sustainable WATERLOO

Environmental Leadership in Waterloo Region

Sustainable Waterloo

Calculating GHG Emissions from Personal Vehicle Travel

4/1/2010

Table of Contents

About Us

Sustainable Waterloo is a not-for-profit that guides organizations in Waterloo Region towards a more environmentally sustainable future. To do so, Sustainable Waterloo facilitates collaboration between industry, local government, academia and NGOs.

The current work of Sustainable Waterloo is centred on the Regional Carbon Initiative, which supports voluntary target-setting and reductions of carbon emissions in organizations across Waterloo Region.

Introduction

Sustainable Waterloo is committed to using the best available methodology to quantify carbon emissions and reductions. In some cases, however, the best available data is not detailed enough to be useful to the members of the Regional Carbon Initiative. The 'Calculating GHG emissions from Personal Vehicle Travel' document is designed to fill the gap by establishing fuel efficiencies for personal vehicle use that work on a business scale with source data available to small organizations.

According to Canada's GHG inventory[1], the best way to calculate GHG emissions from personal vehicles is to record total litres of gas consumed. However, when calculating business travel and commuting travel on an organizational level, fuel records are not always available. It is therefore necessary to establish emission factors for the next best GHG emissions accounting method: fuel efficiency expressed in litres / 100kms.

The government of Canada publishes the fuel efficiency for the average vehicle in Canada. However, this number is not useful to the Regional Carbon Initiatives' Participating Members who encourage not only less personal vehicle travel, but also travel with more efficient vehicles. This report finds more specific fuel efficiency standards for a total of fourteen vehicle categories. These categories were chosen based on the vehicle categories published in the 2009 vehicle efficiency index published by Natural Resources Canada in addition to four other categories that Sustainable Waterloo and its partners felt were missing.

The following report outlines the methods, assumptions, and limitations of the Regional Carbon Initiative's personal vehicle transportation emission factors as applied in Sustainable Waterloo's Carbon Accounting Tool.

Fuel economy ratings in Canada are calculated using a standardized procedure known as the Federal Test Procedure (FTP). Real world fuel economy depends on a number of variables including, engine maintenance, driving behaviour, weather, traffic, road conditions, drive systems and powered accessories installed in the vehicle. All fuel economy ratings used in this report (aside from motorcycle classification) were calculated using the FTP.

The data provided herein is open to all organizations. Any questions or comments can be directed to Sustainable Waterloo's GHG Services Manager at: matthew.day@sustainablewaterloo.org

Executive Summary

'Calculating GHG emissions from Personal Vehicle Travel' outlines the methodology, assumptions and limitations regarding fuel efficiencies used for the fourteen vehicle classifications within Sustainable Waterloo's Regional Carbon Initiative's carbon accounting tool. The fuel efficiencies identified within this report are used to calculate CO_2e emissions for Pledging Partners personal vehicle use including business and commuting travel.

The following is a summary of the fuel efficiencies found in this report (Gasoline Vehicles):

Vehicle class	City (L/100km)	Highway (L/100km)	Combined (55% city/ 45% highway)
Compact	9.4	6.6	8.1
Subcompact	9.2	6.4	7.9
Station Wagon	9.8	7.0	8.5
Mid-Size	11.0	7.3	9.3
Two-Seater	11.7	7.9	10.0
Full-Size	12.1	7.6	10.1
Minivan	12.8	8.5	10.9
Special purpose vehicle (SUV)	13.2	9.4	11.5
Large Van	15.0	10.5	13.0
Pickup Truck	16.0	11.5	14.0
Hybrid Car	5.1	5.0	5.0
Hybrid SUV/Truck	7.5	7.7	7.6
Motorcycle	n/a	n/a	5.1
Unknown	n/a	n/a	9.2

Transport Canada provided Sustainable Waterloo with fuel efficiency data for the ten vehicle types listed in the Fuel Consumption Guide 2009. Fuel efficiency for these classifications is weighted towards sales in Canada.

The 'hybrid car' and 'hybrid SUV' fuel efficiencies were calculated by Sustainable Waterloo using the same weighted average approach, but with a slightly different data set: registered vehicles instead of total sales.

The United Kingdom's Department for Environment Food and Rural Affairs (Defra) emission factors were used to estimate fuel efficiency for the average motorcycle engine size in Canada. The average engine size was calculated using data from the Motorcycle and Moped Industry Council of Canada (MMIC).

The 'unknown' vehicle classification is a Transport Canada figure and is based on a weighted average of all vehicles sold in Canada in 2002.

Unknown Vehicle Classification

In the event there is an unknown type of vehicle listed in the commuting or business travel records for our Pledging Partners, the Government of Canada's Average Fuel Efficiency for all cars and light trucks on the road in Canada will be assigned. This will apply a fuel economy rating of 9.2 L/100km[2].

Limitations / Assumptions

The fuel economy for the unknown classification is based on 2002 data. It represents the average fuel efficiency of all vehicles purchased in that year. 2002 is the most recent year Transport Canada has calculated this figure and though it may seem dated, the result of this calculation has been reasonably consistent since 1981. There is little evidence this number would have significantly changed from 2002 – 2010 and thus was deemed reasonable to include as the fuel efficiency for the 'unknown' classification.

Transport Canada Vehicle Classifications

Transport Canada provided Sustainable Waterloo with fuel efficiency data for the ten vehicle types listed in the Fuel Consumption Guide 2009[3] (Table 1). The fuel efficiency for these classifications is weighted towards sales in Canada. Definitions for each vehicle class are listed in Appendix 1 as outlined in Transport Canada's 2009 Fuel Consumption Guide. Moreover, a sample of the weighted average procedure used by the Government is in Appendix 2. Table 2 outlines the fuel efficiency of Diesel engines according to the same categories. Information for this chart comes from the same sources and uses the same methodology as the gasoline engine vehicles.

Table 1: Gasoline Fuel Efficiency in Litres per 100 Kilometers for Vehicle Class in Canada (weighted by total sales between 1998-2008)[4]

Vehicle class (as per Fuel Consumption Guide)	City (L/100km)	Highway (L/100km)	Combined (55% city/ 45% highway)
Compact	9.4	6.6	8.1
Subcompact	9.2	6.4	7.9
Station Wagon	9.8	7.0	8.5
Mid-Size	11.0	7.3	9.3
Two-Seater	11.7	7.9	10.0
Full-Size	12.1	7.6	10.1
Minivan	12.8	8.5	10.9
Special purpose vehicle (SUV)	13.2	9.4	11.5
Large Van	15.0	10.5	13.0
Pickup Truck	16.0	11.5	14.0

Source: Transport Canada's Vehicle Fuel Economy Information System (VFEIS)

Table 2: Diesel Fuel Efficiency in Litres per 100 Kilometers for Vehicle Class in Canada (weighted by total sales between 1998-2008)[5]

Vehicle class	City (L/100km)	Highway (L/100km)	Combined (55% city/ 45% highway)
Compact	6.2	4.6	5.5
Subcompact	5.7	4.4	5.1
Station Wagon	7.0	4.9	6.0
Mid-Size	8.8	5.8	7.4
Two-Seater	4.6	3.8	4.2
Full-Size			
Minivan			
Special purpose vehicle (SUV)	11.6	8.7	10.3
Large Van			
Pickup Truck	16.2	11.4	14.0

Source: Transport Canada's Vehicle Fuel Economy Information System (VFEIS)

Limitations / Assumptions

The fuel efficiencies for each category were calculated using cumulative data for each model between 1998 and 2008 and weighted by sales of individual models in Canada. Vehicles sold prior to this period are not included in the data sample.

These fuel efficiency factors include all hybrid models in each category. However, due to the limited number of hybrid models sold relative to standard models, their inclusion is unlikely to significantly affect actual fuel efficiency figures.

The VFEIS secures the privacy of car sales data. As such, only the final numbers were given to Sustainable Waterloo.

The data provided by Transport Canada provided a good starting point for a categorical vehicle classification. To best accommodate the needs of our Pledging Partners, additional vehicle classifications were established.

Hybrid Cars and Hybrid SUV Classification

Similar to the Transport Canada classifications, the objective for the hybrid categories was to calculate a weighted average for fuel efficiency for both hybrid cars and hybrid SUVs based on the market share of all available models in Canada. A weighted average for city and highway driving was calculated.

Methodology

Calculating the weighted fuel economy for hybrid cars and SUVs required two pertinent pieces of information – fuel economy ratings and market share for the various hybrid models available in the Canadian market.

Fuel Economy Data

Fuel economy ratings (L/100km) were collected for all hybrid models available in Canada (Appendix 3). The Government of Canada 2009 Fuel Consumption Guide was used to acquire this data for the majority of the hybrid vehicles. This guide provides data on 2009 models; therefore, for hybrid models not included in the 2009 guide, data was acquired from previous years Fuel Consumption Guides or the manufacturers' website. Fuel economy ratings for models not included in the 2009 guide are listed below with the corresponding source:

Hybrid Cars:
Honda Accord – 2007 Fuel Consumption Guide[6]
Honda Insight – Manufacturers data, 2010 model
Ford Fusion – Manufacturers data, 2010 model

Hybrid SUVs:
Lexus RX 400h – 2007 Fuel Consumption Guide
Cadillac Escalade – Manufacturers data, not listed in fuel consumption guide
Dodge Durango – Manufacturers data, not listed in fuel consumption guide
Lexus RX450h – Manufacturers data, 2010 model
Mercury Mariner – Manufacturers data, not listed in fuel consumption guide

Data obtained from the vehicles manufacturers is consistent with the methodology as the Government of Canada Fuel Consumption Guide collects its data from the vehicle manufacturers who use the FTP for calculating fuel efficiencies.

Fuel economy for both city and highway driving was collected from the sources cited above. The combination calculation was tabulated using a mix of 55% city driving and 45% highway driving as recognized by the 2009 Fuel Consumption Guide as a means of estimating total fuel consumption.

Market Share Data

Data for the number of hybrids registered in Canada was obtained through a leading automotive consulting firm. Polk Canada supplied market data for total hybrid registrations from 2004 to August 2009 by make/model (Appendix 4). Polk's data is sourced from each provinces vehicle registrar's office.

To ensure the data provided by Polk Canada was an accurate representation of the Canadian hybrid market, a number of other sources were used as a cross reference. In the three sources were referenced (JD Power and Associates, Polk Canada, and Statistics Canada 2007 Households and Environment Survey) there was no directly comparable data.

Statistics Canada estimated the total number of hybrid vehicles in Canada, from 2001-2008, to be 63,641. The data obtained from Polk estimates total hybrid registrations from 2004 to August 2009 at 59,810. Though not directly comparable, the numbers provide no reason to assume Polk Canada's numbers to be false.

There is a discrepancy between hybrid vehicles sold and hybrid vehicles registered in Canada. A news article from CTV News[7] cited a study done by JD Power and Associates (JDPA) that estimated that the top 3 hybrid models sold 5,584 hybrid cars in 2006 in Canada. The data from Polk Canada lists 5,766 of the top three hybrid car models registered in 2006 in Canada. According to JDPA Camry Hybrid sold 2116 units; the Prius sold 2,003 units; and the Civic hybrid sold 1,465 units. Polk data for the same period lists the Camry, Prius and Civic registrations at 2,162 (2% difference), 2,137 (6.3% difference) and 1,467 (.1%) respectively. Because JDPA was unable to provide a complete data set to this study and because the numbers were not unreasonable, Sustainable Waterloo developed the emission factors based on the registration numbers provided by Polk Canada.

Once the Polk data was cross referenced, hybrid car and hybrid SUVs were separated and the total populations for their respective classifications were calculated. From these numbers, market share by model was calculated by dividing the total number of each model registered by total registrations in Canada (Appendix 3).

The weighted average for city, highway, and combo driving was calculated by weighing each models fuel economy against its share of the Canadian Market (Appendix 3). This produced a single number for city,

highway and combo driving for both the hybrid car and hybrid SUV classifications. It is these numbers that will be included in the carbon accounting and reporting tool for calculating commuter emissions for the hybrid classifications.

The hybrid car market in Canada is dominated by three models: Toyota's Camry and Prius and the Honda Civic. These three models make up nearly 90% of hybrid cars registered in Canada. Based on the methods outlined above, a fuel efficiency rating for the hybrid car classification will be applied as follows:

Fuel Efficiency Hybrid Car Weighted Average L/100km		
City	**Hwy**	**Combo**
5.1	5.0	5.0

Likewise, the hybrid SUV market is dominated by three models: Toyota Highlander, Ford Escape and Lexus' RX 400h. These three models make up 84% of the registered hybrid SUVs in Canada. Based on the methods outlined above, a fuel efficiency rating for the hybrid car classification will applied as follows:

Fuel Efficiency Hybrid SUV Weighted Average (L/100km)		
City	**HWY**	**Combo**
7.5	7.7	7.6

Limitations

Fuel economy ratings for 2009 models were used to calculate the weighted emission factors for both the car and SUV hybrid classifications. Fuel ratings for previous models (i.e. models manufactured in 2009 and one or more other years) were cross checked with previous Fuel Consumption Guides (2007, 2008) and the discrepancies were non-existent or marginal and would not have a material impact on the final calculations.

Registration data obtained for the SUV hybrids does not separate the 4x4 and standard models. Though the exclusive use of fuel economy ratings for 4x4 hybrids or standard models does not change the weighted averages considerably, to obtain a more balanced result, the fuel consumption of the 4x4 and standard models were averaged and that result was used as that model's fuel economy to be weighed against its market share.

Assumptions

The percentage of market share for the various hybrid models was based on Canada wide data. Because of the relatively small number of hybrid vehicles available, and the overall dominance of a few select models, it seemed reasonable to assume the Canadian market would be a reasonable representation of the regional market.

The data obtained by Polk Canada does not include data prior to 2004. Due to the limited number of hybrids available before this time, it was assumed the overall landscape of the Canadian hybrid market would not change significantly with the addition of data prior to the sample used in the calculations.

Motorcycle Classification

Due to the limited amount of data available for motorcycles, the methods used for determining fuel efficiency differ from that of the other vehicle classifications. Canada's Fuel Consumption Guide does not currently track fuel efficiencies of motorcycles.

Sustainable Waterloo uses the average / unknown vehicle motorcycle data presented in the "2009 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting"[8] to estimate fuel efficiency for the motorcycle classification. Sustainable Waterloo found this number to be representative of the fuel efficiency of Canada's average motorcycle engine size. The following is a thorough exploration of the details of this conclusion.

Methodology

The conclusion to use Defra emission factors for motorcycles was based on two pieces of information: the estimated motorcycle engine size in Canada, and its reasonable approximation to the average engine size in Defra's 2009 GHG conversion factors.

Calculating Canada's Average Motorcycle Engine Size

The Motorcycle and Moped Industry Council (MMIC) of Canada produces an annual statistics report on the Canadian motorcycle market. The MMIC is a national non-profit trade association representing the manufacturers and distributors of motorcycle and mopeds in Canada. The 2008 Annual Industry Statistics Report[9] provides sales data by engine class for 2005 to 2008. Using this data as a sample of the Canadian motorcycle market, a weighted average engine size, based on the market share, was calculated to be 647cc (Appendix 5).

The Canadian average engine size was calculated based on five engine groupings. The highest engine size classification had no upper limit (i.e. 951cc and up), and similarly, the smallest engine group had no lower limit (i.e. up to 250cc). The weighted average was calculated using 951cc as the largest engine size and subsequently, each grouping was assigned its lower limit in calculating the overall Canadian average. The smallest engine grouping was assigned a rating of 100cc to capture the moped market. Although this may result is a smaller overall engine size, it was deemed the most accurate snap shot of the Canadian market given the current data available.

Using Defra's Emission Factors

The United Kingdom Government, specifically the Department for Environment, Food and Rural Affairs (Defra), and the Department of Energy and Climate Change calculates emission factors for motorcycles as part of an annual guide for greenhouse gas conversion factors.

The *2008 Guideline to Defra's GHG Conversion Factors*[10] provides a data set for the motorcycles used to calculate CO_2 emission factors. Within this data set is emissions data for a 650cc motorcycle expressed in gCO_2 / km. The 650 cc engine size was used because it was the closest size available to the findings for the average engine size in Canada (647 cc).

Defra estimates the 650cc engine releases 0.115 $kgCO_2$ / km. This number, however, is very similar to Defra's average (or unknown engine size) fuel efficiency factors (0.11606 $kgCO_2$ / km) as published in the 2009 *Guideline to Defra's GHG Conversion Factors* report. Considering: a) the number of assumptions that was made to determine the average engine size in Canada, 2)the limitations of determining an efficiency rating from that number, and c) the fact that we 'erred' on the smaller engine size and hence lower emissions setting it was determined to instead use the Defra's average motorcycle emission factor as fitting Canada as well.

Table 3: Defra's 2009 Motorcycle Emission Factors by Engine Size

Passenger Road Transport Conversion Factors: Motorcycles				
	CO_2	**CH_4**	**N_2O**	**Total GHG**
Size of motorcycle	**kg CO_2 per unit**	**kg CO_2eq per unit**	**kg CO_2eq per unit**	**kg CO_2eq per unit**
Small petrol motorbike (mopeds/scooters up to 125cc)	0.08499	0.00184	0.00057	0.0874
Medium petrol motorbike (125-500cc)	0.10316	0.0019	0.00062	0.10569
Large petrol motorbike (over 500cc)	0.13724	0.00191	0.00062	0.13977
Average petrol motorbike (unknown engine size)	**0.11606**	0.00189	0.0006	**0.11856**

Note: The specific data used to generate emission factors for the engine classifications is not available in 2009 guideline; however Defra reports, "These factors are based on calculations of average emissions data by size category, based on data provided by Clear (*http://www.clear-offset.com/*) of almost 1200 data points, over 300 different bikes from 50-1500cc, and from 25 manufacturers from a mix of magazine road test reports and user reported data."

Arriving at Fuel Efficiency

Sustainable Waterloo uses data from the Canadian GHG Inventory to determine emission factors for gasoline which differs slightly from the Defra data. Therefore, it was necessary to arrive at fuel efficiency and not just the Defra emission factors. To do this, Defra's Total GHG emissions for the average petrol motorcycle (0.11856 $kgCO_2e$/km), was multiplied by one hundred to calculate kg CO_2e/100km (11.856 $kgCO_2e$/100km), and then divided by Defra's fuel emission factor (2.3307 kg CO_2e/L) to arrive at a fuel efficiency of 5.09 L/100km (Appendix 6). This number will then be used by Sustainable Waterloo and applied to the appropriate, Canadian emission factors within the carbon accounting tool.

Assumptions

The average engine size is based on a sample of the Canadian market and does not represent motorcycles sold pre-2005 and post-2008. Market data outside these time frames is unlikely to significantly affect the overall landscape of the Canadian motorcycle market and would not have a material impact on the final calculations.

Limitations

Due to the limited data available on motorcycles fuel economy, highway and city fuel economy was not calculated. Although this deviates from the methodology for the other vehicle classifications, its overall implications would not be material due to the limited number of commuting records for the motorcycle category.

Conclusions

Sustainable Waterloo will continue to consult emerging protocols, international reports, and regional environmental experts to keep the calculating methodology and emission factors of the Regional Carbon Initiative as accurate, fair, and up-to-date as possible. With the information currently available, Sustainable Waterloo believes the approaches documented in this report are the most flexible, relevant, and accurate available for our Pledging Partners. As more research is conducted and published and best practices continue to emerge, Sustainable Waterloo will revisit the methodology section often to make sure it incorporates the best science, current policy, and professional advice in this constantly changing field.

Appendix 1 – Transport Canada Vehicle Classification Definitions

For more information or for a vehicle by vehicle break down of categories, please visit Transport Canada's website:

FUEL CONSUMPTION GUIDE

Vehicle classes

In the Guide, cars are divided into six classes – four of which are based on an interior volume (int. vol.) index that combines passenger and trunk or cargo space, and two of which are based on car line (two-seaters and station wagons). Light trucks are divided into four classes – pickup trucks, special purpose vehicles (i.e. sport utility vehicles [SUVs]), minivans and large vans.

TWO-SEATER CAR (T)

STATION WAGON (W)

SUBCOMPACT CAR (S)

int. vol. less than 2830 L (100 cu. ft.)

PICKUP TRUCK

COMPACT CAR (C)

int. vol. 2830–3115 L (100–110 cu. ft.)

SPECIAL PURPOSE VEHICLE (SUV)

MID-SIZE CAR (M)

int. vol. 3115–3400 L (110–120 cu. ft.)

MINIVAN (V)

FULL-SIZE CAR (L)

int. vol. greater than 3400 L (120 cu. ft.)

LARGE VAN (F)

Appendix 2: Sample of Methodology Used by Transport Canada for Calculating a Weighted Average Vehicle Classification

Fictive data

Year	Model	engine size	# of cyli	Transmis	city FC	Highwa	Combin	sales	weight		
									city	highway	combined
2005	Toyota Corolla	1.8	4	E4E	7.8	5.6	6.8	10354	80761.2	57982.4	70407.2
2005	Toyota Corolla	1.8	4	M5+	7.1	5.3	6.3	7452	52909.2	39495.6	46947.6
2005	Subary Impreza	2.5	4	M5+	11.2	8	9.8	2547	28526.4	20376	24960.6
2005	Subary Impreza	2.5	4	S4E	10.6	7.9	9.4	1255	13303	9914.5	11797
2006	Toyota Corolla	2.2	4	E4E	7.5	6	6.8	11254	84405	67524	76527.2
2006	Toyota Corolla	2.2	4	M5+	7.2	5.6	6.5	8524	61372.8	47734.4	55406
2006	Subary Impreza	2.5	6	M5+	10.5	8.4	9.6	1257	13198.5	10558.8	12067.2
2006	Subary Impreza	2.5	6	S4E	11	7.1	9.2	1854	20394	13163.4	17056.8
							Total	44497	354870.1	266749.1	315169.6
							Sales weight		8.0	6.0	7.1

Appendix 3: Gasoline Fuel Efficiency for Hybrid Cars and SUVs in Canada, Hybrid Market Share and Weighted Fuel Economy – Polk Data

Hybrid Cars					
Model	**City**	**Hwy**	**Combo**	**% in Canadian Market**	**Fraction of**
	L/100km	**L/100km**	**(0.55 City 0.45 HWY)**		**Cdn Market**
Honda Civic Hybrid Sedan	4.7	4.3	4.5	15.57	0.156
Honda Accord Hybrid Sedan	8.2	6.1	7.3	3.24	0.032
Honda Insight	4.8	4.5	4.7	1.26	0.013
Nissan Altima Hybrid Sedan	5.7	5.9	5.8	1.56	0.016
Toyota Camry Hybrid Sedan	5.7	5.7	5.7	36.93	0.369
Toyota Prius	4.0	4.2	4.1	37.04	0.370
Chevrolet Malibu Hybrid	7.9	5.8	7.0	1.89	0.019
Saturn AURA Hybrid	7.9	5.8	7.0	0.49	0.005
Ford Fusion Hybrid	5.4	4.6	5.0	0.7	0.007
Lexus LS600h	10.6	9.1	9.9	0.43	0.004
Lexus GS450h	8.7	7.8	8.3	0.90	0.009

Hybrid Car Weighted Average L/100km		
City	**Hwy**	**Combo**
5.1	5.0	5.0

Hybrid SUV's					
Model	**City**	**Hwy**	**Combo**	**% in Canadian Market**	**Fraction of**
	L/100km	**L/100km**	**(0.55 City 0.45 HWY)**		**Cdn Market**
Chevrolet Silverado Hybrid	9.8	9.2	9.5		
Chevrolet Silverado 4x4 Hybrid	10.5	9.8	10.2		

	Average	10.2	9.5	9.9	0.48	0.0048
GMC Sierra Hybrid		9.8	9.2	9.5		
GMC Sierra 4x4 Hybrid		10.5	9.8	10.2		
	Average	10.2	9.5	9.9	0.45	0.0045
Chevrolet Tahoe Hybrid		9.8	9.2	9.5		
Chevrolet 4x4 Tahoe Hybrid		10.5	9.8	10.2		
	Average	10.2	9.5	9.9	1.86	0.0186
Ford Escape AWD Hybrid		7.0	7.4	7.2		
Ford Escape Hybrid		5.8	6.4	6.1		
	Average	6.4	6.90	6.6	28.5	0.285
Yukon Hybrid		9.8	9.2	9.5		
Yukon 4x4 Hybrid		10.5	9.8	10.2		
	Average	10.2	9.5	9.9	1.9	0.019
Chrysler Aspen 4x4 Hybrid		10.5	9.2	9.9	1.12	0.0112
Toyota Highlander Hybrid 4WD		7.4	8.0	7.7	26.91	0.2691
Saturn VUE Hybrid		8.2	6.1	7.3	7.98	0.0798
Dodge Truck Durango Hybrid		12.4	11.8	12.1	0.04	0.0004
Mercury Mariner Hybrid		6.9	7.6	7.2	0.06	0.0006
Cadillac Escalade Hybrid		11.8	11.2	11.5	0.8	0.008
Lexus RX 400h SUV		7.7	8.3	8.0	28.6	0.2855
Lexus RX 450h SUV		7.8	8.4	8.1	1.34	0.0134

Hybrid SUV Weighted Average (L/100km)		
City	**HWY**	**Combo**
7.5	7.7	7.6

Appendix 4: Canadian Hybrid Vehicle Registrations: 2004 to August 2009 by Make and Model- Polk Canada

COUNT as values			2004	2005	2006	2007	2008	2009	Calendar Year
CHRYSLER CANADA	CHRYSLER TRUCK	CHRYSLER TRUCK ASPEN	0	0	0	0	42	147	189
	DODGE TRUCK	DODGE TRUCK DURANGO	0	0	0	0	7	0	7
	CHRYSLER CANADA		0	0	0	0	49	147	196
FORD CANADA	FORD	FORD FUSION	0	0	0	0	0	300	300
	FORD TRUCK	FORD TRUCK ESCAPE	169	877	610	1,001	1,506	662	4,825
	MERCURY	MERCURY MARINER	0	0	0	0	11	0	11
	FORD CANADA		169	877	610	1,001	1,517	962	5,136
GM CANADA	CADILLAC	CADILLAC ESCALADE	0	0	0	0	49	86	135
	CHEVROLET	CHEVROLET MALIBU	0	0	0	4	483	325	812
	CHEVY TRUCK	CHEVY TRUCK 10	0	0	0	0	5	77	82
		CHEVY TRUCK TAHOE	0	0	0	1	214	100	315
	GMC TRUCK	GMC TRUCK 1500	0	0	0	0	5	72	77
		GMC TRUCK YUKON	0	0	0	3	197	121	321
	SATURN	SATURN AURA	0	0	0	74	70	65	209
		SATURN VUE	0	0	157	542	353	299	1,351
	GM CANADA		0	0	157	624	1,376	1,145	3,302
HONDA CANADA	HONDA	HONDA ACCORD	28	564	529	234	32	1	1,388
		HONDA CIVIC	194	355	1,467	2,148	2,198	317	6,679
		HONDA INSIGHT	6	7	18	4	0	504	539
	HONDA CANADA		228	926	2,014	2,386	2,230	822	8,606
NISSAN CANADA	NISSAN	NISSAN ALTIMA	0	0	0	226	263	180	669
	NISSAN CANADA		0	0	0	226	263	180	669
TOYOTA CANADA	LEXUS	LEXUS GS450H	0	0	145	112	102	25	384
		LEXUS LS600H	0	0	0	107	61	16	184
		LEXUS RX400H	0	792	825	1,132	1,660	424	4,833
		LEXUS RX450H	0	0	0	0	0	226	226
	TOYOTA	TOYOTA CAMRY	0	0	2,162	5,739	6,179	1,755	15,835
		TOYOTA HIGHLANDER	0	615	874	662	1,712	692	4,555
		TOYOTA PRIUS	1,906	1,914	2,137	2,843	4,814	2,270	15,884
	TOYOTA CANADA		1,906	3,321	6,143	10,595	14,528	5,408	41,901
All Corporate Data			**2,303**	**5,124**	**8,924**	**14,832**	**19,963**	**8,664**	59,810

Appendix 5: Canadian Motorcycle Retail Sales by Engine Size from 2005 to 2008 and Weighted Average Engine Size

Canadian Retail Sales by Engine Displacement						Weighted Average Data	
Engine Class	**2005**	**2006**	**2007**	**2008**	**Total**		
	# of Units				**(2005-2008)**	**% of Market**	**Lower End Engine Size (cc)**
up to 250 cc	9,548	10,991	11,089	14,790	46,418	**19.0**	**100**
251 - 600 cc	7,428	7,751	6,437	5,935	27,551	**11.3**	**251**
601 - 750 cc	6,859	6,981	8,940	8,884	31,664	**13.0**	**601**
751 - 950 cc	4,425	5,080	5,684	5,264	20,453	**8.4**	**751**
951cc and up	28,161	27,523	29,104	32,905	117,693	**48.3**	**951**
				Total Sold	**243,779**		
Weighted Average Engine Size (based on Market Share)							**647.61**

Appendix 6: Calculations for Motorcycle Fuel Efficiency

DEFRA 2009 Petrol Emission Factors			
CO2	**CH4**	**NO2**	**Total GHG**
kg CO2 / L	kg CO2e / L	kg CO2e / L	kg CO2e / L
2.3035	0.0047	0.0226	2.3307

DEFRA 2009 Emission Factors - 'Average Motorcycle Class'				
Average Petrol Motorcycle	**CO2**	**CH4**	**NO2**	**Total GHG**
	kgCO2/km	kgCO2e/km	kgCO2e/km	kgCO2e/km
	0.11606	0.00189	0.0006	0.11856
Per 100Km	11.606	0.189	0.06	**11.856**

Calculation

11.856 kg CO2e/100m ÷ 2.3307 kg CO2e/L

5.09 L/100km

Endnotes

[1] Canadian GHG Inventory. Greenhouse Gas Sources and Sinks: *http://www.ec.gc.ca/pdb/GHG/inventory_e.cfm*

[2] Environment Canada. "Fuel Efficiency of New Passenger Vehicles" *http://www.ec.gc.ca/soer-ree/English/indicator_series/techs.cfm?tech_id=51&issue_id=2*

[3] Natural Resources Canada (2009). Fuel Consumption Guide 2009 *http://oee.nrcan.gc.ca/transportation/tools/fuelratings/fuel-consumption-guide-2009.pdf*

[4] Transport Canada's Vehicle Fuel Economy Information System (VFEIS)

[5] Transport Canada's Vehicle Fuel Economy Information System (VFEIS)

[6] Natural Resources Canada (2007). "Fuel Consumption Guide 2007". *http://oee.nrcan.gc.ca/Publications/transportation/fuel-guide/2007/index.cfm*

[7] CTV News (2007). "Hybrid Vehicle Market Growing Every Year". *http://www.ctv.ca/servlet/ArticleNews/story/CTVNews/20070411/hybrid_cars_070411?s_name=&no_ads*

[8] Defra (2009). "2009 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting" *http://www.defra.gov.uk/environment/business/reporting/pdf/20090928-guidelines-ghg-conversion-factors.pdf*

[9] MMIC (2008). "2008 Motorcycle, Scooter, All-Terrain Vehicle Annual Industry Statistics Report". *http://www.mmic.ca/images/content/PDF/COHV%20&%20MMIC%20Annual%20Industry%20Report%20-%202008%20Summary.pdf*

[10] Defra (2008). "2008 Guidelines to Defra's GHG Conversion Factors: Methodology Paper for Transport Emission Factors". *http://www.defra.gov.uk/environment/business/reporting/pdf/passenger-transport.pdf*