An Investigation into the Replacement of Personal Heaters with Electrically Heated Blankets

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APSC 261

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APSC 261 Final Report

An Investigation into the Replacement of Personal Heaters with Electrically Heated Blankets

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ABSTRACT

UBC's Campus Sustainability is looking at alternatives to the personal heaters that staff members use during the cold winter months. This report investigates the possibility of an exchange program to replace high energy-consuming ceramic heaters with electrically heated blankets. The heated blankets are to be provided free of charge with the trade-in of a ceramic heater, with the goal of a two year payback period from the anticipated savings in energy costs. The viability of this project is assessed using the Triple Bottom Line method, considering the social, economic, and environmental implications.

In terms of the social aspect, participants who tested out the heated blanket found it to be very comfortable and were very satisfied. However, many staff members rejected the idea of heated blankets, as per the survey results. Environmentally, the replacement of a single 1500W ceramic heater with the heated blanket will save roughly 834 kWh per year, depending on the amount of use. As a result, about $45 of energy costs will be saved each year, with the initial investment of a $60 heated blanket.

The recommendation is to start a trade-in program for old ceramic heaters for heated blankets. Since many staff members oppose the heated blankets, the trade-in will be optional. However, each replacement will lead to great reductions in energy consumption and costs.

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LIST OF ABBREVIATIONS

W - Watt

kW - kiloWatt

kWh - kiloWatt*hours

PET - polyethylene terephthalate

UBC - University of British Columbia

1.0 INTRODUCTION

In the colder winter months, many staff members use personal heaters in their offices to keep warm. At these times where many occupants are drawing energy for their heaters all at once, the risk of tripping the circuit breaker becomes likely. UBC Campus Sustainability looks at eliminating this problem. Possibilities may be replacing the transmission lines and power stations with ones of higher power capacity. Another possible solution can be lowering the power consumption in the buildings. A 1500W ceramic heater has the ability to draw up to 1% of the building's power (APSC 261 Project Options, September 2013). By reducing the number of high energy consumption heaters, we can effectively reduce the risk of tripping the circuit breaker and avoid costly replacements.

To reduce the number of heaters in use, we are investigating the potential of a trade-in program. Specifically, we will collect your old ceramic heater and provide you with an electrically heated blanket, free of charge. Using the Triple Bottom Line Analysis, we will assess the social, financial, and environmental aspects of such a program if it were to be implemented.

For the product, we decided on the Sunbeam Fleece Heated Throw, available at Wal-mart. We have visited online and several department stores, such as Sears, Superstore, and Canadian Tire. Sunbeam was the brand that was available at these stores and met the budget. Other heated throws were either too large, too expensive (costing over $200), or both. It was simple to decide on the $55, 50"x60" Sunbeam Fleece Heated Throw because there were very few alternatives.

The personal heater being used for comparison is a 1.5kW ceramic heater for 5 hours a day, 5 days a week, 24 weeks a year, which equates to 600 hours of yearly usage (L. Zaremba, Email, October 28, 2013).

2.0 SOCIAL ASSESSMENT

The social aspect of the electrical blanket program is the most relevant to its success. Comfort, practicality, safety, and acceptance by staff are factors to be considered in the social section. Most of the data in this section is collected via surveys. We collected survey responses from 22 staff and faculty members in the Fred Kaiser and Frank Forward buildings regarding environmental awareness and willingness to switch their heaters. 4 people, who tested the heated blanket, completed another survey to indicate their satisfaction.

More participants testing out the heated blanket would have yielded better and more accurate survey responses; however, due to budget and time constraints, only four were able to test it out. Firstly, our budget only allowed us to purchase one heated blanket. As a result, few people were able to test it out. Secondly, because the project was due before December, the weather was often not cold enough to allow for testing on the blanket. Testing out the heated blanket in colder weather would have yielded more accurate responses.

From our stakeholder, Lillian Zaremba, we received a table that indicates the number of staff members who use electric heaters in specified buildings on campus. Of the 14 buildings listed, over 600 staff members use an electric heater. Furthermore, our survey results show that staff members on campus are more or less are concerned

energy conservation.

# staff with heaters	Total staff in bldg	% staff with heaters	Building name and Facility Manager's comments	Zone
265	530	50%	GSAB – 50% of office spaces use space heaters	Green
169	512	33%	Buchanan Tower - lots, one-third of offices	Yellow
100	609	16%	Henry Angus & Addition: 100	Teal
50	234	21%	I.K. Barber Learning Centre: 50	Teal
50	656	8%	Neville Scarfe: 50	Teal
24	47	50%	Friedman (Med Sci B) – WORST - 50% of office spaces use space heaters	Green
20	193	10%	Koerner Library: 20	Teal
20	261	8%	Klinck 20 people	Brown
20	432	5%	Forest Sciences Centre 20 people	Brown
15	214	7%	HR Macmillan 15 people	Brown
10	18	56%	Liu Centre under 10 people	Brown
10	106	9%	CK Choi under 10 people	Brown
10	130	8%	Food, Nutrition & Health 10 people	Brown
30	888	3%	Brock Hall East/West & Annex: 30	Teal

Table. 1: Percentages and Numbers of Staffs Members who uses Heaters in the Specified Buildings

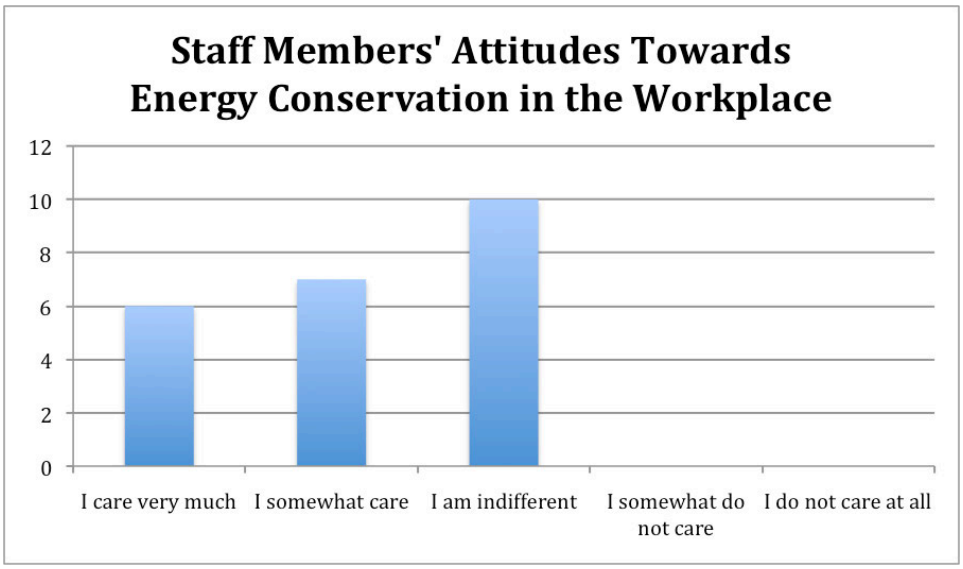


Chart. 1: Number of Surveyed Staff Members who are Concerned for Energy Conservation

2.1 Comfort

Of the 4 who tested out the heated blanket, 2 indicated they were "very satisfied" and 2 indicated they were "somewhat satisfied". A participant indicated that the heated blanket was "toasty warm and cozy," and another responded, "it heated up very quickly and so quickly warmed me up." In terms of comfort, the heated blanket is a great option, as it keeps you warm and does it quickly. One criticism of the heated blanket is uneven thermal comfort. Participants noted that the leg area felt considerably warmer than the torso area.

2.2 Practicality

The heated blanket is unsuitable for use by some members. As specified by the user manual: infants, children, incapacitated or immobile person, paraplegic, quadriplegic, diabetic, anyone insensitive to heat such as someone with poor blood

circulation, anyone that cannot understand instructions and/or operate the controls are unsuitable to use the heated blanket (Sunbeam, n.d.). Furthermore, the heated blanket is very inconvenient for staff members who need to get up and move around a lot. Therefore, it is only practical for those who do not fit any of the categories stated in the user manual, and who will also sit at their desks for long periods of time.

2.3 Safety

The Sunbeam heated blanket has an automatic shut-off program after three hours of use. It prevents overheating or risk of catching fire. Also, those with health concerns, as stated in the user manual, should not use this blanket. To avoid electric shocks and burn injuries, damaged heated blankets should not be used. A major, albeit controversial, health concern is the increased proximity to electromagnetic waves increasing the risk of cancer. Although there is no conclusive evidence to support this, there is also no strong evidence disproving this theory. In a study of bacteria growth on fabrics, it was found that bacteria grow in larger quantities on non-synthetic material (Cotnor, 2010). Electric blankets are made from synthetic material thus have reduced risk of bacteria related illness compared to other types of non-synthetic blankets.

2.4 Acceptability

Staff members' willingness to replace their current heaters will be the biggest obstacle to this potential heated blanket trade-in program. Even at the very beginning, we

met challenges, such as staff members refusing to take our survey. Thus we only collected 22 responses. When approached, 2-3 staff members who did not fill out our survey were appalled at our attempt to take away their heaters in the cold winter months. We had little opportunity to explain that we were merely investigating this option, and not already implementing it. These reactions, although only from a few members, indicate that some staff are very resistant towards the implementation of this program.

50% of the staff members surveyed indicated that they would definitely not use a heated blanket. 45% of the staff members surveyed indicated that they would definitely use a low-energy convection heater, and 36% indicated that they might use a low-energy convection heater. The survey results show that many staff members are accustomed to using their personal heaters, and are resistant to using heated blankets. Concerns raised are the usage of blankets affecting the professional environment of the office. Also, some jobs require walking around constantly, so a blanket would not be appropriate or convenient. Another staff member commented, "the purpose of being at work is to work at maximum efficiency - to have a reasonably warm workplace is NOT a luxury." It appears that this person will definitely not use the heated blanket, along with half of our other surveyees.

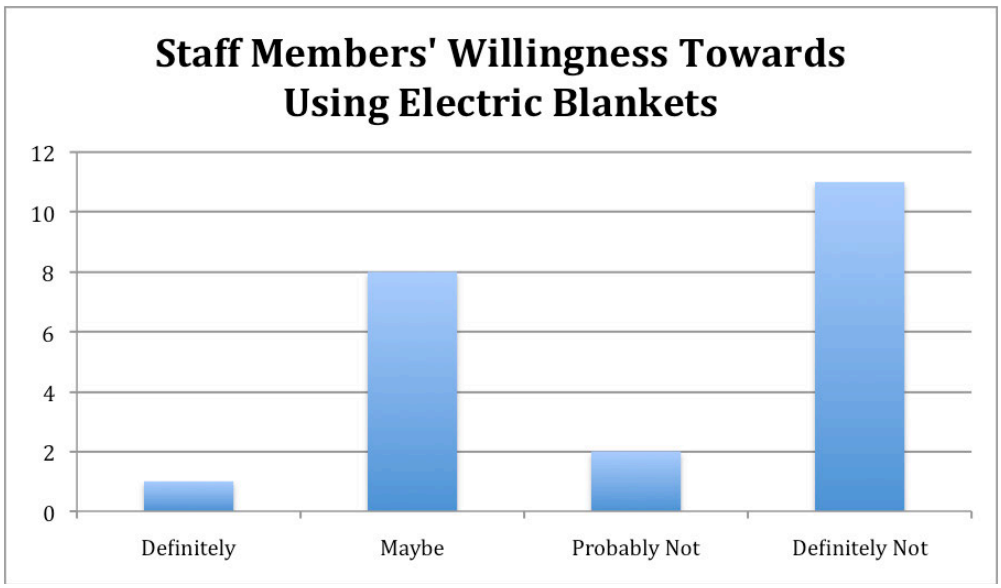


Chart. 2: Number of Staff Members Willing to Use Heated Blankets

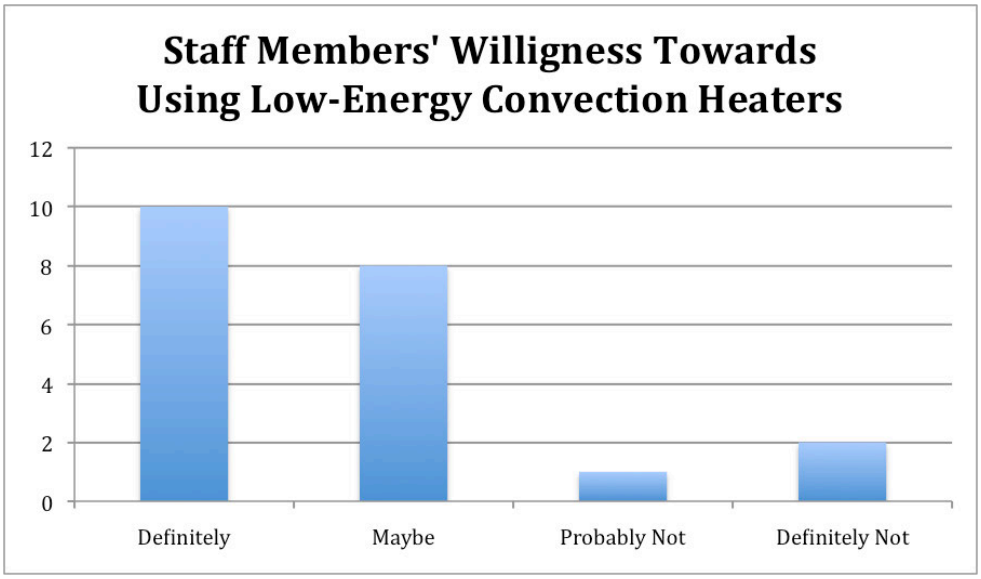


Chart. 3: Number of Staff Members Willing to Use Low-Energy Convection Heaters

2.5 Conclusion to Social Assessment

Due to the work environment of offices at UBC, the heated blanket will not be suitable for many staff members. Besides the heated blankets being unsuitable, many staff members have already decided to not use a heated blanket.

3.0 ENVIRONMENTAL ASSESSMENT

The environmental assessment considered the energy reduction after replacement of the ceramic heater. Other factors considered were the pollution from the fabric and how effective the heat is transferred to a person.

3.1 ENERGY CONSUMPTION

Using the heated blanket for the specified daily usage of 5 hours, the Kill-O-Watt power meter provided a reading of 0.55kWh and an overall power rating of 110W. The heater has an overall power rating of 1500W and a calculated work day usage of 7.5kWh. The electric blanket compared to the heater uses roughly 6.95kWh less energy per work day and about 834 kWh annually. Also, the fabric is only to be hand washed, further reducing energy consumption by avoiding the washing machine.

3.2 POLLUTION

The pollution considered is from the production and disposal of an electric blanket. The main component of the blanket is the fabric, which is typically made of fleece. Fleece is a synthetic fabric made of the petroleum by-product PET. PET is also used in plastic bottles and is recyclable. Although we have programs for recycling plastic bottles such programs are uncommon for fleece even though fleece can be recycled into fleece. Historically, fleece was made from non-recycled PET whereas nowadays it is often made from recycled bottles. In either case, production of fleece is

energy intensive. The benefit of using fleece is less material needs to be used to achieve the same results as other materials such as wool and it has high durability.

3.3 ENVIRONMENTALLY FRIENDLY DESIGN

The way heat is transferred differs between heaters and electric blankets. Heaters warm the air in the room and indirectly heat the person, allowing for the heat to escape through windows or doors. A blanket allows less heat loss because it directly heats the person. As a result, the electric blanket uses less electricity to heat a person to the same thermal comfort level.

3.4 ENVIRONMENTAL CONCLUSION

The heated blanket uses significantly less energy than the heater. Although the production of fleece is a source of PET pollution, the environmental benefits of saving energy on campus outweigh this drawback. The replacement of heaters with heated blankets is environmentally viable.

4.0 ECONOMIC ASSESSMENT

The payback period goal of this project is 2 years, and the economic viability depends on the ability to meet this goal. The savings in energy costs was calculated and compared to the initial investment of the heated blanket.

4.1 SAVINGS

The particular model we purchased, the Sunbeam Fleece Heated Throw, cost $55 + tax. By using UBC's electricity rate of $0.0539/kWh and the annual hours of use of 600 hours, we calculated the electrical cost of each heated blanket to be $3.56/year, and the electrical cost of each personal heater to be $48.51/year. Thus, the savings from replacing a heater with a heated blanket is about $45/year. Moreover, the payback period for an electric blanket would be approximately a year and a half, or 900 hours of use. The expected payback period fulfills the goal of 2 years.

4.2 LIFESPAN

Sunbeam provides a five year manufacturer's warranty for their electric blankets. Therefore, the expected lifespan of the electric blanket will likely be at least five years.

4.3 CONCLUSION TO ECONOMIC ASSESSMENT

The cost of the heated blanket will be recovered in approximately one and a half years from the $45/year savings. After the payback period, each heated blanket will save UBC $45/year in energy costs for the rest of its lifespan, which is expected to be at least 5 years. The replacement program is an economically sound decision.

5.0 CONCLUSION AND RECOMMENDATIONS

In terms of social aspects, we find that the electric blanket trade in program is infeasible due to low practicality and lack of interest in using an electric blanket.

In terms of economic aspects, we find that the electric blanket trade in program is feasible since there is significant amount of savings for using electric blankets rather than heaters. Moreover, the payback period for the blankets is short. Therefore, this program is economically beneficial to UBC.

In terms of environmental aspects, we find that the electric blanket trade in program is feasible because the use of electric blankets as an alternative to personal heaters significantly reduces energy consumption. Although the materials used has more drawbacks than benefits, these drawbacks are not significant enough to dismiss the product as an alternative.

Our recommendation is that a trade-in program be implemented or alternatively a reimbursement program. In either case, people who are interested in using the heated blanket can obtain one at no cost to them with the exchange of the heater they are currently using. Those who are not comfortable with using a blanket can continue using their heaters. Although few people may partake in the program initially, the benefits will be considerable. Furthermore, we believe as more people switch to heater alternatives, the stigma surrounding heated blankets will fade, thus encouraging more people to partake in the program.

REFERENCES

APSC 261 Project Options. (September 2013) Handout. Retrieved from https://connect.ubc.ca/webapps/portal/frameset.jsp?tab_tab_group_id=_2_1&url=%2Fwebapps%2Fblackboard%2Fexecute%2Flauncher%3Ftype%3DCourse%26id%3D_24278_1%26url%3D

Cotner, S.,Navrotski, E.,Sewera, L.,Snyder, V.,Richter, E.(2010) Diversity Of Culturable Bacteria On Natural Vs Artifical Fabrics. *The Internet Journal of Microbiology, 8.* Retrieved from: DOI:10.5580/1ed4

Crawshaw, L., Kanosue, K., Kasuga, M., Nagashima, K., Nakamura, M., Sait, Y., Yoda, T. (2008). Regional differences in temperature sensation and thermal comfort in humans. *Journal of Applied Physiology, 105*, 1897-1906. Retrieved from: doi:10.1152/ japplphysiol.90466.20

Hankinson, S., Holmes, M., Hunter, D., Laden, F., Neas, L., Speizer, F., … Tolbert, P. (2000). Electric Blanket Use and Breast Cancer in the Nurses' Health Study. *American Journal of Epidemiology,152,* 41-49. Retrieved from: http://aje.oxfordjournals.org/content/152/1/41.full.pdf+html08

Huizenga, C; Abbaszadeh, S.; Zagreus, Leah; & Arens, Edward A. (2006). Air quality and thermal comfort in office buildings: Results of a large indoor environmental quality survey. UC Berkeley: Center for the Built Environment. Retrieved from: http://escholarship.org/uc/item/7897g2f8

Lloyd Burrell (December 15, 2011) *Baby, It's cold Outside: Electric Blankets and Your Health.* Retrieved from http://www.modernhippiemag.com/2011/12/baby-cold-electric-blankets-health/

Polar Fleece. (2013, November 25) Retrieved November 26, 2012, from http://en.wikipedia .org/wiki/Polar_fleece

Sunbeam. (n.d.) *Heated bedding user manual* [user manual].

The Electric Blanket Institute (2009) *Are Electric Blankets Safe or Dangerous?* Retrieved from http://www.electricblanketinstitute.com/safety-care html

U.S. Energy Information Administration. (March 7, 2013). *Heating and cooling no longer majority of U.S. home energy use.* November 21, 2013. Retrieved from http://www.eia.gov/todayinenergy/detail.cfm?id=10271&src=‹ Consumption-b1

Zaremba, L. (2013, October 28) Email.

APPENDIX A - Example of Survey Completed

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:

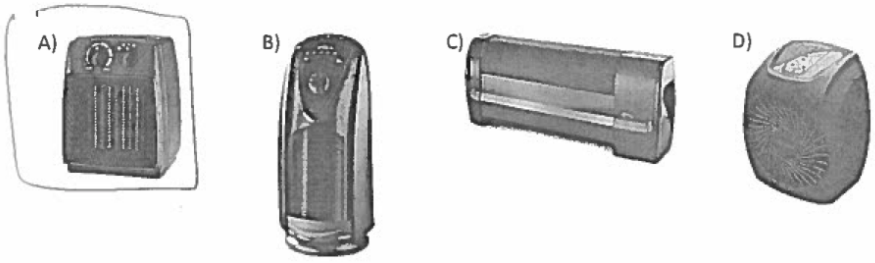
   A) 1 x 100 W lightbulb (B) 15 x 100 W lightbulbs C) 50 x 100 W lightbulbs D) I don't know

3. To keep warm in my workplace, I currently do the following: *(select all that apply)*

   (A) Drink a hot beverage
   (B) Wear warmer clothes
   (C) Put on additional layers
   D) Use a blanket on my lap
   E) Use a shawl/throw around my shoulders
   F) Close door(s)
   G) Close window(s)
   (H) Close blinds or curtains
   (I) Get up and walk around
   (J) Turn on an electric heater
   K) Turn up the thermostat
   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.) 1 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.*

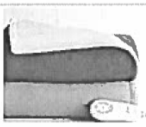
   Appearance 6 Comfort 4 Ease of use 2 Price 3 Quality 5 Safety 1

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 2 Noise 4 Max. heat output 5 Safety 1 Temperature control 3

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)*

Heated blanket



A) Definitely
B) Maybe
C) Probably not
(D) Definitely not

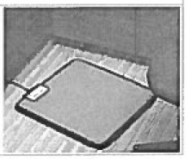
Efficient convection heater

(A) Definitely
B) Maybe
C) Probably not
D) Definitely not

Radiant panel heater (for legs)

A) Definitely
(B) Maybe
C) Probably not
D) Definitely not

Radiant carpet (for feet)



A) Definitely
B) Maybe
(C) Probably not
D) Definitely not

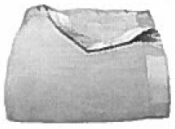
Blanket or throw (non-electric)

A) Definitely
B) Maybe
C) Probably not
(D) Definitely not

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.*

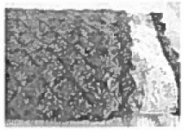
Fleece 1

Silk & polyester 4



Heavy knit 2

Double-sided knit/cotton 3



I am: Staff ✓ Faculty ___ Graduate student ___

I work in: KAISER (building name)

Comments:

A good project + glad to see you are looking at this area of energy conservation and worker comfort.

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