

UBC Social Ecological Economic Development Studies (SEEDS) Student Report

An Investigation into Sustainable Patio Heating Solutions for Koerner's Pub UBC

Ajai Hundal
Ajay Mistry
Tomas Syskakis
Ishan Virk

University of British Columbia

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The University of British Columbia

APSC 261 – Technology and Society

Tutorial Instructor: Dr. Saloome Motavas

An Investigation into Sustainable Patio Heating Solutions for Koerner's Pub UBC

Submitted by:

Ajai Hundal 40066128 – Chemical and Biological Engineering

Ajay Mistry 33907122 – Electrical Engineering (Nanotechnology and Microsystems Option)

Tomas Syskakis 33950122 – Electrical Engineering (Power Systems Option)

Ishan Virk 53642120 – Computer Engineering

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Abstract

The University of British Columbia (UBC) strives to be a global leader in campus sustainability. Koerner's Pub, a well-established pub and restaurant on campus, is committed to improve its reputation as a sustainable and eco-friendly establishment. To fulfill this goal, Koerner's is investigating possible solutions to contribute to the environmentally conscious mentality that UBC is world renowned for. This report will outline the investigation into the financial, environmental and social aspects of the implementation of a new energy efficient patio heating system at Koerner's Pub. By implementing a sustainable patio heating system, Koerner's could extend their outdoor season thereby increasing capacity, improving their brand and attracting more customers and events during the winter and fall months. The purpose of this report is to provide a Triple Bottom Line assessment (TBL) that will advise the stakeholder, Tim Yu, how Koerner's Pub can implement a sustainable, cost-effective and socially viable patio heating system.

Several onsite visits to Koerner's Pub were conducted to gain a comprehensive understanding of the present patio heating situation. Currently, there are three forms of heating being used in the patio area: propane stand-alone heaters (mushroom design), an infrared heater as well as an inherited electric filament heater. Various surveys and meetings with local restaurants proved that propane heaters were the most popular choice and thus using them as a benchmark, alternatives were researched that were more efficient, eco-friendly and cost effective. To research alternative heaters using a TBL assessment, the economic, environmental and social impacts of each heater had to be considered. After narrowing down the preferences to infrared electric, infrared natural gas and propane mushroom heaters, the following summary shows how it was concluded that implementing a system of infrared electric heaters would be the best choice:

Economic: Low overhead costs and utility expenses are included in the pub's lease agreement.

Environmental: No fossil fuels are burned leading to almost zero carbon emissions during operation.

Social: No operating maintenance is required and each heater is portable as extension cords are safer to route around the patio area, as compared to natural gas lines and propane tanks.

The subsequent areas of this report will go into detail regarding the environmental, financial and social aspects of procuring a suitable heating system for the Koerner's Pub patio area.

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Glossary

British thermal unit (BTU): the amount of heat or energy required to heat one pound of water by one degree Fahrenheit. The equivalent of approximately 1055 joules

Gigajoule (GJ): the equivalent of 1,000,000,000 joules of energy

Radiant energy: form of energy that is released by any object or person that is warmer than their surroundings

Kilowatt hour (kWh): unit of energy that is equivalent to one kilowatt of power consumed in an hour

Wattage: amount of power that is required to run or outputted by a device

List of Abbreviations

AQHI	Air Quality Health Index
BTU	British thermal unit
CAC	Criteria Air Contaminants
CO₂	Carbon dioxide
CO	Carbon monoxide
GJ	Gigajoule
kWh	Kilowatt hour
lbs	Pounds
NO_x	Nitrogen Oxides
PM	Particulate Matter
ppm	Parts per million
SO_x	Sulfur Oxides
W	Watts
VOC	Volatile Organic Compounds
V	Volts

1.0 Introduction

Koerner's Pub is hoping to extend the use of its patio into the spring and fall seasons by implementing new heaters that are both sustainable and efficient. The present layout of heaters has only allowed them to use the seating portion of their patio due to the limited number of heaters currently running. Stakeholder, and principal of the pub, Tim Yu is also hoping to erect a tent in the open patio area that can be used for events and during the winter and fall months. This tent would also require a heating system that is both unhazardous and easy to maintain. After narrowing down possible heating solutions to an infrared natural gas, infrared electric and propane mushroom heaters, a triple bottom line assessment was conducted to systematically choose the most optimal choice. The body of this report will discuss our investigative techniques, as well as economic feasibility, environmental effects and social aspects of implementing a new heating system. The economic assessment will outline which heater provides the best costs savings, addressing overhead costs along with long-term maintenance and running expenses. The environmental aspect will provide information about carbon emissions released and overall carbon footprint of all heaters, choosing the heater which proves to be the most eco-friendly. Lastly, we consider social aspects including safety and ease of implementation and portability of such heaters for pub employees. After analyzing these impacts, recommendations will be provided regarding the best proposal to replace and upgrade the current heating system.

2.0 Investigation Process

It was imperative that our group fully understood Tim's problem before researching into viable solutions. Key aspects regarding the layout of the patio, certain utility infrastructure restrictions as well as a budget had to be taken into consideration when investigating practical solutions and presenting our recommendations. Our group conducted several on-site visits to Koerner's Pub to gain a comprehensive understanding of the present patio heating situation. Currently, there are three forms of heating being used in the patio area: propane stand-alone heaters (mushroom design), an infrared heater as well as an inherited electric overhead heater. Due to the building's age, an overhaul of pre-existing electrical systems is not fiscally or structurally feasible; therefore, the heating solution must be easy to install, mobile and cost effective.

Our investigative efforts began by visiting various restaurants with successful outdoor dining environments in Vancouver, such as the LOCAL Eatery and Browns Social House. We

noted the heating system that the establishment utilized and the comfort level of the outdoor eating experience. Upon completion of our independent observations, we then spoke with the manager at each respective restaurant. We asked three questions to gain insight into the decision making process regarding their patio heating:

1. How did you choose your current patio heating system?
2. On average, how much does your current heating system cost to operate?
3. Have you been happy with your current arrangement?

Every restaurant that we surveyed used the propane mushroom heaters to heat their patio area. The managers mentioned that there was no forethought into the heater's environmental effects or recurring financial costs. The easy to maintain, high mobility mushroom heaters are the benchmark among patio heating options. Although this widely used option offered sufficient heat output and simple refilling properties, these heaters were found to be producing an excess of greenhouse gas emissions (Sunswitch, 2008). Using the propane heaters as a benchmark, we investigated further into alternative options with more efficient, eco-friendly specifications that Koerner's Pub could utilize. Recently, the frontrunners in the heating industry are the environmentally friendly and cost effective infrared natural gas and infrared electric heaters. Used in a variety of large scale projects such as sports stadiums (Schwank, 2014c), the infrared natural gas and electric heaters would be viable alternatives to heat a large outdoor area. The subsequent areas of this report will go into detail regarding the environmental, financial and social aspects of procuring a suitable heating system for the Koerner's Pub patio area.

3.0 Overview of Infrared Heaters

Mushroom propane, infrared electric and infrared natural gas heaters are all forms of infrared heaters that emit radiant energy. To understand what radiant heat is, one can recall feeling warmth provided by sunshine on a cold day. The heat that our body absorbs in this situation is a form of radiant energy. Even though the surrounding air is cold, we are still heated by the sun's rays. Radiant energy is a form of energy that is released by any object or person that is warmer than their surroundings (Air Conditioning, Heating and Refrigeration Institute [AHRI], n.d.). Infrared heaters emit radiant energy in the form of heat that radiates downwards warming the floor and any objects within range of its heat distribution. Objects that are warmed by the infrared heat also release some of their own heat that can be absorbed by the air or other bodies around (AHRI, n.d.). When compared to traditional convection heaters, infrared heaters are considered to be capable of delivering a more efficient heat output (Schwank, 2014b). Conventional convection heaters only heat the surrounding air. As the air around the heating

element rises in temperature the hot air rises above the cooler air due to thermodynamics. This recursive heating process is inefficient and requires more energy to heat people and objects at the floor level (Schwank, 2014a). Conversely, infrared heaters directly heat objects; therefore, the heating process is more efficient and faster. Evidently, there will be some losses due to air that is warmed via infrared heating; however, the amount that is lost is much less than from convection heating (Schwank, 2014a). Mushroom propane, infrared electric and infrared natural gas heaters all provide infrared heat, but with different in fuel sources.

Mushroom propane and infrared natural gas heaters function via gas combustion where a steel tube is heated, subsequently emitting radiant heat (Schwank, 2014a). Electric infrared heaters contain a tungsten filament that is heated to high temperature via an electric current. Once the temperature of the filament exceeds a certain threshold, it will emit radiant heat (Tansun, n.d.). Heat output can vary, and depends on the design of the heater, as well as the input wattage or BTUs. Specifically for mushroom propane heaters, a typical 40,000 BTU heater can radiate heat over a 9 foot diameter. However, due to the design of the heater, heat will be concentrated within 3 to 4 feet of the source (Calcana USA Ltd., n.d.). Infrared electric and infrared natural gas heater heat an area of anywhere from 10 meters square to 15 meters square again depending on input wattage or BTUs (2014a).

For the purpose of this investigation, our group looked at patio heaters produced by a company called Schwank, who have distributors in the Lower Mainland. Schwank is a leader in the HVAC industry specializing in infrared heaters, and have been contracted for a variety of large scale commercial projects such as the renovation of BC Place that was completed in 2011. The three models of Schwank patio heaters that will be investigated in this report are the IEP-1520 Infrared Electric heater, the bistroSchwank 2135 Infrared natural gas heater and the supremeSchwank 2312 Infrared natural gas heater, shown in Figure 1 through 3, respectively.



Figure 1: Schwank IEP-1520 Electric Patio Heater (Schwank, 2014c)



Figure 2: Schwank bistroSchwank 2135 Natural Gas Heater (Schwank, 2014c)



Figure 3: Schwank supremeSchwank 2312 Natural Gas Heater (Schwank, 2014c)

4.0 Economic Analysis

When analysing which type of patio heater would be the best option for Koerner's Pub, the economic aspects of the decision play a major role. As Koerner's goal is to increase revenue by attracting more costumers, the purchase of the patio heaters could potentially improve the pub's brand and reputation in the community. Like most businesses however, the pub has a conservative budget for certain expenditures and thus we felt it was in the best economic interests of the pub to invest in heaters that had low overhead costs in comparison with their long term operating and maintenance expenses. As a result, initial purchasing, operating and future expenses of the heaters were taken into consideration during the assessment process. For the purpose of our investigation, we assumed that Koerner's operated each patio heater for 20 hours a week for 30 weeks a year.

4.1 Purchasing Costs

Four models of infrared patio heaters were investigated, all of which can be purchased by from distributors in the Lower Mainland. The Home Depot Stainless Steel mushroom propane heater can be purchased from Home Depot locations in the Vancouver area at a low cost. After contacting Schwank directly for quotes, we were referred to ECCO Supply, a HVAC product distributor in the Lower Mainland, who carry Schwank patio heating products. The prices for the Schwank IEP 1520 Electric heater, bistroSchwank 2135 and supremeSchwank 2312 natural gas heaters were obtained from Product Manager, Rick Jones of ECCO Supply. Contact information for Mr. Jones and ECCO Supply locations can be found in Appendix A. Purchasing costs for the four heaters are summarized in Table 1. For the purpose of the investigation, shipping and delivery costs, as well as installation costs were neglected.

Infrared Heaters	Purchase Cost	Distributor
Home Depot Stainless Steel	\$119.00	Home Depot
IEP 1520 Electric	\$406.00	ECCO Supply
bistroSchwank 2135 (NG)	\$1,507.00	ECCO Supply
supremeSchwank 2312 (NG)	\$1,681.00	ECCO Supply

Table 1: Purchasing costs of infrared heaters

As was mentioned in section 2.0, different heaters have heat output and distribution that depends on heater design and on input wattage or BTUs. It is important to note, as per the heater datasheets, a single IEP 1520 heater can provide coverage over a maximum of 12 m², while a bistroSchwank 2135 or supremeSchwank 2312 will provide approximately the same coverage but at higher intensity and heat output. As a result, more energy will needed by the electric heater to match the heat output of the natural gas heaters.

4.2 Operating and Maintenance Costs

4.2.1 Mushroom Heaters

Koerner's Pub currently utilizes a mushroom propane heater for their patio heating needs. A typical 40,000 BTU mushroom propane heater will burn through a 20 lbs propane tank in approximately 10 hours (Woodland Direct, n.d.). The cost of filling a propane tank in the Lower Mainland is between \$15 and \$20. With the pub running a single heater for 20 hours in one week, the cost of running one heater per week is around \$40. Over the year, the cost of running a heater for 30 weeks a year could amass to over \$1200. Considering

that these heaters typically only heat a 10 foot maximum radius, the pub would need to invest in more than one of these heaters for the patio. Clearly, running more than one of these propane heaters is not a cost effective option. Even though there are low overhead costs, in a year the pub could end up spending 11 times the amount that was spent on a single heater, just on the propane that is needed to run it.

4.2.2 Infrared Electric and Infrared Natural Gas Heaters

Typical rates for FortisBC in Vancouver for natural gas and electricity are \$.075/kWh and \$10.215/GJ, respectively (FortisBC, 2014a). With 1GJ of natural gas being equivalent to 277 kWh of electricity, the cost of natural gas is approximately half that of electricity (FortisBC, 2014b).

Stakeholder Tim Yu informed our group that Koerner's Pub pays a monthly lease, in which their utility expenses are included. Thus Mr. Yu does not pay a separate gas or electricity bill, and was unable to access or provide us with any cost specific information regarding his building's utility rates. Hence, when comparing operating costs of the infrared electric and infrared natural gas heater, there is no considerable advantage of choosing the natural gas or electric option, as both heaters will cost the pub the same amount of money to operate.

Upon consulting the data sheet for the IEP-1520 Electric heater, we learned that the heater's heat lamp has an approximate 5000 hour life time. This future expense will be taken into account in section 1.3 when analysing which heater option is most economically viable. We were unable to receive a quote from Schwank or ECCO Supply regarding the cost to replace the heat lamp. However, as the heat lamp is an important component of the heater, for the purpose of the investigation we will assume that a replacement lamp costs approximately \$250.

Future unpredictable maintenance costs such as broken parts were not considered during analysis, however certain parts may be covered by warranty. We will value general maintenance for the heaters to be around \$50 per year.

4.3 Cost Savings

After considering the initial purchasing costs, as well as future operating and maintenance costs over a 10 year period for the heaters, we determine purchasing Schwank IEP 1520 Electric heaters was the most economically viable option. Equation 1 shows the

calculation for the operating costs for mushroom propane heaters. Before even considering the other heaters, at \$12,000, these propane heaters are clearly the most expensive option.

$$(1) 10\text{years} \times \$20.00/\text{tank} \times 20\text{hours}_{\text{usage}}/\text{week} \times 1\text{tank}/10\text{hours}_{\text{usage}} \times 30\text{weeks}_{\text{usage}}/\text{year} = \$12,000.00$$

As a result and due to that fact that Koerner's already uses propane heaters, cost savings for the other heaters were compared with respect to the propane heater operating costs. There are three reasons why the electric heater was the most economically viable option. Firstly, the initial overhead cost for the IEP electric heater is substantially less than the cost of the natural gas heater. Secondly, even though more energy needs to be consumed by the electric heater to match the output of the natural gas heaters, due to the lease that the pub pays, the operating costs of the heaters is negligible. Finally, 10 year maintenance expenses were considered. The only difference in the maintenance costs of the heaters was the replacement of the heat lamp for the electric heater. After performing a calculation, it was determined that the lamp would need to be replaced just once over a 10 year period. This difference can essentially be accounted for in the initial purchasing cost, and the electric heater would still be the cheaper option and provide the most cost savings. The results our analysis are summarized in Table 2.

It is recommended that stakeholder, Tim Yu contact Schwank or ECCO Supply and inquire about the actual heat lamp replacement cost, should he decide to purchase IEP-1520 heaters.

Heater	Purchase Cost	10 Year Period Expenses	Cost Savings: \$12,119.00 – X
Home Depot Stainless Steel	\$119.00	\$12,000.00	-
IEP 1520 Electric	\$406.00	\$250.00 (Lamp) + \$50.00/year x 10years	+ \$11,463.00
bistroSchwank 2135 (NG)	\$1,507.00	\$50.00/year x 10years	+ \$10,112.00
supremeSchwank 2312 (NG)	\$1,681.00	\$50.00/year x 10years	+ \$9,938

Table 2: Infrared Heater Cost Savings Analysis

5.0 Environmental Impacts

Our investigative analysis into the environmental effects of mushroom propane, infrared electric and infrared natural gas heaters has yielded interesting results. As our society makes the transition to more eco-friendly industry, commercial and domestic practices, our recommendation to Mr. Yu should reflect the environmentally conscious morals that his pub is wanting to promote. While propane and natural gas leave a relatively small carbon footprint compared to other fuels, as seen in Figure 1, the alternative option of using electric patio heaters would overall be the most sustainable option.

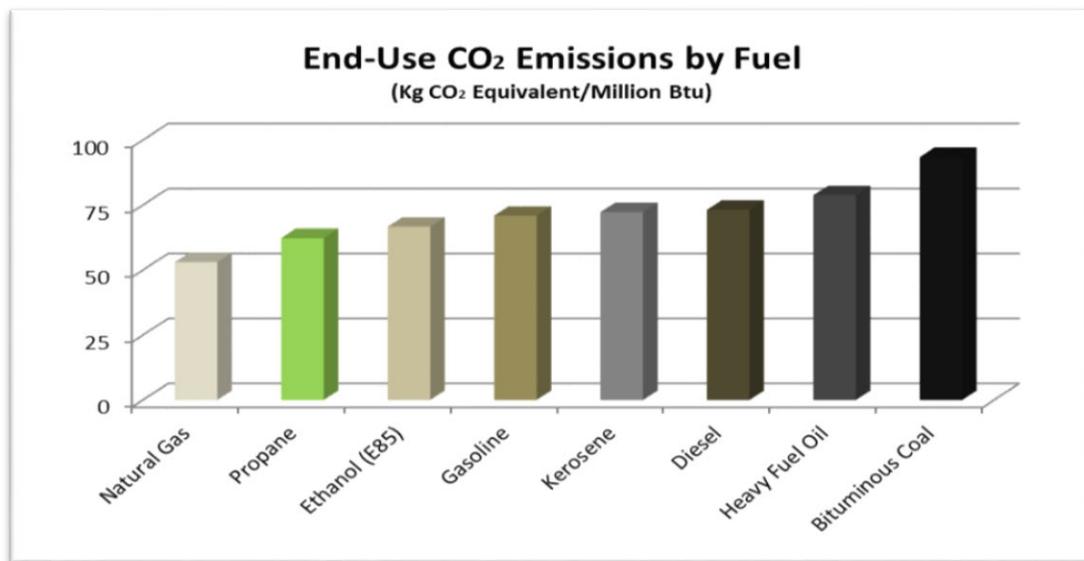


Figure 4: End-Use CO₂ Emissions by Fuel (Canadian Propane Association [CPA], n.d.)

Although propane is perceived to be amongst the cleanest fuels, its use should be limited wherever possible. Patio heaters are a primary example of this as there are alternative options which function with similar performance. The European Union has actually banned the use of propane heaters in restaurants after green groups rose awareness of the negative impact they were having on the environment (Sunswitch, 2008).

When it comes to environmental impacts and air pollutants that affect our health, the key ones to take into consideration are called Criteria Air Contaminants (CAC). These are emissions which contribute environmental problems such as ground level ozone and acid rain formation (CPA, n.d.). The primary Criteria Air Contaminants include: Sulfur Oxides (SO_x), Nitrogen Oxides (NO_x), Particulate Matter (PM), Volatile Organic Compounds (VOC) (CPA, n.d.). There

are internationally accepted indexes and regulations which we can use for justifying our analysis of veering away from the use of propane heaters at Koerner's Pub.

Regulations and guidelines have been established to monitor and control over pollutants let into the environment. A primary index used to consistently monitor PM, nitrogen oxides, hydrocarbons and other pollutants is the Air Quality Health Index (AQHI) (Environment Canada, 2014). Regulations to monitor the quality of air are essential to track the environmental impact that various burning of fuels are having. The burning of propane gives off pollutants such as nitrogen oxides and it is important to control how the extent to which environments and ecosystems are impacted (Environment Canada, 2014). The Air Quality health Index is calculated using concentrations of three contaminant air criteria: Nitrogen Oxides, Ozone and Particulate Matter (Environment Canada, 2014).

This is the means by which we can state that propane heaters are the least environmentally friendly, followed by natural heaters and finally electric heaters which in turn have close to no effect on ambient air quality. Our investigation did not take into account the process in which the electricity was created and the resulting emissions of such processes. Pollutants from the burning of coal or fossil fuel during the production of electricity would raise the net impact of the electrical heaters. Though it was out of our scope to measure the emission rates and concentrations of the heaters currently in place at Koerner's, by contrasting the overall impact of propane, natural gas and electric heaters we were able to confirm that the least sustainable option would indeed be the propane heaters, followed by natural gas. The natural gas heaters (specifically both the bistroSchwank 2135 and supremeSchwank2312) produce less than 20 ppm of NO_x and less than 100 ppm of CO during operation (Schwank, 2014c).

Environmentally, the electric infrared heater produces no greenhouse emissions from the heating process. No fuels are being burned therefore the Air Quality Health Index will read very close to zero which indicates excellent air quality. Propane heaters emit 35kg CO₂ per year making them the least environmentally friendly option (Sunswitch, 2008). Of all fuel powered heaters, natural gas gives of the least emissions but overtime it does accumulate. After taking into consideration the environmental impacts and efficiencies, it is evident that electrical heaters are the heater of choice to be used at Koerner's Pub.

6.0 Social Impacts

The social factors governing a decision play instrumental roles in making the right choice for the social environment. Koerner's, being a reputable pub, aims to present a pleasurable experience to all customers. By installing a heating system, Tim aims to increase the capacity of

the pub by utilizing the patio space and increasing the outdoor season as far into the winter months as possible.

Safety is the top priority when dealing with open heating fixtures in close proximity to people. As the environmental and financial impacts of the propane mushroom heaters have resulted in it being neglected from future use, we focused our investigation into determining the better choice of the remaining two heating options: infrared electric and infrared natural gas. The existing utility infrastructure of the pub allows both electrical extension cords and flexible natural gas lines to be run to heater locations. There are inherent risks when dealing with combustible gases and high voltages.

Option 1: Infrared Electric Heaters

Installing an infrared electric heater system in the patio area would be a straightforward process. As the electric heaters are powered off of industry standard 120V, running a multitude of extension lines to the respective location of each heater is a feasible and low cost option for installation. If any accident should occur and the extension line is disconnected from the heater, the heater will simply turn off and cool down.

Option 2: Infrared Natural Gas Heaters

Tim informed our group that the outdoor area has access to a natural gas hookup. The natural gas can be fed to the heaters via flexible tubing. Risks arise when introducing a large group of people to the area. Again, as with Option 1, if an accident should occur and a natural gas line breaks or bursts, the safety of the patrons is at risk. A highly combustible gas and exposed flame could have destructive consequences if the leak is not dealt with in a timely manner.

When comparing the respective risks associated with each option, our recommendation, from a purely social analysis, is for the Koerner's Pub to adopt infrared electric heaters. The safety concerns in regards to gas leaks corresponding to the natural gas infrared heater usage far outweigh the apprehensions concerning electric infrared heater installation.

7.0 Conclusion and Recommendations

In conclusion, after conducting a triple bottom line assessment of the mushroom propane heaters, Schwank IEP-1520 Electric heaters, and natural gas heaters such as the

bistroSchwank 2100 and supremeSchwank, we determined that an IEP-1520 would be the ideal choice to implement at Koerner's Pub. This report has covered how we reached to this conclusion and the three aspects that were analyzed. In terms of economic aspects, the mushroom heaters came at the lowest overhead cost, but proved to be the most costly in the long run. When comparing the infrared electric and infrared natural gas heaters, the IEP-1520 was as much as three times less expensive than its natural gas counterparts, with both options presenting similar maintenance costs. Moreover, considering that operating costs did not need to be taken into account due to the pub's lease, the IEP-1520 was the most economically viable option. From an environmental standpoint we determined that propane heaters are the least sustainable option as a single heater a large amount of CO₂ emissions per year. Although the natural gas heaters are significantly more eco-friendly than propane heaters, they still burn fossil fuels and thus produce carbon emissions. Conversely, electric heaters themselves have close to zero effect on the environment and air pollution and thus the IEP-1520 was the most eco-friendly option. In terms of social impacts, running propane and natural gas lines across the pub would have proved to be too dangerous in a social setting such as a pub. The electric heaters on the other hand, are not only easy to implement but it is also possible to minimize risks by using extension cords along the sides of the patio to power them. As a result, when considering social aspects, the IEP-1520 was again the best option.

After an in-depth analysis of economic, environmental, and social aspects, it was evident that it would be in the best interests of Koerner's Pub to implement a patio heating system using Schwank IEP-1520 electric infrared heaters. By implementing these heaters, Koerner's Pub improves its brand by achieving higher sustainability standards and successfully extend its outdoor season into spring and fall, providing a positive experience that keeps customers coming back.

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Appendix A

Contact Information for ECCO Supply:

Rick Jones, Product Manager

Allied Air, Lifebreath, Honeywell & Schwank Brands
ECCO Supply

7959 Enterprise Street

Burnaby, BC V5A 1V5

Tel: 604-420-4323

Fax: 604-420-6523

Email: rjones@eccosupply.ca

Web: www.eccosupply.ca

