UBC Social Ecological Economic Development Studies (SEEDS) Student Report

Sustainable Pub: Energy

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EXECUTIVE SUMMARY

"Sustainable Pub: Energy"

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This report contains the analysis and suggestions for improvements on Koerner's Pub located on UBC's Vancouver campus in terms of energy efficiency. The food industry is one of the highest consumers of energy in commercial businesses and as such, there is significant potential for energy savings. The primary stakeholder, Tim Yu, requested for an in depth research into possible low cost solutions that would aid Koerner's Pub in lowering energy consumption. In focusing on the upstairs kitchen area, our team has done research in the following areas: lights, and energy efficient practices.

In our investigation of the site (Koerner's Pub) and through research of restaurants and pubs in general, we have compiled possible improvements that may be applied. Through our research and observation on the operation of the pub, we were able to conclude which appliances consumed the most energy and which ones were wasting energy. We have primarily focused on improving operational use of the walk-in refrigerator, stove, oven, and dishwasher. It was noted that there were certain operations that could be improved or eliminated, such as inefficient use of the refrigerator and the dishwasher. As for lighting, our investigation allowed us to observe the different lighting needs of the many areas of the pub. For example, areas such as the kitchen would need to be well lit while the main dining area should be dim and emit a warm atmosphere. The four light bulbs we investigated were incandescents, compact fluorescent lights (CFL), halogen lights, and light emitting diodes (LED). Certain factors we paid most attention to were environmental impacts, lifetime, initial cost, as well as light properties. Certain lamps could be potentially harmful if not disposed of correctly, some had very short life spans, most efficient lamps had high initial costs, and each lamp gives off its own colour and range and light.

Aiming to be sustainable and energy efficient has many benefits, not only environmental but also economical. Without suggesting appliances or technologies that require a large initial investment by the primary stakeholder, we have concluded that cost effective light bulbs and small appliances/technologies and behavioural changes will provide the most effective reduction in energy consumption. For the upstairs kitchen, the use of CFLs (with proper disposal since they contain mercury) is recommended for their long lifespan and brightness, and LEDs are recommended for the bar and patio areas (energy efficient and long lifespan), while the main dining area continues to use incandescents for the warm light that is emitted, to maintain a pleasing atmosphere. In the kitchen area we highly encourage appliance operators to be aware of unnecessary use of energy as well as the use of interior vinyl strips on the walk-in refrigerators to help maintain the temperature of the refrigerators.

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GLOSSARY

Ballast A device intended to limit the amount of current in an electric circuit.

Diodes A semiconductor device with two terminals, typically allowing the flow of current in one direction only

Lumen A measure of the total amount of visible light emitted by a source.

Lux A measure of light intensity, measured as lumen per square meter.

Omnidirectional Being in or involving all directions.

Perfluorocarbons A powerful greenhouse gas emitted during the production of aluminum

Spectrum The range of all possible electromagnetic frequencies.

LIST OF ABBREVIATIONS

AkWh	Average KiloWatt Hour
kWh	KiloWatt Hour
LED	Light Emitting Diode
CFL	Compact Fluorescent Light

1.0 Introduction

Koerner's Pub is committed to sustainability and has implemented many eco-friendly initiatives to the services they supply. Continuing their trend of becoming more environmentally friendly, they have targeted water and energy consumption as areas that need to be improved. In order to maximize the effectiveness of the various energy consumption assessments being performed by student groups at Koerners Pub, it was recommended that each group select a different section of the pub to analyze.

This investigation is focused primarily on the energy consumption of the upstairs kitchen in Koerner's Pub. It was decided that the two main methods to improve the energy consumption while minimizing the initial costs associated with the solutions was to analyze the overall lighting system and develop behavioural practices that optimize energy consumption of appliances.

This report introduces the various research methods used in finding possible solutions to improved lighting and energy efficient behavioural practices in the pub. For the lighting system, various light sources will be analyzed using the triple bottom line assessment procedure to determine which will be most suitable for implementation in the Koerner's Pub kitchen. In addition to researching behavioural practices, small and affordable tools were also researched in unison.

2.0 Methodology

Through investigation of possible solutions in increasing energy efficiency, many methods were used in calculating the best light bulbs and

2.1 Lighting System

Initially the group decided to take the measurement of lighting daily usage from Koerner's Pub and come up with a new energy efficient solution of saving the lighting power consumption. The team then decided that measuring the daily usage would be inaccurate since the school year contains peak and slow periods. The research was then altered into exploring the existing types of lighting bulbs on the market and analyzing their properties and impacts based on triple bottom line. The current lighting sources of Koerner's Pub were compared with other available lighting solutions to offer the primary stakeholder the most viable options.

2.2 Energy Efficient Practices

Majority of the data collected on energy consumption of the various appliances used in the kitchen was from secondary sources due to the usage of gas on most appliances and our lack of analysis equipment. This data was then used to approximate the energy consumption of the appliances in Koerner's Pub. After energy efficient practices and preventative maintenance procedures were determined, a self assessment document (see Appendix A) was developed and used to rate the current state of Koerner's Pub in terms of energy consumption.

3.0 Lighting System

Lighting accounts for on average 13% of total energy use in a restaurant. Even though it seems lighting is not a large energy consumer, it is still worth finding better lighting system solutions for Koerner's Pub to be more energy efficient. Several different types of light bulbs available on the market were considered and analyzed based on the triple bottom line to present sustainable alternatives to the stakeholders.

3.1 Types of Light Bulbs and Their Features

The following sections will describe the various types of light bulbs currently available on the market. Each light bulb will be assessed in terms of their features.

3.1.1 Incandescent

Incandescent light bulbs are among the most common lighting sources and are manufactured in a wide range of light outputs and voltage ratings. They are relatively cheap compared to other types of light bulbs on the market since they require less equipment to manufacture. Due to the bulb's 'dimmed' feature, most restaurants implement incandescent bulbs in the dining area to create a peaceful and comfortable environment for their customers. High color rendition rating is one the main benefits of incandescent bulbs, which ranks at 98 to 100 out of a 100 on the scale. Incandescent bulbs also instantly emit a warm light in all directions and don't produce any hazardous chemicals.

While they may be cheaper, incandescent bulbs are much less energy-efficient than other types of lighting sources. The luminous efficiency of a typical incandescent bulb is about 2% to 5%. They waste about 95% of the input energy, most of which is converted into heat while only 5% is converted to visible light. The short lifetime is another downside of incandescent bulb. Compared to the 10,000 hours lifetime of an LED bulb, most incandescent bulbs have a rated life of 750 - 1000 hours and will require replacements about ten times as often as LED bulbs (Energy Efficient Lighting, 2013).

3.1.2 Compact Fluorescent Lamp

The design of compact fluorescent lamps (CFL) is aimed to replace incandescent lights and provide more energy-efficient lighting sources. They are called "green" light bulbs because they use less energy and last longer than normal light bulbs. A CFL is structured by a curved or folded tube to fit into the

space of an incandescent bulb and a compact electronic ballast*[1] in the base of the lamp.

The most significant advantages of a CFL is its energy-efficiency and long lifespan. CFLs use 50% to 80% less energy than other light bulbs. The amount of energy saved, if all homes in the United States were to switch to CFL from incandescent, would be enough to power more than 3 million homes (Rogier, 2014). CFLs can last as much as ten times longer than incandescent bulbs. The high initial cost of CFLs is offset by the energy savings of its lifespan.

The main drawback of CFLs would be that they are difficult to dispose of due to small amounts of mercury which could harm the environment and water supply. In addition, CFLs take about 15 minutes to become fully lit.

3.1.3 Halogen Lamp

A halogen lamp is similar to an incandescent lamp with a small amount of iodine or bromine compound added. The chemical reaction required is produced by the combination of halogen gas and a tungsten filament. This reaction redeposits evaporated tungsten back onto the filament to increase its life and maintain the clarity of the envelope. Halogen lamps have become an industry standard for desktop lights and film lights due to their compact size and high lumen* output.

Halogen lamps are capable of being operated at extremely high temperatures and their color temperature is higher than other standard gas-filled lamps. Compared to incandescents, they also have a drastically longer lifetime but is still shorter than a CFL's lifespan. (Russo, 2014) As for energy consumption, halogen lamps use 50% less energy than incandescent bulbs. Halogen lamps can also be easily disposed of without contaminating the environment.

Due to the implementation of halogen gas and tungsten filaments, halogen lamps are about three times the price of a standard incandescent bulb (Russo, 2014). They may also pose a hazard due to the significant amount of heat that they radiate.

3.1.4 LED Lamp

LED lamps are produced based on the technology of light-emitting diodes and are widely regarded as the best lamps on the market. The lifespan and energy

[1] * This term and all subsequent terms marked with an asterisk (*) are defined in the glossary.

efficiency of LED lamps are significantly better than CFLs and the market is predicted to grow at a compound annual growth rate of 25% over the next decade.

As a type of lighting source, LED lamps deliver the best lighting performance in all kinds of aspects. In power consumption, LED lamps require 12 times less watts than typical incandescent bulbs. They also do not require warm up time. The diodes* present in LED lights create more efficient light that does not produce any heat. More importantly, LED lamps possess an unprecedentedly long lifetime of 60,000 hours, which is sixty times longer than incandescent bulbs.

Due to the incredible lighting performance, LED lamps are the most expensive lighting source on the market. Cheaper LEDs are most likely to contain flawed designs which provide unbalanced lighting and poor efficiency.

Figure 1. Different Types of Light Bulbs

3.2 Lighting Solution

This section mainly analyzes the properties of lights and through the use of the triple bottom line assessment provides a solution to lighting at Koerner's Pub. The solution includes detailed suggestions on choosing light bulbs, light fitting and control.

3.2.1 Light properties

The two important properties of light for this application are light intensity and spectrum* emission. The intensity of light is usually measured in lumens and

lux*. The spectrum of a light bulb is a key factor while considering both performance as well as energy efficiency.

An analysis of the light bulbs' emission spectrums is an effective method to select a light bulb that efficiently converts energy to visible light. The two most popular energy efficient bulbs are LED and CFL lights. These bulbs emit only small amounts of energy in the ultraviolet and infrared spectrums. Figure 2 compares the spectrums of different light bulbs. A disadvantage of LED and CFL lamps would be their narrow spectrum, which result in poor light performance that causes negative psychological effects. The CFL (in green), for example, has those peaks in spectrum that make everything look unpleasant. For our application, energy efficient lamps may not be the best lighting sources or dining and bar areas.

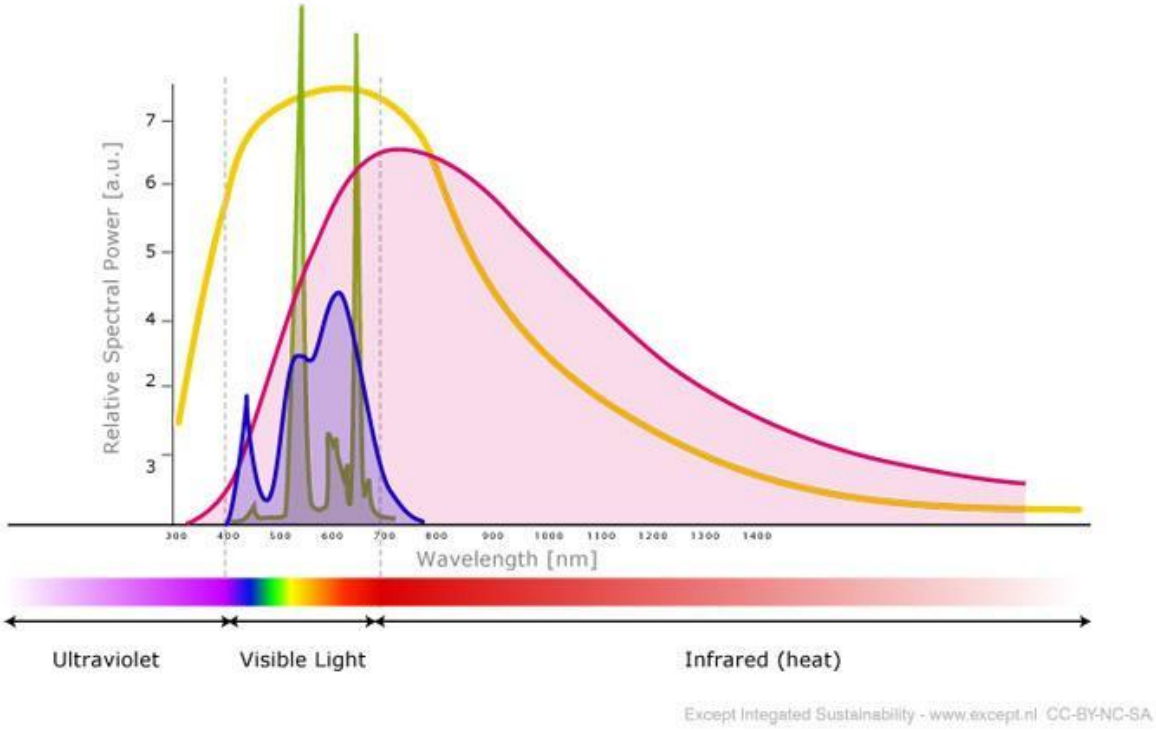

Figure 2. Diagram of the spectrum a LED lamp (blue), a CFL (green) and an Incandescent (purple) superimposed the solar spectrum (yellow) (Bosschaert, 2001).

According to Bosschaert (2001), the area of light emission is another key element to consider when choosing lamps. Most manufacturers provide the three-dimensional area for the light emission of lamps. The two standard spreads are omnidirectional* and spot. Examples of omnidirectional bulbs include both CFL

and incandescent bulbs. Depending on the design of LEDs, some may have proper omnidirectional properties. Spot light and Parabolic Aluminium Reflector (PAR) lamps guide the light in a specific direction, for instance, halogen lamps. This allows for excellent control of light distribution which is important in an artistic sense.

3.2.2 Lighting fittings and controls

For the main dining area of Koerner's Pub, the current incandescent lamps should be kept to continue emitting a warm atmosphere and adding to the positive presentation of food . Halogen lamps could be used to give more directional light above tables.

The patio and bar area are recommended to use LEDs. It also has properties of long lifetime and reliability in different weather/lighting environments.

In the kitchen and other areas, the light properties are not so important other than being a well lit, safe area. For these areas, the CFL is recommended. For the storage room and working areas where visual tasks are only occasionally performed, a light output of 100-150 lumen/m^2 are needed. In the main kitchen area, and office work areas, 500 lumen/m^2 is recommended.

4.0 Upstairs Kitchen Energy Efficient Practices

One method to significantly reduce the energy being consumed in Koerner's pub kitchen is to implement energy efficient practices and techniques when using the various kitchen appliances. In order to maximize the reduction in energy consumption while changing as few existing behaviours as possible it was decided that the focus should be placed on the appliance that consume the most energy in the kitchen. The new environmentally friendly procedures are not drastically different than the current procedures used at Koerner's Pub and it can therefore be assumed that the learning curve associated with these practices will not be long or require a tremendous amount of effort.

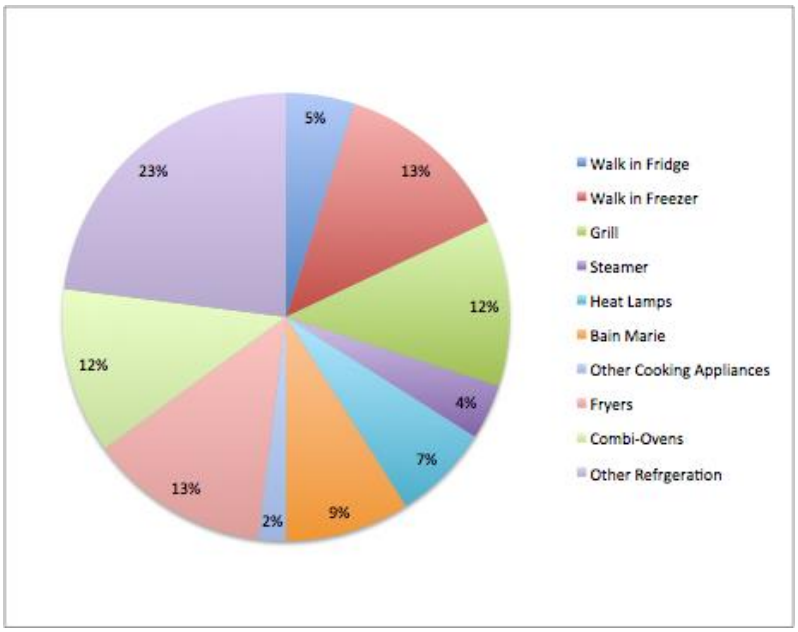

Figure 3: Typical Energy Usage in a Commercial Kitchen (S. Mudie et al, 2013)

The three common appliances that consume the most energy in a typical pub/restaurant are refrigeration systems, grills and ovens (S. Mudie et al, 2013). From site visits to Koerner's Pub it was decided that the energy consumed by the dishwasher would also be analyzed as it is one the primary appliances used in the kitchen.

4.1 Desired Behavioural Changes

The following sections will describe the desired behavioural changes for the various appliances that typically consume the most energy in a commercial kitchen. The environmental, social and economical impacts of the desired behavioural changes will be discussed in later sections.

4.1.1 Walk-in Refrigeration System

The procedure for using a refrigeration system is very basic and does not include many steps. Refrigeration systems are also run continuously and are for the most part left unattended. For these two reasons, preventative maintenance is one of the most effective methods of energy reduction and regular inspections should be performed by certified technicians (Anonymous. Foodservice Equipment and Supplies, 2004). The energy efficiency of refrigeration systems decreases dramatically if the system is not cleaned and maintained properly. This section discusses walk-in refrigerator behaviour and small affordable tools which can help staff members use the refrigerator more effectively by saving energy.

Koerner's Pub site visits showed that the upstairs kitchen was not being used efficiently in terms of energy. It was noted that when the refrigerator door was opened, the refrigerator and room continue to exchange hot and cold air because of lack of temperature equilibrium. The Green Restaurant Association (n. d.) recommends using interior vinyl strip curtains to help maintain the temperature inside of the walk-in refrigerators which would otherwise increase to match the exterior temperature.

The second unsustainable kitchen behaviour noted was that although the walk-in refrigerator light has an on/off switch beside the door, it was left on continuously. This energy loss can be significantly reduced by educating staff about the impact of leaving light sources on when not needed. We suggest that staff members turn off the switch after using the refrigerator. A more permanent solution would be to install an occupancy sensor which turns off the light automatically when the refrigerator is left unoccupied (Anonymous. Foodservice Equipment & Supplies, 2009).

According to a research conducted at Purdue University, it was found that the energy consumption of a family refrigerator could be reduced by 6% if the door is opened 60 times/day instead of 80 times/day (Meier and Obst, 1993). This shows how the behaviour of the operator plays a role and could potentially help reduce the energy consumption of the pub's walk-in refrigerator if employees plan ahead of time to transfer food in and out by large quantities.

We also inspected the door insulation of both walk-in refrigerators by looking for air leaks. It was found that they are in excellent condition with hand locks installed so the door can be sealed completely. Consistent maintenance should be continued.

4.1.2 Stove and Oven

In a typical commercial kitchen the stove and oven are operational throughout the entire hours of food service.

The upstairs Kitchen includes two Market Forge (model unknown because of age) gas stove/oven, which remain off until the operator decides to use them. They use very little to no energy in the off state and can be turned back on and heated to cooking temperature very quickly. It is recommended that when the stove or oven is not in use that they be turned off completely or at least have their temperatures reduced.

During our site visit, we did not notice any significant unsustainable cooking behaviour. Our Sustainable Koerner's Pub Criteria and site visit showed that gas stoves heat ratio is being maximized by using cooking pans and pots that are larger than the burner. The oven is also turned off when not in use. However, there are few minor changes that can be implemented to reduce gas usage. Slicing meat and vegetables thinly for example can help them cook faster and would reduce gas usage significantly.

We also recommend using timers to monitor cooking time so that the operator does not need to continuously open the oven door to monitor the food and allow excess gas to be saved (Green Restaurant Association). If the operator wishes to check the current appearance of the food being cooked it is recommended that they use the oven light and window to do so without opening the oven door. Each time the oven door is opened, 20% of the oven's stored heat is lost (BC Hydro, 2014).

4.1.3 Dishwasher

The upstairs kitchen is currently using a Knight KLE-2335D low energy dishwasher and our site visit showed that most of the sustainable dishwasher behaviour (which are documented in Sustainable Koerner's Pub Criteria, see appendix A) is being followed by the operator. However, our Sustainable Koerner's Pub Criteria showed that there are a few minor behavioural solutions which could still be implement to effectively use the dishwasher.

When the dishwasher was used for the first two cycles of the day, cold water was used. This significantly reduces the performance of the dishwasher and wastes the energy which is being used to run those dishwasher cycles. We recommend that before turning on the dishwasher, a tap or a faucet close to the dishwasher should be turned on for a few seconds until hot water begins to flow through the pipes. This would ensure that the dishwasher receives hot water and

that energy is used efficiently to clean dishes (Trover, 2009). The cold water from the tap or faucet can be filled inside a bucket which then can be used to wash vegetables or pre-rinse dirty dishes during the day.

Our Criteria and site visit also showed that the dishwasher does not provide load settings which could otherwise be used to control the amount of energy needed to clean dishes of varying griminess (Green Restaurant Association, n.d.). The pub's dishwasher operator also mentioned that the dishwasher is not completely loaded at the end of the day or work week when there are few dishes. Although, washing dishes at maximum on one setting does guarantee that your dishes will always come out clean and fresh for reuse; to reduce the excess amount of energy being used every day we recommend washing leftover dishes by hand at the end of the day or pre-rinsing them and saving them for next day/week's wash cycle.

The solutions mentioned above depend on the operator judgement on the amount of dishes at the end of the day, operator's workload and time, and on preparation required for the following business day.

5.0 Environmental Impacts

To assess the environmental effects of the desired operator behaviour, the energy consumption before and after the implementation of the behavioural changes mentioned in section 3 must be compared. However, many of the appliances used in the kitchen are gas powered making difficult to measure energy use with the equipment available. Therefore, research was performed to investigate the average reduction in energy consumption through various energy efficient practices. The energy consumption of the appliances in the kitchen would then be approximated using these averages.

5.1 Lighting Environmental Impacts

The environmental impact of incandescent light bulbs are well known, They emit high amounts of heat to produce light as well as greenhouse gases. It is around four to six times less efficient than CFL or LED lights. Government is pushing to switch to more energy efficient light bulbs to protect environment.

Replacing incandescent bulbs with CFLs and LED lamps can save energy, but they also have other environmental impacts. According to Dienst (2013), the negative impacts are mostly related to the production and disposal phases. Such as the release of mercury as mentioned in section 3.However, the manufacturing of electronic components require significant amounts of resource and use risky substances such as perfluorocarbons*. Both CFL and LED contain several kinds of valuable materials that can be recycled.

5.2 Walk-in Refrigeration System Environmental Impacts

Refrigeration systems account for approximately 40% of the total energy consumed by a typical commercial kitchen (S. Mudie et al, 2013). Below are calculations used to determine how the suggested sustainable operational behaviour of the refrigerator (see section 4.1.1) affected energy consumption..

a. The following calculation shows the effect of lack of vinyl strip curtains on walk-in refrigerator energy consumption.

   Assuming that:

   - Both walk-in refrigerators are about 8 feet by 12 feet
   - They each consume 1136.86 AkWh per month (U. S. Cooler, 2012).
   - Coolers go into sleep mode when desired refrigerator temperature is reached and consumes 0 kWh while in this state.

- Refrigerator door is opened for 2 minutes per trip.
- Refrigerator door is opened 60 time per day.
- Opening the refrigerator door starts up the cooler and it take approximately 30 minute for the refrigerator temperature to drop back down to a desired value

The above measurements were just a few assumptions used to simplify our calculations. To obtain a more accurate result, a technician and a proper walk-in refrigerator inspection is required due to the complexity of the system.

Therefore, when the door is opened, cooler starts up and 1.52AkWh/2 = 0.76 AkWh of energy is used to stabilize the refrigerator temperature back down. In a week approximately 228.9 AkWh is consumed.

0.76AkWh * 60 (door opened per day) * 5 working days = 228.9 AkWh

b. The following calculations show the effect of leaving walk-in refrigerator light bulb continuously on.

Using the same assumptions as part a. our calculations show that the refrigerator door remains open 120 minutes per day. The remaining 22 hours the 13W CFL bulbs remains on and wastes 0.286 kWh of energy every work day or 0.312 kWh on days when the pub is closed.

Light bulb inside the walk-in refrigerator (Quantity – 1)	Energy consumed on a working day	Energy consumed on weekends	Total energy lost per week
13W	13W*22Hrs*5 = 1.43 kWh	13W*24Hrs*2 = 0.624 kWH	1.43kWh + 0.624kWh = 2.05 kWh

Table 1. Energy Usage by Light in Walk-in Refrigerator

For two bulbs (one per walk-in refrigerator) total energy lost per year = 106.6 kWh (Calculation below).

2.05 kWh * 52 weeks/year = 106.6 kWh

Unsustainable Refrigerator Behaviour and missing Walk-In Refrigerator Accessories	Energy lost per year (kWh)

Lack of vinyl strip curtains	228.9
Continuously on Walk-in Refrigerator light bulbs	106.6

Table 2. Energy Loss in Refrigeration

5.3 Stoves

Stoves account for approximately 12% of the total energy consumed by a typical commercial kitchen (S. Mudie et al, 2013). By applying the desired behavioural changes described in section 4.1, significant energy reduction can be achieved. By decreasing the temperature of the stove or shutting it off completely when it is not in use can lead to a 71% reduction in energy consumption (S. Mudie et al, 2013). Ensuring that the pan size is suitable for the element is also an important consideration. A pan that has a diameter 2 inches smaller than that of the element will waste 40% of the energy produced by the element (BC Hydro, 2014).

5.4 Dishwasher Environmental Impacts

The Knight KLE-235D consumes 4025 kWh per hour (Knight, 2012). This means that a half load at the end of the day or week wastes half of the energy which is consumed by the dishwasher as it can only be run on one fixed load setting.

	Energy Lost per year (kWh)
Using only half of the dishwasher load at the end of a work day	4.025 kWh/2 *5 work days * 52 weeks in year = 523.25 kWh

Table 3. Energy Loss in Dishwasher

6.0 Economic Impacts

The economical impacts of the operator behavior changes are almost directly correlated to the environmental impacts. As the amount of energy consumed decreases through the use of environmentally friendly practices, the total operating costs will decrease proportionally. However, the economic impacts of the new procedures will not be entirely beneficial. The new procedures may take some time to get accustomed to and this may cause the kitchen productivity to decrease slightly. Another potential negative economic impact associated with the desired operator behaviours is the preparation time for certain meals. Some of the desired procedures include decreasing the temperature of the appliance when it is not in use, this could lead to an increase in the production time for certain foods.

6.1 Lighting Economic Impacts

The cost of ownership of of lighting extends beyond the light bulb itself, the maintenance and energy consumption cost, the quality of light could affect people's feeling and emotion. Saving energy also helps save the environment. These considerations are difficult to capture into numbers. According to eartheasy.com, below is a simple comparison of the cost of ownership of LED, CFL, and Incandescent light bulbs.

	LED	CFL	Incandescent
Light bulb projected lifespan	50,000 hours	10,000 hours	1,200 hours
Watts per bulb (equiv. 60 watts)	10	14	60
Cost per bulb	$35.95	$3.95	$1.25
KWh of electricity used over 50,000 hours	500	700	3000
Cost of electricity (@ 0.10per KWh)	$50	$70	$300
Bulbs needed for 50k hours of use	1	5	42
Equivalent 50k hours bulb expense	$35.95	$19.75	$52.50
Total cost for 50k hours	$85.75	$89.75	$352.50

Table 4. Economical Impacts of Lighting

From Table 4, it can be seen that over a 50,000 hour period the operational costs associated with LED and CFL light sources are substantially lower than that of the incandescent bulbs.

6.2 Walk-in Refrigeration System Economic Impacts

As discussed in section 5.1 there are two areas which could be improved which are listed below. Assuming Pub's building falls under "Small General Service Rate" is paying lowest BC Hydro rates of about 0.1012 per kWh. This means building is wasting the following amount of money (BC Hydro, 2014) .

Unsustainable Refrigerator Behaviour and missing Walk-In Refrigerator Accessories	Energy lost per year (kWh)	Small General Service Rate - 0.1012 kWh/year ($ Canadian per year)
Lack of vinyl strip curtains	228.9	23.16
Continuously on Walk-in Refrigerator light bulbs	106.6	10.79

Table 5. Economical Impacts of Behavioural Change in Using Walk-in Refrigerators

Assuming a vinyl curtain cost about 100 dollars, the return would take about approximately 3 years. However, the above calculations were made using the cheapest BC Hydro rates (total pub power consumption is unknown as it is part of a building)

6.3 Stoves and Oven Economic Impacts

Gas stoves in the kitchen are old and were installed in the upstairs kitchen before the new pub's ownership. However, the sustainable practices mentioned in section 4.1.2 should help reduce the stove/oven operation cost by saving gas and operator's time.

The recommended changes could decrease operator's productivity until they get used to the new sustainable behavioural practices. However, the training cost and time should be minimal compared to the saving which would be made on natural gas.

6.4 Dishwasher Economic Impacts

In section 5.3 we calculated that approximately 523.25 kWh of energy is being wasted per year. This translates to a minimum economic loss of about 52.95$ using lowest possible business BC Hydro rates (BC Hydro, 2014).

	Energy Lost per year (kWh)	Small General Service Rate - 0.1012 kWh/year

		($ Canadian per year)
Using only half of the dishwasher load at the end of a work day	4.025 kWh/2 *5 work days * 52 weeks in year = 523.25 kWh	52.95

Table 6. Economical Impacts of Dishwasher

This can be eliminated by following the recommendations provided in section 4.1.3. No addition cost is required to implemented the behaviour changes; however, to save energy and money dishwasher operator's cooperation is required.

7.0 Conclusions and Recommendations

The aim of this report was to provide a triple bottom line assessment of Koerner's Pub in terms of methods to improve energy efficiency. It was decided that appliances or technologies that require a large initial investment by the primary stakeholder would not be desirable. Therefore we have concluded that cost effective light bulbs and small appliances/technologies and behavioural changes will provide the most effective solution to improve energy consumption at Koerner's Pub.

For lighting in Koerner's Pub four main light bulb types were assessed. For the upstairs kitchen the use of CFLs (with proper disposal since they contain mercury) is recommended for their long lifespan and brightness, and LEDs are recommended for the bar and patio areas (energy efficient and long lifespan), while the main dining area continues to use incandescents for the warm light that is emitted, to maintain a pleasing atmosphere.

In the kitchen area we highly encourage appliance operators to be aware of unnecessary use of energy. We have provided a guide located in appendix A of this report that depicts the desired operator behavior to reduce energy consumption while maintaining kitchen efficiency. The use of interior vinyl strips on the walk-in refrigerators should also be installed to help maintain the temperature of the refrigerators.

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Appendix A

Group 5 - Sustainable Koerner's Pub Criteria

This criteria focuses on improving sustainable kitchen operation by evaluating Koerner's upstairs kitchen routine and by suggesting sustainable behaviour and affordable tools and equipments for PUB's kitchen. Power and gas distributor, Sustainable Restaurant and food sector organization criteria and standards are used to devise Sustainable Koerner's Pub Criteria.

1) FortisBC Inc: Canadian Electric power and gas distribution/retail company
2) Green Restaurant Organization: USA non-profit organization which provide certificates to environmentally friendly restaurants
3) Leafme : Canadian third party sustainability and certification program for food providers

General Sustainable Kitchen Behaviour

- Turn of cooking equipment at night - (FortisBC, n.d.)

  Turning off lights, dishwasher, heat and cooking equipment can save energy which would otherwise be used to run those equipment in idle mode.

Dishwasher

Check type of dishwater in use:-

Common to all dishwashers:-

- Load machines completely before turning them on (FortisBC, n.d.)

- Check if pre-rinse spray valves are being used (restaurants and pubs may receive free energy and water efficient from City of Vancouver, page also gives information about how to receive free energy consultation from BC Hydro)

  http://vancouver.ca/green-vancouver/sustainable-programs-for-businesses.aspx

- Run hot water using a nearby faucet before starting a dishwasher in winter - (Trover, 2009) (depends on your dishwasher model as some models may not run until the water is hot enough)

  This would ensure that your first cycle is not filled with cold water which could otherwise result in the operator running the dishwasher again.

- Use appropriate settings: light settings can be used as long as the dishing are not super dirty, in case of a super dirty dish wash by hand or group them together to run on heavy settings later on (understand you dishwasher settings)

- clean dishwasher trap regularly (Trover, 2009)
- Avoid using heat drier when dishes are not needed right away (e.g. at night)

Hand washing:-

- Install Low-flow spray values (FortisBC, n.d.)

Flow <= 1.28 gpm

Flow <= 1 gpm

Refrigeration

- Install vinyl strip curtains (FortisBC, n.d.)
- Check walk in doors for leaks and ensure they are aligned (FortisBC, n.d.)
- Clean condenser coils (FortisBC, n.d.)
- Shut doors on walk-in coolers and freezers (FortisBC, n.d.)
- Check if refrigerator has occupancy sensors to turn light on/off

Water Heating

- Low flow hand washing sinks (Kitchen and restroom) (Green Restaurant Association, n. d.)
    - Less than 1.5 gallon per minute
    - Less than 1.0 gallon per minute
    - Less than 0.5 gallon per minute
- Non-fill prep sinks
    - Less than 1.5 gallon per minute
    - Less than 1.0 gallon per minute
    - Less than 0.5 gallon per minute

Lighting

- Occupancy Sensors for stairs to upstairs kitchen which would dim or turn off the lights (Green Restaurant Association, n. d.)

Cooking (groundcherry.wordpress.com: Sustainable cooking for one)

- food warmers (Green Restaurant Association, n. d.)
- Maximize cooking to heat ratio by:-
    - slicing meat and vegetables thin so they cook quickly and use less energy
- Always keep you pan size larger than the heat source to maximize heat transfer (or use stove top heat diffuser)
- Use timers to ensure energy is only being used when needed

Type of Food and waste reductions

- 30% of main dishes are vegetarian (Green Restaurant Association, n. d.)
    - deforestation as more land is being used for grasslands
    - climate change because of methane
    - water shortage and pollution - manure contains phosphorus and nitrogen and about 95% is lost.
- donate leftover food regularly (Green Restaurant Association, n. d.)

Waste and Recycling

- Recycling Bins (Green Restaurant Association, n. d.)
- Bulk Packaging (Green Restaurant Association, n. d.)
- Grease, fats, and oils - Leaf Criteria Version 2.0 (Leafme, 2011)

http://leafme.ca/wp-content/uploads/Criteria-Overview.pdf