NAVIGATING NET-ZERO

ROUTES AND ROADBLOCKS TO COMMUNITY EMISSIONS PLANNING

SERG 5004 Project
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Executive Summary

Given Canada's federal target of achieving net-zero emissions by 2050, community efforts to reduce emissions are critical. Communities are responsible for over 50% of Canada's energy use and GHG emissions (QUEST, n.d.). Given this, this report aims to identify barriers and routes for Canadian communities to initiate and implement net-zero emissions plans. In partnership with QUEST Canada, six unique Canadian communities were interviewed with a series of questions to better understand the community's aptitude in net-zero planning and various roadblocks to achieving their goals. As a practice in net-zero planning, a case study was undertaken based on common barriers that the interviewed communities face. This exercise examined a case where in Grande Prairie, an oil and gas resource-rich region, 50% of the pick-up trucks were electric vehicle models, with the hope to foster more conversation on the issue.

It considers net-zero through the lens of just and durability and explores the concept of implementation within the context of a clean energy transition. The analysis highlighted several key findings and areas of potential intervention. Investing in human resources as a low-cost solution can have cascading impacts on a community's net-zero planning. Regular monitoring and measurement by the communities show commitment and allow for quicker adaptation ensuring they are on the most efficient path to realize their goals. Recognizing that for Canada to meet its net-zero goal, everyone's effort is required, especially communities given their contribution to emissions. However, due to the complexities of interregional activity, emissions counting would be best done at the provincial level to prevent carbon leakage. This implies that collaboration of stakeholders and partnerships between communities, provinces, and the federal government are essential to implementing and realizing the net-zero target in a just and durable way.

Introduction

Canada is actively working towards achieving net-zero emissions by 2050 as a part of its greater efforts to address climate change and its adverse impacts. The efforts toward a net-zero economy require engagement and commitment from all units of society including provinces, territories, cities, Indigenous Peoples, youth, and businesses (Government of Canada, 2022).

Communities, the people of a certain district, neighbourhood, or town under one governing body, are significant energy consumers responsible for over half of Canada's energy use and greenhouse gas (GHG) emissions (QUEST, n.d.) and therefore net-zero emissions targets are not accessible unless communities develop and implement strategies to achieve and maintain the net-zero emission levels. They not only have the potential to contribute significantly to Canada's net-zero target, but they also stand to benefit from the lower GHG emissions including health benefits and climate change resiliency (QUEST, n.d.). Communities are defined by distinctive histories, geography, infrastructure, energy mix, and consequently emission sources, and yet they can learn from energy and emission strategies implemented in other communities and share their best knowledge and practices.

QUEST Canada (Quality Urban Energy Systems of Tomorrow) is a national non-profit established in 2007, that supports Canadian communities in their pathway toward net-zero emission and serves as a catalyst and repository for net-zero community planning. QUEST aids communities to understand, define and map pathways to net-zero by way of improving energy efficiency measures, cutting emissions, and promoting sustainability, economic development, and equality. As part of an effort for large-scale change, QUEST aims to have 500 Canadian communities implement durable and just net-zero strategies by 2030. The QUEST Benchmark initiative qualitatively assessed community energy planning and management. Following the success of the Benchmarking initiative launched in 2019, this project serves as a pulse check to gauge how nine of these communities are progressing in their net-zero planning (QUEST, n.d.) and to further foster net-zero planning conversation and awareness.

In recent years the frequency and magnitude of extreme events have increased due to climate change such as fires, floods, and temperature records with massive impacts on communities. A smart energy community has a framework for the assessment of climate-related hazards and risks that exist and are predicted in the future within the community and designs energy and emissions plans to build environmental protection and resiliency to the impacts of climate change.

The focus on communities helps policymakers to assess the impacts of community plans and strategies and identify short and medium-term outcomes and longer-term impacts achieved and compare the effectiveness of plans and approaches and identify those that worked well and those that were missteps that allow learning from success and failure. It also helps decision-makers and practitioners to determine trends and identify implementation barriers in energy and emissions planning.

Methodology

To understand the barriers and trends of community net-zero planning in Canada, nine communities of interest were selected for an interview. As a follow-up study from the QUEST Smart Energy Communities Benchmark Initiative, our study hoped to evaluate the same coast-to-coast communities as QUEST had used previously. These nine communities were initially chosen to best represent a diverse set of geographical and contextual factors (QUEST, 2019):

- London, Ontario
- Calgary, Alberta
- Bridgewater, Nova Scotia
- Grande Prairie, Alberta
- Beaconsfield, Quebec

- Markham, Ontario
- Inuvik, Northwest Territories
- Campbell River, British Columbia
- Yellowknife, Northwest Territories.

Unfortunately, due to various reasons such as staffing shortages and schedule conflicts, only London, Grande Prairie, Beaconsfield, Markham, and Campbell River were able to partake in an interview via Zoom. Bridgewater was able to provide interview responses via email, which by nature, resulted in less rich and detailed responses. The other three communities (Calgary, Inuvik, and Yellowknife) were unable to participate in any form of an interview, which was unfortunate particularly with Inuvik and Yellowknife as this removed the northern perspective from the project. This would have enriched our data and would have allowed us to understand different kinds of barriers than that of a more southern Canadian community.

For the interviews, in collaboration with QUEST, 20 questions were drafted to best understand the numerous factors of a Community Energy and Emissions Plan (CEEP), or a net-zero plan. The questions touched upon elements such as the community's definitions of net-zero, strategies and actions, actors responsible, measuring success, just planning, mobility planning, behavioural factors, and how circumstances have changed since participation in the Smart Energy Communities Benchmark. The full set of interview questions can be found in Appendix A.

Representatives from each community were first contacted and were provided with a set of interview questions to prepare. Where feasible, as mentioned, the Zoom platform was used to conduct the interviews as this allowed for more of a conversation to be had with each community. Responses were rich and thorough, and any confusion between us and the participants was avoided this way. In cases where a community was too busy to meet over Zoom, the option was given to provide written responses via email. However, this resulted in a much less in-depth set of responses.

Before attempting to gain an understanding of what the general trends and barriers are in the communities' CEEP or net-zero planning, certain factors had to be considered. As each community differs so greatly in terms of size, climate, politics, demographic, lifestyle, and primary sources of emissions, no community can be treated in the same fashion as another. For example, a smaller community with no industry and whose emissions stem primarily from residential heating in Quebec (e.g., Beaconsfield) faces different challenges than another community with a large population, is a hub between two major cities, and faces a lack of provincial support (e.g., London). While we attempt to draw broad conclusions, these differences must be taken into consideration as well.

For each community, based on the interviews and its CEEP or net-zero plan, an analysis was conducted by first providing an overview of the community's current situation and its long-term vision. From here, the main barriers and strengths of the community's plan were considered to understand where improvements could take place. Recommendations were then provided for each community to consider moving forward in its net-zero planning. This analysis was conducted to help the community, give ideas to other communities with similar issues, and for us to better understand routes and roadblocks to net-zero planning.

After the assessment of each community, general trends were drawn and the main barriers were identified that impacted most, if not all communities. From here, it became apparent that there was one key issue that was affecting almost all communities in reaching their goals – the transportation sector. Honing in on this issue, an exercise was completed to evaluate a hypothetical situation in one of the communities. Before delving into this however, a comprehensive analysis was conducted on the transportation sector that considers methods to reduce emissions in this sector, based on level of priority.

Next, using one of these critical methods to reduce transportation emissions, our team considered a case where in Grande Prairie, by 2030, 50% of the pick-up trucks are an electric vehicle (EV) pick-up truck model. The purpose of this case study is to consider the implications of this situation in terms of the environment, the electricity grid, the cost to truck owners, and the social and political factors that would be instrumental in planning for this situation. This exercise is not meant to be a blueprint of the steps Grande Prairie should take to achieve this number, but rather to foster a conversation around this topic and highlight key factors that communities should consider when planning for a similar issue, be it buildings, EVs, land-use planning, etc.

To tie together the case study and the interviews, the next section delves into considerations in net-zero planning. This includes an analysis and deep dive into three key terms: just, durable, and implementation. In essence, doing well in each of these categories relates to the success of a net-zero plan. This section looks at defining these terms, ways of measurement, and implications in net-zero planning. In addition, as a checklist for net-zero, an enhanced table of technical and policy principles to guide planning and priorities is featured.

As a final piece, the report ends with recommendations for net-zero planning. These recommendations can be for the communities that our group interviewed, for any other community, and for net-zero planning considerations in general to increase the likelihood of achieving targets in a just and durable manner. The recommendations are based on the routes and roadblocks identified throughout the interview stage, with the case study in mind as well.

Interview Results

Campbell River

Campbell River is a small city located on Vancouver Island in the province of British Columbia. It has a population of 35 519 which is an increase of 7.6% from 2016 to 2021 (Statistics Canada, 2022b). They received a score of 70% in the Smart Energy Communities Benchmark (QUEST, n.d.). We interviewed Jason Locke, the Manager of Long-Range Planning and Sustainability in the City of Campbell River. One of the key topics discussed was the city's outdated CEEP from 2011. It was understood that Campbell River faces labour shortages and a lack of resources, hence it has been unable to create and implement an updated CEEP or net-zero plan.

One major topic of discussion during the interview was on net-zero buildings. It was explained that British Columbia has a step code with five steps, where all new buildings must be net-zero energy by 2032. However, due to the aforementioned reasons for staffing shortages, Campbell River is not advancing any steps sooner than 2032, although new builds are already meeting Step 2 of the energy step code, which is good progress for the City.

During the interview, net-zero emissions planning and climate justice in the context of Campbell River were also discussed. According to Campbell River, climate justice is defined as a participatory and ongoing process that includes engaging with different stakeholders to prioritize resilience, adaptability, and durability. It was noted that the homeless population in the area is particularly vulnerable to the effects of climate change and the lack of emergency shelters is a serious concern. The city council is currently discussing locations for a shelter.

As a way to support residents, Campbell River has a municipal top-up program that provides a $300 rebate for households that purchase energy-efficient heating appliances. Although the program is open to everyone, we expressed concern that the rebate amount may not be sufficient to incentivize households to switch to energy-efficient heating appliances like heat pumps. Campbell River's sustainability manager agreed that the rebate may not be a big enough incentive, but it is better than nothing.

When it comes to electricity infrastructure, the city is currently not prepared to handle the anticipated increase in electricity demand due to the electrification of various sectors such as EVs and buildings. However, the city is working to update its master transportation plan, which will include an EV and active mobility strategy.

Overall, Campbell River is making strides in net-zero emissions planning and climate justice, with initiatives aimed at reducing carbon emissions and promoting sustainable energy practices. The city is taking a participatory approach, engaging with stakeholders, and promoting events to increase public awareness. However, as noted, the city still faces challenges including resource constraints and a labour shortage issue, which is hindering progress. Moving forward, this would be a good area for Campbell River to focus on – obtaining more qualified staff or hiring consultants to help the city progress towards the creation and implementation of a net-zero plan.

London

Situated in southwestern Ontario, the City of London is a fast-growing community of 422 324 people (as of 2021), featuring a 10% increase in population from 2016 to 2021 (Statistics Canada, 2022b). Previously, when the City of London participated in QUEST's Smart Energy Communities Benchmark, they received a total score of 73%, with an above-average score for each of the ten indicators, apart from Land Use Planning (QUEST, n.d.). From our interview with representatives of the City, Jamie Skimming (Manager of Energy and Climate Change) and Mike Fabro (Manager of Climate Change Planning), it is clear that the City of London's planning concerning climate change and net-zero is thorough, strategic, and well thought-out (full interview transcript is presented in Appendix B).

To address climate change, in April 2022, the City of London released its Climate Emergency Action Plan (CEAP)[1], which plans to achieve three main goals:

1. Net-zero community emissions by 2050
2. Improved resilience to climate change
3. Bringing everyone along

For the City of London, focusing on net-zero energy is not the priority as there could still be emissions associated with net-zero energy; rather, the focus is on net-zero emissions whereby in 2050, any residual scope 1 or scope 2 emissions that the City still emits must be offset by either natural or engineered CO_2 removal technologies. In addition to the community-wide 2050 target, the City's municipal corporate activities must be net-zero emissions by 2045.

As a strategy to achieve its targets, the City has created ten unique work plans with a total of 200 actions or tactics. Within each work plan, the key stakeholders and community partners are listed that will be working to implement the actions. While 200 actions may seem ambitious, the idea behind this was to gain as much traction in as many areas as possible concerning the CEAP's three driving goals. To the City of London, the purpose of these strategies and workplans is to guide the City towards its goals, whereas tactics are what deliver the actual impacts. While some of the 200 actions are very concrete, others are more vague. Regardless of how firm an action is, however, the City sees it as a win to at least have an action or tactic listed that they can then make proper steps towards.

To keep the City of London accountable to its net-zero initiatives and ensure durability, thorough measuring, monitoring, and providing feedback to outcomes is key. In particular, the City has committed to reporting annually to the committees and Council on what is and is not on track in the CEAP.

[1] The City of London's Climate Emergency Action Plan: https://getinvolved.london.ca/12452/widgets/49288/documents/85827

As noted from the interviews, the City of London does face some challenges in reaching its target of net-zero emissions. In particular, both provincial policy and the transportation sector were mentioned as being the largest barriers. In terms of provincial policy, the City of London feels as though they are not supported by the Province of Ontario in a net-zero context. Unfortunately, it seems there is a lack of provincial policy in support of climate change, which is a hurdle that the City of London must face when implementing its plans.

As one example regarding provincial policy, with new buildings, the Ontario Building Code is the bar that municipal building permit offices are allowed to judge new developments against. However, the Ontario Building Code is not in line with net-zero goals, hence this allows for buildings that rely entirely upon natural gas to be built. To prevent higher-emitting buildings to be approved and constructed, some communities that have green development standards must work around this and embed requirements in site planning or subdivision agreements for buildings to outperform the Ontario Building Code. However, the idea is that communities should not have to be strategic and work around provincial policy to meet their net-zero targets. Provincial policy and regulations should be supportive enough of climate change and net-zero such that communities do not have to go the extra mile to be in line with their goals.

Turning to transportation, one key point that was made during the interview is that London has a great dependency on personal vehicles. From the City's work plan on Transportation and Mobility, it's noted that the transportation sector is responsible for 47% of the community's local emissions, with personal transportation making up 1 million of the total 1.4 million tonnes of GHGs emitted from this sector (Get Involved London, n.d.). While there are numerous solutions and alternatives that the City can focus on to reduce transportation emissions (e.g., infrastructure for active modes of transportation, uptake of public transit, financial tools such as increased parking fees, and promotion of EV adoption), it is evident that there is a more systemic and behavioural component that is driving this high level of personal vehicle usage.

Fundamentally, before creating programs to increase public transit usage or active mobility, it is important to engage with community members to understand why residents are willing to pay so much per year to operate and maintain personal vehicles. The easy answer is their level of convenience, but how do they fare in comparison to alternatives? On a per-kilometre basis, personal vehicles are likely more expensive than public transit, for example, so why are residents choosing to pay more while emitting more?

Deeply engaging with the community could lead to answers such as the inconvenience of public transit, unreliability, inaccessibility, or even the cost. Based on these responses from residents, the City of London could then address the root causes of the issue by taking actions such as improved bus routes, better operations for reliability (i.e., planning such that buses are always on time), more frequent routes, or even marketing to show the cost comparison for a trip using a personal vehicle versus a bus fare. Using a more personal and tailored approach for London specifically will allow for the residents' concerns to be heard, and will likely increase the durability and success of reducing transportation emissions.

Bridgewater

Representing the smallest community that we interviewed, Bridgewater, Nova Scotia lies on the east coast of Canada with a population of 8790 (Statistics Canada, 2022b). In the QUEST Smart Communities Benchmark, Bridgewater scored an overall 72%, receiving an above-average score for six of the ten indicators (QUEST, n.d.). While the Town of Bridgewater does not have a net-zero plan, from our interview responses from Leon de Vreede, the Sustainability Planner/Coordinator of Bridgewater, the

Town has committed to the Cities Race to Zero[2] and is contemplating updating its emissions plans (full set of responses can be found in Appendix E). Instead, the Town's sustainability and energy plans are found in *Energize Bridgewater* – a community-wide initiative that is working to achieve a clean and affordable energy economy (Town of Bridgewater, n.d.).

The *Energize Bridgewater* initiative is led by the Bridgewater Community Energy Investment Plan (CEIP) which works to transform and accelerate the community and surrounding area to a sustainable energy future. This is defined by Bridgewater as "transitioning to a low carbon energy future, while enhancing quality of life and meeting the community's basic needs" (SSG, 2018b, p. 5). In terms of emissions, the pathway outlined in this plan achieves an 80% reduction in GHG emissions by 2050, compared to 2011 levels (SSG, 2018a). As this plan was approved by Council in 2018, this is likely why Bridgewater is considering creating an updated plan, as this target is conflicting with the Cities Race to Zero commitment. While an 80% reduction is impressive, there would still remain a net positive amount of emissions in 2050, 74 000 tCO_2e.

The *Energy Shift* pathway, as outlined in the CEIP, is guided by four core community values: clean – this relates to the 80% reduction in emissions; efficient – minimizing unnecessary consumption and waste; secure – a resilient energy system that can withstand economic shocks and climate events; and affordable – affordable energy for all community members (SSG, 2018a).

According to the town's sustainability planner/coordinator, Bridgewater's community energy and emissions planning is pursuing strategies to achieve just outcomes and is applying a lens of equity, diversity, and inclusion. As Bridgewater is located in Sipekne'katik on the unceded territory of the

[2] The Cities Race to Zero is a global campaign where cities commit to a series of pledges, including reaching net-zero by 2050, at the latest. The campaign allows cities to unite and support the goals and targets included in the Paris Agreement. More information can be found here: https://www.c40.org/what-we-do/building-a-movement/cities-race-to-zero/

Mi'Kmaq, in developing the CEIP, the Town had reached out to local Indigenous groups to incorporate their teachings in the Plan and to create an ongoing, mutually beneficial relationship moving forward (SSG, 2018a).

One recommendation for the Town of Bridgewater is to foster relationships and partnerships with surrounding communities. Many residents of Bridgewater commute to neighbouring communities and cities several times a week for work, shopping, and appointments. Most of these trips are likely being made with personal vehicles as there are no community-to-community public transit options. While the Town of Bridgewater does have public transit, it is limited to a small route within town limits. As a way of working with neighbouring communities to make progress towards community goals and even the federal net-zero target, it is important to work together on transportation and mobility planning, as communities are connected in this way. Ideas could include bike paths, car-sharing networks, increased public transit routes, and EV charging stations between communities. Collaboration and fostering conversations create a more unified and concerted effort in working towards climate targets.

Markham

The city of Markham, Ontario sits in the Greater Toronto Area and is home to more than an estimated 330 000 people (QUEST, n.d.). Scoring above-average marks in most categories with a total score of 72% in the Quest Benchmark initiative, Markham is notable for being a technology hub and home to a diverse community, with over 50% of residents identifying as visible minorities (Government of Ontario, n.d.).

Established in 2011, Markham's Greenprint Sustainability Plan included 12 community priorities, creating a strong foundation for proceeding clean energy aspirations. Building off this, the Municipal Energy Plan (MEP), established in 2014, was introduced to improve energy efficiency, reduce energy consumption, and achieve net-zero GHG emissions. Markham defines a net-zero energy emissions plan as “one that has greatly reduced energy needs through efficiency gains and conservation. Annual energy needs for vehicles, thermal, and electricity are met by sustainable and non-fossil fuel sources, carbon offsets and/or carbon sequestration feasible within Markham), resulting in an annual net-zero balance of greenhouse gas emissions” (Murphy et al., 2017, Pp.30). Net-zero goals are guided by three principles:

1. Reduce local energy demand across all sectors
2. Switch to renewables
3. Increase local renewable energy generation

Interim, time-based targets are identified until 2050 to ensure progression remains on target. The largest energy and emissions by sector are residential, transportation, and commercial (Murphy et al., 2017). Like many other communities, Markham does not have jurisdiction over certain contributing factors such as electricity generation and grid infrastructure. Bridging gaps between other interconnected municipalities for a stronger and more integrated grid is an agenda item for Markham and is seen as a win-win situation.

Although all three Markham staff who were interviewed, Jacqueline Tung, Jennifer Wong, and Gabriella Ansari-Correa, are industrious and are using all resources available, the net-zero goals are a hard-fought battle – the real enemy for progress being behavioural and mindset change. For Markham, community engagement is key. For example, strong partnerships with youth and the public are supported using social media and tabling of events – highlighted by the Annual Earth Month celebration.

As revealed during the interview, it is noted that many energy efficiency programs in Ontario are not sensitive to low-income households who experience energy poverty. As such, a feasibility study is in the works to explore options for such residents in Markham, creating a baseline to further understand households. This can then help to foster the development of strategies which promote the uptake of programs accordingly.

Leading by example, Markham has installed rooftop solar on community and corporate buildings as there is not a lot of potential for other renewables. They are also planning to convert its municipal fleet to EVs. To reduce the number of vehicles on the road, there is a plan for more bike lanes to connect the city end-to-end while also subsidizing bus passes and encouraging smart commuting and carpooling.

Markham's approach is not to necessarily focus on energy and emissions as the hard goal, but rather to challenge the community to be more energy focused. By addressing behaviour in this way, the causes of GHG emissions are challenged versus adapting to the effects of said emissions. Concentrating on specific areas instead of treating Markham as homogenous, allows for a better understanding of the localized nuances and strategies that would work best per district or neighbourhood.

New developments are on the horizon for Markham, which recognizes the planning of new neighbourhoods as an opportunity to adopt and further its community energy plans. Urban design strategies such as super-block modelling, passive design, and 15-minute neighbourhoods are all on the agenda for net-zero planning in Markham. These are designed with the intent of reducing vehicle traffic and using zero-waste building materials. However, it is acknowledged that such a tailored approach is resource-intensive.

Budget 2022 committed $150 million to the development of The Canada Green Building Strategy (GBS), set to be released this spring (2023), with the goal to create more net-zero and climate-resilient buildings from development, accelerate deep retrofits, and transform space and water heating (Natural Resources Canada, 2022). It is anticipated that the GBS will provide some solutions and aids to complement Markham's position, including providing solutions for low-income Canadians to improve energy efficiency outside the affordable housing sector and assisting with the procurement and adoption of clean/green building materials and design (Haley, 2022)

Beaconsfield

Beaconsfield is a community in Quebec with approximately 20 000 residents and a total score of 73% in the QUEST Smart Energy Community Benchmark (QUEST, n.d.). It is a community made up of 95% residential with no industrial sector. Institutions (such as churches and schools) and small businesses make up the other 5% of the community. In 2021, to improve the community climate change resiliency, Beaconsfield adopted an adaptation plan along with a corporate-level GHG reduction plan (emissions from corporate-owned buildings, street lighting, water and wastewater treatment, municipal fleet, and corporate and/or community solid waste) and set a 44% GHG reduction goal on corporate emissions by 2030 (corporate GHG emissions is 0.04 tonnes of carbon dioxide equivalent per capita at of the time of the interview, Fall 2022). Andrew Duffield, the director of sustainable development, considers two general approaches to achieving climate goals:

1. Setting a GHG reduction goal and identifying strategies to achieve the target which requires a statement and administrative efforts to determine how to make the statement possible.
2. Determining local opportunities to reduce emissions and estimating the emission reductions and designing a community energy and emission plan.

Beaconsfield takes the second approach and perceives this way as more effective and efficient. An advantage of this approach over long-term goal setting and initiating a political statement is that it sets the community's potential and possibilities as a priority. Determining what is feasible for residents is a critical step because it forms the foundation for the legitimacy and higher community uptake of energy and emissions initiatives. Otherwise, the plan may not get approved by the council and residents. Thus, instead of setting long-term targets, Beaconsfield focuses on finding short-term and intermediate-term (2030 or 2040, and not 2050) solutions with the cooperation of key internal and external stakeholders.

Given Beaconsfield's demographic, the residential profile is the greatest opportunity for the community GHG emissions reduction. 92 to 93% of residential buildings are single-family dwellings (houses with a backyard), therefore, for any plan to be successful must necessarily have buy-in from this group. Considering that the major residential emissions come from oil-burning heating systems, switching to heat pumps and electric heating systems saves significant energy use and emissions associated with combustion-based heating systems.

As a way of engaging with the community, Beaconsfield holds a climate action week every May since the adoption of the two plans in 2021. The idea is to provide a platform for the community citizens (residents, schools, and the commercial sector) to communicate with businesses, schools, and other citizens about available actions and opportunities.

One strength of Beaconsfield's strategy is to tailor the outreach activities by providing its residents with specific information about how to make the change. In addition to the information available on the municipality's website and a forum for interactive guides, Beaconsfield provides a personal exchange of information specifically for senior residents. The Green Patrol group goes house-to-house from May to August every year to promote changes following the completion of the adaptation and mitigation action plans.

In 2026 Beaconsfield will adopt long and intermediate targets and timelines to achieve specific actions.

Grande Prairie

The City of Grande Prairie is located in northwest Alberta, with a population of 64 791 as of 2022 (Government of Alberta, n.d.). The city is committed to being carbon-neutral in its operation activities by

2035. To reach this target, Grande Prairie has an energy strategy plan which creates the foundation for a shift towards efficient energy generation, reduction of GHG emissions, and conscious energy use community-wide. The energy strategy is based on three main pillars:

1. Major Energy Project – Hughes Lake area is located in the northwest section of the City of Grande Prairie, which is a potential location for a major energy project to generate electricity. This project is expected to generate affordable electricity using combined gas-fired generation along with carbon-neutral renewable generation (e.g., solar, geothermal, hydrogen, etc.). This location is ideal as it has access to rail and airports.
2. Community Energy – the City has done an inventory of emissions and its highest emissions come from the transportation sector, making up 38.8% of total emissions, as many people use personal vehicles to commute to the workplace. The City of Grande Prairie has asked for suggestions from community members to meet the emissions reduction target.
3. Carbon Neutral Operations Plan (CNOP) - The carbon-neutral plan will broadly identify energy and emissions reduction opportunities and recommend reduction targets, policies, and actions for becoming carbon-neutral.

Some strategies this city is taking to reach net-zero, as mentioned by Michelle Gairdner, Energy Manager of Grande Prairie, include a solar array of 500 panels that feed into the battery energy storage system, where transit buses are charged; an ICE rink resurfacer that will be electric; and a program called “Get Heated” in which the City provides electric blankets at the workplace to remove space heaters.

According to the interview responses, the City is facing several challenges to reach its net-zero target. The biggest barrier is related to transportation emissions, with personal vehicles contributing a significant amount, as mentioned above. Many residents in the city use pick-up trucks as their primary mode of transportation, and many individuals who work in the oil and gas industry as contractors and subcontractors use company vehicles along with their personal vehicles, further contributing to the emissions. A potential solution could be promoting EV adoption and advancement in the charging infrastructure to facilitate their use.

As per the policy challenge, the provincial government is more focused on heavy-emitting sources of energy, such as the oil and gas sector. As an example, the Government of Alberta has announced a Natural Gas rebate program, in which consumers will get a rebate on their utility bills (Government of Alberta, 2022). However, there is a lack of provincial policy related to climate change. Incentives and policies supporting renewables can be of huge significance to fostering the development of renewables and reducing emissions.

Currently, the electricity generation in the province is mainly from natural gas, with solar and wind farms accounting for only about 10% of the generation (Government of Alberta, 2019). One of the reasons as mentioned by the City's Energy Manager is that solar is not operational during the cold-weather months due to harsh winter conditions, hence it can only be operated from March to October. This presents a challenge to achieving their net-zero target.

A holistic approach that addresses all aspects of the energy systems is necessary to achieve the net-zero target of the City. This includes the adoption of EVs and the development of renewable energy projects. Moreover, a collaboration between the city, provincial government, and private stakeholders is essential to drive the implementation of these solutions. This approach will help to reduce the emissions from the transportation sector and development of renewables.

General Trends

A net-zero emissions target means that any GHG emissions from the economy are balanced by equivalent amounts of GHG removals from the atmosphere. The target is often associated with a year –

usually 2050 which follows the federal government's target. Identifying the major emissions sources and initiating provisions to reduce emissions in those sectors is what all communities are focusing on regardless of the size, energy mix, and other differences.

One general trend observed within the communities is that the residential sector and transportation are the major GHG polluters, with heating systems being the highest GHG contributor in the residential profile. In London (Ontario) and Grande Prairie (Alberta), the major GHG emissions come from the transportation sector. As noted, the residents of London are highly dependent on personal vehicles and Grande Prairie has a "truck culture" according to community representatives. Apart from behavioural reasons, this might be in part due to insufficient infrastructure and services or a lack of incentives for active and public modes of transportation.

Battery EV uptake in most communities has increased considerably during recent years and, most communities have active and public transportation plans in place such as sidewalk development, bike repair shops, bike racks, pass plans, etc. The Grande Prairie interview revealed a lack of an integrated transportation system with policy provision being a fundamental barrier toward mobility plans. Renewable energy share (excluding hydro) tended to be low in communities, which is partially due to the economic infeasibility of renewables capacity promotion. Renewables' current capacity and future development plans are mostly limited to solar.

The interviews revealed that financial support from the provincial government plays an important role in designing and implementing community energy and planning. While Beaconsfield receives financial support from the provincial government of Quebec, provincial support seems to be a larger barrier in Grande Prairie (Alberta), or Campbell River (British Columbia).

Table 1 summarizes the trends found in the interviewed communities.

Table 1: Overview of Community Interview Findings

Community	Barriers	Area of focus
Campbell River	1. Shortage of staff	• Transportation: adding bike lanes and making buildings EV ready • Green Buildings: focusing on net-zero buildings and using solar hot water systems • Power Down Campbell River: offering incentives for efficient heating systems • Carbon Neutral Plan: retrofitting municipal buildings
Beaconsfield	1. Transportation; Lack of public charging stations 2. No authority on public transportation	• Short-term and intermediate-term solutions (2030 or 2040) with the cooperation of key internal and external stakeholders • Switching to heat pumps and electric heating system • Converting non-essential vehicles to 100% EVs for the municipality
London	1. Provincial policy 2. Car dependency	• Climate Emergency Action Plan: focusing on net-zero emissions and improved resilience to climate change • 10 work plans with 200 actions • Annual reporting on progress toward goals
Markham	1. Transportation and residential 2. Behavioural and mindset change for uptake of strategies 3. Provincial government	• Transportation: Planning to convert all of its fleet to EVs • Developing a comprehensive public awareness campaign to educate residents on smart city initiatives • Fostering partnerships and collaboration with businesses, educational institutions, and community organizations to support innovation and technology adoption
Grande Prairie	1. Pick-up truck culture 2. Lack of policy that supports net-zero	• "Get-Heated" program in which they provide electric blankets and remove space heaters • Carbon neutral operational plan – identifies energy and emissions reduction opportunities • Major energy project
Bridgewater	*	• Emissions reductions of 80% or more by 2050 • Economic outcomes: employment opportunities, stimulating investment, and lower energy costs

*Not apparent from interview results

Transportation – How to Effectively Reduce Emissions

As indicated in Table 1, the transportation sector was identified as a major barrier to achieving a net-zero target by almost all interviewed communities. Whether it be due to a lack of infrastructure to support alternatives or a deep culture that has been developed around the reliance on personal vehicles, many communities struggle to implement effective strategies that can result in profound change.

Background

This experience of struggling to reduce emissions in the transportation sector is likely non-unique for many other Canadian communities as well, given Canada's statistics relating to transportation. This sector is a huge source of emissions in Canada, representing 25% of total GHG emissions in 2019 – the second largest source of emissions in the country (Environment and Climate Change Canada, 2022). This statistic is not surprising given that in 2019, approximately 95% of Canadians had vehicle ownership (Statistics Canada, 2022a; Statistics Canada, 2022b) – a staggeringly high number in comparison to other countries that are more well-known for sustainable modes of transportation, such as the Netherlands, who had a rate of vehicle ownership of approximately 54% in 2020 (Statistics Netherlands, 2020).

While Canada's large geographical area and unique climate conditions make a decarbonized transportation system difficult to achieve, this does not imply that there is nothing for Canadian communities to strive towards. Between urban design, cycling infrastructure, efficient public transport, and zero-emitting vehicles, there are changes communities can make to reduce transportation-related emissions. For these reasons, having thorough and wide-reaching strategies for transportation in community net-zero planning is essential.

The Sustainable Accessibility and Mobility (SAM) Framework, developed by the Royal Town Planning Institute (RTPI) (2021), outlines three strategies to help planners in developing tools to reduce emissions in the transportation sector. They are listed by priority in the following order:

1. Substitute trips: Containing travel within a community; making necessities available either locally, online, or by delivery.
2. Mode shifting: Use of active, public, or other shared forms of transport for longer trips, in place of private vehicle trips.
3. Fuel switching: In cases where trips by passenger car are necessary, use zero-emitting vehicles.

The idea behind this framework is to first reduce as much travel as possible. Then for cases where travel is necessary, prioritize public modes of transit, or as a last resort, use electric or hydrogen vehicles. This principle is very similar to the idea behind any net-zero energy and emissions work – reduce as much as possible, then substitute with renewables or abate with carbon removals where needed.

For this type of framework to be successful, there are several strategies that communities could use to enable a reduction in transportation emissions. For the first principle – substituting trips, infrastructure is key (RTPI, 2021). From active travel networks, land-use planning, and IT support, infrastructure can enable residents to stay within their community for needs, have access to online services, and conveniently make use of active modes of transportation while feeling safe doing so. This involves a genuinely connected network; flexible pick-up and drop-off locations for last-mile deliveries, such as hubs; local amenities within a short and convenient distance (e.g., the 15-minute neighbourhood[3]); fast broadband wireless networks; and the online availability of services (e.g., health professionals) and options to work and study remotely.

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[3] The 15 Minute Neighbourhood, according to the City of Ottawa: https://engage.ottawa.ca/the-new-official-plan/news_feed/15-minute-neighbourhoods

Regarding the second principle – mode shifting, the availability and accessibility of shared forms of transportation, street designs, and certain fiscal measures can encourage residents to make the switch away from private passenger vehicles (RTPI, 2021). Some examples of this include car and bike sharing; integrated and rapid forms of public transport; low-traffic and car-free zones or neighbourhoods; bus priority traffic lights and lanes; and certain financial disincentives, such as parking fees and fuel taxes.

For the last and final priority of the SAM Framework – fuel switching, there are also several strategies to promote the use of zero-emission vehicles (ZEVs). Similar to the first set of enablers for trip substitution, infrastructure plays a large role. Without the proper infrastructure to support ZEVs, such as EV and hydrogen fuel cell charging stations (at shops, stations, and work), as well as residential support for EVs (vehicle-to-grid technologies and support for charging in multi-family homes), community members are unlikely to make the transition from Internal Combustion Engine vehicles (ICEVs) to ZEVs (RTPI, 2021). Aside from infrastructure, leading by example can also encourage the uptake of ZEVs. This could involve the conversion of the municipal fleet, commercial delivery and servicing fleet, and public transport fleet to ZEVs. Lastly, financial mechanisms such as grants to trade in ICEVs for EVs can also work to promote fuel switching.

Analysis

Mobility and transportation planning seem to be an important focus for most communities in this study. While the transportation sector may not be the largest source of emissions for each community, in general, efforts are being made to support EV uptake and create safe and accessible active transport infrastructure.

Using the SAM Framework from above, some examples of actions that communities are taking to reduce transportation emissions include but are not limited to, developing infrastructure to support active transportation; strategies to increase the usage of public transit, including making routes more efficient and demand-responsive; creating car and biking sharing services (e.g., Communauto); and infrastructure to support EV adoption and usage, such as EV charging stations throughout the community and in new multi-family homes. Table 2 shows which communities are utilizing and taking advantage of these actions and strategies.

Table 2: Overview of strategies to reduce transportation emissions in the interviewed communities

	Substitute Trips	**Mode Shift**		**Fuel Switching**
Community	**Plans to increase active transportation?**	**Plans to increase usage of public transportation?**	**Car and/or bike-sharing service plans?**	**Infrastructure to support EVs?**
Campbell River	Yes	No	No	No
London	Yes	Yes	Yes	Yes
Bridgewater	Yes	Yes	No	No
Markham	Yes	Yes	?	Yes
Beaconsfield	Yes	No	No	Yes
Grande Prairie	Yes	Yes	No	No

As seen in Table 2, the most consistent strategy to reduce transport-related emissions is through improving and creating infrastructure to support active modes of transportation. This could include bike lanes, sidewalks, and interconnected paths to move around the city. For example, in the case of Beaconsfield, the community has 125 kilometres of road, yet only 30% of this has sidewalks, so installing infrastructure such as a bike network and sidewalks is a priority of their Active Mobility Plan.

One vital but lacking element in most of the communities' energy and emissions plans is a strategy to address the behavioural component of transportation. It is one thing to create bike lanes, have public transit, and have EV charging stations, but without the push to motivate individuals to look at alternatives to using their personal vehicle each day, only so much progress can be made. In the case of Grande Prairie, from our interview with Michelle Gairdner, vehicle ownership seems to be a conflict for emissions reductions. Not only does the average household tend to have several vehicles, but many individuals own and drive pick-up trucks as their primary mode of transportation. While this is a necessity to some for work-related purposes, the average citizen who is going to their office job is unlikely to require a pick-up truck to arrive at work. This is a large issue for not only Grande Prairie but many other communities across Canada due to the cultural shift of a large pick-up truck being attributed to affluence.

While shifting the behaviour of community members is a difficult and complex feat, it is something that must be addressed if transportation emissions are going to decline sufficiently to achieve net-zero emissions.

Case Study

The city of Grande Prairie, located in the northwest part of Alberta, has a goal to become carbon neutral by 2030. As mentioned above, the City has identified the transportation sector as a major barrier, with personal vehicles, in particular pick-up trucks being a significant contributor. For this reason, the case study is on the "Adoption of Electric Vehicles". While it would be most effective for most users to switch away from personal vehicles altogether, considering the deep-rooted behavioural component of Grande Prairie, this study focuses on the easiest method to reduce emissions, as identified in the previous section – fuel switching.

This case study assumes 50% of the pick-up trucks in 2030 are the EV pick-up truck model (F-150 EV Lightning), and the other 50% are the traditional internal combustion engine (ICE) pick-up truck model (F-150). This analysis will help to assess the feasibility of the EV uptake and estimate the reduction in emissions that could result from the widespread EV adoption in the city.

In 2020, 40% of vehicle registrations in Grande Prairie were pick-up trucks (Government of Alberta, 2023). In a ten-year period from 2010 to 2019, the total number of pick-up truck registrations in Grande

Prairie increased by around 9%, from 22 667 to 24 718. Assuming the same growth rate from 2020 to 2030, the total number of pick-up trucks would be approximately 26 000.

In addition, for calculation purposes, we assume that the user will drive the truck an average of 60 kilometres (km) per day, for a total of 21 900 km per year. The 60 km value comes from the assumption that the user will drive 20 km to-and-from work each day, with an extra 20 km for leisure or errands. It is noted that this value could be much higher or lower, but for calculation purposes, the actual km driven per day does not influence the end result, as the emissions, grid, and financial calculations are proportional to the amount driven. That is, each of these calculations could be interpreted on a per-kilometre basis, which is independent of the total driven per year or day.

This case study includes an analysis of emissions which will estimate the potential reduction in emissions from the widespread EV adoption. Additionally, an economic analysis is conducted to see the upfront and ongoing cost associated with the EV transition, from an owner's perspective. Furthermore, the study examines the impact of EV adoption on the electricity grid, through a grid analysis which highlights the importance of smart charging to manage the increased electricity demand. The study also considers the environmental impact, in particular the importance of recycling batteries to minimize the impact of battery disposal. Lastly, the case study includes a social and political assessment considering the just, durability, and implementation of the EV transition.

Economic Analysis

To compare the life cycle cost of the two models, total ownership cost and vehicle cost per km were calculated for the F-150 XLT Standard Range and the F-150 Lightning XLT Standard Range, model year 2023. The vehicle lifetime cost calculations and assumptions are meant to represent the total cost of vehicle ownership from the perspective of the buyer, not at a system level. The cost components are:

- Cost of the vehicle (depreciation): this component is the upfront cost (capital cost) minus the present value of the resale price of the vehicle after 8 years (in 2030).
- Fuel cost: this is part of the operation cost per year that is expected to be the major benefit or savings of the EV model. The regular gasoline price ($ per litre) and the electricity rate ($ per kilowatt hour) were used in the calculation for the F-150 and the F-Lightning, respectively.
- Maintenance and repair costs: these costs are expected to be lower in F-lightning (80% of the F-150 maintenance cost) especially within the 8-year timeframe of our analysis, since Ford offers eight years of warranty with at least 70% retention of the original battery (Ford Motor Company, n.d.a).
- Insurance cost: the Automobile Insurance Rate Board (AIRB) is the regulatory body that sets the maximum premium rates that insurance companies in Alberta can charge for basic coverage. According to the AIRB, the maximum rate for basic coverage in Alberta in 2021 is $1316 per year (AIRB, 2021). Our calculation assumes that an EV insurance cost is 80% lower that its conventional counterparts.
- Taxes and fees: In Alberta, when a new or used vehicle is purchased, the following fees must be paid (Government of Alberta, n.d.):
  - GST (Goods and Services Tax): 5% of the purchase price of the vehicle.
  - AMVIC (Alberta Motor Vehicle Industry Council) fee: $6.25 for every $1000 of the purchase price of the vehicle.
  - Vehicle Registration Fee
  - License Plate Fee

Table 3 summarizes the cost components and their resources.

Table 3: Cost Component Sources

Costs	Cost Occurrence	Data Source	Year
Cost of Car	Upfront	Ford Canada	2023
Fuel Cost	Annual	Natural Resource Canada	2023
Maintenance and repair cost	Annual	Palmer et al.	2018
Insurance Cost	Annual	ARC Insurance	2020
Taxes and fees	Upfront	Government of Alberta	n.d.

Below are the steps that were taken in the ownership cost calculation:

- Defining the functional unit of analysis which is one kilometre driven
- Collecting data including data on the cost components and resale value
- Calculating the present value of annual costs for the lifetime of the vehicles (8 years)
- Summing the present value of upfront and annual cost components to determine the total life cycle cost of the vehicle or total ownership cost
- Dividing the total ownership cost by the total kilometres driven in 8 years to find vehicle cost per kilometre

The assumptions made in this calculation are:

- Fuel costs: fuel consumption ratings search tool (Natural Resources Canada, 2023) was used for annual fuel cost estimations. Estimated annual fuel cost is based on a driving distance of 22 000 km, and prices of $1.25/L for regular gasoline and $0.15/kWh for electricity.
- Maintenance costs for EV cars are based on Palmer et al. (2018), where costs for trucks are assumed to be 1.5 times more expensive and an exchange rate of 1.33 was used to convert USD to CAD (Canada Energy Regulator, 2017). After that, we assumed that the maintenance cost in Canada is 10% higher than that of the US due to weather and exposure to snow salts.

Since EVs have fewer moving parts than conventional models and do not require oil changes, their maintenance costs are expected to be lower (U.S. Department of Energy, 2017c). However, the maintenance cost depends on many factors, including the weather conditions and how the owner uses the vehicle. We assume the same maintenance costs for each year in the analysis, as limited literature exists for projected costs. According to NREL (2017), rapid technological advancement lowers light-duty electric vehicle development by 50%.

- Other assumptions include a 7% discount rate and 22 000 km driven annually. We assumed that after 8 years 53% of the vehicle is depreciated (after 15 years of lifetime, the vehicle is valued at $0) which would give the resale value of the vehicle and is a value in 2030 (that was discounted for its present value in 2023).

Figure 1 shows the breakdown of the vehicle cost per kilometre by nominal cost component, meaning the inflation impacts of costs have not been considered.

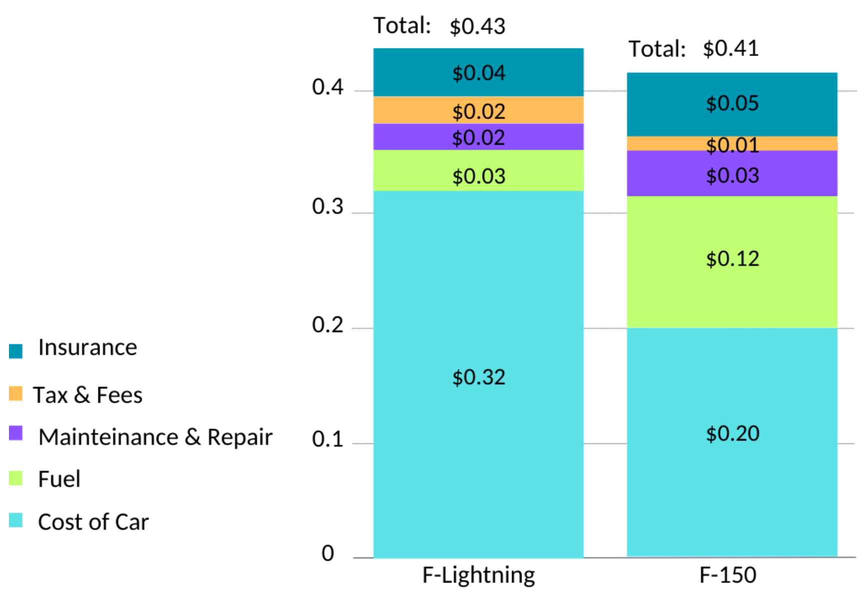


Figure 1: Comparison of vehicle cost per kilometre and cost breakdowns (nominal)

The price of an EV is a major barrier for many buyers. Buyers face a trade-off between the larger upfront cost of an EV against the higher fueling and maintenance costs of an ICE vehicle (Clean Energy Canada, 2022). A buyer in Alberta would have to pay about $30 000 (Ford Motor Company, n.d.a; Ford Motor Company, n.d.b) more upfront for the EV model and yet the per kilometre cost of the vehicle is 2 cents lower for the ICE model, 41 cents per km. Table 4 compares the starting sticker price, total ownership cost, and the cost of the vehicle per kilometre driven.

Table 4: Cost comparison of pick-up truck models

Model	Starting Price	Total Ownership Cost (Nominal)	Vehicle Cost per Km (Nominal)
F-Lightning	$79 000	$76 185.25	$0.43
F-150	$49 225	$72 277.58	$0.41

Emissions Analysis

In this section, the operations emissions are compared on a per-year basis for the EV model of the pick-up truck, versus the ICE model. This includes the tail-pipe emissions (exhaust) from the ICE model and the emissions associated with the electricity demanded during charging from the electricity grid for the EV model. It is noted that these calculations are not comprehensive of all the emissions associated with each model, as scope 3 emissions coming from activities such as manufacturing and raw material extraction and transportation are omitted. The following section will touch upon these points, however, these values are difficult to calculate and are greatly dependent on regional considerations.

Emissions from the ICE model on a per-kilometre basis are mostly unvarying and only differ for the driving style (city driving versus highway driving) and the efficiency of the vehicle model, which only changes by model year. For this analysis, the 2023 F-150 XLT model with a 2.7L EcoBoost® engine was selected for the ICE model. It has a mileage of 12 L/100 km for city driving, 9.2 L/100 km for highway driving, and a combined value of 10.7 L/100 km, which is the value that was considered for this analysis

(Ford Motor Company, n.d.b). This model burns gasoline, which produces 2.3 kg of CO_2 emissions per litre of gasoline consumed (Natural Resources Canada, 2014). From this information, the emissions per year for the ICE model can be calculated as:

$$\text{Emissions/year} = \frac{10.7}{100}\ [\text{L/km}]\ \times 2.3\ [\text{kg } CO_2/\text{L}]\ \times 60\ [\text{km/day}]\ \times 365\ [\text{days/year}]$$

The above equation gives 5389 kg CO_2 per year for one truck. Multiplying this value by 13 000 to account for all the ICE pick-up trucks in 2030 results in 70.1 kilotonnes (kt) of CO_2 per year.

The emissions from the EV model involve a bit more of a complex procedure. Here, regional effects must be taken into consideration, as the emissions resulting from the EV model are highly dependent upon the regional electricity grid mix. Historically, in comparison to other provinces, such as Quebec which relies predominantly on emission-free hydropower, Alberta's grid has significant emissions associated with it due to its fossil fuel resources. Thus, for this calculation, it is important to consider Alberta's mix, particularly for 2030. While data is not available for Grande Prairie itself, the Alberta Electric System Operator's (AESO) 2021 Long Term Outlook (LTO) features scenarios that predict electricity load and generation requirements for 2030[4]. These scenarios reflect uncertainty about the economy, future policies, and technologies. The four scenarios are the Reference Case, Clean-Tech, Robust Global Oil and Gas Demand, and Stagnant Global Oil and Gas Demand (AESO, 2021).

For the emissions analysis in this report, emissions were calculated for all four scenarios to reflect the uncertainty of knowing the breakdown of the grid in 2030. The AESO Long Term Outlook provides data on the predicted output of each generation technology, E_i, (e.g., coal, gas, hydro) in gigawatt-hours (GWh) per year. Using the total generation, the percent make-up for each generation technology i can be calculated for each scenario as:

[4] Alberta Electric System Operator 2021 Long Term Outlook: https://www.aeso.ca/assets/Tariff-2021-BR-Application/Appendix-K-AESO-2021-Long-term-Outlook.pdf

$$\% \text{ generation}_i = \frac{E_\text{i} \text{ [GWh]}}{\sum_i E_i \text{ [GWh]}}$$

The AESO LTO also provides data on the per-year emissions that would occur based on assumptions surrounding electricity demand, emissions factors, and capacity factors. Using the annual emissions for the technologies, e_i, the emissions intensity for each generation technology in tonnes per GWh can be calculated:

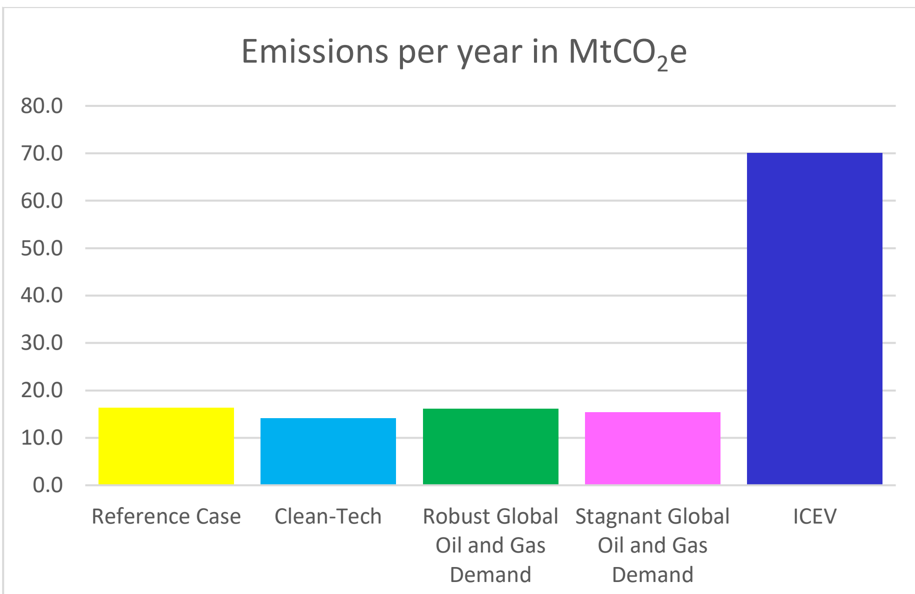
$$\text{Emissions intensity}_i \text{ [tonnes } CO_2\text{/GWh]} = \frac{e_i \text{[tonnes } CO_2\text{]}}{E_i \text{ [GWh]}}$$

Considering the EV pick-up truck model now, the 2023 Ford F-150® Lightning® XLT was assessed. As a standard, this model has a range of 386 km (Ford Motor Company, n.d.a). For the 60 km of travel per day, this model would need to be charged for an approximate total of 61 times per year. The standard battery has a capacity of 98 kilowatt-hours (kWh) (Ford Motor Company, n.d.a). To account for 61 charges for each of the 13 000 EVs, a total of 77.5 gigawatt-hours (GWh) per year would be needed from the grid. From here, the annual emissions for charging 13 000 EV trucks in Alberta can be calculated as:

$$\text{Total emissions} = 77.5 \text{ [GWh]} \times \sum_i \text{Emissions intensity}_i \left[\frac{\text{tonnes CO}_2}{\text{GWh}}\right] \times \% \text{ generation}_i$$

A range of emissions from 14.1 $ktCO_2$ to 16.3 $ktCO_2$ was found for the different electricity grid scenarios, with the lower end reflecting the Clean Tech scenario, and the higher end representing the Reference Case. A comparison to the ICE model is shown in Figure 2 where the four bars on the left represent the EV model's emissions under different grid mixes, and the right bar represents the ICE model. From this analysis, it is clear that for Alberta in 2030, regardless of the grid, the EV pick-up truck model would result in substantially fewer emissions per year than the ICE model. In fact, on average, the EV model would emit 78% fewer emissions than the ICE model.

Figure 2: Emissions comparison between EV and ICE model of pick-up truck



As learned from our interview with Grande Prairie, given that pick-up trucks are part of the lives of so many residents, this switch to EV models would have a profound effect on community emissions and the ability to reach net-zero. However, as mentioned above, pick-up trucks make up approximately 40% of vehicle registrations in Grande Prairie. This makes achieving net-zero much more problematic as pick-up trucks have significantly higher fuel economies than sedan vehicles. For example, the 2023 Chevrolet Bolt EV (sedan) has a battery size of 65 kW (Chevrolet, n.d.). Carrying through the calculations as done before, this would be equivalent to 44.5 GWh needed from the grid to power 13 000 Bolt EVs for a year;

this is 42% less electricity than what is required for the EV truck, and consequently 42% fewer emissions. Additionally, this would result in an average 87% reduction in emissions compared to the ICE truck, as compared to the 78% reduction from the Ford Lightning EV.

This analysis was conducted to demonstrate the emissions reductions that could result from technology switching while keeping the current lifestyle, as a way of fostering a just transition for the residents of Grande Prairie. In reality, however, a transition that is more supportive of net-zero targets would focus on a shift away from pick-up trucks wherever possible, resulting in much greater emissions reductions. As seen from Figure 2, while the EV model has significantly fewer emissions in comparison to the ICE model, there are still notable emissions occurring from EV charging. A sedan EV model would result in even fewer emissions, however other transformations such as active modes of transportation, electric buses, and others would result in the greatest emissions reductions, as described in previous sections. Although, it is understood that in some cases pick-up trucks are necessary for farming activities and some other jobs. For these circumstances, this analysis shows that switching to EVs can result in substantial emissions reductions.

Environmental Analysis

This section discusses the environmental factors to consider when transitioning to EVs. It focuses on the production of batteries and the importance of recycling them properly.

Battery Production

An EV's carbon footprint from production is double that of an ICE vehicle's (McKinsey, 2023). The energy and materials used in the production of EV batteries contribute huge amounts of GHG emissions. The key factors that contribute to GHG emissions in this process are:

1. Raw materials: The extraction and refining process of active materials.

The production of EV batteries requires significant amounts of raw materials such as aluminum, lithium, cobalt, and nickel. The extraction of these materials can have negative impacts on the environment. For example, the mining of lithium uses huge amounts of underground water which get lost in the process, and cobalt mines produce toxic residue which can poison the groundwater. In addition, the refining, and supply chain of the raw materials can be an energy-intensive process, which can generate emissions.

The aluminum extraction carbon footprint for the EV battery can range from 10 to 25 kg of CO_2 per kWh, depending upon the electricity grid mix. This represents around a quarter of the emissions from battery manufacturing (Kelly et al., 2020). Producing aluminum through recycling uses only a small fraction of the energy needed for primary production. By using recycled materials, the emissions related to battery aluminum production can be greatly reduced.

2. Battery manufacturing: The manufacturing of anode and cathode materials.

   The key contributor to the GHG emissions in battery manufacturing is the energy required during cell assembly. This requires extreme heat and high temperatures of around 50°C to 160°C (McKinsey, 2023). Around 80% of the emissions in battery manufacturing come from the natural gas used to supply heat for electrode drying (International Energy Agency [IEA], 2020). The carbon footprint could be reduced if the companies could electrify the production process, and using renewable energy sources could help to reduce emissions by 25%. For example, China currently uses coal for its energy production process, which results in an emissions-intensive production process. By contrast, Sweden has maintained a low level of emissions from battery production from their cleaner sources of energy (McKinsey, 2023).

According to a study by Qiao et al. (2019), EVs emit more GHGs during the manufacturing phase but less during the operation phase. For this reason, to reduce the environmental impacts, it is important to reduce the emissions during the manufacturing phase. Recycling batteries and using recycled materials for new battery production could result in reduced emissions (Qiao et al., 2019). Moreover, the sourcing of the energy used has a large impact on emissions, whether the energy is produced from fossil fuel sources such as natural gas or renewable energy sources like solar and wind power.

Recycling

The recycling of EVs could help to reduce GHG emissions and the environmental impact. It enables the recovery of critical materials, leading to a reduction in demand for raw materials and fewer negative impacts associated with mining and refining. Moreover, domestic recycling enables countries to reduce their reliance on imports for critical materials.

When EV batteries reach the end of their useful life, they possess a serious environmental challenge. Batteries contain toxic materials which can contaminate soil and groundwater if they end up in landfills. Recycling these batteries could help to reduce these impacts. As mentioned, the production of new batteries can require a significant amount of energy, which can lead to the emission of GHGs. EV recycling can help reduce about 35% of energy consumption and GHG emissions during its manufacturing phase (Qiao et al., 2019).

Overall, recycling an EV battery is an important step toward a sustainable future. It helps to conserve resources, reduce GHG emissions, and protect the environment and public health. As the EV market grows, it is important to introduce an efficient recycling policy to ensure less waste generation and more sustainable development.

Grid Analysis

In this section, the effects on the power system from 13 000 EV trucks are analyzed. Based on the aforementioned items, these are the assumptions taken for this analysis:

- Distance travelled per day = 60 km
- Range of truck = 386 km
- Frequency of charge = 6 days
- Number of charges per year = 61
- Battery size of truck = 98 kWh
- Total kWh per year taken from the grid (1 truck) = 5962 kWh
- Total number of trucks 2030 = 13 000
- Total GWh per year from the grid (all trucks) = 77.5 GWh

According to the International Energy Agency's (IEA) Global EV Outlook 2020 report, as the number of EVs on the road continues to grow, the electric grid will need to adapt to handle the increased demand for electricity (IEA, 2020). This transition will require significant upgrades to the existing grid infrastructure and the implementation of innovative technologies and policies.

One key challenge for the electric grid is managing the charging demand of EVs. To ensure that the grid can handle the extra load from EV charging, utilities will need to implement smart charging systems that can communicate with EVs to adjust charging times based on grid conditions. This will help to avoid overloading the grid during peak hours and ensure that EV charging is distributed more evenly throughout the day.

Another important aspect of grid management is the integration of renewable energy sources such as solar and wind power. As EVs continue to grow in popularity, the electricity demand will also increase, and utilities will need to rely more on clean energy sources to meet this demand. By integrating renewable energy sources into the grid, utilities can reduce their reliance on fossil fuels and ensure that the grid can handle the increased demand for electricity from EVs. The electric grid will also need to be upgraded to handle the increased capacity required for charging EVs. This will require investments in new infrastructure such as charging stations and battery storage facilities to ensure that EVs can be charged quickly and efficiently. According to the IEA's report (2020), with careful planning and collaboration between utilities, regulators, and the automotive industry, it is possible to create a more sustainable and efficient energy system that can handle the demands of an electrified transportation system.

According to ICF Canada (2021), Canadian utilities are ready for EVs at the transmission level but at the distribution level, it is a different story. However, the distribution system cannot simply be upgraded as it is very costly. Upgrading transformers and distribution lines in a distribution system can vary widely in cost depending on several factors (National Renewable Energy Laboratory [NREL], 2018). These factors include the size and complexity of the system, the age and condition of the existing infrastructure, and the specific upgrades required to meet the system's needs.

In general, transformer upgrades tend to be more expensive than distribution line upgrades, as transformers are critical components that require careful engineering and testing to ensure they are sized and configured correctly for the system's needs (NREL, 2018). The cost of transformer upgrades can range from several thousand dollars for small single-phase transformers to tens of millions of dollars for large three-phase transformers that serve entire neighbourhoods or communities.

As mentioned, distribution line upgrades are less expensive than transformer upgrades but can still be significant depending on the scope of the work needed. Upgrades may include replacing or upgrading existing lines, adding new lines to support increased capacity, and installing new equipment such as switches and capacitors to improve system performance. The cost of these upgrades can vary widely depending on factors such as the length and complexity of the lines, the terrain and environmental conditions, and the availability of equipment and labour (NREL, 2018).

To manage this demand for electricity coming from EVs while avoiding some of the millions of dollars worth of large infrastructure costs mentioned above, smart charging systems can be used. They include mechanisms such as demand forecasting and intelligent charging applications. One example of that is currently used by Fortis Alberta called Optiwatt.

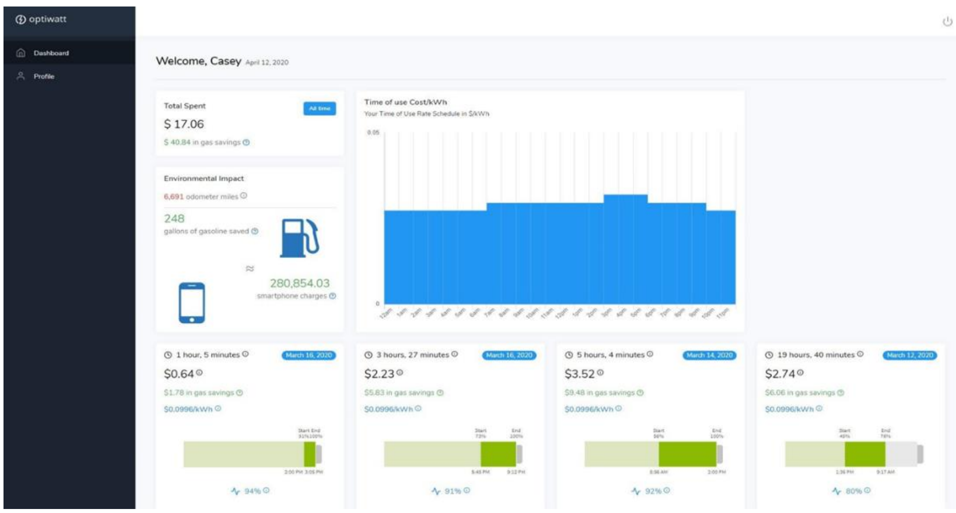


Figure 3: Optiwatt dashboard example

Figure 3 shows an example of the Optiwatt dashboard. It gives a summary of charging times, the amount of money saved, as well as the environmental impact. The low prices at off-peak times can motivate users to shift their charging time from on-peak to off-peak. This application is being tested in certain areas to check the EV readiness of the system and the strength of the grid because of this extra load. Two types of charging options available, "Cheapest" and "Optimized". The "Cheapest" setting schedules a user's car to charge only during the cheapest electricity rates, while the "Optimized" plan allows the user to set a desired target battery level and will automatically charge the car for the cheapest possible price. Utility companies in Grande Prairie could use this app to implement active and managed charging to mitigate grid impacts and save customers money by avoiding costly upgrades (Grace, 2022).

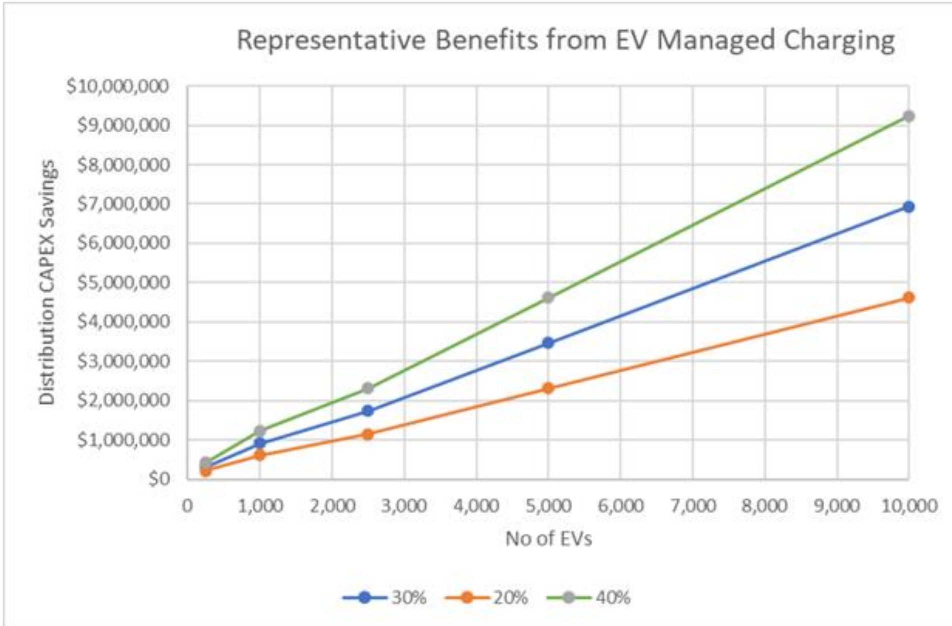


Figure 4: Savings from managed EV charging

Managed EV charging systems can result in significant cost savings. Figure 4 shows the possible savings in costs from shifting EV charging from on-peak to off-peak time. The lines represent the savings that would occur when moving a certain percentage of EVs from on-peak to off-peak charging hours. As seen in the graph, as the number of EVs increases, the larger the savings with this demand management. For example, a program with 5000 EVs and residential Level-2 chargers would save US$2 million in annual costs (Simons, 2020).

Accurate demand forecasting also helps grid operators to provide a reliable and stable supply of electricity to meet the needs of consumers, minimize costs and reduce the risk of disruptions to the system. In addition, this can help to plan and allocate resources, including generation capacity, the load on transmission infrastructure, and energy storage. By being able to predict demand, existing resources can be optimized and grid operators can make informed decisions on when to invest in new infrastructure to meet future demand. Moreover, demand forecasting also helps to maintain the stability of the grid by ensuring that there is enough electricity available to meet demand at any given time. This helps to prevent overloading of the grid which can cause blackouts and thermal issues. Surpluses of electricity generation can be avoided, which prevents wasteful energy consumption, unnecessary costs, and environmental impacts. Grid operators can also plan for the integration of intermittent energy sources such as wind and solar power to ensure that there is enough capacity to balance fluctuations in supply and demand (Vantuch et al., 2018).

Smart grid technology is already being developed to enable the integration of EVs into the power system. This technology allows utilities to monitor the demand for power in real-time and alter the supply appropriately. The future of the smart grid is directly related to the expansion of EVs since the integration of EVs into the grid requires new infrastructure and technology to provide a stable and efficient energy system.

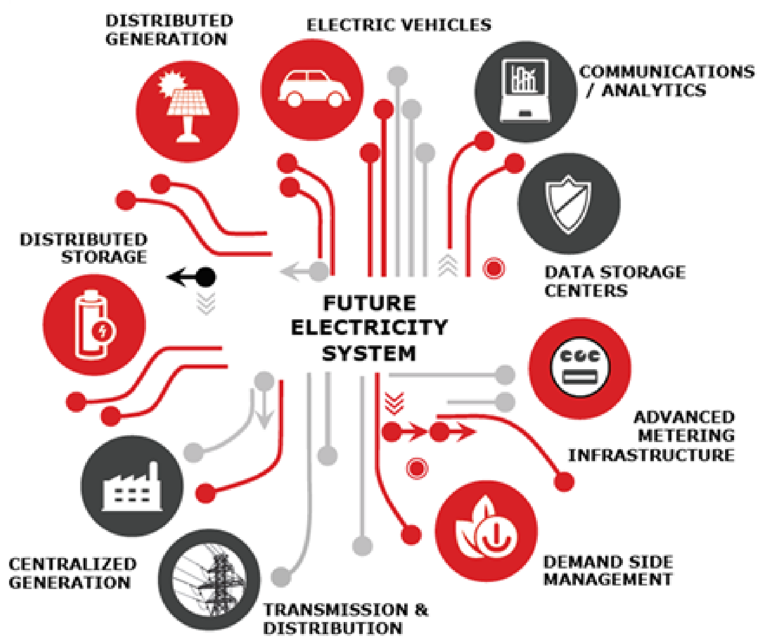


Figure 5: Future electricity system diagram

As Figure 5 shows, with the use of smart meters and advanced metering infrastructure (AMI), utilities may remotely regulate and monitor the charging of EVs to balance the grid and avoid overloading. Smart charging technology may also assist utilities to control peak demand, which can lessen the need for new power plants and transmission lines.

In addition to smart charging, vehicle-to-grid (V2G) technology enables EVs to be utilized as a source of energy storage. Using V2G, EVs may be charged during times of low demand and then discharge their energy back into the grid during periods of high demand (Bibak & Tekiner-Moğulkoç, 2021). This technique may assist in balancing the grid and eliminate the need for extra energy storage, such as batteries or pumped hydro.

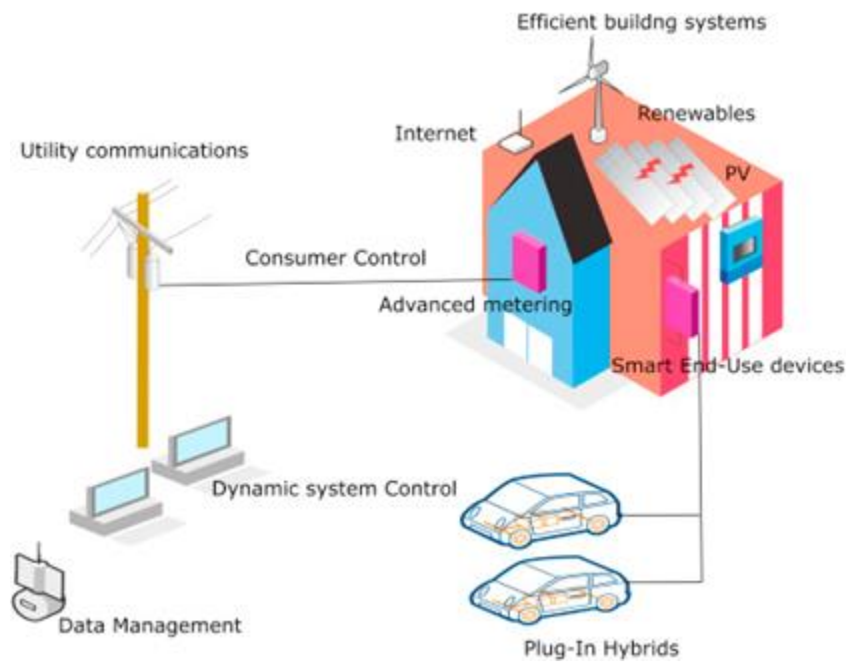


Figure 6: Smart grid diagram

As shown in Figure 6, the expansion of EVs and the smart grid are closely related, since the smart grid may support the infrastructure essential for the broad adoption of EVs and also integrates renewable energy resources in the system. As more people move to EVs, the power demand will grow, and the need for a dependable and efficient grid will become more critical. The smart grid can control this demand and help to guarantee that the transition to EVs is as smooth as possible (Ourahou et al., 2020).

To facilitate the rise of EVs and the smart grid, the Alberta government and power utilities like Fortis Alberta and ATCO Power must work together to design new rules and regulations. This includes incentives to stimulate the installation of additional charging stations, investment in new infrastructure, and the development of new technologies to support the smart grid.

Ultimately, the adoption of EVs is destined to change the way transportation and energy are understood. The development of the smart grid is directly related to the expansion of EVs since the two technologies are interdependent. With the proper regulations, investments, and technology in place, the smart grid can guarantee that the transition to EVs is as seamless and efficient as possible.

Policy/Social Analysis

As seen in the interviews, community behaviour and values are important considerations to municipal net-zero planning, with initiatives and outreach working best when they are tailored to fit the community pulse. As best as possible, from an objective perspective, this section examines the social and political implications of EV Truck adoption in Grande Prairie and considers how values can shape outreach.

Over 65% of Grande Prairie residents are between the economically active ages of 15-65, with a median family income of approximately $120 000 in 2020, and a median age of 32; the community is young, wealthy, and educated (Government of Alberta, n.d). Considered one of the fastest-growing cities in Canada, it boasts modern city comforts within the backdrop of the great outdoors (City of Grande Prairie, n.d.). Agriculture, forestry, tourism, and commerce are the city's main industrial sectors; however, the highest average wage remains in the oil and gas sector.

Rich in natural gas, Grande Prairie sits at the centre of two plays (a group of oil fields in the same region that exhibit the same geological characteristics), the Montney and the Duvernay, which are important to the region, province, and Canada. Home to many oil and gas regional headquarters and oilfield service companies, it is projected that the output from the Montney will be over 50% of the country's total output by 2040 (Grande Prairie, n.d.). Petrochemicals, which are derived from oil and gas, are used in the production of all sorts of daily items such as plastics, medical equipment, and digital devices. This product of refining is set to account for more than a third of the global demand growth of oil in 2030 and nearly half the growth in 2050 (U.S. Energy Information Administration, 2018).

The oil and gas sector is strongly linked to truck culture, as occupational tasks typically require moving heavy equipment or accessing terrain that is unfinished, which is easier done with a truck. Additionally, the abundance of resources allows the cost of gas to be cheaper than in most other provinces, making their operation more affordable. The community's deep economic and social association with oil and gas complicates the EV narrative.

A window of opportunity lies within the youthfulness of the community and the assumption that they are or will soon be starting families. As air pollution negatively impacts infant mortality rates, advocating for cleaner air for better infant health through the adoption of cleaner vehicles such as EV pick-up trucks is a personalized approach that could lower emissions. Complimentary to this, the province's 'Alberta EV corridor project' which aims to provide a reliable EV infrastructure to connect Albertans, could provide Grande Prairie with a charging station given its favourable location (ATCO, n.d.). This is because of the locational importance of Grande Prairie, as well as the fact that it sits at the intersection of Highway 40/43.

Considering net-zero is the goal and not zero emissions (allowing for negative emissions to make up for remaining emissions), Canada will continue to remain a prominent global oil and gas industry leader based on its (relatively) high environmental standards and resource availability. This suggests a dependency on the immediate Grande Prairie area to deliver oil and gas for the next few decades or so, which seems somewhat in opposition to Canada's green energy aspirations. Yet it also stresses the need to heavily decarbonize other sectors to "balance" the emissions, such as transportation. This makes a strong case for EV truck adoption, backed by Budget 2023 which espoused the electrification of the transportation industry. However, it also complicates the initiative – the promotion of EV trucks cannot be disparaging or threatening to the overall oil and gas industry, as it is still the backbone of the economy (GoC, n.d).

The EV truck initiative, with the pressure from the Federal government to reach net-zero by 2050, then, may be supported by the province with the understanding that the oil and gas industry will continue to stay its course. The added benefit of this is an assurance that lifestyles and economic opportunities (jobs) within the oil and gas industry will be minimally, if at all, affected/threatened by the initiative. However, as the population of Grande Prairie is considered relatively wealthy, incentivizing EV trucks in the face of a truck culture may not result in the desired uptake – seeing as a financial constraint is seemingly not the barrier. Appealing to values as responsible parents and caretakers is an infallible way to galvanize change. As described by Michelle Gairdner from Campbell River, her husband, a responsible grandparent, was convinced to switch to an EV after it was pointed out that the emissions to the truck he owned were dangerous for his grandchildren.

Moving Forward

While this case study focused on EV pick-up trucks, care should be taken by Grande Prairie in the future to not over-promote the pick-up truck culture. As a principle in net-zero planning and strategy, the first step is to reduce as much energy consumption as possible. Then, only where necessary, switching to cleaner alternative energy sources is the next step. Marketing for residents to buy pick-up trucks instead of switching to smaller-sized vehicles or public and active modes of transportation can lead to the undesired rebound effect. For example, if a resident was planning on purchasing an EV sedan to replace their ICE sedan, but now EV pick-up trucks have become attractive and incentivized, they may choose to purchase the pick-up truck model instead. While the EV truck is powered by electricity, there are still associated emissions and now this resident has suddenly obtained much higher energy consumption and safety concerns associated with the size of the vehicle, than if they would have stuck with the EV sedan model.

In any Canadian community, there are necessities for larger-sized vehicles such as pick-up trucks. However, in a community like Grande Prairie, a culture has been created where success is symbolized by driving large pick-up trucks to work in an office building, or to drive to the grocery store for example. This has fostered a culture where in many cases, higher emitting vehicles are being used in unnecessary situations, where a much smaller-sized vehicle could be used instead. While part of the idea of "just" is to cater to different cultures and circumstances when transitioning to net-zero, there is great value in scrutinizing the behavioural and lifestyle switches that can promote a net-zero world. That is to say, having the alternative of an EV pick-up truck is an excellent solution for cases where the pick-up truck is necessary. But in cases where the pick-up truck is unnecessary and is more of a status symbol, a different solution should be targeted that involves fewer emissions and energy use.

In place of EV pick-up trucks, electrification of other vehicles could be more feasible in industries where clean technology is seen as a status symbol. For example, as Grande Prairie has a good tourism industry, the electrification of golf carts, ATVs, scooters, tour buses etc., could positively reflect on businesses attracting a wider clientele. Moreover, tourist destinations make ideal charging sites as it usually implies heavy traffic areas. Furthermore, partnerships with businesses such as Costco or other dealerships to establish charging stations could be feasible and appealing.

The city has commissioned a comparative study to determine the feasibility of all alternate energy options, which is currently underway. As reported by Terrapin Geothermic, a waste heat and geothermal company, Grande Prairie has geothermal clean energy potential and green energy investment opportunities. However, the dependency on oil and gas has meant that green projects have not been able to fully take off, with many proposals being put forward and banked. For example, in 2023

Grande Prairie announced the discontinuation of a highly anticipated net-zero methanol plant (Boily, 2023). It is therefore essential that Grande Prairie look to decarbonize all other sectors, – where feasible. The building sector is an ideal area as the community is fast growing. Ensuring new builds use zero waste materials, passive design, and urban modelling, as well as constructing energy-efficient and resilient homes is key to reducing emissions.

Considerations

Stepping back from the case study, this section of the report will consider the project as a whole, including considerations from both the interviews and exercise on EV adoption in Grande Prairie. Moreover, an analysis is conducted of what it means for a community net-zero emissions plan to be just and durable, as well as what the implementation of a plan could look like.

A Just and Durable Transition

The transition to net zero could affect the communities at risk and people who are working in carbon-intensive industries, potentially leading to job losses. Moreover, low-income communities can face high energy costs and inequities (McCauley & Heffron, 2018). A Just and durable transition assumes a holistic lens; it emphasizes the importance of ensuring the energy transition is a collective movement that leaves no one behind. It involves preparing the workforce to fully participate in the low-carbon economy while minimizing the impacts of labour market transitions; identifying and supporting inclusive economic opportunities for workers in their communities; and placing them front and centre in discussions that affect their livelihoods (Government of Canada, 2022).

To ensure that net-zero strategies are inclusive and "JUST", the JUST Framework can be applied (Heffron, 2020). This framework ties climate, environment, and energy (CEE) justice together, covering 5 key elements of justice: distributive, procedural, restorative, recognition, and cosmopolitan with space and time considerations.

Justice includes distributive, procedural, and restorative. The core issue for distributive justice is how revenue is being appropriated. Procedural justice refers to the legal processes involved (the legislature), and restorative justice concerns itself with correcting or addressing injustices while highlighting sustainability and durability.

Universal justice links recognition and cosmopolitan justice. Recognition justice involves stakeholders and considers whether the rights of different groups are being upheld, with a particular interest in Indigenous communities. Cosmopolitan justice considers that we are all global citizens, and our actions have a domino effect.

Space: Space situates the "geographic" location. For example, a district versus town.

Time: Brings to light specific dates regarding net-zero that help to set goals.

When the JUST framework is applied to the net-zero strategies and policies from the interviewed communities, case studies, and research, it is observed that the conditions for a JUST transition have not yet been achieved, but certainly not from the lack of effort of the municipalities. As noted by communities' concerns such as energy poverty, a lack of targeted policy (procedural), support, and opportunity for municipalities to effectively address it. Current initiatives such as EVs and retrofit incentives are available to those who are economically able and who are homeowners (distributive). In this regard, the current policy does not meet the criteria of JUST due to the lack of inclusivity (universal justice).

A net-zero plan is an important aspect to fight climate change, however, it is not sufficient on its own. A JUST transition is necessary to ensure that the transition is equitable, inclusive, and socially just for all members of society, particularly those who are at risk. Including JUST aspects, as many communities displayed in their net-zero plans, aims to widely share the benefits of the transition to a green economy while supporting those who stand to lose economically in this transition (McCauley & Heffron, 2018).

While recognizing that it will take the effort of every person, household, and community to realize net-zero, scope and cosmopolitan justice play significant roles in how we view JUST. It then begs the question of measurement – what is the most appropriate scale to measure if a transition is JUST? Borrowing from the communities' experiences, goals and measurements are like a moving target – adjusting and adapting along the way, a posteriori and ad-hoc. Considering that the current energy networks, major energy players, and policies operate at the provincial and regional scale along with the reciprocal and socio-economic interlacing of communities, the benchmark or measurement of net-zero is best suited to the provincial scale.

Implementation of Plans

Communities' contribution to Canada's energy use and GHG emissions highlights the importance of designing practices and strategies that are feasible for the local government and residents, and at the same time will achieve the highest GHG savings. Energy and emissions planning starts with the collection of data and information, then analyzing the impact and effectiveness of action plans, programs, and projects before and after implementation.

A smart energy community has a standardized framework and process in place for implementation – defined as an ongoing effort which starts with data and information collection for strategy designing and planning. It is a tool for monitoring and fulfilling accountability to key stakeholders and evaluation purposes. The continuous and systematic collection and analysis of information related to a program can provide project management and key stakeholders with an indication as to the extent of progress against stated goals and objectives.

A comprehensive implementation framework ensures that data systems are developed to measure key metrics; information is collected on a regular basis, including baseline and post-implementation; and that monitoring and evaluation processes are in place to feed real-time learning over time. Monitoring is a continuous process that helps understand where programs are in relationship to intended results. It is used to track progress (based on intended results and agreed indicators), identify issues, and analyze relevant information and reports that become available throughout the implementation phase and as implementation occurs. Monitoring helps to communicate, review, and report results to stakeholders and adjust approaches to implementation if necessary.

Communities we interviewed in this project were aware of the importance of developing an implementation framework, yet their definition of an implementation scale and implementation varies. While Bridgewater representatives find implementation as being the execution of action plans, Beaconsfield, and Campbell River representatives believe that implementation is an ongoing process. Markham representatives emphasize the program's learning impacts and incorporating the residents' feedback in future plans, while Grande Prairie and London emphasize the importance of funding in the implementation.

Although most communities do not have a set implementation scale in place, they use evaluation tools to assess the impacts of strategies that were implemented.

Net-Zero Communities Technical and Policy Principles

In QUEST's Smart Energy Communities initiative, a list of technical and policy principles was developed to guide communities in their energy initiatives and solutions (QUEST, n.d.). The first six technical and policy principles in Table 5 were taken from this.

As the focus has shifted from Smart Energy Communities to Net-Zero Communities, additional technical and policy principles to guide communities to net-zero were developed (points 7 and onward).

Table 5: Technical and policy principles to guide net-zero community planning

Technical Principles	Policy Principles
1. Improve efficiency – first, reduce the energy input required for a given level of service	1. Match land use needs and mobility options – understand the energy implication of land use, infrastructure for water and wastewater, waste management, personal mobility, goods movement, and building design decisions
2. Optimize exergy – avoid using high-quality energy in low-quality applications	2. Match energy options to local context – local climate, building on land use choices, industrial structure, availability of local sources of waste and renewables
3. Manage heat – capture all feasible thermal energy and use it, rather than exhaust it	3. Send clear and accurate price signals – consumers should see and pay full real costs, including external costs
4. Reduce waste – use all available resources, such as landfill gas and municipal, agricultural, industrial, and forestry wastes	4. Manage risks and be flexible – maintain technological and fuel diversity; pursue cost-effective opportunities first and incorporate learning; assume the need to adapt quickly to market and technological surprises
5. Use renewable energy resources – tap into local opportunities for geoexchange systems, small-scale hydro, biomass, biogas, solar, wind energy, and opportunities for inter-seasonal storage	5. Emphasize performance and outcomes in policy and regulations – avoid prescribing fuels and technologies
6. Use energy delivery systems strategically – optimize the use of energy delivery systems and use them as a resource to ensure reliability and for energy storage to meet varying demands	6. Pursue policy and program stability – maintain a consistent and predictable decision-making environment to sustain investor confidence
7. Switch by priority – in the transportation sector, focus on substituting trips, then mode shifting where trip substitution is not possible, and finally fuel switching as a last resort	7. Maintain accountability – regular and thorough measuring and monitoring to be accountable to net-zero goals
8. Passive design building strategy – designing buildings with south-facing windows for natural light, and with a natural ventilation system	8. Integrate CEEP into the community planning process – link energy goals with community concept

Recommendations

As identified in the interviews, one key barrier to achieving net-zero community emissions relates to staffing. Communities are either short-staffed or lack the expertise (or a combination of the two) to create and implement a net-zero plan. Since the idea and necessity of net-zero stems mostly from the federal target of net-zero emissions by 2050, support from the federal government to help Canadian communities in this endeavour would be invaluable. As mentioned above, communities make up over 50% of Canada's emissions, so supporting the communities to foster durable and achievable net-zero plans is key.

This federal support could look one of two ways. The first would involve a federal task force composed of various experts in different sectors such as transportation and buildings that would engage with the communities in the early stages of planning. This would create a more tailored and specific plan right from the start. Having a federal task force that is easily accessible to communities also prevents situations where communities do not create a net-zero target or plan due to a lack of human capacity. No one is left behind in this scenario.

Alternatively, a municipality fund could be developed by the federal government. In essence, this would be a pool of money that communities can access to hire consultants to help create and implement their net-zero plans. In a similar sense to the previous idea, this allows communities to engage with experts in various domains to foster comprehensive and well-planned net-zero strategies. With either of these recommendations, the key is for communities to be supported from above. For communities to comply with and create their own net-zero plans requires assistance and direction from both provincial and federal levels of government. This unifies Canada as a whole and ensures that communities have the capacity to support their own and federal targets.

Although net-zero community planning is essential to realize Canada's net-zero target, many of the key energy stakeholders operate at a larger scale; utilities typically span regions, for instance, ATCO power services most of Alberta, and grid infrastructure does not always belong to the city. For example, in Ontario the electricity grid is owned by the province. This limits the influence municipalities have over their CEEPs and perhaps contributes to why the net-zero target seems far-fetched for many communities. As such, at least for the interim, the "hard" measurement of net-zero is best suited at the provincial scale. Moreover, when considering the interactions between communities – for instance, Grande Prairie is a commerce and tourist destination, as such it experiences secondary emissions other than those of its own residents, additionally, many GP residents travel to Edmonton frequently for various services.

Integrating energy and emissions planning into the community planning process instead of as a separate activity ensures opportunities to support energy-efficient and resilient community concepts such as increased budgets for investments derived from energy savings, more resilient and cost-effective systems, and an emphasis on local production that boosts local economies (Zhivov, 2022). Integration also highlights the value of energy as being very much ingrained in community and behaviour – viewing emissions as an output but addressing the systems that produce emissions. One of the most difficult barriers to address is behaviour; including net-zero goals and concepts within the education systems that proactively encourage conservation behaviour for long-term change is important. The federal goal for net-zero is by 2050 which implies that younger generations will inherit and bear the weight of our decisions. Investing in education at all levels will ensure climate preparedness and foster a new wave of creative innovators and apt leadership.

Conclusion

Typically derived from the federal target of net-zero emissions by 2050, community-level net-zero emissions plans will be the backbone of Canada achieving its target. Given their high level of importance, net-zero community plans must be initiated and implemented in a collaborative manner. This is to say that having a small group of experts to facilitate a plan with this much complexity will not be enough. Net-zero considerations touch upon a vast group of stakeholders, from community members, neighbouring communities, local industries and businesses, Indigenous peoples, and many more. We all must rely on one another and work together to create net-zero emissions plans that are achievable, just, durable, and easy to implement. While this is no simple task, this project aimed to point out important factors of consideration on a community level.

As noted throughout the report, the transition to net-zero is not seamless; it comes with many barriers. From interviewing six unique Canadian communities, the main barriers are found to be provincial policy, the transportation sector, behavioural stubbornness, and staffing shortages. While municipal governments are working at their full capacity to create and implement CEEP or net-zero plans, these hurdles are sticking points that are difficult to overcome for communities.

The provincial legislature can either enhance or deter community net-zero planning, as it is the province that sets energy goals with guiding parameters from the Federal government; discord between the jurisdictional goals is observed by many communities. As the lens shifts to the community scale, the importance of understanding the cultural nuances, and values of the community as well as the *viable* energy options is apparent and key in designing and implementing an effective net-zero plan – acknowledging the characteristics, interactions, and drivers/barriers that the community faces.

While the net-zero emissions target is still far from being attained, we as a group are hopeful that through collaboration as well as thoughtful and targeted planning, that net-zero can be achieved on both a community and country-wide scale. With this report aimed at helping to foster conversation on this topic, we hope that communities can learn from one another and this report. Through partnerships and teamwork comes success.

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