Building Energy Benchmarking for UBC Neighbourhood Multi Unit Residential Building (MURBs)

UBC Sustainability Scholars Program
UBC SEEDS Program

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EXECUTIVE SUMMARY

To support the energy and greenhouse gas (GHG) emissions reductions laid out in UBC's Community Energy and Emissions Plan (CEEP)[1] for residential neighbourhoods on campus, the University is developing a building energy benchmarking strategy. One of the first initiatives in the strategy is the implementation of a benchmarking pilot project that focuses on six multi-family rental buildings in UBC's residential neighbourhood; five low-rise (four storey) and one high-rise (fourteen storey) building. The pilot was carried out with funding support from BC Hydro and in coordination with three municipalities: City of New Westminster, City of Surrey, and City of Victoria that are working on benchmarking their own building portfolios.

Energy benchmarking is the process of comparatively assessing a building's energy performance relative to other similar buildings. Many organizations, especially governing bodies, have turned towards benchmarking as a policy tool to overcome informational gaps that act as barriers to energy efficiency investment.[2] For UBC's multi-family buildings, energy benchmarking serves as a precursor for informed decision making around energy efficiency improvements.

The main objectives of this study are to benchmark the six rental buildings in ENERGY STAR Portfolio Manager (ESPM)[3], an online energy management tool that allows for self-serve utility consumption tracking, and to identify an appropriate strategy for communicating the benchmarking results to building owners.

Through the completion of the study, it was determined that benchmarking UBC's multi-family buildings using ESPM is a straightforward process once utility data are acquired. The software is suitable for UBC since it is free and non-proprietary and has multiple connections to other UBC initiatives, such as the Residential Environmental Assessment Program (REAP)[4] and SMARTTool[5] reporting requirements.

To communicate the results, a custom UBC-specific statement of energy performance was produced for each of the buildings in the study. The one-page report, intended for building owners, provides an overview of the building that includes: performance history, a breakdown of GHG emissions by source and an estimated breakdown of the building's energy end-uses.

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[1] The University of British Columbia. "UTOWN@UBC Community Energy & Emissions Plan". Information available online: http://sustain.ubc.ca/campus-initiatives/climate-energy/CEEP

[2] Institute for Market Transformation, 2012. "Energy Transparency in the Multifamily Housing Sector". Report available online: http://www.imt.org/uploads/resources/files/Energy_Trans_MFSector_IMT_ExecSumm_final.pdf

[3] Natural Resources Canada. "ENERGY STAR Portfolio Manager Access Page". Information available online: http://www.nrcan.gc.ca/energy/efficiency/buildings/energy-benchmarking/3693

[4] The University of British Columbia. "Residential Environmental Assessment Plan". Information available online: http://sustain.ubc.ca/campus-initiatives/green-buildings/reap

[5] Province of British Columbia. "Measuring Greenhouse Gas Emissions". Information available online: http://www2.gov.bc.ca/gov/content/environment/climate-change/policy-legislation-programs/carbon-neutral-government/measure

The results and lessons learned from the pilot study will be used to inform the development of UBC's benchmarking strategy. The study is easily scalable and can be applied to other multi-family buildings on campus to improve the university's local benchmark baseline information.

One significant time factor encountered in the benchmarking process was in obtaining aggregated suite level electricity data. An automated electronic data exchange system would greatly facilitate the process of obtaining building level electricity consumption data and would significantly reduce benchmarking time requirements and potential for error.

To improve communication and encourage action on results, the statement of energy performance requires development. The report displays building performance without conveying what the results actually mean for the building owner. To improve the report, it should be revisited and tailored in a way that will encourage building owners to take action on energy efficiency.

Benchmarking UBC's multifamily buildings is a preliminary step on making informed decisions around energy efficiency investments in UBC's neighbourhoods. The pilot project was ultimately a success and has resulted in a number of recommendations and instructions to advance UBC's benchmarking strategy. Through participation in the pilot project and by contributing to the wider discussion around benchmarking, UBC has positioned itself as a local leader in the energy benchmarking transformation.

1   INTRODUCTION

1.1   PURPOSE

Energy conservation and GHG emission reductions in existing neighbourhood multi-family residential buildings are a key component of the Community Energy and Emissions Plan (CEEP) for UBCs residential neighbourhoods. To support these CEEP objectives, UBC is developing an energy benchmarking strategy and establishing benchmarking pilot projects to set the stage for energy efficiency improvements. In this project, select neighbourhood MURB buildings are benchmarked and evaluated using ENERGY STAR Portfolio Manager.

1.2   REGIONAL CONTEXT

UBC has partnered with a number of local municipalities to coordinate energy benchmarking efforts with partial funding provided by BC Hydro. The municipal partnership with New West, Surrey and Victoria has involved information sharing, capacity building sessions and has allowed access to a network of professionals and students who are pursuing similar goals. The primary goal of the sustainability scholars employed by the municipalities is to benchmark corporate facilities, while for UBC, the focus is on multi-family buildings.

1.3   OBJECTIVES

The following sections highlight the major objectives of the project and further describe the deliverables associated with each.

1.3.1   Objective #1: Benchmarking

Benchmark six rental multi-unit residential buildings (MURBs) in UBC's residential neighbourhood using ENERGY STAR Portfolio Manager (ESPM). This includes the collection and input of utility data and additional supporting information such as building area and occupancy. The specific deliverables for this work plan item are:

a) Complete benchmarking of study buildings in ESPM;
b) Evaluate ESPM as a benchmarking tool for UBC neighbourhood MURBs;
c) Develop a sample building energy profile for one of the MURBs in the study;
d) Evaluate the time commitment to keep the MURB data up to date in ESPM;
e) Evaluate energy performance of REAP certified buildings;
f) Review benchmarking results for similar building types in other jurisdictions;
g) Review the City of Vancouver's "How-to Manual".

1.3.2   Objective #2: Disclosure and Communication

Identify an appropriate strategy for sharing and communicating the benchmarking results. The primary audience for this strategy is building owners, but if time permits, additional strategies may be pursued focusing on communications with the general public. The specific deliverables for this work plan item are:

a) Prepare a worksheet for disclosing a building's energy performance;
b) Report on the GHG reporting link between Portfolio Manager and SMARTTool.

2   BACKGROUND

2.1   BUILDING ENERGY BENCHMARKING AND DISCLOSURE

Over the last few years, energy benchmarking programs and regulations have become increasingly prominent across North America. Many organizations, especially governing bodies, have turned towards benchmarking as a policy tool to overcome information gaps that limit energy efficiency awareness and investment. The main components of a benchmarking and disclosure program are to comparatively assess the energy performance of a building and to make these performance metrics available in the marketplace [1].

The most common metric used in benchmarking is the energy use intensity (EUI) which represents the energy consumed by a building relative to its size. Generally, the EUI is expressed as GJ/m^2 or kWh/m^2 and a lower EUI signifies better energy performance.

Establish energy benchmarks for buildings can be used to:

- Identify poorly performing buildings to flag opportunities to optimize energy efficiency;
- Establish a baseline for measuring changes in energy consumption;
- Participate in green building certification programs [2].

Specifically, for multi-family buildings, benchmarking and disclosure will serve as a catalyst to support energy efficiency improvements that lower energy bills for residents; contribute to greater local housing affordability; and create new jobs related to energy efficiency [1].

2.2   BENCHMARKING TRENDS IN NORTH AMERICA

In the U.S., there are 10 cities with benchmarking ordinances, the oldest of which was enacted in the year 2008. A map highlighting the U.S. cities and states with benchmarking policies in place is shown in Figure 1 [3]. The cities and states marked in purple and orange show locations where mandatory energy benchmarking policy has been adopted.

Although the building types and size thresholds differ between cities, there are a number of consistent policy requirements between U.S. programs, such as:

- Building owners in every jurisdiction use the ENERGY STAR Portfolio Manager rating system;
- Building owners in all but one jurisdiction (Washington State) must disclose their energy performance to the government.

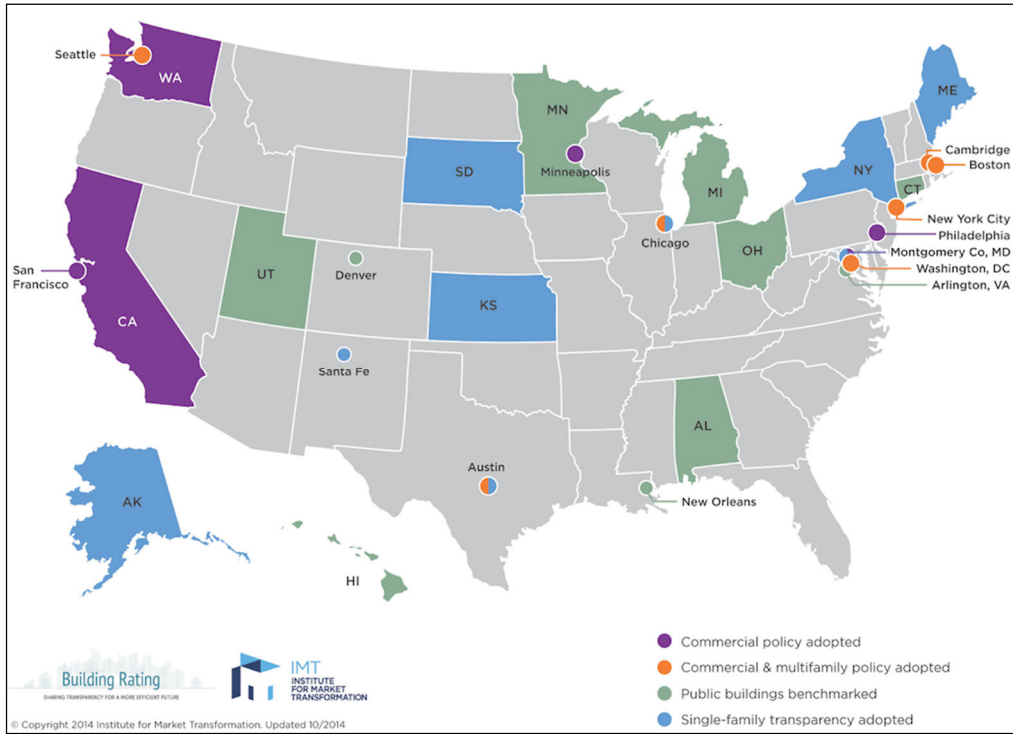*Figure 1: U.S. Building Benchmarking and Transparency Policies*

A comparison of U.S. building energy benchmarking and disclosure policies at the municipal level can be seen in detail in Figure 2 [4]. The U.S. building types, size thresholds, disclosure policies and rating systems form a basis for what is expected to follow in Canada with the recent endorsement of the ENERGY STAR program methodology.

	Legislation				Building Type & Size Threshold			Disclosure				Rating System		Additional Elements		
Jurisdiction	Short Name	Enacted	First Compliance Deadline	Municipal	Commercial	Multifamily	To Gov't	On Public Website	Time of Transaction	To Current Tenants	Energy Star	Other	Utility Req't	Water Use Tracking	Additional Requirements
Austin	Energy Conservation Audit & Disclosure (ECAD) Ordinance	Nov 2008	June 2011	✓	10K SF+	Audits	✓	-	Buyers	-	✓	ACLARA	-	-	Audits & mandatory upgrades for multifamily buildings
Boston	Boston Energy Reporting and Disclosure Ordinance	May 2013	May 2014	✓	35K SF+	35+ units or 35K SF+	✓	✓	-	-	✓	-	-	✓	Periodic energy assessments and/or actions
Cambridge	Building Energy Use Disclosure Ordinance	July 2014	December 2014	10K SF+	25K SF+	50+ units	✓	✓	-	-	✓	-	-	✓	-
Chicago	Chapter 18-14. Building Energy Use Benchmarking Ordinance	Sept 2013	June 2014	50K SF+	50K SF+	50K SF+	✓	✓	-	-	✓	-	-	-	Verification of benchmarking data by licensed professional 1st year, then every 3 years
District of Columbia	Clean and Affordable Energy Act of 2008	July 2008	April 2013	10K SF+	50K SF+	50K SF+	✓	✓	-	-	✓	Energy Star Target Finder	-	✓	-
Minneapolis	Chapter 47.190. Commercial Building Rating and Disclosure Ordinance	Jan 2013	May 2014	25K SF+	50K SF+	-	✓	✓	-	-	✓	-	-	✓	-
New York City	Local Law 84 (additional requirements in LL 87, LL 88)	Dec 2009	August 2011	10K SF+	50K SF+	50K SF+	✓	✓	-	-	✓	-	-	✓	ASHRAE level II audits & RCx (LL 87), lighting upgrades & submetering (LL 88)
Philadelphia	§9-3402 of the Philadelphia Code	June 2012	October 2013	50K SF+	50K SF+	-	✓	✓	Buyers, Lessees	-	✓	-	-	✓	-
San Francisco	Existing Commercial Buildings Energy Performance Ord.	Feb 2011	October 2011	10K SF+	10K SF+	-	✓	✓	†Buyers, Lessees, Lenders	✓	✓	-	†	-	ASHRAE level I or II audits or RCx every 5 years
Seattle	CB 116731	Jan 2010	October 2011	20K SF+	20K SF+	20K SF+	✓	-	†Buyers, Lessees, Lenders	✓	✓	-	✓	-	-

(Cities)

† Required by previous action

Figure 2: Comparison of U.S. Building Energy Benchmarking and Disclosure Policies

2.3   ENERGY STAR PORTFOLIO MANAGER

ENERGY STAR Portfolio Manager (ESPM) is a free, interactive energy management tool that allows users to do self-serve tracking and assessment of energy and water consumption across a portfolio of buildings through a web-based platform.

Developed by the U.S. Environmental Protection Agency (EPA)[6], ESPM is the 'go to' energy benchmarking and disclosure tool in the United States. In the fall of 2011, Natural Resources Canada (NRCan)[7] and the U.S. EPA signed an agreement to adapt the ENERGY STAR Portfolio Manager for Canada and the tool was launched in Canada in June 2013.

Portfolio Manager uses a heavily normalized scoring system to compare the relative energy performance of similar buildings. The ENERGY STAR score is a 1-100 performance index that is currently available for 5 building types in Canada: K-12 schools, commercial office buildings, hospitals, supermarkets & food stores and medical offices. A score of 50 indicates a building's energy performance is average, while a score of 75+ indicates top performance. The score is calculated based on the energy a building is expected to use given its climate, weather and business activity with reference data sampled from a national analysis.

Energy benchmarking is gaining traction as a low cost way to improve energy efficiency and has resulted in proven savings. Figure 3 [5], obtained from a report published by the USEPA in 2012, shows that buildings that benchmarked energy performance over a 4-year period realized average annual energy savings of 2.4%, with a total savings of 7.0%.The analysis is based on the average weather-normalized energy use intensity and the ENERGY STAR score, a 2008 baseline year and 3 consecutive years of post-baseline energy use tracking [5].
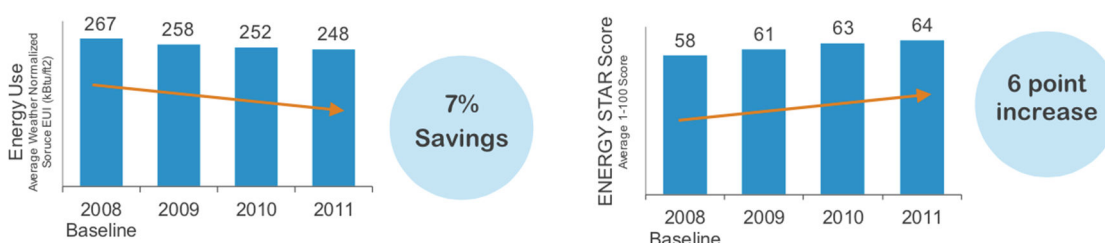
Figure 3: Energy Savings in Portfolio Manager

2.4   LITERATURE REVIEW

The following sections highlight a number of recent studies that focus on energy performance of multi-family buildings. This review is meant to provide context - it is important to note that energy performance is dependent on many factors such as weather, climate and building construction; therefore it is not appropriate to compare performance results across studies.

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[6] United States Environmental Protection Agency. Available online: http://www.epa.gov/

[7] Natural Resources Canada. Available online: https://www.nrcan.gc.ca/home

2.4.1   RDH Study: Energy Consumption and Conservation in Mid- and High-Rise Residential Buildings in British Columbia [6]

In 2012, RDH released a study that assesses the impacts of enclosure rehabilitations on the energy consumption of buildings, specifically mid- to high-rise (5 to 33 storey) multi-family buildings. The main objectives of the study are to review and assess the actual (billed) energy consumption of the buildings and the impacts of building enclosure rehabilitation related improvements on the overall energy consumption.

Local gas and electric utility suppliers provided historical energy consumption data for 39 non-combustible construction, private sector MURBs located in the Lower Mainland and Victoria, BC. All of the buildings were constructed between 1974 and 2002.

A typical multi-unit residential building in the study uses natural gas and electricity energy sources in both the suites and the common areas. Electric baseboard heaters controlled by thermostats normally provide space heating in tenant suites. Electricity is also used to power appliances, lights, fans, miscellaneous electrical devices and plug-loads. Domestic hot water is heated by natural gas and natural gas fired boilers are used in buildings with recreational amenities, including pools and hot tubs. Buildings may also have in-suite gas fireplaces for aesthetic, or partial space heating purposes. Natural gas is also typically used to heat ventilation air from rooftop gas-fired units.

Results

Over the 10 years of data evaluated (1998 to 2008), the average EUI is 213 kWh/m^2/year. For Vancouver specifically, the average EUI is 220 kWh/m^2/year.

2.4.2   Lighthouse Study: British Columbia Building Performance Study [7]

The focus of this study is to evaluate the performance of buildings in British Columbia and provide consideration to the potential impact of third-party rating systems on achieving public policy objectives. The study included 105 MURBs and was released December 2014.

Results

The average site EUI for all MURBs was 215 kWh/m^2/yr. For low-rise (1-3 storey) MURBs, the average EUI was 180.3 kWh/m^2/year.

The study suggests that low rise (1-3 storey) MURBs generally perform better than high-rise (10+ storey) MURBs which generally perform better than mid-rise (4-9 storey) MURBs.

2.4.3   Seattle Building Energy Benchmarking Analysis Report (2011/2012) [8]

In January 2014, the Seattle Office of Sustainability & Environment released their 2011/2012 Seattle Building Energy Benchmarking Analysis Report. The report is a summary of the City's Energy Benchmarking and Reporting program outcomes, building characteristics, trends, and recommendations.

In 2012, 96% of multifamily buildings 20,000 square feet or larger successfully reported their energy performance data to the city providing a comprehensive data source.

Results

Seattle's median EUI for all multifamily buildings is 101 kWh/m^2.

3   METHODOLOGY

The following sections highlight the steps taken to complete the ESPM benchmarking pilot study, the energy savings and weather normalization test, the sample building energy profile for one building in the study, the review of the City of Vancouver's "How-to Manual" and the use of GHG emissions factors for reporting purposes.

3.1   ENERGY STAR PORTFOLIO MANAGER BENCHMARKING PILOT STUDY

Natural Resources Canada offers the 1-100 ENERGY STAR Score for five different building types: K-12 schools, commercial offices, hospitals, supermarkets & food stores and medical offices. ENERGY STAR scores for MURBs are not yet available, but it is expected that the performance score for MURBs will be added in the near future. If a building is unable to receive the ENERGY STAR score, its building use details can still be entered in ESPM in anticipation of future availability.

In lieu of receiving an ENERGY STAR score, a building can receive an EUI performance metric. To fairly compare a building's performance on a year by year basis, ESPM factors out the influence of weather on energy use in a process called weather normalization. The weather normalized site (billed) EUI is the preferred performance metric used to compare the performance of the buildings included in the study because it is the most heavily normalized metric after the ENERGY STAR score.

3.1.1   Creating Properties and Entering Use Details

A few entries in UBC's portfolio consist of more than one physical building, but were entered in ESPM as a single property since they have shared parking, energy systems and metering. The 'Year Built' and 'Gross Floor Area' inputs were obtained from UBC Properties Trust online specifications. 'Occupancy' was entered as 100% and was confirmed by property owners. 'Completely Enclosed Parking Garage Size' was estimated as 20,000 sf when the actual floor area was unknown. Where this is the case, a note was added under the 'Property Notes' ESPM feature. Note that parking area isn't required for the EUI calculation; however for the ENERFY STAR score, accurate parking area is required.

Although building use details are used in the calculation of the ENERGY STAR Score for eligible building types and not the calculation of the building EUI, the details of each building were entered as accurately as possible in ESPM in this project, in anticipation of a multi-family building score.

Table 1: Building Use Details and Information Sources

Use Detail	Inputs and Information Source
Gross Floor Area[8]	Obtained from UBC Properties Trust[9]
Total Number of Residential Living Units	Obtained from Village Gate Homes & Wesbrook Properties[10]
Number of Residential Living Units in a Low-rise Setting (1-4 stories)	Obtained from Village Gate Homes & Wesbrook Properties
Number of Residential Living Units in a Mid-rise Setting (5-9 stories)	Obtained from Village Gate Homes & Wesbrook Properties
Number of Residential Living Units in a High-rise Setting (10 or more stories)	Obtained from Village Gate Homes & Wesbrook Properties
Number of Bedrooms	Obtained from Village Gate Homes & Wesbrook Properties
Resident Population Type	Other
Government Subsidized Housing	No
Number of Laundry Hookups in All Units	Estimated based on 2 hookups (1 washer and 1 dryer) per living unit)
Number of Laundry Hookups in Common Area(s)	Estimated as zero
Percent That Can Be Heated	Estimated 100% i.e. all spaces have mechanical heating
Percent That Can Be Cooled	Estimated 0% i.e. no mechanical cooling

3.1.2   Creating Meters

Utility data are received in different formats with varying units, read dates and from different sources. The best way to manage the data is by following a standard naming convention upload procedure. The generic process for uploading data into ESPM for an individual property is detailed below.

Part 1: Creating Meters

1. Create meters in ESPM – one meter for each utility. Generally, electricity data from BC Hydro is aggregated to include all tenant suites and common area data; therefore only one ESPM meter was required to capture all the electricity use of the building. For buildings metered by UBC Utilities, common area and tenant suite data may be provided separately, in which case two separate meters should be created in ESPM.

2. For the 'Date the Meter Became Active', choose a date before the earliest bill being entered (chose either the completion date of the building or the date the building

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[8] GFA, as defined in Portfolio Manager, is the total size, as measured between the principal exterior surfaces of the enclosing fixed walls of the building(s). This does not include the area of parking lot/garage spaces.

[9] UBC Properties Trust. http://www.ubcproperties.com/portfolio_list.php?category=Type&list=Residential

[10] Village Gate Homes & Wesbrook Properties   http://www.villagegatehomes.com/properties/

became occupied). It is good practice to check the utility data and see if there is a period where there is a jump from low consumption to higher consumption; this transition may indicate the point at which the building became occupied. Any period before this will return unreliable energy use metrics.

3. Select units based on the utility provider. The different billing units encountered from each utility provider are shown in Table 2.

Table 2: Billing Units for Utility Data by Source

Provider	Meter Category	Billing Units
UBC Utilities	Natural Gas	GJ
	Electricity	kWh
BC Hydro	Electricity	kWh
FortisBC	Natural Gas	GJ

3.1.3   Treatment of Utility Data

Entering utility data into ESPM is at the heart of energy benchmarking. Figure 4 conceptually highlights the process followed from obtaining raw utility data to uploading it in ESPM. More detailed explanations follow under each numbered heading.

Organize data by creating a separate folder for each building. Store any data or other documents pertaining to each building in their respective building folders. In addition, create a subfolder called 'Upload Files'. Use this folder strictly for the completed spreadsheet template files that will be directly uploaded into ESPM.
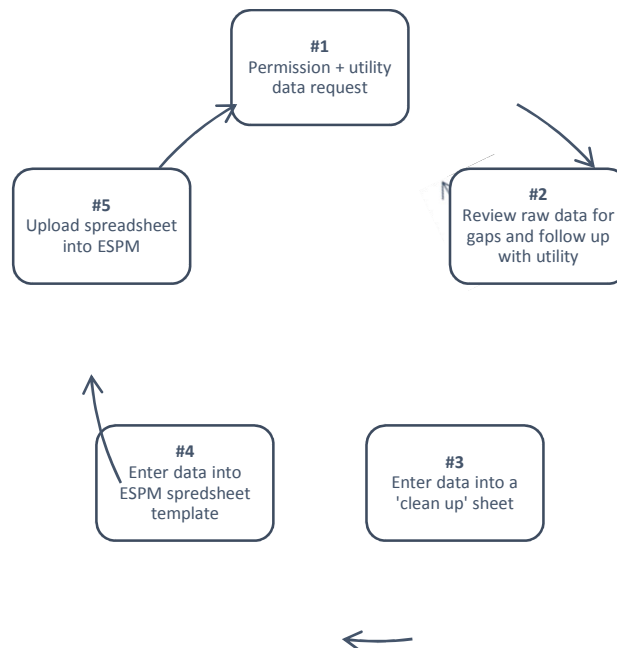

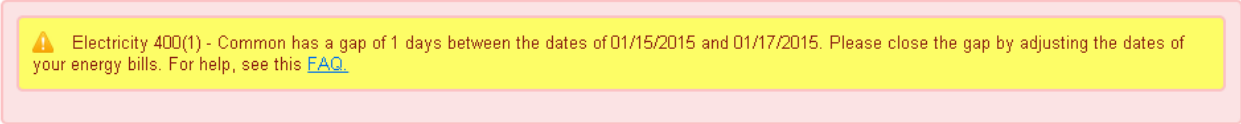*Figure 4: Flowchart for Steps in Treatment of Utility Data*

1. *Permission Piece and Data Request*

   Request three years of historical data from utility providers. For BC Hydro, a new policy is in place to request aggregated data for multi-family buildings. The policy can be seen in Appendix A.

   Requesting three years of data will allow you to evaluate how performance changes over time. Some buildings were constructed less than 3 years ago, so a three years utility history is unavailable.

2. *Data Review*

   Once raw data are received from the utility, review for gaps between bill dates and consumption anomalies. If any are found, flag for follow up with the utility provider. If you have entered any bill dates with gaps or overlaps, ESPM will alert you of the error, as shown in Figure 5. The tool will not calculate performance metrics (e.g. EUI) for any time period with a gap, or overlap in meter dates.

   ⚠ Electricity 400(1) - Common has a gap of 1 days between the dates of 01/15/2015 and 01/17/2015. Please close the gap by adjusting the dates of your energy bills. For help, see this FAQ.

   Figure 5: Sample of ESPM Error: Gap Between Bill Dates

   Reviewing data and following up with utility providers is an iterative process that must be dealt with on a case by case basis.

3. *Clean up Spreadsheet*

   For each set of data sent from utility providers, create a 'clean up' excel spreadsheet that serves as a way to manipulate the data into a format that can easily be transferred to ESPM. In this spreadsheet, format the data into three columns: Start Date, End Date and Consumption. In many cases, the end date (or read date) is given without the start date. If this is the case, the start date of one bill period must be inferred from the end date of the previous period. Enter 'Start Date' and 'End Date' in MM-DD-YYYY format.

   Note that the end date for one reading can be the same as the start date for the next reading (without causing overlap). Alternatively, the start date can be the next day. If there is more than one day between the end date of one reading and the start date of another, ESPM will return an error message.

4. *ESPM Spreadsheet Template*

   For each meter associated with a property, download a spreadsheet template for uploading bulk data into ESPM, as shown in Figure 6. Each meter should have its own spreadsheet template.

Name each sheet according to the property name and the energy type. Copy and paste values from the 'clean up' sheet into spreadsheet template. Do not change any formatting in the spreadsheet, e.g. column headers, as this will cause an error in the upload process.

Figure 6: Bulk Upload Spreadsheet Template

Note that because of the relatively small number of properties in this pilot study, the individual property bulk upload spreadsheet templates are used instead of the multiple property upload/update spreadsheets.

5. ***Upload to ESPM***

In ESPM, click 'Choose File' on the 'Manage Bills' page. Browse for the completed template saved with the property name and energy type, click 'Open', and then click 'Upload'. ESPM automatically enters the new meter entries for your property.

3.1.4   ESPM Time Commitments
#1 – Property Set-up

Setting up a MURB property in Portfolio Manager is a relatively easy process. Acquiring basic property information (address, year built, etc.) is straightforward and can be done by obtaining information from the UBC Properties Trust website. **Time: 15-30 minutes**

#2 – Building Use Details

Building use details take longer than basic property information to input. Inputs such as number of residential living units and number of bedrooms can often be found from the Property Management websites (Village Gate Home & Wesbrook Properties). If this information had been unavailable online, the time commitment would have significantly increased. In that case, a survey to the property manager might have been the best solution. **Time: 30+ minutes**

#3 – Entering Utility Data

It typically takes approximately half hour per meter to enter utility data history from start to finish. This includes creating the meter in ESPM, reviewing the raw data for period gaps and missing data, reformatting the raw data in a 'clean-up sheet' and uploading the data to ESPM. The time commitment presented is for a typical building with three meters. **Time: 1.5 hours**

3.2   ENERGY SAVINGS & WEATHER NORMALIZATION

3.2.1   Weather Normalization

Annual fluctuations in weather conditions can impact the energy use associated with building operation. Weather normalizing energy is the process of determining the energy a building would have used in a specific year under a set of base conditions. The base conditions might be either climate normals (representing the average weather conditions over a 30 year period), or a baseline year (a period before the implementation of energy savings measures that post retrofit energy usage will be compared to).

Normalizing for weather allows a building's energy performance to be fairly evaluated over time by factoring out the influence of changes in weather. This is an important component of reporting both building energy performance and energy savings.

3.2.2   Weather Normalization in ESPM

In ESPM, weather normalization is based on 30 year climate normals [9] and is calculated using behind the scenes regression analysis that allows for easy reporting of energy consumption and performance metrics.

3.2.3   RETScreen Plus Software Pilot

RETScreen Plus[11] is a free energy management software offered by Natural Resources Canada. This tool has a number of powerful features that can be used in parallel to the features available in ESPM.

Weather normalization in RETScreen is based on user-defined regression analysis and a base year(s) is chosen as the point of comparison for future energy use. The tool's functionality was investigated using Building B+C utility data.

3.2.4   Procedure for Weather Normalization Using a RETScreen Baseline
#1 – Start

In RETScren Plus, under the 'Start' tab, click on the 'Select climate data location' button. From the 'Map' tab chose Vancouver Int'l as the location for climate data. Note that the weather stations with red dots are from ground sources and those marked with purple dots are NASA sources.

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[11] Natural Resources Canada. "RETScreen Plus" Information available online: http://www.retscreen.net/ang/performance_analysis.php
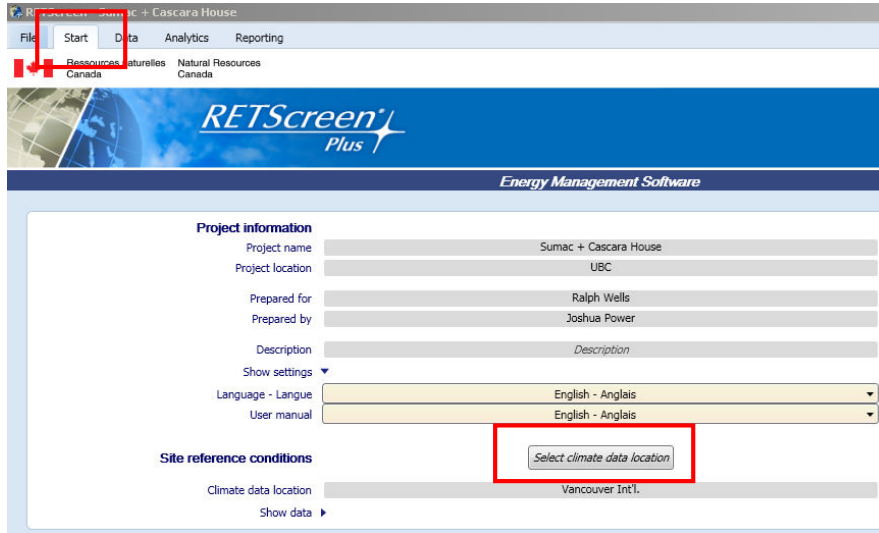
#2 – Data

Step 1 – Consumption / Production

Under the 'Data' tab, select which energy data you want to import (one spreadsheet at a time) by choosing 'Electricity consumption' or 'Fuel consumption'. Then select 'Import from file' to upload spreadsheets containing energy consumption history.
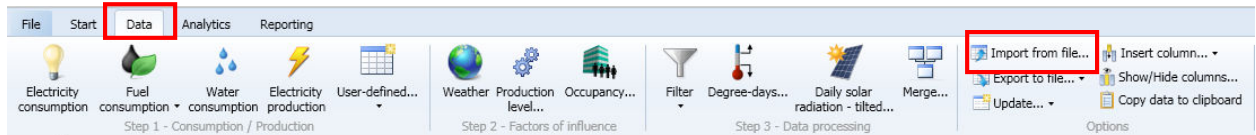
Once the data are imported, RETScreen will try to interpret the right column headings, but they may require editing to match RETScreen's predefined column heading names. If you have two date columns in your excel spreadsheet, allow RETScreen to import the end date instead of the start date (only one can be imported) and manually set the 'Begin' date in RETScreen's dialogue box that appears. The only necessary column headings are 'Date' and either 'Fuel consumption' or 'Electricity' depending on the energy source.

Step 2 – Factors of Influence

Under the 'Data' tab select 'Weather' as the factor of influence. Once 'Weather' has been selected, click on the 'Download NASA satellite data' button that appears to download daily weather data. Alternatively, weather data can be uploaded in spreadsheet format and used instead of NASA data.

Step 3 – Data Processing

Heating degree days are not part of the NASA dataset, but they can be derived from the data by using the 'Degree-days' button. After they have been calculated, add them as a column to the weather data. For the Building B+C pilot, the reference temperature was selected as 18 °C.
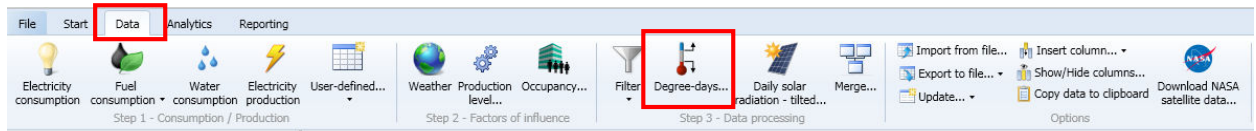
Now the consumption data and weather data need to be merged into a standard time periods. Click on the 'Merge' button to bring the two datasets into a common format. Select the energy consumption data table as the destination table and the NASA data table as the source. Also select heating degree days as the data to be merged. This process converts the heating degree days to monthly HDD under the energy consumption data.
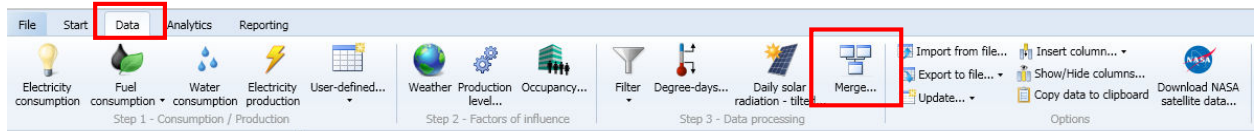
#3 – Analytics

Step 1 – Baseline

Select 'Establish a baseline' then 'Regression analysis' to make RETScreen fit an equation between the consumption data (dependant variable) and heating degree days (independent variable). A linear equation is chosen by default and an R^2 > 0.75 is generally considered a good fit. For the Building B+C pilot, the baseline was chosen to begin 01/01/2012 for each model for consistency. Click on the 'X-Y scatter' tab to show the linear regression.

An outlier was removed from the regression models of both Sumac and Cascara suite electricity. The data points were approximately double the energy consumption of other months and brought about poor relationships between consumption and HDD. Without the points, the regressions improved to an R^2 of approximately 0.9. These data points were not investigated further due to project time restraints.

In terms of regression baseline best practices, a one year baseline is commonly used in industry since organizational reporting on targets and changes are usually based on a single reference year, e.g. 'we saved 10% relative to 2008 energy use'. However, using a baseline of more than one year will likely result in a stronger model. Choose a baseline that is line with UBC's reporting goals.

Step 3 - Comparison

To calculate savings relative to the baseline period, a CUSUM can be created under the 'Cumulative sum' button. The difference between actual and predicted values is calculated for each period and added together, creating a "running total." If the slope of the graph is positive (going upwards), this indicates that the actual energy consumption is higher than the prediction that was calculated based on the baseline. If the slope is negative (going downwards), this indicates that the actual energy consumption is lower that the prediction calculated based on the baseline.

3.2.5   Applying Climate Normals to a RETScreen Regression Model

By applying climate normals to the RETScreen regressions models, it is possible to compare the ESPM weather normalized results (that also use climate normals) to those produced using RETScreen's models. Essentially, using RETScreen allows the user to create their own regression models which would otherwise be created automatically in ESPM.

Once the formula from the linear regression is created in RETScreen, extract the formula and calendarized data to apply them to climate normals. The most recent climate normals (1981-2010) for Vancouver International Airport are used to describe the average climate for UBC. By using the climate normals, the baseline period used to compare yearly consumption data is based on the average climate conditions over a 30 year period instead of the baseline year 2012.

To extract data from RETScreen, use the 'Copy to clipboard' button when under the Regression's Details tab. The linear equation's coefficients will be copied to the clipboard and can be pasted into Excel.

Next, under the 'Analytics' tab and Tools, select 'Graph' and 'Monthly bar graph'. In the dialogue box that appears, multiple years of data can be displayed by selecting the 'User-defined' option. Check the 'Factors of influence' checkbox in the same dialogue box, and choose 'heating degree days'. The graph and data are calendarized so the data can be applied to monthly climate normals. Extract the data by copying it to the clipboard and paste it into Excel.

Using the climate normal HDDs and the regression model generated in RETScreen from the relationship between 2012 energy consumption and HDDs, the predicted consumption for each month is calculated. Summing these predictions over the year gives the predicted consumption for a year with climate normal conditions. Following the same process for 2012, 2013 and 2014, a predicted yearly consumption value is generated for each year for which data are available. Next, a normalization ratio for each year is computed by dividing the predicted consumption of the climate normal year over the predicted consumption each year in question. The weather normalized yearly consumption is calculated by multiplying the normalization factor by the actual consumption for the year in question.

3.3   BUILDING ENERGY PROFILES

Energy profiles provide high level insight into how energy is being consumed for different end uses within the building. By using the regression models created in RETScreen for Building B+C, a sample building energy profile was created based on 2014 energy consumption. The end-uses in the energy consumption analysis for Building B+C are shown in Table 3.

Table 3: Sumac Cascara End-use Breakdown Categories

Natural Gas		Electricity	
Base load	**Weather Sensitive**	**Baseload**	**Weather Sensitive**
Domestic hot water (DHW)	Fireplace & make-up air unit (MAU) heating	Suite lighting & plug loads	Suite baseboard heating
		Common area electricity	

3.3.1   RETSCreen Regression Models

For each regression model (see section 3.2.4) created in RETScreen, copy the y-intercept to an excel spreadsheet. The y-intercept can be located under the "Details" tab when looking at the regression model. The y-intercept is used to find the daily consumption which is used as a proxy for the daily baseload. Multiply the intercept consumption by 365 to obtain an estimate for the annual baseload consumption.
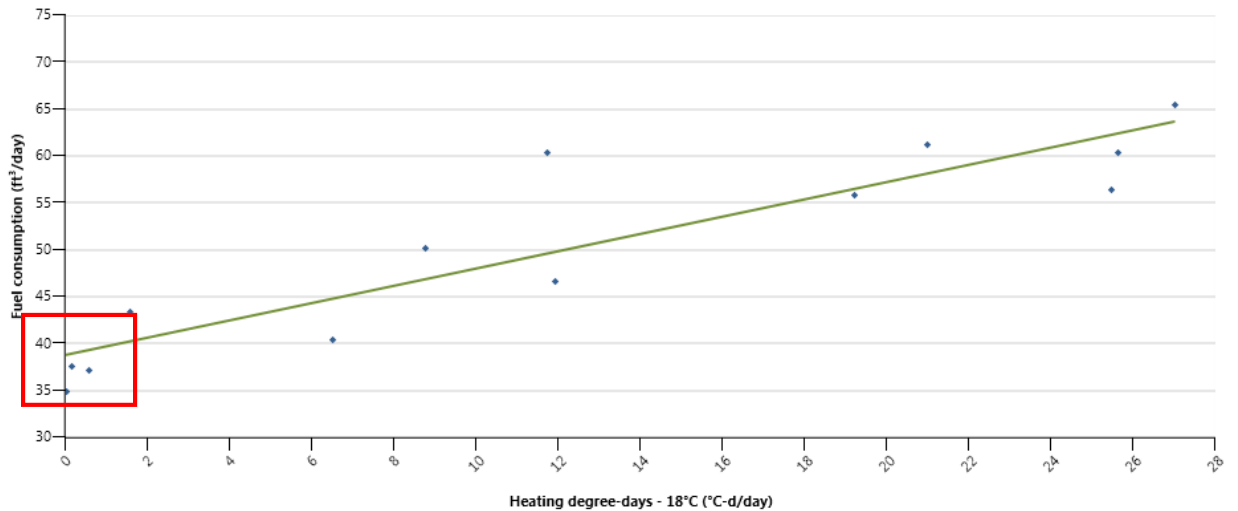
To estimate the weather sensitive consumption, subtract the baseload consumption from the total energy consumption for the year. The total energy consumption for the year can be calculated by copy and pasting the data from the 2014 monthly consumption table in RETScreen to the excel spreadsheet.

Months	Fuel consumption ft³ 2011	Fuel consumption ft³ 2012	Fuel consumption ft³ 2013	Fuel consumption ft³ 2014
Jan		1,955	1,801	1,774
Feb		1,842	1,634	1,769
Mar		1,885	1,675	1,791
Apr		1,671	1,431	1,521
May		1,449	1,404	1,294
Jun		1,216	1,283	1,132
Jul		1,127	1,197	1,091
Aug		1,121	1,117	1,048
Sep		1,169	1,128	1,089
Oct		1,355	1,322	1,325
Nov	930	1,539	1,490	1,619
Dec	1,840	1,742	1,582	1,827

Note that in RETScreen, the units for natural gas are shown as ft^3; however the unit should actually read CCF (100 cubic feet). This discrepancy is a user-defined error. To convert from ft^3 to GJ, multiple by a factor of 0.001055.

For common area electricity, even though the regression model shows a relationship to weather, almost all (95%) of the consumption is baseload; therefore all the common area electricity consumption was assigned as baseload without accounting for the weather sensitive portion.

3.4   REVIEW OF THE CITY OF VANCOUVER'S HOW-TO-GUIDE

In preparation for launching their voluntary benchmarking program, the city of Vancouver has put together a draft Energy Benchmarking How-to-Guide. The guide contains step by step instructions for gathering building use details, requesting utility data, using Portfolio Manager and sharing results with the City.

Throughout the guide comments, suggestions and corrections are added to the document. Comments with red text are suggestions to replace the existing text and comments in black are generally formatting suggestions. Some text in the document has been crossed out using the strikethrough feature; these are the only instances of changes being made directly to the document.

3.5   GHG EMISSION FACTORS

A summary of the emissions factors that can be used to calculate the GHG emissions intensity of UBC's buildings are shown in Table 4. Note that using ESPM for emissions calculations [10] results in a significantly higher emission intensity for electricity compared to BC Best Practices for Quantifying Greenhouse Gas Emissions [11].

Table 4: Summary of GHG Emissions Factors from Two Sources

	Electricity (tCO2e/kWh)	Natural Gas (tCO2e/GJ)
ESPM	0.000034	0.0501
BC Best Practice	0.000010	0.0498
% Difference	109%	1%

In ESPM, emissions for electricity in Canada are computed by province to account for differences in electric generation, transmission, and distribution methods. Natural gas factors are computed by province to account for differences in gas content and supply across the country. These values are determined based on the National Inventory Report submitted by Canada to the United Nations Framework Convention on Climate Change [10].

The primary source document for emission factors for BC Best Practices is the British Columbia Greenhouse Gas Inventory Report 2012. Where provincial data are not available, the factors from Environment Canada's National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2012 have been used. In addition, international documents, such as the Climate Registry's General Reporting Protocol have been used for some emission factors. B.C.-specific emission factors have been developed in other cases, using data provided by energy companies and business travel providers [11].

The standard practice at UBC for reporting on GHG emissions is to use factors from BC Best Practices Methodology For Quantifying Greenhouse Gas Emissions. For the UBC Statement of Energy Performance reports (see section 5.1.2), the BC Best Practice emission factors were also used.

4 RESULTS

The following sections highlight the results for the ESPM benchmarking pilot study, the energy savings and weather normalization test, the sample building energy profile for one building in the study and the review of the City of Vancouver's "How-to Guide".

4.1 ENERGY STAR PORTFOLIO MANAGER BENCHMARKING PILOT STUDY

Table 5 summarizes the weather normalized site EUI for every building in the study from 2012 to 2014. The source report produced from a custom template in ESPM can be found in Appendix B.

Table 5: Summary of 2014 Weather Normalized Site EUIs

Property Name	GFA (m²)	2014 Weather Normalized Site EUI (kWh/m²)
Building B+C	7,009	222.2
Building D	5,387	163.9
Building E	7,659	144.4
Building F	4,880	127.8
Building G+H	9,848	150.0
Building J	8,361	169.4

4.2 BUILDING ENERGY PROFILES

The RETScreen regression models for Sumac-Cascara were used to develop an energy end-use profile, estimating base and variable loads for natural gas and electricity use.

Figure 7 shows a combined estimated energy end-use that includes both natural gas and electricity energy use.
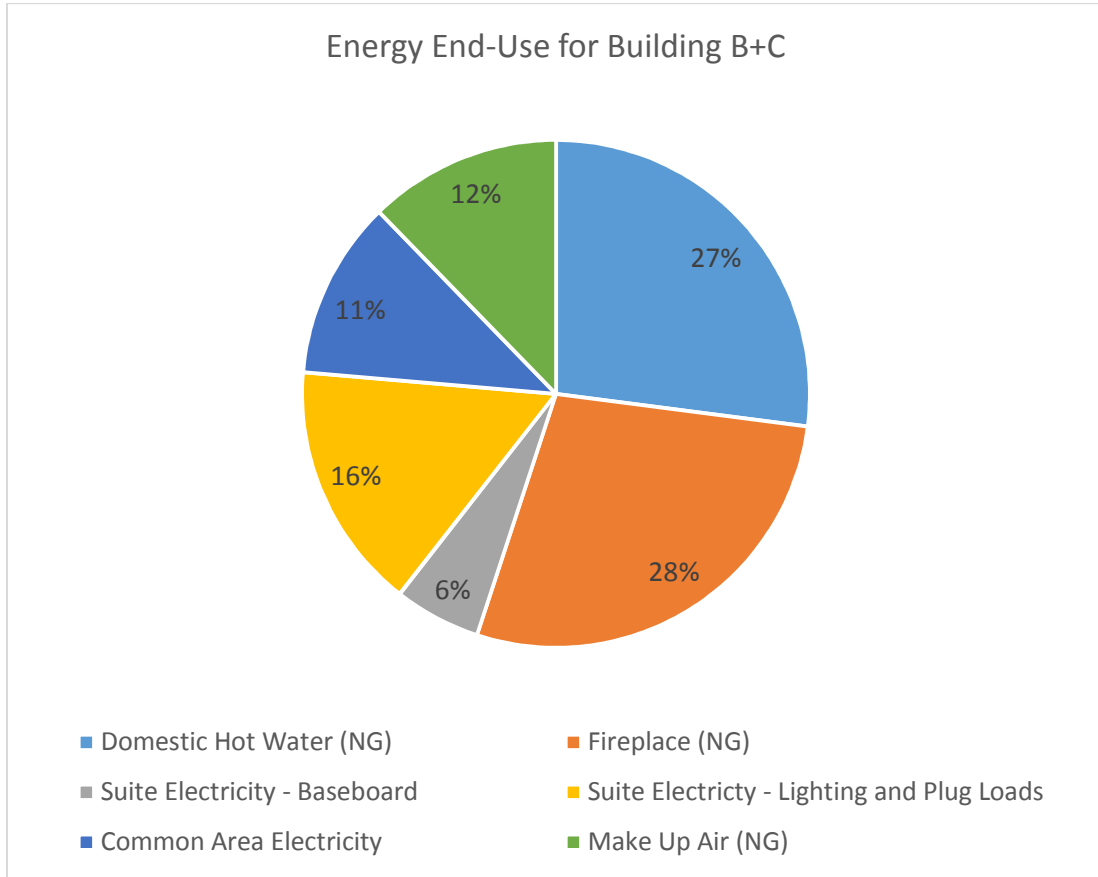
Figure 7: Energy End-use Categories for Building B+C. Natural gas consumption from fireplace use was directly metered. NG is natural gas.

4.3   REVIEW OF THE CITY OF VANCOUVER'S HOW-TO-GUIDE

The City of Vancouver's draft Energy Benchmarking How-to-Guide is a comprehensive resource that provides step by step instructions for getting started with ESPM. The guide is easy to follow and the various screen captures of the ESPM dashboard and utility bill samples are very effective for following along in ESPM.

A copy of the draft report complete with suggestions and comments has been shared with the City of Vancouver.

5 DISCLOSURE & COMMUNICATION

5.1 STATEMENT OF ENERGY PERFORMANCE

The following sections describe the background behind the two-page worksheet prepared for building owners to communicate building energy performance results.

5.1.1 ENERGY STAR Statement of Energy Performance

The UBC Statement of Energy Performance is a concept primarily adapted from ENERGY STAR Portfolio Manager's Statement of Energy Performance report. ENERGY STAR's performance report is a one page document that summarizes the energy consumption of a property. A sample can be seen in Appendix C. The focus of the report is on the ENERGY STAR score achieved by the property, but the report also includes property and contact information; energy consumption and energy use intensity; and a place for a verifying professional to sign and stamp. As part of local legislation, municipalities may require the release of a property's ENERGY STAR statement of energy performance to third parties.
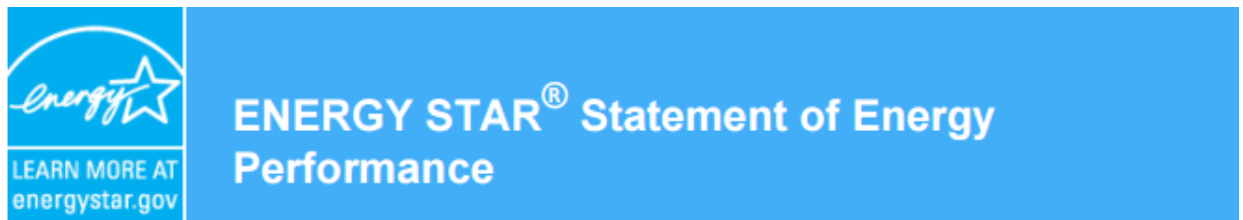

Figure 8: ENERGY STAR Statement of Energy Performance Report

5.1.2 UBC Statement of Energy Performance

The UBC Statement of Energy Performance is a two-page report intended for building owners. The front page of the report provides a quick snapshot of the building including a photo, building type, gross floor area, year built and the weather normalized energy use intensity. There is also a summary of the property and contact information, and a chart comparing the EUIs of all the building in the pilot study.

The back side of the report provides more in depth information on the performance of a building. Here, building owners gain instant insight into their energy performance through an absolute breakdown of the most recent annual energy use, historical building performance metrics over the most three recent years and two charts highlighting the breakdown of energy and GHG emissions by source. In addition (sampled for Building B+C only), there is also an energy profile that shows the estimated energy breakdown by end-use.

Because Canadian multi-family buildings are not yet eligible to receive an ENERGY STAR score, the focus of UBC's Statement of Energy Performance is redirected to other performance metrics and indicators. The design follows a similar format to the ENERGY STAR statement of energy performance except the primary focus is on the weather normalized EUI, the most heavily normalized metric after the ENERGY STAR score.

In addition, there is not yet a Canadian median EUI for multi-family buildings, so there is no way to compare a property's performance to the national building stock. To give building owners a meaningful comparison, a UBC Neighbourhood MURB Benchmark section was added to the

report. This section provides a chart comparing the electricity and natural gas consumption of each building to one another and to the median. The median is computed from the buildings included in the pilot study. The median energy use is considered descriptive normative information because it coveys to the reader what behaviour/result is typically performed; in this case, it informs the reader that 50% of buildings use more energy and 50% use less.

A draft UBC Statement of Energy Performance for the six buildings included in the study are located in Appendix C.

6 INTEGRATION WITH EXISTING UBC ENERGY MANAGEMENT PRACTICES & PROJECTS

6.1 RECEIVING UTILITY DATA

The following sections provide an overview of how the different utilities format their exported utility data, an estimate for how quickly each utility can provide data after the meter read date and a general idea of how long it takes to receive data after a request.

6.1.1 UBC Utilities

Electricity billing data are provided on a monthly basis. Data are separated for each tenant suite and the common area. Natural gas is billed monthly under one account per building.

Meter read data are reported within one week period of being read. After this, the billings are generated within a week. Billing data can be obtained within a maximum of two weeks from meter read date.

Data turnaround time after a request was less than one week and can be as fast as one to three days.

6.1.2 BC Hydro

For multi-family buildings, BC Hydro provides electricity data in an aggregated format. The aggregated consumption data includes tenant suites and common areas. Non-aggregated common area data can also be requested separately.

There is an estimated one month gap between meter read date and data availability.

The turnaround time on a request for common area data takes approximately one to three days while aggregated data takes approximately one week. Note that these relatively quick turnaround times reflect the fact that UBC has a Key Account Manager with BC Hydro. Smaller organizations will likely experience longer turnaround times.

6.1.3 FortisBC

FortisBC's billing periods usually begin and end mid-month and data and consumption data are reported on a monthly basis.

There is approximately a one month gap between meter read date and data availability.

Upon request, FortisBC was able to provide data in one to three days. Note that these relatively quick turnaround times reflect the fact that UBC has a Key Account Manager with FortisBC. Smaller organizations will likely experience longer turnaround times.

6.2 SMARTTOOL

According to the provincial government's "Methodology for Reporting", a company owned by a Public Sector Organization (where the PSO owns more than 50% of the shares) is in scope for reporting GHG emissions to the provincial government. UBC Properties Trust is therefore obligated to annually report the monthly energy consumption of each building on campus to the

provincial government using the government's SMARTTool software [12]. The University uses SMARTTool results to inform GHG offset costs.

If utility data for a building are unavailable, SMARTTool applies a regional EUI to the building. A list of the buildings included in the benchmarking pilot project that had consumption history for at least one utility source estimated in SMARTTool for the year 2014 are shown in the table below.

Table 1 – List of UBCPT-Owned Buildings Included in Benchmarking Study with One or More Utilities Estimated in Annual SMARTTool Reporting[12]

Building Name	Electricity provider and account	Natural gas provider and account
Building D	Estimated	UBC Utilities
Building E	Estimated	UBC Utilities
Building F	Estimated	Estimated

There is potential that SMARTTool's estimated consumption values are overestimated which would result in additional costs incurred by UBC for GHG offsets. By comparing the estimated values to the calendarized ESPM consumption for the year 2014, it's possible to see if UBC incurred an extra cost from SMARTTool's estimations. This analysis was performed for Building F House and is shown in Table 6.

Table 6: Comparison of SMARTTool and ESPM GHG Offset Costs

Building	Metric	2014 Consumption	
		Natural Gas (GJ)	Electricity (kWh)
Building F	SMARTTool	1,658	357,725
	ESPM	995	343,108
	Difference	663	14,617
	% Difference	40%	4%
	GHG Difference (tCO$_2$)	33.0	0.1
	Cost Savings	$826	$4

Based on the analysis, using $25/ton for offsetting CO_2, UBC would have saved $800+ before taxes for Building F if 2014 SMARTTool reporting had been performed using the ESPM calendarized consumption instead of estimation. ESPM has the reporting capability to report on

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[12] The other buildings in the pilot study have utility data for 2014, so they are not estimated in SMARTTool reporting and are not shown in this table.

monthly consumption data over a specified range. The results of this ESPM report could then be input into SMARTtool.

6.3   REAP

UBC designed REAP (Residential Environmental Assessment Program) to guide the development of all residential buildings planned for the UBC Vancouver campus [13]. The rating system is comprised of a number of different performance categories and is analogous to LEED[13]. The program applies to both low and high-rise buildings and ensures lower consumption of water, energy and resources, and higher-quality indoor environments and construction practices compared to standard residential building.

The Energy & Atmosphere (E&A) REAP performance category specifically targets improving building energy performance. By tracking energy performance using building energy benchmarking, UBC may be able to compare the E&A score of a building to its performance to determine if higher E&A scores are promoting relatively improved energy performance. A summary of the REAP scores from the buildings in benchmarking pilot study along with the energy performances expressed as EUIs are included in Table 7.

Table 7: REAP Performance Scores Compared to 2014 EUI[14]

Building Name	Weather Normalized EUI (kWh/m²)	Total REAP Score	E&A REAP Score
Building F	128	122	22
Building E	144	N/A	N/A
Building G+H	150	141	21
Building D	164	N/A	N/A
Building J	169	N/A	N/A
Building B+C	222	N/A	N/A

Using the data from Table 7, Table 8 shows a comparison of the average low-rise EUI for the REAP and non-REAP certified buildings in the study). Based on the comparison, EUIs of REAP certified buildings were approximately 21% lower than non-REAP certified buildings. The low number of samples in the analysis makes it less reliable; however this is an exercise that could be performed in the future as one way to assess the effectiveness of the REAP program.

Table 8: Average Low-Rise 2014 Weather Normalized EUI for REAP Buildings vs. Non-REAP Buildings[15]

	Average 2014 EUI
REAP Building	139
Non-REAP Building	177

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[13] LEED (Leadership in Energy & Environmental Design) is an international green building certification program that recognizes best-in-class building strategies and practices for a variety of project types. Source: LEED. "Overview". Available online: http://www.usgbc.org/leed

[14] REAP scores are not available for buildings that pre-date implementation of REAP, and were not yet available for Building J.

[15] Building J was excluded from this calculation because it is a high-rise (> 4 storey) building

6.4   SEEDS RESEARCH PROJECT: MOTIVATING ENERGY CONSERVATION IN RESIDENTIAL BUILDINGS

As it becomes available, utility data from the benchmarking study are being used to support a behavioural change study at UBC that focuses on energy conservation in residential buildings.

The study compares the efficacy of two methods of motivating electricity conservation and evaluates the applicability of these methods to multi-suite residential buildings. The aim is to examine whether methods previously shown to reduce energy consumption in the individual household can be generalized to the multi-unit building level.

To properly calculate energy savings from this project, an introduction to weather normalizing building energy consumption using RETScreen Plus was taught to members working on this project.

7 CONCLUSIONS

The following sections provide closing thoughts on the ESPM benchmarking pilot study, the energy savings and weather normalization test, and the sample building energy profile developed for Building B+C. It also highlights next steps for benchmarking multi-family buildings at UBC, as well as recommendations for future work.

A detailed write up can be found in Appendix D that provides an overview of challenges encountered during this project and offers discussion and insights into overcoming commonly encountered issues.

7.1 ENERGY STAR PORTFOLIO MANAGER BENCHMARKING PILOT STUDY

ESPM was successfully used to benchmark six UBC neighbourhood multi-family buildings. The tool is a good choice for UBC because ESPM is:

- Technically feasible and straightforward to use;

- Free and non-proprietary;

- The tool of choice for other jurisdictions involved in benchmarking.

The tool also provides multiple connections to other UBC initiatives such as SMARTTool and REAP and will eventually be able to give UBC's buildings scores to compare their performance to local and national databases. Most importantly, the tool's use can be scaled up and to support the CEEP objectives to conserve energy and reduce GHG emissions in existing neighbourhood multi-family buildings.

The time commitments to use the tool once all data have been obtained are minimal with an average building requiring an estimated 2-2.5 hours for set up, data clean up and data upload. Note that if UBC continues to the use the tool, time commitments on a per building basis will decrease as staff become more familiar with the tool. In addition, the set up and collection of building use details only needs to be done once.

It may be worthwhile to postpone expanding benchmarking to other multi-family buildings on campus until BC Hydro releases a process for automated electronic data exchange. The process for obtaining electricity data can be extremely time consuming and an automated process would simplify the time commitments from both BC Hydro and UBC in exchanging utility data. Once the data are received, it is straightforward to upload to Portfolio Manager; however, the constant back and forth to fill data gaps and acquire complete data history is extremely tedious. With electronic data exchange on the horizon, the process will become much more streamlined.

7.2 ENERGY SAVINGS & WEATHER NORMALIZATION

RETScreen is a powerful energy management tool that can be used in parallel with ESPM to create robust regression models for weather and to accurately track energy savings over time.

Compared to ESPM, RETScreen offers more control in creating weather normalized models for tracking energy savings. Although ESPM can be used to set baselines and targets, RETScreen offers a host of tools for improved reporting at the meter level. As a tool, RETScreen is transparent, user friendly and offers a variety of options for refining models. For these reasons, it is recommended to use RETScreen for calculating and monitoring savings from energy efficiency measures once they have been implemented.

7.3 BUILDING ENERGY PROFILES

Using the regression models built in RETScreen, it is possible to estimate the energy end-use breakdown for UBC's multi-family buildings by separating weather sensitive and non-weather sensitive energy uses. This was done for Building B+C to break out the domestic hot water, fireplace & make-up air, common area electricity, suite lighting & plug loads and suite baseboard heating.

Once developed for other buildings, these profiles may serve as a way to identify opportunity areas for targeted energy efficiency measures. This type of breakdown also gives a sense of magnitude to the different end-uses of the buildings. Without conducting a formal energy audit, energy consumption breakdowns calculated from regression models are estimates only.

7.4 NEXT STEPS FOR BENCHMARKING AT UBC

The next steps for benchmarking at UBC provides an overview for moving benchmarking and disclosure past the pilot study phase.

Establish a benchmarking plan for the campus

Based on the results of the pilot project, develop a plan for expanding benchmarking to other buildings. Benchmarking using ESPM is extremely scalable, meaning buildings can be added as they are volunteered to participate. Significant headway has been made on expanding to benchmarking to Strata owned and operated buildings. .

Use results to inform energy efficiency improvements

Benchmarking can provide the basis for more informed decision making around energy efficiency improvements for UBC's existing multi-family building stock. Generally, buildings that achieve poor performance metrics may be good candidates for energy efficiency improvements. Improvements can be identified by completing more detailed retro-commissioning studies and may range from mechanical retrofits requiring capital investment for extremely poor performers to low-cost operations and maintenance tune ups for average performing buildings.

Pair benchmarking with support tools

By communicating performance results to building owners, they are given insight into their buildings they might not otherwise be exposed to. For energy efficiency advances to be made, owners and operators need to be able to access tools that will support improvements such as

operator training opportunities like BOMA e-Energy Training[16], or NRCan's Dollars to $ense Energy Management Workshops.[17] Another option is to bring in energy advisors who can provide location specific recommendations.

Monitor and verify results

Benchmarking building performance can provide a weather normalized baseline for energy use that can be used to verify post-retrofit energy, cost and GHG emission savings.

7.5   RECOMMENDATIONS FOR FUTURE WORK

7.5.1   UBC Statement of Energy Performance

In future iterations of the report, it may be useful to include a qualitative inventory of the building's existing energy efficient features. This may be supplemented with ideas for typical features and an estimate of cost savings to encourage action.

Encouraging action is an important part of the statement of energy performance. In its current state, the report simply displays the information without conveying what the results actually mean for the building owner, or how the owner should act on the information. To improve the report, it needs to be tailored in a way that will encourage building owners to care about and take action on energy efficiency.

The statement of performance acts as a first step, but to be effective, in addition to improvements in data visualization, there needs to be follow up resources in place to support action.

There is a lack of local benchmarks for low rise buildings which affects statement of energy performance. Without a local comparison, it is difficult to explain the relative performance of UBC's buildings. RDH Building Engineering has indicated that they will be completing a low-rise (1-4 storey) multi-family study in the near future to complement their high-rise study completed in 2012. Once published, if the ENERGY STAR score is still unavailable, these results could be used as a local benchmark to provide context to the performance of UBC's low-rose multi-family buildings.

7.5.2   REAP Evaluation based on Benchmarks
Reliable benchmarks paired with REAP scores can be used to assess the performance of the REAP. By comparing REAP and non-REAP certified buildings to the energy performance of UBC's neighbourhood buildings, UBC can develop a procedure to evaluate the effectiveness of the REAP program in a quantifiable way.

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7.6 ACKNOWLEDGEMENTS

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