2008

GHG Emissions Gabriola Island

Island Futures

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INTRODUCTION

Gabriola Island lies off the east coast of Vancouver Island about 5 km from the city of Nanaimo. The island has a land area of 57.6 km^2 and, in 2008, had an estimated population[1] of 4296 with approximately 2590 private dwellings.[2] Economic activities include the social services, construction, tourism, retail, arts and crafts, and farming. An above-average number of residents on Gabriola are retired.

Gabriola is serviced by one ferry operating between Nanaimo and Descanso Bay, and by float-plane services operating between Vancouver and the Silva Bay Marina at the south end of the island.

In this report, an estimate is made of the greenhouse gas [GHG] emissions made by and on behalf of Gabriolans for 2008. The approach used was to gather information on energy usage on Gabriola, and then to estimate the quantity of GHG emitted in the production of this energy using emission factors recommended by various authorities.[3]

The principal GHG is carbon dioxide [CO2], but there are others, notably methane [CH4] and nitrous oxide [NO2]. As is standard practice in audits of this kind, GHG quantities are expressed in terms of the global-warming-potential equivalent quantity of CO2 [tonnes CO2e] regardless of the actual gas being emitted. When comparing this estimate with similar estimates in other reports, it is important to keep in mind that there is not always agreement between authorities as to what some of the emission factors should be and this may partially account for differences in numbers.

Energy usage for the island has been broken into four sectors:

transportation (vehicles, the ferry, boats, float-planes, and large trucks)
buildings (electricity and heating fuels)
food (transportation only); and
waste.

1 Extrapolated from Canada Census Statistics for 2001 and 2006. The growth rate is 2.8% per year.

2 The 2006 census reported 2744 dwellings for the Nanaimo B area, which includes Mudge and De Courcy Islands, but of these only 2552 (93%) were single-detached houses. The annual growth rate is 2.2%, and so, discounting 80 as being not on Gabriola, in 2008, there were an estimated 2590 single-detached houses. BC Hydro reported 2653 "residential service locations" on Gabriola alone in calendar year 2008, a number that is growing at 2.4% per year. Waste Management, Regional District of Nanaimo, collected from 2274 locations in 2008. In this report, the number of residencies is reckoned as being according to the source of the information being discussed or, when this not available, according to the census count of single-detached houses. No attempt has been made to "fine-tune" the census figure to account for semi-detached houses (2%), apartments (1.6%), or mobile homes (3%).

3 See Appendix A for emission factors and calculations.

This audit is confined to those uses that can be readily measured for Gabriola Island. For example, CO2 generated by residents travelling long distances off island by car or plane is not considered.

The energy required to provide services and manufacture goods "imported" to Gabriola is also not included. This will of course result in figures for Gabriola that are way below the per capita national average because Gabriola has virtually no industries.

CO2 is only considered to be a GHG when derived from the burning of fossil fuel such as coal, natural gas, and mineral oil. All photosynthetic plants absorb CO2 while they are living, and emit CO2 when they decay after they die.[4] This natural cycle is considered to be balanced and is not part of this GHG audit.

With the information presented, interested members of the community can begin to identify ways of reducing energy use and corresponding GHG emissions, and government bodies can respond with supportive policy and legislative changes.

Units

Almost all units used in this report are metric units: metres [m], litres, tonnes [t], kilograms [kg], and watt-hours [Wh].

Common relationships are:

1 tonne = 1000 kg
1 litre = 0.001 cubic metres [m^3]
1 watt-hour = 3600 joules [J]
1 cord of wood (128 cubic feet) = 3.62 m^3
1 tonne of CO2 contains 273 kg of carbon.

Common prefixes are:

kilo- (k) = 10^3
mega- (M) = 10^6
giga- (G) = 10^9
tera- (T) = 10^{12}.

4 In the unnatural conditions of a landfill, organic waste generates CH4 in addition to CO2 and this has to be considered a GHG.

1. TRANSPORTATION

Energy use in the transportation sector includes that used for cars, trucks, the ferry, float-planes, and boats. Results show that the transportation sector is responsible for 60% of Gabriola Island's GHG emissions.

Vehicles

As stated in the BC government Greenhouse Gas Emission Assessment Guide for reporting community emissions:[5]

> "There are several different ways of calculating on-road transportation emissions, including fuel sales, vehicle registrations, traffic counts, and traffic modeling."

In this report, the fuel-sales approach is used. This approach is believed to be more suited for Gabriola for several reasons. One is that because Gabriola is an island, usage on the island is more easily identified than it is in areas that are not so geographically isolated; Gabriola has only one gas station. Another is that many part-time residents register their vehicle on Gabriola rather than at their permanent residence in order to get cheaper ICBC rates, so vehicle registrations are not a useful indicator of on-island use. A further consideration is that because of its geography, the average number of kilometres travelled by vehicles registered on Gabriola is lower than average.[6]

The fuel-sales approach uses the litres of fuel sold on Gabriola Island for vehicle use. This approach assumes fuel purchased off island and used on island, and fuel purchased on island and used off island, approximately offset each other. According to the Mid-Island Co-operative (the only gas station on Gabriola), 2,397,451 litres of fuel were sold on Gabriola in 2008. The ratio of gasoline to diesel is 84% to 16%; hence, the GHG emissions[7] from the fuel sold for vehicles on Gabriola are calculated to be:

Table 1: Fuel and GHG emissions from cars and trucks for 2008

	litres	tonnes CO2 equivalent
gasoline	2,013,859	4853
diesel	383,592	1059
total	**2,397,451**	**5912**

Given the estimated 2590 residencies on Gabriola, the average amount of fuel used per residency is 926 litres per year. Assuming an average fuel efficiency for cars, SUVs, and

5 Community Energy Association and Ministry of Community Services, "Greenhouse Gas Emission Assessment Guide." 2008. n.p. http://www.townsfortomorrow.gov.bc.ca/docs/ghg_assessment_guidebook_feb_2008.pdf

6 Public Transportation Committee, "Gabriola Transportation Survey Results", 2008.

7 Community Energy Association and Ministry of Community Services, *ibid*.

light trucks of 11.5 litres per 100 km, this is enough to drive a vehicle about 8000 kilometres per year.

Ferry

The Gabriola-Nanaimo ferry makes 16 return trips every day except Sunday and Wednesday, when the figure is 15. The route is 3.7 nautical miles (about 7 km) each way. When using the ferry *Quinsam*, the average fuel use per round trip is 190 litres, and when using the *Bowen Queen* (the replacement vehicle when the *Quinsam* is in for repairs) the average is 270 litres.[8] The biggest reason for the difference is that the *Bowen Queen* takes longer to load and unload and hence has to travel faster to keep to the schedule. Travelling faster greatly increases fuel consumption.

In 2002, annual fuel use for the Gabriola-Nanaimo ferry was estimated from a statement by a fuel-truck operator that every week the ferry used approximately 20,000 litres of diesel fuel. This amounts to 1,040,000 litres a year. A request was made for a fuel-consumption figure for 2008, but it was not available at the time of printing. It is not expected however to be significantly different from what it was in 2002.

Table 2: Diesel fuel and GHG emissions from the ferry for 2002 and 2008

	litres	tonnes C02 equivalent
2002	1,040,000	2870
2008	**N/A**	**2870**

Float-planes and boats

The energy consumed by float-planes and boats can be estimated from the amount of fuel purchased from the only marine fuel outlet on the island. Figures provided by Columbia Fuels together with the appropriate emission factors gives:[9]

Table 3: Fuel and GHG emissions from float-planes and boats for 2008

	litres	tonnes C02 equivalent
gasoline (float planes and boats)	200,301	483
diesel (boats)	76,020	210
total	**276,321**	**693**

Large trucks

Information still needs to be gathered for large trucks used for delivery, garbage and recycling, construction, maintenance, etc. that fuel off island.

8 Communication with Captain Michael Smit, Nanaimo-Gabriola route, BC Ferries, December 2009

9 Community Energy Association and Ministry of Community Services, *ibid*.

2. BUILDINGS

Electricity

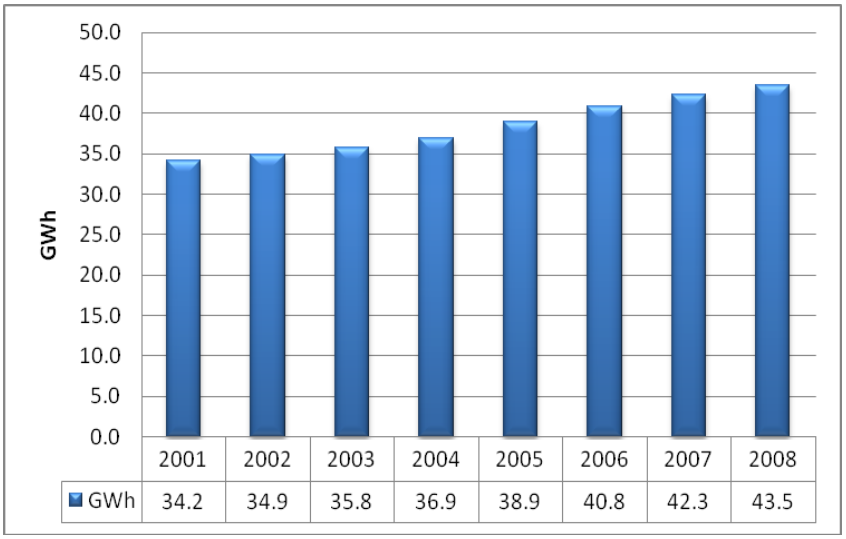
BC Hydro [BCH] is the sole commercial supplier of electricity on Gabriola. Gabriola's electricity is fed through BCH's HWD 25F38 feeder from Cedar. Gabriola Island had 2812 customers (including non-residential customers) in 2008.[10]

Table 4 shows Gabriola Island's monthly consumption based on data from BCH, and Fig. 1 shows Gabriola's electricity consumption for 2001–2008. [11]

Table 4: Monthly electricity consumption for 2008

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
GWh	5.6	4.6	4.8	3.3	3.3	2.3	2.3	2.3	2.2	3.7	3.6	5.7	43.5

Figure 1: Gabriola's electricity consumption from 2001 to 2008



For Gabriola, which has no large industry, the proportion of accounts that are residential was 94.6% in 2008.[12] The remaining 5.4% of accounts are classified as "non-residential" meaning commercial, institutional, etc.

For BC as a whole, the amount of electrical energy used by residential customers is roughly the same (48.8%) as for non-residential customers (51.2%) when large industrial users are excluded. For Gabriola, residential use (87.4%) is much larger than non-residential use (12.6%). This is significant because seasonal use and annual growth differ for the residential and non-residential components.

10 Ted Olynyk, BC Hydro, December 14, 2009.

11 See Appendix B and C for Notes related to calculations for electricity consumption.

12 Ted Olynyk, BC Hydro, January 2010.

Table 5: Customer types in BC and on Gabriola for 2008

	BC		Gabriola	
residential	1,568,508	88.9%	2664	94.6%
commercial, light industry, institutional	194,861	11.0%	153	5.4%
large industry	160	0.01%	0	0.0%
total	**1,763,529**	**100%**	**2817**	**100%**

Table 6: Electricity use in GWh by different types of customers in BC and on Gabriola for 2008

	BC			Gabriola	
residential	17,553	34.2%	48.8%	38.0	87.4%
non-residential	18,406	35.8%	51.2%	5.5	12.6%
large industry	15,380	30.0%	—	0.0	—
total	**51,339**	**100%**	**100%**	**43.5**	**100%**

Gabriola's annual consumption for all users has grown at 3.5% per year over the past eight years. The residential and non-residential portions grew at 3.7% and 2.2% per year respectively.

Of the 3.7% per year of the residential component:

2.4% is attributable to the increase in the number of residencies

1.5% per residence is estimated to be due to the increase in heating[13] requirements that would have resulted had atmospheric temperatures remained the same over the eight years

0.3% per residence is estimated to be due to an increase in baseload (uses other than heating—approximately the summer load)

–0.5% per residence is attributable to the milder-winter trend over the eight years.

It is interesting that the average home on Gabriola requires more power for heating than it used to despite more energy-efficient construction standards.

All of these usage figures will be explained more fully in Island Future's upcoming Energy Report.

To estimate GHG emissions arising from the generation of electricity, the BC Government recommendation is to use emission factors provided by BCH in its annual

[13] "Heating" refers to the temperature-sensitive portion of the load and so will include other seasonal usages such as lighting, although lighting does also provide heat.

Environmental Report.[14] Table 7 shows the results of doing this; however, as explained below, we disagree with this approach.

Table 7: Gabriola electrical energy use and associated GHG emissions, domestic generation for domestic consumption only

	2005	2006	2007	2008
GWh	38.9	40.8	42.3	43.5
emission factor (tC02e/GWh)	24	27	23	28
tonnes C02 equivalent	**934**	**1102**	**973**	**1218**

BC Hydro calculates its emission factor based on the Global Reporting Initiative that recommends for accounting purposes that the GHG emissions used to generate electricity that has been imported for domestic use not be included. The purpose of this recommendation is to avoid having these emissions counted twice, once where they are generated, and again where the resulting energy is consumed.[15] This accounting practice is however contentious. An area that imports electricity escapes responsibility for the GHG emitted in producing it, while from a global perspective the geographic location of the emissions is immaterial. Net imports are significant because increases in peak demand in winter, which is something Gabriolans have some control over, can often only be met by importing energy from producers using fossil-fuelled generators. The following results from Appendix C reflect our approach for including net imports into the calculation of the emission factor. It so happened that in 2008, net imports were low and BCH was able to meet demand from its own resources, but for previous years this was not the case, and it is not expected to be the case in future.

Table 8: Gabriola electrical energy use and associated GHG emissions taking into account net imports by BC Hydro

	2001	2002	2003	2004	2005	2006	2007	2008
GWh	34.2	34.9	35.8	36.9	38.9	40.8	42.3	43.5
emission factor (tC02e/GWh)	58.8	70.6	26.5	45.4	61.1	44.3	58.2	29.4
tonnes C02e	**2011**	**2464**	**949**	**1675**	**2377**	**1807**	**2462**	**1279**

14 www.bchydro.com/about/company_information/reports/gri_index/f2009_environmental_EN16_2.html

15 *ibid*.

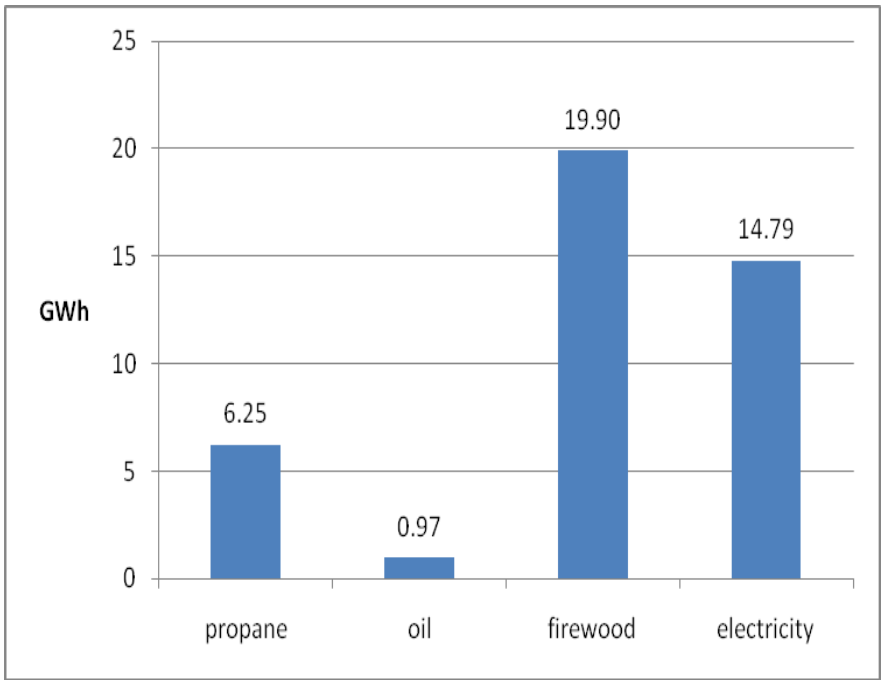
Heating fuel

Electricity, propane, heating oil, wood pellets, and firewood are all used to heat residential and commercial buildings.

Energy use for heating is often measured in units of "joules"; however, this is inconvenient for the purposes of this report because electrical energy is customarily measured in "watt-hours". Rather than using a mix of units, all figures in this report have been converted to watt-hours. Since a joule is, by definition, a watt-second, this avoids the reader having to multiply (or divide) by a constant factor of 3600 when making comparisons.

An estimate of the amount of energy derived from the various sources is shown in Fig. 2.

Figure 2: Energy used for heating for 2008



(1 GWh = 3600 GJ)

In deriving this estimate:

– propane and heating oil consumption figures were provided by companies selling these fuels to Gabriola residents in 2008

– firewood consumption figures are based on the estimate from the Salt Spring Island Energy Strategy Baseline Report carried out in 2005. This report concluded that approximately 84% of households use firewood as a source of heat with

approximately half using firewood as their primary source of heat; and the amount of wood burned per household per year is 1.5 cords.[16]

– electricity consumption and GHG emissions were calculated in the preceding section. Analysis of the outdoor-temperature sensitivity of power consumption on Gabriola suggests that 34% of Gabriola's annual electrical usage is for heating.

The emission factors for these fuel sources came from "A Guide to Residential Heating" produced by Canada Mortgage and Housing.[17]

Dividing the total energy, 41.9 GWh, by the number of residences on Gabriola, 2590, shows the average residence uses 16.2 MWh (58.2 GJ) for heating every year. This compares to estimates for the Vancouver/Victoria area of 16.7 MWh (60 GJ) for a new home, and 23.6 MWh (85 GJ) for an older detached home.[18]

Table 9 shows the GHG emissions for both residential and commercial use of propane and oil in 2008 using emission factors from the BC Government's GHG Assessment Guidebook.[19]

In this report, CO2 emissions from wood pellets and firewood are not included because they are not fossil fuels—CO2 from wood enters the atmosphere regardless of whether it is burned or left to complete its natural cycle and rot.

Table 9: GHG emissions from heating fuels for 2008

fuel	litres	tonnes CO2 equivalent
propane	889,498	1370
heating and furnace oil	91,003	258
total		**1628**

16 Earth Festival Society, "Salt Spring Island Energy Strategy Baseline Report" 2005 http://www.saltspringenergystrategy.org/docs/ssienergybaseline.pdf

17 http://www.cmhc-schl.gc.ca/en/co/maho/enefcosa/upload/wood_heating_EN_W.pdf

18 http://www.cmhc-schl.gc.ca/en/co/maho/enefcosa/upload/wood_heating_EN_W.pdf

19 http://www.townsfortomorrow.gov.bc.ca/docs/ghg_assessment_guidebook_feb_2008.pdf

3. FOOD

"Our food purchases have a large impact on the amount of fossil fuel energy we consume and the GHGs we produce. Energy is used at every step of food production: to manufacture fertilizers, pesticides and herbicides, for tillage and harvesting, for processing and packaging, and last but not least for transportation." Salt Spring Island Community Energy Strategy Baseline Report.

To estimate the GHG emissions produced from food we have considered only the GHG resulting from the transport of food to where it is sold. The complete calculation is complex and is not something that is in any way specific to Gabriola since 95% of the island's food is "imported". [20]

A 2005 Canadian study[21] calculated that the figure for CO2 emissions for locally-produced food was 6.3 kg of CO2 per year per person, and for imported food it was 573 kg C02 per year per person. These calculations were based on the GHG emissions resulting from the transportation of food from its source to a grocery store similar to the grocery stores on Gabriola, and to a local farmers' market.

Table 10: GHG emissions from food transportation for 2006 to 2008

	tonnes C02 equivalent locally grown	tonnes C02 equivalent imported food	tonnes C02 equivalent total
2006	1.3	2205	2206
2007	1.3	2270	2272
2008	**1.4**	**2339**	**2340**

20 Gabriolans for Local Food Choices and Island Good Food Initiative.

21 Bentley, S., Barker, R. "The Role of Local Food Systems in Reducing Greenhouse Gas Emissions." FoodShare Toronto, 2005. http://www.foodshare.net/resource/files/ACF230.pdf

4. WASTE

The Regional District of Nanaimo (RDN) is responsible for picking up garbage and recyclable items on Gabriola. They have provided the following statistics for 2007 and 2008:

Table 11: Garbage and recycling for Gabriola for 2007 and 2008

	houses	garbage (tonnes)	recycling (tonnes)	total (tonnes)
2007	-	504	183 (27%)	686
2008	2,274	465	190 (29%)	655

Source: Regional District of Nanaimo 2009

The trend for the two years 2007 and 2008 is for garbage to decrease and recycling amounts to increase, but more data is required to be sure that these statistical trends are long-term trends.

The average amount of garbage produced by Gabriolans in 2008 was 205 kg per house with 83 kg of recyclables for a total of 288 kg per house (about 0.42 kg/person/day). These amounts are low compared with numbers for the RDN landfill as a whole and Canada in general.[22] Perhaps this is due to a lower occupancy rate and more composting than average on Gabriola. According to the RDN, food waste and other compostable organics comprise 34% of its garbage

No allowance has been made for garbage such as discarded cars and building materials taken off island by means other than RDN collection.

Garbage in landfills emits approximately equal amounts of CH4 (methane) and CO2 (carbon dioxide); however, CH4 has a global-warming-potential 25 times greater than CO2. A substantial fraction of the CO2 is from organic garbage and most of this is not considered a GHG because, having been derived from photosynthesis, it is part of the natural carbon cycle. To calculate the GHG emitted by Gabriola's garbage, we took the composition of RDN's landfill, assigned to each component its EF, and then computed the weighted average. The details of this calculation are given in Appendix D. Considering only the garbage, not the recyclables, the overall EF for Gabriola's waste came out at 1.31 tonnes of CO2 equivalent per tonne of waste, and GHG emissions were:

Table 12: Gabriola garbage and GHG emissions from garbage for 2007 and 2008

	2007	2008
tonnes garbage	504	465
tonnes C02 equivalent	**660**	**609**

[22] According to an RDN site, the Canadian average is over 600 kg per person per year. http://www.rdn.bc.ca/cms.asp?wpID=100

5. OTHER SOURCES OF GHG

The following sources of GHG were not assessed, but perhaps will be in future.

Synthetic fertilizers and peat moss

GHGs come from the fossil fuel used to make synthetic fertilizers. They also produce nitrous oxide (NO2) which, although small in volume, is nearly 300 times as effective as CO2 as a GHG.

Peat moss used in garden soil decays far more rapidly than it would if left alone in its original bog. Left to itself, some peat will eventually become coal, although the process takes millions of years. All peat moss is also imported into BC from other provinces with resultant GHG emissions from transportation.

Farm animals

In 2003, New Zealand proposed a "flatulence tax" to address the over 50% of their GHG emissions that comes from livestock in the form of CH4. Gabriola Island has animals that contribute to GHG emissions in the same way, but the figures were not researched.

Forests and natural vegetation

Trees and other vegetation absorb CO2 from the atmosphere during their lifetime, but this CO2 is slowly emitted back into the atmosphere when the plant material decays.

Forest fires cause a rapid release of CO2, but this still part of the natural carbon cycle.

Using wood for construction delays the emission of CO2, but again, eventually the wood does eventually rot or is burnt and so, over the long term, this wood is still part of the natural carbon cycle.

A one-time contribution to GHG emissions is made when trees are permanently removed from the natural cycle by development, and, conversely, a one-time reduction in GHG emissions is made when trees are planted where none grew before.

A change in plant species will also produce one-time changes.

It is unlikely that in future Gabriola's forests will be able to store more carbon than they do now because of the limited supply of water in summer.

Air travel

Travelling by air has a greater impact than travelling the same distance by car or train. A rough order of magnitude for fuel consumption of commercial aircraft is 3.3 litres/100 km per passenger. Although this appears to be low, it is only low on a per passenger basis. Also, the effect of the GHG emissions of aircraft is 2 to 4 times greater than it is on the ground because aircrafts exhaust GHG directly into the upper atmosphere. The effective equivalent consumption is thus around 10 litres/100 km per passenger. A return flight for two people from Vancouver to Toronto (3360 km each way) generates

approximately 3.3 tonnes of CO2 equivalent while a car travelling with two people would generate a little less than half as much.

No estimates were made in this report of Gabriolans usage of air travel other than float-plane services.

Goods and services

Indirect emissions resulting from the provision of goods and services to Gabriola from sources off island have not been considered. It is likely that including these would substantially increase the total presented here.

6. TOTAL GHG EMISSIONS

Figure 3 depicts percentage of sources for GHG emissions on Gabriola Island in 2008 per the figures shown in Table 13. Assumptions, conversions, and emission factors described throughout are summarized in Appendixes A, C, and D.

Figure 3: Gabriola sources for all GHG emissions for 2008

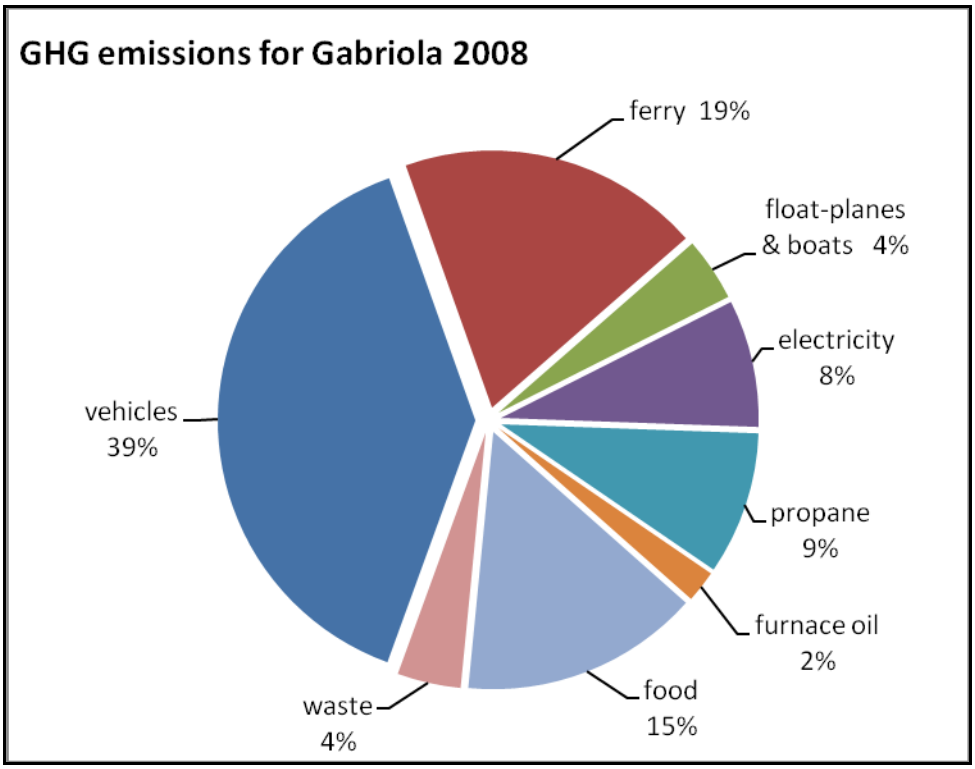


Table 13: GHG emissions by source for 2008

	tonnes of C02 equivalent	%
vehicles	5912	39
ferry	2870	19
float-planes and boats	693	4
electricity	1279	8
propane	1370	9
furnace oil	258	2
food	2340	15
waste	609	4
total	**15,331**	**100**

In 2008, it is estimated that Gabriola Island's population was 4296 people. The annual average GHG emission was thus 3.57 tonnes CO2 equivalent per capita.

Canada's average for 2005, the latest year for which numbers are available, was 22.6 tonnes CO2 equivalent per capita. This of course includes all sectors of the economy.

Appendix A: Calculations and assumptions

Table 14: Assumptions and calculations for each source of GHG emissions

vehicles	litres	emission factor kg/litre	tonnes CO2 equivalent
diesel	383,592	2.76	1059
gasoline	2,013,859	2.41	4853
total			**5912**

ferry	litres	emission factor kg/litre	tonnes CO2 equivalent
2002	1,040,000	2.76	2870
2008			

float-plane and boats	litres	emission factor kg/litre	tonnes CO2 equivalent
gasoline	200301	2.41	483
diesel	76020	2.76	210
total			**693**

electricity	GWh	emission factor t/GWh	tonnes CO2 equivalent
2008	43.5	29.40	1279

heating fuels	litres	emission factor kg/litre	tonnes CO2 equivalent
propane	889498	1.54	1370
furnace oil	91003	2.84	258

	houses	% using wood	houses using wood	annual cords/house	total cords	MWh/cord (GJ/cord)	total GWh
firewood	2590	0.84	2176	1.5	3263	6.1 (22)	19.9

food	% people supported	people	emission factor kg/person	tonnes C02 equivalent total
local food	5	215	6.3	1.4
imported food	95	4081	573	2339
total	**100**	**4296**		**2340**

waste	tonnes	emission factor tonne/tonne		tonnes CO2 equivalent
	465	1.31		609

Appendix B: Notes related to electricity

The formal unit of energy is the joule (J), and the formal unit of power is the watt (W). By definition, a watt is the supply of 1 joule of energy per second, and hence a watt-second is a joule.

It is common practice in reports of electrical energy to use time units other than one second (s) such as hour (h), day (d), month (mth, informal), and year (yr, formal "a"). In calculations for this report, every "month" is taken to be a twelfth of a year, and every year is taken to be 365.25 days. Thus:

1 gigawatt-hour per year (GWh/yr) = 114 kilowatts (kW)
1 gigajoule (GJ) = 278 kilowatt-hours (kWh)
1 kilowatt-hour per day (kWh/d) = 41.7 watts (W)
1 kilowatt (kW) = 8.77 megawatt-hours per year (MWh/yr).

Appendix C: Electricity emission factor calculations

Calculating greenhouse gas (GHG) emissions resulting from electrical energy generation and consumption is problematic. The energy comes from different sources, each with its own emission factor (EF), and, because power supply systems are integrated across North America, it is not possible to identify which source is supplying which customer. Any solution to this accounting problem has to provide useful information, yet be simple enough that the calculation can easily be repeated by others.

Approximately 88% of BCH's installed generating capacity is hydroelectric and emits no GHG. The remaining 12% is fossil fuelled and is used for meeting peak demand in winter and supplying remote off-grid locations. Installed generating capacity however does not accurately reflect usage. Burrard thermal generating plant is a typical example. It only produces expensive and "dirty" power and so is used only when necessary, but it remains on BCH's books as an available generator. Installed capacity is thus a poor indicator of GHG emissions.

A better way is to look at energy statistics. There are two sources of data on energy usage, namely energy production and energy consumption. These two are exactly equal when all sources of production and all sources of consumption are considered in a self-contained system. However, for a selected area within the system, the two numbers will only rarely balance, the difference being made up of the selected area's imports and exports.

Imports are beneficial because imports allow a geographical area to handle its peak demand without having to build generating capacity that would, at other than peak times, not be required. Equally, exports make good use of any available spare generating capacity that would otherwise be idle. Unfortunately for the environment however, once the infrastructure for transmitting energy back and forth exists, decisions as to whether to import or export are made with an eye to making money on the trade, not minimizing GHG emissions.

From a GHG accounting perspective, the difficulty is that the emission factors (EF in kilotonnes of CO2 equivalent per GWh) of imports and exports are not the same. In BC, we like to use an accounting system that uses only the EF of energy produced in BC because it is low. Albertans on the other hand object, with reason, to being held responsible for emissions resulting from the generation of electrical power for out-of-province users because their EF is high. They would prefer a system where only the EF of energy consumed is considered. With an accounting system that counts GHG only where it is emitted, it would be better for Alberta to ship fossil fuel and let their customers use it to generate energy, because that way they avoid having the GHG on their account. BC does exactly this when it exports coal.

Our suggested solution to this problem is as follows. It counts all the energy produced in BC by BCH and Independent Power Producers (IPPs) for the benefit of consumers in BC as having the average EF of BCH using its own facilities. It counts the net energy imported into BC for the benefit of consumers in BC as having the weighted average Canadian EF.

Here are the calculations for 2007 and 2008 using data that is readily available in BCH Annual Reports.

BCH BALANCE SHEET 2008

USED IN BC (GWh)			
Electricity sold, domestic total		53300	
Line loss and system use		5676	
TOTAL		58976	58976
ACQUIRED (GWh)			
Electricity purchased, long-term contracts		11878	
Electricity purchased, short-term contracts		32281	
Less electricity sold, trade		–37450	
Energy exchange net		–486	
TOTAL		6223	6223
GENERATED IN BC			
Burrard thermal generation	260		
Other thermal	353		
Total thermal	613	613	
Hydro generation		52140	
TOTAL		52753	52753
ACQUIRED AND GENERATED			58976

BCH emission factor 2008

GWh		kt/GWh	Mt	
260	@ BCH thermal gas rate	523	136.0	
353	@ BCH thermal diesel rate	640	225.9	
52140	@ BCH hydroelectric generation rate	0	0	
6223	@ Canadian average rate	220	1369.3	
58976			1731.2	
BCH average EF for BC 2008			29.4	kt/GWh

BCH BALANCE SHEET 2007

USED IN BC (GWh)			
Electricity sold, domestic total		52911	
Line loss and system use		5329	
TOTAL		58240	58240
ACQUIRED (GWh)			
Electricity purchased, long-term contracts		10306	
Electricity purchased, short-term contracts		35360	
Less electricity sold, trade		–33372	
Energy exchange net		410	
TOTAL		12704	12704
GENERATED IN BC			
Burrard thermal generation	727		
Other thermal	333		
Total thermal	1060	1060	
Hydro generation		44476	
TOTAL		45536	45536
ACQUIRED AND GENERATED			58240

BCH emission factor 2007

GWh		kt/GWh	Mt	
727	@ BCH thermal gas rate	523	380.2	
333	@ BCH thermal diesel rate	640	213.1	
44476	@ BCH hydroelectric generation rate	0	0	
12704	@ Canadian average rate	220	2794.9	
58240			3388.2	
BCH average EF for BC 2007			58.2	kt/GWh

Appendix D: Waste emission factor calculation

We found it impossible to derive a precise estimate of the emission factor [EF] for Gabriola's waste because so many variables are involved, and many have never been quantified.

To calculate an accurate EF, we need to know:

– the composition of the garbage (organic, plastic, metal, construction waste, etc.)

– the EF of each component. This in itself is often not clear. Discarded carpets and textiles for example, may contain natural fibres, non-biodegradable plastics, minerals, and degradable oil-based products, all with their own EFs

– what proportion of the CO2 content of the landfill gas [LFG] is from organic sources. Most CO2 from food and wood waste for example should not be counted as a GHG because it has been derived from photosynthesis, and, as such, is part of the natural carbon cycle.

To further complicate the calculation, the environmental conditions of the landfill will to some extent determine how much CO2 and how much CH4 there is in the LFG, and this proportion has a significant impact on the final result because CH4 is more potent as a GHG than CO2.

One approach to this problem is to take the reported overall average EF produced by landfills elsewhere, including other countries. Unfortunately however, it is not always clear if these numbers include CO2 from organic sources or not, and there is no guarantee that the composition and environment of these landfills matches our own. A factor influencing composition is that in some jurisdictions there is more re-cycling of materials than in others. Overall EFs available from reports posted on the Internet are usually in the range of 1–2 tonnes of CO2 equivalent per tonne of landfill, but within that range there is no consistency. Assuming that the actual gas in these emissions is predominantly CH4, this range is equivalent to 40 to 80 kg of CH4/tonne.

For the purposes of this report, we decided, despite the difficulties to make our own estimate of the EF based on the results of studies of the composition of the waste going into the RDN landfill (although unfortunately not exclusively from Gabriola)[23] and figures for individual EFs obtained from a variety of sources but principally the Environmental Protection Agency in the USA. This number might not be accurate, but it will provide a basis for comparison in the future.

The EFs in these calculations do not include the GHG emitted in the course of the manufacture of this waste; they only pertain to LFG. Many sources of data are organizations assessing the benefits of re-cycling, and so they do include manufacturers' emissions, but consideration of these numbers is beyond the scope of this report.

[23] Community Climate Change Planning, RCBC Conference, June 26, 2008. http://rcbc.bc.ca/files/u3/con_2008_cmciver__Compatibility_Mode_.pdf

Table 15: RDN landfill composition (2008 report)

RDN landfill composition	%	cumulative %	emission factor tonne CO2 e/tonne	weighted contribution to EF	notes
food waste	31	31	1.58	0.49	2
plastics	12	43	0.04	0.01	3
C & D	11	54	3.42	0.38	4
paper board	8	62	1.49	0.12	5
yard waste	7	69	0.22	0.02	6
textiles	6	75	1.00	0.06	7
metal	5	80	0.00	0.00	8
compostable paper	4	84	4.09	0.16	9
diapers/personal hygiene	3	87	0.04	0.00	10
glass	2	89	0.00	0.00	11
bulky goods	2	91	0.04	0.02	12
small appliances	2	93	0.04	0.02	12
fines	1	94	0.00	0.00	13
mattresses	1	95	1.00	0.01	14
beverage containers	1	96	1.00	0.01	15
carpet & underlay	1	97	1.00	0.01	14
HHW	1	98	1.00	0.01	16
electronics	0.4	98.4	0.04	0.00	17
rubber / tires	0.2	98.6	0.04	0.00	18
other	1.4	100	1.00	0.00	
total	**100**			**1.31**	**19**

Note 1: "EPA" in the following notes is a reference to the US Environmental Protection Agency's Waste Reduction Model [WARM] dated November 2009. An Excel version can be downloaded from: http://www.epa.gov/globalwarming/climatechange/wycd/waste/calculators/Warm_home.html

Note 2: Food waste only contributes GHG when it emits CH4. EF from EPA.

Note 3: Many plastics do not degrade in the landfill so, although a problem for other reasons, they emit very little GHG. EF from EPA.

Note 4: Construction and demolition waste [C&D]. It is hard to quantify the EF because composition is variable and it may contain unusual types of potent GHGs. Waste wood contributes CH4 if not burnt. EF is EPA's "mixed municipal solid waste" [MSW].

Note 5: In BC, most paper is a wood fibre and thus part of the natural carbon cycle; however, in the landfill, it generates CH4. EF is EPA's "corrugated cardboard".

Note 6: Yard waste EF is EPA's "yard trimmings". "Grass trimmings" have an EF of 0.51.

Note 7: Textiles range in composition from natural fibres, effectively emitting no GHG, to synthetic fabrics that do. Re-cycling is encouraged by many jurisdictions to counter the trend for synthetic garments to be discarded before being worn out because they are so cheap. EPA gives no EF, the one used here is a catchall "some, but don't know how much category".

Note 8: The manufacture of metals involves emission of large quantities of GHG, but in the landfill their only role is to help create anaerobic conditions as they rust. Metals are increasingly re-cycled.

Note 9: Similar to food waste. EF from EPA.

Note 10: Diapers in landfills are an issue because of their volume; however, urine, feces, and cellulose are natural products not contributing GHG. Most of the remainder (15%) is polymer plastic that does not biodegrade in the landfill. EF is an EPA catchall for "mixed plastics" which is small enough to make little difference to the final result.

Note 11: Glass does not produce GHG.

Note 12: Difficult to quantify GHG EF. An "average" figure for mixed materials has been used.

Note 13: "Fines" are assumed to be inorganic silt and clay emitting no GHG.

Note 14: Difficult to quantify GHG EF. The manufacturing technology is changing rapidly in response to GHG concerns. An "average" figure for mixed materials has been used.

Note 15: Difficult to quantify because of differing compositions. Some types, for example, metals, may be re-cycled more than others. An "average" figure for mixed materials has been used.

Note 16: Household hazardous waste [HHW]. Difficult to quantify. An "average" figure for mixed materials has been used.

Note 17: Mainly a re-cycling concern because of the valuable rare-element content and the toxicity of some of the components. EF from EPA.

Note 18: Rubber does not biodegrade readily and is usually re-cycled. EF from EPA.

Note 19: The average of 1.31 tonnes of CO2 equivalent per tonne of waste is equivalent to 52 kg CH4/tonne. This compares with an estimated figure of 84 kg CH4/tonne from the Vancouver landfill:

http://vancouver.ca/engsvcs/solidwaste/landfill/pdf/greenhouse%20Emmissions.pdf