How We Calculated the Energy Savings

March, 2012

In order to determine the amount of energy saved by projects on the BCIT campus the energy management team must make assumptions to do the calculations necessary to add up the savings. The goal of this document is to help make the savings estimates as transparent as possible.

This document provides one example calculation (refer to Photo 2 - Cold Water Used for Laundry) and outlines all assumptions for the projects presented in the SEMAC Photography Exhibit. If you have any questions or would like to know how things were done in more details please do not hesitate to contact Andrea Linsky or Alexandre Hebert at:

andrea_linsky@bcit.ca

alexandre_hebert@bcit.ca

We hope you will find this document helpful.

Sincerely,

The SEMAC Photo Exhibit Team

Contents

Conversion to Solar Panels

All of the energy savings calculated was converted to equivalent number of solar panels needed to produce the same amount of energy. Decreasing the amount of energy "imported on BCIT campuses" can be done in two ways: either by decreasing the amount we use or by replacing the amount we use by an alternative source of on-site energy production (such as solar photovoltaic panels). The amount that it costs to implement the measure in each case is provided to help demonstrate the cost effectiveness of conservation vs. installation of generating equipment such as solar photovoltaic. In BC in most cases, it makes more sense to reduce first and produce second.

Reminder of the SEMAC Photo Exhibit objective: We hope you will leave the exhibit even more excited about reducing energy use, increasing energy efficiency, and adopting energy conservation behaviors than you are about alternative energy technologies (and we know that's hard to do!).

<u>Solar panels assumptions:</u>

- Solar Panel Cost:
    - Values determined from quotes for 100 panels installed on Burnaby campus.
    - Cost as quoted: Average of $500 per 200 W (0.2 kW) panel (purchase cost) and $500 per panel for other equipment (inverter, batteries, etc.) and installation (total averaged per panel) for a total of $1,000 per 200 W panel installed.
    - In most cases, price will go down as quantity of panels goes up. Here are the numbers we used for the calculations featured in this photo exhibit. We have tried to make these numbers conservative.
        - Between 100 and 500 panels installed in one project: Average of $400 per 200 W (0.2 kW) panel (purchase cost) and $400 per panel for other equipment (inverter, batteries, etc.) and installation (total averaged per panel) for a total of $800 per 200 W panel installed.
        - Between 501 and 1,000 panels installed in one project: Average of $350 per 200 W (0.2 kW) panel (purchase cost) and $300 per panel for other equipment (inverter, batteries, etc.) and installation (total averaged per panel) for a total of $650 per 200 W panel installed.
        - Between 1,001 and 1,500 panels installed din one project: Average of $325 per 200 W (0.2 kW) panel (purchase cost) and $275 per panel for other equipment (inverter, batteries, etc.) and installation (total averaged per panel) for a total of $600 per 200 W panel installed.
- All costs exclude BCIT's internal project management.
- Area of one 200 W solar panel: 1.5 m^2.
- Amount of energy produced by one solar panel:
  Best alignments (annual) = South-facing, Tilt = Latitude
  For Burnaby, annual = **993 kWh/kW installed or approximately 200 kWh/yr per 200 W panel installed.**
  [from https://glfc.cfsnet.nfis.org/mapserver/pv/municip.php?n=2997&NEK=e]

Freezer Curtains

- Savings calculated by BC Hydro Power Smart Partner calculator. This calculator determines the savings that BC Hydro is willing to incent; this is most likely a conservative estimate. All eligible items are listed here http://www.bchydro.com/ecatalog/ but the calculator is only available to Power Smart Partners.
- Total energy savings: 170,000 kWh/yr
- Total cost of project: $21,000 (excluding BCIT's internal project management cost)
- Equivalent number of 200 W solar panels: 850 panels
- Equivalent cost to produce same annual amount of on-site energy with 200 W solar panels: $552,500, rounded to $550,000.

Cold Water Used For Laundry

Assumptions

- According to a BC Hydro and a CBC study, the following are the typical British Columbian numbers for cleaning clothes:
    - 121 L/load;
    - Average of 2 loads per week;
    - 0.06 kWh/L to heat hot water.
- On average there are 300 students at any given time in the residences.
- Not all water that is used in a load is hot. It is estimated that one quarter of the load is hot water; therefore 30L per load is hot water.
- Measurements taken on the washing machines showed that implementation of the price change strategy (charging more for hot water than for cold water; as opposed to charging one unique price for both) saw a change from 40% of loads with cold water to 85% (i.e.: a 45% increase).
- Total cost of project: $0 (excluding BCIT's internal project management cost)

Example Calculation

Laundry	
30	L/load (of hot water)
300	Students
2	loads per week
50	weeks per year
0.06	kWh/L of hot water
85	% of students that use cold water after price change
40	% of students that use cold water before price change
45	% increase of students using cold water

Total energy used to heat hot water for laundry before change:

$$TotalEnergy = \frac{HotWater}{Load} * Students * \frac{Loads}{Week * Student} * \frac{Weeks}{Year} * \frac{Energy}{HotWater}$$

$$TotalEnergy = 30\frac{L}{Load} * 300Students * 2\frac{Loads}{Week * Student} * 50\frac{Weeks}{Year} * 0.06\frac{kWh}{L}$$

$$TotalEnergy = 54{,}000\frac{kWh}{Year}$$

Energy savings: Change in water use from 40% to 85% means an increase of 45% in students using cold water. Therefore 45% of the total energy used to heat water previously is no longer used to heat water as it is now cold.

$$TotalSAVEDEnergy = 54{,}000\frac{kWh}{Year} * 0.45 = 24{,}300\frac{kWh}{year}$$

The value that was used for further calculations is **24,000 kWh/year** rounded down to be conservative.

Number of panels equivalent:

Using the assumptions from the solar panel conversion section above:

$$TotalEQUIVpanels = \text{energy saved}\frac{kWh}{Year} \div \text{panel output}\frac{kWh}{panel}$$
$$TotalEQUIVpanels = 24{,}000\frac{kWh}{Year} \div 200\frac{kWh}{panel} = 120 panels$$

Equivalent cost to produce same annual amount of on-site energy with 200 W solar panels:

$$\text{EQUIVpanelCOST} = \text{number of panels} \times \text{cost per panel}\frac{\$}{panel}$$

$$\text{EQUIVpanelCOST} = 120\ panels \times 800\frac{\$}{panel} = \$96{,}000$$

Low Flow Shower Heads

- Total number of showers in student housing: 119.
- Sampled 30 out of 119 showers: average flow before retrofit: 18.2 L/min and after retrofit: 9.2 L/min.
- Replacements were put in all 119 showers.
- Ipsos-Reid Pole from 2008 says that the average shower time in Canada is 7.6 minutes.
- On average there are 5 showers per week per student.
- On average 300 students are in the residences per year at any given time.
- The residence is operational for 50 weeks per year.
- According to a BC Hydro and a CBC study it takes 0.06 kWh/L to heat hot water.
- Assuming 50% of water saved is hot (shower flow: 50% hot, 50% cold = warm shower water)
- Cost is $15/shower head and approximately $800 for labor.
- Total energy savings: 150,000 kWh/yr
- Total cost: $2,500 (excluding BCIT's internal project management cost)
- Equivalent number of 200 W solar panels: 750 panels
- Equivalent cost to produce same annual amount of on-site energy with 200 W solar panels: $487,500, rounded to $485,000.

Smart Meters

- Meters were installed in each of the seven student residences buildings. All students have access to real time energy consumption of their building through: ems.bcit.ca
- Although the meters themselves did not create savings they allowed BCIT to run energy saving competitions between houses.
- Three contests were run in residences (in 3 years). The average savings are 25,000kWh/contest. Savings determined from Smart Meter readings.
- The costs for the competition are equal to the prizes.
- Total energy savings: 25,000 kWh
- Total cost: $2,500/yr (excluding BCIT's internal project management cost) or $50,000 for 20 years of contest
- Equivalent number of 200 W solar panels: 125 panels
- Equivalent cost to produce same annual amount of on-site energy with 200 W solar panels: $100,000

LED Fire Exit Signs

- Savings calculated by BC Hydro Power Smart Partner calculator. This calculator determines the savings that BC Hydro is willing to incent; this is most likely a conservative estimate. All eligible items are listed here http://www.bchydro.com/ecatalog/ but the calculator is only available to Power Smart Partners.
- Total energy savings: 50,000 kWh/yr
- Total cost: $12,700 (excluding BCIT's internal project management cost)
- Equivalent number of 200 W solar panels: 250 panels

- Equivalent cost to produce same annual amount of on-site energy with 200 W solar panels: $200,000

Light Savers Campaign

- Total savings were calculated based on lighting logger readings taken before and after the competition (to measure number of hours of unnecessary light in each building). Only one week's data was collected and assumptions were made in order to obtain data for all buildings in the competition as not all buildings had loggers installed before the competition (they all add after). This one week's data was extrapolated out for a full year's worth of hour savings.
- A lighting audit was performed by students to determine the amount of kW worth of lighting within NE02 and therefore a typical BCIT trades building.
- The annual number of "light-hours" saved has been multiplied by the assumed kW lighting load in a Trades building to obtain kWh saved per year.
- For further information on assumptions please contact the energy management team.
- The costs for this project were the cost of the lighting loggers and the prizes and marketing that was used for the campaign, this funding was provided by BC Hydro through the WCA program.
- Total energy savings: 240,000 kWh/yr (for BCIT Trades shop only)
- Total cost: $5,000 (excluding BCIT's internal project management cost)
- Equivalent number of 200 W solar panels: 1,200 panels
- Equivalent cost to produce same annual amount of on-site energy with 200 W solar panels: $720,000

Condensing Boilers

- The original boiler is predicted to have an efficiency of around 70% (estimated by piping instructor). The two new boilers have an efficiency of 92.6% each. This increase in efficiency was proportionally applied to the heating bills for this building which allowed us to determine our GJ savings.
- The heat energy savings were converted from GJ to an equivalent value in kWh (ekWh).
- The cost of the boilers is lower than usual as the piping department managed to obtain the boilers at cost and they did all of the installation in house as part of the curriculum.
- Total energy savings: 125,000 ekWh/yr
- Total cost: $5,600 (excluding BCIT's internal project management cost)
- Equivalent number of 200 W solar panels: 625 panels
- Equivalent cost to produce same annual amount of on-site energy with 200 W solar panels: $406,250, rounded to $400,000.

Solar Canopy

- The following data has been provided by the manufacturer of the solar canopies installed on campus (in building NE-25):
    - The Core Sunlighting System brings sunlight into buildings in order to substantially reduce the need for electric lighting and therefore reduce greenhouse gases.
    - The system has achieved peak daily power savings of 50%, summer monthly average power savings of 42% and annual average power savings of 36.5%.

- In a building like NE-25:
    - Approximately 150 kWh/m^2/yr in average
    - Approximately 35% of electrical load is lighting
    - NE-25 area is: 2,700 m^2
    - Annual electrical consumption of lighting system in NE-25: 140,000 kWh
    - 36.5% of annual electrical consumption of lighting system in NE-25 (assuming all building is equipped with solar canopy technology): 50,000 kWh/yr
    - Total incremental cost: unknown
    - Equivalent number of 200 W solar panels: 250 panels
    - Equivalent cost to produce same annual amount of on-site energy with 200 W solar panels: 200,000$

Dust Extraction System

- This is a comparison between two systems.
- The electricity consumption of the first system was calculated using:
    - The number of hours of measured use during a typical week (as defined by instructors).
    - The maximum amount of horsepower (or kW) needed in order to meet WCB requirement.
    - For a total of 150,000 kWh per year.
- The electricity consumption of the second (new) system was calculated using:
    - A built in power meter that records the kWh used by both fans. The value after a year of regular use was 30,000kWh.
- Total energy savings: 150,000-30,400 = 120,000 kWh
- Total incremental cost: $ 71,000 (The cost of this project is based on the incremental cost of upgrading this system to an energy efficient one. Excluding BCIT's internal project management cost)
- Equivalent number of 200 W solar panels: 600 panels
- Equivalent cost to produce same annual amount of on-site energy with 200 W solar panels: $390,000