UBC Social Ecological Economic Development Studies (SEEDS) Student Report

An Investigation into Induction versus Gas Stovetops

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An Investigation into

Induction versus Gas Stovetops

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Abstract

With increasing population, the aging Student Union Building on UBC is scheduled to be rebuilt to better serve student needs. This will include serving thousands of students and faculty members on a daily basis with food. Not only that, but this project aims to help create a more green campus by being a leading example of sustainability, as the food and beverage department will have the largest consumption of energy.

This report looks into two main technologies, as well as a third possible candidate to use in preparing food in the new student union building. The technologies in consideration include Induction stovetops, and Gas stovetops. Each of the solutions will be compared in a triple bottom line analysis, comparing the economic, environmental and social impact with each other.

After comparison of each technology, it is concluded that induction suits the needs of the campus much better in all three categories. It is seen that economically, while induction stovetops are more expensive on purchase, it is much more efficient in energy consumption, and will save money in the long run, especially when used for thousands of students daily. Environmentally, it is found that due to the higher efficiency, and the possibility that induction stovetops may be powered without creating any harm to the environment, that it is ideal. Lastly it is found that socially, it is better choice due to fact that induction stovetops are safer to work with, and provide no long term health risks when compared to gas stovetops. Therefore induction is considered the better choice in stovetop technologies, and should be used in order to achieve better levels of sustainability in the new Student Union Building.

Table of Contents

1.0	**Introduction**		**P.7**
2.0	**Social Analysis**		**P.8**
	2.1	**Electromagnetic Radiation**	**P.8**
	2.2	**Working Environment**	**P.9**
	2.3	**Social Recommendation**	**P.10**
3.0	**Economic Analysis**		**P.11**
	3.1	**Capital Costs**	**P.11**
	3.2	**Operating Costs and Efficiency**	**P.13**
	3.3	**Incentives and Direct Benefits**	**P.15**
	3.4	**Economic Recommendations**	**P.15**
4.0	**Environmental Analysis**		**P.16**
	4.1	**Gas Stovetops**	**P.16**
	4.2	**Induction Stovetops**	**P.18**
	4.3	**Environmental Recommendations**	**P.18**
5.0	**Conclusions**		**P.19**

List of Illustrations

Illustration 1: Combustion Reaction **P.16**

Table 1: Stovetop Price Range Chart **P.12**

Table 2: Stovetop Efficiency Chart **P.14**

Glossary

Electroencephalography Rhythms	- depiction of the electrical activity occurring at the surface of the brain
Aerate	- Dissolve in air

List of Abbreviations

SUB - Student Union Building

UBC - The University of British Columbia

RF - Radio Frequency

CSTEE - The Scientific Committee on Toxicity, Eco toxicity and the Environment

CO - Carbon Monoxide

NO_2 - Nitrogen Dioxide

SO_x - Sulphur Oxides

1.0 Introduction

This report is an investigation into the uses of Induction and Gas stovetops in the student union building (SUB) to be built inside of the University of British Columbia (UBC). The report will approach and analyze the pros and cons of each technology used from an economic, environmental and social point of view. The goal of this report is to inform the potential decision makers, to use the best solution when choosing stovetops for the new SUB building.

2.0 Social Analysis

This section will take a look at the interactions between gas & induction stovetops with people. One of the key aspects to consider is the safety in association of the different types of stovetops, as any possible hazards may easily injure workers, as the stoves will be used daily. This will also contribute to the working conditions of employees, in which it must strive to be comfortable and while following WorkSafe BC regulations. Also there are ethical issues and these include setting an example for other industries and companies or even restaurants to follow UBC's lead. Another ethical issue is the manufacturers of the stove tops making sure they are also socially responsible

2.1 Electromagnetic Radiation

Induction stoves create an electromagnetic field when it is turned on. Because of this, there are growing concerns as to whether these electromagnetic fields, will cause any considerable safety concerns for humans. However, people must remember that microwaves and cell phones also give off electromagnetic fields, which are also used in a regular basis.

The radiation that induction stovetops emit is the same radiation emitted by microwaves and cellular phones. The radiation field, comprised of Radio Frequency (RF) radiation, is almost zero at approximately a distance of one foot or thirty centimeters. (The Induction Site 2010) That means that an average person would not get a lot of radiation in the body, but if a chef works in a commercial kitchen which the new sub will have, there is a chance the chef will be standing close to the induction cooker for extended periods of time. However, even then, when compared to talking on a cell phone, the user is less than one inch away from the brain and a chef is usually not that close to the stove, so that is a difference one must consider.

In a study on the effects of RF radiation on the human body, the Scientific Committee on Toxicity, Ecotoxicity and the Environment (CSTEE), found that there are no significant decreases in the immune system. The CSTEE also found no correlation between electromagnetic fields, the heart and blood pressure. Also the CSTEE states that there are some studies that propose a possibly correlation between RF radiation on the ion, calcium and membrane protein of neurons, which also effect electroencephalography rhythms; however these cannot be reproduced easily. (CSTEE 2001)

There are also concerns for people in the kitchen who may have a pace maker implanted in them which may malfunction due to the electromagnetic field interference. Werner Irnich and Alan D. Bernstein state that "Patients are at risk if the implant is unipolar and left-sided, if they stand as close as possible to the induction cooktop, and if the pot is not concentric with the induction coil." Another study also found that induction cook tops "do not present any electromagnetic interference… They are insensitive with medically correct settings" (Frank R), and therefore, under normal circumstances, induction stove cook tops should not pose any safety concerns to people who have pace maker implants and are working in the kitchen.

2.2 Working Environment

The air quality is also of concern in commercial kitchens when using gas stovetops. The combustion that occurs within a gas stove is known to be dangerous to health and indoor air quality. (Ricky Cappe 2007) Natural gas contains "radon and beneze, chemicals known to the State of California to cause cancer. (Ricky Cappe 2007) Products such as toluene, found in the combustion of natural gas are also known to cause harm to the reproductive system. (Ricky Cappe 2007)

Studies also suggest that natural gas may increase the chances of asthma and respiratory illness. (David wimberly 2000) Dr. Bill Rea, Chair of Environmental health Center concluded that "of 47,000 patients, the most important sources of indoor pollution responsible for generating (environmental) illness were the gas stoves, hot water heaters, and furnaces." University of California at San Francisco documented that "using a gas stove seven or more times a week doubled the risk of emergency room treatment for asthma patients, and increased hospitalization and urgent doctor visits", therefore gas stoves were not recommended. Gas combustion also provides a transportation mechanism for moulds, dust, mites, viruses, and bacteria, since water vapour is generated. (David W. 2000)

Even though many of the by-products of combustion are hazardous to health, some studies suggest that they can be removed by ventilation systems. However, if induction stovetops were used instead, there would be no need to prevent the health hazards from natural gas.

Induction stove tops in a commercial kitchen on the other hand, has the advantage of being the safer work environment choice. This is because there are no open flames, in which only the cooking vessel is heated up. This reduces the chance of getting injured on the job, due to hot flames or even starting a fire. Although there are some concerns for metal rings and bracelets getting hot, most induction stove tops do have sensors and will only heat items that are a specific size. (The induction Site)

2.3 Social Recommendation

Through thorough investigation of the social aspects of kitchen stove tops, the induction stove top gets the recommendation. First, there are no correlation between electromagnetic radiation and people getting cancer or being harmful in any way. Second, it provides better working environment compared to gas stove. Third, it gives UBC a chance to set an example for other institutions to follow our lead and make this world socially responsible.

3.0 Economic Analysis

In the economic analysis of a long term project, the three main factors to consider are the capital costs, operating costs, and indirect benefits. In our specific case, a comparison between the old conventional stovetops and an upcoming technology, the induction stovetops, is drawn to help determine what would be the more economical and sustainable purchase for the new SUB's kitchen. Conventional stovetops include stovetops such as electric elements and open-flamed gas stove. By looking at all the three factors listed above, a combined cost analysis was conducted to assess both technologies' true cost over the lifetime of its utilization rather than focusing on just the purchase cost. It is important for the analysis to contain all three main factors because basing an economical decision entirely on purchase cost would be very short sighted, and unfair to the induction stovetops as they currently have a considerably higher purchase cost. A detailed analysis of the three areas can be found in the sections below.

It should be noted that due to actual data regarding the current and new SUB's energy practices in the kitchen, regarding the energy consumption and rates are unknown this analysis is an approximate recommendation. Also the pricing of stovetops may change when actual purchases are made, as stovetops will be purchased in 2014 when the new SUB’s construction completes.

3.1 Capital Costs

The capital cost is defined as the upfront costs at purchase in which, they are most visible costs when making the purchase. From looking at the capital costs the induction stovetops are commonly three to four times more than the conventional stovetops. ConsumerReports state that in 2008 induction stovetops usually cost within the range of one thousand to four thousand dollars. Whereas high-end electric may cost between five hundred to seven hundred dollars, and top of the line gas stovetops cost around six hundred to a thousand dollar.

Type of Stovetop	Price Range	
Gas	$650.00	$1,200.00
Electric	$550.00	$750.00
Induction	$1,800.00	$3,500.00

Table 1: Stovetop Price Range Chart

Source: consumer reports (2008)

Additionally to the purchase cost of the stovetops themselves, induction stovetops require the cooking vessels to be made of magnetic materials. The most common materials used for induction cooking vessels are stainless steel and cast iron. This additional requirement should not be a major drawback for the new SUB, assuming cooking vessels has yet to be purchased and the common occurrence of using stainless steel and cast iron vessels in commercial kitchens. Moreover the availability of the proper vessels is abundant in cookware for all price ranges.

As it can be seen, the capital cost of induction stovetops is considerably more than conventional stovetops. This difference in pricing is great presently, but just like all innovations, as the demand grows the pricing will decrease. This trend is evident in Europe and Asia, where the prices are lower due to great demand.

3.2 Operating Costs and Efficiency

The operating costs for day to day usage, is just as important as the capital cost, as it accounts for a recurring cost. The general pricing on gas and electricity are extremely volatile, therefore the rates should not be the only deciding factor. However, if the SUB uses the steam plant's by-product to generate electricity, then the electricity, technically speaking, is free. Thus it is more advantageous to choose an electrically powered stovetop. Nevertheless, in this section below there is a general analysis of the energy rates, and appliance efficiencies.

According to the U.S. Department of Energy, between 1999 and 2008, the national annual average price of natural gas has more than doubled. This demonstrates a skyrocketed increase of natural gas prices. If this trend continues, which are highly likely as natural gas is a non-renewable source of energy, then electricity only becomes more desirable as a fuel source. Especially, in British Columbia where there is an abundant source of renewable energy, water dams. Finally taking in the consideration that the SUB may be receiving free power through the means of its own steam power plant, the choice of using electricity rather than gas base appliances is much more economical.

Next, the focus is on the efficiency on the appliances in using the energy source, and outputting this energy to heat the item or vessel. The various efficiencies of each appliance is shown in table below provided by US Department of Energy.

Type of Stovetop	Efficiency Factor
Electric – Induction	84.00%
Electric – Radiant	71.00%
Gas	40.00%

Table 2: Stovetop Efficiency Chart

Source: US Department of Energy (1998)

As these approximated values were presented in the paper were written in the nineties, these values may have improved especially in induction as it is a thriving technology or vary from brand to brand. From these figures, induction stovetops utilize nearly twenty percent less energy than electrical radiant stovetops and nearly half the energy of gas stovetops. In addition, induction stovetops are more energy efficient as they possess pot size recognition which is not possible on gas or conventional electrical type of stoves. This feature is made possible due to design of induction stovetops and its usage of a magnetic field. The pot size recognition allows the electromagnetic currents to stimulate only the metal that touches the stove, thus only activating areas according to the size of the pot. This ensures no energy is wasted in non-active areas as compared to gas stoves or conventional electric stoves. Moreover, during idle times in commercial kitchens, appliances are not turned off but rather turned to the lowest possible setting. With the induction stovetops, nearly no energy is used during idle, as energy is only used when the stove is in contact with the vessels. Additionally, induction stovetops also heat up much faster. Thus decreasing the cook time and further reinforces the lower operating cost.

3.3 INCENTIVES AND INDIRECT BENEFITS

Finally, other than the capital costs and recurring costs, the value of not so obvious incentives and benefits are pivotal for long term projects such as the SUB's economic state. These benefits are usually indirect and untraceable statistically, but they should not be neglected.

Firstly, due to the efficiency of how induction stovetops transfer heat, induction stovetops also heat food faster as mentioned earlier. According to Consumer Reports, potentially the induction method could heat twenty five to fifty percent faster. This directly decreases the cooking time and thus the energy consumed. Indirectly, the reduced cook time allows for faster food service and potentially making more sales, especially in high paced environments like the SUB. The long wait line and wait time for food often cause people to shy away from these places. Therefore, faster food service will indirectly generate more revenue for the SUB establishments.

Secondly, the precise temperature control and instantaneous heat of induction stoves are similar to that of gas stoves. However, the induction stoves also have the capacity for very low temperature settings and heat food more evenly as the cookware is converted to the source of the heat. These will contribute to a more refined and higher quality of food service, and may indirectly contribute to the success and profitability of the establishments in the new SUB.

3.4 Economic Recommendation

It is evident that the induction stovetop technology brings numerous additional benefits and is the superior technology when compared to gas and electrical stovetops. Therefore, from an economics point of view, the induction stovetops have the clear advantage over the others. From the above discussions, common economic attributes of the induction stovetops include high capital cost, low recurring utility costs, and abundance of incentives. Whereas the gas and electrical conventional stovetops possess low capital cost, potentially higher utility costs with the gas prices increasing overtime, lower efficiency, and no additional benefits that the induction technology cannot provide.

4.0 Environmental Analysis

When considering the environmental impacts of gas stovetops and induction stovetops, the key aspect that we need to look at is the fuel source. In the case of gas stovetops, this is typically Natural gas (methane, CH4), for both domestic and commercial kitchens. Induction stovetops, as identified earlier, use electricity to create an electromagnetic field, and as such, have no primary fuel source. We will be analysis each technology separately for their environmental impacts.

4.1 Gas Stovetops

A gas stovetop operates by burning natural gas through a process known as combustion.. In the following section, we will analyze the combustion of the natural gas, and identify and outline some of the effects of the various by-products from the combustion.

The combustion of natural gas occurs according to the following chemical reaction

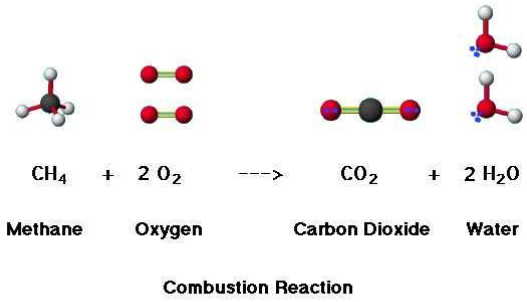

Illustration 1: Combustion Reaction

The thing to bear in mind is that this is for a complete combustion of methane, under ideal conditions. In reality, it is never possible to achieve complete combustion. Due to the incomplete nature of most combustion reactions, the following by-products are also possible: carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter such as soot, SO_x (sulphur oxides), among many others. In this report, we will examine the two big ones: CO and NO_2. These provide the most serious risk to the environment due to their health impacts.

Carbon monoxide is a colourless, tasteless and odourless gas, making it impossible to detect in a normal environment. It is also highly toxic to most life-forms in large quantities; prolonged exposure to CO, as experienced by the cooks in a commercial sized kitchen, can cause serious health issues, as well as death. These health effects are a result of the CO molecules attaching to hemoglobin, preventing the Oxygen in the bloodstream to perform its duty. Due to the chemical properties of the gas, it is also difficult to detect – the cooks will be unaware of the presence of CO until it is too late.

According to a study done by the Department of Mechanical Engineering at the National Cheng Kung University in Taiwan, the emission of CO can increase depending on certain conditions. For example, if the flow rate of natural gas increases, the emission rate of CO also increases. This is intuitive, as you can expect more reactions to occur at a higher flow rate of fuel, resulting in higher production rates of the by-products of the combustion. This can pose a problem in a commercial kitchen, where the flow rate of gas isn't always constant; even a slight increase in flow can increase the CO emissions substantially.

One way to reduce the CO emissions, as examined in the same study, is to aerate the fuel. This results in reduced CO emissions and an increase in performance of the fuel efficiency. However, the issue still remains in that there are still CO emissions; the only way to fully eliminate CO is to ensure complete combustion, which is nearly impossible to attain under realistic conditions.

Nitrogen dioxide is the other big issue with natural gas combustion. The reason NO2 is produced is because there is methane in air, and not pure oxygen. This nitrogen is usually unaffected in a complete combustion of the natural gas. However, in an incomplete combustion, the Nitrogen combines with oxygen, resulting in NO2. Unlike CO, however, it has an acrid smell that is easily detectable even at low emission rates. Due to this reason, inhalation of NO2 can easily be avoided; however, prolonged exposure to the gas can cause adverse health effects.

4.2 Induction stovetops

Induction stovetops are completely different, in that they do not use combustion as a source of heat. Instead, it uses electricity to induce an electromagnetic field, which changes the iron molecules' orientation in the cookware, resulting in heat produced. Due to this reason, induction stovetops do not have a primary source of fuel, unlike gas stovetops, which needs a gas line to feed fuel to the stovetops. All environmental impacts caused by gas stovetops are eliminated when switched to induction stovetops.

However, if we are to consider the electricity that the induction stovetops use, then things may be a little different. Depending on where the electricity comes from, induction stovetops can still have an environmental impact. Fortunately, the new SUB building uses the energy from waste water that is produced from UBC's steam power plant, among other sources. The energy extracted from this water is fairly clean. If we were to trace the source of the hot water back to the steam power plant, then we start to see the environmental impact. The steam power plant at UBC uses natural gas to generate the steam, which goes back to the problem of gas stovetops. While induction stovetops don't directly impact the environment, the source of that energy does have an impact on the environment, as it involves the combustion of natural gas, similar to that of gas stovetops.

4.3 Environmental Analysis

In conclusion, induction stovetops proved to be the better of the technologies; the environmental impacts from them are indirect. Using gas stovetops would mean having another source of natural gas combustion along with the steam power plant on campus, which would mean increased CO emissions. By using induction stovetops, at least a portion of the CO emissions is reduced, if not being fully renewable, non-polluting energy.

5.0 Conclusion

This report highly recommends that the SUB uses induction stovetops in the kitchen in the future. Induction stovetops provide a much cleaner, more efficient use of energy that not only saves money in the long run, but also speeds up cooking, thus increasing revenue. Also induction stovetops provide a much safe work environment for workers, as it does not expose harmful chemical compounds. In order for the SUB to be a statement in green design, induction should be the choice of technology.

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