UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

An Analysis of Suite-level Energy Consumption of Multi-unit Residential Buildings (MURB) in Vancouver

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SUMMARY

As the largest builder of Built Green homes in British Columbia, Adera strives to maintain a leadership role in sustainable building practices, to ensure lower consumption of energy, and to provide higher-quality indoor environment in the new residential buildings. However, those efforts are applied only during the planning and construction phase, which does not always guarantee lower energy consumption in the post-occupancy phase.

The objectives of the project is analyzing and comparing of actual end-user energy consumption data to the predicted energy modeling results in several categories, to determine how each component of the Adera's residential building uses energy-wise (e.g. common electricity kWh/m2/y; suite space heating kWh/m2/y, etc.), and to find out what is the most effect component for building energy efficiency, and what barriers and challenges remain. Assessment also tries to infer the degree possible to what extent behavior contribute to energy consumption versus the design feature of physical system. The results of the study will be used to develop better building design strategies that take into account energy efficiency in the new residential buildings, and to help current residents reduce energy consumption in retrofitted buildings.

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1. INTRODUCTION

1.1 Background and Purpose

Adera is a residential development company that strives to build and maintain its leadership in providing sustainable buildings. Towards this objective, Adera was able to obtain suite-level energy consumption data for several of its multi-unit residential buildings (MURBs) in the Lower Mainland. With these data sets and some building model and test data, Adera proposed to have analyses performed by a UBC student to understand energy consumption by major end users within MURBs, as well as to infer some differences in consumption due to occupant behavior. Six residential buildings were selected for study as summarized in Table1.

Table 1. Description of Buildings

Building Location Year Built	Type	Number of Suites, Floor Space	Energy Model? (Yes/No)	Certification	Energy Equipment
Legacy UBC 2007	4 Story, Apartment	55 57-155 m^2	No	REAP[1] Silver	Suite heat: EB, EFP Hot water: CB, geothermal preheat Strata electric: EB, lights, pumps, fans Strata gas: DHW, MAU
Red Richmond 2006	4 Story, Apartment	84 57-155 m^2	No	None	Suite heat: EB, EFP Hot water: CB Strata electric: EB, lights, pumps, fans Strata gas: DHW, MAU
Salus A Surrey 2009	4, Story, Apartment	73 57-155 m^2	Yes	None ("improved air tightness")	Suite heat: EB, EFP Hot water: high efficiency CB Strata electric: EB, lights, pumps, fans Strata gas: DHW, MAU
Salus Phase 1-3 Surrey 2009	Town House	153 96-225 m^2	Yes	Built Green[2] Gold	Suite heat: EB, EFP Hot water: suite EHT Strata electric: street lights Strata gas: none
Veranda Phase 1-3 Surrey 2006	Town House	90 96-225 m^2	No	None	Suite heat: EB, EFP Hot water: suite EHT Strata electric: none Strata gas: none
Veranda Phase 4-7 Surrey 2008	Town House	110 96-225 m^2	Yes	Built Green Gold	Suite heat: EB, EFP Hot water: suite EHT Strata electric / Gas: none

EB = electric baseboard heat; EHT = electric hot water tank; EFP = suite electric fireplace; DHW = domestic hot water; CB = common boiler; MAU = makeup air

[1]**REAP** (Residential Environmental Assessment Program) is a UBC-specific green building rating system for mandatory application to all residential construction on campus. The program is modeled after the US Green Building Council's LEED® Green Building Rating System.

[2]Canadian Home Builders' Association introduces **Built Green™** standard to promote construction of buildings that are healthier for the occupants and healthier for the environment. The program has four "build green" achievement levels: Brown, Silver, Gold and Platinum.

It is estimated that approximately 31% of Canadians living in apartment buildings (Maruejols and Young, 2010), and MURB are estimated to account for about 24% of the final, annual energy consumption within the residential sector. For instance, in the City of Vancouver (population 590,000), approximately 50% of the natural gas and 35% of the electricity are consumed in residential buildings.

Figure 1 illustrates the typical breakdown of total energy consumed in MURBS (2010): equipment amenity (14%); elevator (2%); electric baseboard heating (12%); fireplaces (18%); ventilation heating (19%); domestic hot water (DHW) (16%); lighting (10%); and appliances (9%),

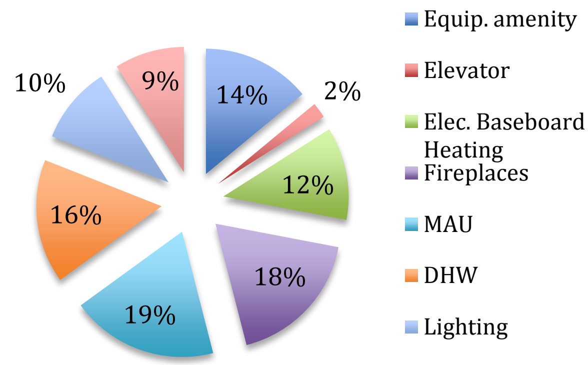

Figure 1 Distribution of Energy Consumption in Building

While there is a much information about residential building energy end-use energy consumption, data on the actual breakdown of energy use within buildings, and comparisons of actual data to modeled energy consumption factors are somewhat lacking .

The analyses of Adera's residential buildings in this study can provide significant information. First, the results have the potential to guide Adera in the developing new design strategies for future buildings. Second, studies of existing building energy consumption could be used to design interventions to help the residents and owners of these buildings to effectively lower their energy consumption and reduce greenhouse gas (GHG) emissions.

1.2 Objectives

The objectives of this project were:

- For all six buildings, estimate the breakdown of annual energy consumption data into the following seven categories
  - Suite lighting (electricity)
  - Suite plug loads (electricity)
  - Suite heating (electricity)
  - Suite hot water (natural gas, electricity)
  - Common area make-up air heating (natural gas)
  - Common area electric heaters, pumps and fans (electricity)
  - Common area lighting (electricity)
- Compare actual energy consumption to the predicted, pre-construction energy consumption model (for those buildings which were modeled, see Table 1)
- Identify potential energy-efficiency measures
- Infer the effect of individual behaviors contributing to actual energy consumption.

Because of metering arrangements, such as a single electric meter for each suite and a single gas meter for each building, it was feasible to breakdown energy consumption into the following five categories:

1. Suite lighting and plug loads (electricity)
2. Suite heating (electricity)
3. Suite hot water (natural gas, electricity)
4. Common area make-up air heating (natural gas)

5. Common area heaters, pumps, fans, and lighting (electricity)

There were additional challenges as well in separating out suite hot water use for those suits which have electric hot water tanks (for all townhomes).

2. LITERATURE REVIEW

A Literature review has been conducted using building energy surveys, commercial study reports, and academic research papers in order to gain a better understanding of the methods used to analyze energy performance data and to compare the energy intensity results for Adera buildings.

2.1 Natural Resources Canada

Natural Resources Canada's (NRCan's) Office of Energy Efficiency (OEE, 2010) released the *2007 Survey of Household Energy Use (SHEU-2007) Detailed Statistical Report*. The objective was to gather information on energy use and the factors affecting energy use in households that reside in detached houses and MURBs.

The data was collected from a sample of 9,773 households intended to represent 12.9 million households across Canada. Of the 12.9 million households, 1.74 million households were in British Columbia, and 1,207 dwellings in British Columbia were chosen as samples among the 9,773 sample households. The dwelling survey, included single detached houses, double/row houses, mobile homes, low-rise apartments (fewer than five storeys), and high-rise apartments (with five or more storeys).

The survey showed that, 7.7% of the total residential buildings were built between 2000 and 2007 across Canada, and approximately 20.2% of the residential buildings were low-rise apartments in British Columbia. Electricity (31.6%) and natural gas (48.9%) were the two main energy sources used for heating. Energy intensity (total annual gas/electric/other fuel energy consumption per unit area) in the buildings was broken down by region and housing type within Canada. The average energy intensity for all types of households in British Columbia is 0.68 GJ/m^2 (189 kWh/m2), compared to 0.83 (231 kWh/m2) for the entire country. Specifically related to low-rise apartment buildings in British Columbia, the average energy intensity is 0.54 GJ/m2 (150 kWh/m2).

In the report *Energy Use Data Handbook: 1990 – 2008*, NRCan (2010) has developed energy models and database in the report, and outlined the energy end use statistics within Canada. In model year 2008, Canada's secondary energy end use in residential sector included: space heating (63%), water heating (17.4%), appliances (13.8%), lighting (4.2%) and space cooling (1.6%).

2.2 RDH Building Engineering

Burnet et al (2011) presented baseline consumption data from a total of 39 MURBs (covered only 6 storeys and higher apartment buildings); which were all constructed between 1974 and 2002, and of the 39 study buildings, 34 are in Metro Vancouver and 5 are in Victoria. All of the buildings use a combination of natural gas and electrical energy. Average energy use intensity for MURBs in the Lower Mainland and Victoria is 213 kWh/m2/yr for the 39 buildings analyzed in the study. The average for Vancouver is

220 kWh/m2/yr and Victoria is 166 kWh/m2/yr.

For the 39 MURBs in the study, a summary of average energy consumption and distribution of energy sources is determined. However, as each building is unique, an average of values is provided:

- Average high-rise MURB consumes 213 kWh/m2/yr
- Average size of the MURBs within the study is 18 floors, 11,023 m2, and contains 113 suites
- Total electricity consumption (49%), 102 kWh/m2/yr
  - 57% of electricity is used in suite
    - 38% of suite electricity is used for electric baseboard heating
    - 62% is used for appliances, lighting, electronics, etc.
  - 43% of electricity is used in common areas
    - 100% is used for operation of elevators, lighting, HVAC distribution, ventilation, plumbing, fans, pumps, parking garage etc. Also within pools, hot tubs and other amenity areas. A very small portion is used for electric baseboard heat in lobby or other common areas
- Total gas consumption (51%), 111 kWh/m2/yr
  - 51% is used for space heat within make-up air units and (where present) fireplaces
  - 49% is used for DHW
- 37% of the total building energy is used for space heat

- 69% of space heat is from gas
- 31% of the remaining space heat is from the in-suite electric baseboard heaters or other electrical heating appliances

NRCan (2009) has further study on Multi-Unit Residential Buildings (MURBs), It was found significant differences in the energy consumption in low-rise apartment buildings based on who paid for the energy. Where someone other than the occupant (i.e. landlord or strata corporation) was responsible for paying at least one of the dwellings energy source, the average energy intensity was 1.62 GJ/m2 (450 kWh/m^2). In contrast, where the occupants pay for all of their energy uses the average energy intensity was 0.68 GJ/m2 (172 kWh/m^2).

Another study of energy use in mid- to high-rise MURBs from RDH (2011) was also shown that space heating and overall energy consumption has not decreased in newer MURBs and actually appears to have increased slightly. Newer MURBs (constructed from the 1990s to present) use more energy on average than the older buildings (constructed between the 1970s and 1980s) based on the analysis of the study buildings. In addition, the overall effective thermal performance of MURBs has not improved, and the amount of space heating associated with ventilation has increased.

2.3 BC Hydro

BC Hydro argues in their *BC Hydro Apartment Report (2011)* regarding to the RDH found that in their sample of 39, ~1990s buildings "the average British Columbia high-rise apartment suite (gross) used more energy than was thought, and far more than they ‘should’”. BC Hydro observed that even Government data services in Canada, and the US, failed to collect much of this energy information when intensity numbers are to be calculated. In NRCan’s report, for electrically heated apartments, the natural gas for the hot water, and the make-up air, as well as the electricity for the commons area are missing, for non-electrically heated apartment units, the commons area electricity is not included, and these omissions can be significant.

Although the information summarized from the RDH work is very useful, where high-rise apartments were carefully studied, baseline and benchmark were provide for build new information, BC Hydro suggested what really needed is to expand the knowledge of high-rise buildings, beyond the 39 studied so far by RDH Building Engineering, and also to do the same type of study on low-rises, such as light building audits, and aggregating the monthly gas and electricity information for a significant number of buildings.

Meanwhile, BC Hydro explored some interesting observations in their report:

(1) In British Columbia high-rise apartment buildings use more energy per dwelling unit than (electrically heated) houses. Recently constructed apartment buildings appear to be less energy efficient than older buildings, as building-wide average electricity consumption is increasing

(2) Recently constructed electrically heated apartment suites use less electricity than older electrically heated suites. Recently constructed non-electrically heated apartment suites use more electricity than older suites. Each age group of suites, within itself, has fairly flat consumption. Differences may be due to more appliances and electronics use

within the suites, and interactions with the electric space heat needs, and the gas heated hallways.

2.4 Others

Another study by Joy H. Wang (2011) explores the adaptation and application of the National Energy Modeling System (NEMS) for estimating the energy impacts of consumer behaviors. The research found that most of energy efficiency solutions to alleviate human energy and environmental impacts have been only focused only on technological solutions, for instance, improved insulation, more efficient heating equipment, better windows and new lighting technologies can all help reduce the energy burden of human existence; but few estimates of energy savings was conducted from residential behavioral change due to the difficulties of modeling such behavioral change.

It was point out that current demand response programs that provide consumers with energy consumption information are small-scale. They currently focus mainly, on peak load reduction, requiring minimal participation from the consumers. In British Columbia, 90% of household consumption occurred during the dinner hour from TV, lighting, refrigeration, and cooking loads. If demand response is used day to day by all the consumers, BC may be able to realize not only greater energy savings, but also greater integration of renewable energy within the electrical grid.

The study also investigated the existing energy models, which estimate of residential energy use; many times the models do not consider consumer behavior impacts on energy demand. Frequently, engineering models are found to overestimate savings from energy efficiency measures, such as home retrofits, by as much as 8-30% due to little consideration for occupant behavior.

3. DATA AND METHODOLOGY

3.1 Data Sources

3.1.1 Building Energy Data

For the purpose of this project, no site measurements were required. The square footage of suite units and common areas was obtained from records drawings and original modeling files (such as project summary and statistics data), mechanical drawings and floor plans. Detailed electricity and natural gas consumption data were provided by Mr. Tom Awram.

The available energy consumption data from BC Hydro & Fortis BC was for the period starting from January 2011 to December 2011. It should be noted that natural gas and electricity is metered on a single meter for the common area and hence, so the data obtained for Legacy Apartment, Red Apartment and Salus Apartments – A covers the entire building's common gas and electricity consumption; meanwhile, the electricity is also metered on a single meter for each suite of Salus Townhouse Phase 1-3, Veranda Townhouse Phase 1-3, and Veranda Townhouse Phase 4-7 buildings, which are electric-heating Townhouse buildings. The summary of energy consumption data supplied by Adera is described in Table 2, and detailed data is shown in Appendix A, Table 1 to Table 12.

Table 2. Summary of Building Actual Energy Data

Building	Suite Level Electricity	Common Area Electricity	Common Area Natural Gas
Legacy	Monthly, Jan - Dec 2011	Monthly, Jan - Dec 2011	Monthly, Apr 2011 - Mar 2012
Red	Monthly, Jan - Dec 2011	Monthly, Jan - Dec 2011	Monthly, Mar 2010 - Aug 2012
Salus A	Monthly, Jan - Dec 2011	Monthly, Jan - Dec 2011	Monthly, Aug 2011 – Jul 2012
Salus TH	Monthly, Jan - Dec 2011	/	/
Veranda TH P1-3	Monthly, Jan - Dec 2011	/	/
Veranda TH P4-7	Monthly, Jan - Dec 2011	/	/

Among the data supplied above, the common area natural gas data provided for Red has many errors, such as missing month data. Also, the electricity data provided for Salus A not only includes Salus A, but Salus B, C, and D apartment suites and common areas, in this case, the electricity data of Salus A was separated by based on percentage of gross area of A from 4 apartment's gross area.

3.1.2 Weather Data

When more than one year of data is available, annual and monthly patterns are reviewed for consistency. The monthly energy consumption data is normalized for weather. The weather normalization is to adjust energy consumption data to factor out the variations in the outside air temperature and it allows a fair comparison of yearly energy consumption of different buildings as well as buildings in different places.

Heating degree days (HDD), which used to normalize the energy consumption of the buildings, are obtained from Environmental Canada. The summary of monthly Heating Degree Days in 2011 at Vancouver International Airport was shown in Table 3.

Table 3. Summary of Heating Degree Days (Vancouver, 2011)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2011	428	428	345	320	211	84	30	11	57	251	386	440	2990

3.1.3 Energy Modeling Results

As the Province of British Columbia continues to increase its environmental and green goals, there are already a variety of new standards that builders are required to meet. Natural Resources Canada introduced EnerGuide for New Houses in 2006 to help plan and build new homes that are cost-effective and energy efficient, lower greenhouse gas emissions and save energy. An EnerGuide rating is required for all new houses programs. As a Platinum sponsor of Built Green BC, Adera is the largest builder of Built Green homes in BC. The Canadian Home Builders' Association has recognized Adera as Built Green Builder of the Year for three consecutive years (2009-2011).

All of their achievements were contributed to apply BuiltGreen consulting and house energy modeling sustainability programs. E3 Eco Group, a certified sustainable building consultant advisor conducts Adera's Built Green projects, to provide insight and cost-effective advice before the construction, to test the integrity of building envelope throughout the building process, and to ensure the end result meets municipal and program standards.

E3 Eco Group used HOT2000 software to evaluate energy efficiency. HOT2000 building energy simulation tool is the most current reference calculation program for the EnerGuide New Housing Program and the basis for government policy work in energy efficiency in Canadian housing. HOT2000 software had simulated three residential construction projects; which are Salus A, Salus TH and Veranda TH P4-7, to forecast energy consumption; and estimate energy requirements for space heating, water heating, lighting and appliances at the design stage.

Among the modeling results supplied, air leakage test is provided. Controlling air leakage is a major factor in building envelope performance; and airtightness is the remaining determinant of whether a building envelope will be energy efficient or not.

The summarized energy modeling results provided by Mr. Tom Awram is in Table 4, and the original data is in Appendix A, Table 19 to Table 21. Meanwhile, among the energy modeling data of Veranda TH, data were only collected for 99 units, and the data for 11 units has been missed.

Table 4. Summary of Building Energy Modeling Results

Estimated Results	Salus A (73 units)	Salus TH (153 units)	Veranda TH P4-7 (110 units)
Total Energy Consumption	Based on Sections 1-3*	Based on each unit	Based on each unit
Energy Intensity	Based on Sections 1-3*	Based on each unit	Based on each unit
Suite Level Electricity: Space Heating	Based on Sections 1-3*	Based on each unit	Based on each unit
Suite Level Electricity: Lights/Appliances	Based on Sections 1-3*	Based on each unit	Based on each unit
Common Area Electricity	Based on Sections 1-3*	N/A	N/A
Common Area Natural Gas: DHW	Based on Sections 1-3*	Based on each unit	Based on each unit
Common Area Natural Gas: MAU	N/A	N/A	N/A
Air Change Rate @ 50pa	Based on Sections 1-3*	Based on each unit	Based on each unit

* Section 1including 22 units & 2 corridors;
*Section 2 including 20 units & 4 corridors;
*Section 3 including 27 units & 4 corridors

3.2 Methodology

3.2.1 Energy Data Analysis

Evaluating energy performance of residential buildings usually involves quantifying the total annual energy consumed for various energy sectors such as gas to heat make-up air unit (MAU) for corridor's space heating, to heat domestic hot water (DHW), to heat pool/hot-tubs and suite fireplaces; and electricity to suite-level for heating baseboard, miscellaneous electric load, plug load; or electricity to common area for interior lighting, central control system and recreation area etc.

In this study, electric baseboard heaters in each suite of the buildings provide space heating, and electricity is also used for lighting and to power home appliances and plug-loads. Natural gas is used for domestic hot water heating and for common area space heating in the apartment buildings, and no natural gas involved in the townhouse energy consumption.

Energy consumption values are usually represented in either kWh or GJ. Here, the convention kWh is used throughout the whole report. Gas consumption data provided by utilities are given in GJ, which, are converted to kWh (1GJ = 277.77 kWh). Energy intensity in kWh/m2 is used to compare the buildings' total annual energy consumption. Electricity and gas meters are supposed to be read regularly at about 30 day of intervals. The amount of energy used for space heating calculated is the method used by RDH Engineering's study. Assuming, for the moment, that the direct space heating is either turned off or dormant for the summer (from June to August, or sometimes longer); an average for the non-variable data can be established and subtracted from this heating data. This is likely to be a conservative approach to determining space conditioning heat energy. Similarly, the gas make-up air unit may not operate over the summer, and suite electric baseboard heaters are also may not operate in the summer.

The non-variable data baseline for gas includes domestic-hot water, and a non-variable data baseline for electricity, namely electrical appliances, such as stoves, all lighting, elevators, miscellaneous electric loads, and plug loads, etc. The assumption that baseline of electric loads and baseline of gas DHW load can be simply separated from suite electric data and common area gas data; and the amount of electricity or natural gas used for space heating can then be calculated by summing up the differences between the total electricity or natural gas used for each month and the average non-variable electricity or natural gas figure.

Using energy billing data of building Legacy as an example, Fig. 2 presents total monthly energy consumption for Legacy and Fig. 3 presents total monthly estimated space heat energy for building Legacy, a typical energy breakdown method in the study.

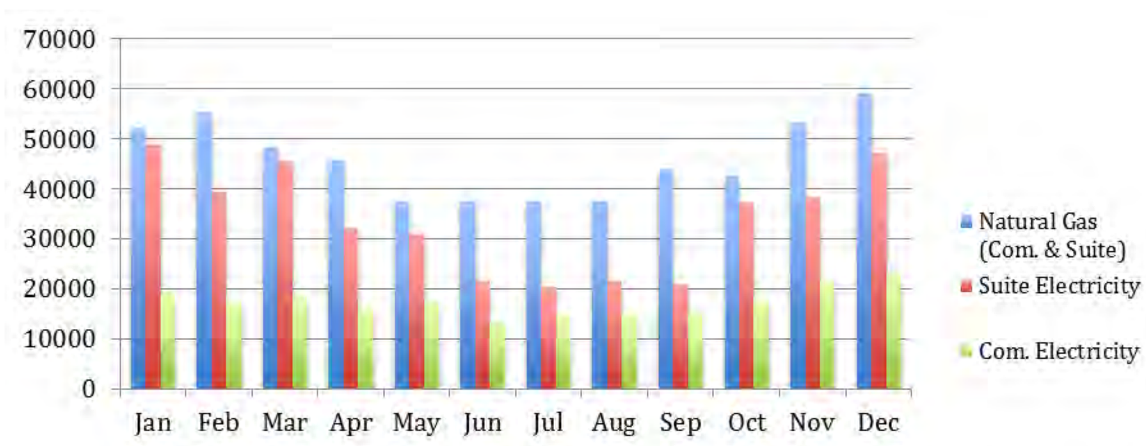

Figure. 2 Legacy - Monthly Energy Consumption, kWh/month

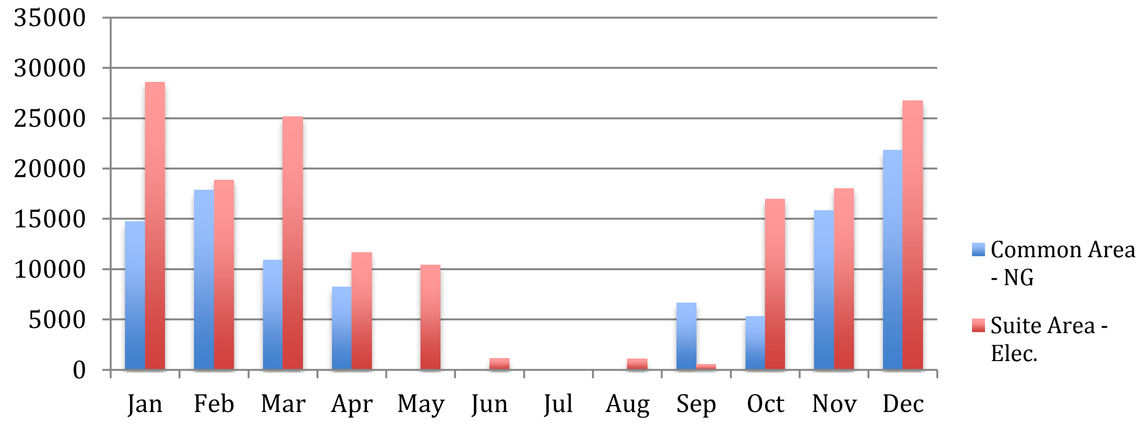

Figure. 3 Legacy - Monthly Space Heating Energy Consumption, kWh/month

3.2.2 Weather Normalized Baseline Value

To determine the weather normalized baseline values, the monthly suite electricity and common natural gas consumption data are plotted versus the monthly heating degree day (HDD) value. Various regression techniques were performed; and for the suite or common energy consumption, linear regression best predicted the electrical and natural gas use for a given HDD.

Typically, it has been assumed that space heating is linearly related to heating degree days to weather normalize utility data. From the analysis of the buildings in this report, this holds true for space heating energy that is controlled on a thermostat which remains at a constant set-point year round. Make-up air units are a good example of this, as the MAU set-point is based solely on exterior air temperature which is directly proportional to the Heating Degree Day value. Make-up air unit gas consumption tends to dominate the gas space heating use in apartments so gas use can typically be approximated using linear relationships to Heating Degree Days based on billing data. This linear dependency is shown for Buildings Legacy as is shown in Fig. 4.

Adjustment of the baseline heating degree day value (i.e. from 18°C to say 15°C or 12°C) does not affect the relationships discussed above. A lower HDD baseline compresses the data at lower HDD values which reduces resolution of the summer to spring/fall months but does not change the relationship. It was found that a18°C baseline best correlates with the space heating data (gas or electrical), the same analysis was performed for all buildings on this assumption.

In addition, when analyzing common electrical data, the relationship between heating degree days and energy use tends to be linear, however, the correlation tends (R^2 = 0.6781) to be poor to HDD as space heating energy (e.g. electrical baseboards in corridors, if have) makes up only a small fraction of the total energy. Therefore when weather normalizing common area electricity there is some uncertainty in the data, and only an average use can be determined.

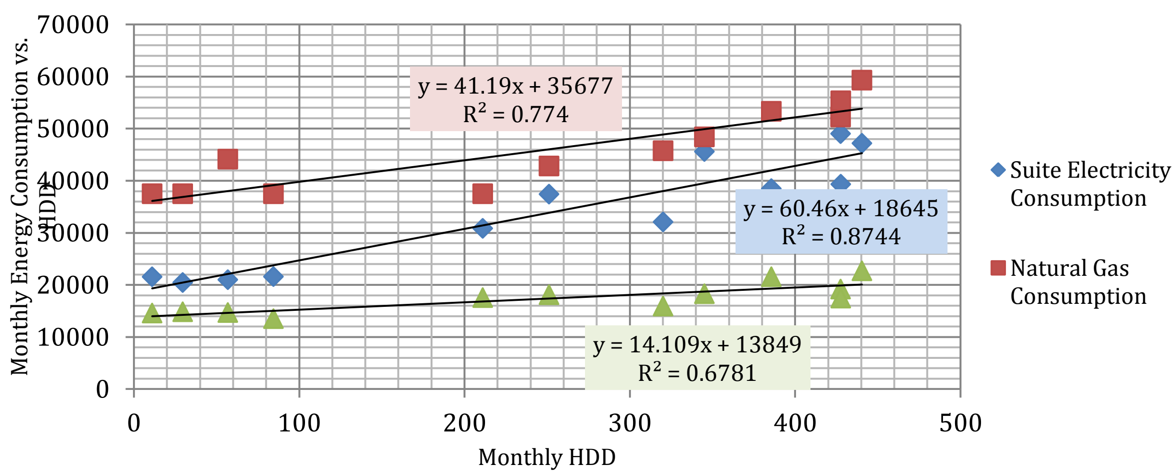

Figure. 4 Legacy - Monthly Energy Consumption vs. Heating Degree Days, kWh/month

From this analysis, the monthly baselines of electrical consumption at suite level and natural gas consumption in common area of approximately 18, 645 kWh / month and 35,677 kWh / month respectively are determined (see Fig. 4), and this is considered that the least heating degree day is in August (11 HDD). However, a visual non-weather normalized analysis of this baseline load are20, 443 kWh / month and 37, 493 kWh / month, which the bill data shown July is the lowest energy consumption month. The total energy consumption for building Legacy is 1, 164, 172 kWh/y comparing to weather normalized energy consumption of 1, 164, 180 kWh/HDD/y.

Using the relationships developed for heating degree days versus suite electricity consumption (y = 60.46x + 18645) and HDD versus natural gas consumption (y = 41.19x + 35677) above, the monthly space heating energy consumption can be determined for a Vancouver weather 2011 year (CWEC data, 2990 HDD) and is plotted in Fig. 5.

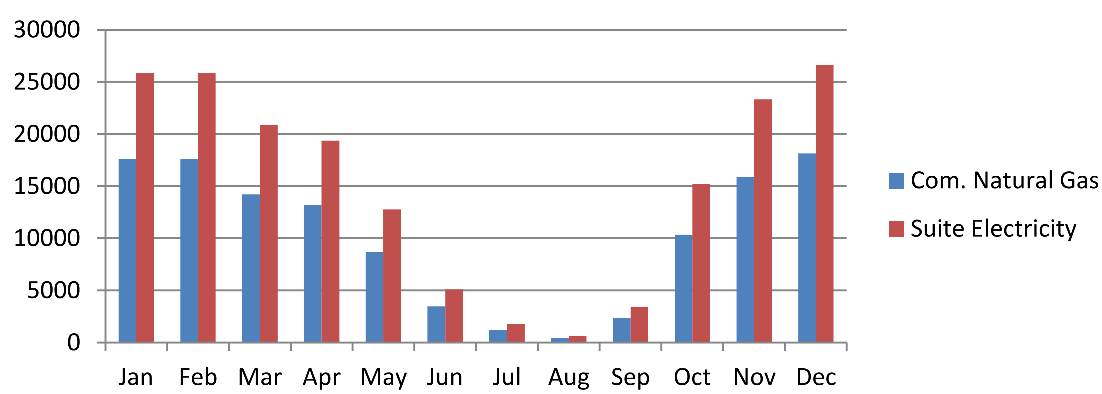

Figure. 5 Legacy - Monthly Normalized Space Heating Energy Consumption, kWh/HDD/month

3.2.3 Building Air Leakage Evaluation

Controlling air leakage is a major factor in building envelope performance. If assume all new buildings have a reasonable level of insulation (e.g. prescriptive or performance-based standards for insulation R-values, glazing products, etc.), airtightness is the remaining determinant of whether a building envelope will be energy efficient or not. It has concluded that up to 40% of the energy consumed to heat or cool a building is due to air leakage into and out of buildings.

Normalizing airtightness to airflow per enclosure area is most useful as this can quickly be converted into a total airflow rate and hence effective air-exchange rate for the building/suite by uncontrolled in/exfiltration. The industry has adopted an air tightness rating of cfm/ft2 of enclosure area as one such measure, and a measurement of the normalized air tightness of the building enclosure component is needed at a standard pressure, typically at 50 or 75 Pa. Multiply the airtightness by the enclosure area and by 60 min/hour and divide the sum by the building volume to determine an hourly air-exchange rate which can be input into most energy models.

The unite measure of airtightness rates ACH50 (air changes per hour at 50 Pa) has been adopted in the building energy modeling, and the Industry Standard of residential airtightness rates from ASHRAE will be used to evaluate energy performance of the buildings.

4. RESULTS AND DISCUSSION

4.1 Energy Consumption Analysis

Data from six buildings is covered in this report. However, some data was deemed unsuitable due to a number of reasons, including: missing or erroneous data, metering issues (i.e. single gas or electricity meters for several buildings grouped in complexes), difficulty in splitting energy consumption in buildings with mixed energy use (lights, pumps and fans on the same meter in common area), or lack of reliable data on the buildings (electricity meters for single unit misrelated to correct unit). All of the three apartment buildings use a combination of natural gas and electrical energy, and all of the other three townhouse buildings only use electricity energy.

In this case, only energy impacts of common area space heating (MAU), common area appliances (e.g. pumps, fans and lighting), hot water heating (DHW), suite-level space heating, and suite-level appliances (e.g. TV, laundry machine, micro-oven, etc.) in whole building will be evaluated in this report due to the data and time limitations.
More detailed data including portions of electricity and gas used for space heating was summarized in Tables A13 and A18 in Appendix A. These tables also summarize the total energy consumption and distribution of the energy.

4.1.1 Energy Breakdown - Legacy

Legacy Apartment consists of 55 suites of one to four bedrooms in four storeys. Suite area is from 69 m2 to 155 m2. The gross floor area is 7,582 m2, which including common area 887 m2 and suite area 6,695 m2.

Using the typical energy breakdown method introduced in Methodology Section to analyze the five energy consumption categories for building Legacy (see Fig. 3 and Fig. 4), it has been found that the majority of energy used within Legacy is electricity, accounting for 52% of the total energy used comparing to 48% of gas usage. The space heating including common and suite area is account for 22% of the whole energy consumption, which 61% of the space heating energy source is from gas.

Energy consumption breakdown categories are demonstrated below:

- Total Energy Consumption (100%), 1, 164, 200 kWh/y
- Total Gas Consumption (48%), 551, 300 kWh/y
    - Suite DHW (39%), 449,900 kWh/y
    - Common space heating MAU ((9%), 101,400 kWh/y
- Total Electricity Consumption (52%), 612, 900 kWh/y
    - Suite Electricity (34%), 404,500 kWh/y
        - Suite plug-in & lighting (21%), 245,300 kWh/y
        - Suite Space Heating (14%), 159,200kWh/y
    - Common lights, fans and pumps (18%), 208,400 kWh/y

The weather normalized energy consumption for Legacy is 1,164,180 kWh/y, comparing to the non-normalized actual energy consumption 1,164,172 kWh/y, are similar, and the energy intensity for Legacy is 154 kWh/m2 based on normalized energy amount.

4.1.2 Energy Breakdown - Red

Red is a four-storey apartment building, which is composed of 84 one to three-bedroom units. The area of each suite ranges from 57 m2 to 109 m2, and the gross floor area is 7,938 m2, including a common area of 930 m2 and total suite area of 7,008 m2.

The non-variable data baseline for gas and baseline for electricity also can be separated from gas or electricity consumption by assuming the lowest non-variable point in the summer month July. Figure 6 presents total monthly energy consumption, Figure 7 presents total monthly space heat energy consumption and Figure 8 is monthly energy consumption versus Heating Degree Days.

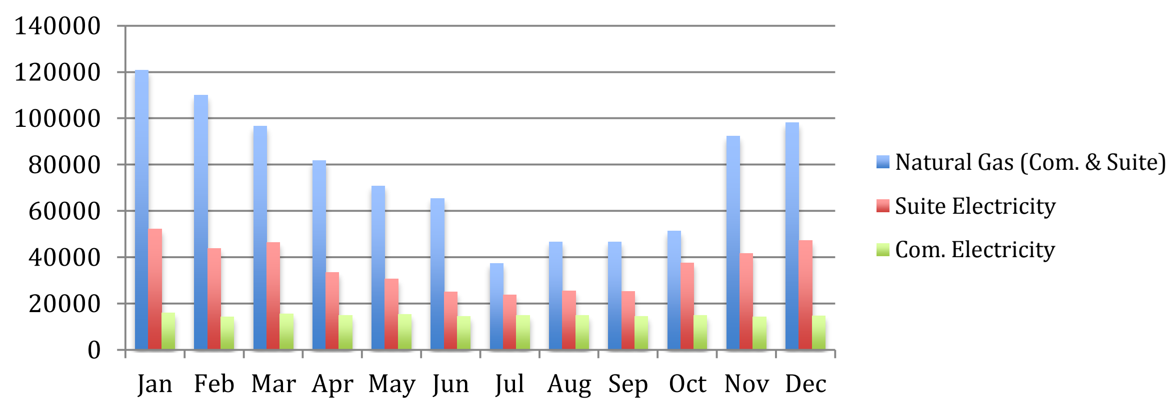

Figure. 6 Red - Monthly Energy Consumption, kWh/month

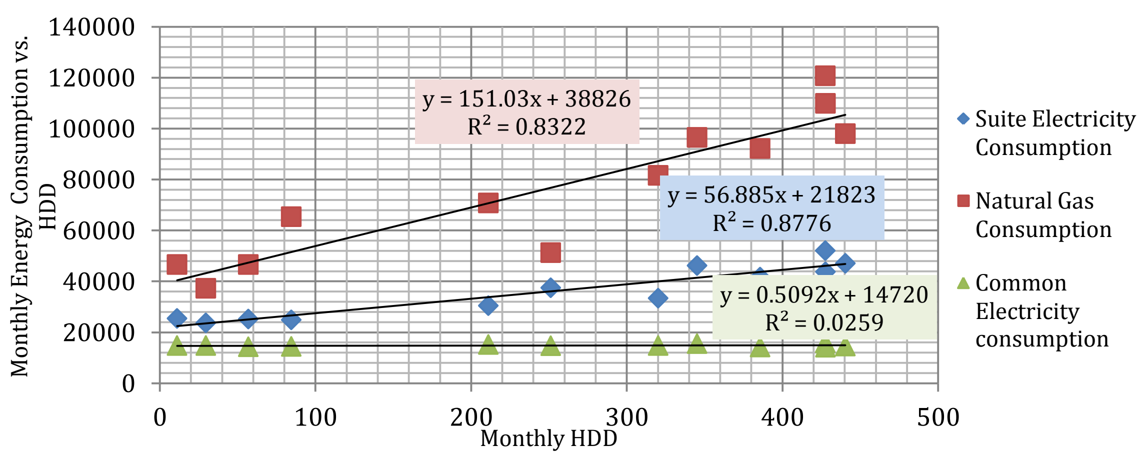

Figure. 7 Red - Monthly Energy Consumption vs. Heating Degree Days, kWh/month

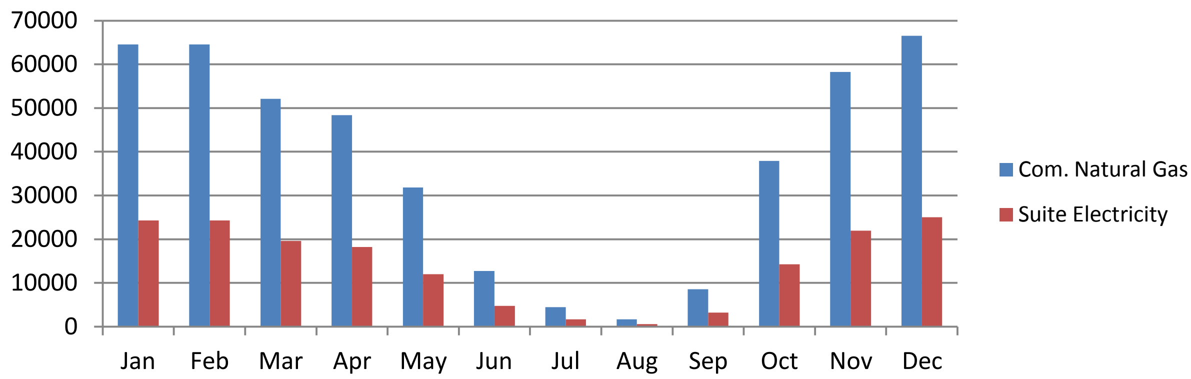

Figure. 8 Red - Monthly Normalized Space Heating Energy Consumption, kWh/month

Within Red, gas was accounting for 60% of the total energy used, comparing to 40% of electricity usage. The space heating is account for 41% of the whole energy consumption, and 31% is for common area corridor space heating and 10% is for suite space heating purpose, and of which half of the space heating energy source is from gas. The annual energy consumption amount of weather normalized is only 4 kWh more than the actual amount, and the energy intensity is 193 kWh/m2 for building Red.

Energy consumption breakdown categories are demonstrated below in details:

- Total Energy Consumption (100%), 1,528,000 kWh/y
- Total Gas Consumption (60%), 917,500 kWh/y
  - Suite DHW (29%), 448,000 kWh/y
  - Common space heating MAU ((31%), 469,500 kWh/y
- Total Electricity Consumption (40%), 610,200
  - Suite Electricity (29%), 432,000 kWh/y
    - Suite plug-in & lighting (19%), 285,000 kWh/y

- Suite Space Heating (10%), 147,000kWhy

- Common lights, fans and pumps (12%), 178,200 kWh/y

It should be noted that there were lots of error figures in natural gas billing data from May 2010 to August 2012 and hence, it was not possible to analyze the gas data as accurately as electricity data. The building Red uses approximately 917,500 kWh of energy provided by gas each year; and the energy intensity of gas consumption is 116 kWh/m2/y.

4.1.3 Energy Breakdown – Salus A

Salus A is quality built with energy saving and earth-friendly materials and is Built Green Gold verified. There are four floor plans offered with 73 one, two or three bedrooms and range from 59 – 92 m2, and the gross floor area is 5,852 m2, including a common area of 742 m2 and total suite area of 5,109 m2.

The baseline for gas and for electricity are breakdown from gas and electricity annual consumption, Figure 9 presents total monthly energy consumption and Fig. 10 presents weather normalized energy consumption. Meanwhile, Figure 11 presents total monthly space heat energy consumption.

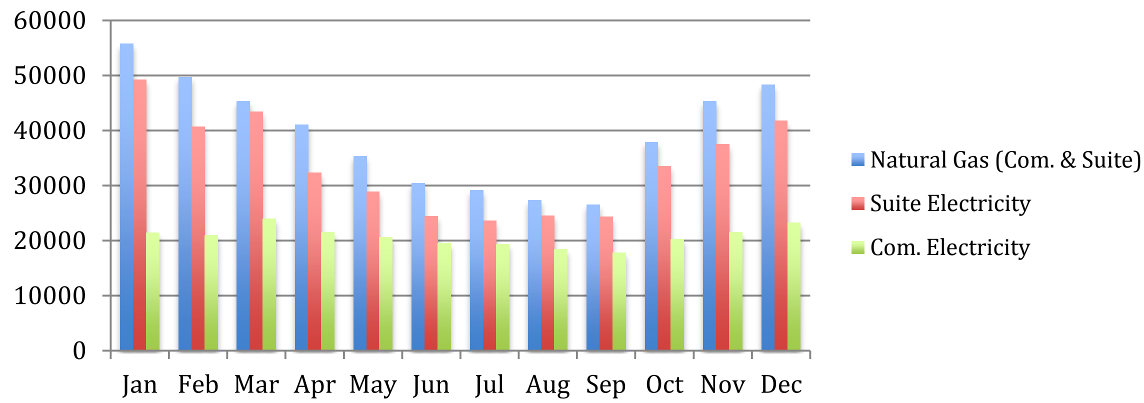

Figure. 9 Salus A - Monthly Energy Consumption, kWh/month

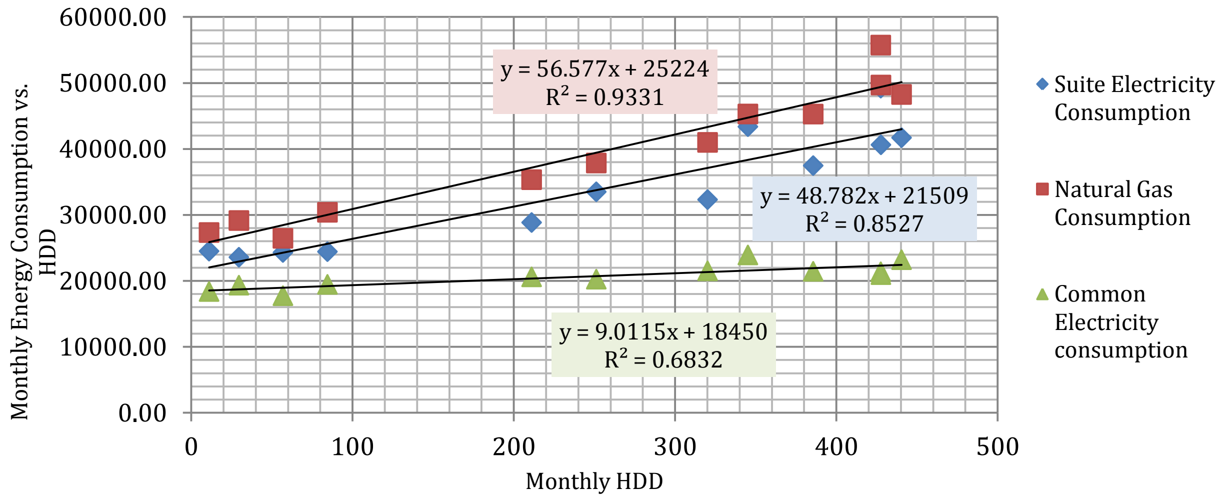

Figure. 10 Salus A - Monthly Energy Consumption vs. Heating Degree Days,

kWh/month

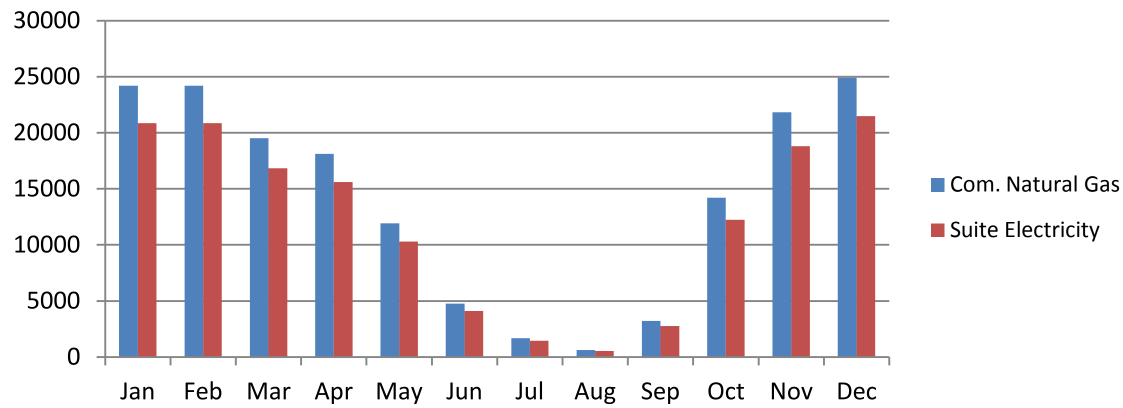

Figure. 11 Salus A - Monthly Normalized Space Heating Energy Consumption, kWh/month

Salus Apartment has the similar energy consumption pattern; the majority of energy used within Salus A is electricity, accounting for 58% of the total energy used comparing to 42% of gas usage. The space heating including common and suite area is account for 25% of the whole energy consumption, which 56% of the space heating energy source is from gas, suites' appliance equipment use 25% of all energy in the building, but common area electric appliances only present 12% of whole energy.

The total normalized energy consumption for Salus A is 1,124,200 kWh/y, and energy intensity was going to 192 kWh/m2/y, which is quite high if considering this building was built as Built Green sample. Energy consumption breakdown categories are shown below:

- Total Energy Consumption (100%), 1, 124, 200 kWh/y
- Total Gas Consumption (42%), 471, 900 kWh/y
    - Suite DHW (28%), 317,500 kWh/y
    - Common space heating MAU (14%), 154,400 kWh/y

- Total Electricity Consumption (58%), 652, 300 kWh/y
  - Suite Electricity (36%), 404,000 kWh/y
    - Suite plug-in & lighting (25%), 283,100 kWh/y
    - Suite Space Heating (11%), 121,000kWh/y
  - Common lights, fans and pumps (12%), 248,300 kWh/y

It should be noted that the total suite and common area electricity consumption calculated for above are not very reliable due to the fact that Salus apartment data is based on a single meter for four different apartment buildings and townhouses. There are 73 apartment units in Building A, 66 apartment units in Building B, 99 apartment units in Buildings C&D, on the lot/parkade are also seven townhouse units connected to the common domestic hot water. Also, they have different building envelopes and used different construction materials. They might use different mechanical systems of different efficiencies from different companies; and they also shared several common amenities (e.g., swimming pool & hot tub). In this situation, Salus A's gross area and common area figures were been used in order to separate the electricity consumption from the single meter bill.

4.1.4 Energy Consumption – Salus TH Phase 1-3

Salus phase 1-3 is a four-storey town house building, which is composed of 153 two and three-bedroom units. The area of each house ranges 108 - 224 m2, and the gross floor area is 18,293 m2. Due to no common area and no gas consumption involved in this town house, electricity consumption separation is easier, Figure 12 presents monthly energy consumption vs. HDD and Figure 13 presents total monthly normalized, baseline for suite lighting and electrical appliance and space heating energy consumption respectively.

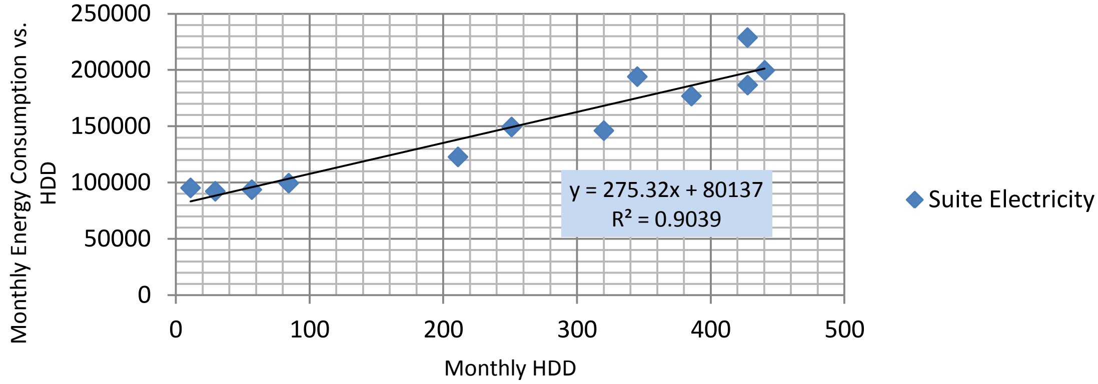

Figure. 12 Salus TH P1-3 - Monthly Energy Consumption vs. HDD, kWh/month

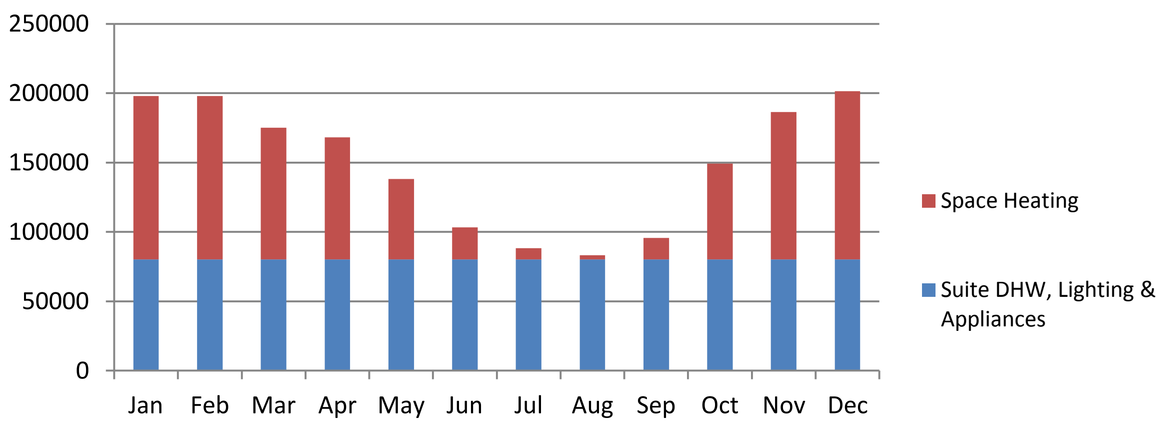

Figure. 13 Salus TH P 1-3 - Monthly Normalized Energy Consumption, kWh/HDD/month

Energy consumption breakdown factors are demonstrated below:

- Total Suite Electricity Consumption 1,784,887 kWh/y
  - 62% - Baseline Usage 1,106,964 kWh/y (i.e. DHW, lighting, appliance, and plug loads)
  - 38% - Space Heating 677,923 kWh/y (i.e. Electric baseboards)

4.1.5 Energy Consumption - Veranda TH Phase 1-3

Designer fireplace mantel and custom paint in Veranda townhouse, electric heating is very cost efficient, Veranda phase 1-3 is a four-storey town house building, which is composed of 90 two and three-bedroom units. The area of each house ranges 96 - 144 m2, and the gross floor area is 10,972 m2. Due to no common area and no gas consumption involved in this town house, electricity consumption separation is easier, and Figure 14 presents total energy consumption monthly normalized, and Figure 15 presents total monthly, baseline and space heating energy consumption respectively.

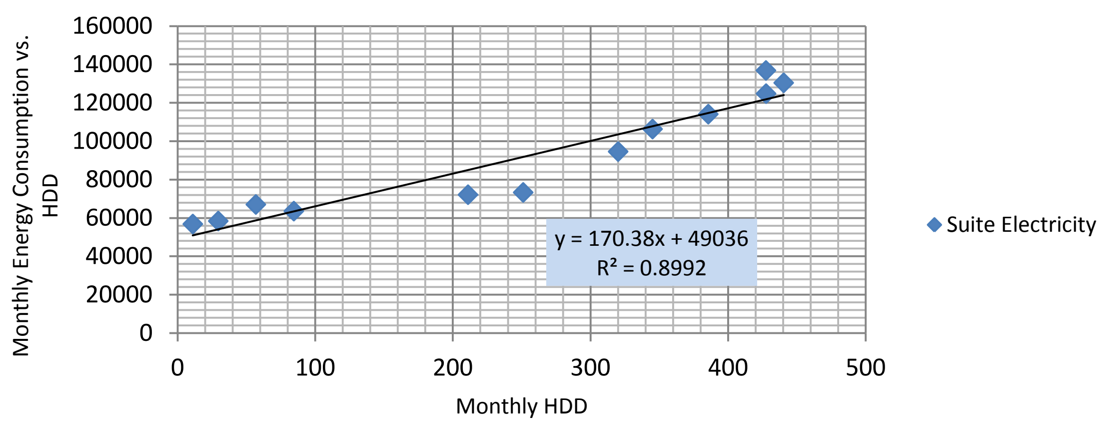

Figure. 14 Veranda TH P 1-3 - Monthly Energy Consumption vs. HDD, kWh/month

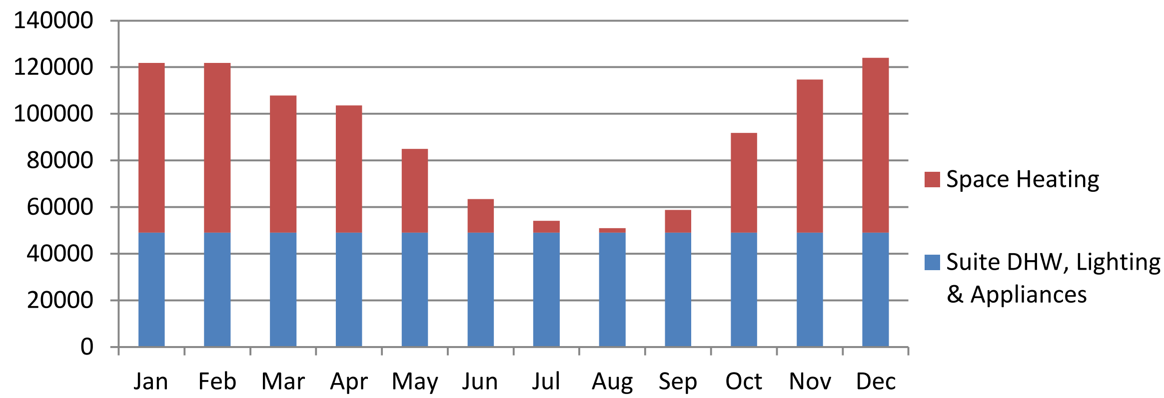

Figure. 15 Veranda TH P1-3 - Monthly Normalized Energy Consumption, kWh/HDD/month

Energy consumption breakdown factors are demonstrated below:

- Total Suite Electricity Consumption 1,097,895 kWh/y (100%)
  - 62% - Baseline Usage 681,630 kWh/y (i.e. DHW, lighting, appliance, and plug loads)
  - 38% - Space Heating 416,265 kWh/y (i.e. Electric baseboards)

4.1.6 Energy Consumption - Veranda TH Phase 4-7

Veranda phase 4-7 is a four-storey town house building, which is composed of 110 two and three-bedroom units. The area of each house ranges 96 - 144 m2, and the gross floor area is 13,059 m2. Figure 16 and Figure17 present total monthly weather normalized, baseline and space heating energy consumption respectively.

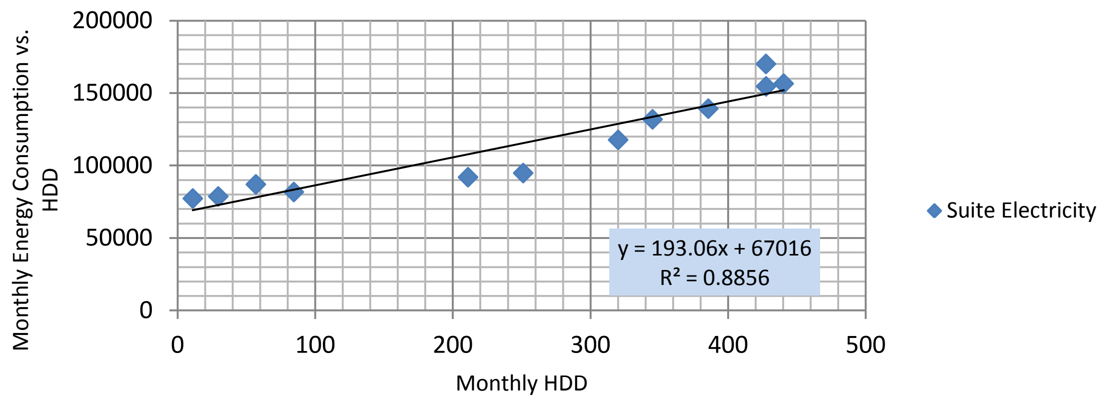

Figure. 16 Veranda TH P 4-7 - Monthly Energy Consumption vs. HDD, kWh/month

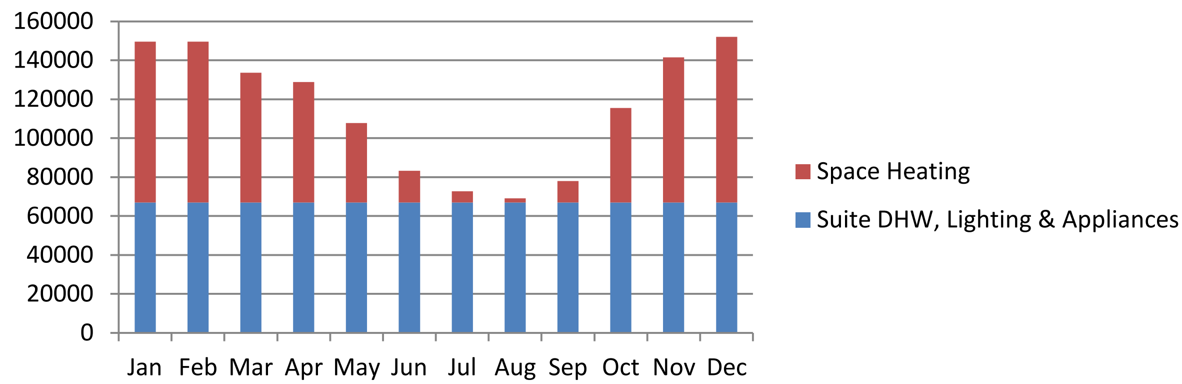

Figure. 17 Veranda TH P1-3 - Monthly Normalized Energy Consumption, kWh/HDD/month

Energy consumption breakdown factors are demonstrated below:

- Total Suite Electricity Consumption 1,381,459 kWh/y (100%)
    - 62% - Baseline Usage 927,147 kWh/y (i.e. DHW, lighting, appliance, and plug loads)
    - 38% - Space Heating 416,265 kWh/y (i.e. Electric baseboards)

4.2 Energy Consumption Comparisons

A comparison of energy consumption for the three apartment buildings and three townhouse buildings to the available modeling results and other residential buildings are presented in this section.

4.2.1 Total Energy Consumption

The total energy consumption result in Table 5 presents the total energy consumption for the six buildings, normalized by gross floor area. The average electricity consumption for apartment buildings is 89.73 kWh/m2/y, and the average gas consumption is 89.65 kWh/m2. The average total energy (electricity and gas) use intensity of apartments is calculated to be 180 kWh/m2/yr, the energy intensity of townhouse is 101kWh/m2, and the average energy intensity of all buildings is141 kWh.m2/yr. This is much lower than the energy intensity value from RDH Engineering's 2010 study in 39 MURBs, which was indicated 102 kWh/m2 for electricity consumption, and111 kWh/m2 for gas consumption, the total energy intensity is 213 kWh/m2.

However, the average total energy intensity for the three apartment buildings is about 33 kWh higher than the value from BC Hydro's database for energy consumption, which is 146 kWh/m2/yr (82 kWh/m2/yr for electricity and 63.89 kWh/m2/yr for gas) for low-rise (4 and lower than 4 storeys) apartment units with electric heat. The BC Hydro's database was based on its 1.5 million resident customer billing data and the energy intensity value mentioned above is for the low-rise apartment buildings that were built after 2007. In general, low-rise residential buildings that are gas-heated have higher energy intensity values than those electric-heated residential buildings.

Table. 5 Total Energy Intensity – Split by Electricity & Gas

Energy Intensity (kWh/m2)	Legacy Apartment	Red Apartment	Salus Apartment A	Salus Townhouse P 1-3	Veranda Townhouse P 1-3	Veranda Townhouse P 4-7	Average
Electricity Consumption	80.84	76.86	111.48	97.57	100.06	105.78	89.73
Gas Consumption	72.71	115.59	80.64	/	/	/	89.65
Total Energy Consumption	154	193	192	98	100	106	180

Building Legacy had less gas consumption as shown of 73 kWh/m2, comparing to RDH's statistics results of 111 kWh/m2, because Legacy uses geothermal pre-heat DHW system and the AFUE (Annual Fuel Utilization Efficiency) of heating system with 80% efficiency. Salus A also adapts high efficiency boiling for water heating and same 80% efficiency AFUE for air heating in the building. However, building Red, which is only used common boiler and normal heating equipment for MAU, used more gas 116 kWh/m2 for heating system. Summary of energy consumption by categories is demonstrated in Table 6.

Table. 6 Summary of Energy Consumption by Categories, per Suite

Energy Consumption Category	Electricity, per suite			Natural Gas, per suite	
	Suite Space Heating	Suite Lighting & Plug Loads	Common Lighting, Fans & Pumps	Common Space Heating (MAU)	Domestic Hot Water
Legacy Apartment	14% 2,895 kWh/yr	21% 4,460 kWh/yr	18% 3,789 kWh/yr	9% 1,843 kWh/yr	39% 8,180 kWh/yr
Red Apartment	10% 1,750 kWh/yr	19% 3,393 kWh/yr	12% 2,121 kWh/yr	31% 5,589 kWh/yr	30% 5,333 kWh/yr
Salus Apartment A	11% 1,656 kWh/yr	25% 3,878 kWh/yr	22% 3,402 kWh/yr	14% 2,115 kWh/yr	28% 2,349 kWh/yr
Salus Townhouse P 1-3	38% 4,431 kWh/yr	62% 7,235 kWh/yr (including DHW)	/	/	/
Veranda Townhouse P 1-3	38% 4,625 kWh/yr	62% 7,574 kWh/yr (including DHW)	/	/	/
Veranda Townhouse P 4-7	33% 4,130 kWh/yr	67% 8,429 kWh/yr (including DHW)	/	/	/

The energy use per suite is average 12,038 kWh/yr, and within a range from 9,883 to 15,540 kWh/yr. Building Legacy, with the highest consumption at 15,540 kWh/yr, which is a building with suites in the 100+m2 range, and the lowest consumption is Salus Apartment, which is with suites in the 55+m2 range.

Within each suite on average, 3,248 kWh/yr of 9,076 kWh/yr (36%) of the suite electricity is used for suite space heat. On average 31% of the gas used within these building is for common area space heat, therefore per suite 6,977 kWh/yr of energy is used for space heat in the whole building.

4.2.2 Actual Energy Comparing to Modeling Results

Energy modeling is performed to further understand how energy is consumed within buildings, and to assess the impact of certain parameters. Of the 6 study buildings, 3 buildings were selected for detailed energy modeling. The results of modeled were summarized in the percent of each simulation factor and total energy usage performance.

Table 7 Salus A: Energy Consumption vs. Modeling Energy Result

Energy Consumption Category	**Actural Energy Consumption**	**Modeling Energy Result**
Total Energy Consumption (kWh/yr)	1,124,200	610,000
Area (m2)	(73 unite) Unite 5,110 / Common 743	(66 unite) Unite 4,470 / Common 542
Energy Intensity (kWh/m2/yr)	192	122
Suite Electricity: Space Heating (%, kWh/yr)	(11%) 120,900	(9%) 52,670
Common Gas: MAU (%, kWh/yr)	(14%) 154,400	(2%) 5,867
Suite Electricity: Lights/Appliances (%, kWh/yr)	(25%) 283,100	(45%) 274,200
Common Area Electricity (%, kWh/yr)	(22%) 248,400	(5%) 33,250
Common Gas: DHW (%, kWh/yr)	(28%) 317,500	(39%) 244,110
Air Change Rate @ 50pa	/	2.9

From the modeling results, 66 unite and 10 common areas were modeled, the estimated building energy use intensity is 122 kWh/m2, the main energy consumption is suite lightings and appliances with 45%, and domestic hot water is using 39% of the whole energy. Comparing to modeling result, the actual lighting consumption in suite is only 25%, and it may be demonstrated that it is hard to simulate consumer's behavior of energy usage. Meanwhile, actually, Salus apartment has 73 unit with total 5,852m2 gross area, and the actual electricity for Salus A is split from the whole electricity bill, which is not reliable, those may explain why the calculated energy intensity (192 kWh/m2) is much higher than the estimated result of 122 kWh/m2.

When the gas-heating system, such as gas-heat boilers, and make-up air ventilation units, are involved in the modeling, it is hard to estimate the energy consumption in the apartment building due to gas equipment efficiency factors and energy losses of the building. However, air tightness rate is another way to evaluate the energy losses of the building, within Salus, air change rate per hour is 2.9 ACH@50 pa, comparing to Industry standard statistics 4.4 – 7.0 ACH@50 pa (ASHRAE, 2007) in Canada, this is a "tight" building with less energy losses, and it is also indicated in the space heating with only11% energy usage in the heating system.

The modeling results are more accurate when the residential buildings are electric-heating, such as townhouse unites. Table 8 and Table 9 summarized the comparing results for townhouse Salus and Veranda P4-7.

Table 8 Salus TH: Energy Consumption vs. Modeling Energy Result

Energy Consumption Category	Actual Energy Consumption	Modeling Energy Result
Total Energy Consumption (kWh/yr)	1,785,000	2,446,000
Area (m2)	Unite (153 unite) 18,300	Unite (153 unite) 22,620
Energy Intensity (kWh/m2/yr)	98	108
Suite Electricity: Space Heating (%, kWh/yr)	(38%) 677,900	(15%) 372,400
DHW (%, kWh/yr)		(30%) 733,300
Suite Electricity: Lights/Appliances (%, kWh/yr)	(62%) 1,107,000	(55%) 1,340,000
Air Change Rate @ 50pa	/	5.22

Table 9 Veranda TH P4-7: Energy Consumption vs. Modeling Energy Result

Energy Consumption Category	Actual Energy Consumption	Modeling Energy Result
Total Energy Consumption (kWh/yr)	1,382,000	1,651,000
Area (m2)	Unite (110 unite) 13,100	Unite (99 unite) 14,430
Energy Intensity (kWh/m2/yr)	106	115
Suite Electricity: Space Heating (%, kWh/yr)	(33%) 454,300	(21%) 342,900
DHW (%, kWh/yr)		(27%) 450,000
Suite Electricity: Lights/Appliances (%, kWh/yr)	(67%) 927,200	(52%) 858,500
Air Change Rate @ 50pa	/	5.65

For Salus TH, 38% of the total energy consumed was used for space heating & DHW and for Veranda P4-7, the energy used for space heating accounts for 33% of the total energy used; comparing to modeling, with 45% and 48% of energy for space heating and DHW individually. Actual electricity usage in suite for lighting and plug-in appliances in both townhouse is approximated 5 -7% higher than estimated consumption. Veranda has more energy losses than Salus, which is 5.66ACH @ 50pa for Veranda comparing to 5.22ACH @ 50pa for Salus, hence the energy for space heating accounts for 15% of the energy used in Salus but 21% of energy needed in Veranda, which infer to building with less air tightness related to high energy consumption within building.

4.3 DISCUSSION

4.3.1 Data Barrier

The main barrier that hindered the energy performance analysis in the buildings was a lack of dependent consumption data. All building uses its own electricity and gas meter to measure the amount of energy used. However, the data obtained contains missing data for some months or recording different intervals, such as Red, it was used the gas data from May 2010 to August 2012. For Salus A, the problem was that they share a single meter for measuring electricity with other three Salus buildings at the same location, for the purpose of analysis, the total electricity consumption of suite level and common area were divided by the sum of the Salus buildings' floor areas. However, they are buildings of different types and they might at least have different electrical equipments in their structure and have different wall thicknesses and window types. Also, they were constructed at a different time. For electricity, some of the consumption for each unit in each building was obtained from Adera and hence, it was possible to analyze the electricity consumption separately, however, that was not the case for gas.

The limitation in using modeled data to compare actual data is the assumption that all suites area and common area are based on the same gross area figures, which is not the case for all three building, and all sum amount area of the modeled are smaller than actual building. Meanwhile, in the modeled data, all suites regardless of size have the same amount of lighting and appliances and usage patterns in buildings, which are also unreliable. However, it gives a benefit to help infer the effects of air leakage and suite lightings related to space heating and occupancy behaviors for any similar building.

4.3.2 Potential Means to Increase Space Heating Efficiency

Of the total energy consumption in the buildings, the space heat portion is the second large of the energy usage for the building in the energy analysis. The thermal performance of the building heating system and air leakage are directly related to the space heat energy consumption, it is evident that the space heating consumes less gas (14%) when building use 80% high efficiency AFUE for gas-fired roof-top make-up air unit in building Salus Apartment, comparing to 31% of energy consumption on gas in building Red In this case, improving the thermal performance of the enclosure components and reduction in the amount of air leakage through the enclosure of the building could increase the heating system efficiency.

Use of high-performance HVAC

Employing high-performance HVAC equipment in conjunction with whole building design can result in significant energy savings. Typically, a 30% reduction in annual energy costs can be achieved with a simple payback period of about three to five years. However, note that highly energy-efficient design utilizing high-performance HVAC equipment often requires more effort and more collaboration from the design team than a conventional, sequential approach. Meanwhile, for existing building, outdated and inefficient equipment can be replaced for reducing energy consumption directly.

Achieving high-performance Air tightness

It is necessary to improve the air tightness of buildings to reduce the energy consumption of building. The design of a building and the quality of its construction will have a major effect on the amount of air leakage. The issue of air tightness needs to be addressed at the early stage:

Design stage:

- Identify the line of the air barrier on drawings
- Avoid complex detailing that is difficult to build as it may result in ad hoc air leakage
- Make sure specify air tight barrier materials

Construction stage:

- Air barrier management to undertake:
- Coordination of the formation of the air barrier
- Check and sign off all “hidden” air barrier elements before covering up

- Undertake air tightness testing at the earliest possible opportunity - some air leakage paths can be impossible to seal if they are only identified at completion stage

For the existing air tightness buildings, it is important to make the owner or property management company aware of the fact. They need to know the location of the air barrier in order not to compromise its effectiveness when carrying out future alterations. The efficiency of the heating and ventilation provided to the house depend upon the air barrier being maintained.

Airtightness techniques also can be used to improve the performance of existing buildings, such as applying an external mastic seal to all window and door frames; repairing any damage to window frames and ensure the casements, sashes and top-lights close firmly; and using sealant materials to fill the gaps around windows and doors to prevent air leakage from the reveals and thresholds.

4.3.3 Potential Saving Strategies on Occupancy Behavior

Except improved insulation, more efficient heating equipment, better windows and new lighting technologies, which can all help reduce the energy consumption, human behavior must be considered as one of solutions to achieve greater energy efficiency as well. However energy savings from residential behavioral change are difficult to be estimated by using modeling tools at the building construction level. Several strategies could be applied to increase potential energy saving from end-user behaviors.

Adaptive Occupancy Prediction Agent

Adaptive intelligently control Sensor Agents in the new or existing building to accurately estimate the number of occupants in a building, could enable significant gains in energy efficiency by enabling the HVAC system to be quickly adjusted to meet the needs of the current number of occupants in the room. The HVAC can be turned on if occupancy is predicted far enough in advance, so that the system has ample time to prepare the room for occupancy by heating or cooling it as needed. The machine learning techniques can estimate room occupancy using a set of simple sensors to predict room occupancy up to an hour in advance; the system can intelligently control the multi-agent HVAC system to minimize energy usage while maintaining occupant comfort.

Applying Energy management Program

One of the biggest barriers to behavior change with respect to energy saving is the “invisibility” of energy, and invisibility to see one’s energy use eliminated the opportunity to assess daily behavior and its effect on energy efficiency and ultimately learn from this process. With the advancement of technology such as smart meter for each home, energy flows have become almost undetectable to energy end-users. Providing feedback through different means, such as the energy consumption monitor, lets people become more directly aware of their own consumption even if they are unable to immediately see the economic consequences of this energy use.

Another one of the most significant barriers to effective behavior change is the lack of convenience for the necessary information. It has show that behaviors associated with inconvenience have low participation levels. It is important for residents to know how much energy their home consumes in order to evaluate what measures can be taken to use energy more efficiently. The energy assessment shows residents how they use energy, where the energy is wasted, how much energy and money can be saved over time. Home owners can perform a simple energy assessment from billing information or a professional energy auditor can be hired by property manager to perform a more thorough assessment.

The strategies listed above are general. It is required that the design company or current building management company to evaluate the actual situation in the buildings in order to find out measures that can be applicable specifically to the new buildings or existing buildings.

5. CONCLUSIONS

This study was established to evaluate the energy performance of Adera's six residential buildings and analysis of energy consumption was made. The results describe the energy use of the total 565 units containing 63,696 m2 of floor space, which about 61,136 m2 is the sum of individual units and 2,560 m2 is the sum of common areas. The average total energy intensity for all buildings was found to be 140 kWh/m2/y. Of this, 50% of the energy consumption was gas, approximately 48% of the gas was used for space heating and 52% of the gas was used for domestic hot water heating. Of the electricity used for all the six buildings in 2011, 31% was used for space heating, considering the total energy used by five categories, energy used for space heating was approximately 30%, 22% for suite lighting & appliance, 17% for common area lights, pump & fans, and 31% for DHW. Electricity used for other purposes could not be determined due to the lack of breakdown in end use energy consumption data. Air tightness level can be improved at the design and construction stage to increase space heating efficiency and applying energy management strategies to predict occupant behavior or access their behavior change is another ways to save energy consumption.

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APPENDIX A

Table A 1. Legacy Suite Electricity Consumption in 2011

Legacy	Jan	Feb	Mar	Apr	May	Jun	
Total Suite Electricity (kWh)	49033.77	39322.38	45595.37	32079.63	30847.50	21582.81	
Electricity for Suite Lighting & Appliances (kWh/HDDs)	20442.48	20442.48	20442.48	20442.48	20442.48	20442.48	
Electricity for Suite Space Heating per Heating Degree Days (kWh/HDDs)	28591.29	18879.90	25152.89	11637.15	10405.02	1140.33	
Electricity per Area (kWh/m2)	6.47	5.19	6.01	4.23	4.07	2.85	
Legacy	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Total Suite Electricity (kWh)	20442.48	21548.14	20988.00	37415.56	38471.50	47187.57	404514.71
Electricity for Suite Lighting & Appliances (kWh/HDDs)	20442.48	20442.48	20442.48	20442.48	20442.48	20442.48	245309.76
Electricity for Suite Space Heating per Heating Degree Days (kWh/HDDs)	0.00	1105.66	545.52	16973.08	18029.02	26745.09	159204.95
Electricity per Area (kWh/m2)	2.70	2.84	2.77	4.93	5.07	6.22	53.35

Table A 2. Legacy Gas Consumption in 2011

Legacy	Jan	Feb	Mar	Apr	May	Jun	
Total Common Gas (kWh)	52223.54	55342.89	48412.53	45748.72	37492.70	37492.70	
Gas for Common DHW (kWh/HDDs)	37492.70	37492.70	37492.70	37492.70	37492.70	37492.70	
Gas for Common MAU per Heating Degree Days (kWh/HDDs)	14730.84	17850.19	10919.83	8256.02	0.00	0.00	
Gas per Area (kWh/m2)	6.89	7.30	6.39	6.03	4.94	4.94	
Legacy	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Total Common Gas (kWh)	37492.70	37492.70	44137.65	42821.02	53320.73	59306.67	551284.56
Gas for Common DHW (kWh/HDDs)	37492.70	37492.70	37492.70	37492.70	37492.70	37492.70	449912.40
Gas for Common MAU per Heating Degree Days (kWh/HDDs)	0.00	0.00	6644.95	5328.32	15828.03	21813.97	101372.16
Gas per Area (kWh/m2)	4.94	4.94	5.82	5.65	7.03	7.82	72.71

Table A 3. Legacy Common Electricity Consumption in 2011

Legacy	Jan	Feb	Mar	Apr	May	Jun	
Total Common Area Electricity (kWh)	19189.43	17450.14	18298.82	15917.61	17548.17	13507.66	
Electricity per Area (kWh/m2)	2.53	2.30	2.41	2.10	2.31	1.78	
Legacy	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Common Area Electricity (kWh)	14830.70	14586.64	14682.33	18103.17	21560.70	22697.39	208372.76
Electricity per Area (kWh/m2)	1.96	1.92	1.94	2.39	2.84	2.99	27.48

Table A 4. Red Suite Electricity Consumption in 2011

Red	Jan	Feb	Mar	Apr	May	Jun	
Total Suite Electricity (kWh)	52116.48	43813.05	46253.13	33443.63	30515.68	24933.47	
Electricity for Suite Lighting & Appliances (kWh/HDDs)	23748.73	23748.73	23748.73	23748.73	23748.73	23748.73	
Electricity for Suite Space Heating per Heating Degree Days (kWh/HDDs)	28367.75	20064.32	22504.4	9694.9	6766.95	1184.74	
Electricity per Area (kWh/m2)	6.57	5.52	5.83	4.21	3.84	3.14	
Red	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Suite Electricity (kWh)	23748.73	25494.5	25261.72	37543.17	41719.63	47125.58	431968.77
Electricity for Suite Lighting & Appliances (kWh/HDDs)	23748.73	23748.73	23748.73	23748.73	23748.73	23748.73	284984.76
Electricity for Suite Space Heating per Heating Degree Days (kWh/HDDs)	0	1745.77	1512.99	13794.44	17970.9	23376.85	146984.01
Electricity per Area (kWh/m2)	2.99	3.21	3.18	4.73	5.26	5.94	54.42

Table A 5. Red Gas Consumption in 2011

Red	Jan	Feb	Mar	Apr	May	Jun	
Total Common Gas (kWh)	120774.40	109941.37	96580.63	81664.38	70831.35	65442.61	
Gas for Common DHW (kWh/HDDs)	37332.29	37332.29	37332.29	37332.29	37332.29	37332.29	
Gas for Common MAU per Heating Degree Days (kWh/HDDs)	83442.11	72609.08	59248.34	44332.09	33499.06	28110.32	
Gas per Area (kWh/m2)	15.21	13.85	12.17	10.29	8.92	8.24	
Red	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Total Common Gas (kWh)	37332.29	46665.36	46665.36	51331.90	92219.64	98052.81	917502.09
Gas for Common DHW (kWh/HDDs)	37332.29	37332.29	37332.29	37332.29	37332.29	37332.29	447987.46
Gas for Common MAU per Heating Degree Days (kWh/HDDs)	0.00	9333.07	9333.07	13999.61	54887.35	60720.52	469514.63
Gas per Area (kWh/m2)	4.70	5.88	5.88	6.47	11.62	12.35	115.58

Table A 6. Red Common Electricity Consumption in 2011

Red	Jan	Feb	Mar	Apr	May	Jun	
Total Common Area Electricity (kWh)	15903.49	14190.48	15619.65	14859.08	15273.65	14500.74	
Electricity per Area (kWh/m2)	2.00	1.79	1.97	1.87	1.92	1.83	
Red	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Total Common Area Electricity (kWh)	14860.00	14860.00	14380.65	14788.69	14273.68	14649.24	178159.35
Electricity per Area (kWh/m2)	1.87	1.87	1.81	1.86	1.80	1.85	22.44

Table A 7. Salus A Suite Electricity Consumption in 2011

Salus A	Jan	Feb	Mar	Apr	May	Jun	
Total Suite Electricity (kWh)	49221.62	40635.77	43384.68	32324.37	28852.68	24435.31	
Electricity for Suite Lighting & Appliances (kWh/HDDs)	23590.13	23590.13	23590.13	23590.13	23590.13	23590.13	
Electricity for Suite Space Heating per Heating Degree Days (kWh/HDDs)	25631.48	17045.64	19794.55	8734.24	5262.54	845.18	
Electricity per Area (kWh/m2)	8.41	6.94	7.41	5.52	4.93	4.18	
Salus A	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Total Suite Electricity (kWh)	23590.13	24511.35	24307.96	33512.32	37479.19	41714.98	403970.37
Electricity for Suite Lighting & Appliances (kWh/HDDs)	23590.13	23590.13	23590.13	23590.13	23590.13	23590.13	283081.59
Electricity for Suite Space Heating per Heating Degree Days (kWh/HDDs)	0.00	921.22	717.83	9922.19	13889.06	18124.85	120888.78
Electricity per Area (kWh/m2)	4.03	4.19	4.15	5.73	6.40	7.13	69.03

Table A 8. Salus A Gas Consumption in 2011

Salus A	Jan	Feb	Mar	Apr	May	Jun	
Total Common Gas (kWh)	55748.44	49693.05	45304.29	40998.85	35346.23	30401.93	
Gas for Common DHW (kWh/HDDs)	26457.59	26457.59	26457.59	26457.59	26457.59	26457.59	
Gas for Common MAU per Heating Degree Days (kWh/HDDs)	29290.85	23235.46	18846.69	14541.26	8888.64	3944.33	
Gas per Area (kWh/m2)	9.53	8.49	7.74	7.01	6.04	5.20	
Salus A	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Total Common Gas (kWh)	29151.96	27332.57	26457.59	37873.94	45290.40	48262.54	471861.79
Gas for Common DHW (kWh/HDDs)	26457.59	26457.59	26457.59	26457.59	26457.59	26457.59	317491.11
Gas for Common MAU per Heating Degree Days (kWh/HDDs)	2694.37	874.98	0.00	11416.35	18832.81	21804.95	154370.68
Gas per Area (kWh/m2)	4.98	4.67	4.52	6.47	7.74	8.25	80.63

Table A 9. Salus A Common Electricity Consumption in 2011

Salus A	Jan	Feb	Mar	Apr	May	Jun	
Total Common Area Electricity (kWh)	21386.82	20952.56	23938.11	21529.74	20615.01	19473.69	
Electricity per Area (kWh/m2)	3.65	3.58	4.09	3.68	3.52	3.33	
Salus A	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Total Common Area Electricity (kWh)	19354.64	18393.86	17760.03	20263.80	21454.28	23218.37	248340.90
Electricity per Area (kWh/m2)	3.31	3.14	3.03	3.46	3.67	3.97	42.44

Table A 10. Salus TH Suite Electricity Consumption in 2011

Salus TH	Jan	Feb	Mar	Apr	May	Jun	
Total Suite Electricity (kWh)	228,798.00	186,619.00	194,073.00	146,103.00	122,788.00	99,445.00	
Electricity for Suite DHW, Lighting & Appliances (kWh/HDDs)	92247.00	92247.00	92247.00	92247.00	92247.00	92247.00	
Electricity for Suite Space Heating per Heating Degree Days (kWh/HDDs)	136551.00	94372.00	101826.00	53856.00	30541.00	7198.00	
Electricity per Area (kWh/m2)	12.51	10.20	10.61	7.99	6.71	5.44	
Salus TH	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Total Suite Electricity (kWh)	92,247.00	95,279.00	93,704.00	149,385.00	176,836.00	199,610.00	1,784,887.00
Electricity for Suite DHW, Lighting & Appliances (kWh/HDDs)	92247.00	92247.00	92247.00	92247.00	92247.00	92247.00	1106964.00
Electricity for Suite Space Heating per Heating Degree Days (kWh/HDDs)	0.00	3032.00	1457.00	57138.00	84589.00	107363.00	677923.00
Electricity per Area (kWh/m2)	5.04	5.21	5.12	8.17	9.67	10.91	97.57

Table A 11. Veranda TH P1-3 Suite Electricity Consumption in 2011

Veranda TH P1-3	Jan	Feb	Mar	Apr	May	Jun	
Total Suite Electricity (kWh)	136810.04	124758.04	106290.02	94553.83	72079.92	63532.59	
Electricity for Suite DHW, Lighting & Appliances (kWh/HDDs)	56802.52	56802.52	56802.52	56802.52	56802.52	56802.52	
Electricity for Suite Space Heating per Heating Degree Days (kWh/HDDs)	80007.52	67955.52	49487.50	37751.31	15277.40	6730.07	
Electricity per Area (kWh/m2)	12.47	11.37	9.69	8.62	6.57	5.79	
Veranda TH P1-3	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Total Suite Electricity (kWh)	58356.47	56802.52	66995.78	73270.18	114054.97	130390.65	1097895.01
Electricity for Suite DHW, Lighting & Appliances (kWh/HDDs)	56802.52	56802.52	56802.52	56802.52	56802.52	56802.52	681630.24
Electricity for Suite Space Heating per Heating Degree Days (kWh/HDDs)	1553.95	0.00	10193.26	16467.66	57252.45	73588.13	416264.77
Electricity per Area (kWh/m2)	5.32	5.18	6.11	6.68	10.39	11.88	100.05

Table A 12. Veranda TH P4-7 Suite Electricity Consumption in 2011

Veranda TH P4-7	Jan	Feb	Mar	Apr	May	Jun	
Total Suite Electricity (kWh)	170084.08	154607.72	131878.84	117704.94	91940.88	81740.97	
Electricity for Suite DHW, Lighting & Appliances (kWh/HDDs)	77262.22	77262.22	77262.22	77262.22	77262.22	77262.22	
Electricity for Suite Space Heating per Heating Degree Days (kWh/HDDs)	92821.86	77345.50	54616.62	40442.72	14678.66	4478.75	
Electricity per Area (kWh/m2)	13.02	11.84	10.10	9.01	7.04	6.26	
Veranda TH P4-7	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Total Suite Electricity (kWh)	78671.99	77262.22	87006.59	94798.03	139256.51	156506.18	1381458.95
Electricity for Suite DHW, Lighting & Appliances (kWh/HDDs)	77262.22	77262.22	77262.22	77262.22	77262.22	77262.22	927146.64
Electricity for Suite Space Heating per Heating Degree Days (kWh/HDDs)	1409.77	0.00	9744.37	17535.81	61994.29	79243.96	454312.31
Electricity per Area (kWh/m2)	6.02	5.92	6.66	7.26	10.66	11.98	105.79

Table A 13. Legacy Energy Consumption Summary

Building Description:				
Year Built	2007			
No of levels	4			
No of Suites	55			
Gross Area	7582	m2		
- Common Area	887			
- Suite Area	6695			
Consumption and Distribution Summary in 2011:				
Total Energy	1,164,172	kWh		
Total Energy / Suite	15,535	kWh/suite		
Total Energy / Gross	154	kWh/m2		
Total Energy used from Gas	551,285	kWh		
Total Energy used from Electricity	612,887	kWh		
Total Energy used from Gas / Gross	73	kWh/m2		
Total Energy used from Electricity / Gross	81	kWh/m2		
Distribution by Category				
1.Total Energy used for Space Heating	260,577	kWh		
- Space Heating from Gas	101,372	kWh		
- Space Heating from Electricity	159,205	kWh		
2. Total Energy used for Suite Level	854,427	kWh		
- Space Heating	159,205	kWh	14	%
- Lighting, Appliances	245,310	kWh	21	%
- DHW	449,912	kWh	39	%
3. Total Energy used for Common Area	309,745	kWh		
- Space Heating (MAU)	101,372	kWh	9	%
- Lights, Pumps & Fans	208,373	kWh	18	%

Table A 14. Red Energy Consumption Summary

Building Description:				
Year Built	2006			
No of levels	4			
No of Suites	84			
Gross Area	7938	m2		
- Common Area	930			
- Suite Area	7008			
Consumption and Distribution Summary in 2011:				
Total Energy	1,527,630	kWh		
Total Energy / Suite	10,352	kWh/suite		
Total Energy / Gross	193	kWh/m2		
Total Energy used from Gas	917,502	kWh		
Total Energy used from Electricity	610,128	kWh		
Total Energy used from Gas / Gross	116	kWh/m2		
Total Energy used from Electricity / Gross	77	kWh/m2		
Distribution by Category				
1.Total Energy used for Space Heating	616,499	kWh		
- Space Heating from Gas	469,515	kWh		
- Space Heating from Electricity	146,984	kWh		
2. Total Energy used for Suite Level	879,956	kWh		
- Space Heating	146,984	kWh	10	%
- Lighting, Appliances	284,985	kWh	19	%
- DHW	447,987	kWh	29	%
3. Total Energy used for Common Area	647,674	kWh		
- Space Heating (MAU)	469,515	kWh	31	%
- Lights, Pumps & Fans	178,159	kWh	12	%

Table A 15. Salus A Energy Consumption Summary

Building Description:				
Year Built	2009			
No of levels	4			
No of Suites	73			
Gross Area	5852	m2		
- Common Area	743			
- Suite Area	5109			
Consumption and Distribution Summary in 2011:				
Total Energy	1,124,173	kWh		
Total Energy / Suite	9,883	kWh/suite		
Total Energy / Gross	192	kWh/m2		
Total Energy used from Gas	471,862	kWh		
Total Energy used from Electricity	652,311	kWh		
Total Energy used from Gas / Gross	81	kWh/m2		
Total Energy used from Electricity / Gross	111	kWh/m2		
Distribution by Category				
1.Total Energy used for Space Heating	275,259	kWh		
- Space Heating from Gas	154,371	kWh		
- Space Heating from Electricity	120,889	kWh		
2. Total Energy used for Suite Level	721,461	kWh		
- Space Heating	120,889	kWh	11	%
- Lighting, Appliances	283,082	kWh	25	%
- DHW	317,491	kWh	28	%
3. Total Energy used for Common Area	402,712	kWh		
- Space Heating (MAU)	154,371	kWh	14	%
- Lights, Pumps & Fans	248,341	kWh	22	%

Table A 16. Salus TH Energy Consumption Summary

Building Description:				
Year Built	2009			
No of levels	4			
No of Suites	153			
Gross Area	18,293	m2		
- Common Area	n/a			
- Suite Area	18,293			
Consumption and Distribution Summary in 2011:				
Total Energy – Suite Electricity	1,784,887	kWh		
Total Energy / Suite	11,666	kWh/suite		
Total Energy / Gross	98	kWh/m2		
Distribution by Category				
1. Energy used for Suite Space Heating	677,923	kWh	38	%
Energy used for Suite Space Heating / Gross	37	kWh/m2		
2. Energy used for Suite Lighting, Appliance & DHW	1,106,964	kWh	62	%
Energy used for Suite Lighting, Appliance & DHW / Gross	61	kWh/m2		

Table A 17. Veranda TH P1-3 Energy Consumption Summary

Building Description:				
Year Built	2006			
No of levels	3			
No of Suites	90			
Gross Area	10,973	m2		
- Common Area	n/a			
- Suite Area	10,973			
Consumption and Distribution Summary in 2011:				
Total Energy – Suite Electricity	1,097,895	kWh		
Total Energy / Suite	12,199	kWh/suite		
Total Energy / Gross	100	kWh/m2		
Distribution by Category				
1. Energy used for Suite Space Heating	416,265	kWh	38	%
Energy used for Suite Space Heating / Gross	38	kWh/m2		
2. Energy used for Suite Lighting, Appliance & DHW	681,630	kWh	62	%
Energy used for Suite Lighting, Appliance & DHW / Gross	62	kWh/m2		

Table A 18. Veranda TH P4-7 Energy Consumption Summary

Building Description:				
Year Built	2008			
No of levels	3			
No of Suites	110			
Gross Area	13,059	m2		
- Common Area	n/a			
- Suite Area	13,059			
Consumption and Distribution Summary in 2011:				
Total Energy – Suite Electricity	1,381,459	kWh		
Total Energy / Suite	12,559	kWh/suite		
Total Energy / Gross	106	kWh/m2		
Distribution by Category				
1. Energy used for Suite Space Heating	454,312	kWh	33	%
Energy used for Suite Space Heating / Gross	35	kWh/m2		
2. Energy used for Suite Lighting, Appliance & DHW	927,147	kWh	67	%
Energy used for Suite Lighting, Appliance & DHW / Gross	71	kWh/m2		

APPENDIX B

Sep 04, 2012 $3,248.33

Invoice Number: 150002049681

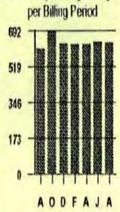
Go paperless and get instant access to your account. To get started, visit bchydro.com/youraccount

Meter Reading Information

Electric:	
Meter #	2990542
Jun 08	12395
Aug 08	12761
Mult	x80
62 days	29280
kVarh:	
Meter #	2990542
Jun 08	3527
Aug 08	3655
Mult	x80
	10240

Next meter reading on or about Oct 09

kWh Daily Average Usage per Billing Period



Daily Average Comparison
Aug 2011 608 kWh
Aug 2012 637 kWh

Take action to save electricity and money. Call 604 431 9463 or visit bchydro.com/powersmart

Other questions? Call the numbers displayed in the Customer Service area at the top of this bill.

Customer Service

Phone: (604) 224-9376 **Power Out?** 1-888-769-3766
Mail to: BC Hydro, PO Box 9501 Stn Terminal, Vancouver BC, V6B 4N1

Previous Bill

Balance payable from your previous bill	3,071.24
Thank you for your payment Jun 22, 2012	3,071.24CR
Balance from your previous bill	**$0.00**

BC Hydro **Electric Charges**

Jun 08 to Aug 08 (Residential Conservation Rate 1101)

Basic Charge: 62 days @ $0.15050 /day	9.33*
Usage Charge¹	
Step 1: 1376 kW.h @ $0.06800 /kW.h	93.57*
Step 2: 27904 kW.h @ $0.10190 /kW.h	2,843.42*
kVarh: Power Factor 94 % surcharge 0 %	0.00
Rate Rider at 5.0%	147.32*
* HST	371.24
BC HST Residential Energy Credit	216.55CR
	$3,248.33

Your total consumption for the billing period is 29280 kW.h and your Conservation Rate breakdown is as follows:

27904 kWh @ 10.19¢
1376 kWh @ 6.80¢

Your Step 1 threshold of 1376 kW.h is prorated based on 62 days

¹For more information on the Conservation Rate visit **bchydro.com/conservationrate**

Taxes

The following is a summary of taxes billed to your account since your last invoice:
HST at 12 % on 3,093.64 371.24

RECEIVED AUG 1 5 2012

Balance payable **$3,248.33**

WD 07

BChydro REGENERATION

Return this portion with your payment
ALL PAYMENTS SHOULD BE MADE PAYABLE TO BC HYDRO

Billing Date	Account Number
Aug 10, 2012	7483 591
Pay By	**Please Pay**
Sep 04, 2012	**$3,248.33**

Amount Paid

RECEIVED AUG 1 5 2012

K1533L BCMNR 5098 xx349(N) 005098

2198U004

19 STRATA PLAN BCS 2055 349(B)
THE OWNERS
C/O REMAX PROP MGMT SERVICES
270-4311 VIKING WAY
RICHMOND BC V6V 2K9

60 00 000007483 591 000324833 000000000

⑆06390⑉900⑆ 96

	Jul 03, 2012	$3,071.24

Invoice Number:
150002026014

Go paperless and get instant access to your account. To get started, visit bchydro.com/youraccount

Meter Reading Information

Electric:

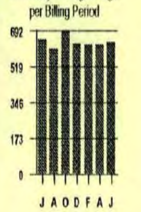
Meter #	2990542
Apr 11	12049
Jun 07	12395
Mult	x80
58 days	27680

kVarh:

Meter #	2990542
Apr 11	3409
Jun 07	3527
Mult	x80
	9440

Next meter reading on or about Aug 08

kWh Daily Average Usage per Billing Period



Daily Average Comparison
Jun 2011 650 kWh
Jun 2012 640 kWh

Take action to save electricity and money. Call 604 431 9463 or visit bchydro.com/powersmart

Other questions? Call the numbers displayed in the Customer Service area at the top of this bill.

Customer Service

Phone: (604) 224-9376 **Power Out?** 1-888-769-3766
Mail to: BC Hydro, PO Box 9501 Stn Terminal, Vancouver BC, V6B 4N1

Previous Bill

Balance payable from your previous bill	2,782.37
Thank you for your payment Apr 27, 2012	2,782.37CR
Balance from your previous bill	**$0.00**

BC Hydro

Electric Charges

Apr 11 to Jun 07 (Residential Conservation Rate 1101)

Basic Charge: 58 days @ $0.15050 /day	8.73*
Usage Charge[1]	
Step 1: 1287 kW.h @ $0.06800 /kW.h	87.52*
Step 2: 26393 kW.h @ $0.10190 /kW.h	2,689.45*
kVarh: Power Factor 94 % surcharge 0 %	0.00
Rate Rider at 5.0%	139.29*
* HST	351.00
BC HST Residential Energy Credit	204.75CR
	$3,071.24

Your total consumption for the billing period is 27680 kW.h and your Conservation Rate breakdown is as follows:

26393 kWh @ 10.19¢
1287 kWh @ 6.80¢

Your Step 1 threshold of 1287 kW.h is prorated based on 58 days

[1]For more information on the Conservation Rate visit **bchydro.com/conservationrate**

Taxes

The following is a summary of taxes billed to your account since your last invoice:
HST at 12 % on 2,924.99 351.00

Balance payable **$3,071.24**

WD 07

BC hydro REGENERATION 50

Return this portion with your payment
ALL PAYMENTS SHOULD BE MADE PAYABLE TO BC HYDRO

Billing Date	Account Number
Jun 11, 2012	7483 591
Pay By	**Please Pay**
Jul 03, 2012	**$3,071.24**

Amount Paid

RECEIVED JUN 14 2012

K0442L BCMNR 5474 xx349(U) 005474

19 STRATA PLAN BCS 2055 349(U)
THE OWNERS
C/O REMAX PROP MGMT SERVICES
270-4311 VIKING WAY
RICHMOND BC V6V 2K9

2174J001

54 00 000007483 591 000307124 000000000

⑆06390⑈900⑆ 96

May 03, 2012	$2,782.37

Invoice Number:
150001989771

Go paperless and get instant access to your account. To get started, visit bchydro.com/youraccount

Meter Reading Information

Electric:	
Meter #	2990542
Dec 09	11318
Feb 08	11684
Mult	x80
62 days	29280
Meter #	2990542
Feb 09	11684
Mar 31	11989
Mult	x80
52 days	24400
Meter #	2990542
Apr 01	11989
Apr 10	12049
Mult	x80
10 days	4800
kVarh:	
Meter #	2990542
Dec 09	3168
Feb 08	3288
Mult	x80
	9600
Meter #	2990542
Feb 09	3288
Apr 10	3409
Mult	x80
	9680

Next meter reading on or about Jun 07

Customer Service — **Phone:** (604) 224-9376 **Power Out?** 1-888-769-3766
Mail to: BC Hydro, PO Box 9501 Stn Terminal, Vancouver BC, V6B 4N1

Previous Bill

Balance payable from your previous bill	3,246.16
Thank you for your payment Mar 05, 2012	3,246.16CR
Balance from your previous bill	**$0.00**

BC Hydro — **Electric Charges**

Dec 09 to Feb 08 (Residential Conservation Rate 1101)	
Basic Charge: 62 days @ $0.14480 /day	8.98*
Usage Charge[1]	
Step 1: 1370 kW.h @ $0.06670 /kW.h	91.38*
Step 2: 27910 kW.h @ $0.09620 /kW.h	2,684.94*
kVarh:Power Factor 95 % surcharge 0 %	0.00
Rate Rider at 2.5%	69.63*
Dec 09 to Feb 08 (Residential Conservation Rate 1101)	
Basic Charge: 62 days @ $0.14480 /day	8.98CR*
Usage Charge[1]	
Step 1: 1370 kW.h @ $0.06670 /kW.h	91.38CR*
Step 2: 30310 kW.h @ $0.09620 /kW.h	2,915.82CR*
kVarh:Power Factor 95 % surcharge 0 %	0.00
Rate Rider	75.40CR*
Feb 09 to Mar 31 (Residential Conservation Rate 1101)	
Basic Charge: 52 days @ $0.14480 /day	7.53*
Usage Charge[1]	
Step 1: 1138 kW.h @ $0.06670 /kW.h	75.90*
Step 2: 23262 kW.h @ $0.09620 /kW.h	2,237.80*
kVarh:Power Factor 94 % surcharge 0 %	0.00
Rate Rider at 2.5%	58.03*
Apr 01 to Apr 10 (Residential Conservation Rate 1101)	
Basic Charge: 10 days @ $0.15050 /day	1.51*
Usage Charge[1]	

RECEIVED APR 1 7 2012

WD 07

BC hydro REGENERATION 50

Return this portion with your payment
ALL PAYMENTS SHOULD BE MADE PAYABLE TO BC HYDRO

Billing Date	Account Number
Apr 11, 2012	7403 591
Pay By	**Please Pay**
May 03, 2012	**$2,782.37**

Amount Paid

RECEIVED APR 1 7 2012

X8214L BCMNR 503 000503

2103N009

19 STRATA PLAN BCS 2055 349(R)
THE OWNERS
C/O REMAX PROP MGMT SERVICES
270-4311 VIKING WAY
RICHMOND BC V6V 2K9

66 00 000007483 591 000278237 000000000

⑆06390⑈900⑆ 96

Mar 05, 2012 $3,246.16

Invoice Number:
150001922101

Go paperless and get instant access to your account. To get started, visit bchydro.com/youraccount

Meter Reading Information

Electric:

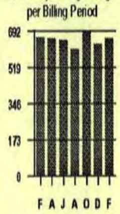
Meter #	2990542
Dec 09	11318
Feb 08	11714
Mult	x80
62 days	31680

kVarh:

Meter #	2990542
Dec 09	3168
Feb 08	3284
Mult	x80
	9280

Next meter reading on or about Apr 10

kWh Daily Average Usage per Billing Period



Daily Average Comparison
Feb 2011 663 kWh
Feb 2012 661 kWh

Take action to save electricity and money. Call 604 431 9463 or visit bchydro.com/powersmart

Other questions? Call the numbers displayed in the Customer Service area at the top of this bill.

Page 1 of 2

Customer Service

Phone: (604) 224-9376 **Power Out?** 1-888-769-3766
Mail to: BC Hydro, PO Box 9501 Stn Terminal, Vancouver BC, V6B 4N1

Your bill shows an estimate.

Previous Bill

Balance payable from your previous bill	2,776.60
Thank you for your payment Jan 09, 2012	2,776.60CR
Balance from your previous bill	**$0.00**

BC Hydro — **Electric Charges**

Dec 09 to Feb 08 (Residential Conservation Rate 1101)

Basic Charge: 62 days @ $0.14480 /day	8.98*
Usage Charge[1]	
Step 1: 1370 kW.h @ $0.06670 /kW.h	91.38*
Step 2: 30310 kW.h @ $0.09620 /kW.h	2,915.82*
kVarh:Power Factor 95 % surcharge 0 %	0.00
Rate Rider at 2.5%	75.40*
* HST	370.99
BC HST Residential Energy Credit	216.41CR
	$3,246.16

Your total consumption for the billing period is 31680 kW.h and your Conservation Rate breakdown is as follows:

30310 kWh @ 9.62¢

1370 kWh @ 6.67¢

Your Step 1 threshold of 1370 kW.h is prorated based on 62 days

[1]For more information on the Conservation Rate visit **bchydro.com/conservationrate**

Taxes

The following is a summary of taxes billed to your account since your last invoice:
HST at 12 % on 3,091.58 370.99

WD 07

BChydro REGENERATION 50

Return this portion with your payment
ALL PAYMENTS SHOULD BE MADE PAYABLE TO BC HYDRO

Billing Date	Account Number
Feb 10, 2012	7483 591
Pay By	**Please Pay**
Mar 05, 2012	**$3,246.16**

Amount Paid

2191N007

X7035L BCMNR 691 000691

19 STRATA PLAN BCS 2055 349(G)
THE OWNERS
C/O REMAX PROP MGMT SERVICES
270-4311 VIKING WAY
RICHMOND BC V6V 2K9

59 00 000007483 591 000324616 000000000

⑆06390⑈900⑆ 96

RICHMOND BC V6Y 0B3 Code: Amt. Jan 03, 2012 $2,776.60

Invoice Number: 150001868401

Memo — Go paperless and get instant access to your account. To get started, visit bchydro.com/youraccount

Charge Back: $ To:

Meter Reading Information

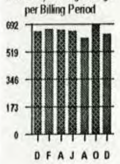
Customer Service — **Phone:** (604) 224-9376 **Power Out?** 1-888-769-3766
Mail to: BC Hydro, PO Box 9501 Stn Terminal, Vancouver BC, V6B 4N1

Electric:	
Meter #	2990542
Oct 13	10979
Dec 08	11318
Mult	x80
57 days	27120

kVarh:	
Meter #	2990542
Oct 13	3058
Dec 08	3168
Mult	x80
	8800

Next meter reading on or about Feb 08

kWh Daily Average Usage per Billing Period



Daily Average Comparison
Dec 2010 652 kWh
Dec 2011 630 kWh

Take action to save electricity and money. Call 604 431 9463 or visit bchydro.com/powersmart

Other questions? Call the numbers displayed in the Customer Service area at the top of this bill.

Previous Bill

Balance payable from your previous bill	3,138.30
Thank you for your payment Oct 27, 2011	3,138.30CR
Balance from your previous bill	**$0.00**

BC Hydro — **Electric Charges**

Oct 13 to Dec 08 (Residential Conservation Rate 1101)	
Basic Charge: 57 days @ $0.14480 /day	8.25*
Usage Charge[1]	
Step 1: 1265 kW.h @ $0.06670 /kW.h	84.38*
Step 2: 25855 kW.h @ $0.09620 /kW.h	2,487.25*
kVarh:Power Factor 95 % surcharge 0 %	0.00
Rate Rider at 2.5%	64.50*
* HST	317.33
BC HST Residential Energy Credit	185.11CR
	$2,776.60

Your total consumption for the billing period is 27120 kW.h and your Conservation Rate breakdown is as follows:

25855 kWh @ 9.62¢

1265 kWh @ 6.67¢

Your Step 1 threshold of 1265 kW.h is prorated based on 57 days

[1]For more information on the Conservation Rate visit **bchydro.com/conservationrate**

X

Taxes — The following is a summary of taxes billed to your account since your last invoice:

HST at 12 % on 2,644.38 317.33

Balance payable **$2,776.60**

Page 1 of 2

WD 07

BChydro REGENERATION

Return this portion with your payment
ALL PAYMENTS SHOULD BE MADE PAYABLE TO BC HYDRO

Billing Date	Account Number
Dec 12, 2011	7483 591
Pay By	Please Pay
Jan 03, 2012	**$2,776.60**
	Amount Paid

X5887L BCMNR 765 000765

19 STRATA PLAN BCS 2055 349(M)
THE OWNERS
C/O REMAX PROP MGMT SERVICES
270-4311 VIKING WAY
RICHMOND BC V6V 2K9

65 00 000007483 591 000277660 000000000

⑆06390⑈9001⑆ 96

1635904 Aug 31, 2012 $1,265.40

Previous bill	1,640.86	
Less payment - Thank you	1,640.86CR	
Balance from previous bill		0.00
Delivery Charges		
Basic charge (29 days at 4.3538 per day)	126.26	
Delivery (136.9 GJ at 2.362 per GJ)	323.36	
		449.62^*
Commodity Charges		
Midstream (136.9 GJ at 1.052 per GJ)	144.02	
Cost of Gas (136.9 GJ at 2.977 per GJ)	407.55	
		551.57^*
Other Charges and taxes		
Carbon Tax (136.9 GJ at 1.4898 per GJ)		203.95^*
HST (12% of ^ amounts)		144.62
Residential Energy Credit (7% of * amounts)		84.36CR
Please pay		**1,265.40**

The smell of rotten eggs or sulphur could be a sign of a natural gas leak. If you smell gas, get out, then call 911 or the FortisBC 24-hour emergency line at 1-800-663-9911.

Gas usage calculation (Meter ODM536822)

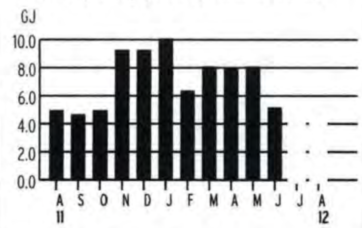
Present reading	- Previous reading	x Conversion factor	= Gas used in gigajoules (GJ)
Aug 8 '12	Jul 10 '12		
282,881	280,239	0.0518159	136.9

Point of Delivery: 975147

Comparison to previous year

Billing Period	Number of days billed	Average daily temp	Average daily usage GJ	Total Billing period usage GJ
Aug '2012	29	19°C	4.72	136.9
Aug '2011	31	18°C	5.03	155.9

Average daily gas usage over 13 months



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HST #R100431592
Recycled Paper

NATURAL GAS

Payment return slip - Make cheques payable to FortisBC-Natural Gas

FORTIS BC

After August 31, 2012, a late payment charge of 1.5% will be assessed.

Account number	Due date	Amount due	Amount paid
1635904	Aug 31, 2012	$1,265.40	

039777 B 349

063954616767 - m/

Strata Plan BCS 2282
270-4311 Viking Way
Richmond BC V6V 2K9

RECEIVED AUG 17 2012

00 001 635904 0 00126540 3

⑆00831⑈900⑆ 96

Previous bill	1,355.03	
Less payment - Thank you	1,355.03CR	
Balance from previous bill		0.00
Delivery Charges		
Basic charge (33 days at 4.3538 per day)	143.68	
Delivery (184.2 GJ at 2.362 per GJ)	435.08	
		578.76^*
Commodity Charges		
Midstream (184.2 GJ at 1.052 per GJ)	193.78	
Cost of Gas (184.2 GJ at 2.977 per GJ)	548.36	
		742.14^*
Other Charges and taxes		
Prior to July 1, 2012		
Carbon Tax (131.3 GJ at 1.2415 per GJ)		163.01^*
Effective July 1, 2012		
Carbon Tax (52.9 GJ at 1.4898 per GJ)		78.81^*
HST (12% of ^ amounts)		187.53
Residential Energy Credit (7% of ^ amounts)		109.39CR
Please pay		**1,640.86**

On July 1, 2012, the carbon tax will increase from $1.2415 to $1.4898 per gigajoule. FortisBC collects this tax on behalf of the provincial government. To learn more about these tax updates, call toll free 1-877-388-4440 or visit fortisbc.com/taxupdates.

There was a misprint of some BC Utilities Commission website addresses in the insert you received on common rates in your previous month's bill. To view the correction, please visit fortisbc.com/commonrates.

Gas usage calculation (Meter QDM536822)

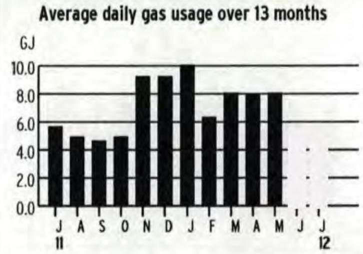
Present reading	- Previous reading	x Conversion factor	= Gas used in gigajoules (GJ)
Jul 10 '12	Jun 7 '12		
280,239	276,689	0.0518887	184.2

Point of Delivery: 975147

Comparison to previous year

Billing Period	Number of days billed	Average daily temp	Average daily usage GJ	Total Billing period usage GJ
Jul '2012	33	15ºC	5.58	184.2
Jul '2011	32	16ºC	5.72	183.0

Average daily gas usage over 13 months



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HST #R100431592

Recycled Paper

NATURAL GAS

FORTIS BC

Payment return slip - Make cheques payable to FortisBC-Natural Gas

After August 1, 2012, a late payment charge of 1.5% will be assessed.

Account number	Due date	Amount due	Amount paid
1635904	Aug 1, 2012	$1,640.86	

042312 B 349

065106119806 - m/

Strata Plan BCS 2282
270-4311 Viking Way
Richmond BC V6V 2K9

RECEIVED JUL 20 2012

00 001 635904 0 00164086 0

⑆00831⑈900⑆ 96

1635904 Jun 29, 2012 $1,355.03

Previous bill	2,034.61	
Less payment - Thank you	2,034.61CR	
Balance from previous bill		0.00
Delivery Charges		
Basic charge (29 days at 4.3538 per day)	126.26	
Prior to June 1, 2012		
Delivery (114.9 GJ at 2.451 per GJ)	281.62	
Effective June 1, 2012		
Delivery (36.3 GJ at 2.362 per GJ)	85.74	
		493.62^*
Commodity Charges		
Midstream (151.2 GJ at 1.052 per GJ)	159.06	
Cost of Gas (151.2 GJ at 2.977 per GJ)	450.12	
		609.18^*
Other Charges and taxes		
Carbon Tax (151.2 GJ at 1.2415 per GJ)		187.71^*
HST (12% of * amounts)		154.86
Residential Energy Credit (7% of * amounts)		90.34CR
Please pay		**1,355.03**

Natural gas delivery rates change effective June 1, 2012. Annual charges will decrease by approximately 1.3 per cent, depending on consumption. This is a decrease from the interim rates effective January 1, 2012. The BC Utilities Commission approves this rate change. For more details, visit fortisbc.com/rates.

Gas usage calculation (Meter QDM536822)

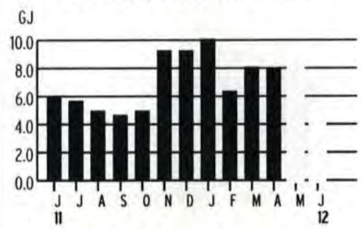
Present reading	Previous reading	Conversion factor	Gas used in gigajoules (GJ)
Jun 7 '12	May 9 '12		
276,689	273,775	0.0518995	151.2

Point of Delivery: 975147

Comparison to previous year

Billing Period	Number of days billed	Average daily temp	Average daily usage GJ	Total Billing period usage GJ
Jun '2012	29	13°C	5.21	151.2
Jun '2011	30	13°C	5.93	177.8

Average daily gas usage over 13 months



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HST #R100431592
Recycled Paper

NATURAL GAS

Payment return slip - Make cheques payable to FortisBC-Natural Gas

FORTIS BC

After June 29, 2012, a late payment charge of 1.5% will be assessed.

Account number	Due date	Amount due	Amount paid
1635904	Jun 29, 2012	$1,355.03	

038009 U 349

065489947344 - m/

Strata Plan BCS 2282
270-4311 Viking Way
Richmond BC V6V 2K9

RECEIVED JUN 15 2012

00 001 635904 0 00135503 0

⑆00831⑈900⑆ 96

Previous bill	2,483.01	
Less payment - Thank you	2,483.01CR	
Balance from previous bill		0.00
Delivery Charges		
Basic charge (29 days at 4.3538 per day)	126.26	
Delivery (234.6 GJ at 2.451 per GJ)	575.00	
		701.26^*
Commodity Charges		
Midstream (234.6 GJ at 1.052 per GJ)	246.80	
Cost of Gas (234.6 GJ at 2.977 per GJ)	698.40	
		945.20^*
Other Charges and taxes		
Carbon Tax (234.6 GJ at 1.2415 per GJ)		291.26^*
HST (12% of ^ amounts)		232.53
Residential Energy Credit (7% of ^ amounts)		135.64CR
Please pay		**2,034.61**

Always call before you dig. Doing some landscaping? Installing a fence? Call BC One Call at **1-800-474-6886 or *6886** from any cell phone for natural gas line information 3 business days before you start digging. Stay safe. Make the call.

Gas usage calculation (Meter QDM536822)

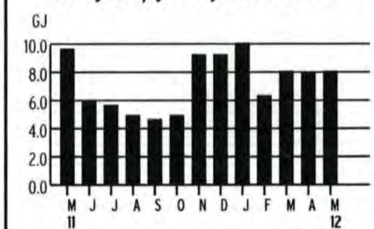
Present reading	- Previous reading	x Conversion factor	= Gas used in gigajoules (GJ)
May 9 '12	Apr 10 '12		
273,775	269,249	0.0518321	234.6

Point of Delivery: 975147

Comparison to previous year

Billing Period	Number of days billed	Average daily temp	Average daily usage GJ	Total Billing period usage GJ
May '2012	29	11°C	8.09	234.6
May '2011	32	9°C	9.73	311.3

Average daily gas usage over 13 months



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HST #R100431592
Recycled Paper

NATURAL GAS

Payment return slip - Make cheques payable to FortisBC-Natural Gas

FORTIS BC

After May 31, 2012, a late payment charge of 1.5% will be assessed.

Account number	Due date	Amount due	Amount paid
1635904	May 31, 2012	$2,034.61	

042332 U 349

066929335167 - m/

Strata Plan BCS 2282
270-4311 Viking Way
Richmond BC V6V 2K9

RECEIVED MAY 17 2012

00 001 635904 0 00203461 8

⑆00831⑈900⑆ 96

1635904	May 2, 2012	$2,483.01	

Previous bill	2,283.24	
Less payment - Thank you	2,283.24CR	
Balance from previous bill		0.00
Delivery Charges		
Basic charge (33 days at 4.3538 per day)	143.68	
Delivery (262.9 GJ at 2.451 per GJ)	644.37	
		788.05^^
Commodity Charges		
Midstream (262.9 GJ at 1.052 per GJ)	276.57	
Prior to April 1, 2012		
Cost of Gas (185.9 GJ at 4.005 per GJ)	744.53	
Effective April 1, 2012		
Cost of Gas (77.0 GJ at 2.977 per GJ)	229.23	
		1,250.33^^
Other Charges and taxes		
Carbon Tax (262.9 GJ at 1.2415 per GJ)		326.39^^
HST (12% of ^ amounts)		283.77
Residential Energy Credit (7% of ^ amounts)		165.53CR
Please pay		**2,483.01**

Natural gas rates change from $4.005 to $2.977 per gigajoule effective April 1, 2012. Large commercial customers' annual charges will decrease by approximately 13 per cent depending on consumption. The BC Utilities Commission approved this rate adjustment.

Gas usage calculation (Meter 0DM536822)

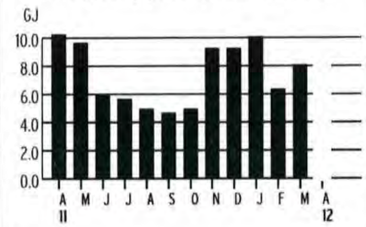
Present reading	- Previous reading	x Conversion factor	= Gas used in gigajoules (GJ)
Apr 10 '12	Mar 8 '12		
269,249	264,165	0.0517053	262.9

Point of Delivery: 975147

Comparison to previous year

Billing Period	Number of days billed	Average daily temp	Average daily usage GJ	Total Billing period usage GJ
Apr '2012	33	6ºC	7.97	262.9
Apr '2011	29	7ºC	10.35	300.1

Average daily gas usage over 13 months



P000043013-C000055334-1/1-VIP /SEL /1/2/
HST #R100431592

NATURAL GAS

Payment return slip - Make cheques payable to FortisBC-Natural Gas

FORTIS BC

After May 2, 2012, a late payment charge of 1.5% will be assessed.

Account number	Due date	Amount due	Amount paid
1635904	May 2, 2012	$2,483.01	

043013 D 441

065010133024 - m/

Strata Plan BCS 2282
C O Southview Property Management
110-7580 River Rd
Richmond BC V6X 1X6

RECEIVED APR 20 2012

00 001 635904 0 00248301 3

⑆00831⑈900⑆ 96