

**An Investigation into  
Radiant Carpet Personal Heater  
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University of British Columbia  
APSC 261  
November 28, 2013**

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APSC261: Technology and Society I

# An Investigation into Radiant Carpet Personal Heater

**Date Submitted:** November 28, 2013

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## **ABSTRACT**

The SEEDS (Social Ecological Economic Development Studies) project is done every year in APSC 261 to study real world sustainability (SEEDS UBC, 2010). With difficulty on controlling temperature of large buildings to satisfy all the occupants, personal heaters are used by some occupants. However, use of personal heaters demands more electricity. An investigation is made to find an optimal radiant carpet personal heater to replace the originally used convection heater. Assessment on choosing the new heater is based on the triple bottom line analysis which looks into economic, social and environmental aspects that it impacts. Our product, Foot Warmer™ saves \$45.60 per year compared to the convection heater and it has a payback period of 1.2 years. The heater impacts office workers in a positive way with sustainability awareness. The radiant heater uses 1410 W less than the convection heater and produces 14kg less CO<sub>2</sub> emissions in the production stage. The main methods of investigation were conducting a survey, testing Foot Warmer™, and interviewing office workers. Secondary sources such as articles, magazines, and newspaper were used to gather technical data to compare specifications between Foot Warmer™ and the convection heater. Foot Warmer™ is a decent candidate for a more sustainable personal heating system. An insulation layer such as cardboard is recommended to be put between Foot Warmer™ and carpet or wood floors to prevent the floor from cracking or discoloring.

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## **GLOSSARY**

### **Ecological Footprint**

The ecological footprint is a measure of human demand on the ecosystems. It measures the planet's resources contrasting to planet's ecological capacity to regenerate

### **Sustainability**

The capacity to endure the world's environments. It can also describe how ecological systems survive and stay diverse

### **Thermo-comfort**

Thermal comfort is the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation

## **LIST OF ABBREVIATIONS**

|       |  |
|-------|--|
| APSC  | Applied Science                                |
| CHBE  | Chemical and Biological Engineering            |
| PVC   | Polyvinyl Chloride                             |
| SEEDS | Social Ecological Economic Development Studies |
| TBL   | Triple Bottom Line                             |
| UBC   | University of British Columbia                 |



## **1.0 INTRODUCTION**

As University of British Columbia is the leading sustainability campus in Canada, UBC always try to educate and inspire people and communities to understand the importance of sustainability; however, pursuing sustainability is always challenging and difficult. UBC now has a difficulty with controlling temperature of large buildings to make every UBC staff comfortable. Many occupants who have different accepted temperatures are now using additional personal heater at their work stations to satisfy their thermo-comfort. As the result of using personal heaters, UBC has a concern of failing energy performance in terms of demand and consumption. A typical convection heater which most occupants are using uses 1500 watts at maximum power and demands up to 1% of total building power. Furthermore, the building's heat sensors can be trapped and turn the cooling system on due to high temperature produced by heaters and it causes the increase of energy consumption. Therefore, UBC wants to provide an optimal personal heater which uses less energy to UBC staffs for free of charge and reduce the expenditures on electricity as well as informing the staffs the importance and potential of sustainability.

UBC collaborates with students who are taking APSC 261 to find an optimal personal heater and the stakeholder, Lillian Zaremba, wants the group which is assigned to this project to choose a heater among radiant panel heater, radiant carpet heater, and ceramic heater, and investigate the heater based on Triple Bottom Line (TBL) studied and discussed during lecture.

## 2.0 BACKGROUND

The following subsections will provide a general background and overview for the traditional convection heater as well as the modern personal heater known as the radiant carpet.

### 2.1 Convection heater

The convection heater is one of the most common types of heater available in the market. This heater is inexpensive, safe, and easy to control. The convection heater normally functions with the following principle; the high electric resistance coils inside of the heater, heat up the air while the fan, which is assembled next to the coils, sucks in and blows out the warm air, which consequently, warms up the user as well as the immediate environment. Such devices are usually stationary and use at least 1500 watts of power (Alibaba, 2013).



Figure1. Convection Heater (Rona, 2013)

### 2.2 Radiant carpet heater

There are many types of personal heaters as well as blanket available in the market. The main purpose of such heaters is to be more sustainable, cost efficient and energy efficient than the convection heater. Most of the personal heaters function similarly to the convection heater except on a much smaller and simpler scale i.e. they only heat up the user not the environment. One of the companies that are most famous for producing personal heaters is Cozy Products. The specific model of radiant carpet,

which is analyzed in this report, is Foot Warmer™ and bears this company's label as well (Global Industrial,2013).



Figure2. Radiant Carpet Heater (Global industrial, 2013)

### 2.1.1 What is radiant carpet heater

One of the most common types of personal heaters is the radiant carpet. This heater's functionality is based solely on warming up the user's feet and consequently body. The heater needs to be plugged in and turned on via the ON/OFF switch. While some radiant carpets offer more adjustability for one's thermal comfort, the model, which is analyzed in this report, does not. After reaching a certain temperature, which has been previously set by the manufacturer, the device will warm up the user's feet. Its functionality is much simpler than that of the convection heater (Rona, 2013).

### 2.1.2 How it works

Foot Warmer™ Radiant carpet is a compact and portable product, which offers utilization and serves as a versatile source of heat in personal spaces such as underneath desks in offices or cubicles. It weighs 6 lbs. and warms up to about 50° C. Its dimensions are 16" x 21" and it uses only 90 Watts of power. This device uses an ON/OFF switch and upon reaching its designated temperature, could be used to warm up the user's feet. This product

is made almost entirely from long lasting rubber and is also waterproof (Cozy Product™, 2013).

### **2.1.3 Advantages and Disadvantages**

The advantages and disadvantages of using Foot Warmer™ radiant carpet instead of the convection heater could be easily determined using the Triple Bottom Line (TBL) analysis for measuring sustainability. From the Economic standpoint, the radiant carpet is overall more cost efficient, from the price of the product to the amount of usage of electricity. Considering the environmental aspect, the radiant carpet is superior due to it being more energy efficient but it lacks the convection heater's lifespan as well as its recyclability and reparability (Alibaba, 2013). Lastly, from the social view, the personal thermal comfort, adjustability and utilization offered by personal heaters is much greater than those of the convection heaters, but it will take time for people to get used to personal heaters and actually start using them instead of the traditional convection heaters (Global industrial, 2013).

### **3.0 METHOD OF INVESTIGATION**

To study the three aspects of the TBL, investigations had to be done. For the economic aspect, secondary investigation was done. For the social and environmental aspect, primary investigation was done to obtain the necessary data.

#### **3.1 Primary Investigation**

Primary investigations include first-hand information gathering such as surveys, interviews, and testing. In the discussion with our stakeholder, our group members decided to investigate primarily on the CHBE building.

##### **3.1.1 Survey**

All the groups that were investigating on personal heaters decided to make a survey to see what the office workers at UBC actually think about the idea of a different personal heater. The actual survey is attached on Appendix A. The survey questions were put together by Pouya Memar, a student investigating on personal blankets. Each group thought of two questions each to form ten questions in total. The survey was revised by the stakeholder and we distributed to office workers at CHBE. We have got a total of ten responses. All of them did not use a personal heater because the CHBE offices were already warm enough. They answered that they drink hot beverages, walk around, and wear additional clothes when they feel cold. Also, noise and auto-shutdown function are what they look for in a new personal heater.

##### **3.1.2 Interview**

To gain social views on personal heaters, we have interviewed the administrative officer in CHBE, Lori Tanaka, about the usage of personal heaters in CHBE. She answered that no one needs personal heaters in CHBE during the winter times. She stated, “The entire building is heated well, the staff may need heaters during the summer times when the A/C is overworked and we feel cold”. CHBE was not a good building to investigate the radiant personal heater on, the product isn’t feasible in CHBE.

### 3.1.3 Testing

To see the social acceptance of our radiant personal heater product, we conducted tests to students in CHBE including graduate students. The basis of the test was warmth, comfort of usage, and will of purchase. Most of the testers answered that it was warm but some did not feel it was warm enough. Results show that it was comfortable to use except one complaint of the rubber odor being uncomfortable. 60% of the testers showed the will to purchase the product.

### 3.1.4 Kill-a-Watt

A Kill-a-Watt meter is a device that can measure the energy usage of any machine that can be plugged into an electric socket. It can measure in the units of Volts, Watts, Amps, and KWH. To see if the energy specification of Foot Warmer™ wasn't biased, we plugged our product to the Kill-a-Watt and found out the actual energy consumptions matched with the given specification energy consumptions by the company.



Figure3. The Kill-a-Watt Meter (Sustaina Blog, 2010)

### 3.1.5 Stakeholder

To keep our project on the right track, we constantly contacted with Zaremba, our stakeholder. She gave us answers to all the questions we had (Appendix B), organized and revised our survey, coordinated the tastings, and funded for Foot Warmer™. Communication with Zaremba was not a problem; she responded to e-mails in a timely manner.

### **3.2 Secondary Investigation**

To compare our radiant carpet heater to the convection heater, data was collected from journals, books, and articles including online sources. For all the data taken, we have referenced the sources. The information on convection heater was given by our stakeholder. All our secondary sources are listed in the references section in APA style. For this project, secondary information was used for only references because there were not any scholar journals about heaters. We could not use research data and resulted charts given from Cozy Products because it is not reliable due to chance of biasity.

## **4.0 RESULT AND DISCUSSION**

Foot Warmer™ was studied and compared with the typical convection heater based on TBL. Moreover, it is discussed whether it can replace the convectional heaters and the project can be implemented to UBC.

### **4.1 Economic analysis**

Foot Warmer™ is significantly using less energy, 90 watts, to heat up itself compared to the convection heater using 1500 watts (Cozy Products, 2013). The annual energy consumption and expenditures of electricity by one heater were calculated based on the average usage of personal heater in UBC: 5 hours a day, 5 days a week, and 24 weeks a year, and the cost of electricity UBC pays, as shown in Table A1. As the results, one Foot Warmer™ uses only 54 kWh compared to one convection heater using 900 kWh in a year and it saves \$45.60 per year per a unit from reducing energy consumption. Furthermore, the cost of Foot Warmer™ will be paid back in 1.2 years by significant amount of saving from electricity. Foot Warmer™ is a good candidate for this project in terms of economic analysis.

### **4.2 Environmental analysis**

This section of the Triple Bottom Line (TBL) focuses on the impact of the product on the environment and consequently on the lives of people in the near future. The environmental aspect of the TBL plays an important role when determining whether or not this product is a suitable candidate as a sustainable replacement for the convection heaters.

#### **4.2.1 CO<sub>2</sub> emission**

Carbon emission by generating electricity was calculated based on the data from BC hydro. (BC hydro, 2012). The carbon emission is significantly reduced by 8.5kg CO<sub>2</sub>e per year per unit as the heater uses less energy shown in Table A3. Another important factor when measuring the CO<sub>2</sub> emission is to determine the amount produced, when the product is being manufactured. Every 1kg of PVC (Polyvinyl chloride), which is mostly what both radiant



carpets and convection heaters are made off, produces 4.1Kg of CO<sub>2</sub>, while being manufactured. Comparing the weights of both radiant carpets and convection heaters, it's simple to see that each unit of each heater produces 11.11kg and 25.35 kg of CO<sub>2</sub>, respectively, during production (Green Lifestyle, 2011).

#### **4.2.2 Material of the product**

Though PVC (Polyvinyl chloride) is an important part of manufacturing both convection heaters and radiant carpet personal heaters, Aluminum is also greatly used to produce the panels for convections heaters, while rubber is used to make a suitable cover for most radiant carpets. Also, the heating elements inside the convection heaters are mostly made from Nickel-molybdenum and aluminum alloys, while the one used in radiant carpets are mostly made from Carbon Fiber (Alibaba, 2013).

#### **4.2.3 Energy Consumption**

The most important factor of the environmental aspect, when comparing the convection heater and the radiant carpet personal heater, is their level of energy consumption. The radiant carpet only uses 90 Watts of power, while convection heaters usually use more than 1500 Watts of power to function properly. This low energy consumption greatly reduces the amount of carbon emissions from electrical energy consumption. It also greatly reduces the lifetime cost of using a heater if one chooses to use the radiant carpet instead of the convection heater (U.S. Energy Information Administration, 2013). Considering the initial low cost of buying the radiant carpet as well as the lower cost of operating it, it's clear that it is indeed a suitable and more sustainable candidate as a replacement for the traditional convection heater.

### **4.3 Social analysis**

This part of the analysis will be based on impacts on people, health and safety of the radiant heater usage, consumer demand and satisfaction, and social awareness of sustainability.

#### **4.3.1 Impact on people**

As stated on the economic analysis, the cost saving per Foot Warmer™ is \$45.60. Purchasers will feel like they earned more in a short period of time due to the short payback period. The producers of Foot Warmer™ will gain a positive impact from increase of sales. The office workers who use Foot Warmer™ will feel cozier at work because they feel warmer. Also, the workers will gain awareness of sustainability from using less electricity and indirectly generate less CO2 emissions.

#### **4.3.2 Demand and Satisfaction**

It is hard to conclude on the demand of a new personal heater among the office workers because nobody used personal heaters in CHBE. However, through testing the level of satisfaction of Foot Warmer™ is fit for use. Also, the demand for Foot Warmer™ has increased after the testing from 20% to 60%. Testers were fonder of the product when they knew that Foot Warmer™ used only 90W of energy compared to the 1500W using convection heater. As the heater can only heat up the feet, it depends on the user on the thermal satisfaction.

#### **4.3.3 Limitation**

As this project is focused on only office worker who use personal heaters, the project is limited to only those people. From survey results, no one uses personal heaters in CHBE. Also, there are several other buildings where occupants do not use personal heaters. The switch from convection heater to radiant carpet heater has its limitations as well. Workers who care about energy conservation in their workplace was 2.2 (1 being I care very much, 5

being not caring at all) averaged from 10 people. Some people may not want to switch to radiant carpet heaters because it gives less warmth even though it saves energy. The product may discolor if used on carpet so this limits the use of heater in offices with carpet flooring.

## **5.0 CONCLUSION and RECOMMENDATIONS**

Based on TBL analysis, the Foot Warmer™ radiant carpet personal heater is very suitable candidate when considering a sustainable replacement for the traditional convection heaters currently in use in UBC offices. The heater requires less electricity to generate the heat while the typical convection heater requires almost 20 times more of electricity. By replacing the convection heaters with Foot Warmer™, UBC can save significant amount of expenditures and expect the short payback. With the short payback, consumers will give positive feedback and acceptance to the new heater as long as they like its quality. The product may smell like rubber of the first few uses but it is expected to go away. It heats only the feet and not the whole body so it has limits to the satisfaction of usage. The lower cost of the initial price and the low energy usage are only a few qualities, which rank better than those of the convection heater. Less energy usage means more sustainability, which gives environmental resources a small break from constant consumption and depletion. This product is proven to be even more sustainable by the fact that it caused much less CO2 emissions, both in the production stage and while using electricity.

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# **Appendix A**

## **Results**

**Table A1. Results of economic analysis**

|   | <b>Convectional Heater</b> | <b>Foot Warmer™<br/>(Radiant Carpet Heater)</b> |
|---|----------------------------|---|
| <b>Purchase Cost (\$)</b>                       | <b>40.00</b>               | <b>55.95</b>                                    |
| <b>Energy Consumption (W)</b>                   | <b>1500</b>                | <b>90</b>                                       |
| <b>Annual usage in time (Hour)</b>              | <b>600</b>                 | <b>600</b>                                      |
| <b>Energy Consumption for a year<br/>(kWh)</b>  | <b>900</b>                 | <b>54</b>                                       |
| <b>Annual Energy Saving (kWh)</b>               | <b>-</b>                   | <b>846</b>                                      |
| <b>Price of electricity (CAD\$/kWh)</b>         | <b>0.0539</b>              | <b>0.0539</b>                                   |
| <b>Expenditure of electricity (\$/year)</b>     | <b>48.51</b>               | <b>0.00</b>                                     |
| <b>Annual Expenditure Saving<br/>(\$/year)</b>  | <b>-</b>                   | <b>48.51</b>                                    |
| <b>Payback Period of Cozy Feet™<br/>(years)</b> | <b>-</b>                   | <b>1.2</b>                                      |

**Table A2. Results of environmental analysis**

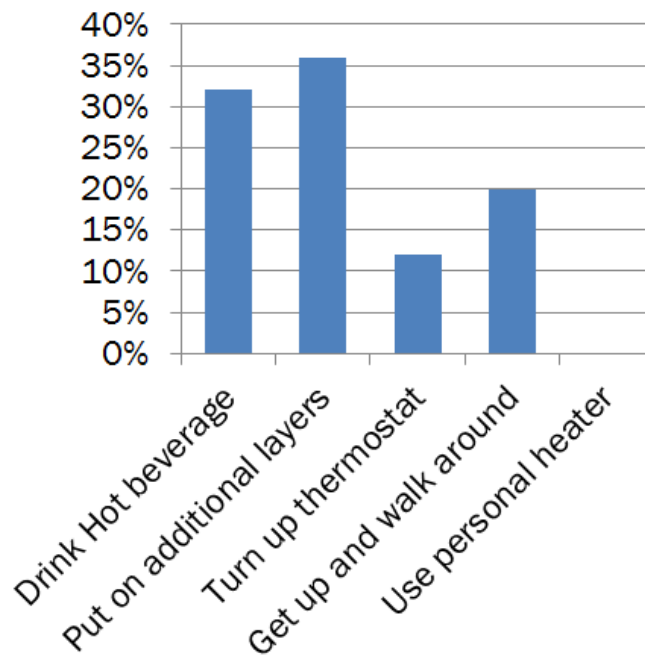
|   | <b>Convection Heater</b>            | <b>Cozy Feet™<br/>(Radiant Carpet Heater)</b> |
|---|-------------------------------------|---|
| <b>Energy Consumption</b>   | <b>1500 Watts</b>                   | <b>90 Watts</b>                               |
| <b>Outside Cover Material</b>   | <b>Aluminum / Plastic</b>           | <b>Rubber</b>                                 |
| <b>Inside Heating Element</b>   | <b>Nickel-<br/>molybdenum Alloy</b> | <b>Carbon Fiber</b>                           |
| <b>Recyclable</b>   | <b>✓</b>                            | <b>✗</b>                                      |
| <b>Lifespan</b>   | <b>13 Years</b>                     | <b>10 Years</b>                               |
| <b>Repairable</b>   | <b>✓</b>                            | <b>✗</b>                                      |
| <b>Average Percentage of Daily<br/>Electricity Used per Household</b> | <b>7.5%</b>                         | <b>0.45%</b>                                  |



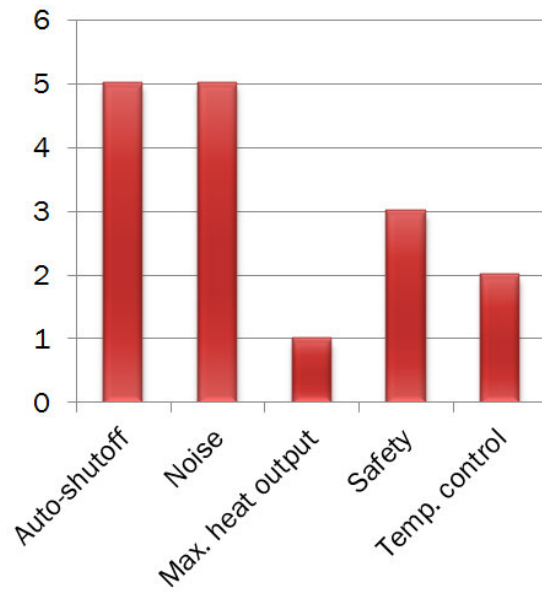
|  |   |  |
|--|---|--|
| <b>Average Ecological Footprint During Production Per Unit</b> | <b>25.35 Kg of CO<sub>2</sub> Emissions</b> | <b>11.11Kg of CO<sub>2</sub> Emissions</b> |
| <b>Compact/Portable/Noiseless</b>                              | <b>✗</b>                                    | <b>✓</b>                                   |

**Table A3. Results of environmental analysis on carbon emission by generating electricity**

|  | <b>Convection Heater</b> | <b>Foot Warmer™<br/>(Radiant Carpet Heater)</b> |
|--|--------------------------|---|
| <b>CO<sub>2</sub> emission(kg/kWh)</b>                                   | <b>0.01</b>              | <b>0.01</b>                                     |
| <b>Annual electricity usage (kWh)</b>                                    | <b>900</b>               | <b>54</b>                                       |
| <b>Annual CO<sub>2</sub> emission by the heater (kg CO<sub>2</sub>e)</b> | <b>9.01</b>              | <b>0.54</b>                                     |



**Figure A1. Result of Survey: Things office workers do to keep warm**



**Figure A2. Result of Survey: Factors on choosing a new personal heater**

# **APPENDIX B**

## **Raw Survey Data**

Thank you for taking the time to fill out this survey. This survey is being conducted as part of an APSC 261 class project to learn more about workplace attitudes toward thermal comfort and use of products including heaters and blankets. The results have the potential to contribute to energy efficiency and conservation in UBC buildings.

Please circle your choice of answer for each question below.

1. I care about energy conservation in my workplace.  
I care very much – 1 2 3 4 5 – I care not at all
  
2. I would guess that a portable heater uses as much electricity as:  
A) 1 x 100 W lightbulb    B) 15 x 100 W lightbulbs    C) 50 x 100 W lightbulbs    D) I don't know
  
3. To keep warm in my workplace, I currently do the following: *(select all that apply)*

|  |                                 |
|--|---------------------------------|
| A) Drink a hot beverage                  | G) Close window(s)              |
| B) Wear warmer clothes                   | H) Close blinds or curtains     |
| C) Put on additional layers              | I) Get up and walk around       |
| D) Use a blanket on my lap               | J) Turn on an electric heater   |
| E) Use a shawl/throw around my shoulders | K) Turn up the thermostat       |
| F) Close door(s)                         | L) Call UBC Building Operations |
| M) Other _____                           |                                 |

If you answered (J) above, please answer the following 3 questions.

3.1 My current personal heater most closely resembles: *(please circle one)*



3.2 I typically need to use my personal heater in these months: *(circle all that apply)*

Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

3.3 When I use my personal heater, I typically turn it on for (approx.) \_\_\_\_\_ hours per day

4. Please rank the following factors in terms of importance when choosing a thermal comfort product such as a heater or blanket, 1 being most important and 6 being least important.





Appearance \_\_\_ Comfort \_\_\_ Ease of use \_\_\_ Price \_\_\_ Quality \_\_\_ Safety \_\_\_

\*

5. Please rank the following features in terms of importance when selecting a personal electric heater for use in the workplace, 1 being most important and 5 being least important.

Auto-shutoff \_\_\_ Noise \_\_\_ Max. heat output \_\_\_ Safety \_\_\_ Temperature control \_\_\_

6. If a replacement product were provided free of charge, I would be willing to use the following instead of my current personal heater: *(select all that apply)*

|  |   |  |   |
|--|---|--|---|
| <p>Heated blanket</p> <p>A) Definitely<br/>B) Maybe<br/>C) Probably not<br/>D) Definitely not</p>                  |  | <p>Efficient convection heater</p> <p>A) Definitely<br/>B) Maybe<br/>C) Probably not<br/>D) Definitely not</p> |  |
| <p>Radiant panel heater (for legs)</p> <p>A) Definitely<br/>B) Maybe<br/>C) Probably not<br/>D) Definitely not</p> |  | <p>Radiant carpet (for feet)</p> <p>A) Definitely<br/>B) Maybe<br/>C) Probably not<br/>D) Definitely not</p>   |  |
| <p>Blanket or throw (non-electric)</p> <p>A) Definitely<br/>B) Maybe<br/>C) Probably not<br/>D) Definitely not</p> |   |  |   |

7. Please rank your preference for the following types of blankets for use at your desk, 1 being most preferred and 4 being least preferred.

Fleece \_\_\_      Silk & polyester \_\_\_      Heavy knit \_\_\_      Double-sided knit/cotton \_\_\_






|  |
|--|
| <p>I am: Staff ___ Faculty ___ Graduate student ___</p> <p>I work in: _____ (building name)</p> <p>Comments:</p> |
|--|

**Thank you! Please direct any questions to the staff sponsor for this project:**  
Lillian Zaremba, Climate and Energy Engineer, Campus Sustainability, 827-3441, [lillian.zaremba@ubc.ca](mailto:lillian.zaremba@ubc.ca)