UBC Social Ecological Economic Development Studies (SEEDS) Student Report

An Investigation Into Sustainable Water Consumption - Water Bottles versus WaterFillz Units

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Abstract

Drinking water is one of the issues that has not been thoroughly investigated in green building design projects. As part of the new Student Union Building project, the Alma Mater Society in University of British Columbia is trying to include many of the newest and greenest technologies. One of the areas that needs investigation is the drinking water solutions that can serve as an alternative to the current use of bottled water. To reduce the carbon footprint of students in the new SUB, one of the focuses of the project is to eventually eliminate the wide use of plastic water bottles as a source of student drinking water. This paper looks mainly into possible improvements the selected WaterFillz machines will have over the current bottled water infrastructure, as well as look at a few other alternatives for water purification. It does this by looking at a triple bottom line assessment of the different options, which includes positives and negatives in environmental, economic, and social aspects. This report concludes that the WaterFillz machines are a much more sustainable option than water bottles for addressing students' drinking water needs in the new SUB.

1.0 Introduction

The University of British Columbia is in the process of designing and building a new Student Union building. One of the major goals of this program is that the new building should be able to get a LEEDs Platnium certificate. The LEEDs certificate is designed and awarded by the US Green Building Council. This certificate is an internationally recognized green building certification system. This certificate is awarded to buildings and communities that are built using sustainable methods with an aim to minimize CO2 emission and carbon footprints of any related projects[1]. Major focus areas of using sustainable methods are energy and water efficiencies. As a part of our project our group was asked to help the new SUB to reduce its carbon foot print by possibly looking at more sustainable solutions to address the problem of drinkable water. One major alternative that we looked at is the WaterFillz units provided by Safestar, a local Vancouver based company which is specialized in producing sustainable drinking water solutions.

The main goal of this paper is to show whether the new WaterFillz machines are more sustainable than the refrigerated bottled water they are meant to replace. To answer this question, a triple bottom line analysis was conducted on both the WaterFillz machines and bottled water. In addition to this, a number of alternatives were discussed for potential use in the new SUB, and their pros and cons were weighed. In our conclusion, we will evaluate the merits of the WaterFillz machines' use in the new SUB and make a conclusion of whether they should be used, whether an alternative should be used, or whether the current system of water bottle distribution should be kept.

2.0 Alternative 0: Plastic Bottles

Consumption of bottled water has come under a lot of scrutiny in recent years because of a number of economic, social, and environmental concerns they raise. Though they do provide economic benefits in terms of creating an industry that employs many people, and do hold some social benefits, their negative environmental impacts have begun to vastly outweigh their benefits. This triple bottom line analysis is aimed at providing a look at the sustainability of

[1]U.S. Green Building Council. (2010) "USGBC: Intro - What LEED Is" [Online] Available At: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1988, [November 2010]

water bottles in a broad sense. Through this we will try to draw conclusions on their feasibility as a sustainable drinking water option in the new SUB.

2.1 Economic

Doing an economic analysis on water bottles consumption is not an easy task. Deciding what factors need to be included in the economic analysis of this alternative is the main challenge. There are many factors like transportation and labor cost that is shared with other products and this causes extreme difficulty in calculating a final number to quantify the cost of water bottles. To seek help we contacted the UBC Alma Maters Society (AMS) officials and asked about the economic figures associated with the consumption of water bottles. We were informed that the AMS sells around 30,000-35,000 water bottles annually. Pricing each bottle on average at about $2/bottle we calculated that the sale of bottled water generates an annual revenue of $60,000 to $70,000. Various water bottles are purchased at different prices for resale in the stores at the SUB, but based on research on the web it was concluded that bottled water is purchased by the AMS at 50c/liter and resold at $2/liter. Most of this profit margin is allocated to the operational costs that are associated with retailing water such as labor cost. It is important to note that most of this revenue is generated by selling water to students. The Alma Mater Society will forfeit this source of income by switching to a different alternative that will not charge students for water consumption, such as a tap water solution.

2.2 Environmental

Environmental issues are a major concern for the consumption of bottled water. Bottled water production, consumption, and disposal has produced many environmental problems. First of all, water bottles produce approximately 1.5 million tons of plastic waste per year[2]. This is a significant amount of waste, an amount that recycling systems cannot and do not keep up with. 80 percent of water bottles in the United States simply end up in land fills. 2.7 million tons of plastic is used to manufacture water bottles every year. In order to manufacture all these bottles, 47 million gallons of oil is required per year[3], which produces approximately 2.5 million tons of

[2]Chris Baskind. (March 15, 2010) “5 Reasons not to Drink Bottled Water,” [Online] Available At: http://www.mnn.com/food/healthy-eating-recipes/stories/5-reasons-not-to-drink-bottled-water
[3]Emily Arnold. (March 8, 2006) “Bottled Water: Pouring Resources Down the Drain” [Online] Available At: http://www.theglobalist.com/storyid.aspx?StoryId=5110

carbon dioxide that is released into the atmosphere[4]. Also, in order to produce the plastic for a bottle of water, it takes at least twice amount of water as it will hold, meaning that in production facilities there has been a significant reduction of local groundwater available[5]. This leaves additional problems with access to clean drinking water, which is a necessity of human survival.

Putting this into the perspective of the Student Union Building, we were informed that around 35,000 bottles of water were sold per year. The most popular plastic for making water bottles is Polyethylene Terephthalate (PET). A life cycle analysis of a 12 ounce water bottle was looked at to provide some insight into the cost of the current bottled water usage in the SUB. According to the analysis, 35,000 PET 12-ounces water bottles will consume 58 GJ of energy, produce 570 kg of solid waste, and produce 2650 kg of carbon dioxide in their lifetime[6]. This is the amount of energy consumption, waste, and greenhouse gas emissions that could be avoided by using an alternative drinking water source in the new SUB.

2.3 Social

The use of water bottles has a large impact on people's lives. Included in these people are both those that are in direct contact with them in their lifecycle and those that are indirectly affected by their manufacturing, distribution, consumption, and waste. There are significant populations affected in each of these areas because of the scale at which the water bottle industry operates. One must think of the entire life cycle of the product, not just consumption, and look at the jobs the industry creates not just in production but in handling the waste. These impacts include both positive and negative impacts, and both will be discussed in this section.

There are a number of positive social aspects with regards to consumption of water bottles, which is one of the reasons they are used today: they are convenient and portable, provide an alternative to other sources of water that may be undesirable, and can be very beneficial when they are readily available to help in disaster situations.

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[4]Darmok. (August 27, 2007) "Tap Water vs. Bottled Water and the Environment" [Online] Available At: http://imparo.wordpress.com/2007/08/27/tap-water-vs-bottled-water-and-the-environment/

[5]Darmok. (August 27, 2007) "Tap Water vs. Bottled Water and the Environment" [Online] Available At: http://imparo.wordpress.com/2007/08/27/tap-water-vs-bottled-water-and-the-environment/

[6]Franklin Associates " FINAL REPORT, LCI SUMMARY FOR PLA AND PET 12-OUNCE WATER BOTTLES" Franklin Associates, A Division of Eastern Research Group, INC., Prairie Village, Kansas, December 2007

One of the main aspects that make bottled water so appealing to many customers is how convenient it is to acquire and dispose of. If one is thirsty, they can walk into nearly any store and buy a bottle of water, keep it for as long as they desire, and throw it away afterwards. There is no need to carry around any empty containers or wash them when they are finished, as would be the case with most reusable containers, including the ones proposed in the SUB. Because they are so portable, they can be used when there is no other source of water available as well, such as water fountains or publicly available taps.

Another main benefit to water bottles is that they can provide an alternative when there are actually health concerns with the public water in the area. This could include times when there are problems with the content of the water distribution system in an area due to local industry or natural conditions (occurrences of boil water orders occur when the water source has been contaminated due to abnormally wet or dry weather, which the entire city of Vancouver experienced in 2006). This could also include places where there is no access to treated public water, and there are health risks associated with local water sources. In all of these situations, potential health risks can be mitigated by the use of bottled water.

Bottled water has also been seen to be widely adopted when there are aesthetic concerns with the water, such as with taste, odor, or colour. Although there were no health concerns with the water supply, a study was conducted on residents of Quebec and between 30-45% of people drank bottled and tap water, and between 4-6% of people drank bottled water only. While people cited health concerns being a reason for drinking bottled water (20-30%) almost all of the remaining people's main reason for drinking the bottled water was the odor, colour, or most of all the taste[7]. This in an interesting observation as water testing at UBC has revealed that a number of water sources tested are above the "aesthetic guidelines for drinking water" in the areas of copper and aluminum content[8]. Judging from the results of this research, this could potentially be part of the reason for the diminished confidence in the tap water at UBC.

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[7]P. Levallois, J. Grondin, S. Gingras, " Evaluation of consumer attitudes on taste and tap water alternatives in Quebec," Water Science and Technology, v 40, n 6, Elsevier Ltd, 1999, pp. 135-139.

[8]Department of Health, Safety, and Environment "Building Results - June 2010 | Health, Safety and Environment | Department of Health, Safety and Environment" [Online] Available At: http://www.hse.ubc.ca/health/community-health/water-quality

One must also not forget to include the jobs that this industry creates, such as the procurement of raw materials needed, energy required during manufacturing, transportation and distribution of the water, the retailers, and the disposal and recycling of the bottles after use. Plastic beverage container production accounts for a large portion of the PET production in the world, and thus is a large cause for employment in that industry.

A final positive social impact of bottled water is that it is able to provide – and has provided – relief during disaster situations because it is so readily available and can be quickly produced, shipped, and distributed.

Despite these positive impacts, however, there are many negative impacts of plastic water bottles. These negative impacts include diminished confidence in public tap water, creating a barrier to clean water, and health concerns caused by bottled water.

Diminished confidence in public water systems is more prevalent as water bottle consumption gets increasingly adopted. Advertising campaigns aimed at increasing sales of water bottles tend to – whether it be implicitly or explicitly – attack the quality of the public water system, when in reality there is nothing wrong with the system. Diminished support for the public water system can lead to budget cuts and/or privatization of these water utilities, and ultimately systems such as water metering for household consumption. This leads into the next point of creating financial barriers to clean water[9].

The selling of water at a premium in order to make a profit brings up an ethical question: should we be creating a barrier to entry for something as basic and needed for human survival as drinking water? Public water systems provide a source of water that is affordable and accessible to lower income people and families that would not be able to provide themselves with water should it cost anything similar to the price of bottled water today. Many parts of the world still do not have regular access to clean water, and is the focus of many aid initiatives. To do away with affordable clean water would be going against these initiatives, and going against the notion of providing or enabling people access to basic means of survival[10].

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[9]Canadian Federation of Students, Sierra Youth Coalition, Polaris Institute. “Bottled Water Free Day – Social Impacts of Bottled Water” [Online] Available At: http://www.bottledwaterfreeday.ca/index2.php?section_id=21

[10]Canadian Federation of Students, Sierra Youth Coalition, Polaris Institute. “Bottled Water Free Day – Social Impacts of Bottled Water” [Online] Available At: http://www.bottledwaterfreeday.ca/index2.php?section_id=21

A last negative social aspect of bottled water is the sanitation in comparison to tap water. In a study of bacterial growth in tap and bottled water, there were a number of tests performed with bottled water and tap water that included growth tests on freshly opened water as well as water that had one sip taken of it. In these tests, bottled water can develop over 10 times as much bacteria as tap water under the same conditions in 48 hours when just opened and an even higher percentage when a sip has been taken. It was also noted that opened bottled water that has been refrigerated will develop more bacteria than tap water that has been left at room temperature for the same amount of time. It should also be noted that the study found bottled water to have a greater concentration of bacteria to start with than the tap water taken out of the faucet[11].

3.0 Alternative 1: WaterFillz

The WaterFillz kiosks are our main alternative to replace bottled water at the new SUB building. These kiosks use city water and a standard 110 volts wall plug to operate. Using the pipeline water pressure, WaterFillz provides cool, fresh and clean filtered water while preserving the water's useful natural minerals and salts. The filtering and purification system implemented in each kiosk uses chemical-free physical barriers and advanced Ultra Violet light. The water treatment process consists of four steps and involves four units. In the first step, water travels through a Sediment filter which removes any contaminants in the water dislodged from the city pipeline. Then in the second step, water travels through an activated charcoal filter. This unit mainly eliminates chlorine and also mercury, copper, manganese and lead which may exist in the water. Step three involves the refrigeration unit which cools the water to 5 degrees Celsius using a cold water bath[12]. The last step uses an advanced Ultraviolet light system. This computer-controlled unit adds the final touch to the water and removes any micro-organisms that may still exist in the water. These back-to-back units remove unwanted substances form the water, and block out any viruses, bacteria and cysts. However, they are specially designed to leave the useful dissolved minerals and salts in the water. Therefore, besides providing safe and clean water, WaterFillz provides us with super tasting odorless water.

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[11]Sean D. Raj, " Bottled Water: How safe is it?," Water Environment Research, v 77, n 7, Water Environment Federation, November/December 2005, pp. 3013-3018.

[12]SafeStar Products. "The WaterFillz Kiosk Promotes Real Sustainability" [Online] Available At: http://www.waterfillz.com/ecological-benefits-of-the-kiosk.php

3.1 Economic

To gather economic data based on the usage of Waterfillz units we contacted Paul Wilson from SafeStar. SafeStar is the producer and owner of the brand Waterfillz. The Waterfillz units cost at about $7,500 retail. Even though the units are virtually maintenance free the filters have to be changed around once a year and minor maintenance and checks have to be performed at a yearly interval. The cost of this minor maintenance adds up to about $300/year.

The power consumption of the Waterfillz unit is pretty low compare to other competitors. While a normal soft drink refrigeration unit use about 2000W of power the Waterfillz units use only 46W. This includes the refrigeration system and the UV filter inside the Waterfillz machine[13].

Based on the data from the National Energy Board of Canada the price of electricity is about 10c/kW.h. Assuming that the Waterfillz unit is running 24x7 for the entire year we realize that we will use about 403kW.h of electrical energy. This means that Waterfillz machine will have around $40/year electricity cost[14]. But it is important to note that we expect to actual electricity usage be much less that this amount since the energy usage of this machine is expected to be lower during summer break and weekends.

3.2 Environmental

The designers and stakeholders of the new SUB building are aiming to achieve LEED Platinum status and design one of the most sustainable buildings in the world. To do so, they need to come up with a solution to minimize the amount of waste that the new SUB building produces or try to recycle it as sustainably as they can. As was mentioned above, water bottles are a major source of plastic waste produced every day in North America. Also, considerable amounts of energy and fossil fuels are being used by companies to manufacture and transport these bottles. Unfortunately, more than 80 percent of these plastic water bottles simply end up in landfill sites[15].

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[13]SafeStar Products. “The WaterFillz Kiosk Promotes Real Sustainability” [Online] Available At: http://www.waterfillz.com/ecological-benefits-of-the-kiosk.php

[14]National Energy Board. (October 28, 2010) “Electricity – How Canadian Markets Work” [Online] Available At: http://www.neb.gc.ca/clf-nsi/rnrgynfmtn/prcng/lctrct/cndnmrkt-eng.html

[15]Food and Water Watch. “Bottled Water” [Online] Available At: http://www.foodandwaterwatch.org/water/bottled/

Plastic water bottles make up a significant amount of waste produced every day on UBC campus including the SUB current building. Based on the numbers and figures stated above, recycling alone cannot reduce the impact of these plastic bottles on our environment. Moreover, recycling alone would not suffice to achieve LEED Platinum + certificate for the new SUB building. A more rational and practical solution to address this issue and achieve LEED Platinum status must result in a minimized production of plastic waste.

Our main alternative, the WaterFillz machines, can offer a solution to significantly reduce the amount of waste produced by plastic water bottles at the new SUB building. The WaterFillz kiosks provide students with fresh pure water which is free of charge. More importantly, these kiosks do not add another empty plastic bottle to the landfill sites for 0.5L of water. UBC AMS has already installed two kiosks in the SUB current building and within two weeks a total of 7600 bottles were saved from waste[16]. Furthermore, each kiosk only consumes 48 watts of electrical power to purify and cool the water[17]. The energy consumption of each unit is considerably less than the average energy consumption of regular vending machines which is in the range of 1500 to 3500 watts.

To make a more in depth triple bottom line analysis, we contacted SafeStar to gather information regarding the materials and manufacturing processes used to produce the Waterfilz units. Unfortunatley we were not able to get a response or credible data for this analysis. A further study is required to gather information regarding these details. From the data on hand, however, we can conclude that the WaterFillz kiosks are a notably more sustainable and environmentally friendly option than regular bottled water.

3.3 Social

The social aspect of each project which aims to be sustainable is another important aspect of its triple bottom line assessment. The reason for this importance is that a project can be environmentally and economically sustainable, but if it fails to gain the general public trust or attract people, it simply will be unable to make a positive impact. This fact is also applicable to the choice between the WaterFillz machines and bottled water. An oral survey was conducted

[16]SafeStar Products. “The WaterFillz Kiosk Promotes Real Sustainability” [Online] Available At: http://www.waterfillz.com/ecological-benefits-of-the-kiosk.php

[17]SafeStar Products. “The WaterFillz Kiosk Promotes Real Sustainability” [Online] Available At: http://www.waterfillz.com/ecological-benefits-of-the-kiosk.php

and participants, who were mainly UBC students, were asked to state their preferences for either tap or bottled water and the reasons for that. Based on the information gathered, the main two reasons for choosing bottled water over tap water were the taste and accessibility of bottled water on UBC campus. Even the participants who did not have any taste preference, claimed that they drink bottled water more often that tap water since bottled water is more accessible around the campus. However, most of the participants agreed on the points that bottled water produces a significant amount of waste and costs them money. Afterward, each participant was introduced to the WaterFillz machine and asked whether they were willing to use it. Almost in all cases, participants agreed that if the water provided by the WaterFillz is good tasting and the kiosks are accessible in the SUB new building, they were willing to use the kiosks. Based on this short survey, we can conclude that if UBC students are informed about the WaterFillz units and how they can reduce the amount of plastic waste while having access to clean, safe, super-tasting free water, there is almost no doubt that the WaterFillz is the more sustainable choice. The first step towards informing students about the WaterFillz machines is to advertise. There are two units already installed and being used in the current SUB building which can greatly raise the students' awareness of the WaterFillz machines[18].

4.0 Other Alternatives

Water bottles and WaterFillz are the two alternatives that we are analyzed, but are not the only options for drinking water purification in the SUB. There are three other alternatives that were considered: activated carbon filters, the PENTEK fitration system being used at the UBC Okanagan campus, and solar water purifiers.

The first alternative considered was the activated charcoal filter. Activated charcoal filters remove much of the undesirable elements from the water, including volatile organic compounds and chlorine. The have been successfully installed into all of the drinking water fountains at UBC Okanagan with positive feedback[19]. Activated charcoal filters do not remove aluminum from the water, however, which is an element that was found to be above the desired

[18]Eric Teillet, Christine Urbano and Sylvie Cordelle, "Consumer Perception and Preference of Bottled and Tap Water," Journal of Sensory Studies, Volume 25, Issue 3, 2010.
[19]Jody Jacob. (October 23, 2008) "New device puts better water on tap at UBC Okanagan" [Online] Available At:
http://web.ubc.ca/okanagan/publicaffairs/mediareleases/2008/mr-08-065.html

"aesthetic" levels in a number of UBC buildings' drinking water[20]. This would make it less of a desirable choice, as it would not be able to completely solve drinking water issues at water fountains on campus.

A more complicated water filtration system was also installed at UBC Okanagan. It gave yet another alternative to buying bottled water for students. It is located in the main entrance of the Sciences building in UBC Okanagan. It uses filtration through a PENTEK FreshPoint Ultrafiltration System designed to improve water quality while preserving naturally occurring minerals. The system is extremely energy-efficient, requiring only minimal power to operate as it provides quality water free-of-charge to students, staff and faculty[21]. One downside to this system is its cost, which sits at roughly ten thousand dollars.

Another alternative is the use of solar powered water purifiers. Large scale solar water purifiers can offer an option for distilled or otherwise disinfected water while requiring no external energy source. They have been implemented both in very small and large scale, and could be an option for drinking water disinfection and substance removal in the new SUB[22]. A good example of a self contained, self powered solar water purifier is one from Naiade. Its cleans and disinfects enough water for 400 people using solar power, and can be used in remote locations. The machine kills all pathogens and makes drinking water safe without the use of chemicals[23].

5.0 Conclusion

Comparing the two main alternatives, bottled water and Waterfillz, they each have advantages and disadvantages with regards to the triple bottom line. For the new Student Union building, we need to not only pick the best one in terms of sustainability and LEED Platinum

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[20]Department of Health, Safety, and Environment "Building Results - June 2010 | Health, Safety and Environment | Department of Health, Safety and Environment" [Online] Available At: http://www.hse.ubc.ca/health/community-health/water-quality

[21]Jody Jacob. (October 23, 2008) "New device puts better water on tap at UBC Okanagan" [Online] Available At: http://web.ubc.ca/okanagan/publicaffairs/mediareleases/2008/mr-08-065.html

[22]Jaceline Pierrera. "Advantages of Solar Powered Water Filter Technologies" [Online] Available At: http://ezinearticles.com/?Advantages-of-Solar-Powered-Water-Filter-Technologies&id=4240303

[23]Naiade. "Water purifiers on solar energy" [Online] Available At: http://www.safe-drinkingwater.com/

certification, but also social and economic aspects. The triple bottom lines of these two alternatives are subsequently compared. The main problem with bottled water is that it produces too much waste. Although some of the plastic waste is recycled, most of the materials are still being thrown away. Using WaterFillz can help mitigate this problem by encouraging people to bring their own bottles and preventing single serving beverage containers from going in the landfill, though if will be difficult to persuade people to bring their own bottles instead of buying bottled water. When looking at upkeep costs, the new SUB can also gain an advantage by using the WaterFillz machines, as the refrigeration costs of the machines are much less than that of a vending machine that would dispense bottled water. This will hopefully offset some of the forfeited revenue from water bottle sales that introducing the WaterFillz machines would cause. While not directly affecting the sustainability of the new SUB, implementing the WaterFillz machines would also decrease the pollution caused by transportation of water bottles, as deliveries would consume a great deal of gas. Looking at all these advantages, while still considering the disadvantages such as greater up front cost and WaterFillz manufacturing materials, it is evident that investing in Waterfillz machines for the new Student Union building would be beneficial from a triple bottom line standpoint. Bottled water may still be available in the new SUB, but adding WaterFillz machines would add a competitive alternative to bottled water that would hopefully, in the long term, replace it completely.

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