Quebec-based Solutions to Tailpipe Emissions: Assessing Electric Vehicle and Public Transit's Feasibility in Reducing Emissions

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Introduction

Conventional cars have had a massive impact on our land and energy systems over the past century contributing significantly to the current climate crisis (Budinsky and Bryant 2013, 217). One of the primary proposed solutions to the transit sector's greenhouse gas emissions (GHG) reductions is the electric vehicle (EV). Quebec has been a proponent of this transition, having implemented policies that support EV purchases and, more recently, developing mineral extraction projects needed for producing them in-province (Ibarra-Gutiérrez et al. 2022). The feasibility of this solution is investigated through the Van der Ven model, which sets the project within the greater goal of moving towards low-emission, shared means of transport. A depiction of this model is seen in Figure 1. Although Montreal has a transit network of busses, metros, and commuter trains, the agglomeration is still dominated by car infrastructure (Boisjoly and Yengoh 2017, 43). This theory of change exemplifies how as part of a transition away from the conventional car, electric cars and public transit need to be increased in tandem to tackle the issue of ever-increasing GHG emissions and consumption.

Challenge

Overview

The tailpipe emissions and consumption habits that privately-owned vehicles generate are significant drivers of climate change. Since the 1950s, when this observation was made, significant improvements to the engines and fuel quality have come about; however, CO_2 emissions continue to rise (US EPA 2015). In Quebec, personal vehicles represent 20% of the province's total GHG emissions, which, in 2019, was equivalent to 16 megatonnes of CO_2 (Laffont, Waygood, and Patterson 2022, 1). Quebec's abundance of low-cost and low-emission

hydropower has promoted the electrification of the fleet as one of the main ways for the province to reduce its emissions (Lemphers et al. 2022, 6). However, not all can be solved by changing this one component of the transport system; private vehicles also foster consumption habits that contribute to climate change and dramatically affect our world's landscape. A more inclusive approach to solving emissions in our transport sector needs to take place.

A car economy

Personal vehicles are deeply tied to our capitalist economy; they have led to a path dependency that encourages people to accumulate material goods, travel farther distances, and own more property (Schmelzer, Vetter, and Vansintjan 2022, 150). This resulted in a dramatic change in the landscape where streets became wider, buildings were demolished to make space for parking, public transit was left to fill in gaps in a disorderly fashion, and perhaps the biggest change was the creation of suburbs (Jakle et al. 2004). This suburban expansion was not only a response to the innovation of the personal vehicle. It was also facilitated by the expansion of new profitable outlets put forth by the acceleration of mass consumption (Eliot Hurst 1981, 76). Structural interventions, like policies conducive to capitalist production, were made by the state to promote the concentration of the means of production and capital accumulation (Eliot Hurst 1981, 75). An increase in relatively low-cost housing, affordable to the middle- and working classes, was a significant element of that planned expansion. Due to zoning laws, different land uses (housing, retail, offices, industry, recreation) were separated, leading to extensive road coverage (Frumkin 2002, 201). This low-density planning has not been conducive to transit-oriented development (TOD), has caused the inefficient use of land, resources, and people's time and has contributed to environmental degradation.

Proposed intervention

Electric Vehicle

To reduce emissions from the transport sector, Quebec has been considering the possibility of sourcing the materials and energy needed to create an all-electric fleet in-province as part of their plan for a green economy by 2030 ("Électrification des transports" 2022)The worldview making this proposed solution possible is that it doesn't require making any drastic changes; people can continue to own and use privatized means of transport and live in the suburbs, far away from their workplaces and services. While it is true that the province is supporting the electrification of public transit networks in Quebec, Gatineau, Laval, Longueuil, Montreal and Monteregie ("Électrification des transports" 2022), few major investments are being made to increase the span of public transit infrastructure to reach populations living farther out. With these new EVs, there is a belief that we can transition to a "green" society, all while life continues business as usual (Budinsky and Bryant 2013).

According to Ibarra-Gutiérrez et al. 2022, throughout the 11 lithium projects listed in Table 1, there are 98.4 Mt proven and probable mineral reserves, 94.1% of which are found to be in Quebec. Since Quebec's energy source is relatively clean compared to other leading lithium-extracting countries: Argentina, Bolivia, and Chile (which rely on fossil fuels as their primary energy source (Ritchie, Roser, and Rosado 2022)), the province is in a good position to develop this industry (Ibarra-Gutiérrez et al. 2022, 76). If decisions go ahead to extract from these mines, mineral reserves will exceed domestic needs, opening the opportunity to export to neighbouring Ontarian and American auto industries (Ibarra-Gutiérrez et al. 2021, 4)

Despite having more than enough minerals needed to support the transition, the timeline at which the switch is made must be considered. Laffont, Waygood, and Patterson's 2022 study found that

if vehicles were switched purely on a voluntary basis and not by rank of most emitting, the replacement of nearly two-thirds of the fleet by EVs should be expected. Conversely, if the highest CO_2-emitting vehicles were prioritized, less than half of the fleet would need to be replaced to meet the 2030 goal (Laffont, Waygood, and Patterson 2022, 16). A study by Roy, Menard, Samson, et al. 2016 that compared conventional vehicles to EVs determined that EVs only have reduced impacts if used for at least 25,000 km. The results from this study are shown in Figure 2. These two studies demonstrate how EVs pose challenges to emissions reductions if the timeline and lifecycle of the transition are not considered. Additionally, in a context where SUVs are increasing in popularity, where the most emitting vehicles, trucks, are only starting to have electric models, and where subsidies are not yet specific to the vehicle type, we need to pursue a second intervention.

Public and Shared transit

I propose the increased ridership and expansion of public transit as this second intervention to work alongside EVs. A huge barrier to reducing car usage is the lack of accessible and reliable public transit. Before explaining, I acknowledge that shared transit is not feasible in remote parts of the province in the near future and therefore recommend prioritizing those regions for EV use. If public transit options were offered more frequently and on a grander scale, the undesirable aspects that typically drive people away from using them would decrease. This includes time spent getting to the transit stop and waiting for the bus/train/metro, as well as unpleasant conditions such as crowded vehicles with no seating (Litman 2022, 25). If discretionary riders (people who have the option of travelling by automobile) were properly incentivized to use public transit, and if the number of transfers needed to get to one's destination were reduced,

then ridership would increase significantly (Litman 2022; Eluru, Chakour, and El-Geneidy 2012, 146-147).

Equitability

In North America, public transit currently serves a small portion of the population's total trips, but the trips it serves tend to be of high value to users (Litman 2022, 26). Transit provides essential mobility to important activities such as medical services, education, and employment to people that would not otherwise be able to reach those destinations (Litman 2022, 26). For low and middle-income non-drivers, as well as people facing disabilities that restrict them from driving, access to a monthly public transit pass could grant them the ability to make trips every day rather than one or two taxi trips per week for the same cost (Litman 2022, 26). By reducing personal vehicle use, public transit will reduce air and noise pollutants which were found to disproportionately affect low-income populations (Boisjoly and Yengoh 2017, 43). I believe that if public transit were more evenly between groups of varied incomes, barriers between social classes could be broken by creating a shared space where these groups encounter each other more often.

Land use

Since the 1950s, when suburbs gained traction (Frumkin 2002), there has been a shift in people's values when buying property: According to a survey by Belden, Russonello, and Stewart (2004), 60% of prospective homebuyers reported that they preferred "a neighbourhood that offered a shorter commute, sidewalks, and amenities like local shops, restaurants, libraries, schools, and public transport over a more automobile-dependent community with larger lots but longer commutes and poorer walking conditions." This indicates the need for transit and greater mixed land use in areas of Quebec where walkability was not deemed an essential component of urban

planning. If public transit were prioritized over private vehicles, land designated for roads and parking facilities could be greatly reduced (See table 2) (Litman 2022, 60). This would lower the copious amounts of energy spent on concrete production and likely reduce the amount of converted farmland. Additionally, if neighbourhoods were made more walkable, improvements would likely be seen in the affected population's physical and mental health (Frumkin 2002). Public transit is also an alternative to the self-driving car, a technological innovation that I would consider a *destructive creation*. Shared transit offers people the advantages of increased safety, stress reduction, and time to do personal activities (reading, conversing, listening to music) without the risks of increasing urban sprawl and increased housing pricing (Frumkin 2002, 205-206; Larson and Zhao 2020, 2).

The aim is to achieve more transit-oriented development (TOD), where people own fewer vehicles, drive less, and rely more on shared modes of transport. The following section explores existing and potential methods that can be used to realize the TOC.

Strategies for solution

There are several methods the province has already implemented to encourage people to buy electric vehicles as part of their goal of reducing 1990 CO2 emissions by 37.5% by 2030. Firstly, individuals, businesses, organizations, and Quebec municipalities are offered rebates on the purchase or lease of a new electric vehicle. For all-electric vehicles less than 60,000, the rebate amount is 7,000 ("Québec Government Rebates" n.d.). Second, in addition to housing charging outlets, which have a reduced installment price by Hydro-Quebec, there are now 7,314 charging stations across the province, an 800-unit increase since 2020 ("Statistiques SAAQ-AVÉQ" 2020). Third, vehicles with green license plates have free access to toll bridges on Highways 25

and 30, can use certain ferries at no charge and can operate in multiple carpool lanes, regardless of passenger capacity (“Électrification des transports" 2022).

These financial and infrastructure-development policies, paired with increased oil prices and improvement of the lithium-ion battery (which has reduced the selling price of EVs), have encouraged people to switch to electric, Ibarra-Gutierrez et al. (2022, 74) write.

Similar financial strategies can be used to help push public and shared transit, but according to Meadows (1999), these solutions, called parameters, have the least effect on creating significant change. If the goal is to encourage more people to move away from private vehicles, which presumably cost more than a bus pass, then I do not believe that the cost of public transit is the real issue. For these reasons, I will not explore financial incentives such as income-based subsidies or free transport. Instead, I recommend strategies that will increase accessibility, awareness, and in some cases, enforcement.

Firstly, the metro line should be extended, and more buses should be added to transit deserts. Boisjoly and Yengoh's (2017) use of interviews found a lack of connectivity to employment and services, especially within and between boroughs, not necessarily to the central business district (CBD). It was also noted that transit was especially weak in low-income areas (Boisjoly and Yengoh 2017, 42-44). Thus, increasing the number of transit lines and improving the existing ones based on GIS trip data would reduce the number of connections people have to make, increasing its usage (Eluru, Chakour, and El-Geneidy 2012, 146-147).

Secondly, restrictions on car companies’ greenwashing advertisements should be tightened. Budinsky and Bryant (2013, 217) give the example of a 2007 hybrid advertisement, which pictured Kermit the Frog struggling to live a “green lifestyle” until he discovered that he could buy Ford’s new *Hybrid Escape*. They explain that commercials like these are harmful because by

playing into green consumerism, attention is “deflected away from the forms of collective action often needed to bring about meaningful social/environmental change” (Budinsky and Bryant 2013, 208). They also note that these advertisements naturalize driving by making viewers feel that cars are a necessity (Budinsky and Bryant 2013, 218). Schmelzer, Vetter and Vansintjan (2022) explain that advertising drives continuous and excessive consumption, especially in inherently unsustainable industries.

Third, laws that require all future housing development plans in Quebec to be transit-oriented should be passed. Both in existing and future neighbourhoods, community groups should be included in discussions on public transit infrastructure as they tend to effectively represent marginalized groups improving the equitability of transit systems (Boisjoly and Yengoh 2017, 43). This can include improved bicycle paths, sidewalks, and pedestrian signage, workplace carpooling requirements, and increased transit services outside of regular working hours.

Lastly, once public transit has been improved throughout transit deserts, I believe that Montreal should adopt zero-emission zones, beginning in the CBD. This has been done successfully in several European cities, and Montreal has already considered implementing one of its own (Blais 2022). I believe this approach would transform streets from being dedicated to car traffic towards public space shared between users. It would dissuade people from taking their car to get downtown, thus decreasing GHG emissions and encouraging active and shared modes of transport.

The output of these interventions can be measured by looking at GHG emissions and public transit ridership over time.

Assumptions

The above-proposed interventions would only be possible with a greater cultural shift moving away from privatized wealth. One outcome will likely be a slowing down of our system, which will frustrate many people. It is possible that this will prevent us from ever achieving the goal. Several relevant forms of environmental thought were ignored in this paper that should be considered in future research. First, if Quebec exports lithium-ion batteries to neighbouring countries, how can we guarantee that they will use electric vehicles in conjunction with public transit use? Furthermore, batteries may be exported to regions that use fossil fuels to generate electricity to charge the EVs. In that case, Quebec will not be aiding the larger goal of decreasing climate change drivers. Second, no considerations were made regarding the environmental and social effects of extracting the minerals needed for EVs. Not only do mines pose severe impacts on the landscape, often causing deforestation and soil and water contamination, but they can also cause nearby communities to be dependent on the stresses and strains of the industrial cycles (Rodon, Keeling, and Boutet 2021, 3). Third, a low-carbon future does require significantly more rare minerals whether we transition to EVs or electric shared modes of transport. That's why the recycling of precious metals is an essential component that needs to be further studied to reduce the amount of wasted resources (Ibarra-Gutiérrez et al. 2022, 77). Last, an important component of the transit sector that was not mentioned is the decentralization and municipalization of the electrical grid needed to power EVs and public transport systems. This will help diffuse the concentration of power that few wealthy companies hold and grant communities collective ownership over their local, renewable energy source (Schmelzer, Vetter, and Vansintjan 2022, 220).

Conclusion

EVs and shared transport should be used together to move Quebec away from conventional cars and the consumerist lifestyle that they encourage. However, as the transition towards EVs is already underway and requires people to make few lifestyle changes, more efforts should be focussed on the adoption of shared transport. The main obstacle that TOD and public transport usage will entail is a revisioning of our Western individualist culture. For this change to occur, willingness to discard private vehicles (in locations that permit) and move toward an economy based on services expenditure is necessary. While I do not claim that these strategies will act as a silver bullet solution to a problem as massive as transport emissions, I do believe that the significant social and environmental benefits to be gained from this transition make it worthwhile. These interventions can be used to lead to a potential outcome where people rely less on energy-inefficient modes of transport and instead have greater acceptance of public utilities that help decrease consumption.

Figure 1: Theory of Change Van der Ven Model

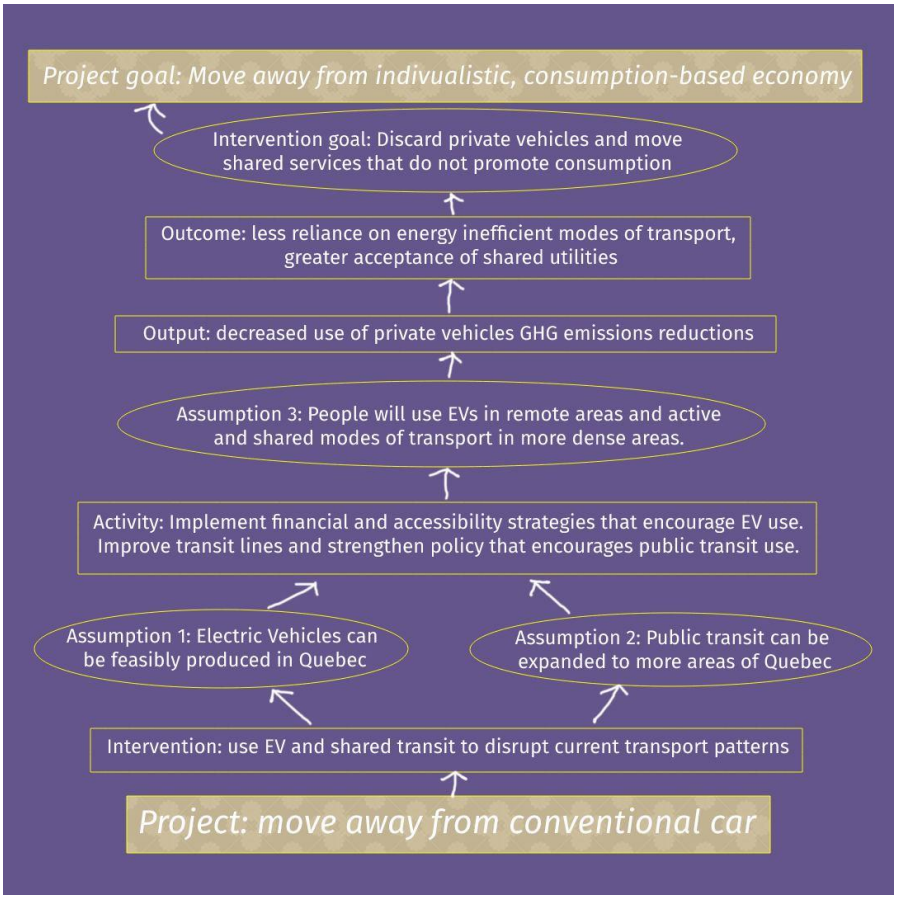


Table 1: Mineral reserves in Canada. Source; Ibarra-Gutiérrez, Sebastián, Jocelyn Bouchard, Marcel Laflamme, and Konstantinos Fytas. 2022.

Table 1. Canadian lithium mineral resources and mineral reserves in compliance with NI 43–101.

			Reserves(proven + probable)			Resources(measured + indicated + inferred)			
Province	Deposit name	Type	Mt	Grade	Unit	Mt	Grade	Unit	Source
Alberta	Buckton Zone	Black shales	–	–	–	0.30	374.04	ppm	[50]
Manitoba	Zoro Lithium	Pegmatite	–	–	–	1.07	0.91	Li_2O (%)	[51]
Ontario	Georgia Lake	Pegmatite	–	–	–	13.29	1.09	Li_2O (%)	[52]
Ontario	Pakeagama Lake	Pegmatite	5.8	2.00	Li_2O (%)	10.42	1.82	Li_2O (%)	[53]
Ontario	Separation Rapids	Pegmatite	–	–	–	10.20	1.40	Li_2O (%)	[54]
Quebec	Authier	Pegmatite	12.1	1.00	Li_2O (%)	20.94	1.00	Li_2O (%)	[55]
Quebec	James Bay	Pegmatite	–	–	–	40.30	1.40	Li_2O (%)	[56]
Quebec	Lithium Quebec	Pegmatite	17.1	0.94	Li_2O (%)	47.00	1.20	Li_2O (%)	[47]
Quebec	Moblan	Pegmatite	–	–	–	14.25	1.41	Li_2O (%)	[57]
Quebec	Rose Li-Ta	Pegmatite	26.8	0.85	Li_2O (%)	34.70	0.92	Li_2O (%)	[58]
Quebec	Whabouchi	Pegmatite	36.6	1.30	Li_2O (%)	55.70	1.40	Li_2O (%)	[59]

Figure 2: Figure 2: Compared EVs and Conventional cars based on their impacts on climate change, human health, fossil fuel depletion, mineral depletion and ecosystem quality. Source: Roy, P. O., J. F. Ménard, S. Fallaha, and R. Samson. 2016.

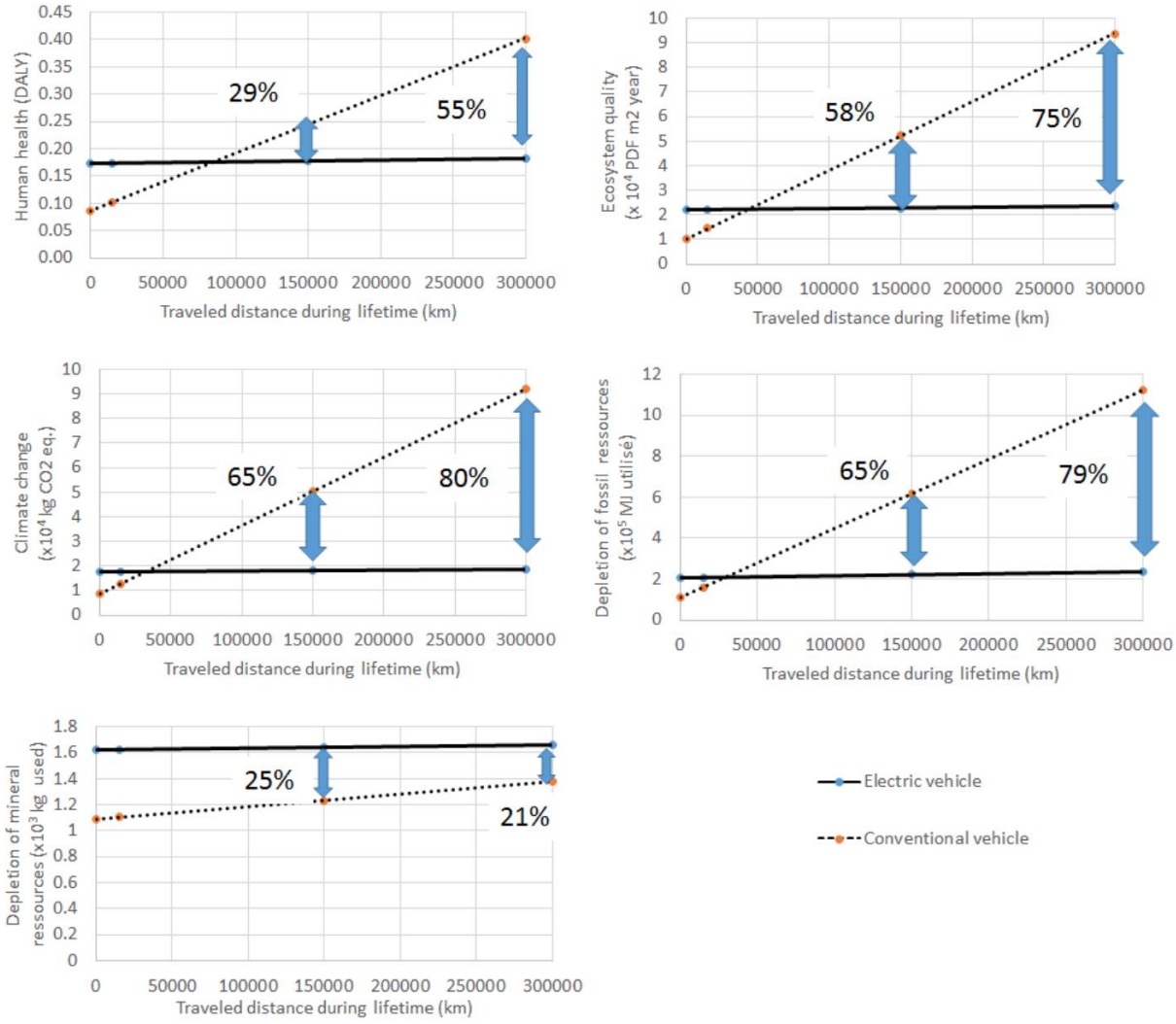
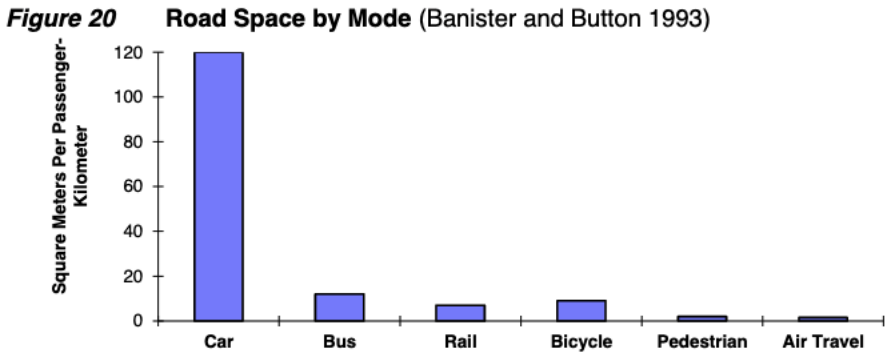


Table 2: Road space requirements by mode of transport. Source: Litman, Todd. 2022.



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