THE IMPACTS OF ELECTRIC VEHICLES ON GHGs, TRANSIT TAXES AND ELECTICITY DEMAND IN METRO VANCOUVER

November 2015

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ABSTRACT

This Report attempts to quantify the impacts of electric vehicles: how the introduction of electric vehicles could affect our greenhouse gas emissions, how the substitution of electricity for gasoline and diesel will impact negatively on fuel tax revenues now required to fund transit and maintain our roads and highways, and how electricity demand will increase, putting greater stress on the province's ability to provide long-term stable supplies of electricity.

As a compendium to earlier reports on GHG emissions to 2030 in Metro Vancouver, and the impacts of the Carbon Tax on GHGs, this report extends the analysis to 2040 and present two cases: the first using standard assumptions from the US Energy Information Agency (where electric vehicles will be 9% of new purchases) and the Metro Vancouver Regional Growth Strategy, and the second assessing the impacts of a more optimistic uptake of electric vehicles. Under this second analysis, the proportion of new passenger vehicles that will be electric in 2040 reaches 45%.

The analysis concludes:

1. under Base Case conditions GHGs will be higher in 2040 than in 2007 and even with significant electric vehicles entering the vehicle stock, GHGs in 2040 will only be 9% lower than 2007 levels;

2. transit taxes (allocated to TransLink) will begin falling by 2022 and will be 28% lower under our Base Case assumptions. With the assumption of significant electric vehicles, transit taxes will fall by 36% by 2040, requiring TransLink to find alternative sources of revenues;

3. under Base Case assumptions, electrical demand in 2040 will increase by approximately 90 GWh (more than what an additional turbine at the Revelstoke dam will generate). Under the higher electric vehicle assumption, demand will increase by roughly 20% of Site C capacity and by 2050, electric vehicles in the province could demand over half of what Site C will produce.

The Impacts of Electric Vehicles on GHGs, Transit Taxes and Electricity Demand in Metro Vancouver

With the recent refocus on climate change by the Federal Government and many provincial governments, electric vehicles have been touted as an important component in the battle to reduce overall Greenhouse Gas (GHG) emissions. Indeed, in a recent report from Simon Fraser University,[1] electric vehicles could reduce GHGs by 80 - 98% in British Columbia in the long term.

While few dispute that electric vehicles will impact positively on eliminating GHG emissions, there has been little detailed quantitative analysis of what those impacts could be, and how the replacement of electricity for gasoline and diesel will affect future fuel tax revenues, and exactly how much electricity will be demanded by these electric vehicles.

This report uses our VKT/GHG Forecasting Model[2] to estimate the impacts on GHGs, fuel tax revenues and vehicle electricity demand for Metro Vancouver for two electric vehicle scenarios. The first scenario extends our earlier Base Case forecast analysis from 2030[3] to the year 2040 using updated input data from the US Energy Information Agency's (USEIA) energy model – particularly the projections for the proportion of new vehicle purchases by vehicle class that are electric - and updated exogenous data linked to the Metro Vancouver Regional District as described later in this report.

We then assess an IMPACT scenario that has new electric vehicle purchases in Metro Vancouver five times higher than in the Base Case. We use a figure of five times for no other reason than, by using that figure, the proportion of new vehicle passenger vehicle purchases approaches 50% by the mid-2040s. It is chosen to be reflective of the optimistic view of the potential of electric vehicle penetration, but it is not, in any way, suggesting that this is a likely outcome.

It should noted, however, that the analysis undertaken in this report is NOT presenting a "forecast" of what will happen in the future. Rather, it is saying that, IF ONE AGREES WITH THE ASSUMPTIONS IN THIS REPORT, then the results of the analysis are likely to occur. If one has disagreements with the results, then it is incumbent on the reader to challenge which assumptions are not valid.

[1] Electrifying Vehicles: Insights from the Canadian Plug-in Electric Vehicle Study, http://rem-main.rem.sfu.ca/papers/jaxsen/Electrifying_Vehicles_(FINAL)_V2.8_(July10)_ExecutiveSummary.pdf

[2] A complete description of the VKT/GHG Forecasting Model along with all data sources can be found at the website: **http://pacificanalytics.ca/autostat**

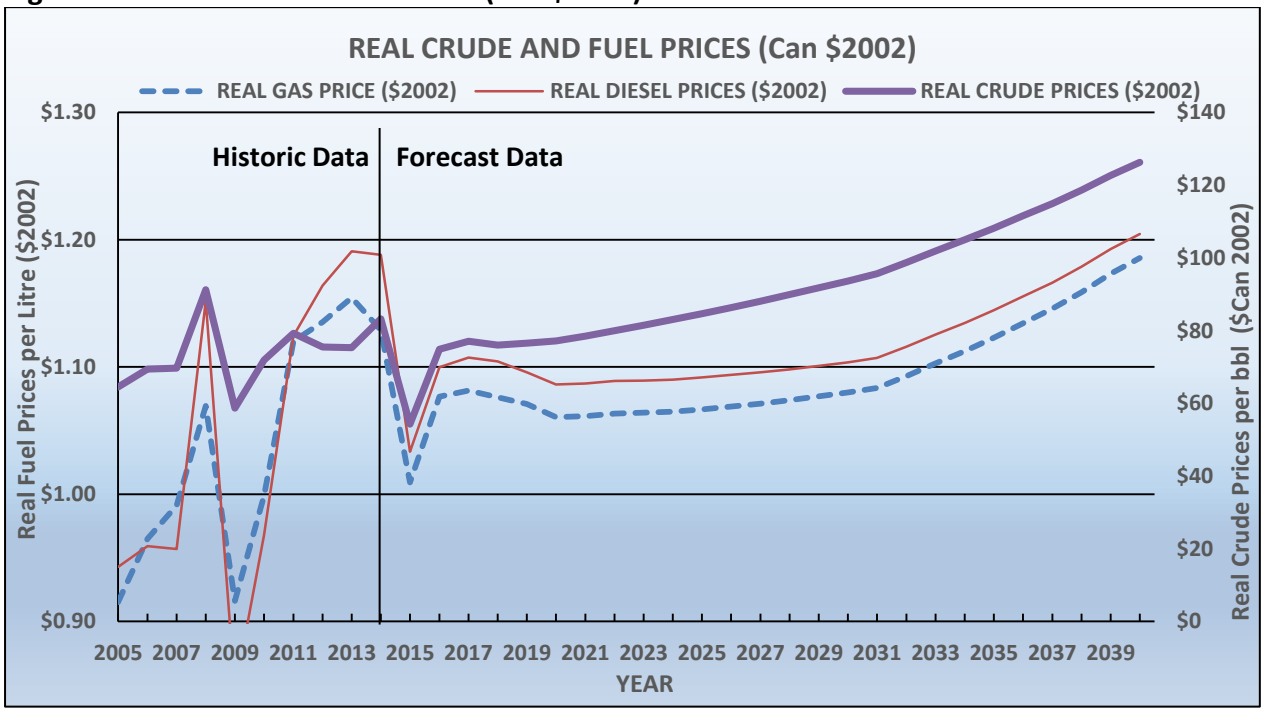
[3] Vehicle Greenhouse Gases to 2030 in Metro Vancouver and the Naked Emperor, can be downloaded from the website: **http://pacificanalytics.ca/autostat**

ASSUMPTIONS

For this modelling exercise, the main economic and vehicle-related assumptions are taken from the US Energy Information Agency (USEIA) whose own internal model provides the best systematic and objective set of official US government data on expected vehicle attributes and driver behaviour. The USEIA model[4] provides internally consistent forecasts for a number of variables which are used in our VKT/GHG Forecasting Model; most of which were discussed in detail in an earlier paper.[5] Below is a brief summary of the important variables.

Economy-Wide Data: The model incorporates forecasts of US economic growth, inflation and crude oil prices which, in turn, drive expectations for vehicle attributes. For the purposes of this analysis we have used the USEPA 2015 Reference Case. **Figure 1** below displays the estimates of real ($2002) crude oil prices (WTI $Can/bbl) which we have incorporated into our Model as well as the resultant real ($2002) gasoline and diesel prices in Metro Vancouver.

Figure 1: Real Crude and Fuel Prices (Can $2002)



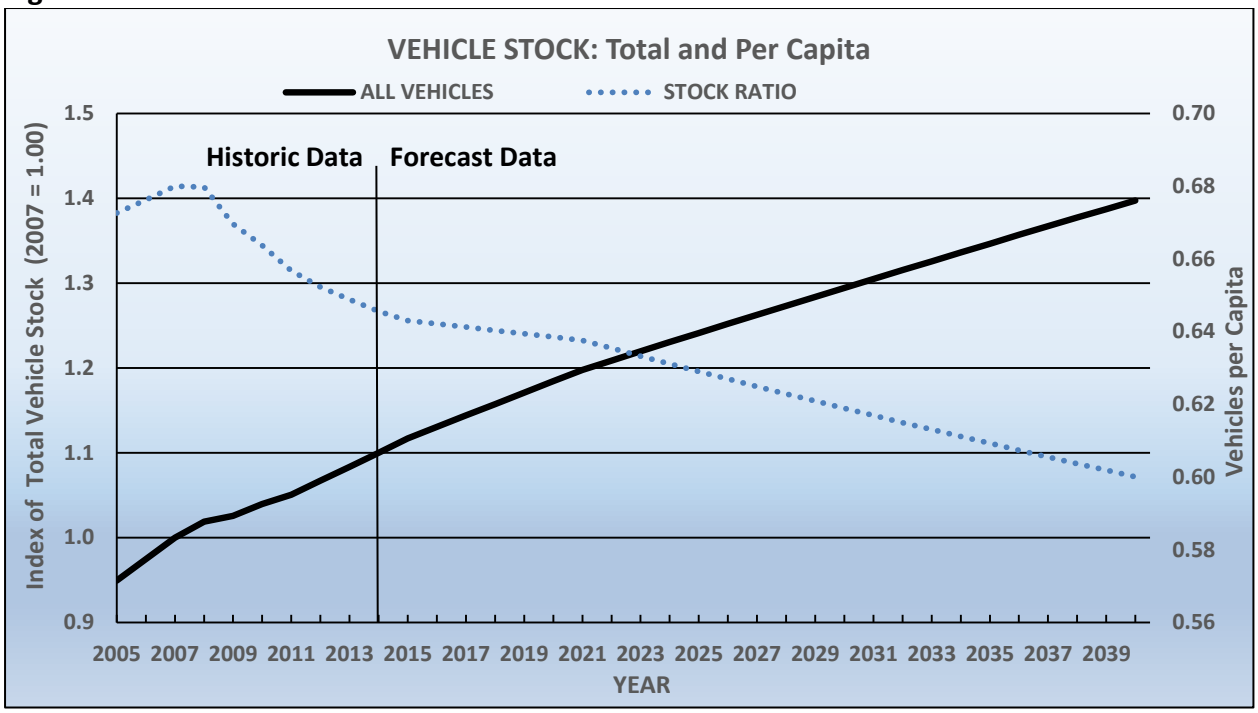
Source: USEIA (2015 Reference Case) and VKT/GHG Forecasting Model

[4] The USEIA model is a comprehensive econometric model in which the price of crude oil directly impacts economic growth, new vehicle purchasing behavior, and the impetus (slightly) to improvements in vehicle efficiencies. Higher fuel prices result in somewhat larger uptake in more fuel efficient vehicles, especially diesel and electric, and leads to somewhat greater purchases of smaller vehicles.

[5] Vehicle Greenhouse Gases to 2030 in Metro Vancouver and the Naked Emperor, op. cit.

Vehicle Stock: As discussed in the cited earlier report, vehicle stock consists of previous period stock adjusted for attrition and outflows, inflows from outside BC and from outside the Metro Vancouver region plus new vehicles. The number of vehicles is determined by multiplying the vehicle stock-to-population ratio (by age cohort and sex) by population growth. Continuing the trends established since 2007, the Base Case adopts a declining stock ratio in the future for all non-senior age/sex cohorts. The result, as displayed in **Figure 2**, is a fairly steady decline in the overall average stock ratio over time, but because of expected population growth, the actual number of vehicles continues to increase in the Metro Vancouver region.

Figure 2: Vehicle Stock and Vehicle Stock Ratio



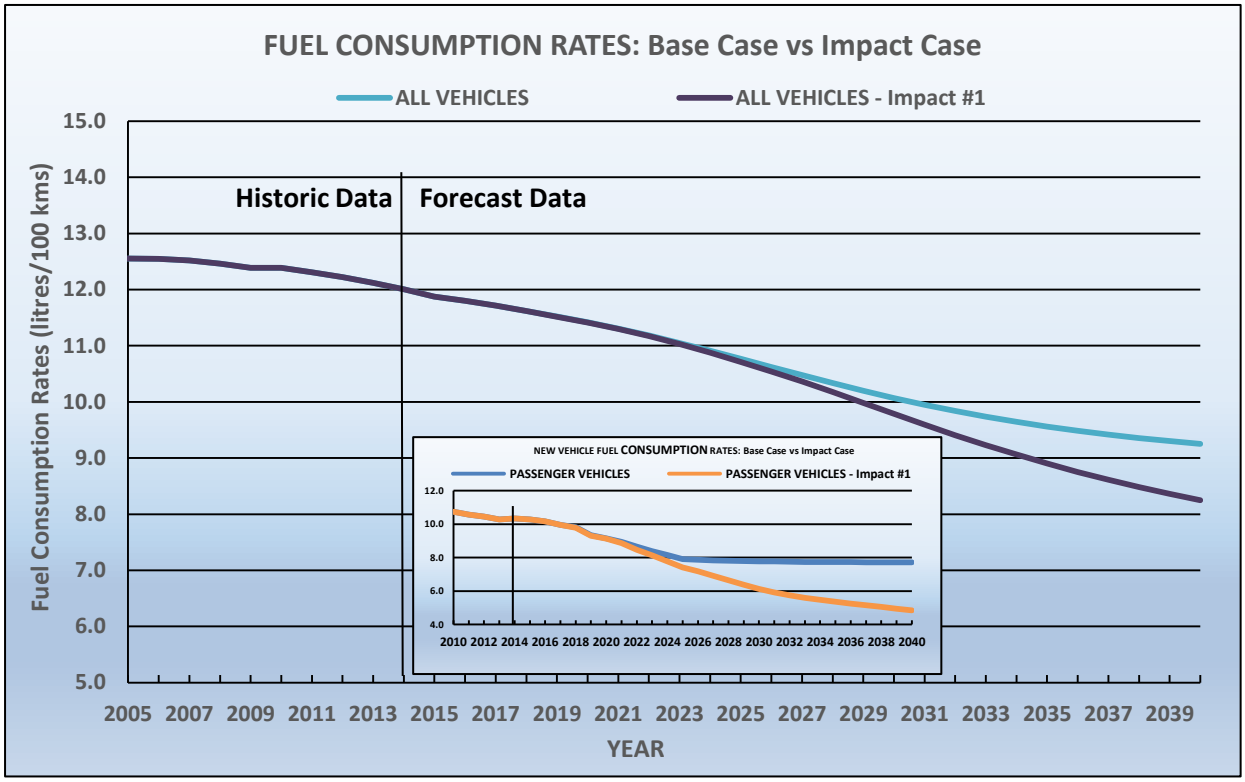
Source: VKT/GHG Forecasting Model

Fuel Efficiencies[6]**:** Projections for expected new model fuel consumption rates by vehicle type and fuel type are generated based on US legislative requirements and, to a small extent, on expectations of US growth and future crude oil prices. Incorporating those trends into our Model suggests that average new passenger vehicle fuel consumption rates will improve by just over 25% between 2014 and 2040, falling from a weighted average of 10.4 litres/100 kms for model year 2014 vehicles to 7.7 litres/100 kms for model year 2040 vehicles. In contrast, under our IMPACT assumption (with much higher electric vehicle purchases) average new passenger fuel consumption rate drops to 4.9 litres/100 kms by 2040.

[6] The USEIA model generates forecasts of fuel efficiencies in term of miles per US gallon. For our purposes, these are converted to fuel consumption rates – litres per 100 kms.

The weighted average for all vehicles (passenger, medium and heavy-duty vehicles, buses and taxis) in Metro Vancouver is projected to fall from an average of 12.0 litres/100 kms in 2014 to 9.3 litres/100 kms in 2040 under our Base Case. In our IMPACT scenario, all vehicle fuel consumption rates fall to 8.3 litres/100 kms by 2040. **Figure 3** below displays the projected trends in both new passenger vehicle fuel consumption rates and all vehicle fuel consumption rates over the study period.

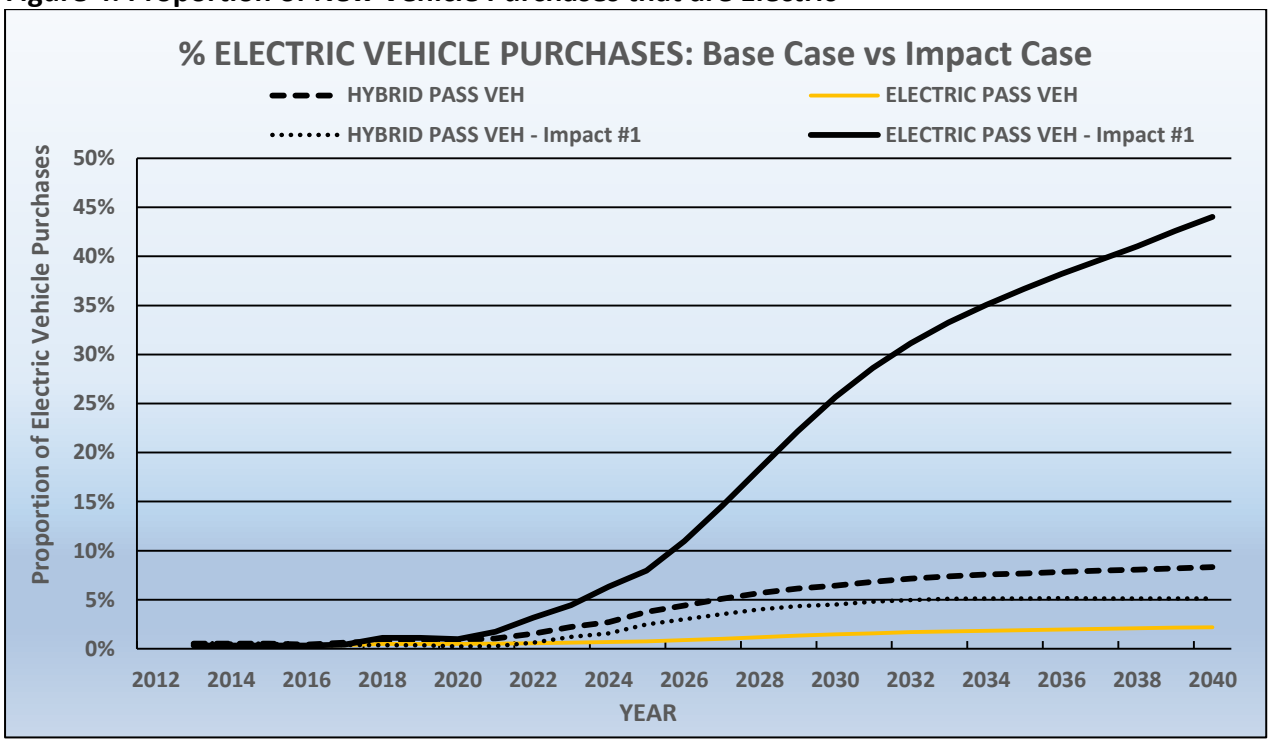
Figure 3: Fuel Consumption Rates (litres/100 kms)



Electric Vehicle Purchases: The VKT/GHG Forecasting Model includes two groups of electric vehicles: hybrids (a portion of which are plug-in hybrids and therefore make demands on the electrical grid) and pure electric vehicles. The USEIA model provides estimates of the proportion of new vehicle purchases that are electric by each of these groups; their Reference Case estimates (shown in **Figure 4** on the following page) constitute the Base Case. The IMPACT scenario (electric vehicle purchases 5 times higher than the Reference Case) is also displayed in Figure 4. Note that as pure electric vehicles become more popular the proportion of plug-in electric hybrids actually falls.

Besides data from the USEIA relating to the general economy and vehicle characteristics and behaviour, the Model also incorporates data on a number of other variables as detailed on the following page:

Figure 4: Proportion of New Vehicle Purchases that are Electric



Source: USEIA (2015 Reference Case) and VKT/GHG Forecasting Model

1. Real Per Capita Median Incomes: Growth in Metro Vancouver for this variable averaged 1.1% over the 2001-2013 period (the latest for which there are data); accordingly, in keeping with using conservative assumptions, we have used a growth of .75% for the forecast period;

2. Population Growth by Age and Sex: these data are based on Metro Vancouver's Regional Growth Strategy which identifies population growth by small area (Transit Area Zone – TAZ) over the forecast period;

3. Density and Driving Distance variables: These data are based on the Metro Vancouver Regional Growth Strategy (density equals population divided by area in hectares for each TAZ) and weighted population average of the distance of each TAZ from the Central Business District (downtown Vancouver) and from the Regional Town Centre;

4. Transit policy variables: These data include forecasts of transit access, number of bus hours, the number of Skytrain hours, and the real dollar price of the monthly fare card. For the purposes of this forecast, we have assumed that transit access follows the Regional Growth strategy expectations, that bus hours increase with population growth, that Skytrain hours increase with the completion of the Evergreen Line beginning in 2018, and that real dollar fare card price stays constant over the forecast period.

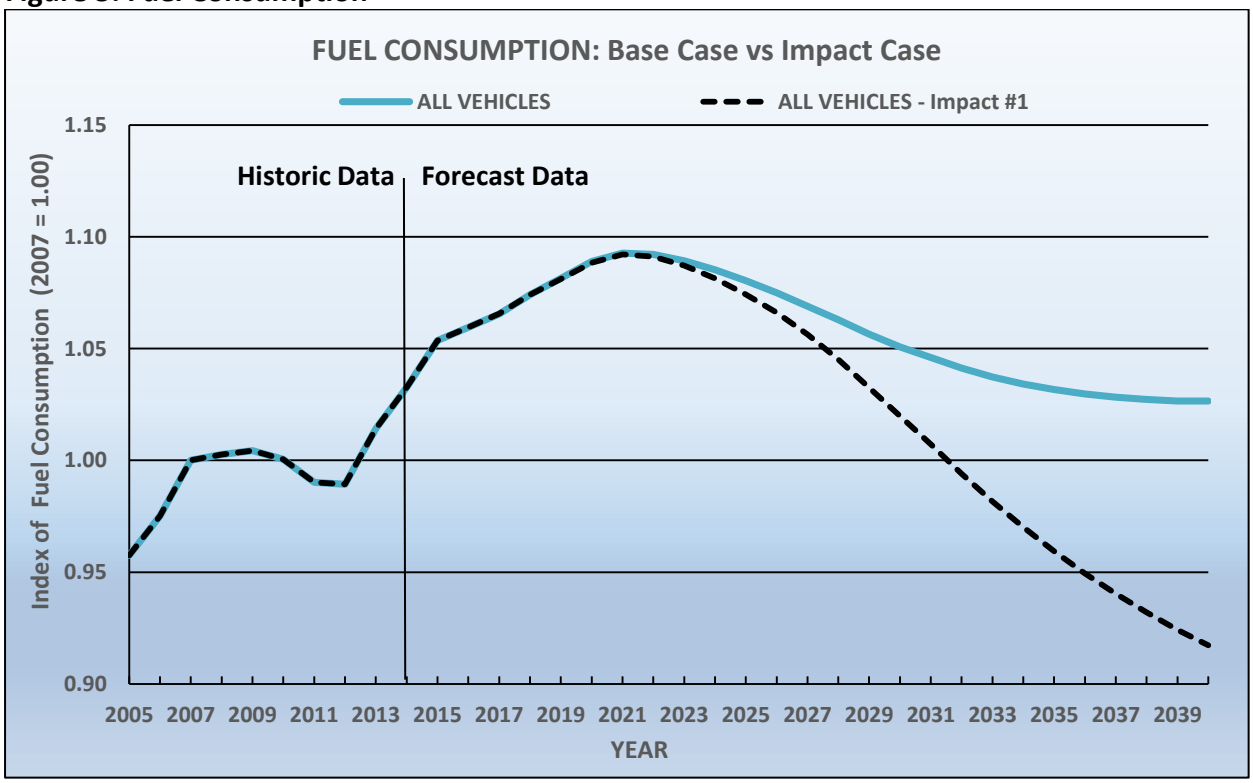
RESULTS

Given the above assumptions, we are now in a position to estimate the trends in GHGs, transit taxes, and electrical demand over the 2014 to 2040 time period based on the USEIA Reference Case data, the Metro Vancouver exogenous input data, and the previously defined IMPACT scenario.

Fuel Consumption

Figure 5 below highlights the trend in Fuel Consumption over the study period. In the Base Case, consumption peaks in 2022 then slowly declines, but even by 2040, total fuel consumption remains 3% higher than the total consumption recorded in Metro Vancouver in 2007 (the base year from which many climate change data are calculated).[7] Under the IMPACT scenario, while fuel consumption still peaks in 2022, it declines much faster as the proportion of new electric vehicles in total sales gradually increases. By 2040, overall fuel consumption is estimated to be 8% below the 2007 level.

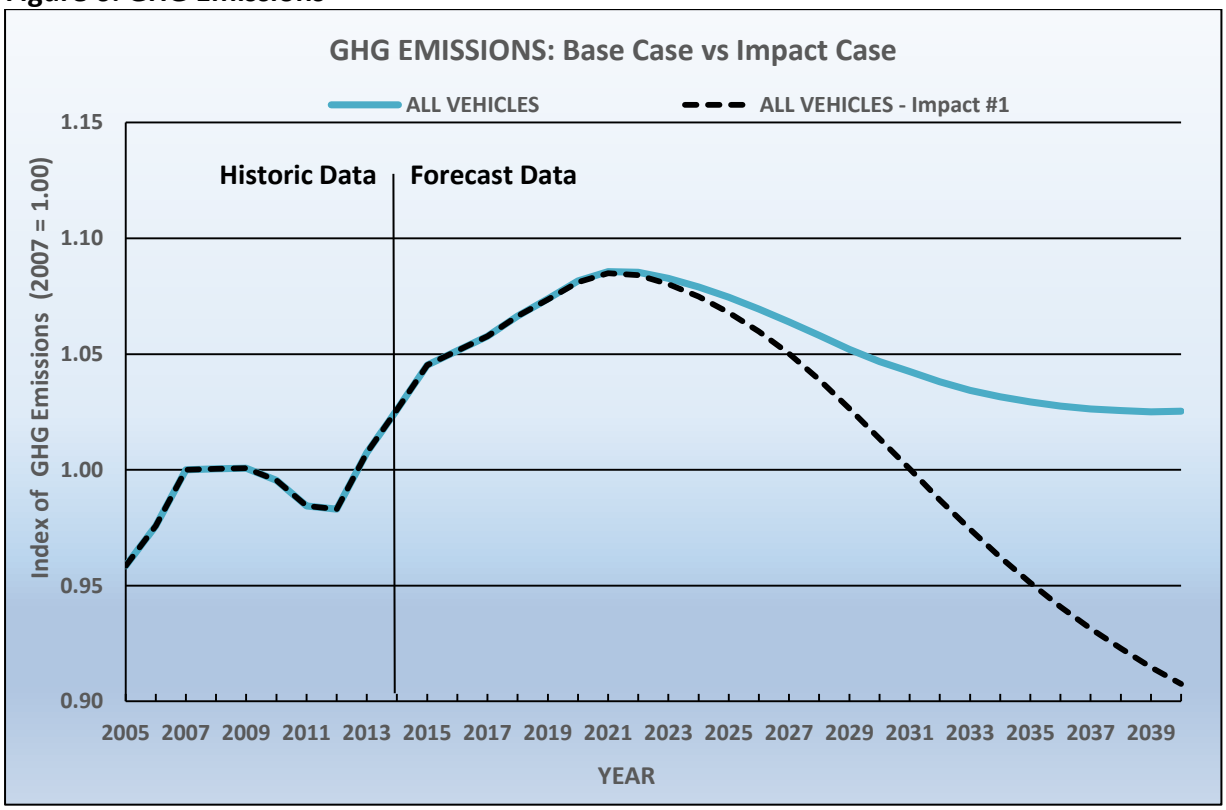
Figure 5: Fuel Consumption



Source: USEIA (2015 Reference Case) and VKT/GHG Forecasting Model

[7] The Federal Government recently announced a climate change goal of reducing total Canadian GHGs by 30% by the year 2030 compared to a baseline value in 2005; the BC Government's own objective is to reduce total provincial GHGs by 33% from a baseline value inf 2007, although that aim is to be accomplished by 2020, some five years from now.

Figure 6: GHG Emissions



Source: USEIA (2015 Reference Case) and VKT/GHG Forecasting Model

GHG Emissions

Directly related to fuel consumption are GHG emissions.[8] **Figure 6** above highlights the impacts on these emissions over time for both the Base Case and the IMPACT scenario.

GHG emissions stabilised in 2008 and 2009 and then dropped to 2012. Since then, however, emissions have trended upward (the 2015 emissions increase is confirmed by the most recent Ministry of Finance fuel sales data for the Lower Mainland).

As with fuel consumption, Base Case GHG emissions peak in 2022 and then decline slowly, while the IMPACT scenario has GHG emissions falling much more rapidly. Despite the IMPACT scenario being quite aggressive in electric vehicle uptake, the decline in GHGs by 2040 is still only 9% lower than 2007 levels, a far cry from the major reduction in GHGs that International groups and the Federal and Provincial governments are calling for.

[8] Fuel consumption and GHG emissions are closely linked but not quite exactly. A litre of gasoline burned will always produce 2,289 grams of CO_2 while burning a litre of diesel produces 2,263 grams and propane 1,510 grams. Consequently, a small difference may occur if the proportion of diesel-to-gasoline-to-propane vehicles changes over time or, obviously, if electric vehicles become a greater proportion of the stock. At the same time, newer vehicles generally emit much less CH_4 and N_2O emissions and therefore as the vehicle stock renews itself, emissions will fall.

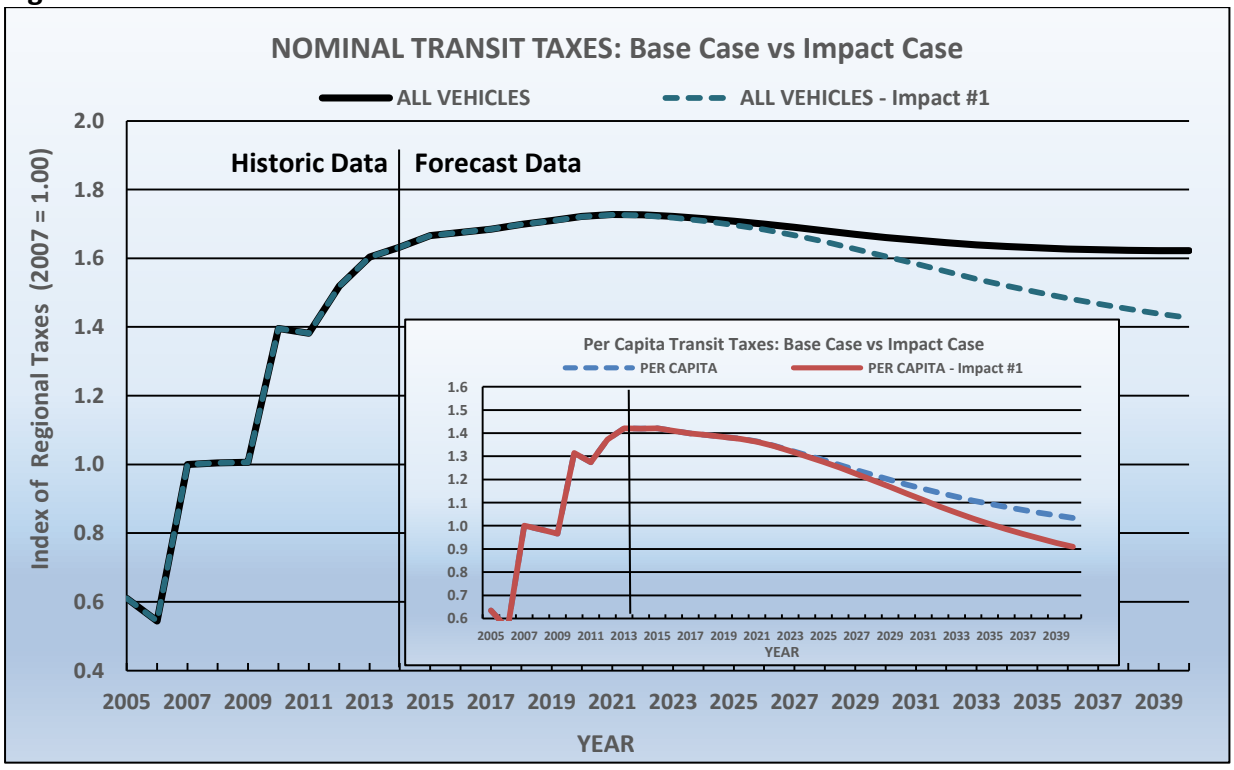
Transit Taxes

In the Metro Vancouver region, there is a 17 cent transit tax levied on each litre of gasoline and diesel sold, the revenues from which go to TransLink to assist in funding transit operations. As fuel consumption declines over the next 25 years, the revenues from these taxes will decline, unless, of course, the tax rate is increased.

Figure 7 below highlights the trend in transit taxes assuming no change in the tax rate of 17 cents per litre.[9] Mirroring the increase in fuel consumption, transit tax revenues are expected to increase slightly to 2022 and then begin falling. By 2040, the tax revenues under the Base Case will more-or-less match revenues generated in 2014. In contrast, under the IMPACT scenario, because of the much greater use of electricity (and hence lower use of taxable fuels), nominal fuel taxes will be some 12% lower in 2040 than in 2014.

A more revealing trend may be the value of transit taxes per capita since the demand for transit services are expected to increase as the population increases. In that case, Base Case per capita revenues would be almost 28% lower and 36% lower under the IMPACT scenario.

Figure 7: Transit Taxes



Source: USEIA (2015 Reference Case) and VKT/GHG Forecasting Model

[9] The rapid and uneven increase in tax revenues during the 2005 to 2013 period reflects the increase in the tax rate over that period, rising from 6 cents in 2006 to 12 cents in 2007 to 15 cents in 2010 to 16.5 cents in 2012 and 17 cents in 2013.

An alternative interpretation is that, if all fuel taxes increase at the rate of inflation over the 2016 to 2040 period, the purchasing power of the transit tax revenues would be 28% lower under the Base Case and 36% lower under the IMPACT scenario. Accordingly, in order to maintain the purchasing power of transit tax revenues per capita, under the Base Case assumptions the transit tax would need to increase by 5 cents over inflation by 2040 and by 6.5 cents over inflation by 2040 under the IMPACT scenario. This would lead to a transit tax of approximately 32 cents per litre in 2040 (34 cents under the IMPACT scenario) as opposed to the present 17 cents.

The emergence of electric vehicles will thus have a major impact on transit tax revenues even if electric vehicles do not form a major proportion of new purchases by 2040. And it should be noted that this substantive decline is mirrored by the provincial tax (presesntly 8.5 cents per litre for gasoline and 9.0 cents for diesel[10]) and the provincial carbon tax (6.67 cents per litre and 7.67 cents per litre for diesel). Since the provincial tax provides a good portion of the provincial budget for highway construction and maintenance, the provincial government will need to find additional sources of revenues to continue highway upkeep.

Electricity Demand

Often electric vehicles are presented as a critical part of the solution to ever-increasing GHG emissions, without much recognition that electric vehicles themselves will have important and far-reaching impacts. One of these impacts will be an increase in the demand for electricity.

Figure 8 on the following page displays the projections of electricity demand for all electric vehicles (plug-in hybrids and pure electric) for the Base Case and the IMPACT scenario. Not surprisingly, the Base Case has minimal electricity demand by vehicles in 2040, less than 100 GWh. The IMPACT scenario, in contrast, has electricity demand of almost 900 GWh.

To put this in context, under the Base Case assumptions electric vehicles will demand all (and then some) of the new electricity provided by installing Unit 6 turbine at the Revelstoke dam. Under the IMPACT scenario assumptions, vehicles in Metro Vancouver will demand about one fifth of the electricity generated by Site C.[11]

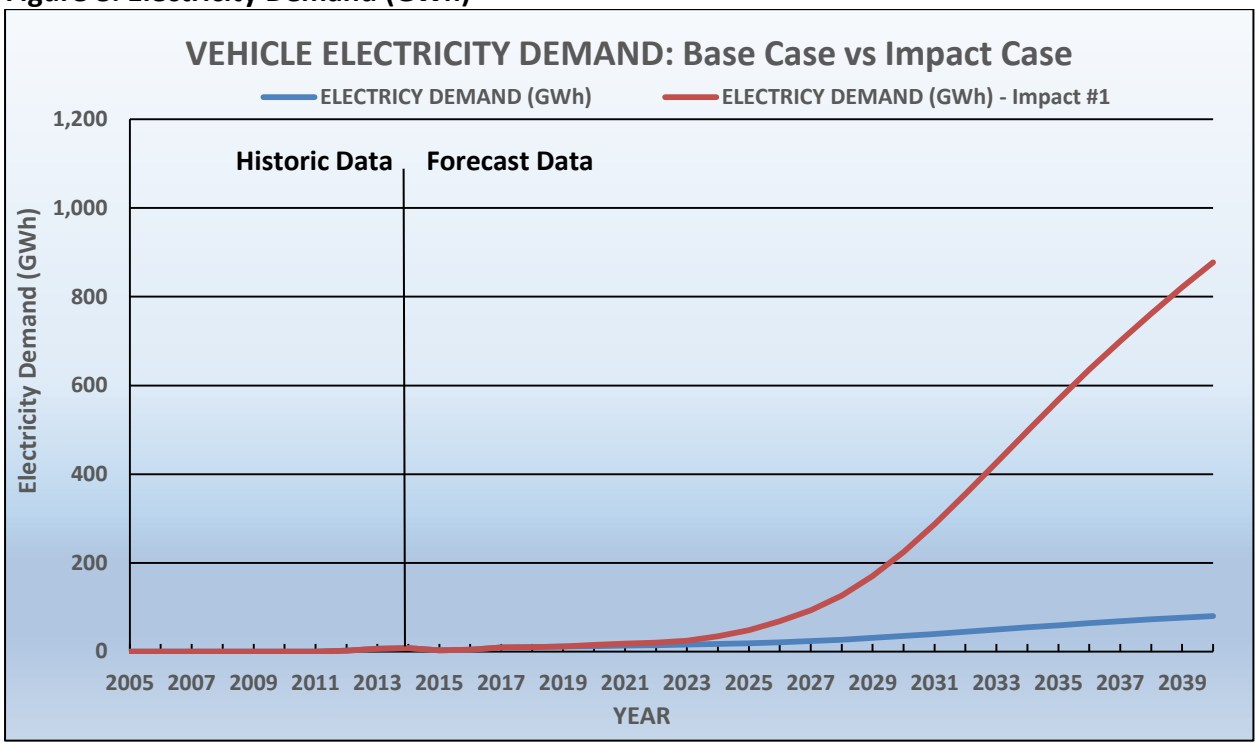
[10] These provincial taxes are made up of a "Dedicated Motor Fuel Tax" allocated to the BC Transportation Financiag Authority (presently set at 6.75 cents) and the remainder – a "Provincial Motor Fuel Tax" – allocated to general revenues.

[11] The addition of the 500 MW Unit 6 turbine at the Revelstoke dam will increase electity availabity in the province by approxmately 60 GWh per year. The Site C project will provide approximately 5,100 GWh of electricity yearly.

Revelstoke:https://a100.gov.bc.ca/appsdata/epic/documents/p321/d31486/1251914328764_6cbaa94c7115a8b5628a2c926928fa21847522e41e6d75cb541c4aeee7efeb14.pdf page 12 I 3

Site C: https://www.bchydro.com/energy-in-bc/projects/site_c.html

Figure 8: Electricity Demand (GWh)



Source: USEIA (2015 Reference Case) and VKT/GHG Forecasting Model

Since the rate of increase of electricity demand in the IMPACT scenario is approximately 50 GWh per year, one can project that by 2050 that the demands on the BC Hydro system will be well over 25% of Site C generation. And further, since Metro Vancouver only represents approximately 45% of all vehicles in the Province, the demand by electric vehicles in the whole of the province could well represent over half of all the capacity of Site C by 2050.

Conclusion

The conclusion of this analysis is that there is little likelihood that GHGs will decline significant by 2040 without significant changes to transit availability; that the tax revenues available for transit and provincial roads and highways will fall substantially without major changes to tax rates; and finally, that if electric vehicles do form a significant portion of new vehicle sales by 2040, the demand on electricity will be large.

It should noted, however, that the analysis undertaken in this report is NOT presenting a "forecast" of what will happen in the future. Rather, it is saying that, IF ONE AGREES WITH THE ASSUMPTIONS IN THIS REPORT, then the results of the analysis are likely to occur. If one has disagreements with the results, then it is incumbent on the reader to challenge which assumptions are not valid. That said, the input assumptions do follow expectations of the US Energy Information Agency (an organisation noted for its conservative outlook), data from the Metro Vancouver Regional Growth Strategy, and conservative estimates of incomes, vehicle ownership and driving behavior.

This report can be downloaded from the website: http://pacificanalytics.ca/autostat