VEHICLE GHG EMISSIONS IN METROVAN AND VANCOUVER: 2005 TO 2015

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PACIFIC ANALYTICS INC.

Pacific Analytics Inc.
P.O. Box 5103 Stn. B
Victoria, B. C. Canada V8R 6N3
Voice/Fax: (250) 370-1775
Email: JimJ_PA@shaw.ca
http://pacificanalytics.ca/autostat

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ABSTRACT

Based on 2007 to 2010 trends published by the Community Energy and Emissions Initiative (CEEI) and improving fuel efficiencies since then, many people in Metro Vancouver and many in the Region's municipalities believe that vehicle greenhouse gas (GHGs) emissions have been falling and that the Region is on track to achieve provincial emissions goals in the medium term.

This Report applies the same detailed modelling approach as was used in the CEEI published data for 2007 and 2010 but incorporates updated vehicle data and a more comprehensive methodology for estimating kilometres driven. The findings reject the belief that GHG emissions are declining. While GHGs did decline in both Metro Vancouver and in the City of Vancouver between 2009 and 2012, between 2012 and 2015 GHG emissions in both regions climbed sharply (7.0% in Metro Vancouver and 6.5% in the City of Vancouver). Based on expected fuel prices in 2016, these upward trends are projected to continue.

The Climate Leadership Team recently issued recommendations on how BC can reduce vehicle GHG emissions (of roughly 2% per year over the next 15 years). The findings of this Report suggest that the trends are going in the exact opposite direction and without major changes to factors affecting driving behavior well beyond increasing the carbon tax and relying on electric vehicles, the hoped-for major reduction in GHG emissions will simply not happen.

In February, 2105, Pacific Analytics posted a report entitled GHG Emissions in Metrovan[1] describing the pattern of vehicle GHG emissions for Metro Vancouver over the 2007 to 2013 period. Using our VKT/GHG Forecasting Model[2], this report updates those estimates to the year 2015 and includes estimates over the same period for the City of Vancouver.

As noted in the earlier report, the expected decline in vehicle GHGs in Metro Vancouver after 2010[3] did not materialize. Indeed, as that report indicated, while there was a decline between 2009 and the middle of 2012, after that date, vehicle emissions began climbing. This report revisits the historical data (updated using more comprehensive data for vehicle kilometres travelled - VKTs) and presents new emission estimates for the 2014 and 2015 period.

Provincial emission regulations issued in 2008 aimed to reduce emissions by 33% between 2007 and 2020. Recently announced goals contained in the Climate Leadership Plan[4] is to reduce vehicle GHGs by 30% between 2015 and 2030. The Federal Government, in contrast, has committed Canada to reduce overall GHG emissions by 30% by 2030 from a benchmark in 2005. In keeping with the Federal directives, we have chosen to index all of the present results to 2005, although, if desired, one can easily recalculate the estimates based on a benchmark year of 2007.

There are three major components that determine changes in fuel consumption and thus emissions (the minor differences between emissions and fuel consumption are discussed later in footnote 11):

- changes in the vehicle stock;
- changes in fuel consumption rates (aka fuel efficiencies[5]); and
- changes in the average number of vehicle kilometres travelled (VKTs).

Each of these components is assessed below for Metro Vancouver and the City of Vancouver separately.

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[1] http://pacificanalytics.ca/autostat

[2] Our VKT/GHG Forecasting Model was first developed in the mid-2000s in cooperation with the BC Ministry of Transportation. It was later use to provide detailed input data on fuel consumption rates and vehicle kilometres travelled (VKT) by region to the Community Energy and Emissions Initiative (CEEI) for their 2007 and 2010 estimates. The Model was later enhanced in cooperation with TransLink to incorporate addition transit variables when estimating VKTs. A full explanation of the Model can be found at the website: http://pacificanalytics.ca/autostat

[3] "2010 Lower Fraser Valley Air Emissions Inventory and Forecast and Backcast", *http://public.metrovancouver.org/about/publications/Publications/2010LowerFraserValleyAirEmissionsInventoryandForecastandBackcast.pdf*

[4] "Climate Leadership Team – Recommendations to Government", October 31, 2015, *http://engage.gov.bc.ca/climateleadership/files/2015/11/CLT-recommendations-to-government_Final.pdf*

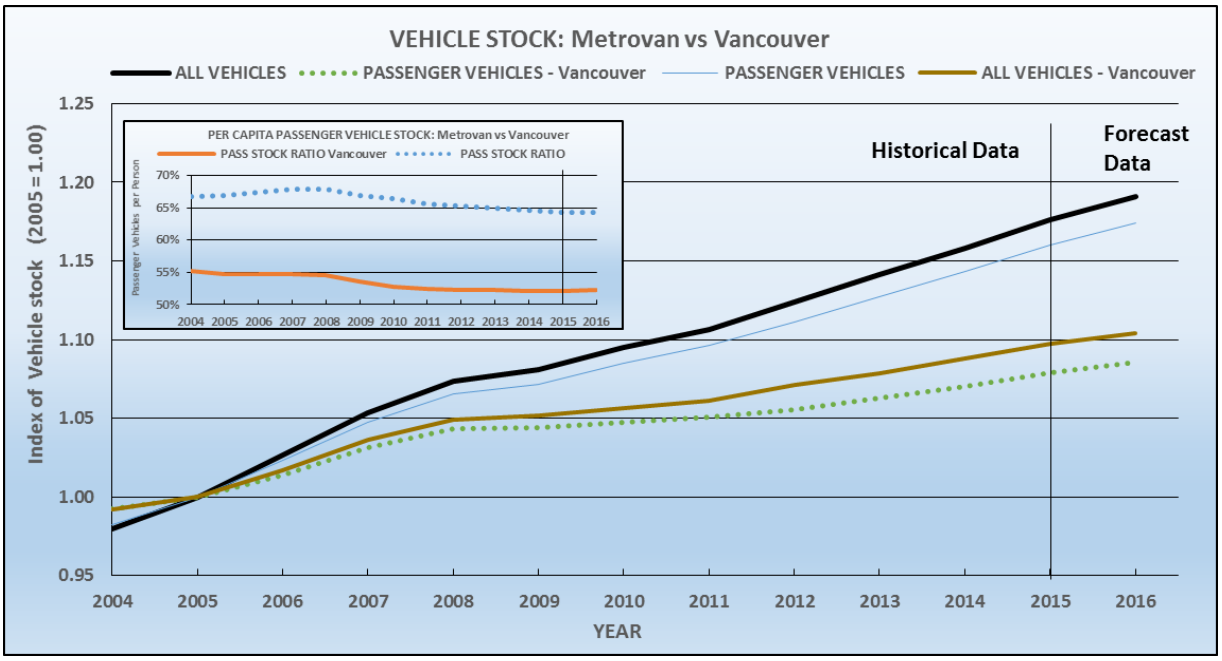
[5] Strictly speaking, fuel consumption rates relate to the number of litres per 100 kms (where a decrease implies an improvement) while fuel efficiencies refer to miles per gallon (where an increase infers an improvement). In common parlance, the terms are used inter-changeably.

Vehicle Stock

As Metro Vancouver anticipated in its outlook, the total number of vehicles in the region continues to rise and is expected maintain this trend as population increases. **Figure 1** below confirms that vehicle stock has indeed increased: total stock in Metro Vancouver rose by roughly 18% between 2005 and 2015. Even during the low-growth period following the 2008 financial crisis, vehicle stock continued to rise, albeit at a lower rate, rising by 2.0% between 2008 and 2010. Between 2010 and 2015, overall stock rose by 5.8%. Passenger stock increased at a slightly lower rate than total vehicle stock, increasing by 16% over the same 2005 to 2015 period.

In the City of Vancouver, stock also rose, although at a slower rate, increasing by just 9.8% between 2005 and 2015; passenger vehicles increased by 7.9% over that period. Between 2013 and 2015, total vehicle stock rose 1.7% while passenger vehicle stock increased by 1.5%. Based on population growth and trends in vehicle ownership, the expectation for 2016 is that vehicle stock will continue to rise (1.2% in Metro Vancouver vs 0.6% in the City of Vancouver).

Figure 1: Index of Vehicle Stock: Metro Vancouver vs Vancouver (2005 = 1.00)



Source: VKT/GHG Forecasting Model

The reason that the changes in stock in Metro Vancouver compared to in the City of Vancouver are different is twofold: First, the population of the two regions experienced different growth rates: driving-age population (age 16 – 85) in Metro Vancouver rose by 20.5 % between 2005 and 2015 while in Vancouver that same population cohort only rose by just over 13%. At the same time, the number of passenger vehicles per person fell in both regions: in Metro Vancouver from a rate of .669 passenger vehicles per person in 2005 to a rate of .643 in 2015 (a 3.9% decline). In Vancouver where vehicle ownership has always been lower than in the Regional District as a whole,

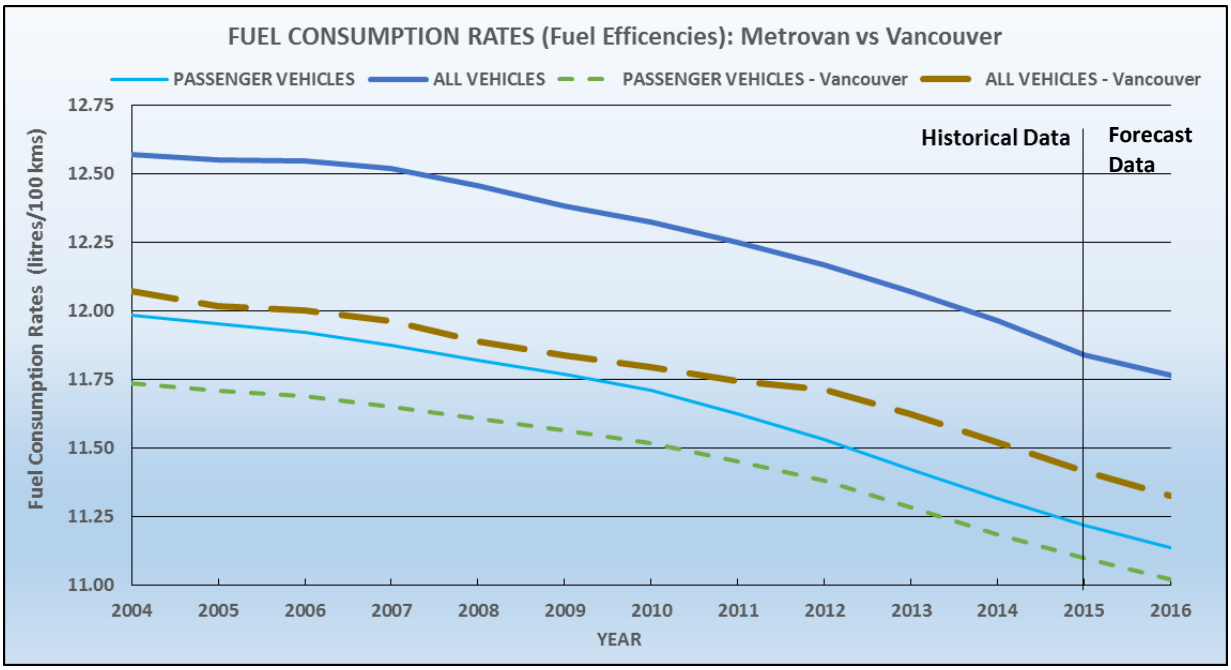
the rate of passenger vehicle ownership fell from .548 vehicles per person in 2005 to .522 in 2015 (a 4.7% decline).

Fuel Consumption Rates

The main reason given by Metro Vancouver for expecting that GHG emissions would continue to decline after 2010 was the assumption that overall fuel consumption rates (aka fuel efficiencies) will improve: "with the implementation of new tailpipe standards for GHGs, emissions from cars and trucks are projected to decline."[6] Indeed, the perceived belief is that fuel efficiencies are improving and that the average vehicle on the road today is far more efficient than 10 years ago. So what really has happened to these fuel consumption rates?

Figure 2 below highlights the trends in fuel consumption rates since 2004 in Metro Vancouver and in the City of Vancouver.

Figure 2: Fuel Consumption Rates (litres/100 kms)



Source: VKT/GHG Forecasting Model

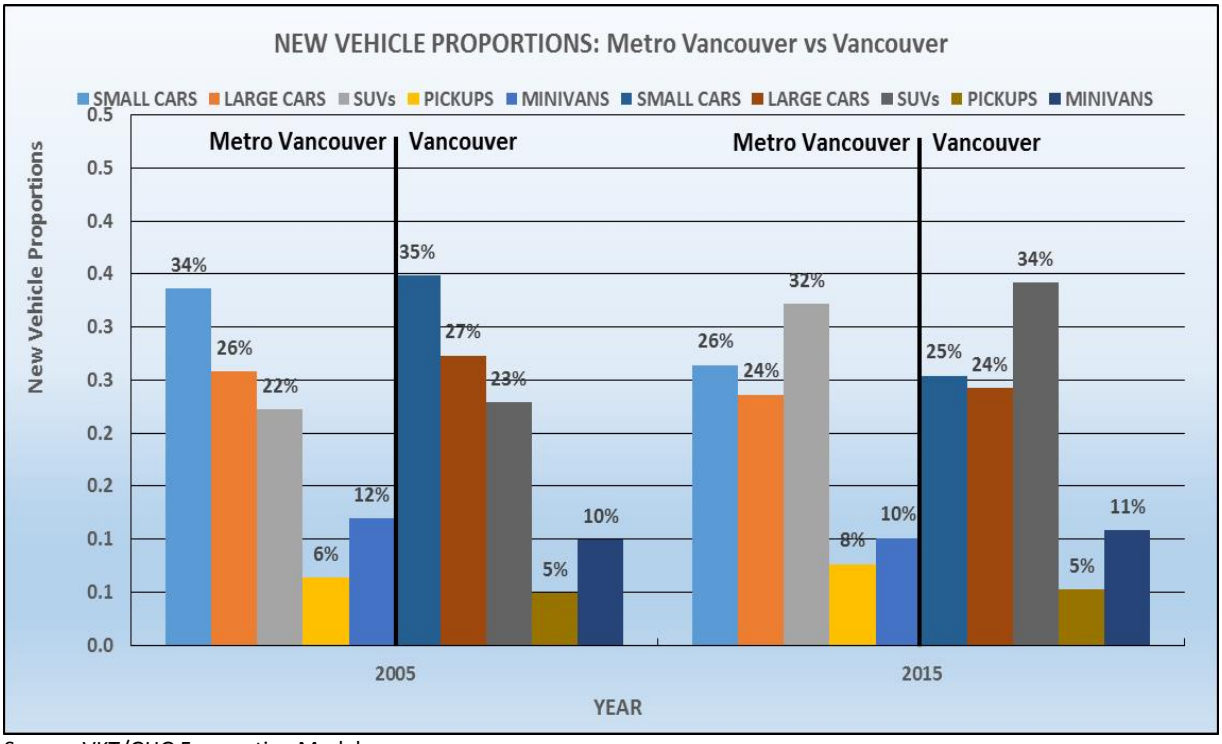
Average fuel consumption rates over the 2005 – 2015 fell in both Metro Vancouver and Vancouver, but the rate of change (somewhat less than 1 litre/100 kms) over the entire 10 year period (or less than 0.1 litres average improvement per year) may seem low to some readers. It must be remembered, though, that most of the vehicle stock year-to-year is preserved, and that the improvement in overall fuel consumption rates only comes about by the replacement of new, more fuel-efficient vehicles for older stock.

[6] Ibid, page 3

It is interesting to note that fuel consumption rates in Vancouver generally are slightly lower than in Metro Vancouver as a whole.[7] This has to do with the mixed of vehicle types, both in terms of vehicle classes (e.g., small cars vs pickups) and in terms of the makeup of vehicle types with a class (e.g., the average size of pickups in Metro Vancouver are larger than the average size in the City of Vancouver). The proportion of vehicles depends on a number of factors: the number of vehicles that remain in the region from one year to the next, the number of vehicles moving in and out (either from other locations in BC or from outside BC), but most of all by the number of new vehicles.[8]

Figure 3 displays the changes between 2005 and 2015 in the proportion of new vehicles sold in Metro Vancouver and the City of Vancouver respectively.

Figure 3: New Vehicle Proportions – 2005, 2015: Metro Vancouver vs City of Vancouver



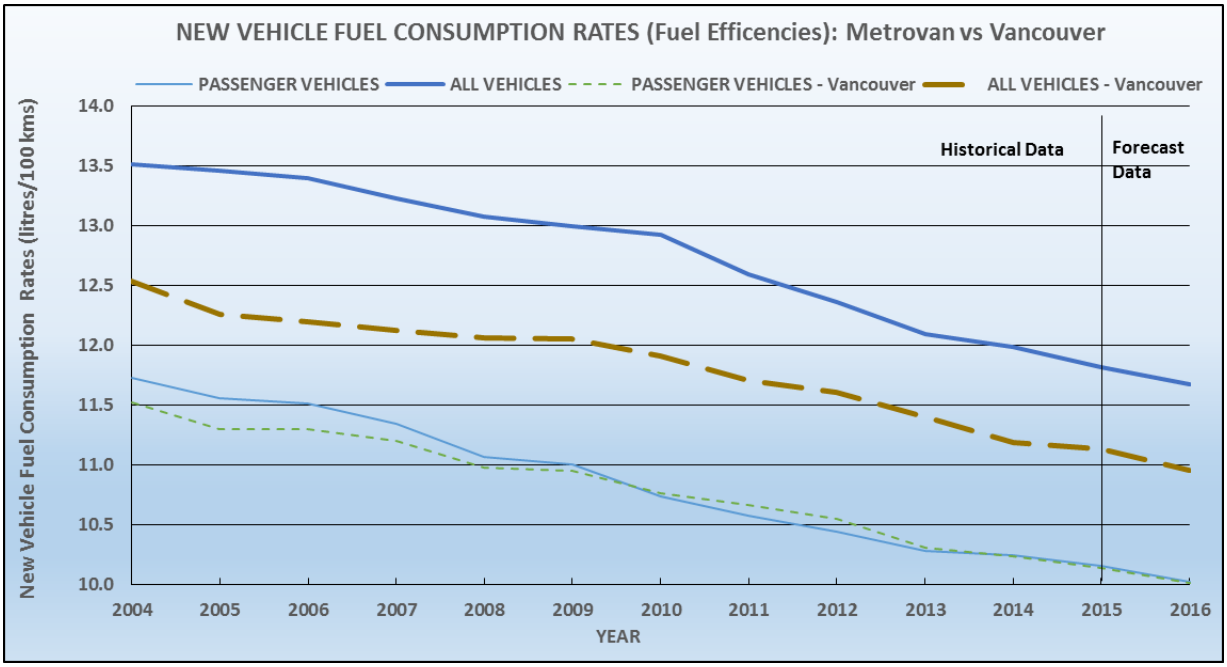
Source: VKT/GHG Forecasting Model

The major determinant of improving average fuel consumption rates are the fuel efficiencies of new vehicles – these have experienced greater improvements, as highlighted in **Figure 4** below.

[7] Fuel Consumption Rates are partly a reflection of improving vehicle fuel standards but also in the types of vehicles that make up the stock. Average fuel consumption rates for gasoline Small Cars in Metro Vancouver, for example, improved by almost 9.3% from 2005 to 2015 and gasoline SUVs improved by 12.5%. In contrast, gasoline Pickups improved by only 2.3% (this, itself, a reflection of an increase in the proportion of larger pickups in new sales). At the same time, the proportion of new passenger vehicles in Metro Vancouver that were "Small Cars" fell from 33.6% in 2005 to 26.3% in 2015 while the proportion of SUVs increased from 22.2% to 32.2% over the same time period (see Figure 3).

[8] New vehicles are defined as vehicles that are newly register with the Insurance Corporation of BC. New vehicles purchased in, say, Alberta are counted as imported vehicles, not new vehicles.

Figure 4: New Vehicle Fuel Consumption Rates - Metro Vancouver vs Vancouver



Source: VKT/GHG Forecasting Model

Over the entire decade, new vehicle fuel consumption rates improved, but again the average improvement may appear smaller than what the media would have one believe. In Metro Vancouver the total improvement for passenger vehicles was about 1.5 litres between 2004 and 2015 while in Vancouver the improvement was in the order of 1.3 litres (or roughly 11% - 12%). But again, the proportion of new vehicles in each class makes a difference. For example, Small Car (gasoline) rates improved by 15% and SUVs by 16% whereas Pickups only experienced an improvement of 7%. We want to reiterate that the improvements for individual vehicles was larger, but as vehicles have become more efficient, people have chosen to purchase larger vehicles, either by switching from (say) small cars to SUVs or by purchasing larger vehicles within the class (e.g., the average GVW capacity of pickups grew by 12% in Metro Vancouver between 2005 and 2015).

Thus far we have discussed two of the three components contributing to changing emissions: total vehicle stock in Metro Vancouver which we saw increase by approximately 17% over the 2005 to 2015 period (10% in the City of Vancouver); and average fuel consumption rates which, as we just discussed, improved by approximately 4.7% over the same period (5% in Vancouver). What of the remaining component: vehicle kilometres travelled (VKT).

Vehicle Kilometres Travelled (VKT)

The last component that influences the level of GHG emissions is the average number of kilometres travelled by each vehicle. In the VKT/GHG Forecasting Model, the estimates of VKT are calculated for each vehicle class, fuel type, licence category, and model year for each municipality. For example, the model estimates the average quarterly VKT for Small Cars fuelled by gasoline and driven for Pleasure in the City of Vancouver for each vehicle model year. These estimates are determined econometrically using the variables: fuel prices, average incomes, age and sex of driver, age of vehicle, average distance from the Central Business District (downtown Vancouver), average distance from the regional city centre, population density, access to transit, number of bus hours, number of Skytrain hours, and transit fares. All the variables are specific to the municipality being estimated as are all the estimated equations. As a consequence, each municipality is assigned its own set of equations and resulting VKT estimates. This also means that the impacts of a change in a variable, say a change in fuel prices, will impact one municipality differently from another municipality (for example, the gasoline fuel price elasticity for passenger cars in Metro Vancouver is -0.20; in the City of Vancouver it is -0.16 – meaning that Vancouver has a slightly smaller response to gasoline price changes[9]). A full explanation of the Model and the equation estimation methodology can be found at http:\pacificanalytics.ca\autostat. A more in-depth explanation of elasticities for each of the factors influencing VKT (e.g., incomes, bus hours, transit fares, etc.) in Metro Vancouver can be found in the report GHG Emissions in Metrovan found at the same website.

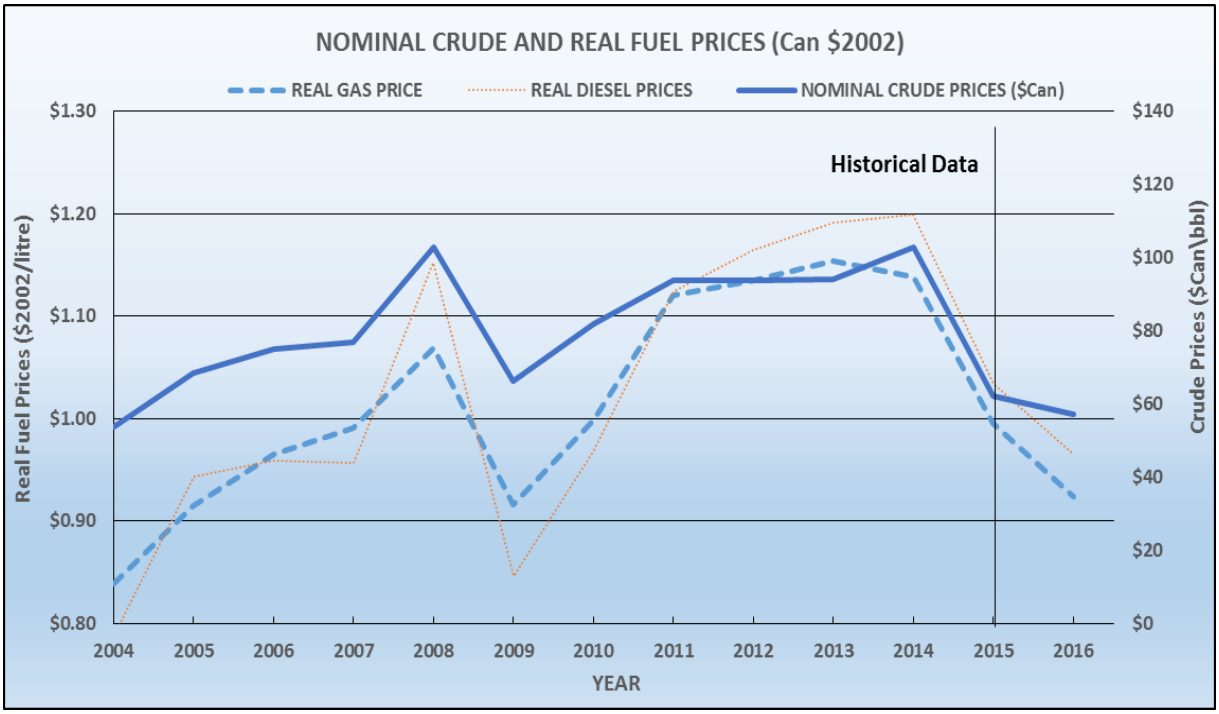
Before examining the results of the estimation for Metro Vancouver and the City of Vancouver, it might be useful to review these fuel prices, since fuel prices are one of the most important factors affecting driving behavior.

Figure 15 on the following page highlights the historical patterns of crude oil prices (in Canadian dollars) and in the real ($2002) price (that is, after adjusting for inflation) of gasoline and diesel fuel per litre in Metro Vancouver.

During the 2005 to 2008 period there was a general uptrend in crude prices which lead to a similar upwards movement in the real price of motor fuel (2008 also saw the introduction of the carbon tax) which, all things equal, would put downward pressure on average VKT. In 2009, there was a strong fall in crude prices reflected in gasoline and diesel prices at the pump after which crude and pump prices began their upward movement until the crude price crunch in 2015. The fall in pump prices in 2015 was some 15% - 17% and lead to, all things equal, an increase in average VKT by roughly 3%. The expected continued fall in pump prices will again lead to rising average VKTs in 2016.

[9] An elasticity of -0.20 suggests that if fuel prices decrease by 10%, average VKT will increase by 2.0%, all other things equal; an elasticity of -0.16 indicates that with the same change in fuel prices, average VKT will increase by 1.6%.

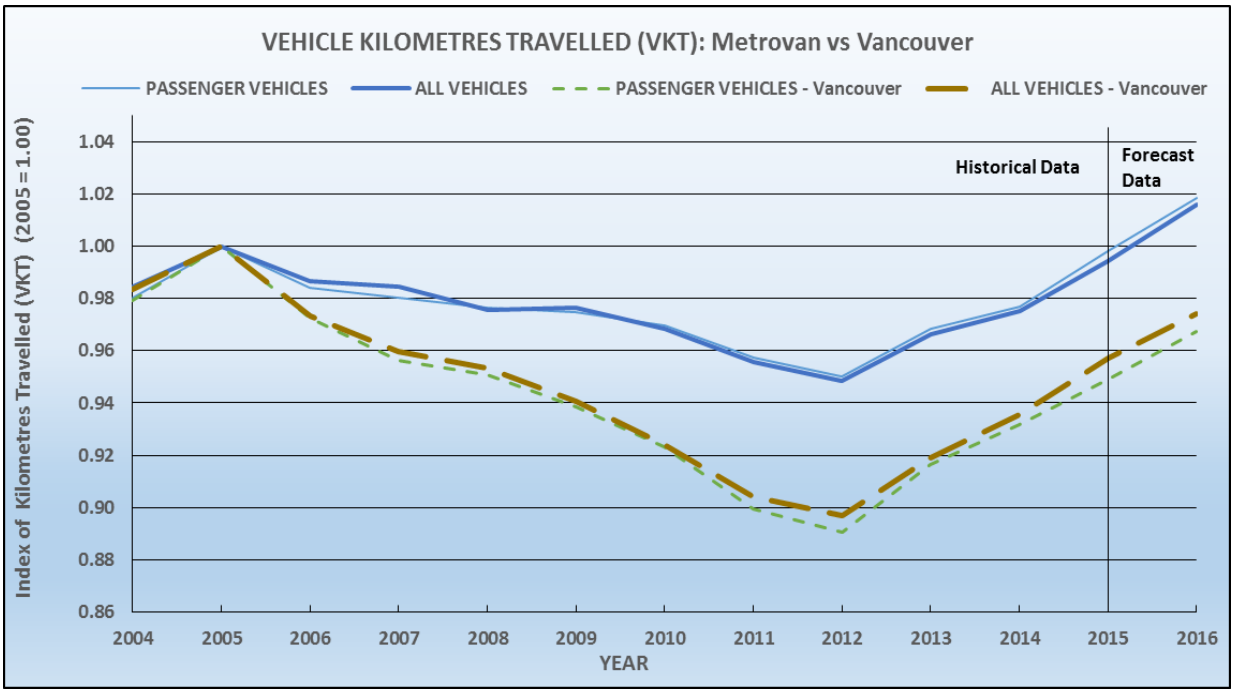
Figure 5: Nominal Crude and Real Fuel Prices



Source: VKT/GHG Forecasting Model

Figure 6 below highlights how the average annual VKTs have changed since 2005 for all vehicles and for passenger vehicles in both Metro Vancouver and in the City of Vancouver.

Figure 6: Vehicle Kilometres Travelled (2005 = 1.0) – Metro Vancouver vs Vancouver



Source: VKT/GHG Forecasting Model

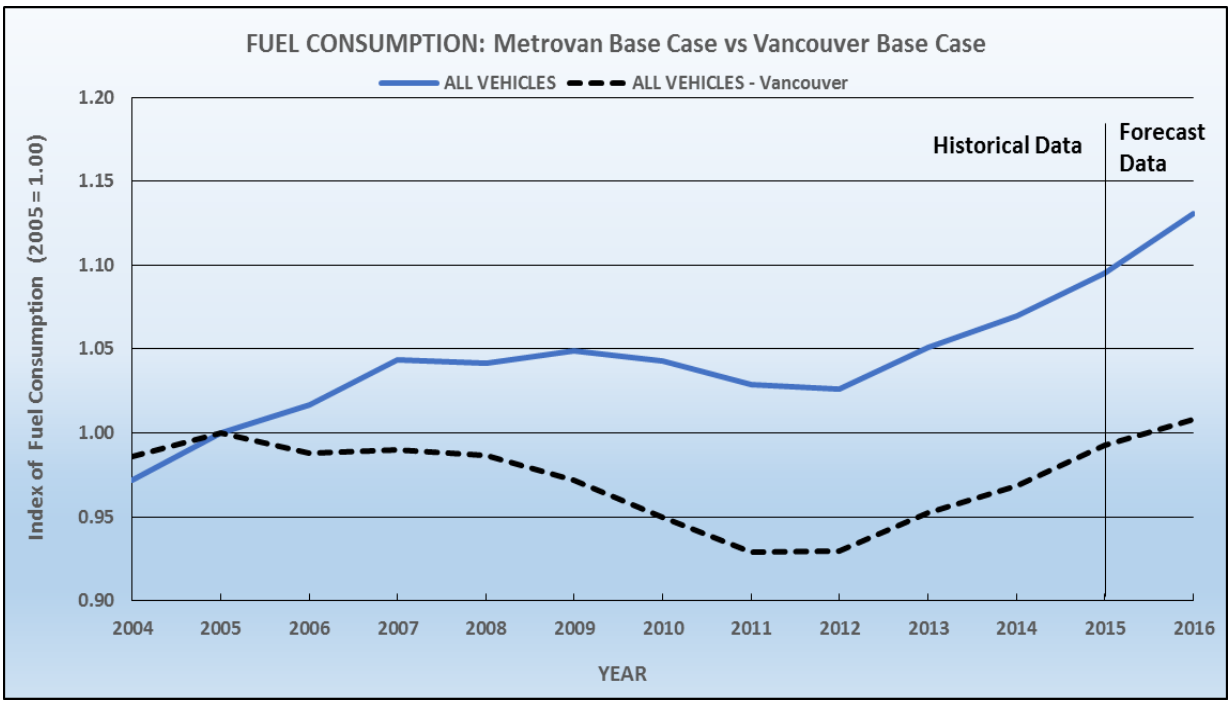
In Metro Vancouver average VKTs fell slightly (just over 2%) over the 2005– 2009 period for both passenger vehicles and all vehicles. From 2009 to 2012 there was a noteworthy fall in VKTs for vehicles in general (almost a further 4% from 2009) and somewhat less for passenger vehicles (just over a 2% decline from 2009). From 2012 to 2015 VKTs increased rapidly: almost 7% for all vehicles including passenger vehicles (quarterly data indicates that the increase in VKTs began in the 2nd or 3rd quarter of 2012.

In Vancouver, the downward trend in VKT began in 2006 and continued right through to 2012.[10] After that date, VKT began rising; projections suggesting that the upward trend will continue through 2016.

Fuel Consumption

Combining the three factors that make up fuel consumption (stock, fuel efficiencies and average VKT) results in trends in fuel consumption as outlined in **Figure 7** below.

Figure 7: Fuel Consumption: Metro Vancouver vs Vancouver



Source: VKT/GHG Forecasting Model

[10] Readers may notice the radically different profile of VKTs for the City of Vancouver over the 2007-2010 period from what the Community Energy and Emissions Initiative (CEEI) published in 2014 and which still informs many analysts. The CEEI data, it must be understood, used average VKT estimated by vehicle class for Metro Vancouver for each municipality in the Metro Vancouver region. As a consequence, the only difference in municipal VKT values is due to the slightly different proportions of vehicles in the stock. The VKT estimates in the VKT/GHG Forecasting Model, in contrast, are based on econometric equations specific to each municipality. Consequently, not only are the VKT estimates different, but the underlying elasticities (i.e., how does VKT change when, say, gasoline prices change or when bus hours increase, or when transit fares increase) are specific to the municipality.

Fuel consumption in Metro Vancouver trended upward over the 2004 to 2007 time period, remained relatively stable over the 2007 to 2009 period and then began declining to 2012. After that date, fuel consumption has increased steadily. Overall, fuel consumption in Metro Vancouver has risen by 6.7% since 2012 (6.6% for passenger vehicles) and is a full 9.5% higher in 2015 (7.8% for passenger vehicles) than in the benchmark year of 2005. These upward trends are projected to continue in 2016.

Clearly, the idea that fuel consumption is falling is a serious misunderstanding of driving behaviour in Metro Vancouver and must be recognised before any strategies are developed to meet emissions goals.

In the City of Vancouver, the downward trend in fuel consumption began in 2006 and continued through to 2012 (the actual turn-around began in the 2nd quarter of 2012) falling by some 6.6%, but since that time there has been a continuous upward trend in fuel consumption. Between 2012 and 2015, fuel consumption increased by 6.8% (6.3% for passenger vehicles). Due to the large decline between 2005 and 2012, overall fuel consumption between 2005 and 2015 did not change appreciably. Nevertheless, with a projected increase in 2016 of 1.5%, fuel consumption trends are still going in the wrong direction.

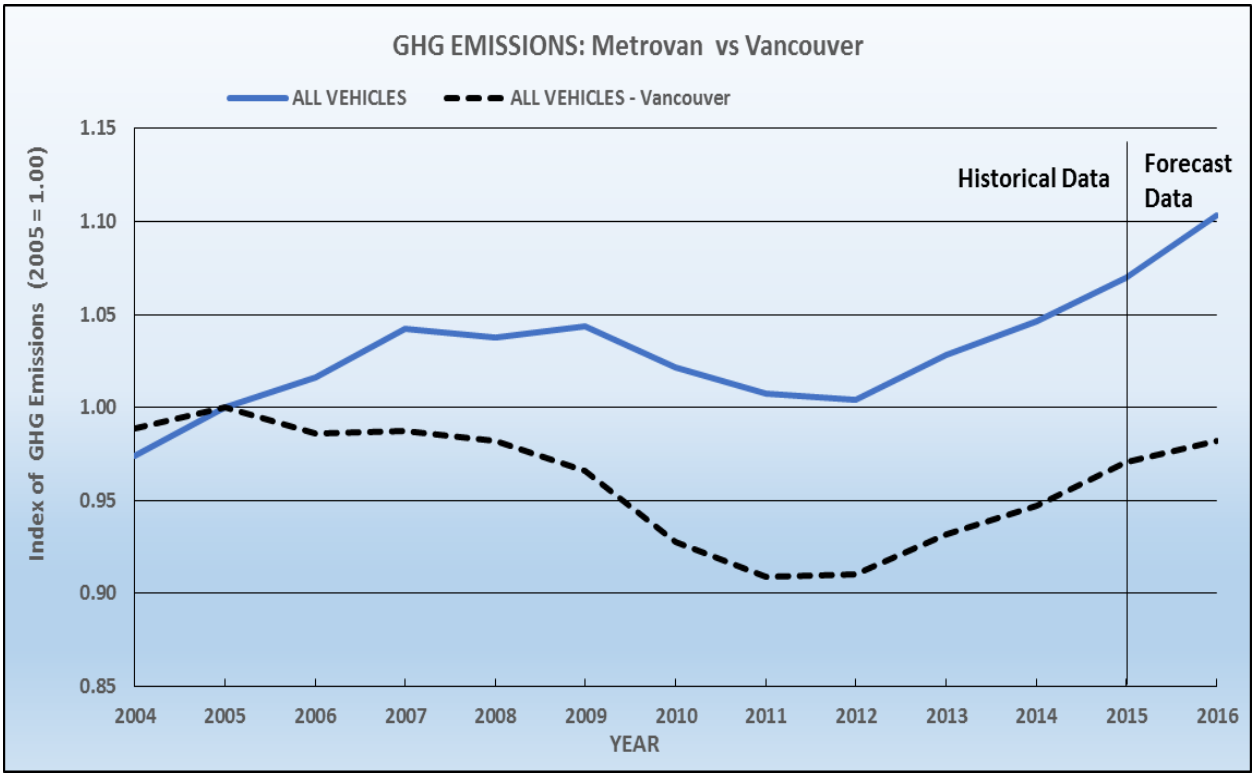
Greenhouse Gas Emissions

As displayed in **Figure 8** on the following page total vehicle GHG emissions mirror quite closely the trends in fuel consumption. Indeed, the link between GHG emissions and fuel consumption is virtually exact (but not quite).[11] The inexact link is due the improvements in vehicles with the introduction of catalytic converters and other "clean" technologies. As older vehicles slowly leave the stock and are replaced by new vehicles, these technical improvements are leading to a reduction of ~0.04% per year in emissions vs consumption. However, this differential will slowly dissipate as the number of older vehicles is reduced. At the same time, different types of vehicles generate different levels of CH_4 and N_2O, therefore the mix of vehicles also influences the link between fuel consumption and GHG emissions.

Like fuel consumption, vehicle emissions in Metro Vancouver have increased significantly since 2005 (7.0%), but almost all of this increase has come since 2012. In the City of Vancouver GHG emissions have fallen slightly since 2005 (2.4%), but since 2012 emissions have increased by over 6.5%. And, as we saw with fuel consumption, these emissions are projected to increase again in 2016.

[11] 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 (electric vehicles will not change this linkage since using electricity as a fuel will affect neither fuel consumption nor emissions). 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.

Figure 8: GHG Emissions – Metro Vancouver vs Vancouver



Source: VKT/GHG Forecasting Model

Conclusion

Data and reports published by the BC Government and by analysts working in Metro Vancouver and in many of the municipalities within Metro Vancouver continue to suggest that GHG emissions from vehicles are falling and that over the next years this decline will continue. The evidence presented in this report suggests that, historically, this has not been the case and that the hoped-for decline in the near future may be a seriously overly-optimistic view. Since 2005, the number of vehicles has continued to rise at a rate faster than the improvements in fuel consumption rates (a difference of about 0.5% per year); accordingly, the only way that emissions could fall is if average VKT had declined. While such a decline did occur in both Metro Vancouver and the City of Vancouver over the 2005 to 2012 period, since that time, average VKTs has increased and is projected to increase again this year.

These increases in VKT are due, in part, to declining fuel prices, a recovery of incomes levels from the 2009 – 2011 slowdown, an increase in transit fares charged by TransLink, as well as an expansion of transit availability (bus hours and Skytrain hours) well below population growth. In addition, the high cost of housing is pushing people outside the central areas of the Lower Mainland leading people substituting lower housing costs for longer commute times.

The question of Climate Change has once again become an issue high on the public's mind and governments – federal, provincial and municipal – are responding to this call by establishing

climate change plans. The Provincial Government established a Climate Leadership Team which recently issued recommendations to achieve a reduction (of approximately 2% per year for the next 15years) in vehicle emissions. The main recommendations to achieve this goal relate to increasing the Carbon Tax and encouraging electric vehicles. An analysis of the Carbon Tax in an earlier Report[12] by Pacific Analytics found that an increase of 10 cents in the Carbon Tax would reduce vehicle GHG emissions by less than 1.5%. In another Report[13], an increase in electric vehicles as recommended by the Climate Leadership Team would lead to a reduction of approximately 6% in vehicle GHGs by the year 2030.

The purpose of this Report primarily is to provide updated vehicle emissions data for Metro Vancouver and the City of Vancouver. However, a secondary purpose is to illuminate the danger of creating climate change plans when a region's progress on emissions is based on poor, out-of-date information. When plans are created in the absence of good data, the plan is in danger of becoming a wish rather than an objective, informed strategy. As we have often said:

Assuming an outcome is not a plan.

[12] The Impacts of the Carbon Tax on Vehicle Fuel Use in Metro Vancouver, http://pacificanalytics.ca/autostat

[13] The Impacts of Electric Vehicles on GHGs, Transit Taxes and Electricity Demand in Metro Vancouver, http://pacificanalytics.ca/autostat