An Investigation into Optimal Personal Heaters: A Triple Bottom Line Analysis

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Abstract

This report provides an in depth investigation into the most sustainable personal space heating option available for use in offices on the UBC campus. The personal nature of thermal comfort and the variability of temperature from summer to winter and even between buildings often necessitates the use of electric space heaters by many of UBC's faculty and staff. Because these heaters are often very energy intensive to operate the UBC Sustainability program desired to have an investigation into the most sustainable option as determined by a Triple Bottom Line analysis for potential use in a future trade in program. The TBL analysis conducted and summarized in this report looked at economic factors such as first cost and operating costs. The environmental factors considered were the energy consumption, and the materials used and their ability to be recycled. Finally, the social factors considered were the presence of key safety features, the presence of features making using the heater easier and more intuitive, and evidence of a corporate responsibility program. The outcome of this report is to recommend the Envi High Efficiency Panel heater as it scored the highest in all three categories and has been identified as the most sustainable option for use in any future UBC sponsored trade in program.

The investigation was conducted primarily by examining secondary sources. Of particular interest were past APSC reports which also conducted investigations into various heating options and contained useful survey results. The report focuses on analyzing three heater models (the Holmes HFH436, the Lasko 6462, and the Envi Panel Heater (HW1022T)) identified for their excellent ratings and consumer reviews. Excluded from the investigation were low wattage convection heaters, radiant panel type heaters, and radiant carpet heaters as these options were already investigated in past APSC reports.

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List of Abbreviations

APSC – Applied Science; a faculty within UBC. In this report APSC is used in the context of the class APSC 262 Technology and Society II.

CSA – Canadian Standards Association; a not-for-profit standards organization which develops safety standards for products such as space heaters.

ETL – Electrical Testing Labs; an internationally recognized (although mostly in Canada and the United States) third party testing laboratory specializing in testing electrical equipment and ensuring that certain applicable safety standards are met.

GFCI – Ground fault circuit interrupter; a specific type of safety plug or outlet that will break the circuit if it senses current is flowing through and unintended path such as through water or through a person. GFCI plugs and outlets are commonly used in bathrooms, outdoors, or in any environment where water or the possibility of other short circuits exist.

kWh – Kilowatt hour; a unit of energy consumption equal to one kilowatt consumed for one hour (equal to 3,600,000 joules).

TBL – Triple Bottom Line; an analysis method that looks at the economic, environmental, and social impacts of a project or product.

UBC – The University of British Columbia.

1.0 Introduction

The following report is an investigation into the optimal electric personal space heater for use on campus at UBC. The purpose of this report is to recommend a space heater for use in a potential future trade in program which would replace older heaters currently in use on campus with a more sustainable model as recommended by this report. Electric space heaters come in a variety of types, shapes, and sizes but all have some sort of element that converts electrical energy into thermal energy or heat and all are considered to be nearly 100% electrically efficient in that almost all of the electrical energy they consume is converted into heat. This makes a direct comparison of electric space heaters a challenging task. To assess the available heaters and recommend an optimal model a Triple Bottom Line analysis looking at economic, environmental, and social factors will be used. The economic investigation will look at factors such as purchase price and operating costs. The environmental investigation will look at factors such energy consumption, and materials used and their ability to be recycled. The social investigation will look at factors such as user reviews and independent testing, safety and usability features, location of manufacture and labor conditions, and corporate responsibility programs. At the end of the report the results of the investigations will be summarized and synthesized into an overall recommendation of a particular model of heater.

2.0 Background

In Canada, heating of spaces can account for as much as 60% of total energy consumption. Space heaters are no exception to the rule and are often very energy intensive appliances to operate. One 1500 watt heater operating on high consumes as much energy as about 25 standard light bulbs. When used strategically, space heaters can offer energy savings by only heating the spaces being occupied. However, if used inappropriately space heaters can often confuse or work against central heating systems and exacerbate the problem or cause unnecessary and excessive energy consumption. This report will assume that space heaters are being used strategically, appropriately, and in concert with central heating systems and will focus instead on recommending the most sustainable heater as determined by the TBL analysis.

Thermal comfort is a highly personal experience. An environment that might be 'just right' for some will inevitably be 'too hot' or 'too cold' for others. In fact, studies have even shown that psychological factors such as a thermometer reading higher than the true room temperature can have dramatic effects on an individuals reported level of thermal comfort. Furthermore, UBC is an aging campus and many of the buildings and office spaces were constructed several decades ago using less efficient construction and insulation materials and methods. Add to all of this the fact that UBC has a diverse faculty coming from a variety of climates, cultures, and countries and it becomes safe to say that they variety of thermal preferences on campus are as diverse as the faculty or the student body and thus a need for electric space heaters arises.

Indeed the use of space heaters in offices on UBC campus to achieve thermal comfort is prevalent. The faculty project coordinator, Kara McDougall, was able to provide a campus heater inventory by building which resulted from previous APSC projects looking at various heating options. According to the inventory there are approximately 841 personal space heaters in operation in offices on campus with the three worst buildings being the General Services Administration Building, Buchanan Tower, and the Henry Angus Building and its addition which together account for more than 60% of heaters in use on campus. The primary purpose of this report is to recommend an available and sustainable space heater option to be used in a potential future trade program which would enable UBC staff to exchange their old space heaters for the recommended new sustainable option at no personal cost

After extensive consumer research looking at outside testing by sites such as ConsumerReports.org as well as other consumer reviews, three potential heaters were selected for further review. The three heaters selected for this report are the Holmes HFH436, the Lasko 6462, and the Envi Panel Heater (HW1022T) shown respectively in Figure 1, Figure 2, and Figure 3 below. The Homes and Lasko heaters classify as portable while the Envi Panel Heater is hardwired and wall mounted.

Figure 1: Holmes HFH436

Figure 2: Lasko 6462

Figure 3: Envi Panel Heater (HW1022T)

In order to facilitate the investigation and report a variety of assumptions and exclusions had to be made. As advised by the projects faculty coordinator, Kara McDougall, this report assumes the price of electricity as a constant $0.06 per kWh and an average heater use of 5 hours per day and 5 days per week for 24 weeks during the winter months. Low wattage convection heaters, radiant panel heaters, and radiant carpet heaters were excluded from this investigation as they have already been considered by past APSC projects and those findings are cited in this report when relevant.

3.0 Economic Analysis

For general users, choosing personal heaters can be a daunting task. Not only does one have to consider the thousands of heaters available on the market, but the users have to consider not just short term costs to their wallet, but also long term costs such as maintenance and energy bills. Factors in other areas of consideration such as warranty, life span and efficiency and the user starts getting a headache. Where does one begin to evaluate which heater is the best from an economic perspective?

In our investigation, we are fortunate enough to be able to simplify the parameters for evaluating heaters economically due to using the TBL. Many of the potential parameters mentioned in the above paragraph had more to do with other factors, such as social or environmental considerations, than economic ones. As a result. We are able to come up with a list of parameters to be used to compare heaters.

Specifically, we look at:

1. "First Look" Price: How much the heater costs at first glance
2. Additional Costs: Costs per period, i.e: Energy bill, Space capacity costs
3. Fuel Type: Which type of fuel does heater use? Is the fuel used inexpensive in the current market?

By simplifying the parameters required to evaluate heaters to the above 3, we can make a recommendation based on economic analysis of the three types of heaters addressed in this report:

Table 1: Results of the Economic Investigation

			
"First Look" Price	$40	$75	$140
Additional Costs	$ 0.6 per day at 1500 W	$ 0.6 per day at 1500 W	$ 0.14 per day at 475 W
Break Even Time for HFH436 and HW1022T	N/A	N/A	217 days
Conclusion	Buy if using for less than 217 days	Worst	Buy if using for more than 217 days

Table 1 on the previous page paints a clear picture of the comparisons between the 3 heaters. The cheaper heater, the Holmes HFH436, is not always the best choice. Given the long term cost of electricity as defined in the "Background" section of this report, we can conclude that the more environmentally friendly Envi Panel Heater eventually wins out in cost compared to the cheapest "first glance" heater. The graph also

shows that unless you are buying a short term heater that you plan to throw away after using less than a year, you should purchase the Envi Panel Heater.

Of course, many assumption were made when comparing those heaters. The first assumption is that the Envi Panel Heater, even with less wattage, has the same heating performance as the other 2 heaters. The other assumption is the life span of the 3 heaters are the same. If those constant parameters that were made assumptions were to change, the outcome of the comparisons may be different. Otherwise, we can conclude that from an economic analysis standpoint, the Envi Panel Heater is clearly better when planned for long term usage, whereas the Holmes HFH436 is better for short term usage.

4.0 Environmental Analysis

When users are satisfied with economic and financial issues, then environmental ethics must be taken into consideration. Environmental problems are usually associated with many ethics problem. In general, when users choose a heater or any other modern machines, they tend to consider the price and functionality of the heater only. However, this can have severe environmental consequences because there will be more energy consumption for heaters with a lot of functionality (larger in size as well) than that of the ones with less functionality. As the heaters consume more energy, there will be more chemical and waste generation that will yield negative environmental result. Likewise, according to many research, or from our common sense, machines that are lower priced tend to emit more harmful materials than that of higher priced ones.

In order to minimize or avoid negative environmental issues, this document will consider several factors when performing environmental analysis. These factors are also used in engineering economics courses in the University of British Columbia and are closely related to environmental issues. When considering potential environmental issues for each heaters, there are three factors to consider:

1. Useful lives or durability
2. Method of heating
3. Material of the heater and whether each material is decomposable or not.

According to the chart below, Holmes, Lasko and Envi have useful lives of 5-10, more than 10 and 20 years respectively. This means that after useful lives, the heaters are likely to malfunction, break or needs replacement. Therefore, the less useful lives the heater has, the more waste and negative environmental issues it will create. Another factor is method of heating. Because three heaters are modern devices, they all run electrically. Lastly, we consider material of the heaters and their decomposability. All three heaters are composed of plastic and steel and each material by default are decomposable (in land or chemically).

To decide which heater to use, one can approach this problem in two ways: take environmental issues only or consider price as well. We cannot completely ignore price as it will be impractical because majority of users will take price into consideration. This section will analyze both solutions for the users to choose.

If only environmental issues are to be considered, then only one factors are significant: waste. In general, negative environmental issues are commonly related to wastes. More wastes will be generated when heaters are no longer working and therefore if that heater must be buried or chemically decomposed into parts. As shown in the chart, Envi has the longest lifespan.

If one decides to take price into consideration along with the environmental factors, then ratio of useful lives and price must be used. This represents how long a heat will last depending on the price. For example, if there is a heater that will last 1 years but costs $1 and if there are an alternative heater that

will last 10 year but costs $2, of course the latter will be chosen. Now, considering the third row of the chart, it is clear that Holmes has highest factor while Envi has lowest factor.

However, because this section only analyses environmental issues, our best solution is Envi.

Table 2: Results of Environmental Analysis

	Holmes	**Lasko**	**Envi**
Useful lives (durability)	5-10 years	more than 10 years (approximately 15)	20 years
Method of heating	electrical	electrical	electrical
Material & Decomposability	Plastic & steel yes	Plastic & steel yes	Plastic & steel yes
Useful lives / Price ratio (time/cost)	10y/$40 = 0.25	15y/$75 = 0.20	20y/$140 = 0.14

5.0 Social Analysis

In any TBL analysis the identification of important and relevant social factors is a difficult task. To complicate this matter further social indicators are often subjective and difficult to quantify or measure. How does one measure safety, ease of use, or visual appeal? How does one measure the social effects of a product? These indicators are far more abstract and difficult to grasp then concepts such as cost or greenhouse gas emissions and as such some judgement has to be exercised when deciding what is important and what is not. Fortunately, surveys distributed by past APSC groups as well as guidance from our faculty project coordinator, Kara McDougall, led to the conclusion that the safety of the heater was of utmost importance. Of lesser importance is ease of use and corporate responsibility. As such, the investigation looked for the presence of safety features, usability features, and an indication of corporate responsibility. A score of 3 was assigned if a heater had a particular feature and a score of 0 was assigned if it did not. To reflect the importance of safety, a weighting factor of 0.4 was applied to the safety score of a heater while a weighting factor of 0.3 was applied to ease of use features and corporate responsibility. The heater to be recommended is the heater with the highest overall weighted score.

To evaluate the heaters in terms of safety, specific features were looked for such as automatic tip-over shutoff, independent testing, a GFCI plug, and automatic overheat shutoff. A score of 3 was given if the feature was present and 0 if not. The results of this analysis are presented in Table 3 below. It can be seen that the Holmes heater and the Envi Panel heater tie in this category. However, the Holmes heater lacks automatic tip-over shutoff, a critical safety feature and thus it could be said that the edge goes the Envi panel heater in the event of an overall tie.

Table 3: Results of Safety Investigation

	Holmes		**Lasko**		**Envi**	
	Yes/No	Score	Yes/No	Score	Yes/No	Score
Automatic tip-over shutoff	No	0	No	0	N/A (wall mounted)	3
Independent testing/safety standards	ETL listed	3	ETL listed	3	CSA listed	3
GFCI Plug	Yes	3	No	0	No	0
Automatic overheat shutoff	Yes	3	Yes	3	Yes	3
Total Score	9		6		9	
Weighted Score	3.6		2.4		3.6	

To evaluate the heaters in terms of ease of use, specific features were looked for such as a programmable thermostat and timer. Once again a score of 3 was given if the feature was present and 0 if not and the total score was weighted by a factor of 03. The results of this analysis are presented in Table 4 below. It can be seen that all three heaters scored perfectly in this category.

Table 4: Results of Ease of Use Investigation

	Holmes		Lasko		Envi	
	Yes/No	Score	Yes/No	Score	Yes/No	Score
Programmable Thermostat	Yes	3	Yes	3	Yes	3
Timer	Yes	3	Yes	3	Yes	3
Total Score	6		6		6	
Weighted Score	1.8		1.8		1.8	

To evaluate the corporate responsibility of each heater, the webpage of each parent corporation was investigated for evidence of corporate responsibility programs. A score of 3 was given if a corporate responsibility program existed and a score of 0 was given if not. It should be noted that although Envi did not explicitly have a corporate responsibility program, it was given credit anyway as its heaters are made in America providing American jobs and subject to American labor laws while the country of origin of the other two heaters was unable to be determined. In addition to a corporate responsibility program, each heaters warranty was also looked at as a sign of willingness of the manufacturer to stand behind their product and one point was given for each year of warranty. Once again the total score of the heaters in this category was weighted by a factor of 0.3. The results of this analysis are presented in Table 5 below. It can be seen that the Lasko and Envi heaters tied in this category.

Table 5: Results of Corporate Responsibility Investigation

	Holmes		Lasko		Envi	
	Yes/No	Score	Yes/No	Score	Yes/No	Score
Corporate Responsibility Program	Yes	3	Yes	3	No, but made in America	3
Warranty (in years)	1 year	1	3 years	3	3 years	3
Total Score	4		6		6	
Weighted Score	1.2		1.8		1.8	

The results of the overall social investigation, after weighting, are presented in Table 6. As can be seen the results are very close however the Envi panel heater takes a slight edge for top position with the Lasko and Holmes heaters coming second and third respectively. Based on this investigation into social aspects, the Envi panel heater is recommended as the most socially sustainable heater.

Table 6: Results of Overall Social Investigation

	Holmes	Lasko	Envi
Total Weighted Score	6.6	6	7.2
Rank	2nd	3rd	1st

6.0 Conclusion and Recommendations

Based on the analysis contained in the body of the report, it can be concluded that the Envi Panel Heater (HW1022T) is the most sustainable heater option in terms of the economic, environmental, and social factors considered by the TBL analysis. While the Envi panel heater has the most expensive purchase price, its energy savings more than offset its first cost making it the most economical choice. The durability of the Envi heater and its minimal environmental impact make it the most environmentally sustainable option. Finally, its wealth of safety features and ease of use features as well as the fact that it is made in America and has an exceptional warranty make it the most socially sustainable option. With all of these factors considered it is recommended that UBC use the Envi Panel heater in any future trade in program.

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