

Technical Annex to the *Research Paper “Can We Get Rid of Oil? The Costs of an Accelerated Energy Transition”* published in December 2014

In the pages that follow, we present an overview of some of the measures proposed by Équiterre and Vivre en ville and their costs as estimated by them. We then conduct our own estimation of these costs. Finally, our analysis will allow us to put into perspective the costs associated with these measures.

The Measures Proposed in the 2009 and 2011 Reports

In the first report published in 2009, Équiterre stated that market mechanisms would not allow for the technological innovation required to reduce the consumption of gasoline and that it was therefore necessary to intervene in order to count on “the optimization of our practices and the calibration of our real needs.”¹ To give an idea of the scope of the plan, the following table presents a list of certain objectives and courses of action proposed in Équiterre’s 2009 report.

¹ Équiterre, *Pour un Québec libre du pétrole en 2030*, September 2009, p. 5.

Table A1: Objectives and/or measures proposed by Équiterre (2009)

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| Section 3.1 Land use planning | |
| <ul style="list-style-type: none"> • Reforming the <i>Act Respecting Land Use Planning and Development</i> in order to put an end to the automobile-centric development model and to connect the development of cities with principles of energy conservation and the efficient use of resources: <ul style="list-style-type: none"> ○ Introduce into the planning and development strategies of cities and towns (urban plans, DDPs, development schemes, etc.) regulatory criteria based on energy challenges, including that of the increasing scarcity of affordable oil. • Undertaking the densification and requalification of already built-up areas while creating “town centres” in the first ring of suburbs and reorganizing transit between these entities around public transit axes. • Imposing a moratorium on all new construction in green zones and reforming the <i>Act Respecting the Preservation of Agricultural Land and Agricultural Activities</i> in order to better protect quality land in urban settings and to allow more flexibility in the occupation of land in rural settings. • Revise the municipal taxation system with a view to diversifying municipal revenue sources and thus escaping the vicious revenue cycle created by the dependence on property taxes: carbon taxes, parking taxes, royalties on gasoline and other petroleum products, etc. • Equipping all municipalities with a proven fiscal calculation tool allowing for the evaluation of the true viability of a residential, commercial or industrial development. • Favouring the establishment of policies to decentralize energy production—for example, through feed-in tariffs—in the regions in order to replace petroleum products in the self-contained production of electricity and to create new employment opportunities. | |
| Section 3.2 Personal transportation | |
| <ul style="list-style-type: none"> • Channelling an increasing portion of investments in the transportation sector into public transit and active transportation in order to meet the short term needs identified (\$5.2B) and those to come in the medium term. • Developing, if necessary, new financing tools (parking tax, highway tolls, gasoline royalties, etc.) to ensure future public transit and active transportation needs. • Ensuring that land use planning reforms allow for the acceleration of neighbourhood development where the modal transfer toward public transit and active transportation is a reality. • Adopting at the same time standards requiring energy efficiency for the automobile sector (Californian and eventually European norms). • Adopting at the same time a standard for the carbon content of fuels including a tight framework for admissible replacement fuels. | |
| Section 3.3 Transportation of goods | |
| <ul style="list-style-type: none"> • Financing much more substantially projects aiming for the intermodality of the transportation of goods. | |

| | |
|--|--|
| <ul style="list-style-type: none"> • Ensuring that land use planning reforms increase the supply of basic local food products through short distribution circuits in the majority of Quebec regions. • Promoting the adoption of energy efficiency standards for new trucks (similar to Californian standards for automobiles). • Ensuring the inclusion of the transportation of goods as part of a Quebec standard for the carbon content of fuels. | |
| Sections 3.4 Agriculture | |
| <ul style="list-style-type: none"> • Reduce the use of petroleum energy products in the operation of Quebec’s agricultural sector, including by: <ul style="list-style-type: none"> ○ accelerating efforts to substitute other, renewable energy sources like biomass, solar, wind and geothermal; ○ emphasizing and financially supporting the development of self-generated energy production technologies on the farm. | |
| Section 3.5 Residential heating oil | |
| <ul style="list-style-type: none"> • Reducing the energy consumption of existing residential housing among other things by improving energy efficiency. • Prohibiting oil-fired heating systems in all new construction. | |

Source: Équiterre, *Pour un Québec libre du pétrole en 2030*, September 25, 2009, pp. 44 – 57.

As for the 2011 document, it follows the same logic as its predecessor, but concentrates more specifically on urban planning and transportation. Among other things, the proposed measures aim for, by 2030, a reduction in kilometres travelled per vehicle, greater efficiency for gasoline-powered cars and more public transit.

Because of the difficulty of estimating the costs of several of the proposed initiatives, our analysis of the true costs will deal with those having a substantial impact in terms of costs and for which estimation is methodologically possible. Équiterre and Vivre en ville’s plan also includes numerous proposals whose costs are difficult, if not impossible, to calculate, since they are not sufficiently detailed. For example, the two groups propose to “make municipalities prepare annual development statements, modelled after their financial statements, regarding land use issues (use of land and energy, GHG emissions)” and to “reinforce the protection of agricultural land.”² Therefore, five measure and one secondary objective proposed by Équiterre and Vivre en ville were retained for the purposes of our analysis (see Table A2).

² Équiterre et Vivre en Ville, *Changer de direction : Chantier aménagement du territoire et transport des personnes*, May 2011, pp. 49 and 54.

The first two measures we analyze in detail concern augmenting the supply of public transit in urban settings. *Équiterre* and *Vivre en ville* propose to double the supply of public transit service by 2030 and to substantially increase the support provided to the use of this service.

Two other measures concern the supply of intercity collective transportation: developing a high-speed rail system and also developing a conventional electric train network connecting at least Quebec’s six large urban centres. The cost of these measures was not estimated by *Équiterre* and *Vivre en ville*.

The fifth measure concerns the practice of active transportation. *Équiterre* and *Vivre en ville* propose to support the setting up of bicycle sharing service systems across the province. Although less expensive than other measures, we estimated the cost of this measure because it was possible to quantify it with more precision. Beyond the sums involved, this also shows the substantial gap between a rigorous economic evaluation and the estimates presented in their report.

Finally, we will also evaluate a secondary objective proposed by *Équiterre* and *Vivre en ville*: a series of measures aiming to increase the proportion of the private automotive fleet made up of fully electric cars to 5% by 2030.

Table A2: The *Équiterre* and *Vivre en ville* measures whose costs we estimated

| |
|---|
| T1-1: Doubling the supply of public transit by 2030 |
| T1-2: Increasing support for the use of public transit |
| T1-4a: Developing a high-speed electric train network connected with the North American network (NY-Boston-Toronto-Montreal-Quebec) |
| T1-4b: Developing a train network connecting at least Quebec’s six large urban centres |
| T2-3: Supporting the implementation of bicycle sharing service systems across Quebec |
| Secondary objective 2.2: Reaching a 5% share of fully electric vehicles |

How Do We Measure the Cost of These Proposals?

It is necessary to determine the proper methodology for measuring the cost of the six measures retained. We consider that the one used by *Équiterre* and *Vivre en ville* is problematic.

Indeed, in the annex to the most recent report in 2011, *Équiterre* and *Vivre en ville* evaluate the annual amount that would need to be spent by the government to finance their initiatives. To measure T1-1, T1-2 and T2-3, the total cost is made up of expenditures related to investments and operating costs until 2030. For these measures, however, the authors deliberately omitted a calculation of the portion of the costs that will have to be borne by users of the services.³ This omission means that a part of the total costs of these three measures is therefore excluded from the calculations.

³ *Équiterre* and *Vivre en ville*, *Changer de direction : Chantier aménagement du territoire et transport des personnes*, Annexes, May 2011, pp. 4, 6 and 7.

The authors therefore implicitly assumed that policies 100% financed by users would cost society nothing and that only the cost for governments needs to be taken into account. Yet whether the cost is borne by users (in the form of fees, for instance) or by taxpayers (through higher direct or indirect taxes), it must be admitted that in the end, it is the same people who foot the bill.

Ideally, the most rigorous method to recommend for the economic evaluation of this kind of initiative is a cost-benefit analysis. Such an approach allows us to compare a project's total costs (for users, taxpayers, businesses) with its total benefits. However, we cannot adopt this method for the current analysis because the lack of data and the imprecision of certain proposals make the task much too difficult, if not impossible, to carry out.

For our calculations, we opted for a more rigorous methodology that brings two basic improvements to those of Équiterre and Vivre en ville. The first improvement consists of estimating total annual operating expenses, including the portion paid by users. Obviously, this approach leads to higher estimated costs than those of Équiterre and Vivre en ville, since no costs are hidden by the fact that users pay a portion of them. The second improvement concerns the cost of investments. Whereas Équiterre and Vivre en ville measure the gross value of acquiring the physical capital needed to reach their objectives, we measure the cost spread out over the useful life of the equipment, which is to say that we also take into account the amortization of the capital (also known as depreciation). This way of measuring the cost of investments produces costs that are constant, but also lower than the estimates of Équiterre and Vivre en ville. Note also that their estimates are in 2011 dollars, whereas we are using 2013 dollars to provide a current picture of the costs involved.

The following section will present the total annual costs of the six measures retained, which includes both infrastructure and operating costs. Besides an overall annual amount, we also found it useful to illustrate this annual cost per household in order to have a better sense of its size.

Measures 1 and 2: Developing the Supply of Public Transit

The first two proposals of Équiterre and Vivre en ville retained are:

- T1-1: Doubling the supply of public transit by 2030
- T1-2: Increasing support for the use of public transit

Table A3: Estimated annual costs of doubling the supply of public transit and increasing support for its use

| | Measures proposed by Équiterre and Vivre en ville | Costs (in 2013 dollars) | |
|-------------|---|-------------------------|------------------------------|
| | | Our estimate | Équiterre and Vivre en ville |
| T1-1 | Doubling the supply of public transit | \$970,548,498 | \$2,044,776,119 |
| T1-2 | Increasing support for the use of public transit | \$1,783,515,150 | \$2,249,253,731 |

A first question must be addressed here: What exactly is meant by “doubling the supply of public transit”? In the absence of more precision in this regard in the *Équiterre* and *Vivre en ville* documents, we have retained the general sense given to the supply of service by the STM and by other transit authorities, namely the number of kilometres travelled annually by buses and metro trains.⁴ We therefore measured the expenditures required to double this supply.

According to *Équiterre* and *Vivre en ville*, these two measures would cost a total of \$4.2 billion a year in 2030, when the project is completed. This includes \$1 billion a year to develop infrastructure, \$1 billion a year to maintain additional infrastructure (which will be much more extensive in 2030 than it is today) and another \$2.1 billion to support its use.⁵

To evaluate the investment and operating costs implied by a 100% increase in the supply of public transit, we used a scenario described in a document published by the Société de transport de Montréal (STM). In the context of a program to improve public transit service, the STM increased the supply of public transit in terms of kilometres travelled by 25% over the period from 2006 to 2011.⁶

To get a precise idea of the budgetary growth related to the STM’s increased supply, we referred to the 2011 financial report, which provides a detailed presentation of expenses by category (network use costs, administrative costs, infrastructure maintenance costs, amortization and financing costs).⁷ These categories are only available since 2007, however, when the program to improve public transit service had already been in effect for one year. From 2007 to 2011, then, the supply of public transit increased by 21.6%.

Starting from its 2007 expenses, we calculated what the STM’s expenses would have been in 2011 if it had simply kept its assets up to date through an indexation of its expenses to the inflation rate.⁸ Then, we subtracted from the actual expenses for the year 2011 the indexed 2007 amount.⁹ We therefore hypothesized that the difference between the actual expenses observed in 2011 and those resulting from the indexation of the 2007 expenses represented the increase in spending attributable to the 21.6% supply increase in terms of kilometres.

We proceeded in this way for the five categories of expenses. The real increase in expenses for each category was then used to estimate the total annual expenses that would be incurred in order to double the supply of public transit starting in 2010, as proposed by *Équiterre* and *Vivre en ville*.

⁴ Société de transport de Montréal, *Budget 2010*, December 2009, p. 26.

⁵ *Équiterre* and *Vivre en ville*, *op. cit.*, footnote 2, pp. 3 and 4.

⁶ Société de Transport de Montréal, *Bilan 2007-2011 : Programme d’amélioration des services de transport en commun*, August 2012, p. 18.

⁷ Société de Transport de Montréal, *Rapport financier annuel 2011*, pp. 67 and 68.

⁸ To calculate this amount, we used the Bank of Canada’s inflation calculator.

⁹ While it would have been methodologically preferable to use a scenario going from 2006 to 2012 as a reference to capture the magnitude of the budgetary impact attributed to this program, the comparable data are only available from 2007 to 2011. Nonetheless, it seems more credible to us to compare the evolution of expenses per comparable category, because expenses do not evolve the same way in all categories when there is an increase in the supply of public transit.

To estimate the cost for all the transit authorities included in the *Act Respecting Public Transit Authorities*,¹⁰ we used a ratio based on each transit authority's portion of total expenditures. Given that the STM represented 57% of total public transit expenditures in Quebec in 2011, we assumed that every 57¢ spending increase for the STM would be accompanied by a 43¢ increase in the rest of the province, prorated based on the respective sizes of each local transit authority.

The additional investment costs required to double the supply of public transit compared to 2010 add up to \$556 million for Montreal (57% of the total) and \$414 million for the other transit authorities, for a total of \$971 million. As for the operating costs related to a doubling of the supply of public transit compared to 2010, they total \$1 billion for Montreal and \$761 million for the other transit authorities, for a total of \$1.8 billion (see Table A3).

By adding the operating and investment costs together, we get a total amount of \$1.6 billion of expenses for Montreal and of \$1.2 billion for the other transit authorities, for a grand total of \$2.8 billion.¹¹

It is interesting to note that according to the STM's scenario, a 25% increase in the supply of kilometres travelled generated an increase in ridership (trips) of only 11.4%.¹² Therefore, according to our calculations, increasing the supply of the STM's services by 21.6% between 2007 and 2011 entailed an increase in ridership of just 7%. Of course, with a growing population (particularly in the region of Montreal), ridership naturally increases. According to the STM's 2020 strategic plan, if it simply keeps its network assets up to date from 2010 to 2020, ridership will increase by 8%.¹³

Table A4: The impact that Équiterre and Vivre en ville's proposal to double the supply of public transit would have on ridership

| STM scenario | Increase in the supply of transit | Real increase in ridership | Increase in ridership due to the increased supply |
|--|-----------------------------------|----------------------------|---|
| 2007-2011 | 21.6% | 7.0% | 3.87% |
| Proposal of Équiterre and Vivre en ville | Increase in the supply of transit | Real increase in ridership | Increase in ridership due to the increased supply |
| 2010-2030 | 100% | 32.4% | 17.91% |

We can therefore calculate the effect of doubling the supply of public transit on ridership, by hypothesizing that the trends observed between 2007 and 2011 will be maintained in the future. Thus, as shown in Table A4, doubling the supply of public transit, as proposed by Équiterre and Vivre en ville, would entail an increase in net ridership (the difference between total ridership growth and ridership growth due to population growth) of just 17.91%. These

¹⁰ Government of Quebec, *Act Respecting Public Transit Authorities*, December 2014.

¹¹ These amounts are in 2013 dollars.

¹² Société de Transport de Montréal, *op. cit.*, footnote 6, p. 22.

¹³ Société de transport de Montréal, *Plan stratégique 2020*, June 2012, p. 16.

figures demonstrate that even investments in public transit as colossal as those proposed by Équiterre and Vivre en ville would be very unlikely to significantly increase ridership on the network.

Measures 3 and 4. T1-4: Developing the Supply of Quality Intercity Collective Transportation.

The proposed measures are:

- Developing a high-speed electric rail network connected to the North American network (NY-Boston-Toronto-Montreal-Quebec)
- Developing an interregional train network connecting at least Quebec’s six large urban centres (Montreal, Quebec, Gatineau, Sherbrooke, Trois-Rivières and Saguenay) with a frequency of at least one departure every two hours (8 to 10 departures per day).¹⁴

While these measures seem ambitious, they are considerably less so than what was initially proposed in the document published by Équiterre in 2009. The objective then was to connect not six large urban centres, but rather the fifty largest cities in the province by 2030.¹⁵ Establishing a passenger rail transportation network between fifty larger cities would impose a far greater annual cost than our present estimate. For want of an estimate to represent this ambitious project, Équiterre and Vivre en ville are content to raise the idea. Table A5 presents an estimate of the costs related to the implementation of a rail transportation system connecting Quebec’s six large urban centres.

Table A5: Estimated annual costs of a high-speed electric rail network and a rail transportation system connecting Quebec’s six large urban centres

| | | Annual costs (in 2013 dollars) | |
|--------------|---|--------------------------------|------------------------------|
| | Measures proposed by Équiterre and Vivre en ville | Our estimate | Équiterre and Vivre en ville |
| T1-4a | Developing a high-speed electric rail network | \$447,159,809 | Not measured |
| T1-4b | Developing an interregional electric rail network | \$1,427,485,149 | Not measured |

The third measure studied, namely a high-speed rail project in the most heavily populated area of Eastern Canada, is a proposal that has resurfaced in public debates for over a decade. The governments of Quebec and Ontario produced a study in 2009 on a high-speed rail project connecting Quebec City and Windsor. Note moreover that this proposal by Équiterre and Vivre en ville is purely hypothetical, insofar as it implies that an agreement between several governments (Ontario, Quebec and the northeastern states of the United States) would be reached.

¹⁴ Équiterre and Vivre en ville, *op. cit.*, footnote 2, p. 77.

¹⁵ Équiterre, *op. cit.*, footnote 1, p. 51.

According to the 2009 study from the governments of Ontario and Quebec, the cost of the initial investment would be \$21.3 billion in 2009 for a fully electric system (E300+), including trains and infrastructure. For the first year of operation, a sum of \$520 million would be required to run the system. Out of the 1,260 kilometres of the Quebec-Windsor project, exactly 300 km of rails would be located in Quebec, which represents 24% of the total. If we assume that Quebec's portion of the project would also represent 24% of total infrastructure costs, we arrive at a figure of \$5.06 billion in 2009. If we amortize this amount over a period of 40 years, with an annual interest rate of 5%, the infrastructure cost would amount to \$293 million a year.

As for the operating costs of the project, they would amount to \$520 million per year, according to the study produced by the governments of Quebec and Ontario. The portion taken on by Quebec, namely 24% of the route, would be \$124 million a year. In total, combining operating and infrastructure costs, the annuity taken on by Quebec to establish high-speed rail would therefore be \$447 million in 2013 (\$417 million in 2009 dollars).

Given the size of these amounts, it is not surprising that the study produced by the governments of Quebec and Ontario conclude that the project would not be economically cost-effective for the provinces, apart from a few stretches.¹⁶

The fourth measure proposed by *Équiterre* and *Vivre en ville* consists of developing an interregional electric rail network connecting at least Quebec's six large urban regions (Montreal, Quebec, Gatineau, Sherbrooke, Trois-Rivières and Saguenay) with a frequency of at least one departure every two hours (8 to 10 departures a day).

Aside from the Montreal-Quebec and Montreal-Ottawa connections that already exist and are served by VIA Rail, there would be five regions to cover in the rest of Quebec with conventional electric trains using five rail links (see Table A6).

Table A6: Rail connections serving the province of Quebec proposed by *Équiterre* and *Vivre en ville*, in addition to existing connections

| | |
|---------------------------|---------------|
| Montreal – Trois-Rivières | 140 km |
| Quebec – Trois-Rivières | 130 km |
| Montreal – Sherbrooke | 160 km |
| Sherbrooke – Quebec | 200 km |
| Quebec – Saguenay | 210 km |
| Total | 840 km |

For the estimation of the costs for trains and infrastructure, the Train de l'Est project of the Metropolitan Transportation Agency (AMT) served as a reference.¹⁷

¹⁶ Quebec Department of Transportation, Ministry of Transportation of Ontario and Transport Canada, *Updated Feasibility Study of a High Speed Rail Service in the Quebec City – Windsor Corridor*, Final Report, February 14, 2011, pp. S28 and 92. <http://www.mto.gov.on.ca/english/pubs/high-speed-rail/final-report/P020563-1300-001-EN-01.pdf>

¹⁷ Despite the fact that the Train de l'Est project is not identical to *Équiterre* and *Vivre en ville*'s project— among other thing in terms of the number of stations, of park-and-ride facilities, of locomotives and

Once again, our evaluation is probably prudent, given that Équiterre and Vivre en ville's scenario implies the construction of new rails over the entirety of the new routes, whereas the Train de l'Est project was made up of new rails over only 27% of its route. This could compensate for the number of stations, which will probably be proportionally lower over the 840 total kilometres.

In all, the Train de l'Est project includes the acquisition of 30 multilevel cars and 5 bimodal locomotives, in addition to the construction of a maintenance station and 10 new passenger stations. This AMT project was evaluated at \$671 million in 2012, not counting a \$90-million reserve to cover possible cost overruns.¹⁸ To this amount must be added \$244 million for the electrification of the route.¹⁹ Expressed in 2013 dollars, this \$244 million is equivalent to \$250 million. The total cost therefore amounts to \$930 million for the rail infrastructure and its electrification. The route being 52 kilometres long, we can estimate the cost per kilometre at \$18 million.

By multiplying this cost per kilometre by the 840 kilometres of the routes proposed by Équiterre and Vivre en ville, we get a total amount of \$15 billion for the year 2013. Amortized over 40 years, at an interest rate of 5%, the annuity for the infrastructures would therefore amount to \$870 million.

As for operating costs, we used the only AMT train route that is entirely electric, namely the Montreal–Deux-Montagnes line. The operating and administration cost related to this line is \$44 million a year for 8 park-and-ride facilities, 12 stations, 279 departures per week (or 14,508 per year) and a 29.9-kilometre route.²⁰ To arrive at the total operating cost of the Équiterre and Vivre en ville project, we used the train-kilometre measure, namely the total distance travelled by one train over a given period of time. Therefore, we multiply the number of annual departures by the total length of the course to obtain a supply of 434,000 train-kilometres. The annual operating budget of \$44 million therefore corresponds to a cost of \$101 per kilometre travelled.

Équiterre and Vivre en ville introduce an ambiguity in their analysis of interregional trains, by speaking of 8 to 10 departures a day for each connection. Obviously, the total number of kilometres travelled will vary as a function of the number of departures. By taking the average of 9 departures per day per destination, we arrive at 32,850 departures per year and a grand total of 5.5 million kilometres travelled. At \$101 per kilometre travelled, the operating cost would therefore be \$560 million per year.

cars—it nonetheless provides a good estimate, since it was analyzed with a lot of rigour in the context of a recent cost-benefit analysis. See Karine Daigneault, *Projet du Train de l'Est: Est-il économiquement rentable?* Research report from the Université de Montréal, April 15, 2013.

¹⁸ Agence métropolitaine de transport, Budget et financement.

¹⁹ See Karine Daigneault, *op. cit.*, footnote 17, p. 13.

²⁰ Agence métropolitaine de transport, *Budget d'exploitation 2014*, pp. 44 and 50.

By combining the amortization (based on useful lifespan), financing costs related to initial investment needs, and operating costs, we obtain a grand total of \$1.4 billion per year for the interregional electric train project. The measures concerning the high-speed rail link and the regional trains together amount to \$1.9 billion per year.

A Fifth Measure. T2: Favouring the Practice of Active Transportation

- T2-3: Supporting the implementation of bicycle sharing service systems across Quebec.²¹

Table A7: Estimated annual costs of implementing bicycle sharing service systems across Quebec (BIXIS)

| | | Annual costs (in 2013 dollars) | |
|-------------|--|---------------------------------------|-------------------------------------|
| | Measure proposed by Équiterre and Vivre en ville | Our estimate | Équiterre and Vivre en ville |
| T2-3 | Supporting the implementation of bicycle sharing service systems across Quebec (BIXIS) | \$101,075,138 | \$39,668,657* |

*This amount includes the portion paid by government and the portion paid by users.

For Montreal, Équiterre and Vivre en ville determined the operating costs based on an evaluation dating back to 2009 concerning the implementation of BIXI in the Quebec City region.²² According to the Market Research Corporation, cited by Équiterre and Vivre en ville, the operating costs for the year 2010 were estimated at between \$1,250 and \$1,750 million, and between \$1,830 and \$2,560 for the year 2014.²³ Having no information allowing them to estimate the operating costs in different cities, Équiterre and Vivre en ville assume that it would be inversely proportional to the populations of cities. For example, for a city with a population of between 20,000 and 30,000, the operating costs would be 133% higher than in Montreal, 100% higher for populations of between 40,000 and 100,000, and 66% higher for cities with 230,000 inhabitants.

The recent bankruptcy of BIXI Montreal allows us to have access to the financial statements of the Public Bike System Company (PBSC) and to examine its actual operating expenses. It now appears that the operating costs are seriously underestimated by Équiterre and Vivre en ville. Indeed, while they were estimated at \$1,500 a year for the city of Montreal, Superior Court documents show that spending per bicycle was actually \$3,535²⁴ (see Table A8), which is nearly two and a half times higher. We therefore use this estimate for operating expenses, to which we apply the same markups as Équiterre and Vivre en ville for other cities.

²¹ Équiterre and Vivre en Ville, *op. cit.*, footnote 3, pp. 6-7.

²² *Ibid.*, p. 6.

²³ Market Research Corporation, *Feasibility Study for the Implementation of a Bike Share Service in Ottawa-Gatineau*, November 2009, p. 38.

²⁴ We include operating, sales and marketing, and administrative expenses, for a total of \$18.1 million for 5,120 bicycles during the 2013 season. Quebec Superior Court, *Rapport du Syndic sur l'état des finances de la débitrice en relation avec la demande de prorogation de délai*, April 4, 2014, pp. 2 and 4.

Table A8: Estimated annual costs (per bicycle) of the implementation of bicycle sharing service systems across Quebec, by city population

| Cities and Équiterre markup | Our estimate | Équiterre and Vivre en ville |
|---|--------------|------------------------------|
| Montreal (no markup) | \$3,535 | \$1,500 |
| 230,000 inhabitants (66.66% markup) | \$5,892 | \$2,500 |
| 40,000 to 100,000 inhabitants (100% markup) | \$7,071 | \$3,000 |
| 20,000 to 30,000 inhabitants (133.33% markup) | \$8,249 | \$3,500 |

Équiterre and Vivre en ville do not seem to take into account the cost of investment in their calculations. Investment costs are considerable, though, and must be taken into account in the estimate of total costs.

The bankruptcy of the PBSC allowed us to learn that the bicycles had been purchased at a cost of \$910 each, and that the stations cost \$36,000 each.²⁵ According to the City of Montreal's accounting valuation, over five years, the bicycles lost 58% of their value, versus 44% for the stations. A linear depreciation would therefore imply a useful lifespan of approximately 9 years for bicycles and around 11 years for stations. Taking into account depreciation and assuming an interest rate of 5%, the annual cost of a bicycle would therefore be \$135, and the cost of a station \$4,600.

Regarding our estimate of the necessary investment costs per bicycle and per station, based on the PBSC's inventory of assets on December 31, 2013, we can say that it is rather prudent. Indeed, according to data from BIXI Montreal, the amount spent by the City of Longueuil to acquire 70 bicycles and 6 stations in 2012 is 17% higher than the amount that we used for our calculation.²⁶

To quantify the number of stations required for each city, we used the ratio for the city of Montreal for the year 2013, namely 11 bicycles per station.²⁷ For the number of bicycles for each municipality, we use the numbers of Équiterre and Vivre en ville.

Table A9: Estimated annual costs of the implementation of bicycle sharing service systems across Quebec

| Number of stations | Number of bicycles | Operating costs | Investment costs/year | Total cost*/year |
|--------------------|--------------------|-----------------|-----------------------|------------------|
| 1,562 | 17,350 | \$91,589,174 | \$9,485,963 | \$101,075,138 |

*The total cost is expressed in 2013 dollars.

²⁵ Pierre-André Normandin, "Montréal paiera 412\$ par vélo BIXI," *La Presse*, February 22, 2014.

²⁶ Sara Champagne, "BIXI en péril à Longueuil," *La Presse*, August 24, 2014.

²⁷ Quebec Superior Court, *op. cit.*, footnote 24, p. 2.

In Montreal, most of the costs were supposed to be financed from the profits generated by sales of the concept abroad. However, these revenues exist independent of the provision of the local bike service and are therefore independent of the costs of providing this service. Furthermore, even if the government covers 50% of expenses, it is taxpayers who ultimately pay for all costs. We therefore conclude that 100% of the costs related to measure T2-3 should be considered as directly or indirectly paid by taxpayers. According to us, the total amount of measure T2-3 is \$101 million (see Table A9), compared to \$39.7 million according to Équiterre and Vivre en ville (see Table A7).

The Electrification of 5% of the Automotive Fleet

A sixth measure proposed by Équiterre and Vivre en ville is also evaluated here: the electrification of private passenger transportation.

Table A10: Estimated annual costs of electrifying 5% of the private automotive fleet

| Measure | Our estimate | Équiterre and Vivre en ville |
|--|-----------------------|------------------------------|
| Electrification of 5% of the private automotive fleet | \$789 million in 2013 | Not measured |

In their 2011 document, Équiterre and Vivre en ville propose that 5% of the automotive fleet should be fully electric by 2030.²⁸ The lack of precise information concerning the size of the automotive fleet in 2030 in the Équiterre and Vivre en ville document complicates the estimate of the cost of this measure. However, it is still possible.

We must begin by estimating the number of gasoline-powered cars in 2030. Équiterre and Vivre en ville propose furthermore that the energy efficiency of gasoline-powered vehicles be improved by 50% (a measure whose cost we are not evaluating in the present *Research Paper*). Since the consumption of gasoline was 1,524 litres per year per vehicle in 2009, a 50% efficiency improvement would bring consumption down to 762 litres per vehicle per year in 2030. Équiterre and Vivre en ville also provide a consumption target for all private vehicles in 2030, namely 2.6 billion litres.²⁹ By dividing the total predicted consumption of the automotive fleet in 2030 by the annual consumption per vehicle in 2030, we obtain 3.4 million gasoline-powered cars in 2030.

By using the ratio prescribed by Équiterre and Vivre en ville, namely 5% fully electric vehicles, it is therefore simple to calculate the number predicted for 2030, namely 176,945 for passenger vehicles. Équiterre and Vivre en ville also propose to electrify governmental and municipal

²⁸ Équiterre and Vivre en Ville, *op. cit.*, footnote 2, p. 34.

²⁹ *Ibid.*, p. 32.

fleets.³⁰ We estimated that this proportion would represent 18,305 vehicles in 2030. All told, there would therefore be 195,250 electric vehicles in 2030.³¹

How much would the electrification of 195,250 vehicles cost? We are in uncharted territory here, since such an objective has been achieved just about nowhere on Earth. The case of Norway can provide us with some guidance, however. Norway's immense prosperity, stemming in large part from their development of oil, has allowed the government to set ambitious objectives in terms of reducing gasoline consumption in the country. We therefore estimate the cost for Quebec starting from the Norwegian experience.

Norway is the most advanced country in terms of the electrification of personal transportation with 7.7 electric cars per 1,000 inhabitants already, which is 12 times the ratio observed in Quebec. In this context, we postulate that to achieve such an ambitious objective, subsidies in Quebec would have to be increased in order to be at least as generous as those granted in Norway.³²

The cost of the annual subsidy in Norway is based on estimates from a report for The Committee on Climate Change³³ that evaluates overall government incentives for a vehicle with a before-tax value of \$46,500. This amount is representative of the electric car fleet, since the Nissan Leaf, the vehicle with the biggest market share,³⁴ sells for a little over \$40,000 in Norway.³⁵

For initial purchase support, there is an exemption from the value added tax of \$11,600 as well as an exemption from the registration tax of \$8,200, for a total of \$19,800. To obtain an annual cost, we must amortize this amount over the useful life of an electric car, which we have estimated at ten years, with an annual interest rate of 5%. The corresponding annuity is \$2,569.

To this amount must be added the annual cost of subsidizing the use of the electric car. This support takes the form of an exemption from the road tax (\$657), an exemption from road tolls (\$1,245) as well as free parking (\$854). This therefore amounts to an annual subsidy of \$5,325.

This annual support for ten years is equivalent to a lump sum of \$41,100 at the time of vehicle purchase (with an annual interest rate of 5%). Knowing that the annuity was calculated for a car with a value of \$46,500, we can determine that the value of the support is equal to 88% of the price of the vehicle.

³⁰ Équiterre and Vivre en Ville, *op. cit.*, footnote 2, p. 9.

³¹ By private vehicles, we mean automobiles and light trucks in the passenger vehicle category as well as the institutional, professional or commercial category. Société de l'assurance automobile du Québec, *Le Bilan 2013: accidents, parc automobile et permis de conduire*, 2014, p. 22.

³² Association des véhicules électriques du Québec, *Statistiques au Québec*, October 2014; Statistics Norway, *Population 1 January, 2014*, February 2014; Gronnbil, *EVs in Norge okt*, 2014; Statistics Canada, *Population by year, by province and territory*; Institut de la statistique du Québec, *Le bilan démographique du Québec*, Édition 2013, December 2013, p. 5.

³³ Celine Cluzel *et al.*, *Pathways to high penetration of electric vehicles*, Element Energy Limited, prepared for The Committee on Climate Change, December 2013.

³⁴ EV Norway, *What does the Norwegian EV market look like today?*

³⁵ Bjart Holtsmark, Anders Skonhoft, "The Norwegian support and subsidy policy of electric cars. Should it be adopted by other countries?" » *Environmental Sciences & Policy*, Vol. 42, 2014, pp. 160-168; Bank of Canada, *Year Average of Exchange Rates (Average of 250 Days)*, Financial Markets Department, 2013.

By postulating that Quebec consumers have the same sensitivity as Norwegians when it comes to price variations, we therefore apply this 88% ratio to the average value of the base price of the two most widely sold electric cars in Quebec (Volt: \$38,900 and Leaf: \$31,800). We therefore would need a purchase subsidy of \$31,200 in Quebec. This amount corresponds to an annuity of \$4,046 for a period of ten years.

For institutional vehicles, governments would have to pay for the entirety of the costs of the vehicles since they cannot subsidize themselves. To be prudent, we will use the same annual amount calculated for the subsidy to other individuals, even though it is lower.

In total, the number of electric vehicles to integrate onto Quebec roads is 195,250 for a total annual cost of \$789 million (see Table A10).

Table summarizing the measures proposed by Équiterre and Vivre en ville

According to the calculations of Équiterre and Vivre en ville, the measures retained would cost \$5.2 billion annually, once the projects were completed. According to our calculations, the total annual cost of the measures proposed by Équiterre and Vivre en ville amounts to \$6.4 billion a year in 2013 dollars (see Table A11).

To better appreciate the magnitude of these two amounts, they represent \$1,526 and \$1,875 per household, respectively.³⁶

³⁶ Quebec had 3,395,345 households in 2011. Institut de la statistique du Québec, Ménages privés selon le genre (familiaux et non familiaux), Québec, 1951-2011.

Table A11: Estimated costs of various measures aiming to reduce Quebecers' oil consumption, according to our calculations and those of Équiterre and Vivre en ville

| Measures | | Our calculations | Équiterre and Vivre en ville* |
|--------------------------------|--|-------------------------|--------------------------------------|
| T1-1 | Doubling the supply of local public transit | \$970,548,498 | \$2,044,776,119 |
| T1-2 | Increasing support for the use of public transit | \$1,783,515,150 | \$2,249,253,731 |
| T2-2 | Financing the development of utility cycling infrastructure | \$10,223,881 | \$10,223,881 |
| T2-3 | Supporting the implementation of bicycle sharing service systems across Quebec (BIXIS) | \$101,075,138 | \$39,668,657 |
| T5-2 | Sensitizing and informing the population about sustainable transportation | \$6,134,328 | \$6,134,328 |
| T5-3 | Supporting transportation management agencies | \$8,179,104 | \$8,179,104 |
| A2-3 | Revising housing policy | \$715,671,642 | \$715,671,642 |
| A3-1 | Providing technical support to municipalities | \$5,111,940 | \$5,111,940 |
| A3-2 | Expanding financial support programs for densification and revitalization | \$51,119,403 | \$51,119,403 |
| A3-3 | Encouraging and supporting the creation of model neighbourhoods (eco-districts) | \$51,119,403 | \$51,119,403 |
| Secondary objective 2.2 | Electrifying private transportation | \$789,981,500 | Not estimated |
| T1-4a-4b | Setting up regional trains and high-speed rail | \$1,874,644,958 | Not estimated |
| Total | | \$6,367,324,945 | \$5,181,258,209 |
| Total per household | | \$1,875 | \$1,526 |

*For purposes of comparison, we have expressed the costs estimated by Équiterre and Vivre en ville in 2013 dollars.