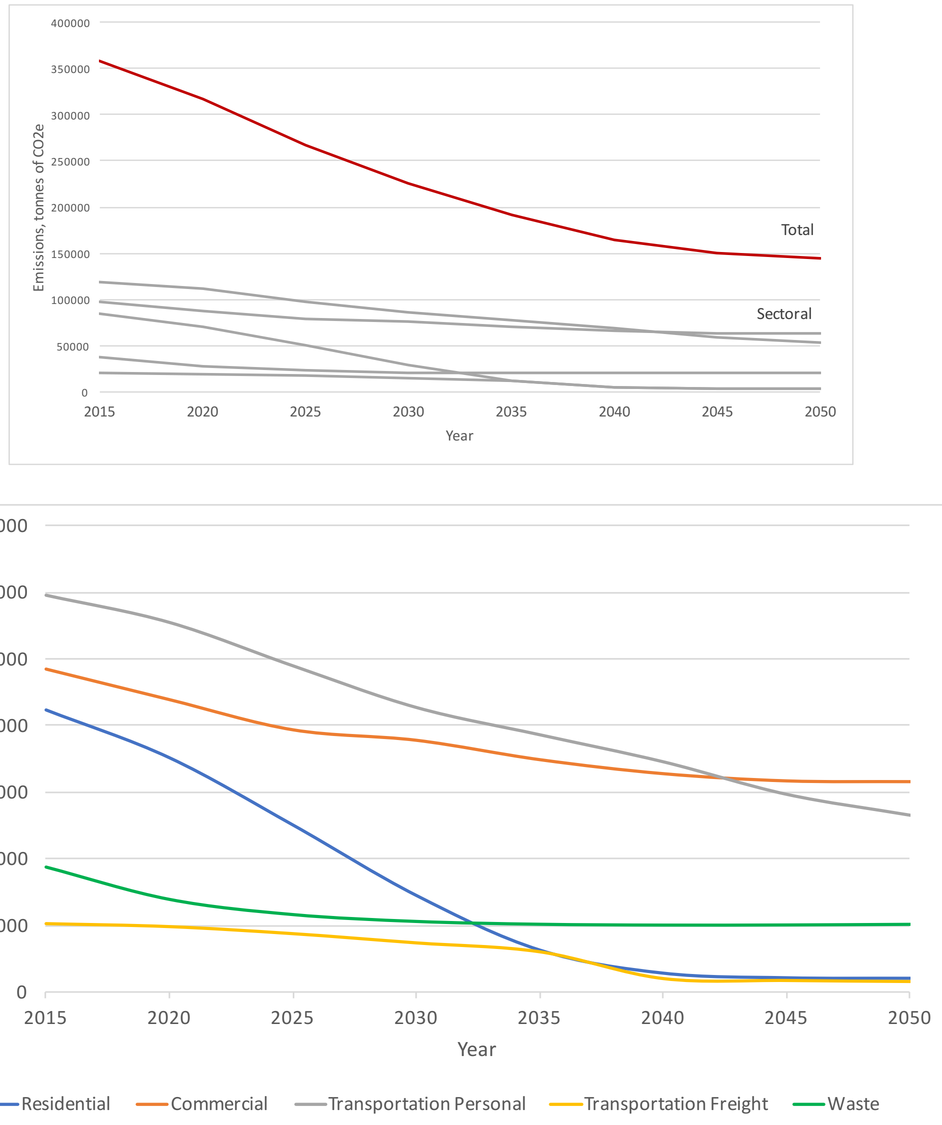

Figure 6: Victoria's greenhouse gas emissions by sector, Urban + Senior Policy scenario

3.4.3 Energy Use by Scenario

Figure 7 shows energy use for the BAU scenario. Overall energy use mimics the trend in emissions for BAU, though rather than an initial decline it remains steady before gradually increasing. As is the case for emissions, this trend is likely driven by the early implementation of key policies that do not increase in stringency to 2050. This increase in total energy is driven primarily by increases in electricity and natural gas use in the buildings sector. The balance between natural gas and electricity shifts slightly, although natural gas still accounts for a significant portion of energy use by the end of the simulation. Heating oil is virtually phased out by 2030. In the transportation sector, some gasoline is displaced by ethanol, whereas diesel remains relatively stable. Given the small uptake of biofuels, this change is likely caused by the increased renewable fuel blending requirement in the LCFS. Overall, 47% of energy used in 2050 in the BAU scenario is renewable.

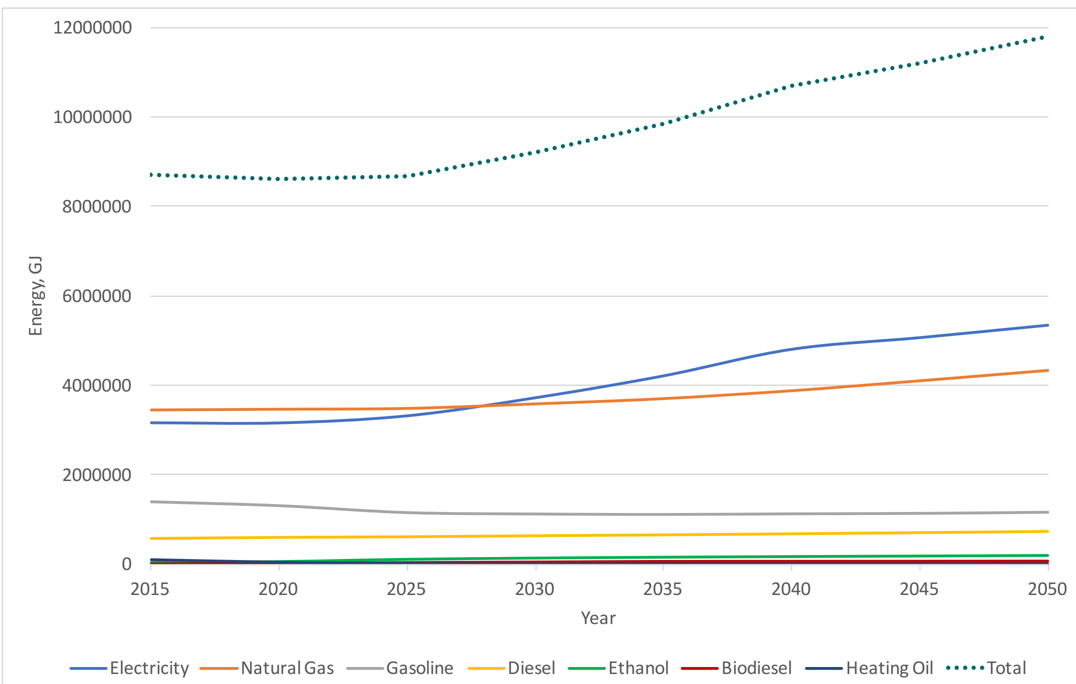

Figure 7: Victoria's energy use by type, Business as Usual scenario

Under the Urban policy scenario, overall energy use remains fairly stable to 2025 before increasing, but not to the same extent as under BAU (Figure 8). However, in this scenario there is a significant increase in electricity compared to natural gas, especially in the buildings sector. In the transportation sectors, both gasoline and diesel decrease slightly. However, there is still very little uptake of biofuels. Some gasoline is displaced by electricity in personal transportation and, to a lesser extent, freight transportation, reflecting the urban policies that favour plug-in vehicles in both of these sectors. The overall trend in this scenario is therefore not a drastic reduction in energy use, but some switching between fuel types as electricity increases its share of energy in comparison to fossil fuels in both buildings and transportation. Under this scenario, 60% of energy comes from renewable fuels by 2050, falling short of the 100% target.

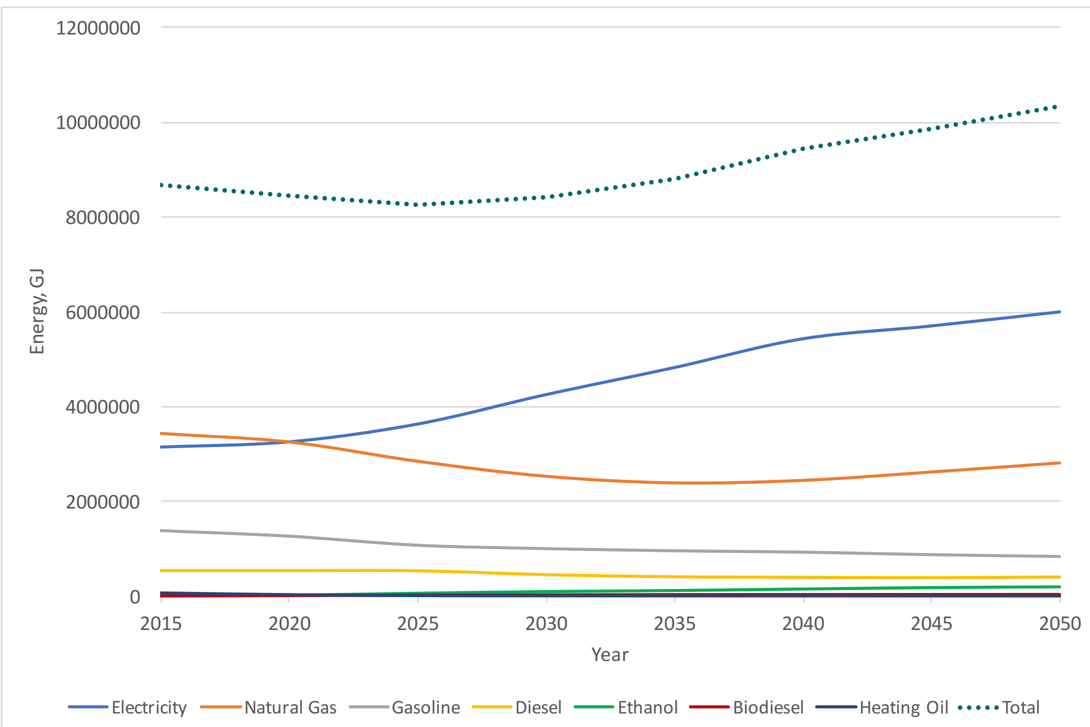

Figure 8: Victoria's energy use by type, Urban Policy scenario

Energy use under the Urban + Senior scenario shows an initial decline followed by a slight increase, though overall it increases only slightly by 2050 compared to 2015 (Figure 9). The higher carbon tax in this scenario leads to even more uptake of renewable energy, as 75% of all fuel used in 2050 is renewable in this scenario.

Electricity displaces more natural gas than in the Urban scenario. This increased uptake of electricity is largely in buildings, especially commercial buildings. There is increased use of electricity in both the personal and freight transportation sectors as well. Both gasoline and diesel decrease more than they do under the Urban scenario. Biofuels account for more energy in the transportation sector under Urban + Senior than in the Urban scenario, though overall uptake remains low. Ethanol and biodiesel each only account for about 2% of total fuel use in 2050, compared to gasoline use at about 5% of total energy used and diesel at about 2% of total energy used by 2050.

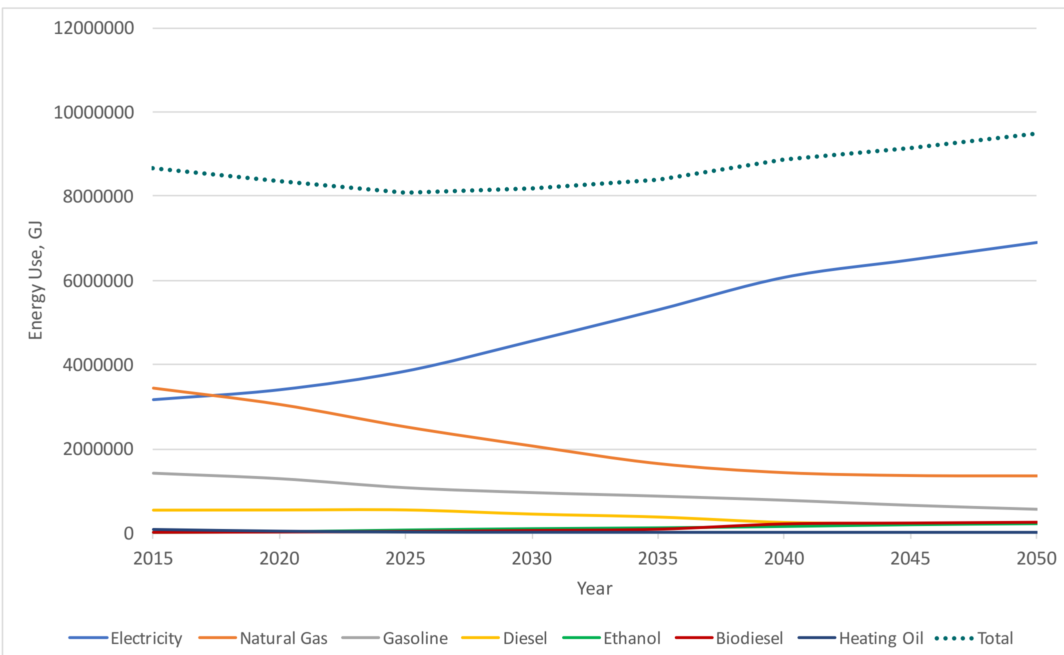

Figure 9: Victoria's energy use by type, Urban + Senior Policy Scenario

3.4.4 Discussion

The results of this modeling exercise suggest that it would be difficult for Victoria to achieve its 100% renewables target via increasingly stringent city-level policies alone. Victoria is only able to achieve 60% renewables under the Urban policy package I modeled. With a rapidly rising carbon tax under the Urban + Senior scenario, renewables increase substantially to 75% but still fall short of the target. While the Urban policy package suggests that Victoria does have the potential to substantially decrease emissions from some sectors – particularly residential buildings – through the policy options available to it, the enhanced results from the Urban + Senior scenario suggest that stringent policy from a senior level of government is needed to drive deeper emissions reductions through fuel switching away from gasoline, diesel, heating oil and natural gas.

Emissions from residential buildings decrease substantially under the Urban policy scenario, suggesting that Victoria can make significant progress in this sector through city-level policies, notably by implementing the Step Code modeled in this scenario. The higher carbon tax modeled in the Urban + Senior scenario drives additional decreases in emissions and fuel switching, indicating that this sector would also benefit from additional policy from senior government.

In contrast, adoption of the Step Code for commercial buildings appears to have only a limited effect on emissions. This isn't surprising given that commercial buildings can only be required by municipal governments to meet Step 3 of the Code in its current form. The contrasting results between residential and commercial buildings suggest that Victoria is severely limited in its ability to reduce emissions in the commercial sector as a result of the differing stringencies of the Step Code, as stipulated by the BC government. A study conducted for Vancouver, which has much more authority to regulate commercial buildings, suggests that more stringent urban-level policy applied to commercial buildings has the potential to reduce emissions and lead to significant levels of fuel switching (Zuehlke, 2017).

Another challenge facing Victoria with regards to commercial buildings is availability of renewable natural gas (RNG). Increased use of RNG could be an effective way to displace natural gas use in commercial buildings as the stock turnover and retrofit rate for HVAC equipment tends to be longer and slower than in residential buildings. However, given its limited ability to regulate the use of RNG through fuel-based policy, it is very challenging for Victoria to find a way to require that commercial buildings move towards use of RNG through city-level policy alone. Additionally, Victoria has no ability to augment the supply of RNG, since this is entirely the domain of FortisBC, the provincial natural gas distributer. More aggressive provincial policy in this area or enabling policy for Victoria to take its own initiatives is needed to drive significant uptake of RNG.

Victoria faces a similar challenge in personal and freight transportation. By design, the policies modeled for these sectors in the Urban policy scenario favour electric over biofuel vehicles. Given Victoria's limited ability to affect the supply of biofuels, such as ethanol and HDRD, it is challenging to implement policies that specifically encourage their uptake. For instance, the preferential parking policy I modeled allows for ethanol vehicles, but parking for these vehicles is of no use in affecting vehicle fuel choice if there are no ethanol (E85) refueling stations in the city. In the case of HDRD, there is an additional challenge of enforcement and compliance monitoring. As a "drop in" fuel, HDRD can be used in any standard diesel engine. As a result, it would be very difficult for Victoria to verify whether vehicles are using HDRD or conventional diesel, or to incentivize this fuel switching. In contrast, it is well within Victoria's jurisdiction to install charging infrastructure for plug-in electric vehicles. Additionally, it is easy to visually confirm whether or not a vehicle meets the plug-in requirement, making enforcement straightforward. As a result, the Urban policy scenario includes policies that encourages the electrification of vehicles in both personal transportation and freight. These results may therefore obscure the potential for biofuel vehicles in helping Victoria meet its 100% renewables target if provincial or federal policies promote biofuel supply chains.

Under the Urban + Senior policy scenario, there is some uptake of biofuels in the transportation sector relative to gasoline and diesel use, though their use is low overall. Specifically, there is a substantial increase in biodiesel use in freight transportation. In personal transportation, both E85 ethanol and electricity increase their relative share of vehicle fuel use. In this sector, it's possible that this result is also skewed by the emphasis on electrification in the Urban policy package. However, these results for both freight and personal transportation are comparable to those found by Vass & Jaccard (2017), who noted that similar levels of fuel switching in the transportation sector may be achieved through either a high carbon tax, such as the one simulated here, or a national LCFS (currently referred to as a Clean Fuel Standard by the federal government).

Though the personal transportation sector shows some encouraging emissions reductions and decreases in gasoline and diesel, this sector remains the second-highest source of emissions after commercial buildings in 2050 in both the Urban and Urban + Senior scenarios. As with commercial buildings and freight transportation, this sector is very difficult for Victoria to regulate under its current legislative authority. The parking policy simulated here is quite aggressive, but use of gasoline or diesel cars is still feasible. The higher carbon tax modeled in the Urban + Senior scenario drives even deeper emissions reductions, suggesting that this sector would also likely benefit from additional policy from the Provincial and/or Federal level.

While the high carbon tax modeled in the Urban + Senior scenarios drives emission reductions across all sectors except for waste, this scenario still does not achieve Victoria's targets for emissions reductions or renewable energy use. This outcome could be due to the limitations of running an economy-wide policy in a model designed to explore the effects of local policies. Due to the exclusion of macro-economic and energy supply/demand feedbacks in the model, the effect of the carbon price is likely under-represented in this scenario. However, the results suggest that the costs of further reducing emissions at a local level exceed the high carbon price used in this study. While a carbon price of this magnitude might achieve reductions of 80% at a national level (as found in Vass & Jaccard, 2017), several key emissions sectors – notably heavy industries – are excluded from this analysis due to their negligible contribution to emissions in Victoria. These results could therefore indicate that trying to further drive down emissions from commercial buildings and transportation could be very costly relative to the costs of reducing emissions in other industrial sectors when emissions reductions efforts are considered at a provincial or national scale.

3.5 Conclusions on the energy and GHG policy modeling case study

The three policy scenarios modeled in this study show that Victoria's municipal government has potential to reduce emissions and move toward greater renewable energy use, especially in residential buildings, waste, and – to a lesser extent – personal transportation. However, significant barriers to achieving 100% renewable energy remain, particularly in commercial buildings, freight transportation and personal transportation. Though the high carbon tax modeled in this study isn't sufficient to arrive at 100% renewable energy, the Urban + Senior scenario achieves significantly lower emissions and higher levels of fuel switching to renewables. Victoria would likely need to rely on policy intervention from senior levels of government to move closer to its targets, especially in commercial buildings and transportation.

The analysis presented in this section provides insight on the policies that Victoria can implement, within their legislative authority, that have the potential to help achieve its 100% renewable energy target. The way in which cities are able to conduct policy evaluations and how they interpret and implement policy recommendations are an essential aspect of any attempt to reduce GHG emissions. However, conducting this type of policy analysis is only one component of community energy planning as a whole. In addition to facing significant legislative barriers, cities face social, political, and staffing and expertise capacity issues that further complicate the implementation of policies within their legal authority. In the next section, I turn to the question of how these modeling tools might be applied, if at all, in the urban energy and GHG emissions policy challenge.

Chapter 4: Community Energy Practitioner Survey and Workshops

4.1 Survey Context

4.1.1 Background: The Implementation Gap in Community Energy Planning

Community energy planning (CEP), or management, is a way of focusing energy-based policy at the local level by integrating it with typical municipal policies and planning concepts. The latter can include policies in transit, land use, and buildings, among others. It is within this framework that targets such as Victoria's 100% renewables goal are set. However, the concept of CEP pre-dates much of the GHG reduction rhetoric that has increased in popularity at the local level over the last few years. For instance, the use of district energy and combined heat and power have been widespread in Europe, especially in Scandinavian countries such as Denmark and Sweden, for decades. Early work suggesting that CEP, as a formal planning framework, has the potential to affect local energy use and help communities achieve GHG reduction targets dates back to the 1980s (Jaccard, Failing, & Berry, 1997).

For almost as long as CEP has been more formally established as a planning framework to achieve GHG emissions reductions, the challenges and limits to implementing effective policy at this level have been acknowledged. For instance, many of the recommendations in Jaccard, Failing & Berry (1997) involve cooperation between different entities, such as utilities and transportation planning authorities, as well as changes to legislation governing land use planning. Twenty years after this work, scholars continued to observe a "stubborn gap between the rhetoric and reality of local climate policy" (Betsill and Bulkeley, 2007, p. 448). Today, there is still a gap between the increasing interest and enthusiasm shown by cities in setting GHG reductions targets and their understanding of the dynamics involved in urban policy and how to go beyond target-setting to implement effective emissions measures (Hughes, 2016; Daniel, 2015).

Adopting climate targets is an inexpensive and relatively uncontroversial way for cities to demonstrate concern for climate change, but this does not guarantee local implementation of policies that lead to significant emissions reductions (Sharp, Daley, & Lynch, 2011). For instance, one study found that 20% of municipalities in Indiana had a clearly articulated GHG reductions target, but only 5% had performed a GHG inventory, developed a dedicated plan, or allocated money to emissions reductions initiatives (Krause, 2011). As discussed in Chapter 2, local governments do have the ability to influence emissions from buildings, transportation and waste. However, they face substantial limits to their legal authority that require them to consider creative and often unpopular policies.

Quantitative studies that evaluate GHG and energy policies, such as the energy-economy modeling study presented in the previous chapter, provide important insights as to which policies at what degree of stringency are likely to be effective in achieving ambitious GHG reduction objectives. Starting with an understanding of which policies have the potential to help governments reach their GHG reduction targets and which are likely to have little impact is an important first step in moving from target adoption to effective policy implementation. However, the influence that cities can have on emissions is not only dependent on their ability to identify potentially effective policies within their legislative authority, but also on social and political factors such as municipal government expertise and policy development and implementation capacity, as well as political will. It is in the interest of addressing this dimension of the urban GHG policy challenge that I developed a survey for community energy practitioners in Canada aimed at exploring the current and potential use of policy evaluation tools in community energy planning.

4.1.2 The Community Energy Knowledge Action Partnership

The Community Energy Knowledge Action Partnership (CEKAP) is a three-year project that aims to explore the challenges to and opportunities of CEP in Canada. At the core of the project is a network of partners consisting of academic groups, governments, civil society groups, and other community energy practitioners. The Energy and Materials Research Group (EMRG), an academic unit within the School of Resource and Environmental Management at Simon Fraser University, is one of the academic partners on this project.

A core pillar of CEKAP's mandate is to facilitate knowledge exchange between the researchers and practitioners involved in the project. In line with this mandate, CEKAP hosted a series of half-day workshops across Canada in the fall of 2017 to explore the use of analytical tools for community energy planning, including energy economy models, Geographic Information Systems (GIS), and cost benefit analysis tools. As EMRG's representative at these workshops, I delivered a presentation on the use of CIMS for municipal policy evaluation. Our goal was to share expertise across the partnership, while engaging in conversation about how analytical tools might be improved to support decision-making in the community energy planning process, from planning to implementation.

To further focus this analysis, I followed up the workshops with a Canada-wide survey targeted at community energy practitioners. The survey focuses on practitioners' use of analytical tools in their field to explore the implementation gap in community energy policy. While 'analytical tool' is a term that can be applied very broadly, in this case I use it to describe a process or method that can be used to perform an evaluation of a policy option. In administering the survey, my objective was to explore if and how such tools are currently used and understood. The survey explored three central questions:

1. What analytical tools are currently available to community and corporate energy managers to make decisions about local energy initiatives and policies?
2. How have these tools been used in the decision-making process?
3. What are the opportunities to improve these tools and their use for local decision-makers?

In the following section I describe the methods used to design and circulate the survey. I then review the key results, and then discuss relevance of the survey insights for municipal GHG policy.

4.2 Survey Methods

4.2.1 Question Design

The survey consisted of 25 questions regarding respondents' use and perception of analytical tools in their professional experience. I developed these questions in consultation with Dr. Kirby Calvert, CEKAP Co-Director and Professor at the University of Guelph. Questions were a mix of close- and open-ended. The latter allowed for detailed qualitative responses. Given the exploratory nature of the survey, these open-ended questions were appropriate as a means of gathering information from a highly specialized pool of respondents. The close-ended questions were designed to capture general trends and levels of knowledge of the respondents before delving deeper into specific areas. Generally, each close-ended question or grouping of themed close-ended questions was accompanied by an open-ended question allowing respondents to expand on their answers. A copy of the survey questions is included in Appendix A.

4.2.2 Sampling Method

The target sample was community energy practitioners in Canada, with an emphasis on those working at or with local governments. For the purposes of this study, I have defined a community energy practitioner as someone who is professionally involved with local level energy policy. By limiting the sample to this group, I aimed to provide high quality observations that are reflective of those working in CEP. Respondents were recruited through the CEKAP network via an email that solicited voluntary participants, who were offered a copy of the results report as an incentive to complete the survey.

The survey was administered over a period of about seven weeks. The survey was hosted online through the Qualtrix platform, with a web link circulated to participants. I gathered 15 complete sets of responses. This is a small but meaningful sample, as the pool of Canadian community energy practitioners with experience with analytical tools is fairly small. Eight of the 15 respondents are community energy practitioners who work at local governments. In light of the low number of respondents in this category, all 15 responses are analyzed in the results below. Given this small set of responses, the data is best suited for exploratory analysis.

4.3 Survey Results and Discussion

4.3.1 Experience with Analytical Tools

Over half of the respondents to the survey had no experience with analytical tools (as defined above), with only 45% reporting that they have used an analytical tool to measure or evaluate the performance of policies or programs related to community energy. Of those that responded that they had used tools for this purpose, GIS tools were most commonly reported as being used (55% of those who had used tools). Other types of tools used by respondents include spreadsheets tracking energy consumption or used to create inventories of greenhouse gas emissions, cost-based tools, and simulation or forecasting tools. 25% of all respondents reported having used energy-economy models such as CIMS. Given the limited sample in this study, these numbers are not necessarily representative of all community energy practitioners in Canada, but provide some context for responses to the rest of the survey questions.

4.3.2 Factors influencing use of results from analytical tools

We asked respondents to identify factors that influence whether or not the results of an analytical evaluation of a community energy policy or program are likely to affect future decisions on community energy initiatives. Financial resources and political context were identified as influencing factors by most respondents, though there was quite a variety in the factors that respondents selected (Figure 10).

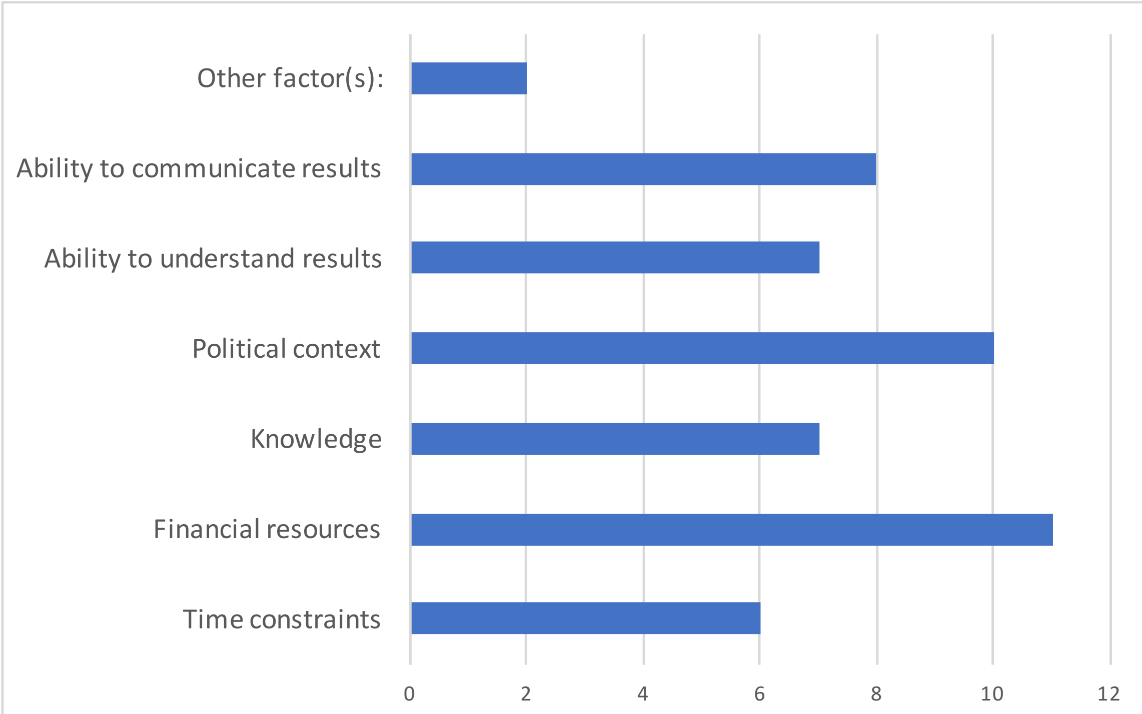

Figure 10: Number of respondents that selected the above factors as influencing whether or not the results of an evaluation of a community energy policy or program are likely to affect future decisions on community energy initiatives in their jurisdiction

Detailed responses show that while tools bring capacity to the planning process, they do relatively little to fill the capacity deficit in implementation. Results of analytical tools are only one factor, albeit an important one, in shaping community energy planning outcomes and implementation. As one respondent noted, “It often seems that political and time constraint factors are more important than the quality of results.” Another suggested that “Moving beyond awareness raising and communications activities requires a lot of time and money, both of which are in short supply within municipal government. The analysis tells us what we need to do, but there is a lack of resources to actually implement policies to achieve what the analysis suggests.”

This theme was expanded on by another participant who noted that “In short, tools are neat and provide useful information but a lot of other factors also affect success,” further suggesting that the results of an analytical process have the potential to be useful, but may or may not be depending on how results are generated and used. This observation was captured through another response, suggesting that tools “. . . are necessary but there is a balance between time/cost/level of detail vs other factors that will affect successful implementation.”

4.3.3 Level of trust in analytical tools

In spite of their limited experience with tools, respondents generally indicated a trusting or neutral attitude towards the results of analytical processes. When asked how respondents would rate their level of trust in these results, 40% indicated “Somewhat high” and 40% indicated “Neutral” (20% were not sure). No one responded that they have “Very high,” “Somewhat low” or “Very low” trust in results from tools. Key factors influencing levels of trust were previous experience, the respondent’s level of knowledge, and the person or organization who uses the tools (Figure 11). Respondents also indicated that the assumptions or data informing the tool affects their level of trust.

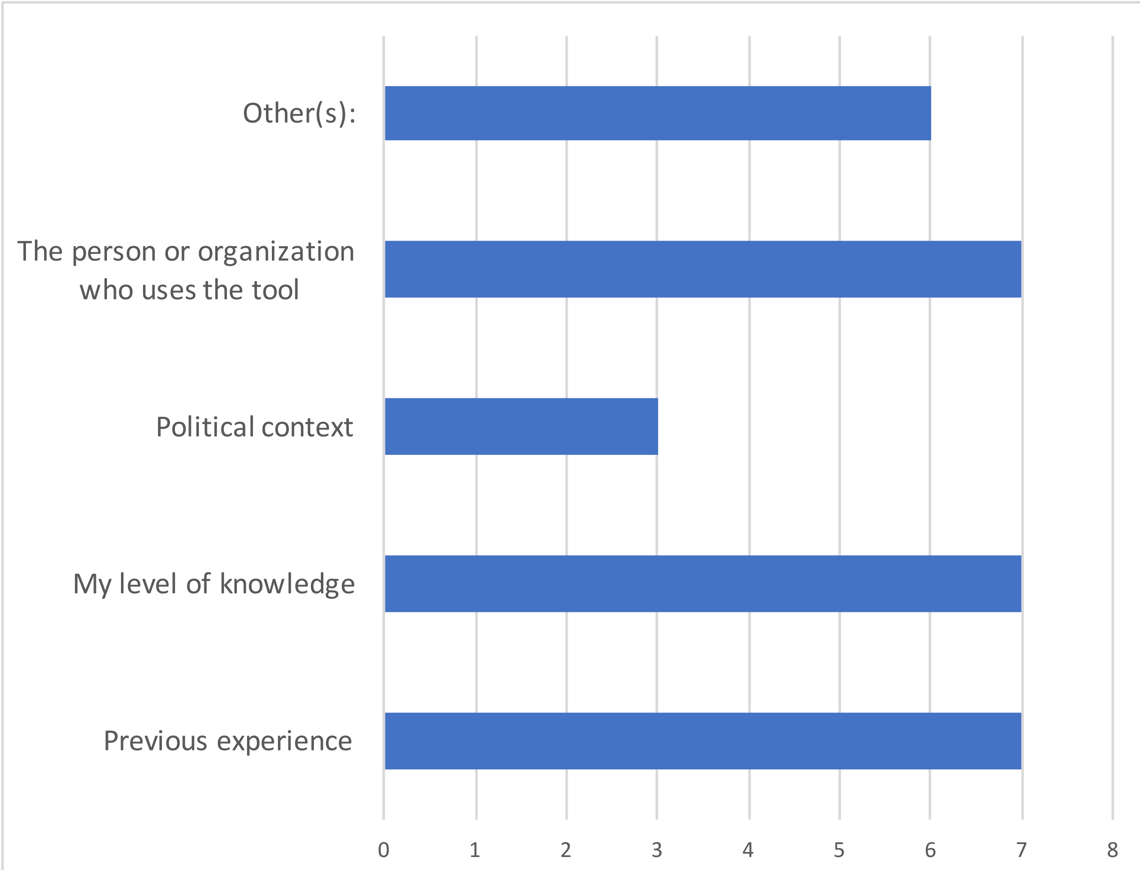

Figure 11: Number of respondents that selected the above factors as influencing their level of trust in analytical tools

Although no respondents indicated that they distrust analytical tools outright, qualitative explanations as to respondents' trust in tools suggest that trust is dependent on the specific situation or case. For instance, one respondent indicated that "an analytical tool or model is only as good as the assumptions that go into it" echoing a common sentiment that model results can be challenged in terms of the strength of the model itself but also in terms of the strength of the presumptions made by the model builders and the modelers more directly. This view was shared by another respondent, who expressed that their concerns regarding the use of tools "is less about the tools, and more about the operators."

4.3.4 Perceived usefulness of tools

All respondents found tools to be “Always or almost always useful,” or “Sometimes useful” in garnering council support (Figure 12). This indicates the high political value of analytical tools. The perceived usefulness of tools in garnering public support or communicating internally was not as strong, though the majority (73%) found them to be “Sometimes useful” or “Always or almost always useful.”

According to many respondents, the results of analyses can provide a solid starting point for discussion. One noted that “Being able to "show your math" . . . sets a high standard for discourse on topics.” Another also weighed in on this theme:

> “Council participation in a workshop enables long term support for the plan in addition to understanding the potential impacts of actions. While communities are often disappointed in the low impact of the 'easier' actions, it serves the purpose of capacity building for key players and allows them to get started on achieving and reporting on their GHG emission reduction targets that they were required by the province to include in . . . their community plans.”

Comments to this effect suggest that the results of analyses can provide a solid starting point for discussion.

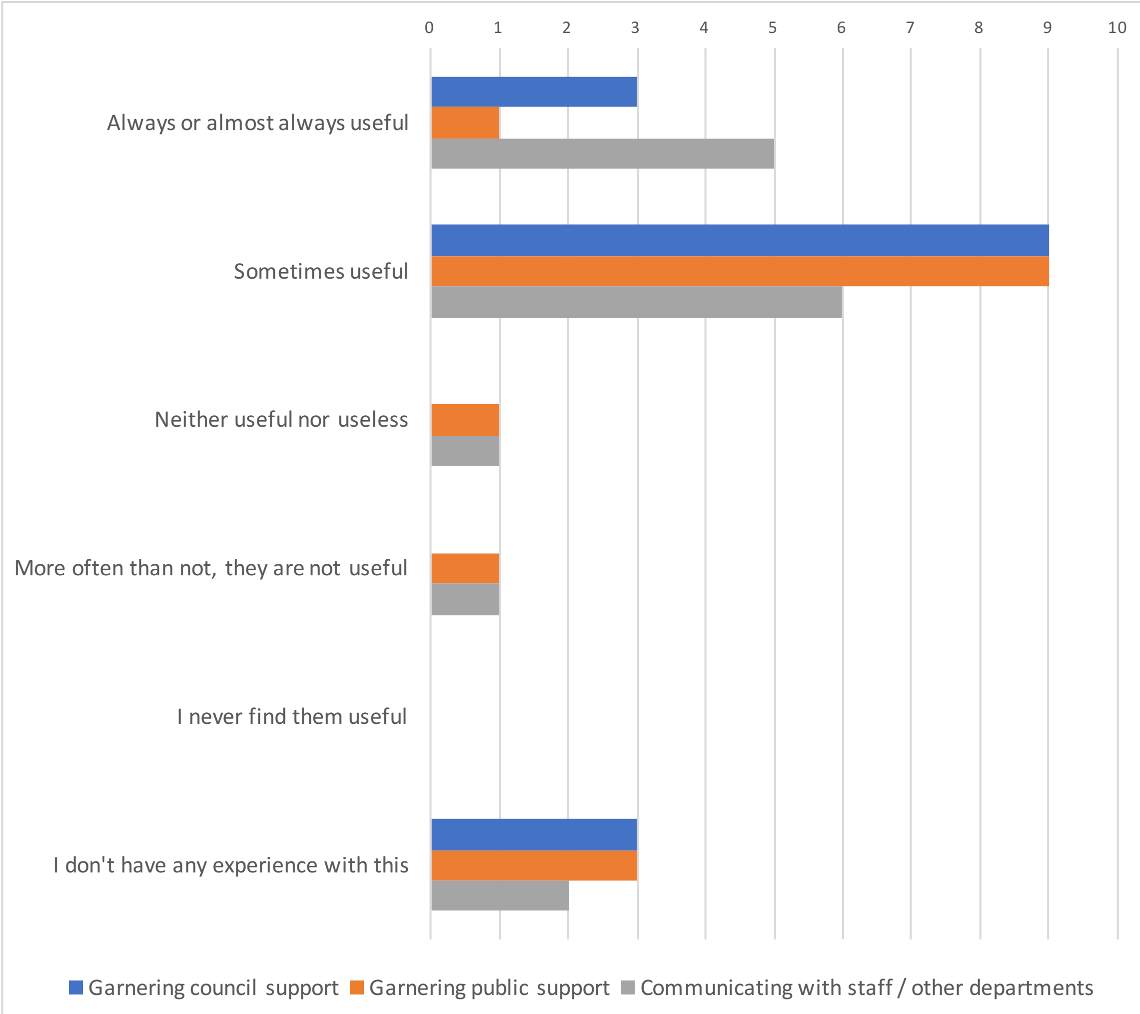

Figure 12: Number of respondents who indicated the extent to which analytical tools are useful for garnering council support, garnering public support, or communicating internally

However, other respondents identified limits to how useful tools may be. One noted that political and social challenges are often left unanswered through an analytical process using a tool:

> "In my (limited) experience, the analytical tools tell us what the long-term game is, but don't help us answer the near-term questions of how we overcome the political and public resistance to changing the status quo. So, the analysis tells us that it is technically possible to achieve low emissions, etc., but provides no

> intelligence on the social/political pathway to actually realizing it. That isn't a concern with analytical tools per se, but just a limitation in terms of their usefulness."

Similarly, another noted that "In our experience, there is an upper limit of usefulness in a tool - they are very useful to guide decision-making and create five-year (relatively short term) action plans. This field is evolving rapidly and assumptions will change. Political will often changes with election cycles."

Respondents also noted that the usefulness of tools varies depending on the audience. One observed that "The results of analytical tools are most helpful in communicating to staff and other technical experts. Politicians and general public are much more likely to reject analytics if the information presented differs from their philosophies and perceptions of the issue." This comment was reflected by another participant, who responded that "If a tool and its output is complicated, councils and the public will not understand. Case studies work better (what another, similar community has experienced)." These responses suggest that the effective communication of results from policy evaluations are critical in determining the impact that such studies can have.

4.3.5 Discussion

The results from this survey provide a glimpse into the challenges facing community energy practitioners. On the one hand, respondents acknowledge the usefulness, and in some cases the necessity, of using tools to create a solid foundation for discussions on what policies are needed and effective as they look to meet their community energy goals. On the other hand, practitioners find that the results of using a tool to evaluate policies are often insufficient, on their own, to drive the implementation of policies. This challenge again points to the "implementation gap" in community energy policy already identified in the literature, and suggests that the results of policy evaluation exercises are a necessary but, in and of themselves, insufficient condition for the successful execution of community energy policy.

These insights may be valuable for those performing policy analyses such as the one I conducted for Victoria. Understanding the potential usefulness of these types of studies and their limitations can help modelers consider the narrative they are presenting through their work. For instance, using a local government's specific energy or GHG objectives to define policy scenarios can be a useful way to help frame policy effectiveness when presenting results.

These responses also point to some potential issues in using the results of energy and GHG analytical tools in a municipal context. While the generally high or neutral level of trust in and perceived usefulness of these tools is encouraging, if combined with a low level of staff and expertise capacity to interpret these complex results it could lead to acceptance of the results even when the methods may be highly questionable. For instance, results of conventional bottom-up analysis of GHG abatement potential have been widely accepted for several decades, in spite of studies suggesting that these provide an overly-optimistic view of the potential for energy-efficiency policies to reduce emissions (Murphy & Jaccard, 2011). Accepting results from these bottom-up studies could lead policy makers to prioritize policy measures that don't have the expected effects. Additional research might provide more definitive information on the relationship between trust, perceived usefulness and interpretation of policy evaluation.

Many respondents indicated a healthy skepticism of modeling assumptions and inputs, which could help avoid the issue described above. However, it is challenging for non-experts to clearly identify specific issues and their implications for the results of a policy evaluation. Therefore, it is important that modelers are effective in delivering the key messages of their analyses while also making clear the assumptions and limitations of their work. At the same time, they must also strike the right balance between communicating uncertainty without undermining the validity of the results. This balancing act draws attention to the challenges of communicating highly technical or academic results in a way that maintains confidence in the process.

Taken together, these results suggest that even when cities are aware of the policies most likely to help them achieve their objectives through a well-founded evaluation based on legitimate analytical tools, substantial barriers to implementing these policies remain. While some of these challenges face other levels of government as well (e.g. rapidly changing political priorities, difficulty in implementing unpopular policies), some factors are either unique to local governments or provide a different challenge. Resource constraints such as time, money, political context, and capacity to interpret and communicate results were all identified as factors affecting the implementation of policy recommendations generated through an analysis. Given the smaller support staff of cities compared to provincial or federal government departments, these constraints would likely affect local governments the most. However, beyond this observation, the data generated by this survey is not sufficient to comment on how the capacity and political challenges identified by respondents might differ between different levels of government.

Further research that explores how these challenges facing local governments compare to the challenges facing provincial and federal governments might provide insights on the extent to which these challenges are unique to cities. This could also provide context for assessing what level of government is better suited to implement GHG reduction policy, not only in terms of the efficacy of policies explored in the modeling study presented in Chapter 3, but also in terms of internal capacity and political barriers.

4.4 Conclusions on the community energy survey

The results of this survey provide a useful entry point for an understanding of how community energy practitioners are currently using policy evaluation tools, and how they would like to use them in future. These insights are useful for modelers and others conducting policy evaluation as they can see how they might align their approach with the municipal planning process to provide maximum benefit to practitioners. However, they should also be aware of the possibility of providing misleading or unclear results to decision makers. Additionally, these survey outcomes are exploratory and intended only as a starting point.

While there are obvious staff and budget constraints that affect local governments more severely than senior governments, the latter also face great political and economic challenges to implementing aggressive policies such as the high carbon tax modeled in Chapter 3 of this study. Further research that explores how the implementation challenges facing local governments compare to those facing senior levels of government would provide valuable insight as to what levels of government are best suited for implementation of different energy- and GHG-related policies in terms of capacity issues and political barriers.

Chapter 5: Conclusions

While countries, provinces, regions and cities around the world have started to adopt highly ambitious targets aimed at reducing GHG emissions and fossil fuel use, few governments have made significant progress towards meeting their goals through policy implementation. Cities in particular face special challenges in this area as they have limited legislative authority to pursue stringent, compulsory policies that phase-out the use of gasoline and diesel in vehicles and natural gas in buildings, the two most essential developments for substantial GHG reduction in an urban setting. Victoria is one of the most recent cities to adopt an ambitious climate target, and it is facing these very challenges as it determines a pathway to achieving 100% renewable energy use by 2050.

It is in this context that I conducted a modeling study of policy options available to Victoria. The results suggest that while it will be very difficult to achieve deep reductions in GHG emissions and fossil fuel use, there are significant possibilities for Victoria to pursue some emissions reductions initiatives. Victoria has the ability to drive long run emissions reductions in residential buildings, waste disposal and personal transportation through policies such implementation of the Step Code for new residential buildings, waste diversion programs and a preferential parking policy. However, some sectors, notably commercial buildings and freight transport, remain difficult for Victoria to impact through policy action of its own.

In this modeling study, additional policy intervention at senior levels of government is shown to help drive down emissions across all sectors except for waste. These results suggest that while Victoria can make significant progress in moving to renewables use and reducing GHG emissions in some sectors, policy intervention from the provincial or federal government is needed to drive major emissions reductions and fuel switching overall. It is particularly difficult for cities to implement policies that directly lead to the uptake of biofuels given the challenges of supplying RNG for buildings and ethanol, biodiesel, and HDRD for transportation. Cities like Victoria lack a clear mandate to price or regulate GHG emissions, which is essential for the comprehensive fuel switching entailed in the shift to 100% renewables. In contrast, the high carbon price modeled in this study leads to more uptake in these renewable fuels, as well as electricity. While neither the Urban or Urban + Senior policy packages modeled in this study achieve 100% renewable energy use, it is clear that additional policy intervention by senior government will be needed to reach such a dramatically ambitious target.

In order to better understand the challenges of implementing policies of the type I explored in my modeling study, I have also presented the results of a survey I conducted aimed at understanding the use of analytical tools by community energy practitioners. Though the survey results are exploratory in nature due to the limited sample size, they present some insights for modelers and policy makers. Notably, the general trust in and perceived usefulness of tools in community energy policy provide an opportunity for modelers to share their work with open-minded practitioners to help inform policy direction. However, the same qualities of trust and perceived usefulness could create an environment where community energy practitioners implement flawed policy recommendations. This possibility underscores the need for results that are clear, easy to interpret, and clearly communicate the assumptions and limitations used by the modelers without undermining the credibility of the results. It also points to the need for transparent analyses for which independent expert overview is solicited.

While the survey provides an entry-point for discussion on the challenges of implementing municipal-level GHG and energy policies, there is room for more detailed work that explores this implementation gap. Specifically, work that compares the implementation challenges facing local governments to those facing more senior levels of government would provide valuable insights as to what policy pathways at what level of government might have the best chance of resulting in lowered GHG emissions and an increased share of renewable fuel use.

When taken together, the two parts of this study suggest that growing enthusiasm for GHG policy at the city level is not necessarily matched with the legislative authority or analytical capability needed to identify and implement the policies that are essential if cities are to meet ambitious targets such as 100% renewable energy use. However, this outcome doesn't suggest that there is no role for cities to play in GHG policy. Rather, it suggests that cities that wish to drive ambitious GHG reductions can be most effective if they partner with senior levels of government to complement their own policy initiatives, and understand the likely impact of local policies. Additionally, cities may need to rethink their role in GHG reduction policy. While it may be tempting for cities to see themselves as the champions of GHG policy in response to an enduring lack of leadership in this area by senior government, they may ultimately be more helpful and lead to greater emissions reductions if they increase political pressure on senior government to provide greater policy support in areas that are difficult for cities to affect.

Perhaps most importantly, the survey and literature on implementation of community energy policy both suggest that understanding effective policy options is only the first step in executing a successful community energy strategy. Significant legal, political, social, and economic challenges constrain the potential that some of the most promising policies have to reduce emissions and transition to renewable energy. In light of this, it is important to understand the role that local governments could play in emissions reductions and how this compares to action by more senior levels of government. Understanding both the policy options that are most likely to be effective and further exploring the barriers that might prevent the implementation of these policies are both critical pieces of the path that cities must follow if they are to go from being policy takers to policy makers in the realm of urban climate policy.

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Appendix A: Survey Questionnaire

CEKAP: Retooling Community Energy Survey

Start of Block: Welcome

Q1 Welcome to our survey, 'Retooling Community Energy.' The purpose of this survey is to get information on how professionals working in the field of community energy use analytical tools. With this information, we hope to gain some insight in to how tools have been used, and how tools could be better designed to meet the needs of professionals. We plan to share the results of this survey with those who respond so that those in working in the field can benefit from this information.

The Community Energy Knowledge Action Partnership (CEKAP) is administering this survey through the Energy and Materials Research Group (EMRG) at Simon Fraser University as part of a three-year project that aims to remove to the barriers to and improve implementation of community energy policy and programs in Canada. This survey focuses on the use of analytical tools to improve implementation.

For more information on CEKAP and EMRG, please follow the links below:

CEKAP: www.cekap.ca

EMRG: www.emrg.sfu.ca

End of Block: Welcome

Start of Block: Consent Page

Q2 **Survey Consent Form Retooling Community Energy in Canada: Survey   Who is conducting this survey?** This survey is being administered by Morgan Braglewicz, a graduate researcher at Simon Fraser University. The survey is part of the Community Energy Knowledge Action Partnership, a three-year research project that aims to remove barriers to the implementation of community energy initiatives in Canada funded by the Social Sciences and Humanities Research Council of Canada. This survey consists of five sections of questions on the use of analytical tools in community energy planning, and should take roughly 20 - 30 minutes to complete. **Why should you complete this survey?** As part of the project, we will be using the results of this survey to produce a report on the use of analytical tools in community energy planning in Canada. The report will help disseminate information on the use of analytical tools across Canada, benefiting community energy professionals by expanding their knowledge base. This report will be shared with CEKAP project partners and survey participants. This report or others may also be shared externally with a wider audience, either as a semi-public report or publication in an academic journal, or in a master's thesis. **How will the results be stored and used?** The survey results will be uploaded to SFU Radar, an online repository, and maintained indefinitely. The information uploaded to the repository will be anonymized, with all identifying information removed. The full set of responses with consent information will be kept in a secure digital location for two years, only accessible to CEKAP project researchers via password protected computers. After two years, consent information with identifying details will be destroyed. Results will be shared outside of project leadership in the form of a report or thesis as mentioned above. As part of the survey, we will collect your name and contact information so that we can share the results of the survey with you. However, the results communicated in any reports will be anonymized and not attributed to a specific respondent (e.g. responses will be attributed to 'CEP Practitioner C' rather than to the name or workplace of an individual). **Consent to Participate** Taking part in this study is entirely up to you. You have the right to refuse to participate in this study. If you decide to take part, you may choose to pull out of the study at any time without giving a reason and without any negative impact. In proceeding with this survey, your consent to the terms outlined above is implied. If at any point you wish to withdraw from the study, you may end your session. If you wish to remove your survey responses from the study, please contact the principle investigator for the survey (Morgan Braglewicz, [...]@sfu.ca). Previously collected data will be destroyed unless it has already been released or published, or you give consent to continue to use your data. You may also request to view your own responses to the survey. **Who to contact with questions or concerns** You may contact Dr. Mark Jaccard ([...]@sfu.ca), the senior research supervisor for this survey, with any questions on the significance of this research for community energy planning. If you have any concerns about your rights as a research participant and/or your experiences while participating in this study, you may contact Dr. Jeffrey Toward, Director, Office of Research Ethics[...]@sfu.ca or 778-[…] CEKAP Survey Consent Form Version 1 SFU ORE Study number **2017s0279 V2**

Q3 By clicking the box below and completing the survey, you are providing your consent to the terms outlined above.

○ I consent to participate in this survey (1)

End of Block: Consent Page

Start of Block: Introductory Questions

Q4 Do you work for a municipal or local government?

○ Yes (1)

○ No, I work at: (2) ____

Q5 What is your role in the community energy planning process?

○ Manager (1)

○ Planner (2)

○ Municipal analyst working on community energy planning (3)

○ Consultant (4)

○ Other (please specify) (5)
____

Q6 Please provide your contact information (e-mail address) so that we may share the results of the study with you:

____

End of Block: Introductory Questions

Start of Block: Analytical Tools for Evaluation

Q7 An analytical tool can be anything (a method, a type of software) used to perform analysis. Examples of tools commonly used in community energy planning include energy-economy models (e.g. CIMS), spatial tools (e.g. GIS), and cost benefit analysis. Please keep this in mind as you complete the survey.

Q8 Have you or the organization that you work for used an analytical tool to **measure or evaluate** the performance of policies or programs related to community energy?

○ Yes, I/we have used the following tool(s): (1) ____

○ No (2)

Q9 Have you or the organization that you work for used an energy-economy tool (e.g. CIMS, CityInSight, GHG Proof, etc.) to **measure or evaluate** the performance of policies or programs related to community energy?

○ Yes, I/we have used the following tool(s): (1) ____

○ No (2)

Page Break

Display This Question:

If Have you or the organization that you work for used an analytical tool to measure or evaluate the... = Yes, I/we have used the following tool(s):

Q10 Please give at least one example of a case in which the results of using an analytical tool helped your organization **measure or evaluate** the outcome of an initiative, such as a policy or program, related to community energy. In your answer, please consider:

-What tool was used?
-What type of study or report has been completed?
-What types of results were produced?
-Who completed this work (e.g. was it completed in house or contracted out?)
-How were the results used?

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Display This Question:

If Have you or the organization that you work for used an analytical tool to measure or evaluate the... = Yes, I/we have used the following tool(s):

Q11 Which of the following factors help to explain why the use of the tool **was** helpful in the example that you have provided? You may select more than one answer. Please feel free to add to the list.

- ☐ Time constraints (1)
- ☐ Financial resources (2)
- ☐ Knowledge (3)
- ☐ Political context (4)
- ☐ Ability to understand results (5)
- ☐ Ability to communicate results (6)
- ☐ Other factor(s): (7) ____

Display This Question:

If Have you or the organization that you work for used an analytical tool to measure or evaluate the... = Yes, I/we have used the following tool(s):

Q12 Which of the following factors help to explain why the use of the tool **was not** helpful in the example that you have provided? You may select more than one answer. Please feel free to add to the list.

- ▢ Time constraints (1)
- ▢ Financial resources (2)
- ▢ Knowledge/expertise (3)
- ▢ Political context (4)
- ▢ Ability to understand results (5)
- ▢ Ability to communicate results (6)
- ▢ Other factor(s): (7) ____

Display This Question:

If Have you or the organization that you work for used an analytical tool to measure or evaluate the... = Yes, I/we have used the following tool(s):

Q13 Please elaborate on how these factors affected the outcome of using the tool in your example.

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Page Break

Q14 Which of the following factors influence whether or not the results of an evaluation of a community energy policy or program are likely to affect **future** decisions on community energy initiatives in your jurisdiction? You may select more than one answer. Please feel free to add to the list.

- ☐ Time constraints (1)
- ☐ Financial resources (2)
- ☐ Knowledge (3)
- ☐ Political context (4)
- ☐ Ability to understand results (5)
- ☐ Ability to communicate results (6)
- ☐ Other factor(s): (7) ____

Q15 Please elaborate.

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End of Block: Analytical Tools for Evaluation

Start of Block: Trust in Tools

Q16 How would you rate your level of trust in results generated by an analytical tool?

	Very high (1)	Somewhat high (2)	Neutral (3)	Somewhat low (4)	Very low (5)	I'm not sure (6)
I would rate my level of trust as: (1)	○	○	○	○	○	○

Q17 Which of the following factors influence your level of trust in the use of analytical tools, as you've indicated in the previous question? You may select more than one answer. Please feel free to add to the list.

- ▢ Previous experience (1)
- ▢ My level of knowledge (2)
- ▢ Political context (3)
- ▢ The person or organization who uses the tool (4)
- ▢ Other(s): (5) ____

Q18 Please elaborate on how the factors you have indicated in the previous question affect your level of trust in analytical tools.

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Page Break

Q19 In your experience, to what extent are the results of using analytical tools useful in terms of:

	Always or almost always useful (1)	Sometimes useful (2)	Neither useful nor useless (3)	More often than not, they are not useful (4)	I never find them useful (5)	I don't have any experience with this (6)
Garnering council support (1)	○	○	○	○	○	○
Garnering public support (2)	○	○	○	○	○	○
Communicating with staff / other departments (3)	○	○	○	○	○	○

Q20 If you'd like to elaborate on any of your answers to the question above, please use this space to provide an explanation:

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____

End of Block: Trust in Tools

Start of Block: Block 3

Q21 Have you encountered any questions/issues that you think should be answered through the use of a tool, but haven't been?

- ◯ Yes (1)
- ◯ No (2)

Display This Question:

If Have you encountered any questions/issues that you think should be answered through the use of a... = Yes

Q22 Please explain these questions/issues and how you think a tool might help address this gap.

____

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Page Break

Q23 Have you observed any problems in the way that analytical tools are used or applied in the practice of community energy planning?

○ Yes (1)

○ No (2)

Display This Question:

If Have you observed any problems in the way that analytical tools are used or applied in the practi... = Yes

Q24 Please describe the problem(s) in the way that analytical tools are used or applied in the practice of community energy planning that you have encountered.

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Page Break

Q25 In general, what concerns do you have regarding the use of analytical tools in community energy planning?

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End of Block: Block 3
