Context:
Gabriola, electrical power usage

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Author:
Nick Doe, 1787 El Verano Drive, Gabriola, BC, Canada V0R 1X6
Phone: 250-247-7858
E-mail: nickdoe@island.net

Gabriola's electrical energy consumption in 2008 and over the period 2001–8.

NOTES

1. In this report, "2008" means calendar year 2008 (Jan.08–Dec.08, or C2008). Sometimes data is only available for financial year 2008 (Apr.08–Mar.09, or F2008). In these cases, the convertion used is C2008 = 0.25F2007 + 0.75F2008. This may mean that numbers used here differ slightly from numbers quoted elsewhere. Statistically, "2008" means 2008.5, that is the mid-point of the year.

2. All "growth" figures are compounded growths calculated using annual data for the years 2001–8, with 2001 as the base year. The only exception is population where annual counts are not available. Growths have been estimated using a least squared error match with the raw data.

3. The term "non-residential" when applied to Gabriola includes both institutional accounts (school, churches, public spaces, etc.) and commercial accounts (stores, restaurants, small businesses, etc.). Use by some small home-based businesses on Gabriola is not distinguishable from residential use, but it is doubtful that this is statistically significant and in any case is an unknown quantity.

4. In analyses like this, it is easier to consider numbers of BC Hydro (BCH) "service locations" than it is population because annual population figures are only available by extrapolation from census figures taken very five years whereas BCH service-location counts are readily available annually. For residential customers on Gabriola, a service location is taken to mean a residence, most often a single house. A second advantage of using service-location numbers is that the number of residences is not seasonal, whereas population is. There were 1.58 residents per residential BCH account on Gabriola in census year 2006, which is not significantly different from census year 2001 when it was 1.55.

5. 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 per second, and hence a watt second (Ws) is a joule (J).

6. The standard SI prefixes are kilo- (k) = 10^3, mega- (M) = 10^6, giga- (G) = 10^9,and tera- (T) = 10^{12}. 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, 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 megawatt hour per month (MWh/mth) = 1.37 kilowatts (kW)
1 gigajoule (GJ) = 278 kilowatt hours (kWh)
1 kilowatt hour per day (kWh/d) = 41.7 watts (W)
1 kilowatt (kW) used continuously = 24.0 kilowatt hours per day (kWh/d)
1 kilowatt (kW) used continuously = 731 kilowatt hours per month (kWh/mth)
1 kilowatt (kW) used continuously = 8.77 megawatt hours per year (MWh/yr).

The electrical energy (GWh) used in BC every year is roughly divided equally between supplies to large industry (30%), commercial & light industry (36%), and residents (34%).

About 88.9% of all BCH customers are residential, and 11.0% are commercial and light industry. There are only a handful of large-industry accounts.

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

For BC as a whole, the total energy use by residential customers is roughly the same (48.8%) as for non-residential customers excluding large industry (51.2%). For Gabriola, residential use (87.4%) is much larger than non-residential use (12.6%). This is significant because seasonal-use and annual-growth is different for the residential and non-residential components. Gabriola's use and growth cannot be expected to match the norm for the rest of BC.

2008	BC		Gabriola	
residential	1568508	88.9%	2664	94.6%
comm.,light industry, instit.	194861	11.0%	153	5.4%
large industry	160	0.01%	0	0%
TOTAL	1763529	100%	2817	100%

Table1: The numbers of different types of BCH customer in BC and on Gabriola.

2008	BC			Gabriola	
residential GWh/yr	17553	34.2%	48.8%	38.04	87.4%
non-residential GWh/yr	18406	35.8%	51.2%	5.49	12.6%
large industry GWh/yr	15380	30.0%	—	0	—
TOTAL	51339	100%	100%	43.53	100%

Table 2: Energy use (GWh/yr) by different types of customer in BC and on Gabriola. For BC, percentage use is given both including (left column) and excluding (right column) large industry.

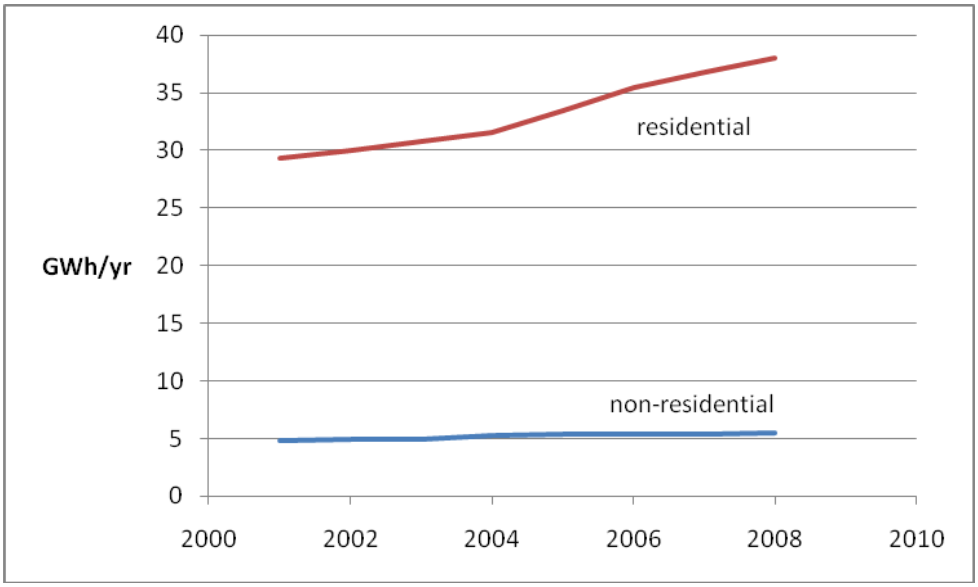

Figure 1: Annual trends in energy use (GWh/yr) on Gabriola.

It will come as no surprise that Gabriola's electrical energy use is increasing. Over the period 2001–8, the total electrical power supplied to Gabriola (GWh/yr) has grown by an average of 3.5% per year. This is made up of a 3.7% per year growth in supply to residents, and a 2.2% per year growth in supply for non-residential use.

For the purposes of analysis, we can consider Gabriola's growth in energy use as being a result of three factors: the growth in population, the growth in consumption per existing customer, and the building of new residences with higher than existing average consumption.

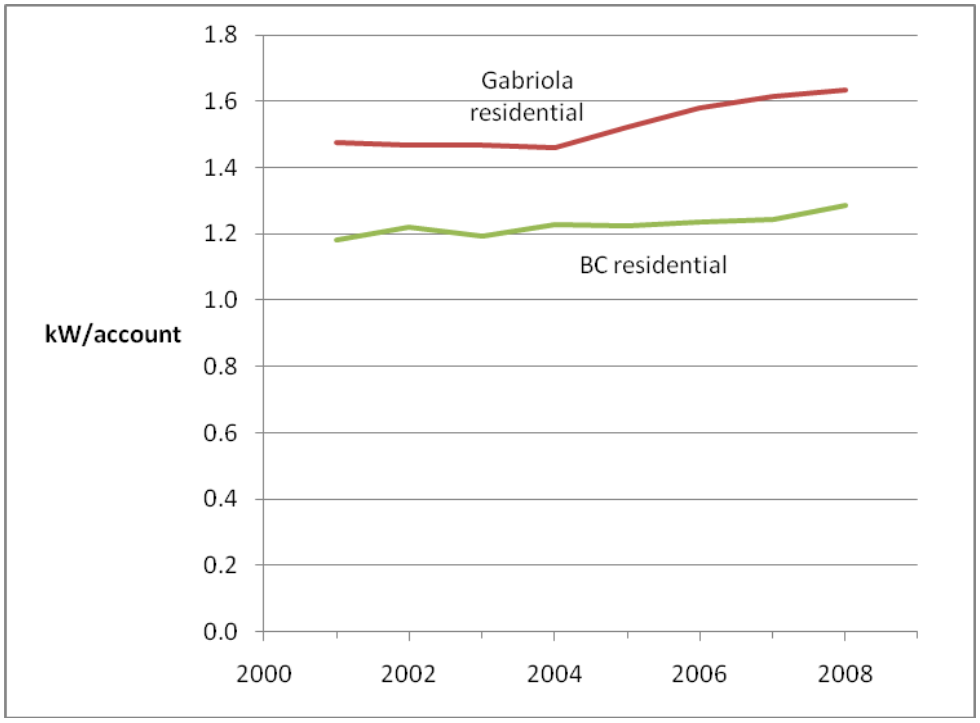

Figure 2: Annual trends in residential power supply (kW/account) for Gabriola and BC as a whole. According to BCH, the average BC household is currently (2009) using 12 MWh/yr = 1.37 kW.

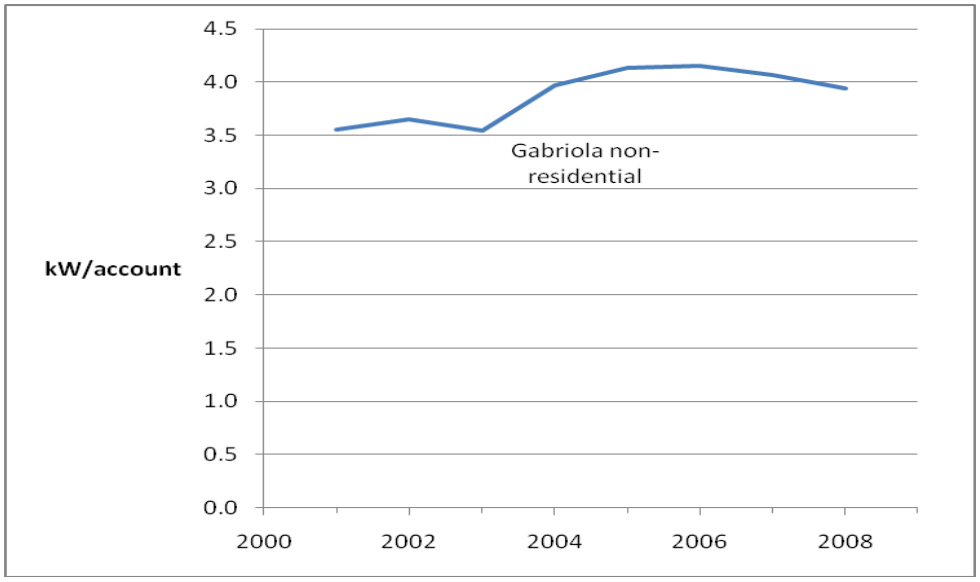

Figure 3: Annual trend in non-residential power supply (kW/account) for Gabriola.

Figures from BCH show that the growth in the number of Gabriola's residential customers over the period 2001–8 has been 2.4% per year. This is not far from the crudely estimated population growth of 2.8% per year. The growth in residential energy use (3.7%) is thus only partially explained by a growth in population.

There has been no growth in the number of Gabriola's non-residential customers over the period 2001–8, the calculated growth amounting to –0.1%. The growth in energy use (2.2%) is thus solely a result of growth in use by individual non-residential customers.

In 2008, estimated residential use was 14.4 MWh per year per customer. This is equivalent to a non-stop year-round power use of 1.63 kW/account, a number that has grown at 1.2% per year since 2001. Figure 2 suggests that much of this growth has been in the last few years rather than evenly over the 2001–8 period.

Also in 2008, estimated non-residential use was 37.5 MWh per year per customer. This is equivalent to a non-stop year-round power use of 4.27 kW/account, a number that has grown at 2.3% per year since 2001, though, as can be seen in Figure 3, the growth has not been consistent over the 2001–8 period.

Compared to the rest of BC, Gabriola's use on a per residential customer basis is high. In 2008, estimated residential use was 11.2 MWh (compared with 14.4 MWh) per year per customer, which is equivalent to a non-stop year-round power use of 1.28 kW/account (compared with 1.63 kW/account). Two possible explanations come to kind. Gabriolan homes use more electrical energy for heating because of the lack of a piped gas supply, and Gabriolans use more electricity than usual because they have a more luxiourous lifestyle. BCH regards a use of more than 93 kWh/day = 3.8 kW/account as "suspicious".

Compared to the rest of BC, Gabriola's use on a per non-residential customer basis is low. In 2008, estimated non-residential use was 94.5 MWh (compared with 37.5 MWh) per year per customer, which is equivalent to a non-stop year-round power use of 10.78 kW/account

(compared with 4.27 kW/account) per customer. A simple explanation for this is that Gabriola businesses and institutions are smaller than those off- island.

Clues as to why Gabriola's electrical energy use by residential customers is so relatively high may be found in the monthly use figures. The energy can be divided into two components, one depending on the time of year, and one not. The time of year component reflects use for space heating and lighting. Heating and lighting cannot be separated because they both go up in winter, and down in summer, and because energy used for lighting also provides heat as do all electrical devices—although switching off a device in winter reduces power consumption, it does not reduce daily energy consumption in an adequately-electrically-heated house—only lowering the thermostat setting can do that.

Generally, it is reckoned that the average home in BC uses about 50% of its energy (all kinds) for space heating, 30% for water heating, 15% for lighting, and 5% for appliances.

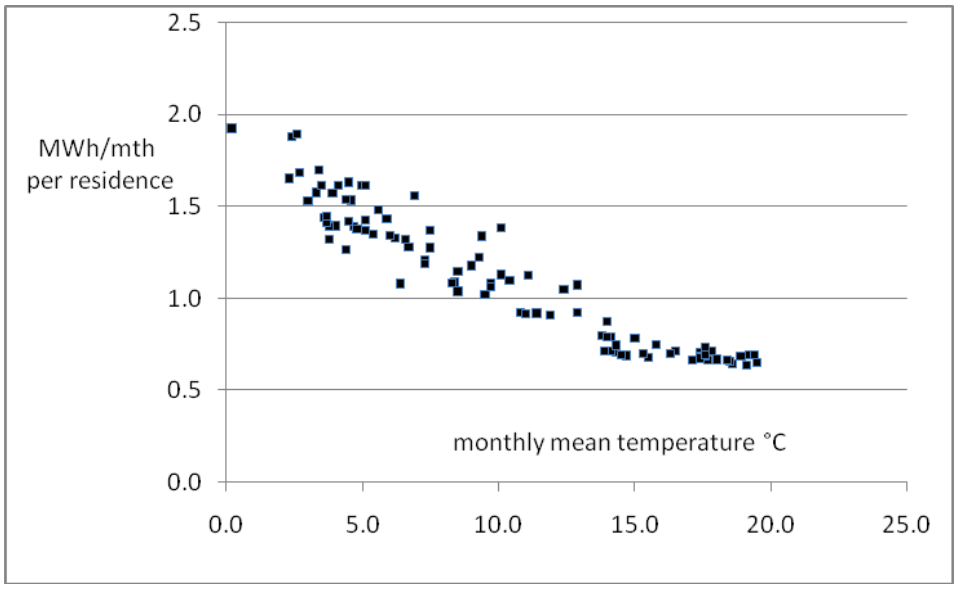

Figure 4: Monthly residential energy (MWh/account) over the period 2001–8 as a function of monthly mean temperature.

Figure 4 shows the monthly energy (1 MWh/account/mth, = 1.37 kW) used by residents as a function as of average temperature for the month. The use shows a steadily declining trend as the temperature rises towards about 15°C. Thereafter the use is roughly independent of the outside temperature. The winter to summer ratio in 2008 was 2.51. In 2001 it was 2.20. This trend is bad news for BCH because the winter peak is increasingly difficult to supply using low cost non-polluting sources, and because there is only one transmission line to Gabriola.

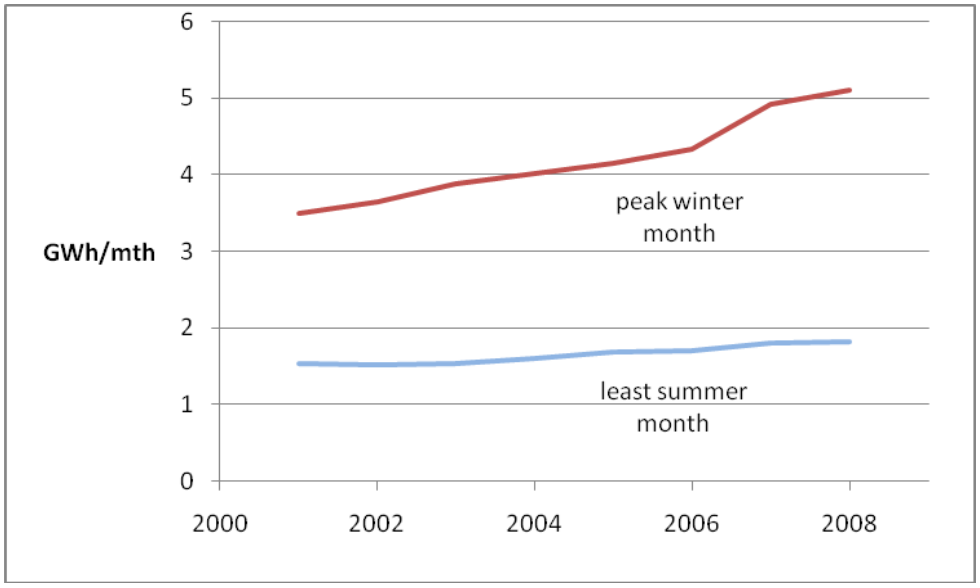

Figure 5: The highest and least monthly energy (GWh/mth/account) for residential customers on Gabriola.

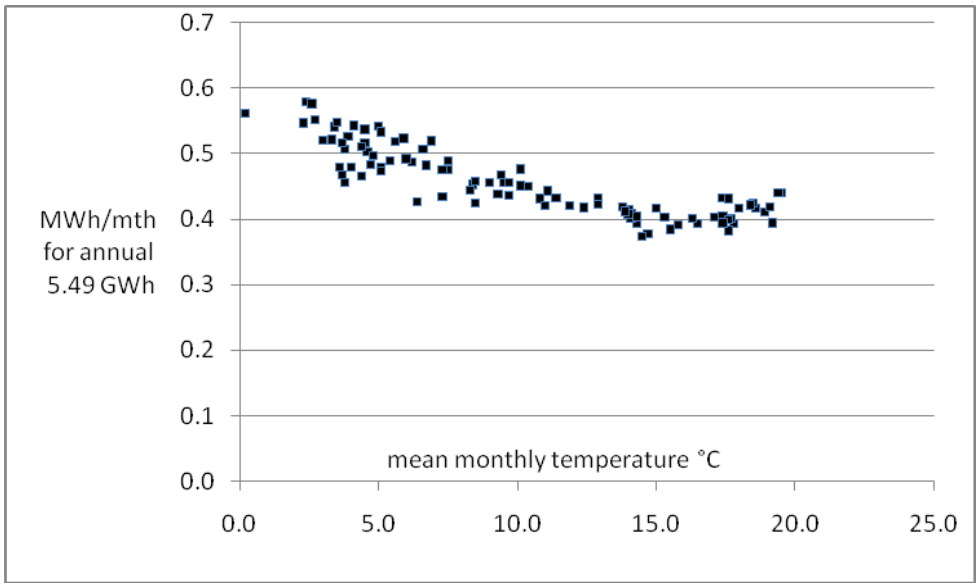

Figure 6: Total monthly energy (MWh/mth) for non-residential customers as a function of monthly mean temperature. All monthly figures for the period 2001–8 were normalized to the same annual figure (5.49 GWh, 2008) to reduce non-temperature-related scatter.

Figure 5 similarly shows Gabriola's electrical energy use by non-residential customers on a monthly basis as a function of average temperature for the month. Because non-residential users have less well-defined usage patterns than residents, the monthly energy figures have been normalized to have the same annual totals.

Non-residential use is less dependent on outside temperature than residential use. Interestingly, there is hint in the data that when the temperature is above about 18°C, consumption begins to

rise. A guess is that that this is due in part to additional requirements for refrigeration in retail stores selling food, and perhaps because restaurants are busier than usual when the weather is nice.

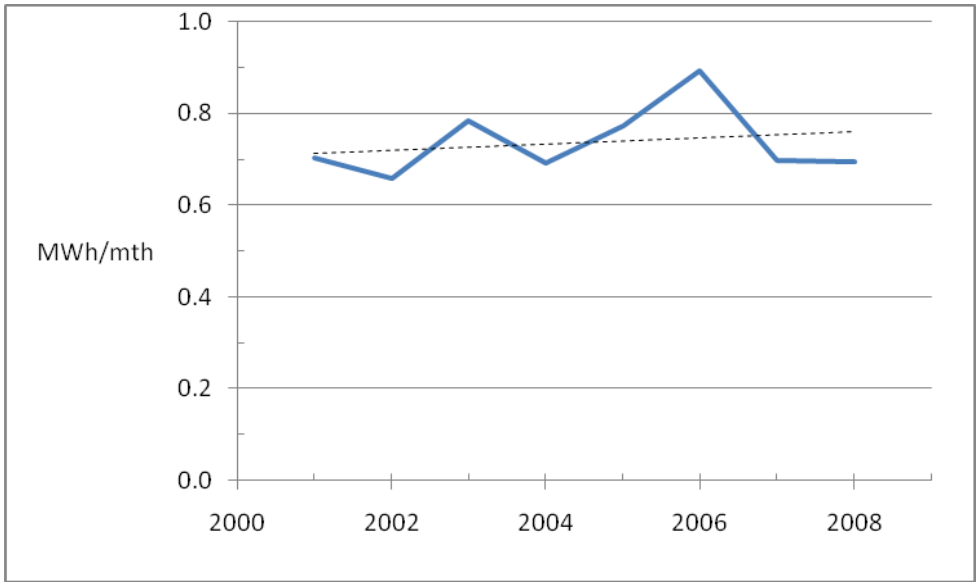

Figure 7: Estimated monthly energy (MWh/mth) per residence of the non-temperature-sensitive component over the period 2001–8.

An interesting statistical exercise is to see how the "base load", that is the non-temperature dependent component, and the "heating load" have varied over the years.

For residencies, the base load in 2008 of about 0.76 MWh per month per residence (1.04 kW/account) has possibly risen since 2001 at 0.9% per year, though the data is sparse. An increase in the base load might be expected given the increase in the number of "gadgets" in the home. The baseload constitutes on average roughly about 66% of the annual electrical energy used by residents on Gabriola, so this growth accounts for an average 0.6% annual growth in each home's total electrical use.

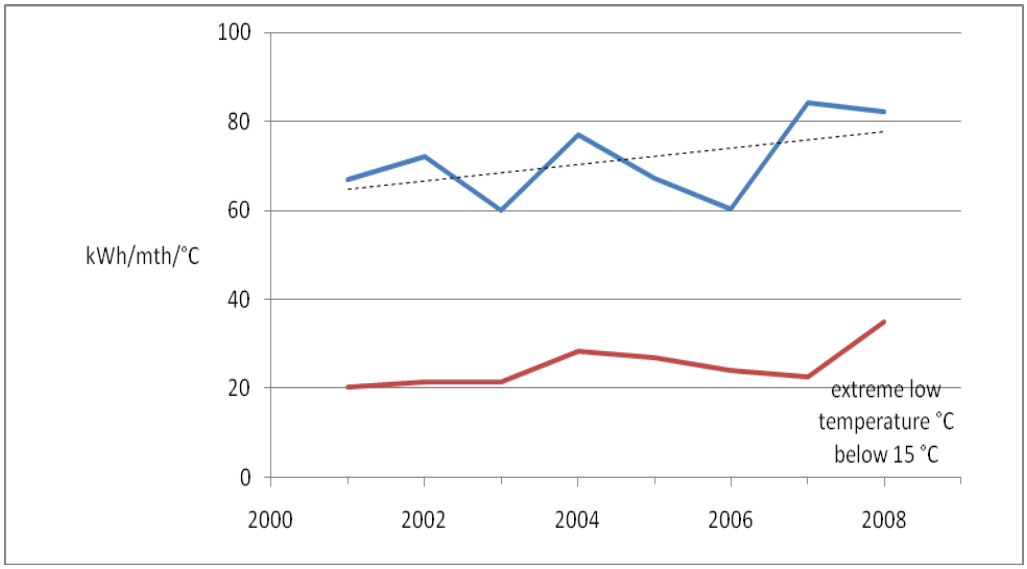

Figure 8: Estimated monthly energy (kWh/account/°C below 15°C) of the temperature sensitive component over the period 2001–8. Also shown is the lowest temperature of the year in °C below 15°C.

The heating load sensitivity in 2008 of around 77.9 kWh/mth/account/°C below 15°C (107 W) has risen since 2001 at 2.8% per year when it was 64.7 kWh/mth/account/°C below 14.5°C (89 W). The increase is perhaps unexpected given that modern homes are more effectively insulated. Perhaps modern homes are on average increasing in size, or we just set our thermostats higher than we used to, or new homes prefer to use electrical rather than other forms of space heating. The heating load constitutes on average roughly about 34% of the annual electrical energy used by residents on Gabriola, so this growth also accounts for an average 1.0% annual growth in each home's total use.

As noted, according to these numbers about 34% of the energy used residentially on Gabriola in 2001–8 has been for heat. This number varies from year to year. In 2008, it was an estimated 42% of 38.4 GWh = 16.0 GWh. The proportion has varied from year to year between 23% and 44%. These numbers are however only crude estimates as no hard data is available on what use individual residential consumers make of their power supply.

Bottom lines?

Gabriola's total (all users) use is growing at 3.5% per year over the past 8 years. The residential portion has been growing at 3.7% per year and the non-residential portion at 2.2% per year.

Of the 3.7% per year residential component, 0.6% is estimated to be due to an increase in baseload (non-heating) per account, and 1.0% is estimated to be due to an increase in heating requirements per account. Together with a 2.4% increase in the number of residential accounts, this makes an estimated 4.0%, which compares favorably with the actual 3.7%. The estimates for heating likely need to be improved to take into account the extra usage during extremely-low-temperature winter days.