UBC Social, Ecological Economic Development Studies (SEEDS) Student Reports

AN INVESTIGATION INTO THE SUB RENEWAL PROJECT:

SECTION RENEWABLE ENERGY SOURCE

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ABSTRACT

As the student population increase on the UBC campus, it is become crucial to improve the campus facilities. The Student Union Building is one of the most used buildings on campus; due to the out dated equipment in the SUB a SUB renewal is necessary. In 2008, the AMS have gotten approval for the development of the new SUB. To make the new SUB energy efficient, renewable energy source are to be used, i.e. solar power, bio-fuel and geothermal.

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INTRODUCTION

The world is becoming increasingly concern about energy consumption and green house emission. UBC, as one of the world leading University, is working hard to create a greener and more sustainable campus. The increasing population of students is making older building harder to keep up with today's energy consumption standards. The Student Union Building (SUB) is one of the most used buildings on campus and is dated all the way back to 1968. To accommodate the growing volume of students and improve the energy consumption, AMS proposed to build a new SUB between the current SUB and the aquatic centre. Because the cost of modified the current SUB and the size limitation, the idea of upgrading the current SUB is not considered. In 2008, UBC approved the development and construction of the new SUB.

As dedicated UBC engineering students, we have been assigned by our APSC 262 professor to conduct a triple bottom line analysis (economic, environmental and social) on possible renewable energy sources for the new SUB. Seeing that the future SUB will not only be a place for student to study and eat but a model for University campuses worldwide, our group decided to conduct studies on three types of renewable energy, wind, bio-fuel and geothermal, in hoping that we can use a combination of the energy sources to maximize the efficiency of the new SUB.

One of the goals of the new SUB is to achieve the LEED Platinum rating, the highest green building rating in North American. To achieve this rating, the new SUB must score over 80 point in the following five categories: sustainable site development, water efficiency, energy efficiency, material selection and indoor environmental quality. With an overall 37 possible points in the energy efficiency section, finding the right renewable energy source for the new SUB is crucial.

Table 1. New SUB Energy Consumption Estimation

Total Energy Used for Educational Services (GJ/yr)	35535.41
Energy Used by (%)	
Space Heating	52
Water Heating	8
Auxiliary Equipment	16
Auxiliary Motors	10

Lighting	12
Space Cooling	2
Floor Size (m2)	23225.76
Energy Intensity (GJ/m2)	1.53
Energy Use by Energy Source (%)	
Electricity	46
Natural Gas	44
Light Fuel Oil and Kerosene	5
Heavy Fuel Oil	3
Steam	0
Others	2

For energy comparison in this report, we calculated the average energy consumed per year assuming that the new SUB will be equip with the same type of utility and powered by the same energy sources. It is estimated that the average energy per year will be around 35500 GJ. From there will we work out how each of our renewable energy can improve the new SUB energy consumption and conduct a triple bottom line analysis.

SOLAR ENERGY

Solar energy is a very feasible energy source for our new and old Student Union Building. The solar panel industry is blooming and many companies are researching on ways to lower the costs and raise the efficiency on these photovoltaic cells. Currently, the leader in the solar panel industry according to multiple surveys is SunPower. To help the SUB achieve platinum LEED status, we will be looking at the possibility of using solar panels for the purpose of temperature regulation or regular electricity usage. SunPower offers three different types of solar panels. In this assessment we will be looking at their most efficient and powerful solar panel, the “315 Solar Panel”.

The 315 Solar Panel is SunPower’s latest solar panel that boasts increased energy conversion efficiency. These solar panels convert 19.3% of the solar radiation compared to 12.8% of a conventional solar panel. The 315 solar panel generates peak wattage of 315W compared to

~200W of a similar solar panel dimension. These solar panels cost around $2800 each and take up 1.631m^2 of space.

Social

When dealing with photovoltaic panels, there are minimal social effects on the student body or the SUB itself. The panels are first installed on the roof of the building, in this case, the SUB. The solar panels themselves do not need any regular maintenance for anyone to manage. The panels themselves are stationary parts that stay on the roof so there should not be any hazard to students walking underneath or around the SUB. The use of solar panels does not involve any ethical or human right violations. They do not release any form of toxins nor do they disrupt the wildlife seen on campus.

Although there are few social limitations involving solar energy, there are some minor complications when applying this solar technology. The SUB committee will need to dedicate a room to install a solar inverter in order to convert the solar radiation into AC voltage used for electricity. A large amount of roofing space will need to be dedicated to installing these solar panels. Each of these 315 Solar panels will take up 1.6307m^2 of space. Based on a 25,000 square foot roof, we can install approximately 1,400 solar panels which average 441killowatts per year. Based on our calculations, the SUB should average about 520killowatts of energy usage per year. If the SUB is agreeing to use half of the roof as a garden then UBC may need to build tall solar panel towers to capture more sunlight. These towers may be protested by students because they take up a lot of space and trees or branches may have to been removed if they are blocking any sunlight to these solar panels.

Environmental

The use of solar panels for the SUB provides many benefits and a few setbacks for the environment. Using solar power means that we can reduce our use of non renewable resources like fossil fuels. The amount of energy we can obtain from the sun is endless and therefore it is deemed to be a renewable energy source that can last the entire duration of the building's lifetime. Capturing sunlight with photovoltaic solar panels do not release any wastes to the environment and do not contribute to global warming. The process of installing these solar panels onto the roof of the SUB will not cause any environment effects as well nor do they cause any noise of any kind. The energy captured from the sun can be converted into electricity and

can be stored for future use in electrical storage banks. The use of solar energy is clean, quiet and accessible in many places.

The only negative environment issues dealing with photovoltaic solar cells include manufacturing and decommissioning of these panels. It is proven that the energy generated with these solar cells outnumber the energy spent manufacturing and decommissioning these cells. Most solar cells and the one developed by SunPower are made out of monocrystalline silicon. . Silicon is one of the most abundant materials on Earth and can be found just about anywhere. According to research done in Germany, the energy payback in implementing monocrystalline silicon in photovoltaic solar panels can be returned after only one year of use. The energy required to manufacture the silicon is low considering the lifetime of the solar panels can last up to around 25 years. After the 25 years of use, the solar panels can be disassembled and broken down into smaller silicon pieces to be recycled by companies producing these silicon solar wafers. A company that is known to recycle these monocrystalline pieces is named ReneSola and originates from Shanghai China. Other parts of these solar panels include the glass or plastic layering on top of these panels. The glass and plastic can be separated from these solar panels and be recycled by their respective recycling plants.

Economic

The main contributions of costs from Solar panels come from the initial stages of implementation. The costs of purchasing the 315 Solar panel average around $10,000 per kilowatt. The 315 Solar panel costs around $2,800 per panel and can provide 315 Watts of power. Installing 1,400 solar panels would cost the SUB around 3.92million dollars. Up to 15% of these costs could be sponsored by the government for the use of renewable energy sources. After this 15% grant, the approximate total would be 3.33 million dollars. Although the initial costs seem to be a bit pricey, the costs are spread over the 25 years of lifetime. Calculating the costs per year, the solar panels would only cost $133,280 per year. The energy generated from these solar panels could well cover the costs they incur for their lifespan. Since the SUB itself is planning to spend 110 million dollars, the costs of this renewable energy source are only 3% of their total SUB costs. Overall the costs of these solar panels are covered by the energy they generate over their lifespan and should be considered to be used for the SUB.

BIO-FUEL

Biofuels are not considered a new technology and have been around since 1892, when a German engineer created the first diesel engine to run on peanut oil. However after World War II, the low price of crude oil gave way to its dominance in the world market. Until recently, the rising price and insecure supply of crude oil is starting to raise general concerns, and a new type of energy source which is more environmental and economic friendly is needed. Biofuels which are based of biomass are considered a renewable energy source. The economic, environmental and social aspects of biofuels seem to be very promising.

Social

Socially biofuels will have little impact on the everyday lives of people generators for buildings already exist and are in use regularly so replacing the fuel that they use will have no impact on the people in the surrounding environment except the side effect of better a cleaner environment. People also do not need to alter their ways of living or make any special changes to their routine this is a huge plus for biofuels because they use the current infrastructure that are already integrated into people's lives that changing it will have no overall impact on how they go about their daily activities.

Environmental

Environmentally biofuels burn clean and release no sulphur emissions which are a cause of smog, ozone and acid rain. They also produce up to 50% less carbon monoxide which is a poisonous gas. Particulate matter in general is reduced by a third, while smaller particulate matter is reduced by over two thirds[3]. The burning of biofuels is also a closed carbon cycle which means that there is no excess gain of carbon in the atmosphere unlike fossil fuels that add carbon to the atmosphere among other things.

Economic

Economically biofuels are one of the cheapest renewable energy sources. Biodiesel, one common type of biofuel is very useful in the aspect of power generation. It can be used in common diesel generators with little to no modification which translates into very low initial costs. Costs range from $10k for a small 11kW generator to $400k 2.5MW generator[1].The cost of regular diesel is $2.34/gallon while the cost of biodiesel is $2.54/gallon[2]. With the price of

regular diesel projected to go up and the cost of biodiesel going down, the potential for biodiesel is there.

Biofuel are a way of the near future in order to wean ourselves from fossil fuels until other forms of power generation have matured. It is a little bit like a “nicotine patch” solution to our current problems. They meet economic, environmental and social aspects of a triple bottom line assessment and should be recommended for the new sub either in the form of backup power, emergency power or even as a combined head and power system.

GEOTHERMAL ENERGY

Geothermal energy uses the energy (heat) stored in the earth for heating or generating power for buildings. Geothermal energy generated from the initial formation of earth and the the movement of the tectonic plates. Currently, geothermal energy accounts for 0.3% of worldwide electricity consumption and is growing by 3% annually. Around 28 gigawatts of geothermal energy are used for heating homes. Geothermal energy is a cost effective, reliable, sustainable and environmental friendly source of energy and is an ideal energy source for areas near the tectonic plates like Vancouver.

Geothermal electricity is becoming more popular worldwide, with an annual growth of 3%. The mechanics of geothermal electricity is very simple. Pipelines are installed deep into the earth and hot fluids are pumped from underneath the ground. The hot fluids are transfer to tanks where the steams from the fluid are used to pressurize the tank. The pressure is channelled thru a turbine to generate electrical power. The used fluid, containing green house gases like CO2, H2S, CH4 and NH3 are carefully pump back into the earth to prevent any harmful emission.

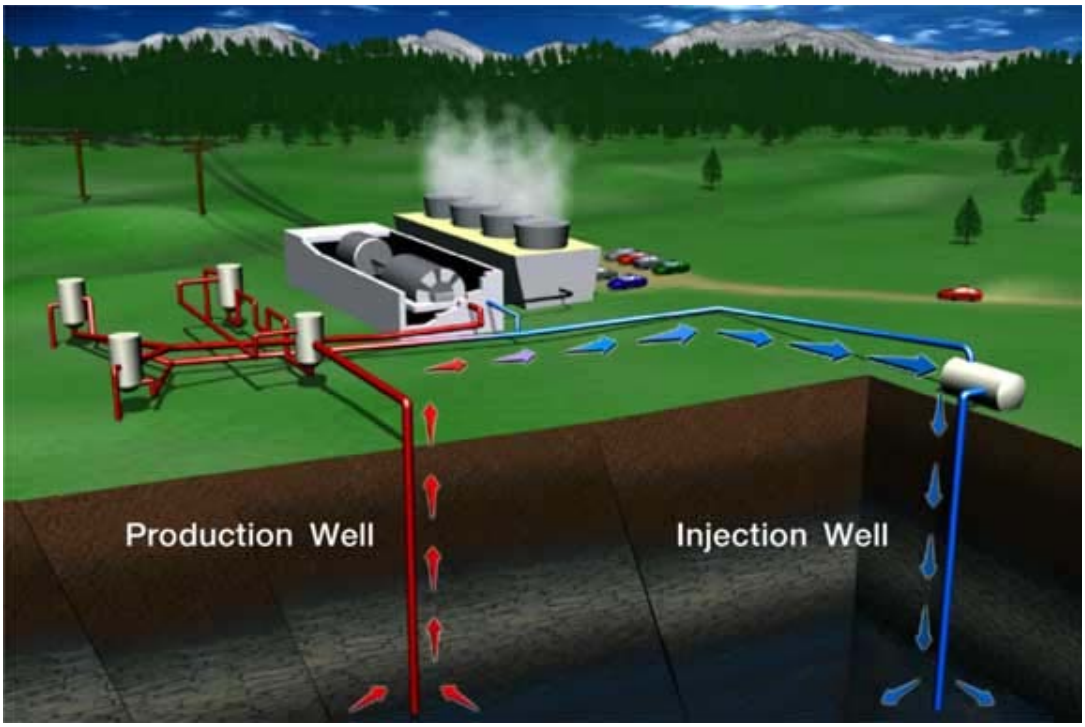

Figure 1. Geothermal Electricity Plant

Although, geothermal electricity is a very sustainable way of producing energy, it requires a plant to be built nearby. Unless this geothermal electricity plant is going to generate power for the whole campus, it is not an economical idea for the SUB because the drilling will cost $10 million and up.

Geothermal heating is a more direct method of using geothermal energy. Since heating doesn't require as high temperature as for generating electricity, it makes geothermal heating more efficient and easier to access. Geothermal heating only requires loops of pipe lines to be place underground, this can be done when the support of the building is being constructed. The pipelines will carry water or other heat exchangers which will carry transfer the heat to a heat pump to distribute the heat in the building.

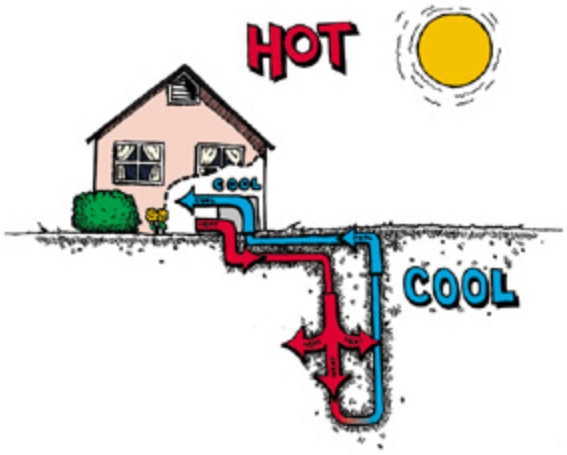

Figure 2. Geothermal Heating

The cost of installing a geothermal heating system is around $2000 per kW, for the new SUB it is around 520 kW. So the installation cost is estimated to be around $1 million dollar. Currently, around 52% of the energy is used for heating spaces in the SUB and another 2% for cooling the building. Upon the success of the installation, we are estimated to save up to 50% on utility cost in heating and cooling, and 54% on energy consumption.

Social

New technology often triggers many debate on social acceptance. For example, nuclear energy is a good sustainable source of power that produces no greenhouse gas but on the other hand it creates radioactive wastes. For geothermal power, social acceptance is not a problem because the energy taken from the earth's core is only a very small faction and will not affect the earth's core temperature. Geothermal can not only be used directly for heating home but also be used to generate power without producing any waste or green house gas. The size of the geothermal electricity plants are also smaller so they can place closer to the urban areas, therefore cut down on the cost of transmitting the power.

Environmental

Geothermal heating does not produce any harmful gases to the environment but if it was to be used to generate power then it may process a risk of releasing harmful gases. Because fluids used for generating power contains gases like carbon dioxide (CO_2), hydrogen sulfide (H_2S), methane (CH_4) and ammonia (NH_3) which are harmful to our atmosphere. If the gases are

safety pumped back in the earth, this will not be a problem. Other problem is taking heat from the earth's core might decrease the core temperature but the faction we extracting are so small so it won't affect the core temperature. Geothermal energy is view as a renewable, self sustainable and environmental friendly energy source.

Economic

The capital cost of geothermal heating system may cost up to double of what conventional heating system cost. But the main cost benefit of comes from the maintenance and utility saved. Using geothermal heating system can save over 50% in utility cost. On top of that, government are also giving grants for installing environmental friendly equipment. Using as heating can eliminated a large portion of the utility cost spend on heating since geothermal heating is self sustainable.

Conclusion

Solar panels, biofuels and geothermal energy are all great form of renewable energy sources that the sub can use. They passed the triple bottom line assessments that they were subjected to. They all exhibit marked improvement in environmental performance, with solar panels being one of the cleanest forms. All have marginal increases in cost, with biofuels being the cheapest of the bunch having a relatively low initial cost and upkeep especially if UBC can make its own biodiesel. The social impacts of that these sources of energy are a lot smaller than the impacts of the traditional energy sources that we use today.

Solar panels might have a problem performing alone in the lovely lower mainland rainforest. Having over 1400 panels installed on the roof seems like a lot especially if they want to install a green roof then the panels need to be installed elsewhere. Geothermal energy on the other hand requires a lot of initial drilling and a high initial capital costs. While biofuels still release greenhouse gases into the environment even though it is part of a closed cycle loop. It seems that not one of these sources will be able to handle the energy requirements alone. Combining two or even three of these sources into a combined heat and power (CHP) system seems like it would be a good idea. For example have a small scale geothermal for heating/cooling, while solar panels and biodiesel generators as part of a CHP system for electricity generation. This system will be more robust and able to handle more situations than any one of these systems can alone.

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