VEHICLE GHG EMISSIONS IN METROVAN

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ABSTRACT

Greenhouse Gas Emissions (GHGs) from vehicles in MetroVan declined after 2009 but have not continued to decline as expected by the Regional District; rather, beginning in mid-2012 and through 2013 and into 2014 GHGs have climbed. Trends in the three factors influencing GHGs: changes in changes in and vehicle stock, fuel consumption rates (efficiencies), and changes in average VKTs were examined. The chief reason for the increase was found to be the upward trend in Vehicle Kilometres Travelled (VKTs) after mid-2012.

The report presents a detailed examination of the underlying reasons for changes in VKT over time, providing an analysis of possible components that contribute to changing VKT: fuel prices, incomes, transit fares, hours of bus and Skytrain service, access to transit, population density, and the distance that vehicles must travel from home to downtown Vancouver (the Central Business District) and to their municipality's town centre.

In September, 2013, the Air Quality Policy and Management Division of the Regional District of Metro Vancouver issued a report entitled *"2010 Lower Fraser Valley Air Emissions Inventory and Forecast and Backcast"*[1] which highlighted MetroVan's expectations for Greenhouse Gas (GHG) emissions in the region over the next decades. While not a detailed look at vehicle emissions specifically, the report suggests that "GHG emissions from light-duty vehicles are projected to start declining [from 2010 onward] due to new federal tailpipe standards". Revised emissions data for the 2001 to 2010 time period and new emissions data for the years 2011 to 2013 provide a more comprehensive look at vehicle GHG emissions in MetroVan and the findings may be surprising.

Provincial emission regulations aim to reduce emissions by 33% between 2007 and 2020; consequently, all trends are indexed 2007 = 1.00. **Figure 1** below displays the trend in GHG emissions in MetroVan since 2007.

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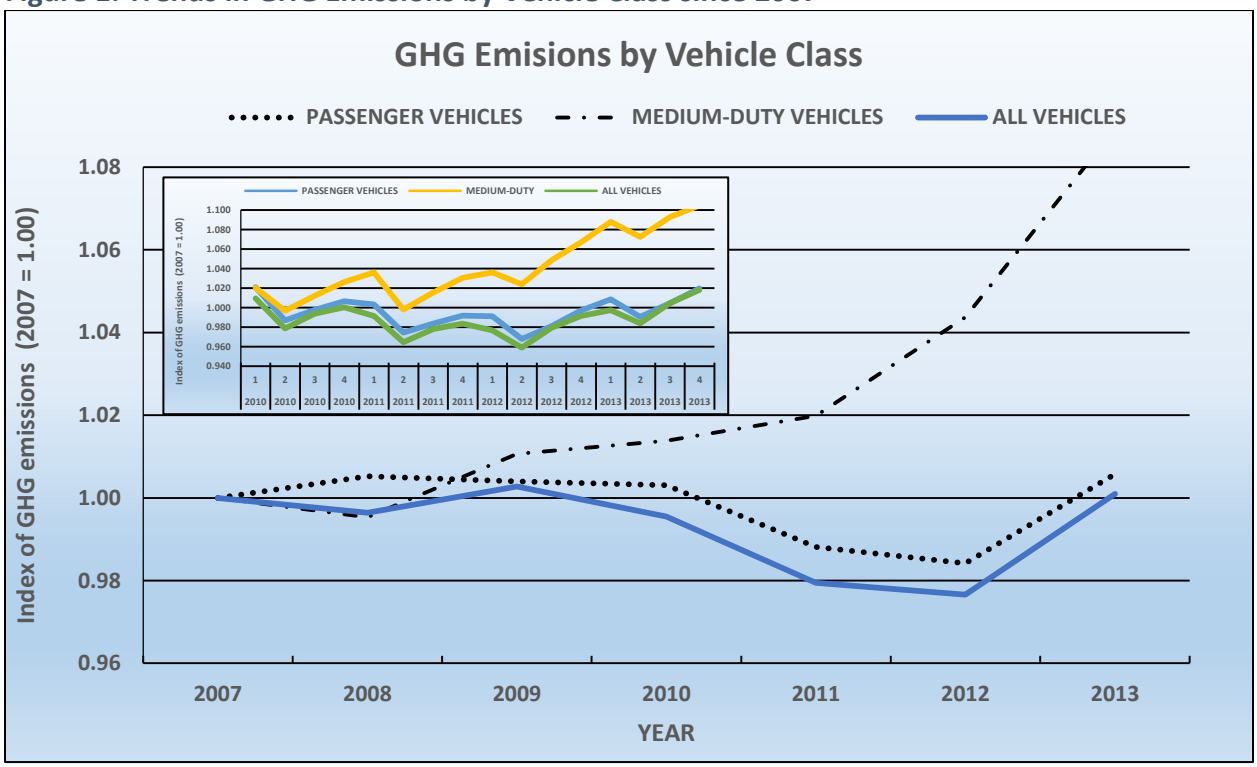
1 (http://public.metrovancouver.org/about/publications/Publications/2010LowerFraserValleyAirEmissionsInventoryandForecastandBackcast.pdf

Figure 1: Trends in GHG Emissions by Vehicle Class since 2007



Passenger Vehicles include small and large cars, SUVs, minivans, and pickups under 3,850 kg GVW; Medium-Duty Vehicles include pickups and vans 3,850-15,000 kg GVW. Data for other vehicles classes (motorcycles, motorhomes, heavy trucks, non-transit buses and taxis) are calculated, but are not shown.

Total vehicle GHG emissions in MetroVan remained relatively stable from 2007 to 2009, then declined in 2010 and 2011, flatten-out in in 2012 and began rising 2013. Emissions were lower in 2010 and 2011 than in 2007, just as MetroVan reported. However, the previous upward trend returned in mid-2012 and 2013 (and preliminary data for 2014 suggests this upward movement is continuing). Since MetroVan anticipated GHG emissions to continue to decline after 2010, this is a surprising finding and begs the question: what caused the initial decrease after 2009 and the later increase after 2011 and how likely is it that this upward trend will continue.

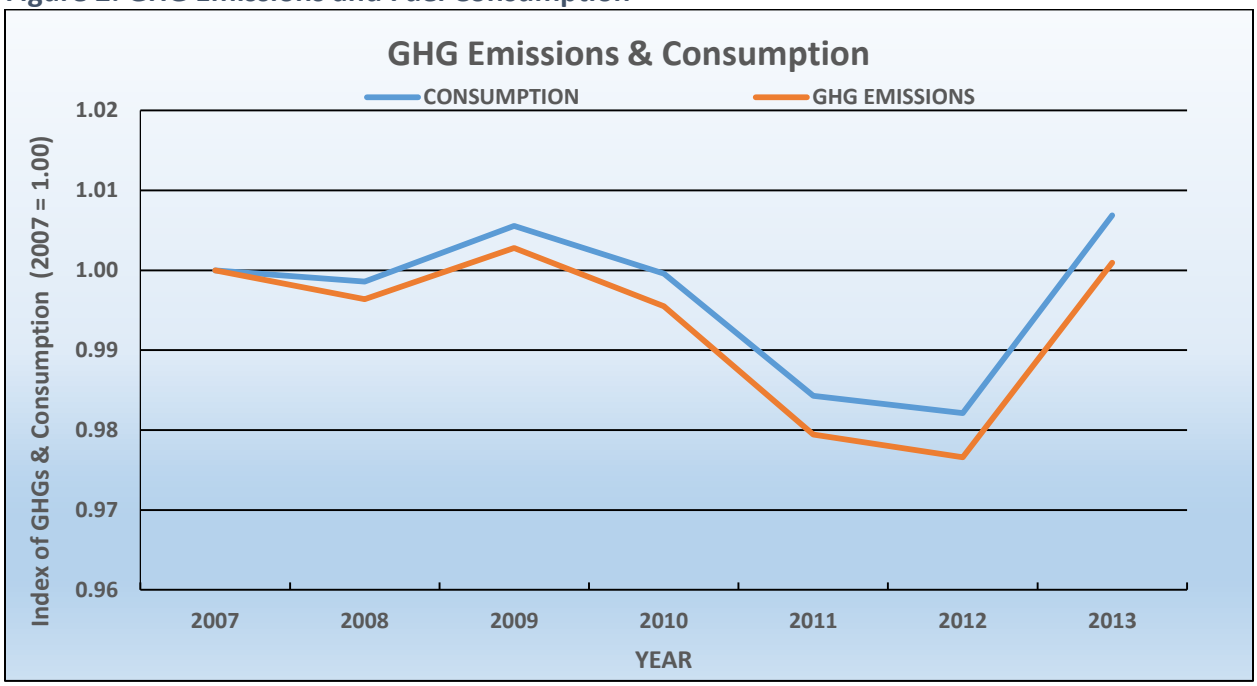
GHGs vs Fuel Consumption

There is a very close relationship between fuel consumption and GHG emissions, but the link is not exact. **Figure 2** below displays the trend in total vehicle emissions versus the trend in total fuel consumption. The link between CO_2 emissions and fuel consumption is virtually exact.[2]

[2] 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 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 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.

Figure 2: GHG Emissions and Fuel Consumption



Three major components influence changes in fuel consumption and thus emissions: changes in the vehicle stock; changes in fuel consumption rates (aka fuel efficiencies[3]); and finally, changes in the average number of vehicle kilometres travelled (VKTs).

Vehicle Stock

As acknowledged by MetroVan, the total number of vehicles in the region continues to rise and is expected maintain this trend as population increases. **Figure 3** confirms that vehicle stock has indeed increased: total stock rose by roughly 20% between 2001 and 2013 and 8.3% between 2007 and 2013. Even during the period of falling emissions (2010 and 2011), stock continued to rise, by 2.3% from 2009 to 2011.

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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.

[3] 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.

Figure 3: Trends in Vehicle Stock since 2007

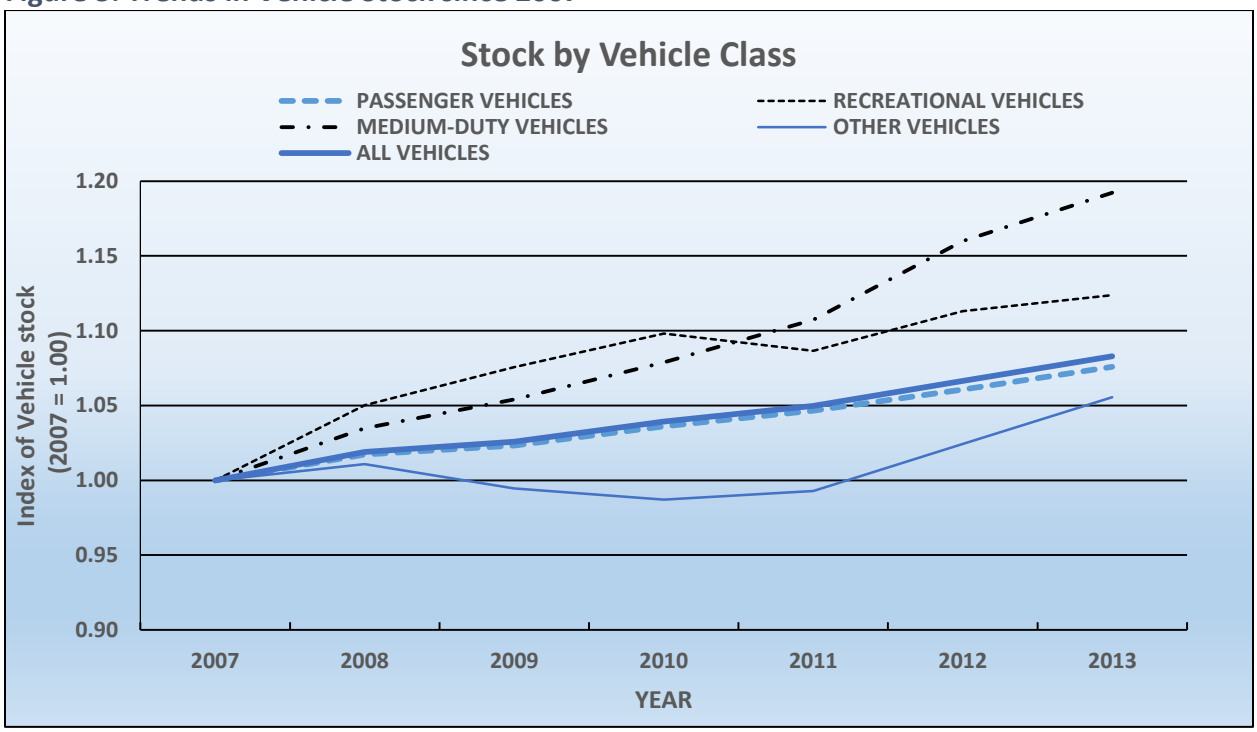

Figure 4 below displays how the proportion of vehicle types have changed between 2007 and 2013. Passenger vehicles represent the largest (albeit, slightly declining) percentage of the total vehicle stock (just over 90% in 2007 to just under 89% in 2013). As we will show, changes in vehicle types within this component plays a role in explaining how VKT and thus emissions have changed since 2007.

The proportion of Small Cars (i.e., cars less than 1,350 kg NVW) within the total vehicle stock has seen a substantive decline, from roughly 38% in 2007 to roughly 32% in 2013. In contrast the proportion of SUVs has increased 50% over the same period and the share of Large Cars has increased from 18% of total stock in 2007 to 20% in 2013. The proportion of smaller pickups and minivans fell slightly (despite an increase of smaller pickup sales of roughly 20% in 2013 over 2012 to almost 6,500). Medium-Duty Vehicles also witnessed a small increase in share, while the share of Recreational and Other vehicles remained relatively stable.

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.[4]

[4] 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: Trend in Vehicle Class Stock Proportions 2007, 2013

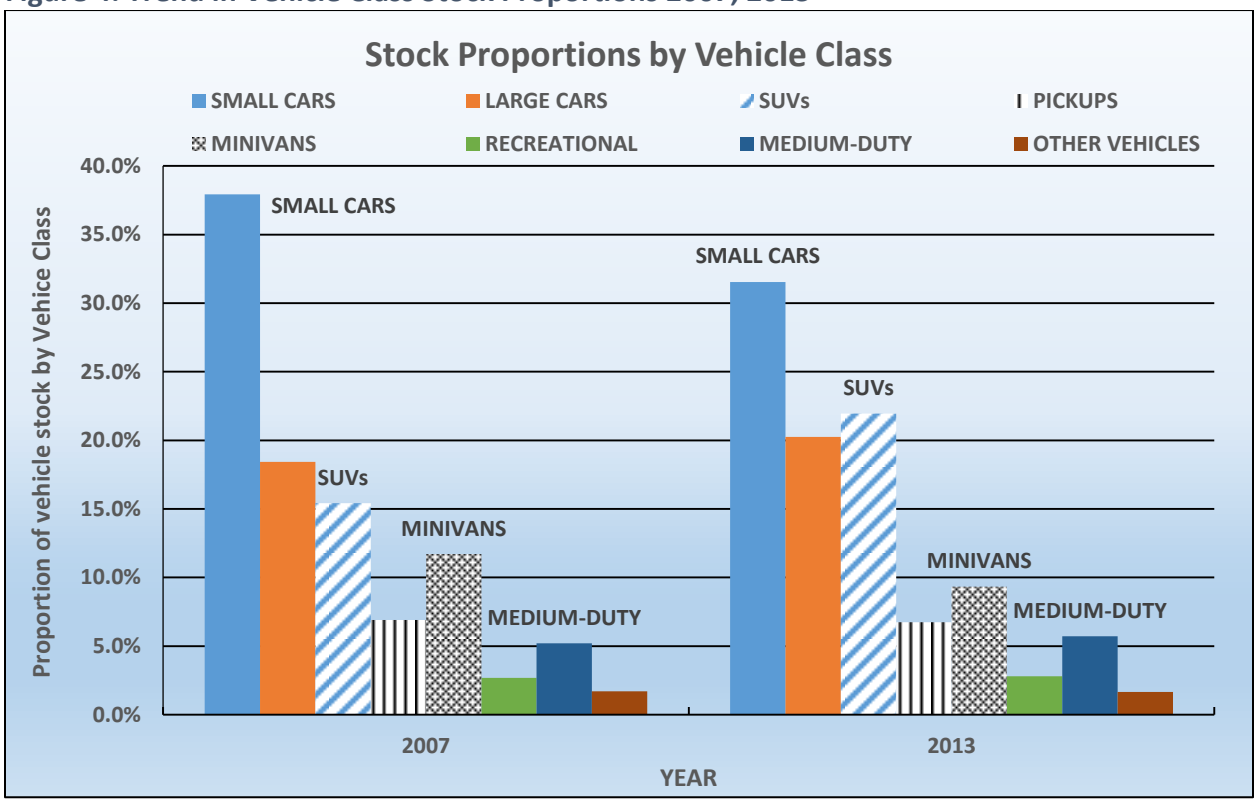

Figure 5: New Vehicles Sales in MetroVan since 2007

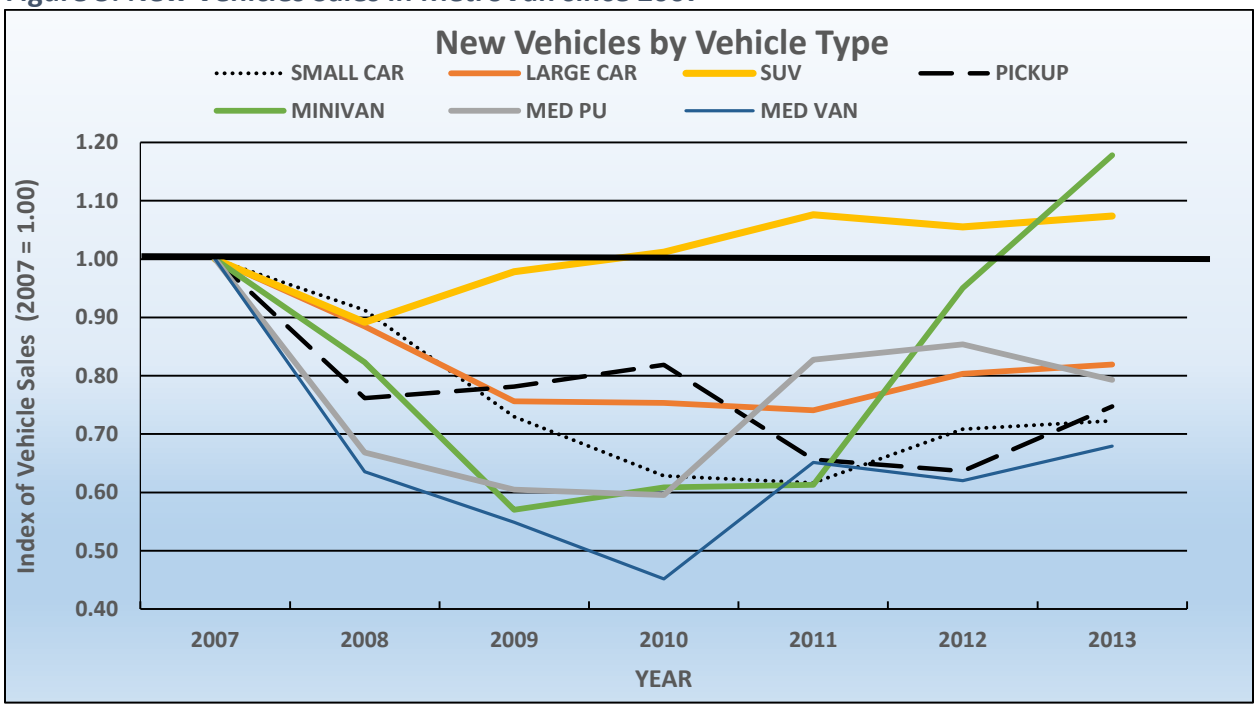

Figure 5 above highlights the trends in new vehicle sales in MetroVan since 2007 for a selection of vehicle types. Overall, new vehicle sales in 2013 were almost 13% lower than in 2007 (at over 120,000 total new vehicles (108,950 passenger vehicles), 2007 witnessed the highest level of sales in the decade). Only SUVs and Minivans experienced higher sales in 2013 than in 2007; all other types had lower sales.

Fuel Consumption Rates

The main reason given by MetroVan for expecting that GHG emissions would continue to decline after 2010 is an 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."[5] Indeed, the perceived belief is that fuel efficiencies are improving and that the average vehicle on the road today is far more efficient that 10 years ago. So what really has happened to these fuel consumption rates. [6]

Figure 6 below highlights the trends in fuel consumption rates since 2007 in MetroVan. Prior to 2007, fuel consumption rates (not shown) did not enjoy any significant improvement, but this was due entirely to a deteriorating consumption rate for Other Vehicles (itself due to a changing stock composition in Other Vehicles – a much greater proportion of larger vehicles in 2007 vs 2002). After 2007, however, rates began a marked decline, improving by almost 1% per year over the 2007 to 2013 period.

These improvements in average consumption rates were experienced by all types of passenger vehicles, from Small Cars to SUVs to Pickups. **Figure 7** below highlights the rates of improvement over the 2007 to 2013 period. While all vehicle types experienced improvements, some types did better than others. SUVs, for example, witnessed an average improvement of almost 9% over the six years. Some of this improvement was due to more efficient new SUVs (new 2013 gasoline SUVs were almost 13% more efficient than new 2007 gasoline SUVs). However, much of the improvement was due to older SUVs exiting the vehicle stock and a relatively large number of relatively more efficient diesel SUVs being purchased.

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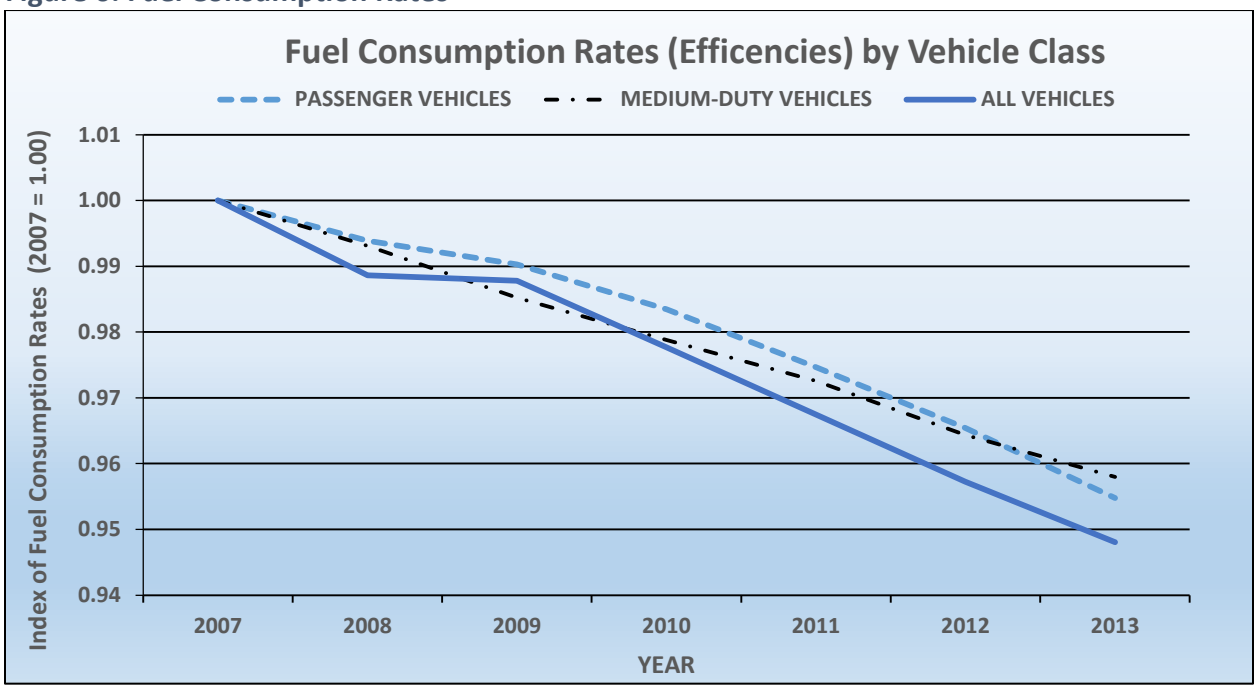
[5] Ibid, page 16

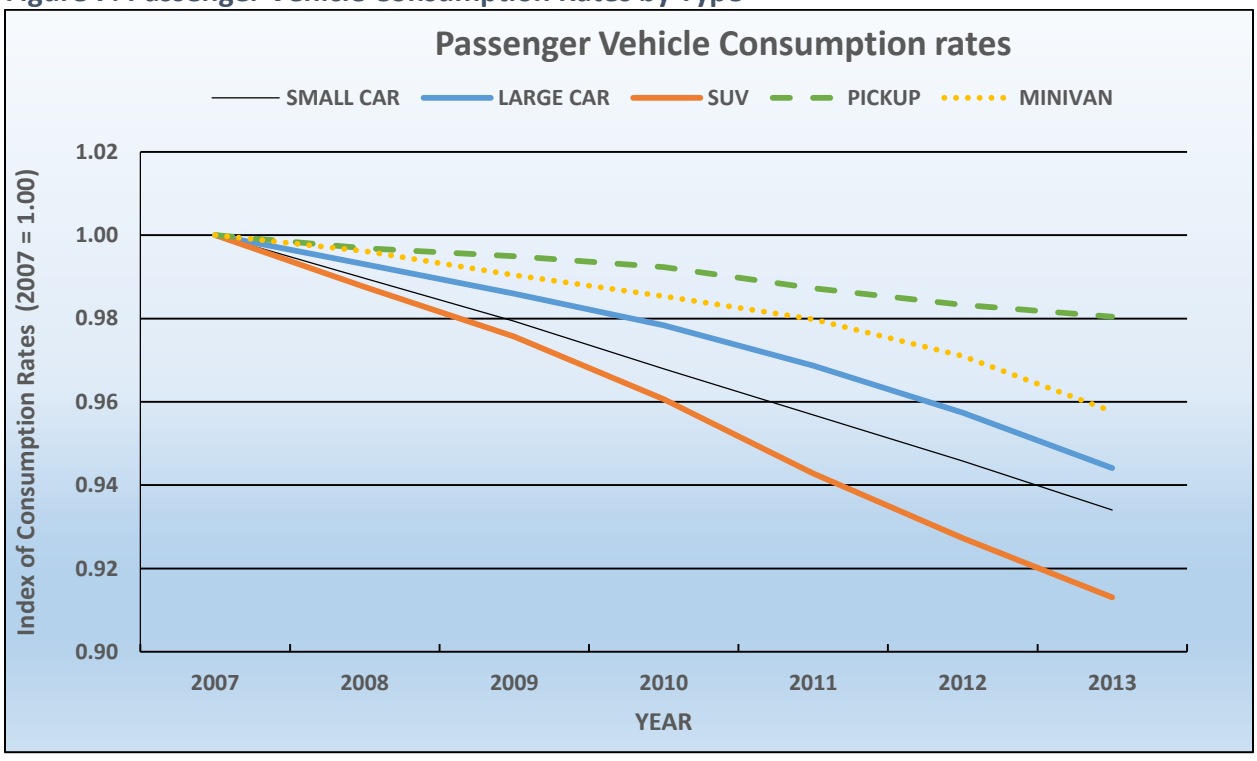
[6] Actual Fuel Consumption Rates are partly a reflection of improving vehicle fuel standards but also in the types of vehicles that make up the stock. Average fuel consumption rates for Small Cars, for example, improved by almost 7% from 2007 to 2013 and SUVs improved by 9%. In contrast, Pickups improved by only 2.5%. Overall, then, the 4.7% improvement in passenger vehicle consumption rates also reflects a changing proportion of vehicles. Furthermore, within a particular vehicle type consumption rates in one locale can be different from another region due to dissimilar make/model composition, differing age of vehicles (younger vehicles usually are more fuel efficient), different size (for example, the average pickup in MetroVan is roughly 3.5% smaller (~3,096 kgs vs ~3210 kgs GVW) than the average pickup in the Fraser Valley Regional District.

Figure 6: Fuel Consumption Rates



While consumption rates for all other vehicle categories are estimated individually (Recreational Vehicles - motorhomes and motorcycles; and Other Vehicles - heavy city and heavy highway trucks, small and large buses and taxis), the mix of vehicles with radically different consumption rates (efficiencies) make the time trends unstable.

Figure 7: Passenger Vehicle Consumption Rates by Type



Pickups, in contrast, only enjoyed a 2% improvement. The changing age composition of the pickup stock and the fuel types of pickups being purchased influenced these changes, but mostly the small improvement in consumption rates was due to the relatively low efficiency gains for new pickups (roughly 4%) over the 2007-2013 period.

This is a somewhat surprising fact, given that car maker advertising is telling us that pickups are becoming much more efficient. A closer look at the data reveals that the size and configuration of pickups have been changing: new 2013 pickups were over 10% larger than new 2007 pickups (10.1% for GVW, 11.4% for NVW) and the average engine size and general accessories also expanded. What appears to be happening is that purchasers are setting an "efficiency budget"; as long as a vehicle achieves a minimum efficiency rating (or, equivalently, a set fuel cost requirement), then the purchaser prefers to substitute greater efficiency for a larger vehicle or more accessories. If true, this bodes badly for further efficiency improvements as gas prices fall.

Thus far we have discussed two of the three components contributing to changing emissions: vehicles stock which we saw increase by approximately 8.3% over the 2007 to 2013 period; and fuel consumption rates which, as we just discussed, improved by approximately 5% over the same period. What of the remaining component: vehicle kilometres travelled (VKT).

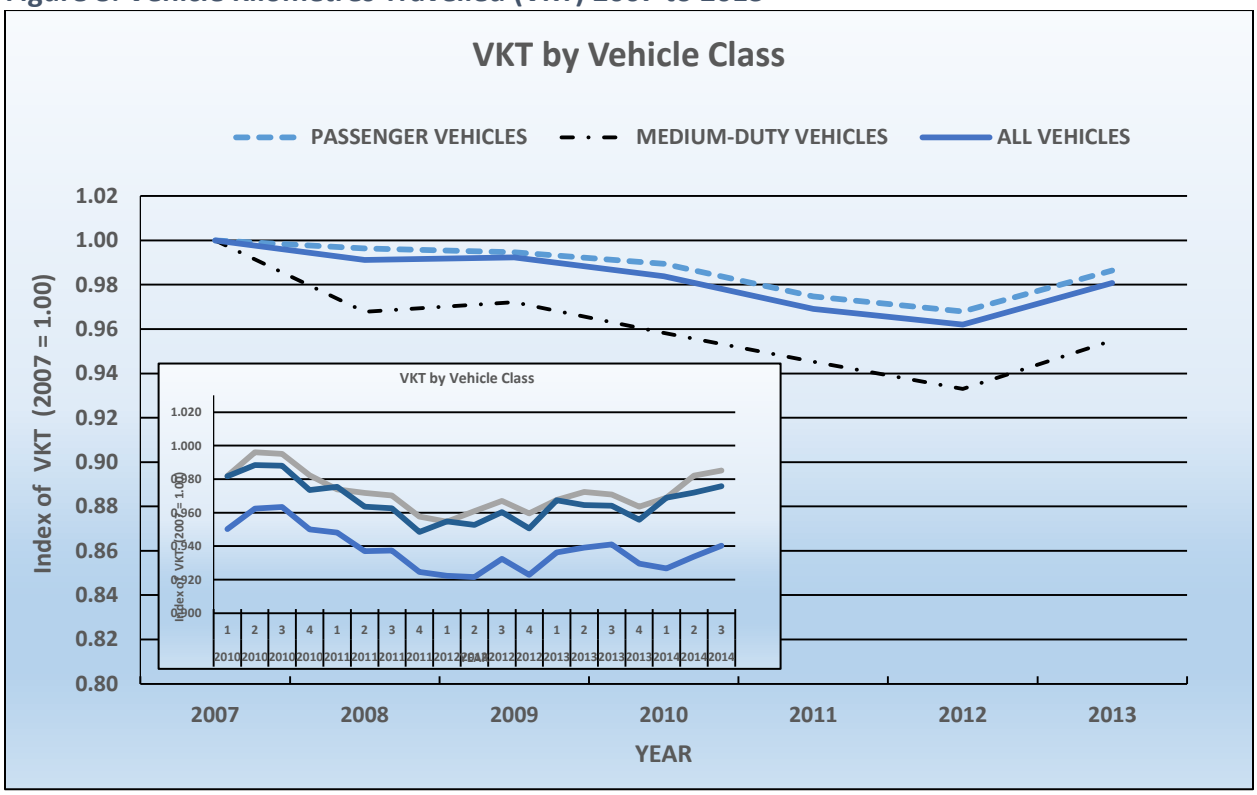
Vehicle Kilometres Travelled (VKT)

The last component that influences the level of emissions is the number of kilometres travelled by all vehicles. **Figure 8** below highlights how the average annual VKTs have changed since 2007 for various vehicle classes.

Average VKTs generally remained fairly stable over the 2007– 2009 period. From 2009 to 2012 there was a noteworthy fall in VKTs for all vehicle types after which VKT began rising (this is also true for all vehicle types within Passenger vehicles). The quarterly data indicates that the increase in VKT began in the 2nd or 3rd quarter of 2012 and continues through 2013 and the first part of 2014.

The question arises: what caused this decline in average VKT: Was it due to the relatively poor economy? Was it due to rising fuel prices (or even the Carbon Tax)? Or initiatives initiated by regional authorities to reduce traffic? Or perhaps public recognition that driving is bad for the environment? Many people look for the answer – witness recent comments in the media that the Carbon Tax was responsible for the decline in GHG emissions in BC (more on the Carbon Tax in an upcoming paper). The truth is, there are many factors that contribute to changing VKT, some influencing average VKT upward, some influencing it downward.

Figure 8: Vehicle Kilometres Travelled (VKT) 2007 to 2013



The quarterly data for 2014 are preliminary.

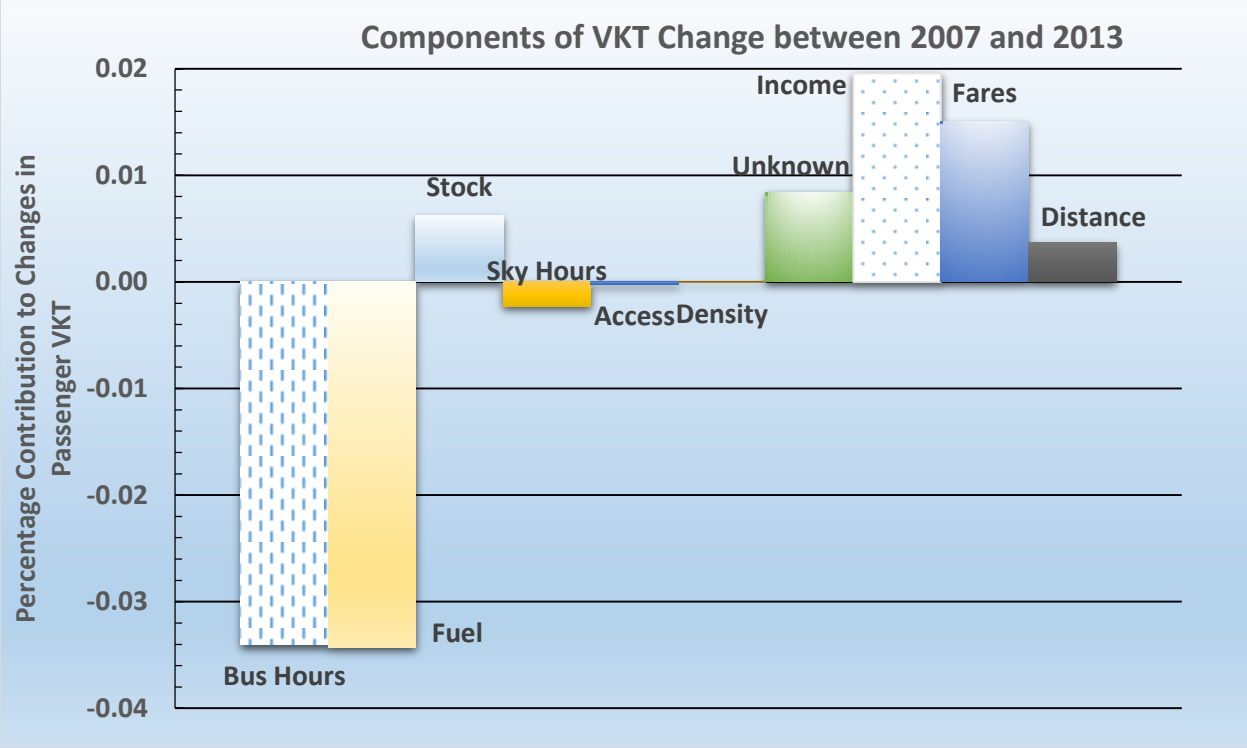
In order to try to understand what factors influence average VKT in MetroVan our VKT Forecasting Model[7] was run for a variety of scenarios.

Figure 9 below attempts to provide a detailed answer to the above question for Passenger Vehicles. Overall, average VKT for Passenger Vehicles fell by 1.8% between 2007 and 2013. Three factors were identified that, if all other factors were unchanged, would have pushed average VKT upward: Incomes, Transit Fares, and Distances.

As highlighted in **Figure 9**, the increase in real per capita incomes between 2007 and 2013 (4.9%) was responsible for a 2.0% increase in average VKT (an income elasticity of 0.40); Real Transit Fares (monthly fare card cost) rose 21.1% between 2007 and 2013 which, all other things constant, would have increased average VKT by 1.5% (an elasticity of 0.07); and the increase in the average distance (0.7%) that vehicles were based from their local municipal centre and the Central Business District – CBD- would have pushed average VKT up by 0.4% (an elasticity of 0.55), all things equal.

[7] A description of the VKT Forecasting Model with a detailed discussion of the econometric equations used to estimate VKT for each vehicle group can be found at the website: http//autostat.ca.

Figure 9: Components of VKT Change in MetroVan, 2007 to 2013



A number of factors lead to a decreasing average VKT. The increase (roughly 17%) in real fuel prices (gasoline and diesel)[8] was responsible for 3.4% of this fall. That is, if fuel prices had held constant between 2007 and 2013, we would have seen average VKT to be 3.4% higher than what actually occurred (a fuel price elasticity of -0.21).

As mentioned earlier, the changing composition of the vehicle stock and the type of drivers also influence average VKT. For instance, between 2007 and 2013, the number of Small Cars declined by close to 10% while the number of SUVs increased by over 50%. A ballpark analysis suggests vehicle composition lead to an increase of 0.2% in VKT. In addition, the time the average vehicle was registered increased over the 2007 – 2013 period which would have increased average VKT.[9] A ballpark analysis of this factor suggested that changing part-time rates increased VKT up by 0.4%. The total change in the structure of vehicle stock, then, lead to an increase of 0.6% in average VKT, all other things constant.

[8] Real gasoline prices increased by 16.5% while real diesel prices increased by 24.5% over the 2007 – 2013 period. The weighted average of fuel usage for passenger vehicles, then would be in the 17% range.

[9] Vehicles may not be registered full time in a quarter for a variety of reasons. One, some people de-register their vehicle during the winter months; two, vehicles moving into the region usually register some time during the quarter and therefore are not on the road over the full period; and three, new vehicles will only be on the road part-time during the quarter of purchase.

Another two factors were identified that prompted VKT to fall: the increase in the number of bus hours in the MetroVan region (10.6%) and the increase in the number of Skytrain hours (53.2%). If all other things had remained the same, the increase in bus service hours would have nudged down average VKT by 3.4%. This is equivalent to saying that the increase in bus service hours that took place between 2007 and 2013 was responsible for taking roughly 42,000 vehicles off the road. For the increase in SkyTain service hours, the impact is not nearly as large, reducing average VKT by only 0.2%. But it should be noted that changes in SkyTrain service hours are highly location specifc. For the City of Richmond, for instance, the influence of changes in Skytrain hours (effectively, the opening of the Canada Line) was much greater than in MetroVan as a whole.[10]

We also evaluated two additional factors: the increase in the average population density in MetroVan and the increase in transit accessibility: together these factors would have decreased average VKT by 0.4%.[11]

The remaining factor - Unknown– represents all other components that, together, would generate a 0.8% increase in VKT all other things the same. Various factors can be suggested that could have influenced VKT up or down, but were not evaluated in this analysis. For one, the number of vehicles driven by males between age 24 and 64 (who drive relatively more than other demographic groups) shrank between 2007 and 2013 (a decline of 0.4% when the overall passenger vehicle stock increased by 7.4%). Similarly, the increase (3.0%) of passenger vehicles driven to/for work which are driven less was much less than the increase in all passenger vehicles (8.3%).

Conclusion

The view of MetroVan (and many of the municipalities within MetroVan) is that their GHG emissions from vehicles have begun to fall and that over the next years this decline will continue, helping to meet the goal of a 33% reduction in overall emissions by 2020. The evidence presented in this report suggests, at least in the near term, this may be over-optimistic. Since 2007, 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 can fall is if average VKT declines.

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[10] Using the example of gasoline-power SUVs driven to/for work, the influence of the change Skytrain hours (effectively, the opening of the Canada Line) is small in MetroVan as a whole, reducing average annual VKT by roughly 25 kms for said SUVs. In contrast, in the City of Richmond the change reduces average VKT by just over 500 kms for that same type of vehicle.

[11] Factors such as Density, Accessibility, Distance (to the local municipal centre and to the CBD) are calculated at the Transit Area Zone (TAZ) level, a much finer gradation than at the municipal level.

How likely is it that average VKT will decline? The average vehicle kilometres travelled (VKT) by all vehicles in MetroVan increased in 2013 (by some 2.0%) and appears from preliminary data to have maintained that upward trend in 2014 (estimated at between 1.0% and 1.5%). Given that vehicle stock in MetroVan is expected to grow by 10% by the year 2020 and average fuel efficiencies only by 6%-7%, the only way that MetroVan can begin to achieve reductions in GHGs (let alone meet a 33% decline) by 2020 is for the average VKT to decline over the 2015 – 2020 period.

While MetroVan has relatively little control over the number of vehicles in the region and almost no control over improvements in fuel consumption rates, the Regional District (as well as municipalities and related agencies such as TransLink) does have some influence over future trends in VKT.

This Report has attempted to identify some of those factors: those outside of any local influence (e.g., incomes), those that are partially controllable (e.g., fuel prices through some fuel taxes), some that can be directed (e.g., transit fares, hours of bus and Skytrain service) and some that are outcomes of municipal land planning (e.g., density, distances travelled, and perhaps transit accessibility).

This report has detailed the importance of each of these factors in influencing changes in VKT. Higher incomes will tend to push VKTs higher, but a policy of trying to reduce overall incomes is unlikely to find much support, even among those demanding decreases in GHG emissions. Likewise fuel prices are another important driver of VKT, having a short-run elasticity[12] of roughly --0.21 (with the rapid decrease in fuel prices in late 2014, this elasticity suggests that, if prices continue to remain low, future VKTs will increase, all other factors the same). Transit service hours and the cost of that transit have a definite impact on average VKT: for example, increasing bus service by 10% could result in close to a 3.5% decline in average passenger vehicle VKTs. And while the impact of increasing Skytrain service has a much smaller impact on MetroVan as a whole, it does have significant impacts on average VKTs in certain municipalities (e.g., the City of Richmond).

It is hoped that this paper has shed some light on how GHGs are changing in Metrovan and more importantly, what policy variables governments and agencies have to respond to the demands for reducing GHG emissions. For what is clear is that without implementing changes, the goal of reducing GHGs is not attainable.

[12] An elasticity of -2.1 suggests that if fuel prices decrease by 10%, average VKT will increase by 2.1%, all other things equal. Since the 3rd quarter of 2014, fuel prices have dropped around 25% suggesting that 2015 could witness average VKTs above those in 2007 for the first time.