Electric Vehicle
Association of Canada
Association canadienne
du véhicule électrique

Summary Report for Project

Full Fuel Cycle Emissions Reductions through the replacement of ICEVs with BEVs

Computer Modeling of Full Fuel Cycle
Battery Electric Vehicle Emissions
vs
Current Internal Combustion Engine Vehicle Emissions
in the Lower Fraser Valley

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Important Notes on Modeling Accuracy and Limitations

While extensive care was taken to model a broad range of parameters, it is recognized that all parameters could not be included due to either lack of suitable information or data, as well as due to further complications in the model. Due to this fact, the following is a list of disclaimers and limitation which are recognized by EVAC.

1. CO2 and other emissions due to flooding of land and biodegradation for the purposes of hydro generation were not included in this model.
2. Emissions associated with production and recycling of motor oil for internal combustion engine (ICE) vehicles was not included in the modeling.
3. Emissions due to idling for the purposes of preheating of ICE vehicles was not included in the modeling.
4. Emissions of particulate matter due to operation of brakes was not included in the modeling.
5. Emissions due to operation of auxiliary equipment and lighting for mining and production of gasoline and for production and distribution of electricity was not included in the analysis.
6. The report compares new full fuel cycle battery electric vehicle emissions to the full fuel cycle emissions of the average ICE light duty vehicle currently in operation in the Lower Fraser Valley. A comparison is not made against current average "new" ICE light duty vehicles. If this report compared the full fuel cycle emissions of BEVs against new ICE vehicles, the following results would have been expected:
    a. The benefits of EV with respect to the following pollutants would not have been as great: VOC, CO, NOx and CH.
    b. Emissions of CO_2 would be very similar to the values presented in this report.
    c. No comment can be made on the emissions of N_2O, $PM_{2.5}$, PM_{10} and SOx since these emissions are not regulated under existing ICE vehicle emissions standards.

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1. Executive Summary

The objective of the project was to calculate the changes in Greenhouse Gas emissions, non-GHG emissions and total energy consumption for the Lower Fraser Valley (LFV) for the year 2005 which would result based on the substitution of "fleet average" gasoline internal combustion engine vehicles with comparably sized battery electric vehicles. Various electricity generating scenarios are analyzed which are representative of Canada's diverse electricity generation mix between provinces.

While the analysis is based on vehicle population and emission inventory data for the Lower Fraser Valley, the vehicle data can easily be considered to be generic in nature and can be directly applied to most regional and Provincial scenarios across Canada, with virtually no degradation of the resultant accuracy.

This document is intended to serve as a project summary document, rather than a detailed technical paper, and for this reason describes only key input parameters as well as key findings.

Following is a summary of the key findings of the analysis:

1) Electric Vehicles provide significant Greenhouse Gas reduction benefits of between 55% and 99.9% reductions (CO_2 equivalent) depending on the energy source used for generation of electricity.
2) Operation of an electric vehicle will result in significant reductions of non-renewable energy ranging from 100% reductions to 55% reduction depending on the energy source used for electricity generation.
3) Battery electric vehicles operating in provinces which rely primarily on electricity which is generated by hydro sources will produce between 98% and 99.9% less Greenhouse Gas emissions (CO_2 equivalent) as compared to a gasoline ICEV and will produce less than 0.1% of the total other (non-CO_2) emissions.
4) Battery electric vehicles operating in provinces which rely primarily on electricity generated from combined cycle natural gas generating systems, will produce approximately 85% less Greenhouse Gas emissions (CO_2 equivalent) as compared to a gasoline ICEV and will produce less than 0.5% of the total other (non-CO_2) emissions.
5) Battery electric vehicles operating in provinces which rely primarily on electricity generated from Conventional natural gas generating systems will produce approximately 74% less Greenhouse Gas emissions (CO_2 equivalent) as compared to a gasoline ICEV and will produce approximately only 0.5% of the total other (non-CO_2) emissions.
6) Battery electric vehicles operating in provinces which rely primarily on electricity generated from coal burning generation systems, will produce 55% to 59% less Greenhouse gas emissions as compared to a gasoline ICEV and will produce between 80% and 92% less total other (non-CO_2) emissions depending on the specific type of coal used.

2. Project Objectives

The objective of the project was to calculate the changes in Greenhouse Gas emissions, non-GHG emissions and total energy consumption for the Lower Fraser Valley (LFV) for the year 2005 which would result based on the substitution of "fleet average" gasoline internal combustion engine vehicles with comparably sized battery electric vehicles. Various electricity generating scenarios are analyzed which are representative of Canada's diverse electricity generation mix between provinces.

While the analysis is based on vehicle population and emission inventory data for the Lower Fraser Valley, the vehicle data can easily be considered to be generic in nature and can be directly applied to most regional and Provincial scenarios across Canada, with virtually no degradation of the resultant accuracy.

3. Methodology

The analysis was performed using a Microsoft Excel 2000 based model called EVCalc 3.0. This model was developed by and is the property of the Electric Vehicle Association of Canada.

A key point to understand is that the results represent the emissions and energy differences which would result by replacing one "average" vehicle in the year 2005, with a year 1999 technology battery electric vehicle. New 2005 model year vehicles are expected to have lower emissions for CO, NOx and VOC than that values used in this analysis which are designed to approximate the "average" vehicle on the road in the year 2005. Use of data for 2005 model year vehicles would have resulted in somewhat reduced improvements of non-CO2 emissions reductions, however, would have had no effect on Greenhouse Gas emissions or on energy consumption.

4. Scenario's Modelled

The analysis was performed for the following 120 scenarios:

1. 5 battery electric vehicle penetration rates were modeled as a % of total vehicle population: (0%, 25% 50%, 75% and 100%)
2. 3 season Scenarios: Summer, Winter and Total
3. 8 electricity generation sources or mixes
   a) BC System Average
   b) Canadian Average (Hydro & Nuclear)
   c) Canadian Average (Natural Gas)
   d) Canadian Average (Combined Cycle Natural Gas)
   e) Canadian Average (Heavy Fuel Oil)
   f) Canadian Average (Imported bituminous)
   g) Canadian Average (Lignite)
   h) Canadian Average (Subbituminous Coal)

Not Modelled:

1. Variances in emissions due to Peak vs Off-Peak charging for the BC System Scenario was not modeled due to low correlation between BC Hydro's electricity generation power mix and peak/off-peak demand periods.

IMPORTANT:

1. It must be recognized that while the analysis is based on year 2005 projected vehicle population and emission inventory data for the Lower Fraser Valley, the vehicle data can easily be considered to be generic in nature and can be directly applied to most regional and Provincial scenarios across Canada, with virtually no degradation of the resultant accuracy. This statement can be made since only the following data was specifically based on Lower Fraser Valley data (it is important to differentiate that all Lower Fraser Valley data was supplied to EVAC by the Greater Vancouver Regional District Authority (GVRDA)
   - the predicted non-CO_2 emissions/km of the ICE fleet for 2005
   - annual vehicle km traveled
   - distribution of cars vs trucks.
2. Consideration of the above information one is clearly able to conclude that while this data does affect the total mass of emissions produced or eliminated within Lower Fraser Valley as a result of EV market penetration, the % emission reduction results for EVs vs ICEVs are completely not affected by this data. Therefore, % emission reduction information contained in this report is fully transportable between all regions and provinces.
3. It must be recognized that the electricity generating scenarios b) through h) described in "Section 3 – Scenario's Modeled" are generic in nature and are therefore fully transportable between all regions and provinces.

Definition:

"Transportable between all regions and provinces" means that the results can be applied to all regions and provinces with the same level of accuracy as is implied by the data for the specific test scenario, namely Lower Fraser Valley.

5. Assumptions

Following are assumptions and input data which are important to the understanding of the results:

Type	VKmT in 2005	Annual km/Vehicle (1)	# of Vehicles	% of Population
Cars	12,532,517,800	17,656	709,816	78.11%
Trucks (T1)	3,818,042,000	19,198	198,877	21.89%
		Total	908,693	

1) Vehicle Populations Used (Provided by GVRDA)

- For modeling purposes it was assumed that the Trucks (T1) category consisted of 50% Trucks and 50% Vans. Both Trucks and Vans were assumed to produce equivalent emissions, had the same fuel consumption and were driven the same Annual km/vehicle. It is important to understand that the specific proportion assumed here is irrelevant since Trucks and Vans are assumed to have the same fuel consumptions.
- Vehicle Km Traveled in summer is 55 of of annual V km T. (Winter =45%)
- It was assumed that 55% of Annual km/vehicle were city driving and 45% highway

2) Total Emissions for Lower Fraser Valley (Provided by GVRDA)

The analysis base based on the projected year 2005 Average Vehicle which will be operating in the Lower Fraser Valley. This fleet will be composed of a range of vehicle ages including very old vehicles, as well as brand new vehicles which will comply with year 2005 new vehicle emission standards and whose emissions will be significantly lower than the values used in this analysis.

This analysis is intended to provide a comparison which can be described as: "If an *average* vehicle which is operating in the Lower Fraser Valley in the year 2005 was replaced by a zero emission battery electric vehicle, what would the resulting emissions change be".

Description	Emissions (tonnes) 2005	Emissions g/km	Emissions/vehicle Grams	Source
Vehicles				
Total (N2O)	2185.0	0.0300	529.7	NRCan
Total (CH4)	279.2	0.0992	1751.5	NRCan
Total (CO2)	2,909,765	232.1772	4099321.1	Calculate Fuel consumption as litres/100 km
Total (PM2.5)	227.9	0.0182	321.1	GVRD
Total (PM10)	339.4	0.0271	478.2	GVRD
Total (Total Particulates)	348.7	0.0278	491.2	GVRD
Total (SOx)	318.7	0.0254	448.9	GVRD
Total (VOC)	13781.0	1.0996	19414.9	GVRD
Total (NOX)	10829.3	0.8641	15256.5	GVRD
Total (CO)	116449.1	9.2918	164055.2	GVRD
Trucks (T1)				
Total (N2O)	904.9	0.0300	4200.3	NRCan
Total (CH4)	166.7	0.0992	1388.9	NRCan
Total (CO2)	1,168,917	306.1561	5877584.5	Calculate Fuel consumption as litres/100 km
Total (PM2.5)	82.6	0.0216	415.3	GVRD
Total (PM10)	119.8	0.0314	602.4	GVRD
Total (Total Particulates)	121.9	0.0319	612.8	GVRD
Total (SOx)	126.8	0.0332	637.7	GVRD
Total (VOC)	3259.9	0.8538	16391.3	GVRD
Total (NOX)	3580.9	0.9379	18005.3	GVRD
Total (CO)	34401.5	9.0102	172978.6	GVRD

3) Additional Fuel Economy Reducing Factors

Vehicle Winter Load and Temperature Effects.	Summer	Winter	
Temperature Effect Compensation Factor	4.0%	11.0%	A temperature effect compensation factor of 4% for summer temp cold start compensation and 11% for winter cold start
Winter Road Load		5.0%	Value of 5% agreed to

- For ICE vehicles, both the temperature Effect Compensation Factor, as well as the Winter Road Load was used to determine actual fuel economy
- For battery electric vehicles, only the winter road load was used since battery electric vehicles do not suffer from cold start, and winter idling.
- No factor was included for ICE vehicle to compensate for the increased emissions associated with cold start due to ineffective operation of the catalytic converter.

4) Fuel Economy.

Since limited models of battery electric vehicles are currently available, an “average EV” energy consumption rating is not available. Due to this fact, it was necessary to compare identical ICE vehicle models and battery electric vehicle models.

As a result, fuel ecomony data, which is directly used in the calculation of CO2 emissions is based on the formula:

CO2 Emissions per Litre of Gasoline = 2360 g/litre

and was based on the following vehicles:

- Passenger Cars – ICE – Toyota RAV-4, 2.0 Litre, E4E transmissions
  EV - Toyota RAV-4 Electric
- Light Trucks - ICE – Ford Ranger (3.0 Litre E4E transmissions)
  EV - Ford Electric Ranger (NiMH batteries)
- Minivan Assumed same data as for Light Trucks.

It is important to understand that the fuel consumption data has an effect on 3 results

- Total CO2 emissions
- Total Energy Consumption Comparison
- Consumption of Non-Renewable Resources.

The values in the tables below show the actual ICE fuel consumption values which were used in the analysis, after consideration of the “Additional Fuel Economy Reducing Factors” listed in item 3) above.

ICE Vehicle Fuel Consumption Values Used in Model (Unadjusted for cold start and temperature effects

ICE L/100km (summer/winter)		
Pass	9.8	Assume RAV-4 (RAV-4 2.0 Litre E4E (9.9 litre/100 km city, 7.4 litre/100 km highway) vs RAV-4 EV) is average passenger car. Based on CAFÉ standards, Actual average city car is 20.7 mpg (11.5 litre/100 km) and average highway car is 27.5 mpg (8.5 litres/100 km)
Light Trucks	12.0	Assume Ford Ranger (3.0 Litre E4E (14.1 L/100 km city, 9.5 l/100 km highway) vs Electric Ranger-Ni-MH) is average Light Truck
Minivans	12.0	Assume same data as for Light Truck (Ford Ranger, 3.0 Litre E4E (14.1 L/100 km city, 9.5 l/100 km highway)

ICE Vehicle Fuel Consumption Values Used in Model (Adjusted for cold start and temperature effects)

Adjusted Fuel Consumption ICE L/100km (summer/winter)	summer	winter
Pass	10.2	11.4
Light Trucks	12.5	14.0
Minivans	12.5	14.0

Battery Electric Vehicle Energy Consumption Values Used in Model (Adjusted for Temperature)

EV kW-hr/km (summer/winter)	summer	winter	Winter: 5% increase for winter road load, 15% increase for battery thermal management
Pass	0.115	0.138	Assume RAV-4 (RAV-4 2.0 Litre E4E vs RAV-4 EV) is average passenger car (For EV (Toyota Spec Sheet Data): 23 kW-hr capacity at 85% discharge @ 200 km FUDS Range)
Light Trucks	0.143	0.171	Assume Ford Ranger (3.0 Litre E4E vs Electric Ranger-Ni-MH) is average Light Truck (For EV (Ford Spec Sheet Data): 19 kW-hr capacity at 85% discharge @ 133 km FUDS Range)
Minivans	0.143	0.171	Assume same data as for Light Truck

5) Other Data

EV Charger Efficiency (%) (Level 2 charger, 6.6 kW)	92%	Efficiency based on Charging system used in Ford Ranger - 92%

Power Transmission Efficiency	93%	CERI values

6) EV Heater Data

EVCalc permits modeling of electric and gasoline fired cabin heaters. It was assumed that 90% of installed heaters would be electric with only 10% of heaters being gasoline fired.

Heater Size and Fuel Source (kW)	1.00	based on a 3kW installed which is operated most of the time at 1kW setting. Additional assumptions: Neither the EV, nor the ICEV uses air conditioning.
Number of hours of use/day	1.11	Assumes that 16200 km is at 40 km/h over 365 days
Number of days of use/year	182	60% of Ottawa hourly temp is below 10oC - assume heater on in this period this value can be adjusted for Tor, Van and Edmonton- need to get data from Env Can
Electric heater efficiency	95%	
Fuel fired thermal efficiency	85%	based on EMRD tests of a variety of fuel-fired heaters
% of Heating supplied by Electric Heaters	90%	

7) Utility Emissions Data

Electrical Power Plants Which May Produce Electricity for Charging EVs in Lower Fraser Valley

List of all electric generating facilities which will be used
to produce electricity for the additional incremental energy required to recharge EVs.
You will then refer to these facilities by the "Facility Number" in the following section.

Plant Name	Fuel Type	Generation (Gw-hr)	Generating Efficiency	Emission Production (Kg per MW-hr of energy production)										
							HC							
				CO_2	CO	NO_x	VOC	PM10	PM2.5	SO_2	TPM	N_2O	NMOG	CH_4
Burrard	Natural Gas-Steam	3,812	35.00%	530.00	0.02	0.09	-	-	-	0.00	0.03	-	-	-
Combined Hydro Stations	Hydro	45,506	100.00%	-	-	-	-	-	-	-	-	-	-	-
BC System Average	Hydro + Gas	49,318	94.98%	40.97	0.00	0.01	-	-	-	0.00	0.00	-	-	-
Canadian Average (Hydro & Nuclear)	Hydro	45,506	100.00%	-	-	-	-	-	-	-	-	-	-	-
Canadian Average (Natural Gas)	Natural Gas	49,318	34.00%	553.17	0.02	0.07	-	-	-	-	0.01	-	-	-
Canadian Average (Combined Cycle Natural Gas)	Natural Gas	49,318	55.00%	340.00	-	0.03	-	-	-	0.00	0.02	-	-	-
Canadian Average (Heavy Fuel Oil)	Heavy fuel oil	49,318	32.48%	795.15	-	2.27	-	-	-	10.77	0.34	-	-	-
Canadian Average (Imported bituminous)	Imported bituminous	49,318	34.84%	959.35	-	2.41	-	-	-	3.75	0.28	-	-	-
Canadian Average (Lignite)	Lignite	49,318	29.89%	1,066.72	-	3.39	-	-	-	7.99	3.88	-	-	-
Canadian Average (Subbituminous Coal)	Subbituminous coal	49,318	32.00%	948.46	0.12	1.87	-	-	-	3.37	0.20	0.02	-	0.21
Canadian Average (Canadian Bituminous)	Canadian bituminous	49,318	34.14%	976.38	-	2.85	-	-	-	17.67	0.30	-	-	-

Hydro, wind and solar are considered renewable resources and are rated at 100% Renewable. Nuclear fuel, while technically non-renewable, has an estimated 500,000 year reserve based on known, recoverable reserves and thus for this calculation is considered as a renawable fuel.

Energy & Emissions of Resource Extraction, Fuel Production & Delivery in Lower Fraser Valley

Enter the information related to the resource extraction, processing and transportation
of the fuel to the Power plant. Do not include emissions related to production of the
electricity. That information should have been entered in the table above.

Plant Name	Fuel Type	Upstream Energy Consumed (MW-hr consumed MW-hr Produced) (%)	% which is non-renewable energy (%)	Non-Generating Emission Production (Kg per MW-hr of energy production)										
							HC							
				CO_2	CO	NO_x	VOC	PM10	PM2.5	SO_2	TPM	N_2O	NMOG	CH_4
Burrard	Natural Gas-Steam	0.15%	100.00%	7.79	-	0.06	0.03	-	-	0.08	-	-	-	0.13
Combined Hydro Stations	Hydro	0.00%	0.00%	-	-	-	-	-	-	-	-	-	-	-
BC System Average	Hydro + Gas	0.01%	7.73%	0.60	-	0.00	0.00	-	-	0.01	-	-	-	0.01
Canadian Average (Hydro & Nuclear)	Hydro	0.00%	0.00%	-	-	-	-	-	-	-	-	-	-	-
Canadian Average (Natural Gas)	Natural Gas	0.15%	100.00%	7.79	-	0.06	0.03	-	-	0.08	-	-	-	0.13
Canadian Average (Combined Cycle Natural Gas)	Natural Gas	0.15%	100.00%	7.79	-	0.06	0.03	-	-	0.08	-	-	-	0.13
Canadian Average (Heavy Fuel Oil)	Heavy fuel oil	0.54%	100.00%	24.32	0.12	0.05	0.65	-	-	0.04	-	0.00	-	0.63
Canadian Average (Imported bituminous)	Imported bituminous	0.54%	100.00%	2.09	0.03	0.02	-	-	-	0.00	0.23	-	-	0.22
Canadian Average (Lignite)	Lignite	0.54%	100.00%	2.09	0.03	0.02	-	-	-	0.00	0.23	-	-	0.22
Canadian Average (Subbituminous Coal)	Subbituminous coal	0.54%	100.00%	2.09	0.03	0.02	-	-	-	0.00	0.23	-	-	0.22
Canadian Average (Canadian Bituminous)	Canadian bituminous	0.54%	100.00%	2.09	0.03	0.02	-	-	-	0.00	0.23	-	-	0.22

8) ICE Vehicle Emission Data

Average Vehicle in 2005 in Lower Fraser Valley

Summer

	ICEV LEV Emissions as a Function of Vehicle Age (Including I & M Program) (g/km)										
Vehicle Age	CO2	CO	NOx	VOC	PM10	PM2.5	SO2	TPM	N2O	NMOG	CH4
Fleet Average	252.654	9.226	0.881	1.042	0.028	0.019	0.027	0.029	0.030		0.099

Winter

	ICEV LEV Emissions as a Function of Vehicle Age (Including I & M Program) (g/km)										
Vehicle Age	CO2	CO	NOx	VOC	PM10	PM2.5	SO2	TPM	N2O	NMOG	CH4
Fleet Average	283.142	9.226	0.881	1.042	0.028	0.019	0.027	0.029	0.030		0.099

6. Summary of Results

1) Energy Consumed by one Battery EV vs one ICEV

Energy Consumed by one Battery EV vs one ICEVs

Total Fuel Consumption

	Total Full Fuel Cycle Energy Consumption		
	Electric Vehicles	ICEV	
Electricity Source	Semi-Annual MW-hr of Fuel Energy Consumed MW-hr	Semi-Annual MW-hr of Fuel Energy Consumed MW-hr	% Energy Consumed by EVs Compared to ICEVs (%)
BC System Average	3.2	22.3	14%
Canadian Average (Hydro & Nuclear)	3.0	22.3	13%
Canadian Average (Natural Gas)	8.9	22.3	40%
Canadian Average (Combined Cycle Natural Gas	5.5	22.3	25%
Canadian Average (Heavy Fuel Oil)	9.4	22.3	42%
Canadian Average (Imported bituminous)	8.7	22.3	39%
Canadian Average (Lignite)	10.2	22.3	46%
Canadian Average (Subbituminous Coal)	9.5	22.3	43%

Non-Renewable Fuel Consumption

	Total Full Fuel Cycle Non-Renewable Energy Consumption		
	Electric Vehicles	ICEV	
Electricity Source	Semi-Annual MW-hr of Non-Renewable Fuel Energy Consumed MW-hr	Semi-Annual MW-hr of Non-Renewable Fuel Energy Consumed MW-hr	% Energy Consumed by EVs Compared to ICEVs (%)
BC System Average	0.24	22.26	1.1%
Canadian Average (Hydro & Nuclear)	0.00	22.26	0.0%
Canadian Average (Natural Gas)	8.82	22.26	39.6%
Canadian Average (Combined Cycle Natural Gas	5.46	22.26	24.5%
Canadian Average (Heavy Fuel Oil)	9.25	22.26	41.6%
Canadian Average (Imported bituminous)	8.62	22.26	38.7%
Canadian Average (Lignite)	10.05	22.26	45.1%
Canadian Average (Subbituminous Coal)	9.39	22.26	42.2%

2) Emissions

Total - Annual **Emissions Change per Average Vehicle**

	Change in Emissions for EVs compared to Low Emission ICEVs (Kg) in Lower Fraser Valley												
				HC								Global Warming	Non CO2 Emissions
Electricity Source	CO2	CO	NOx	VOC	PM10	PM2.5	SO2	TPM	N2O	NMOG	CH4	Potential (Kg)	Reduction (Kg)
BC System Average	-5,654.82	-170.70	-21.49	-21.88	-0.51	-0.34	-2.88	-3.53	-0.54	0.00	-14.04	-6,117	-235.9
Canadian Average (Hydro & Nuclear)	-5,779.48	-170.70	-21.52	-21.89	-0.51	-0.34	-2.90	-3.53	-0.54	0.00	-14.07	-6,242	-236.0
Canadian Average (Natural Gas)	-4,097.24	-170.65	-21.14	-21.80	-0.51	-0.34	-2.66	-3.50	-0.54	0.00	-13.67	-4,552	-234.8
Canadian Average (Combined Cycle Natural Gas)	-4,736.50	-170.70	-21.26	-21.80	-0.51	-0.34	-2.65	-3.49	-0.54	0.00	-13.67	-5,191	-235.0
Canadian Average (Heavy Fuel Oil)	-3,321.98	-170.36	-14.56	-19.94	-0.51	-0.34	29.50	-2.50	-0.54	0.00	-12.18	-3,745	-191.4
Canadian Average (Imported bituminous)	-2,896.23	-170.62	-14.21	-21.89	-0.51	-0.34	8.37	-2.00	-0.54	0.00	-13.40	-3,345	-215.1
Canadian Average (Lignite)	-2,574.22	-170.62	-11.30	-21.89	-0.51	-0.34	21.08	8.81	-0.54	0.00	-13.40	-3,023	-188.7
Canadian Average (Subbituminous Coal)	-2,928.87	-170.26	-15.85	-21.89	-0.51	-0.34	7.21	-2.24	-0.47	0.00	-12.76	-3,343	-217.1

Total Emissions Produced by Battery Electric Vehicles vs Gasoline Internal Combustion Engine Vehicles

	% Emissions Produced by EVs Compared to ICEVs in Greater Vancouver Regional District											Global	Non CO2
				HC								Warming	Emissions
Electricity Source	CO2	CO	NOx	VOC	PM10	PM2.5	SO2	TPM	N2O	NMOG	CH4	Potential	Reduction
BC System Average	2.3%	0.0%	0.2%	0.0%	0.0%	0.0%	0.8%	0.3%	0.0%		0.4%	2.1%	0.1%
Canadian Average (Hydro & Nuclear)	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%		0.2%	0.1%	0.0%
Canadian Average (Natural Gas)	29.2%	0.0%	1.8%	0.4%	0.0%	0.0%	8.5%	1.1%	0.0%		3.0%	27.2%	0.5%
Canadian Average (Combined Cycle Natural Gas)	18.2%	0.0%	1.3%	0.4%	0.0%	0.0%	8.7%	1.4%	0.0%		3.0%	17.0%	0.5%
Canadian Average (Heavy Fuel Oil)	42.6%	0.2%	32.4%	8.9%	0.0%	0.0%	1115.6%	29.4%	0.0%		13.6%	40.1%	18.9%
Canadian Average (Imported bituminous)	50.0%	0.1%	34.0%	0.0%	0.0%	0.0%	388.0%	43.4%	0.0%		5.0%	46.5%	8.9%
Canadian Average (Lignite)	55.5%	0.1%	47.5%	0.0%	0.0%	0.0%	825.6%	349.2%	0.0%		5.0%	51.6%	20.1%
Canadian Average (Subbituminous Coal)	49.4%	0.3%	26.4%	0.0%	0.0%	0.0%	348.3%	36.6%	12.8%		9.5%	46.5%	8.0%

7. Conclusions

1) Battery Electric Vehicles provide significant Greenhouse Gas reduction benefits of between 48% and 99.9% reductions (CO_2 equivalent) depending on the energy source used for generation of electricity.
2) Operation of a battery electric vehicle will result in significant reductions of non-renewable energy ranging from 100% reductions to 55% reduction depending on the energy source used for electricity generation.
3) Battery electric vehicles operating in provinces which rely primarily on electricity which is generated by hydro sources will produce between 98% and 99.9% less Greenhouse Gas emissions (CO_2 equivalent) as compared to a gasoline ICEV and will produce less than 0.1% of the total other (non-CO_2) emissions.
4) Battery electric vehicles operating in provinces which rely primarily on electricity generated from combined cycle natural gas generating systems, will produce approximately 85% less Greenhouse Gas emissions (CO_2 equivalent) as compared to a gasoline ICEV and will produce less than 0.5% of the total other (non-CO_2) emissions.
5) Battery electric vehicles operating in provinces which rely primarily on electricity generated from Conventional natural gas generating systems will produce approximately 73% less Greenhouse Gas emissions (CO_2 equivalent) as compared to a gasoline ICEV and will produce approximately only 0.5% of the total other (non-CO_2) emissions.
6) Battery electric vehicles operating in provinces which rely primarily on electricity generated from coal burning generation systems, will produce 48% to 60% less Greenhouse gas emissions as compared to a gasoline ICEV and will produce between 80% and 92% less total other (non-CO_2) emissions depending on the specific type of coal used.

Electric Vehicle
Association of Canada

Association canadienne
du véhicule électrique