Salt Spring Island Community Energy Strategy Baseline Report

Energy and Emissions Baseline Data Report

prepared by

The Earth Festival Society

for

the community of Salt Spring Island,
the Islands Trust Local Trust Committee,
and the Capital Regional District

May, 2004

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Any errors and omissions remain the responsibility of the author and the Earth Festival Society.

Foreword
Salt Spring Island lies off the east coast of Vancouver Island, between Victoria and Vancouver BC. It is the largest and most populated of the Southern Gulf Islands. The island is about 27 kilometers long by 13 kilometers wide, with hilly and mountainous forested terrain. Economic activities include the social services sector (health and education), construction, tourism, retail businesses, arts and crafts, and farming. Salt Spring Island is accessible by three ferry routes, and scheduled float plane services from Vancouver.

The Energy Baseline Report is the first step in the development of an Energy Strategy for Salt Spring. With the information presented here, interested members of the community can proceed to set energy use reduction targets, and can begin to identify measures by which to achieve those targets.

The energy strategy process is driven by the rapid onset of climate change, probably the most serious environmental issue we have ever faced. The problems and issues are global in their implications but local solutions are crucial, and can be a positive force for economic development and environmental sustainability within the community. While the reduction of GHG emissions may be the primary objective, these measures also provide benefits such as reduced energy costs, and new economic development opportunities. Small communities like Salt Spring have much to offer as a model of what can be accomplished with minimum resources but with solid community support.

Salt Spring Baseline Energy Data Report

Contents

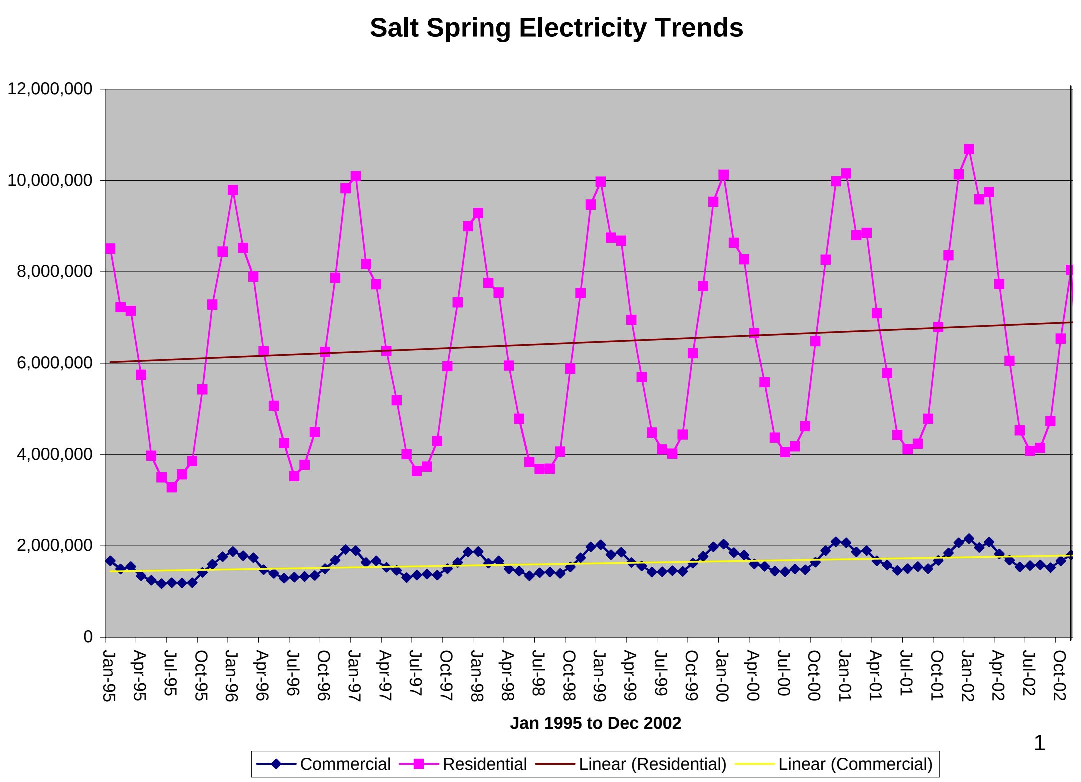
1.0 Introduction

We have looked at Salt Spring's purchased energy supply—electricity, transportation fuels, and heating fuels—in order to quantify the amount of annual energy consumed on Salt Spring, and the associated greenhouse gasses (GHG) produced. We have also looked at the fossil fuel energy content and associated GHG of our conventional food purchases. Salt Spring is, as far as we know, the first community to include the impact of food purchases in its baseline data. We have looked at trends over time. Where data are available, we have analyzed records between 1995 and 2003 to determine rate of growth in terms of energy consumption and GHG emissions. We have noted seasonal fluctuations in energy consumption. Using linear trendlines, we have made forward projections to 2012. Where we are missing data, we have also projected backwards. Projected figures are shown in the tables in blue. Data sources and assumptions are noted beneath the tables. Units of energy consumption vary by commodity— litres for gasoline, kWh for electricity, etc. These numbers have been converted to Gigajoules (GJ) for purposes of comparison. GHG emissions are presented in tonnes of CO2 equivalent.

2.0 Electrical Energy Consumption

BC Hydro provided monthly consumption figures from 1995 to 2002. BC Hydro is the sole commercial supplier of electricity on Salt Spring. Total annual consumption in 2002 was 386,035 GJ (107,232 MWh). The residential sector currently uses 80% of that amount, with the bulk of the

Chart 1—Salt Spring Electricity Trends (source—BC Hydro)



energy used during the heating season. By comparison, the commercial sector shows less of a seasonal peak, suggesting that space heating makes up a smaller proportion of the commercial sector's electrical energy consumption, compared to the residential sector (see residential heating fuels). In 2002, there were 545 open commercial accounts, compared to 5,244 residential accounts. The average annual consumption per account was 38,961 kWh and 16,400 kWh, respectively. The provincial average consumption for residential customers is 15,000 kWh, however many customers have access to natural gas and therefore consume less electricity.

Table 1— Summary of Electrical Energy and associated GHG emissions

	1996	2000	2001	2002	2012
Total electricity consumption, MWh	96,207	101,548	104,266	107,232	130,458
Total Residential consumption, MWh	77,526	81,200	83,538	85,998	102,880
Total Commercial consumption, MWh	18,681	20,348	20,728	21,234	27,578
Percentage residential	81	80	80	80	79
Percentage commercial	19	20	20	20	21
Total energy, GJ	346,347	365,573	375,358	386,035	469,649
Energy, residential, GJ	279,095	292,320	300,737	309,593	370,368
Energy, commercial, GJ	67,252	73,253	74,621	76,442	99,281
GHG emission factor t CO2 / MWh (1)	0.015	0.042	0.042	0.042	0.074
Total GHG , t CO2 eq. (2)	1,443	4,265	4,379	4,504	9,654
GHG emissions – residential , t CO2 eq. (2)	1,163	3,410	3,509	3,612	7,613
GHG emissions – commercial , t CO2 eq. (2)	280	855	871	892	2,041

1. from Bowen CEP—BC Hydro - VCR projection for 2005 used for 2012. 2000 factor used for 2001—2002
2. " consumption" times "GHG emission factor"

GHG emissions from electricity have tripled between 1996 and 2000. 2012 projected emissions are six times greater than 1996 emissions. These numbers are linked to the GHG intensity (i.e., the amount of GHG emissions per unit of electricity produced) for electricity generation in the province. BC Hydro emission factor projections are something of a moving target. Greater use of "green" energy for power generation reduces the emission factor, greater use of fossil fuels increases the emission factor. See www.bchydro.com/rx_files/environment/environment4097.pdf for latest BC Hydro projections.

3.0 Energy Consumption in the Residential Sector

3.1 POPULATION & DWELLING UNITS

Salt Spring's population in 2001 was 9,279 (StatsCan census data). Between 1991 and 2001 (StatsCan census data) the population increased 17.89%, or about 1.79% per year. The linear trendline projects forward to a population of 10,911 in 2012. The average annual percentage increase for population is lower than most of the other indices, suggesting that per capita use of energy resources is on the increase.

There are currently (2003) 5,278 dwelling units on island (including apartments and mobile homes). This figure is based on StatsCan census data, and is higher than the number of dwelling units estimated by the Salt Spring CRD Building Permit Office (4,623) and slightly higher than the number of BC Hydro Residential Accounts for 2002 (5,244).

Table 2—Population and dwelling Units

	1991	1996	2000	2001	2002	2003	2012
Population (1)	7,871	9,247	9,272	9,279	9,503	9,644	10,911
Dwelling Units, census (2)		4,014	4,565	4,913	5,156	5,278	6,767
Residents per Dwelling Unit		2.30	2.03	1.89	1.84	1.83	1.61

1. StatsCan census 1991, 1996, 2001, Salt Spring Electoral Area.
2. CRD Regional Planning Services: Stats Can census data for 1996 and 2001. 2002-2003 figures from adding building permits to 2001 data.

Between 1996 and 2003, the number of dwelling units increased by 31.5%, an average annual rate of increase of 4.5%.

The average number of residents per dwelling unit is steadily declining and has been less than two since 2001. In general, the lower the occupancy, the higher the per capita energy consumption.

3.2 RESIDENTIAL ELECTRICITY USE

As stated above, total residential electrical energy consumption in 2002 was 309,593 GJ (85,998 kWh) and in 2012 is projected to be 370,368 GJ (102,880 kWh). The number of residential BC Hydro accounts in 2002 was 5,244, giving an average consumption per residential account of 16,400 kWh/y. Data for previous years was unavailable. Residential electrical consumption increased by 10.93% between 1996 and 2002, an average of 1.4% per year, less than the rate of population increase, and considerably less than the rate of increase of new dwelling units (4.5%). Considering that the number of dwelling units heated with electricity is assumed to be increasing (see below), this low rate of consumption increase is difficult to explain unless an increasing number of homes are unoccupied during the winter months.

Residential electrical energy consumption on Salt Spring shows a strong annual peak during the heating season, which is to be expected, considering that we estimate over 85% of the dwelling units are at least partially heated with electricity. (See Residential Heating Fuels below.)

Table 3— Residential electricity use (excerpted from Table 1)

	1996	2000	2001	2002	2012
Total residential consumption MWh	77,526	81,200	83,538	85,998	102,880
Energy, residential, GJ	279,095	292,320	300,737	309,593	370,368
GHG emissions – residential, t CO2 eq. (2)	1,163	3,410	3,509	3,612	7,613

3.3 RESIDENTIAL HEATING FUELS

StatsCan no longer collects data on heating fuel for dwelling units. 1996 figures are therefore based on the last available StatsCan data, collected in 1986 for the whole Southern Gulf Islands. No other statistics on dwelling unit heating fuels are available. The assumptions presented here, and in Table 4, therefore represent our best guess.

Anecdotal reports from fuel and service providers suggest that the number of oil and propane furnaces is declining slightly. However, we have assumed the number of installations remains constant. The number of electrically heated dwellings is increasing. Propane use for fireplaces is on the increase. We estimate that 80% — 90% of the dwellings on Salt Spring have some form of wood heat, and about half of these use wood as their primary form of heat, i.e. a wood stove is burning whenever the dwelling is occupied. The primary wood heat dwellings typically have supplementary electric heating. (Assumptions are based on anecdotal evidence and informed guess.) Projecting the percentages to 2012, electricity and wood, at 48% and 42% respectively, remain the primary heating fuels of choice. Announced annual rate increases of 7%—2% (total 9%) by BC Hydro may increase the percentage of dwelling units using wood as the primary heating fuel, since homeowners may use their existing wood burning appliances more frequently. Electricity rate increases may also lead to some fuel switching to oil and propane. For the base case projections we have assumed no fuel switching.

Table 4— Residential heating fuels

	primary electrical heat (1)	primary electrical heat (1)	secondary electric heat (2)	secondary electric heat (2)	oil heat (3)	oil heat (3)	propane heat (4)	propane heat (4)	primary wood heat (5)	primary wood heat (5)	occasional wood heat (6)	occasional wood heat (6)
	%	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**
1996	38	1,525	45	1,806	16	642	1	40	45	1,806	45	1,806
2000	40	1,826	45	2,054	14	642	1	40	45	2,054	45	2,054
2001	42	2,063	44	2,162	13	642	1	40	44	2,162	44	2,162
2002	43	2,217	44	2,269	12	642	1	40	44	2,269	44	2,269
2003	44	2,322	43	2,270	12	642	1	40	43	2,270	43	2,270
2012	48	3,248	42	2,847	9	642	1	40	42	2,847	42	2,847

Notes: 1996 electrical, oil, propane (gas) and primary wood (other) figures from Stats Can census data for 1986 for the Southern Gulf Islands. Numbers are calculated from percentage of total dwelling units from Table 2.

1. Primary electrical heat percentages calculated from total dwelling units, less other primary heating fuels.
2. Secondary electrical heat assumed to be the same as Primary wood heat.
3. The number of dwelling units with oil heat is assumed to be constant
4. The number of dwelling units with propane heat is assumed to be constant.
5. Wood percentages from firewood suppliers and educated guess.
6. Occasional wood heat assumed to be equal to primary wood heat.

3.4 FIREWOOD

Based on estimated average annual consumption rates of about 1.5 solid cords (more for primary firewood users and less for occasional firewood users), we estimate that about 6,800 cords of wood were burnt in Salt Spring homes in 2003. This was local wood. Small amounts of firewood are imported from off-island, but these are more than offset by wood exported from Salt Spring.

Salt Spring is self-sufficient in firewood and annual regrowth is considerably greater than the annual harvest (ref: Sally Jean, forest geneticist, personal communication).

Wood combustion in the residential sector is not a large net emitter of greenhouse gases, but it is the biggest source of air pollution in the form of particulate matter (PM), carbon monoxide (CO) and volatile organic compounds (VOCs). Combustion of wood is assumed to be carbon neutral (i.e., the life-cycle of the wood removes as much carbon from the atmosphere as it adds) but it does produce methane, which is a potent GHG.

Table 4—Firewood

	1996	2000	2001	2002	2003	2012
Annual residential firewood consumption, solid cords (1)	5,419	6,163	6,485	6,806	6,809	8,578
Energy @ 18 MJ / kg, in GJ	97,540	110,928	116,733	122,507	122,555	154,398
Emission factor, kg CO_2eq / t wood (2)	1,576	1,576	1,576	1,576	1,576	1,576
GHG emissions, t CO_2eq. (3)	8,540	9,712	10,221	10,726	10,730	13,518
Energy cost, wood (4)	894,119	1,016,836	1,070,051	1,122,977	1,123,422	1,415,314

1. Assumes average of 1.5 solid cords per house with primary or occasional wood heat (informed guess).
2. From Bowen CEP— GVRD-FVRD
3. From Bowen CEP— Assumes 1,000 dry kg wood = 1 cord [GVRD - RS]
4. $165 / cord, no increase projected.

3.5 FUEL OIL

We have assumed that the number of dwellings heated by oil remains constant.

Table 5—Residential Fuel Oil

	1996-2012 (2)
Annual residential fuel oil consumption, litres (1)	802,800
Energy, GJ	30,667
Emission factor, t CO_2 / m3	2.8
GHG emissions, t CO_2 eq.	2,248

1. Assumes 1,250 litres / dwelling / yr (EnerGuide data)
2. Assumes constant number of dwellings (642) heated with oil.

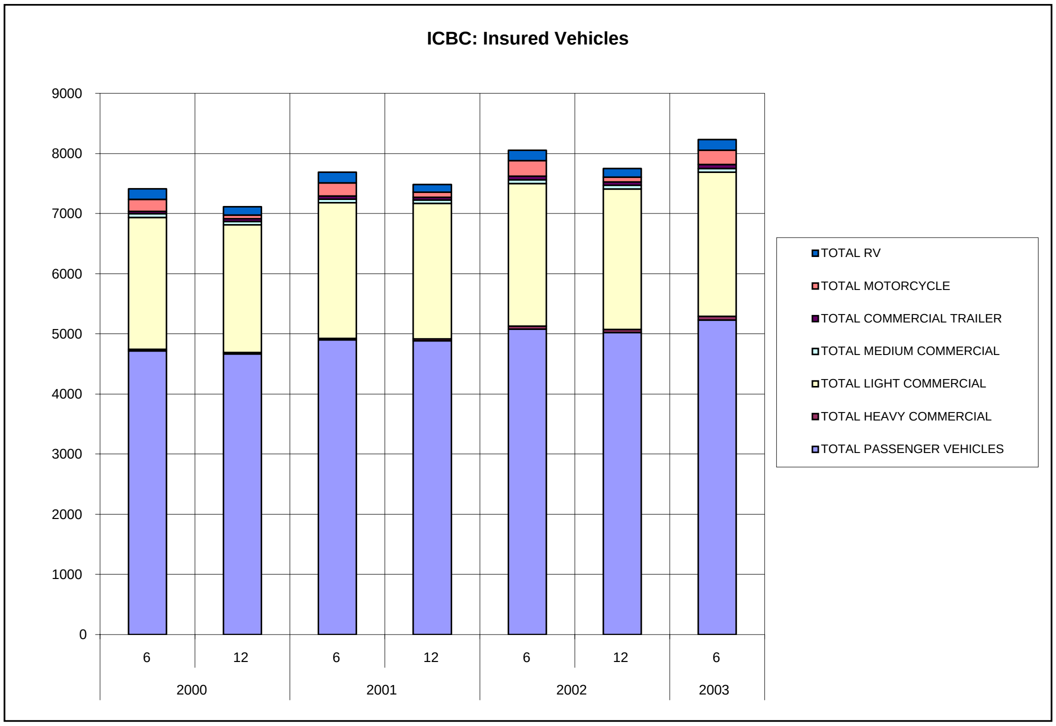
3.6 PROPANE

We estimate Salt Spring's annual propane use to be about about 1 million litres / year. Most of this amount is used by the commercial and institutional sector (restaurants, the Middle School, etc.). Residential use is on the increase, as people replace wood burning appliances with propane fireplaces. We estimate there are between 500 and 750 dwellings on Salt Spring, each using on average 500 litres per year, for a total of 250,000—375,000 litres.

4.0 Island Vehicles' Fuel Consumption

From ICBC data, automobiles and light trucks make up over 90% of insured vehicles registered on Salt Spring. The total number of insured light vehicles has increased from 6,908 in June, 2000 to 7,631 in June 2003, an increase of 10.5% in three years, or 3.5% per year. This is about double the population growth rate of 1.79%. The number of insured vehicles drops slightly each winter. The number of medium commercial vehicles has remained constant at 61, but the number of heavy commercial vehicles has more than doubled, going from 26 to 57 in the three year period.

Chart 2— Insured Vehicles as of June and December, 2000— June, 2003



4.1 MEDIUM AND HEAVY COMMERCIAL VEHICLE FUEL CONSUMPTION

School buses School District 64 operates 8 diesel school buses full time on Salt Spring, plus one spare (propane) and a sports bus (gasoline). For the 2002-2003 school year, approx 58,500 litres of diesel were purchased at a cost of approximately $47,300. Assuming that a school bus, in terms of fuel consumption, represents an average of all medium and heavy commercial vehicles registered on Salt Spring, total annual diesel fuel consumption in 2002 would be 636,000 litres.

Table 6—Medium and Heavy Insured Commercial Vehicles

	2000	2001	2002	2003	2012
Medium Commercial vehicles (1)	61	59	61	61	61
Heavy Commercial vehicles (2)	26	28	51	57	116

1. ICBC, medium commercial insured vehicles 5000 -10,9000 kg GVW as of June of each year, 2000, 2001, 2002, 2003.
2. ICBC, insured heavy commercial vehicles >= 10,900 kg GVW as of June of each year, 2000, 2001, 2002, 2003.

4.2 LIGHT VEHICLE FUEL CONSUMPTION

No data specific to Salt Spring, or the CRD, exist regarding average kilometers traveled, or average fuel consumption. We have therefore used NRCan data for BC and the Territories. We have assumed that all light vehicles use gasoline, and that automobiles and light trucks consume, on average, the NRCan "small car" litres / 100 km. This factor probably understates the actual fuel consumption rate, but we suspect that the average km traveled (13,546 km in 2001) to be overstated for Salt Spring. Based on these assumptions, gasoline consumption is increasing at an average rate of 7% per year, compared to a rate of increase in the number of vehicles of 3.5%.

Table 7—Estimated light vehicle energy consumption

	1996	2000	2001	2002	2003	2012
Automobiles (1)	4,027	4,714	4,898	5,076	5,232	6,625
Light trucks (2)	1,901	2,194	2,253	2,373	2,399	3,003
Total light vehicles (3)	5,928	6,908	7,151	7,449	7,631	9,628
Avg. Km/yr/light vehicle (4)	15,120	14,734	13,546	14,880	14,803	14,112
Litres/ 100 km/light vehicle (5)	10	10	10	10	10	9
Light vehicles fuel, 1000 litres	8,873	10,280	9,784	11,150	11,423	14,413
Energy, GJ	283,947	328,961	313,076	356,808	365,526	461,202
Emission factor, g CO2eq /km (6)	352	352	352	352	352	352
Total light vehicle GHG emissions, t CO2 eq.	31,550	35,827	34,097	39,016	39,763	47,827

1. ICBC, insured passenger vehicles as of June of each year, 2000, 2001, 2002, 2003.
2. ICBC, insured light commercial vehicles <= 5000 kg GVW as of June of each year, 2000, 2001, 2002, 2003.
3. "Automobiles" plus "Light Trucks"
4. NRCan, OEE Transportation Sector data for BC and Territories, small car consumption
5. NRCan, OEE Transportation Sector data for BC and Territories
6. from Bowen CEP

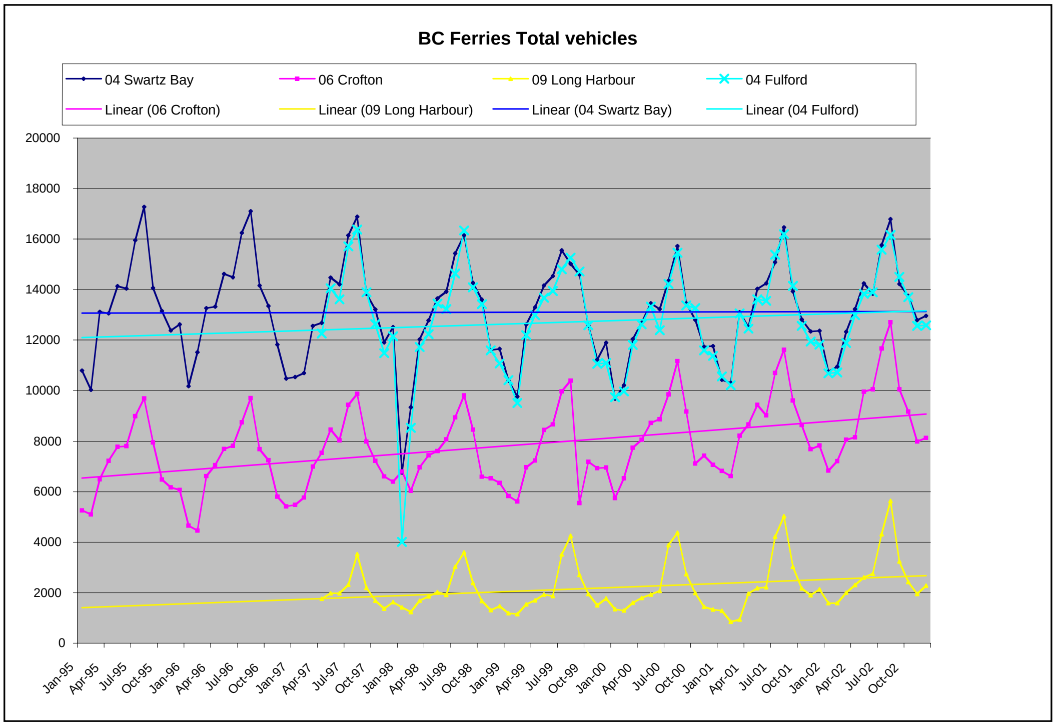
5.0 BC Ferry Corporation, Salt Spring Traffic and Fuel Data

Three routes service Salt Spring: Route 4 from Swartz Bay to Fulford Harbour, Route 6 from Crofton to Vesuvius, and Route 9 from Tsawwassen to Long Harbour. On the latter route, Salt Spring vehicles make up about one third of the traffic, although probably a somewhat greater fraction of the ferry miles, assuming most passengers from Long Harbour travel to Tsawwassen. Monthly traffic data from 1995 to Dec 2002 was analyzed. The data collection system changed in 1998, figures prior to that date appear to be inconsistent with the more recent data, which reports outbound, ticketed, trips separately from inbound, ship's log, trips. We used the most recent data. Through fare traffic is not included in BC Ferry's data system for Route 4. We attempted to quantify through fare traffic by comparing outbound with inbound trips, but the results were inconclusive (see Chart 3). The Route 4 data is therefore understated by the number of through fare vehicles.

5.1 TRAFFIC

Traffic is increasing on all three routes, with Crofton showing the greatest increase. Despite strong anecdotal evidence of rapid growth in traffic from regular users of Route 4, the numbers show a modest increase of 6.5% between 2000 and 2002 (3.25% per year). Route 4 truck traffic has increased from 4,552 to 5,437, an increase of 19.4% in two years. Route 6 truck traffic has increased from 3,568 to 4,469, or 25.2% in the same period (Table 8).

Chart 3—BC Ferries vehicle traffic by month, Jan 1995—Dec 2002



Source: from BC Ferries monthly traffic data. Note: data collection method changed in 1998.

Table 8—Routes 4 and 6, private and commercial traffic

	1996	2000	2001	2002	2012
Swartz Bay Annual underheight + overheight	155,616	146,092	152,243	155,620	173,163
Swartz Bay Annual commercial + semi	4,454	4,552	4,873	5,437	6,577
Crofton Annual underheight + overheight	80,322	93,745	100,667	105,411	151,216
Crofton Annual commercial + semi	2,443	3,568	4,034	4,469	8,532

Source: from BC Ferries monthly traffic data. Note: data collection method changed in 1998.

5.2 VISITOR VEHICLES

We estimated the amount of visitor traffic on routes 4 and 6 by subtracting the amount of private vehicle traffic in the off-season (October through March) from the private vehicle traffic in the tourist season (April through September). These figures indicate that the number of visitor vehicles was just under 28,900 in 2002, up from 27,600 in 2001, but down from 1998 figures of 31,800.

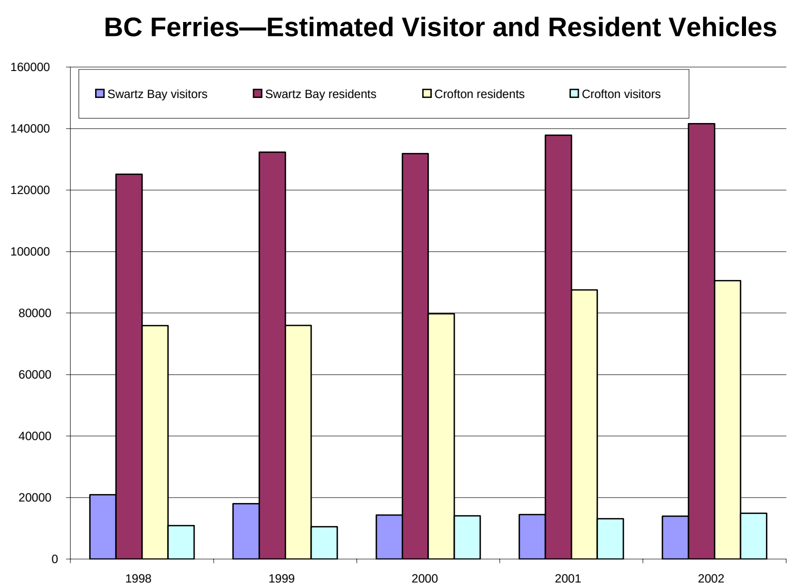
Table 9—BC Ferries traffic, all routes, and estimated visitor vehicles

	1996	2000	2001	2002	2012
Private vehicles on VI ferries (1)	235,938	239,837	252,910	261,031	288,276
Commercial on VI ferries (2)	6,897	8,120	8,907	9,906	13,403
Est. resident vehicle trips (3)	202,842	211,544	225,338	232,162	266,775
# VI trips / light vehicle (4)	34	31	32	31	28
Est. visitor vehicles (5)	33,096	28,293	27,572	28,869	21,499
Total SSI vehicles Route 9 (6)	12,294	25,786	27,886	32,665	45,897

Source: from BC Ferries monthly traffic data. Note: data collection method changed in 1998.

1. BC Ferry Corporation, sum of monthly traffic data, 1996-97, Routes 4 and 6; 1998-2002,departing Swartz Bay and Crofton, private vehicles, underheight plus overheight.
2. BC Ferry Corporation, sum of monthly traffic data, 1996-97, Routes 4 and 6; 1998-2002, departing Swartz Bay and Crofton, commercial plus semi.
3. BC Ferry Corporation, sum of monthly traffic data, Routes 4 and 6 between October and March of each year times 2.
4. "Est. resident vehicle trips" divided by "Total light vehicles" from ICBC data.
5. "Private vehicles on VI ferries' less 'Est. resident vehicles'.
6. BC Ferry Corporation, sum of monthly traffic data, 1999-2002, departing Long Harbour

Chart 4—Estimated visitor and resident vehicles, BC Ferries, 1998—2002



Visitor vehicles made up about 11% of the private vehicles on the Vancouver Island routes in 2002. Resident vehicles made an average of 31 trips each to Vancouver Island in 2002.

5.3 FERRY FUEL

BC Ferry Corporation provided two years of fuel consumption data. For Route 9, one third (Salt Spring's estimated share) of the fuel is shown. Route 6 is the shortest and most economical by far at 5.4 litres per light vehicle, followed by Route 4 at 13 litres, and Route 9 is the longest and least efficient at 40 litres per vehicle (32,665 in 2002).

Chart 5—BC Ferries Fuel

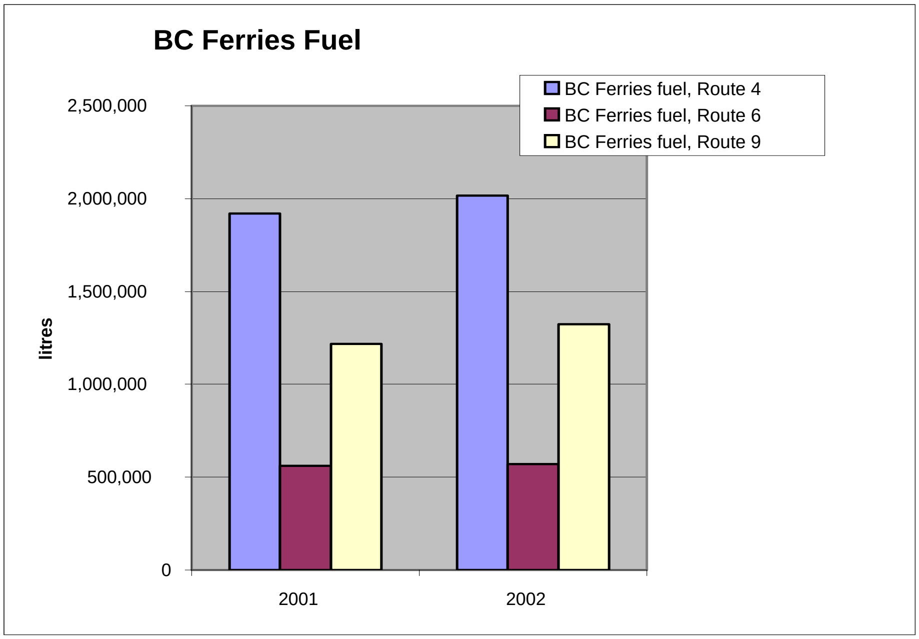


Table 10—BC Ferries Fuel

	1996	2001	2002	2012
BC Ferries fuel, Route 4 litres	1,514,575	1,920,435	2,017,520	3,067,935
BC Ferries fuel, Route 6 litres	508,079	560,543	569,287	647,983
BC Ferries fuel, SSI share Route 9, litres (1)	468,230	1,217,399	1,323,753	2,169,894
Total BC Ferries fuel litres (2)	2,490,884	3,698,377	3,910,560	5,885,812
Emission factor kg CO2eq / kl diesel (3)	2,871	2,871	2,871	2,871
Total GHG emissions t CO2eq.	7,152	10,620	11,229	16,900
GHG emissions route 4 t CO2eq.	4,349,042	5,514,452	5,793,228	8,809,453
GHG emissions route 6 t CO2eq.	1,458,929	1,609,577	1,634,685	1,860,657
GHG emissions route 9 t CO2eq.	1,344,504	3,495,713	3,801,103	6,230,764
Total energy GJ	96,347	143,053	151,260	227,663

1. 33% of BC Ferry Corporation, annual fuel for Route 9, Long Harbour-Tsawwassen. 2001, 2002.
2. Sum of fuel Route 4, Route 6 and SSI share Route 9.
3. From Bowen CEP—GVRD/FVRD

6.0 Indirect energy associated with grocery purchases

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. The average North American's annual grocery shopping cart represents 1,514 litres (400 US gallons) of oil equivalents. (Source: Pimentel, D. and Pimentel, M. 'Food, Energy and Society' published by University Press of Colorado,1996. (363pp.) Pimentel, D. and Pimentel, M. 2003. World Population, Food, Natural Resources, and Survival. In, *World Futures* 59: (3-4) 145-167, and personal communication).

Assuming that the average Salt Spring islander's annual food purchases equal the North American norm, and based on a population of 9,503, then 2002 energy use and emissions attributable to food purchases are 14.4 million litres and 41,313 tonnes of CO2 equivalent, respectively. However, there is less certainty with these figures than with direct energy consumption, such as BC Ferry Corporation fuel data. Given the apparent magnitude of the food-related fossil fuel energy, further research is warranted.

Table 11— Energy associated with grocery purchases

	1996	2000	2001	2002	2012
Population	9,247	9,272	9,279	9,503	10,911
kilo-litres of oil equivalent (1)	14,000	14,038	14,048	14,388	16,519
Emission factor, kg CO2eq / kL diesel (2)	2,871	2,871	2,871	2,871	2,871
GHG emissions, tonnes CO2eq.	40,200	40,309	40,339	41,313	47,434
Total energy, GJ	541,518	542,982	543,392	556,510	638,965

1. Based on 1,514 litres / person / year, source: D. Pimentel, Cornell University
2. Based on diesel emissions from Bowen CEP—GVRD/FVRD

A partial switch in consumption to local organic food could reduce the energy component significantly. For example, a study by Eliot Coleman found that the energy cost of producing an organic lettuce under plastic in Maine was 6% of the energy cost of shipping a lettuce from California to Maine. (Source: 'The Winter Harvest Manual', Eliot Coleman, 1998, and personal communication.)

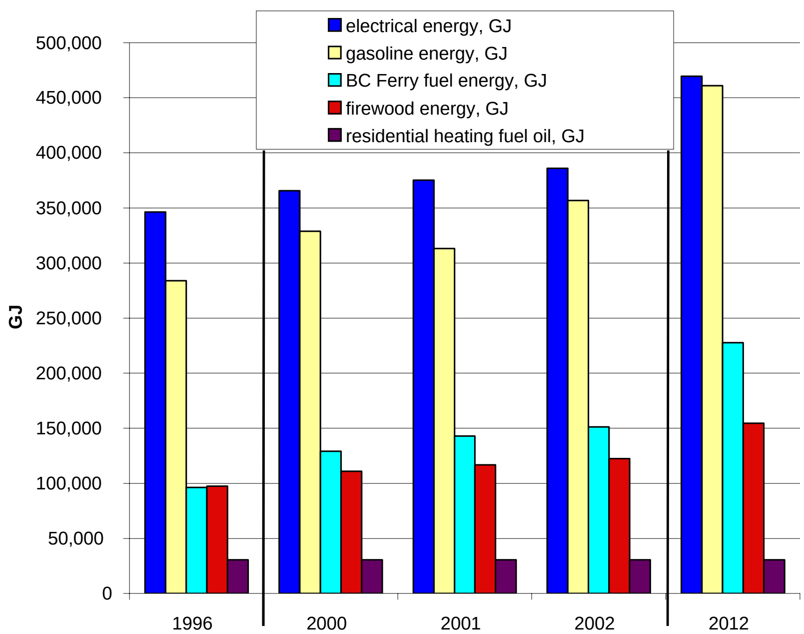
7.0 Summary

The following charts and tables compare the impact of different fuel types over time. Per capita figures are included. Note that propane is not included in the summary charts. We have not included the impact of the indirect energy associated with food purchases in the island totals, although we have included them in the per capita breakdown. We have not examined the impact of other indirect energy consumers, such as construction. These contributions will be smaller than those associated with food.

7.1 ENERGY

Total annual energy consumption for Salt Spring is increasing for all categories examined, except residential fuel oil, which is assumed to be constant.

Chart 6—Salt Spring's Annual Energy Consumption, Gigajoules



Electricity is the largest energy category, followed by gasoline. Gasoline and firewood show growth rates greater than the growth rate in population. Note that the indirect energy associated with food purchases are about equal to the electricty and gasoline figures (see Table 12).

Table 12—Annual Energy Consumption in Gigajoules

	1996	2000	2001	2002	2012
electrical energy, GJ	346,347	365,573	375,358	386,035	469,649
gasoline energy, GJ	283,947	328,961	313,076	356,808	461,202
BC Ferry fuel energy, GJ	96,347	129,176	143,053	151,260	227,663
firewood energy, GJ	97,540	110,928	116,733	122,507	154,398
residential heating fuel oil, GJ	30,667	30,667	30,667	30,667	30,667
Total direct energy, GJ	854,848	965,305	978,887	1,047,277	1,343,579
food fossil fuel energy, GJ	541,518	542,982	543,392	556,510	638,965
Total, include food, GJ	1,396,366	1,508,287	1,522,279	1,603,787	1,982,544

7.2 ENERGY COSTS

The energy cost data presented below uses 2002 average costs. BC Hydro has announced a rate increase of 8.9% over two years, with a 7.23% increase on April 1, 2004 and a 1.67% increase after the BC Utilities Commission rate hearing is completed. Other energy resource prices are also expected to increase. Therefore the 2012 projections are considerably understated.

Chart 7—Energy costs, 2002 prices

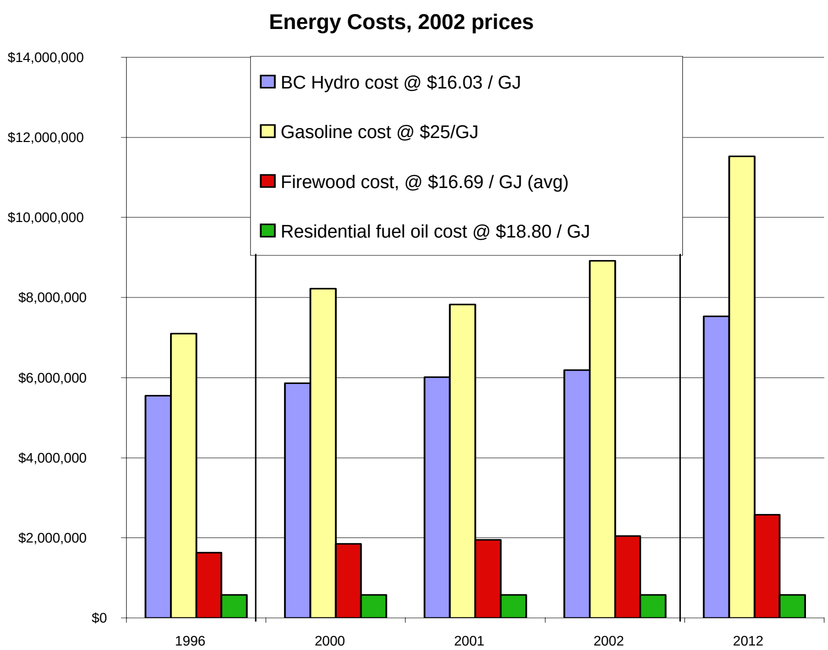


Table 13—Annual Energy costs at 2002 prices

	1996	2000	2001	2002	2012
BC Hydro cost @ $16.03 / GJ	$5,551,151	$5,859,302	$6,016,130	$ 6,188,144	$ 7,528,479
Firewood cost @ $16.69 / GJ (avg.)	$1,627,946	$1,851,381	$1,948,272	$2,044,634	$2,576,901
Residential fuel oil cost @ $18.80 / GJ	$576,539	$576,539	$576,539	$576,539	$576,539
Gasoline cost @ $0.80/litre	$7,098,684	$8,224,024	$7,826,890	$8,920,207	$11,530,048
TOTAL costs	$14,854,320	$16,511,246	$16,367,831	$ 17,729,524	$ 22,211,967

In 2002, Salt Spring spent $17.7 million on fuel. With the exception of the estimated $2 million spent on firewood, and the markup retained by the local fuel vendors, most of that money left the community.

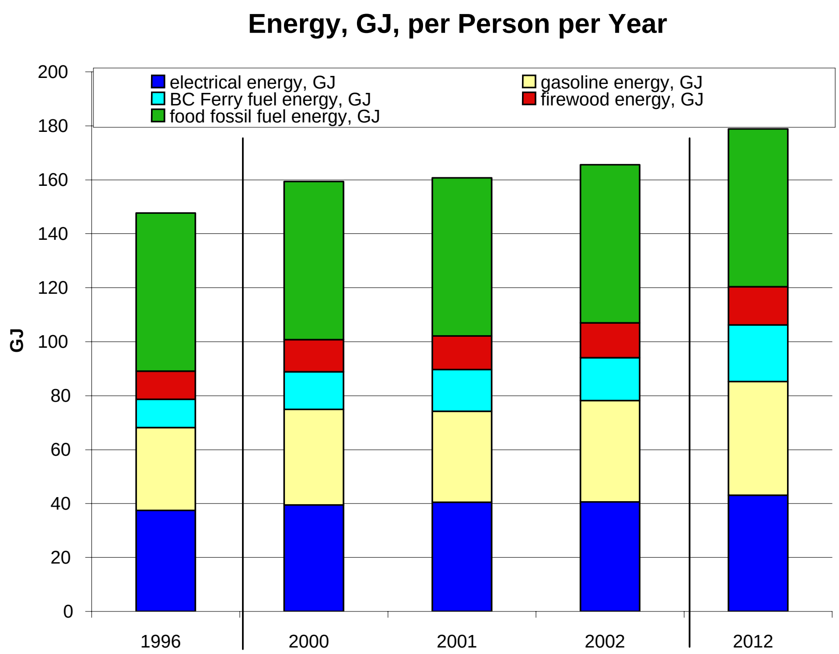
7.3 PER CAPITA ENERGY USE

Taking the energy data presented in Table 12 and dividing the totals by the population (Table 2), we find that the average Salt Springer consumed 166 GJ of energy in 2002 (Table 14). Dirct annual energy consumption is increasing, by an average of 3% per year between 2000 and 2002.

Table 14—Energy, GJ, per person per year

	1996	2000	2001	2002	2012
electrical energy, GJ	37	39	40	41	43
gasoline energy, GJ	31	35	34	38	42
BC Ferry fuel energy, GJ	10	14	15	16	21
firewood energy, GJ	11	12	13	13	14
Total direct energy	89	101	102	107	120
food fossil fuel energy, GJ	59	59	59	59	59
Total energy, incl food GJ	148	159	161	166	179

Chart 8—Energy, GJ, per person per year

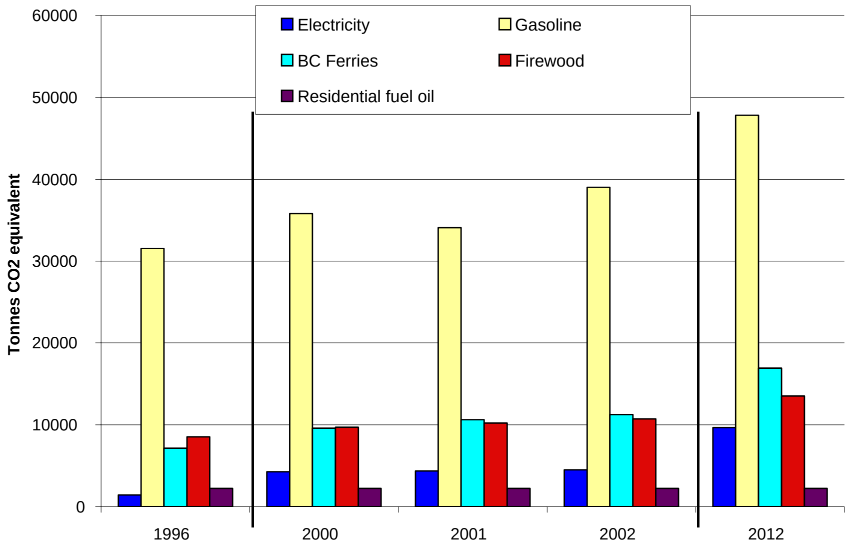


The food purchase figures contain uncertainties and merit further investigation. But even if overstated here, the fossil fuel content of our food is clearly very significant.

Note that propane and fuel oil have not been included. For people using these fuels, propane would likely replace firewood energy, while fuel oil would replace part of the electrical energy. The totals would remain about the same.

7.4 GHG EMISSIONS

Chart 9—Salt Spring's Annual Greenhouse Gas Emissions



Fossil fuel energy associated with conventional food, and gasoline are by far the largest contributors to greenhouse gas emissions (GHGs). The gasoline GHG emissions are produced on Salt Spring. The emissions related to conventional food purchases are largely produced off-island. GHGs are increasing most rapidly in the electrical sector because of the increasing reliance by BC Hydro on thermal generating stations. The firewood emissions presented here are the gross emissions; carbon dioxide emissions (but not methane emissions) are offset by regrowth.

Table 15—Salt Spring's Annual GHG Emissions, tonnes CO2 equivalent

Annual GHG emissions tonnes CO2 eq.	**1996**	**2000**	**2001**	**2002**	**2012**
Electricity	1,443	4,265	4,379	4,504	9,654
Gasoline	31,550	35,827	34,097	39,016	47,827
BC Ferries	7,152	9,590	10,620	11,229	16,901
Firewood	8,540	9,712	10,221	10,726	13,518
Residential fuel oil	2,248	2,248	2,248	2,248	2,248
Total GHG emissions, tonnes	50,933	61,642	61,565	67,723	90,148
Indirect from food fossil fuel	40,200	40,309	40,339	41,313	47,434
Total GHG emissions incl food	91,134	101,951	101,904	109,036	137,583

7.5 PER CAPITA GHG EMISSIONS

Taking the GHG data presented in Table 13 and dividing the totals by the population (Table 2), we find that the average Salt Springer produced 11.2 tonnes of GHG emissions in 2002 (Table 15). Excluding GHG from food purchases, the total is 6.9 tonnes. Annual GHG emissions are increasing, by an average rate of 2.14% per year between 2000 and 2002. GHG emissions are increasing more rapidly than the increase in energy consumption because of BC Hydro's ever increasing reliance on fossil fuels.

Chart 10—Tonnes GHG, CO2 equivalents, per person per year

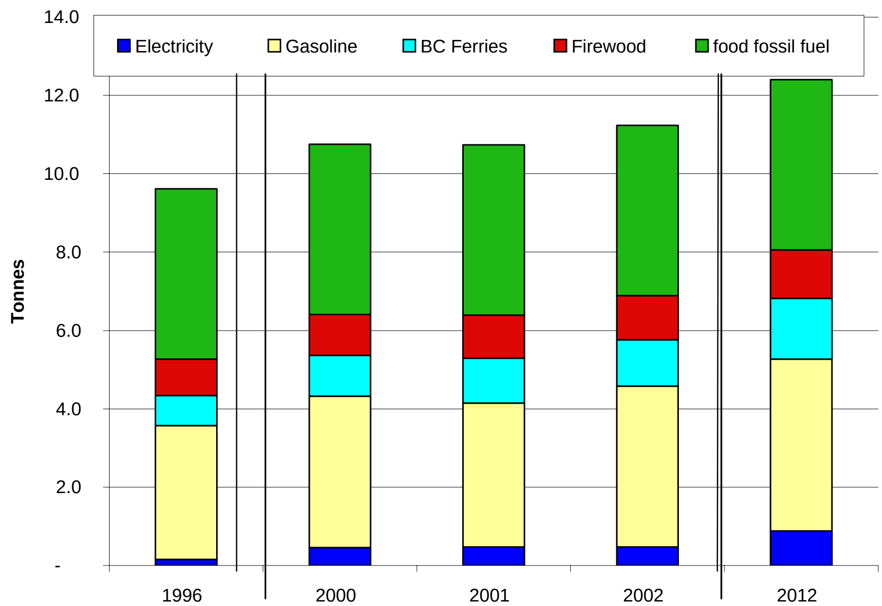


Table 16—GHG emissions, tonnes, per person per year

GHG emissions, tonnes CO2 equ.	**1996**	**2000**	**2001**	**2002**	**2012**
Electricity	0.2	0.5	0.5	0.5	0.9
Gasoline	3.4	3.9	3.7	4.1	4.4
BC Ferries	0.8	1.0	1.1	1.2	1.5
Firewood	0.9	1.0	1.1	1.1	1.2
Total GHG per capita	5.3	6.4	6.4	6.9	8.0
food fossil fuel	4.3	4.3	4.3	4.3	4.3
Total GHG per capita, incl food	9.6	10.8	10.7	11.2	12.3

7.6 AIR POLLUTANT EMISSIONS

Use of fuels such as wood, gasoline, diesel, and fuel oil not only contributes to global warming, it also pollutes the air with a range of toxic substances, many of which pose significant health hazards. Air pollutants include the following:

- **Particulate matter** (PM), which is harmful to the respiratory tract and a constituent of smog, has been classified into three sizes: all sizes (PM), smaller than 10 microns (PM10), and smaller than 2.5 microns (PM2.5). The smaller the particle size, the deeper into the lungs that the particle can penetrate and, resultantly, the more potential damage it can cause. Wood combustion emits particulates in all three categories. Matter from construction activity results in coarse particulate emissions, but very little of the finer particles. BC Ferries contribute particulate matter emissions for all size categories.
- **Carbon monoxide** (CO), which impairs the body's ability to deliver oxygen to cells, is emitted in the largest quantity of all the air pollutants investigated. Vehicles and wood combustion are responsible for almost all CO emissions.
- **Volatile organic compounds** (VOC), which contribute to ground level ozone or "urban smog" (harmful to the respiratory tract and plant productivity; a constituent of smog) and PM formation, are emitted primarily through vehicle operation and wood combustion.
- **Nitrogen oxides** (NO_X), which are harmful to the respiratory tract, contribute to acid deposition, and are a precursor to ground level ozone (i.e., "smog") and PM creation, are emitted primarily by the ferry (73% of total NO_X emissions). Personal vehicles also contribute 23% of the total NO_X emissions.
- **Sulphur oxides** (SO_X), which are harmful to the respiratory tract, contribute to acid deposition, and are a precursor to PM creation, are emitted by the ferry and to a smaller degree by vehicles.

Emissions from the burning of slash from the clearing of land is difficult to quantify, but the types of emissions are likely comparable to the wood combustion emissions described above. Emissions from the burning of household garbage and construction waste is also difficult to quantify but is likely to contribute to emissions in all categories.

Table 17—Air pollutant emissions, tonnes, Salt Spring, 2002

	From electricity (incurred off-island at thermal generating stations)	From gasoline (light vehicles)	From residential fuel oil	From BC Ferries	From firewood	From Food purchases
CO	0.32	1,401.00	0.48	23.47	785.41	86.33
VOC	0.22	155.40	0.68	8.13	149.05	29.93
NOX	0.69	145.40	1.77	191.64	9.53	704.99
SOX	0.10	5.55	2.77	20.73	1.36	76.25
PM	0.31	3.33	0.24	7.82	104.13	28.78
PM10		3.33	0.13	7.82	104.13	28.78
PM2.5		2.22	0.08	7.18	96.85	26.43
PM1		2.22				
CH4		5.55	0.17	1.17	16.33	4.32
N2O		15.54	4.82	1.56	1.09	5.76

The following table provides the emission factors used to calculate the quantities of each pollutant generated by each fuel source.

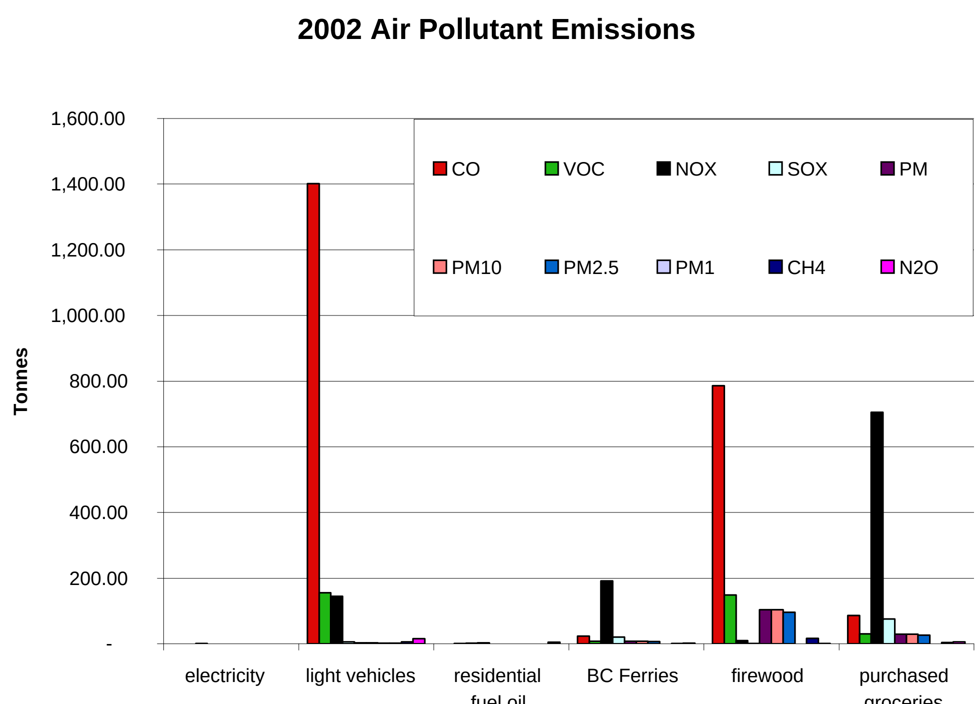
Table 18— Emission Factors

POLLUTANT	Electricity g/kWh (1)	Light vehicles g/km (2)	Residential fuel oil kg/m3(2)	BC Ferries (2) kg/kL	Firewood kg/t (2)	Food energy kg/kl (3)
Carbon monoxide CO	0.0031	12.62	0.60	6.00	115.40	6.00
Volatile organic compounds VOC	0.0022	1.40	0.09	2.08	21.90	2.08
Nitrous oxides NOX	0.0068	1.31	2.20	49.00	1.40	49.00
Sulphur oxides SOX	0.001	0.05	3.45	5.30	0.20	5.30
Particulate Matter PM	0.003	0.03	0.30	2.00	15.30	2.00
PM less than10 microns PM10		0.03	0.17	2.00	15.30	2.00
PM less than 2.5microns PM2.5		0.02	0.10	1.84	14.23	1.84
PM less than 1 micron PM1		0.02				
Methane CH4		0.05	0.21	0.30	2.40	0.30
Nitrogen dioxide N2O		0.14	0.01	0.40	0.16	0.40

Source:

1. from Bowen Island CEP—BC Government
2. GVRD/FVRD
3. Assumed to be equivalent to BC Ferries emissions.

Chart 11— Air pollutant emissions, tonnes, Salt Spring, 2002

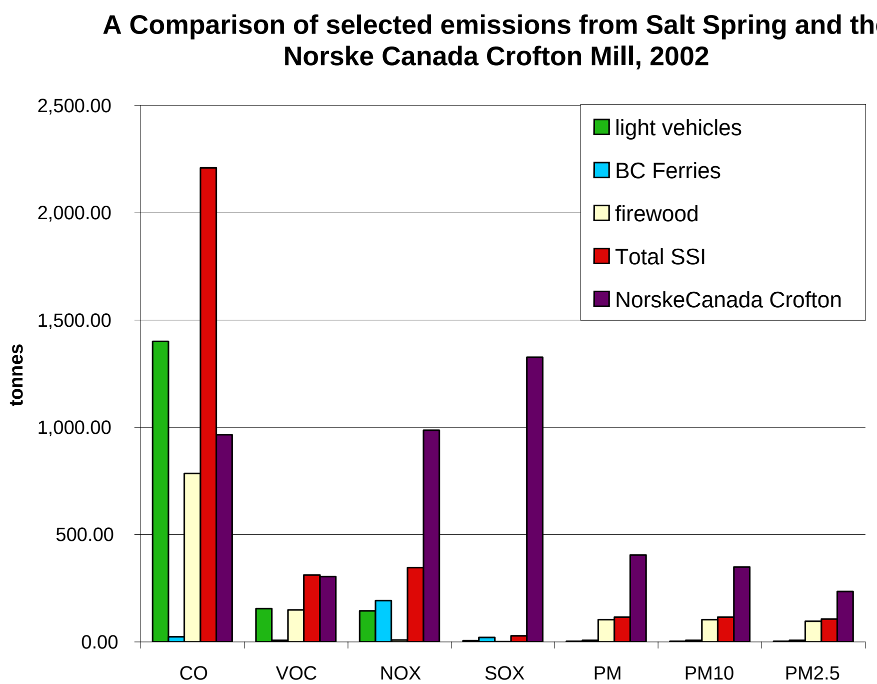


Not all air pollutant emissions occur on island. Emissions from BC Hydro are generated elsewhere, as are almost all the emissions resulting from conventional food purchases (the exception being the energy used to transport groceries from ferry to store and from store to home).

7.7 OTHER SOURCES OF AIR POLLUTION

Salt Spring not only "exports" air pollutants, it also "imports" them, the closest large source being the Crofton Mill. A comparison of Salt Spring and Crofton emissions is presented in Chart 9.

Chart 12— A Comparison of selected emissions from Salt Spring and the Crofton Mill



Source of Norske Canada data: Environment Canada, NPRI ID - 01266

8.0 Conclusions

Salt Spring's current direct (on-island) use of energy is fairly evenly divided between buildings (including appliances and electronic equipment) and transportation. The total direct energy used in 2002 is estimated to be 1,047,277 GJ. The GHG emissions associated with this energy consumption is estimated at 67,723 tonnes of CO2 equivalent.

The indirect energy associated with conventional food purchases—the fossil fuel content of the Salt Spring annual shopping cart—is estimated at 556,510 GJ in 2002. The associated GHG emissions are estimated at 41,313 tonnes. Although this energy use, and associated GHG emissions, is not incurred on-island, it is a significant amount and merits further investigation.

Per capita annual direct energy use on Salt Spring is increasing by about 3% per year. In 2002, the average consumption was 107 GJ. The average per capita GHG emissions were 6.9 tonnes. The indirect energy associated with conventional food purchases was estimated to be 59 GJ and GHG emissions 4.3 tonnes.

Electricity is the most used form of energy on Salt Spring, at 386,035 GJ (107,232 MWh) in 2002. 80% of this energy is used in the residential sector, mostly in the winter. The average BC Hydro Salt Spring residential account uses 16,400 kWh, compared to a provincial average of 15,000 kWh. The fact that there is no natural gas available on Salt Spring probably accounts for the higher than average consumption. The GHG emissions associated with electrical energy use are low, but because BC Hydro is increasing its reliance on fossil fuel generation, any changes in future electrical consumption may be assumed to be supplied by, or offset, fossil fuel generation. This will result in a four-fold increase in emissions per person from electricity use between 1996 and 2012.

Comment: I have always heard that the average is 10,000 kWh/year – that is on the BC Hydro website.

Gasoline consumption by light vehicles is estimated at 356,808 GJ in 2002. Gasoline use is expected to increase by 29% in 2012 compared to 1996 consumption levels, exceeding electrical energy use by that year. This increase will have significant implications on GHG emissions and air quality. Light vehicles are the largest source of Salt Spring's direct GHG emissions, responsible for over half of the annual GHG emissions (39,016 tonnes in 2002). Light vehicles are also responsible for more toxic air emissions than any other island source, including, for 2002, 1,401 tonnes of carbon monoxide, 155 tonnes of volatile organic compounds and 145 tonnes of nitrous oxides.

Diesel fuel used by BC Ferries for the Salt Spring routes (including the Salt Spring portion of Route 9, Long Harbour) is the third largest direct energy use, at 151,260 GJ in 2002, and the second largest GHG emitter (11,229 tonnes in 2002). BC Ferries also contributes to air pollution. It produces the highest levels of nitrous oxides and sulphur oxides (192 tonnes and 21 tonnes respectively in 2002).

Firewood remains a significant space-heating fuel and is the fourth largest direct energy use, estimated at 122,507 GJ, or about one third of the total electrical energy use, in 2002. Firewood is responsible for much of the local air pollution, producing large quantities of carbon monoxide, volatile organic compounds and particulate matter.

Comment: Are we assuming the gross emissions levels or are we giving it a credit for regrowth? In either case, we should explain our assumptions here, because this is a bit of a surprise.

Salt Spring islanders spent about $17.7 million in 2002 on direct energy purchases with the majority on gasoline and electricity. Most of that money left the community. Future energy use reductions would provide an opportunity to retain dollars on-island, with the associated multiplier benefits.

APPENDIX A—BC Residential Fuel Cost Comparison 2002 prices

FUEL	Approx Cost	unit	Assumed combustion efficiency, %	Type	Comparison formula	$/GJ of useful heat
Nat. Gas, VI	$14.05	GJ	70	STD	$/(GJ * SE)	$20.07
$ @ 85% oil			83	MID		$16.93
			90	HIGH		$15.61
Electricity	$0.0577	kWh	100		$/kWh * 278	$16.03
Propane	$0.55	litre	70	STD	$/l*37.6/SE	$29.54
			83	MID		$24.92
			90	HIGH		$22.98
Oil	$0.51	litre	70	STD	$/l*25.8/SE	$18.80
			80	MID		$16.45
Mixed softwood	$165.00	cord	50	STD	$/c*.059/SE	$19.47
			70	HIGH		$13.91
Pellets	$200.00	ton	75		$/t*.059/SE	$15.73
Coal	$75.00	ton	70		$/t*.039/SE	$4.18

Notes: 1GJ = 947,867 BTU = 278 kWh
SE = Seasonal Efficiency
BC Hydro = commodity + $6.92 bi-monthly billing charge
Source: Dave Hill and local information

APPENDIX B—Fossil Fuel Energy Content of Food

Excerpted from Eating Fossil Fuels by Dale Allen Pfeiffer © Copyright 2003, From The Wilderness Publications, www.fromthewilderness.com. October 3 , 2003

The Green Revolution increased the energy flow to agriculture by an average of 50 times the energy input of traditional agriculture. In the most extreme cases, energy consumption by agriculture has increased 100 fold or more.

In the United States, 400 gallons of oil equivalents are expended annually to feed each American (as of data provided in 1994). Agricultural energy consumption is broken down as follows:

- 31% for the manufacture of inorganic fertilizer
- 19% for the operation of field machinery
- 16% for transportation
- 13% for irrigation
- 8% for raising livestock (not including livestock feed)
- 5% for crop drying
- 5% for pesticide production
- 8% miscellaneous

Energy costs for packaging, refrigeration, transportation to retail outlets, and household cooking are not considered in these figures.

To give the reader an idea of the energy intensiveness of modern agriculture, production of one kilogram of nitrogen for fertilizer requires the energy equivalent of from 1.4 to 1.8 liters of diesel fuel. This is not considering the natural gas feedstock. According to The Fertilizer Institute (http://www.tfi.org), in the year from June 30 2001 until June 30 2002 the United States used 12,009,300 short tons of nitrogen fertilizer. Using the low figure of 1.4 liters diesel equivalent per kilogram of nitrogen, this equates to the energy content of 15.3 billion liters of diesel fuel, or 96.2 million barrels.

Agriculture directly accounts for 17% of all the energy used in the US. As of 1990, we were using approximately 1,000 liters (6.41 barrels) of oil to produce food of one hectare of land.

In 1994, David Pimentel and Mario Giampietro estimated the output/input ratio of agriculture to be around 1.4. For 0.7 Kilogram-Calories (kcal) of fossil energy consumed, U.S. agriculture produced 1 kcal of food. The input figure for this ratio was based on FAO (Food and Agriculture Organization of the UN) statistics, which consider only fertilizers (without including fertilizer feedstock), irrigation, pesticides (without including pesticide feedstock), and machinery and fuel for field operations. Other agricultural energy inputs not considered were energy and machinery for drying crops, transportation for inputs and outputs to and from the farm, electricity, and construction and maintenance of farm buildings and infrastructures. Adding in estimates for these energy costs brought the input/output energy ratio down to 1. Yet this does not include the energy expense of packaging, delivery to retail outlets, refrigeration or household cooking.