

UBC Social Ecological Economic Development Studies (SEEDS) Student Report

An Investigation into Sustainable Housing: Application to the UBC Farm Sustainability

College

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**An Investigation into Sustainable Housing:
Application to the UBC Farm Sustainability College**

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ABSTRACT

This report assesses three case studies about various sustainability housing options in university settings based on a triple bottom line assessment that considers social, economic, and environmental factors. The Bastyr University Student Village is located in Kenmore, Washington, Nottingham University of the United Kingdom is home to the Creative Energy Homes, and Hamilton Hall at Harvard University is located in Cambridge, Massachusetts of the USA. The report discusses the sustainable options employed by the three case studies, and how they are relevant or irrelevant to the planned UBC Farm Sustainability College.

The report begins by speaking to the immense importance of sustainability in today's society and continues with a triple bottom line assessment of the three case studies. These case studies make recommendations for the UBC Farm Sustainability College, and this report evaluates the benefits of them. The report concludes with an overview of the short and long term effects of the recommendations made throughout this report.

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LIST OF ABBREVIATIONS

CEH – Creative Energy Homes

CHP – Combined Heat and Power

EAHE – Earth-Air Heat Exchanger

FSC – Forest Stewardship Council, an international non-profit organization established for the responsible management of forests.

LEED – Leadership in Energy and Environmental Design

1. INTRODUCTION

Sustainability is often regarded as a pinnacle of importance in the twenty first century. With the emergence of climate change theory and the idea of resource depletion taking an ever-increasing precedence in the modern world, it is essential to consider options that are available in regards to a sustainable lifestyle. The proposed UBC Farm Sustainability College is a residential complex aimed at providing a renewable way of life for around 75 to 100 individuals. Accompanying this project are many significant questions. How will the building be powered? How much land mass will be utilized as arable land? And what social implications does this have for residents? The aim of this project is to compile a report which serves to answer such questions. By doing so, we develop a clearer idea of how the sustainable college should be approached in regards its design. Through the course of the report we will be analyzing three primary case studies through triple bottom lines assessments which will assist us in the formation of ideas that can be utilized in order to ensure the maximum success of the buildings that are to be implemented. The three case studies of focus are as follows: Bastyr University Student Village, Harvard University Hamilton Hall, and the Creative Energy Homes at the University of Nottingham. Because these three regions share a terrain which exhibits similar geographic features to that of UBC Farm, we came to the conclusion that these would be the most relevant designs in regard to the planning and layout of the sustainable college.

2. TRIPLE BOTTOM LINE ASSESSMENT

2.1. Bastyr University Student Village

2.1.1. Case Study Description

The Bastyr University Student Village is one of the cases studies we have chosen to analyze in our report. Bastyr University is located in Kenmore, Washington, USA just outside Seattle, and the student village is situated in a semi-forested area within Saint Edward State Park. The village consists of eleven three-storey cottages, each housing twelve students with separate bedrooms and bathrooms, as well as a common living area used for studying, dining, or social gatherings. This student village is intended for approximately 132 students, and each cottage occupies 4,600 square feet of space. Furthermore, the village is designed to integrate into its natural environment (Figure 1), also one of the design goals for the UBC Farm Sustainability College, thus implementing an eco-friendly design with energy efficiency in mind. In addition, this project was honored with many awards, most notably the 2010 LEED for Homes Project of the Year as well as a Merit Award at the 2011 EcoHome Design awards. The following section investigates the social, economic, and environmental aspects of the student village.



Figure 1. Bastyr University Student Village

2.1.2. Economic Assessment

The student village cottages at Bastyr University were completed within a budget of \$16.5 million. The cost to live at one of these cottages is \$2,325 per quarter (11 weeks) excluding a meal plan, in comparison to between \$6,500 and \$8,500 to live at a traditional multi-storey residence for an eight-month school year at UBC (Two terms, 13 weeks each), meal plan inclusive. Working out the math and taking into account a meal plan for Bastyr, the total cost comes out to be very comparable, hence from a student's perspective it's just a matter of first getting admitted and then deciding whether or not they want to welcome the opportunity to embrace a more sustainable lifestyle versus a traditional one.

2.1.3. Environmental Assessment

The Bastyr University Student Village was undoubtedly designed with the environment in mind, from the eleven cottages being connected with green gardens containing edible crops to the strategically light coloured pavement designed to minimize heat gain within the courtyard. The cottages are constructed from local FSC certified wood, giving them a naturally defined look that greatly contributes to their integration into the environment. Additionally, “Butterfly” roofs are used for storm water collection, which is stored in a vault beneath a nearby parking lot, and used for watering plants and in some cases as a natural insulate for the building that works to retain heat (Figure 2).

The interior of these cottages continues to impress, with natural ventilation implemented by operable windows at the top and bottom of rooms to allow heated air to escape and cool air to enter (Figure 2). The floor is composed of concrete with a SoyCrete finish on top to make it optimal for radiant floor heating, a heating system that makes use of radiation to supply heat through the floor. Furthermore, high efficiency boilers and Energy-Star appliances are placed in each cottage.



Figure 2. Sustainable Features of the Student Village

Overall, this project was originally designed to attain a LEED certification of Gold, but the project exceeded expectations and achieved Platinum certification, first-ever on the West Coast.

The major keys to success were the water efficiency, landscaping, lighting, as well as air filtration. Bastyr University was also able to divert 97% of the construction waste away from landfills through careful planning and with the help of students as well as faculty (USGS, 2010).

Many of the specifications presented above may just be a matter of preference or necessity, but many seem to speak out to the UBC Farm Sustainability College. For example, Vancouver's 1474 mm of annual precipitation strongly hints at the Butterfly roof option, as such an investment would make clear use of treated storm water for vegetation, typical household usage, and in some cases heat retention (The Weather Network, 2012). Additionally, British Columbia's recently struggling logging industry could certainly benefit from such a project, thus the use of local FSC certified lumber would be an ideal construction material for the Sustainability College.

2.1.4. Social Assessment

The cottages at Bastyr University are constructed from local FSC certified wood. Not only does this choice promote and support local businesses, it also helps the building better integrate into its environment. Furthermore, interaction amongst students promotes a sense of comfort and easiness, thus the need for a place for social gatherings at the residence. Interaction amongst residents is vital for intellectual energy (CollinsWoerman, 2010). This is the case with Bastyr University as they have a common living area with a dining and living room, as well as the gardens located between the cottages to promote interaction amongst neighbors.

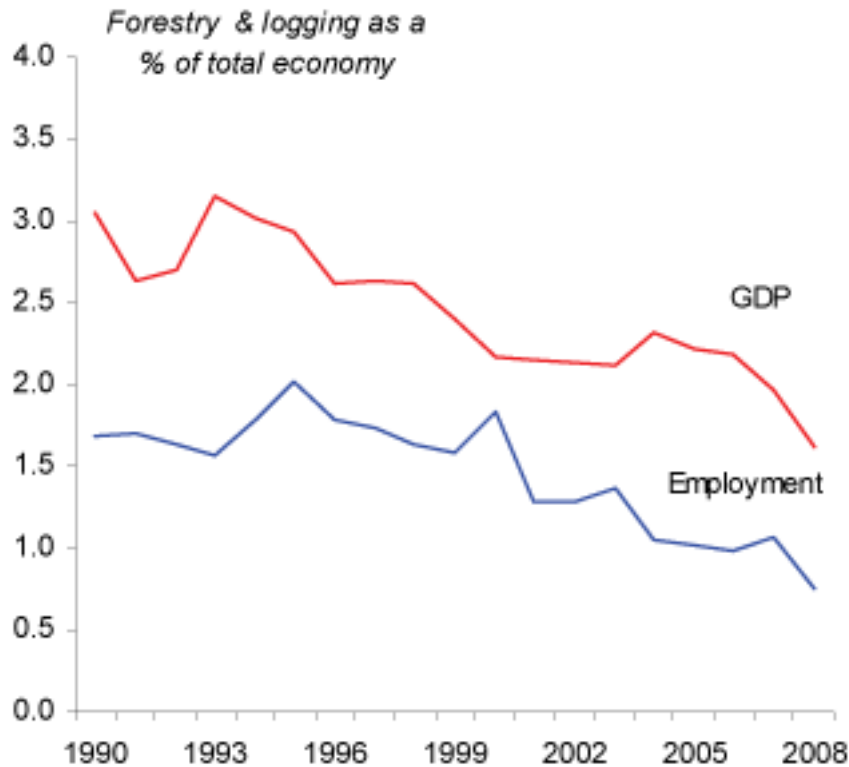


Figure 3. Forestry and Logging Industry GDP & Employment vs. Time

Accordingly, the logging industry in British Columbia is comprised of 17,400 workers including forestry technicians, professional foresters, transportation, equipment operators, as well as many finance and management positions. They earn an average of \$25.22 per hour (Forestry & Logging: A Guide to BC Economy and Labour Markets, 2008). However, the forestry and logging industry has been declining over the years as today's work force is only 2/3 that of the year 1990 (Figure 3).

Also, given the Sustainability College is planned to be built in a semi-forested area at the UBC farm, there are many local residents that enjoy the current layout and view at the farm.

Therefore, any changes such as the construction of the Sustainability College can significantly change the landscape, for example the scene of a bright metallic building every morning might not blend in well with the forest and vegetation in the surroundings. Consequently, a wood based design for the Sustainability College is an ideal investment for UBC's green ideology, as well as a boost for a BC industry in need. The use of wood would evidently help the new college

integrate into the natural environment at the UBC farm. In essence, this creates more jobs locally with the hope that this project will inspire many more to come.

2.2. Creative Energy Homes at the University of Nottingham

2.2.1. Case Study Description

The Creative Energy Homes (CEH) case study is located on the University Park Campus of the University of Nottingham in the United Kingdom. The 330 acre campus, situated a few miles away from Nottingham city centre, features extensive woodland, gardens, and green fields. The CEH was conceived by the university's Department of Architecture and Built Environment first and foremost as a test bed for modern methods of construction, energy efficient design, and renewable energy systems developed by industry. Presently, the CEH project consists of seven one to two family houses, as seen in Figure 4 below which represents the project site plan.

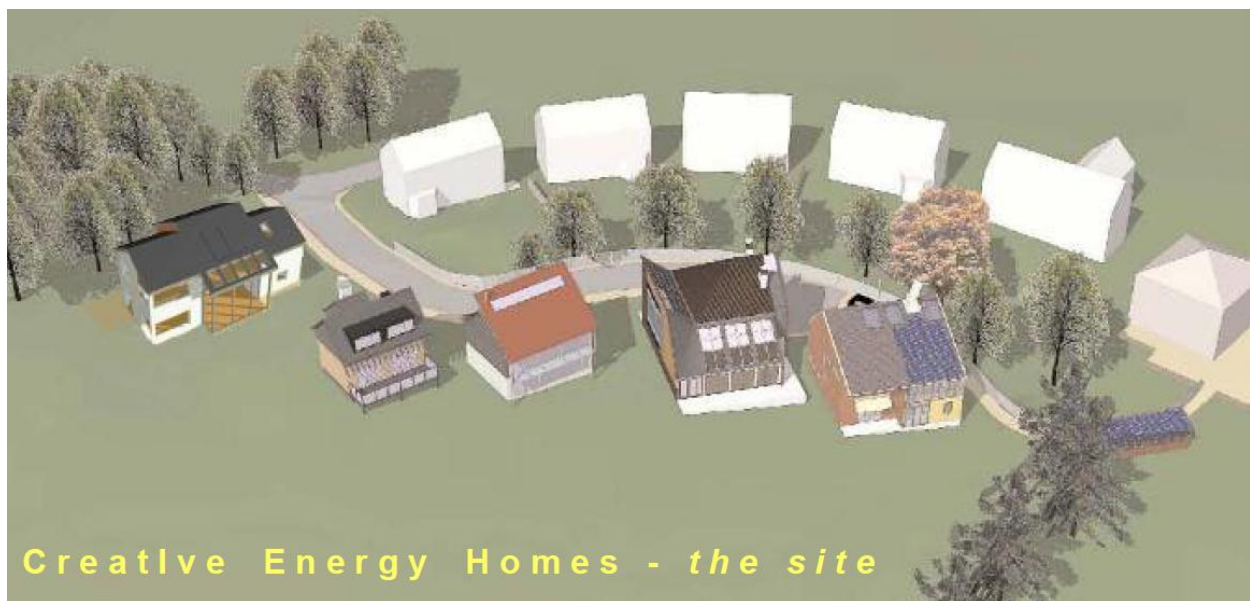


Figure 4. Creative Energy Homes Site Plan

These homes were designed and built by the department in collaboration with a myriad of industry partners. Located just steps away from the buildings of the department, it houses architecture students and researchers involved in the testing and evaluating of the systems and

designs implemented in these homes, thus also providing data for analysis of occupant interaction. While many design elements of the CEH involve state-of-the-art energy efficient systems which may not be suitable for the low-tech sustainability philosophy intended for the UBC Farm Sustainability College, there are also several passive architectural features which may be pertinent. Figure 5 below depicts one of the homes, the David Wilson Eco-House, and some of the sustainability innovations that were incorporated. This section assesses a few relevant technologies and the CEH project in terms of economic, environmental, and social impact.



Figure 5. David Wilson Eco-House

2.2.2. Economic Assessment

Unfortunately, specific data on the financial costs of construction and operation of the CEH is not publicly available. However, BASF, one of the main industry partners for the project, states the low target build cost of £70,000 for a home with similar specifications as the BASF Research House, one of the CEH houses (ICIS Chemical Business, 2008). As well, it is expected the

financial burden of installing the sustainable technology systems is reduced by involving industry partners in their implementation.

As to operation costs, they are expected to be dramatically lower as compared to similar traditional houses as well. This is because the CEH houses were all built to operate individually using only renewable energy generated by the various domestic energy systems incorporated into them (Czyzewski, 2011). Micro-CHP (combined heat and power), photovoltaic, and micro-wind energy generation systems all contribute to supplying power to these off-grid dwellings. Cost savings are also realized through decreased water demand through incorporation of rainwater harvesting systems.

2.2.3. Environmental Assessment

At the centre of many CEH design decisions is the passive house idea, which may be relevant to the guiding philosophy for the UBC Farm Sustainability College. Originating in Germany as the Passivhaus standard, it entails the design of houses that require a minimal amount of energy for operation through employing passive design elements and efficiently using the surrounding environment. Another stated key sustainability target is minimal carbon footprint. It should be noted that the sustainable solutions highlighted below are more suited to a compact built environment like a small detached house and becomes harder to implement at larger scales, though not impossible.

One core Passivhaus technique applied is passive solar design. Firstly, the choice in structure type of small houses for the CEH project was intentional. It took into consideration that a compact structure reduces exposed surface area that contributes to heat loss through conduction (University of Nottingham, 2012). Other aspects such as orientation of the houses and glazing were also considered. For example, the BASF House is sited so its south façade is fully glazed while the other sides are highly insulated. This design serves to maximize passive solar heat gain, reduce heating requirements, and take advantage of natural daylighting. Also, a metal louvre system on the façade was implemented to prevent overheating in summer months (University of Nottingham, 2012).

A related design consideration is the energy-efficient application of thermal mass. The solar heat storing capacity of the materials the house is constructed from can be used to regulate internal temperature and also shift cooling and heating loads from peak to off-peak periods (Gillott, 2010). This is achieved through the use of phase change materials in the construction of the ceilings. Phase change materials are modified materials able to start retaining or dissipating heat at designed temperatures. The thermal mass of the ground on which the house sits is also exploited through an earth-air heat exchanger (EAHE) system. The EAHE's operating concept is to make use of the mass of earth to impart or dissipate heat by circulating air through buried pipes (Gillott, 2010). This is possible because soil temperature for at a depth of about 2 meters varies only between 8-12°C throughout the year.

Other passive technologies implemented include natural ventilation systems, rainwater harvesting systems, and solar water heating systems. In the BASF House, the glazed south façade and the buffer area behind it serves another purpose by absorbing solar heat for natural ventilation. Ventilators on the lower south façade and the roof can be opened to allow for natural circulation of the solar heated air, as illustrated in Figure 6 below. A different implementation of natural ventilation is seen in Figure 5 in the form of a solar chimney, which works under similar principles.

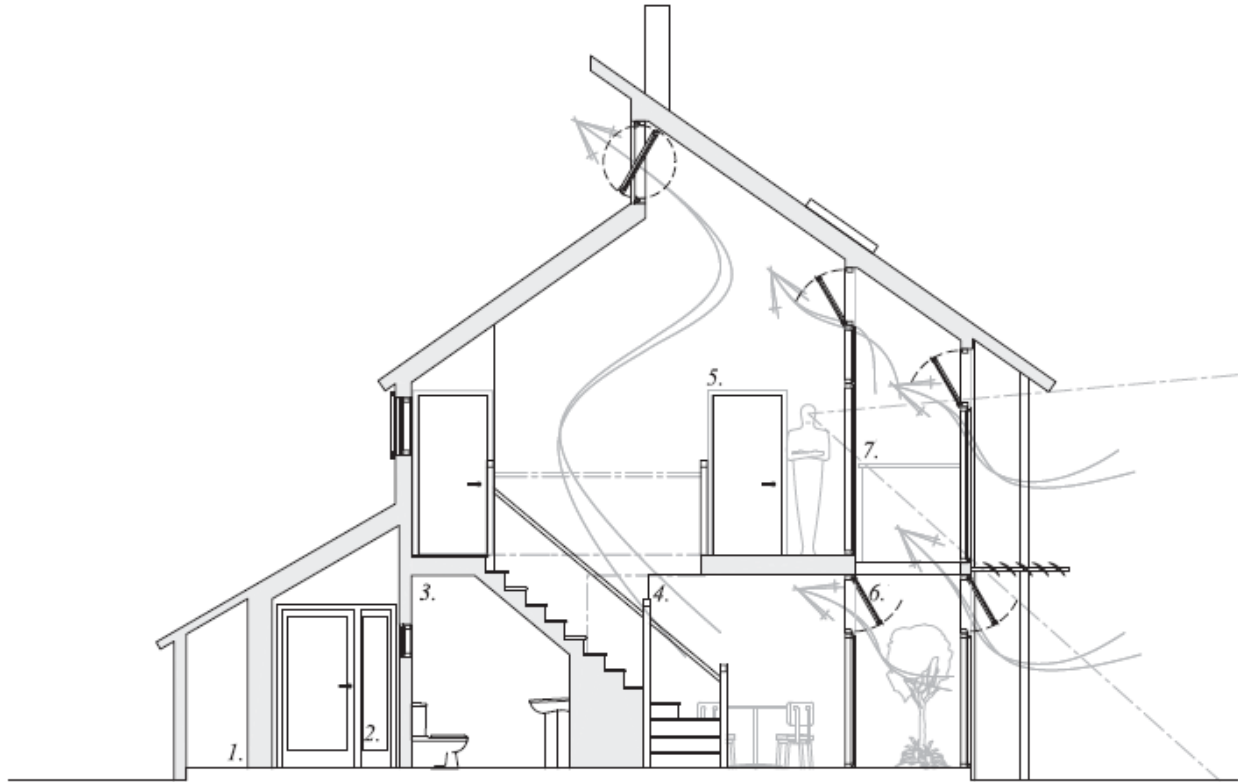


Figure 6. Natural Ventilation Diagram of the BASF House

2.2.4. Social Assessment

The most apparent social impact of the CEH is that the project became an integral part of encouraging community involvement in sustainable development within the University. The project directly led to student participation in the Solar Decathlon 2010 where students designed and built zero carbon homes as part of a competition. The resulting Nottingham H.O.U.S.E is expected to be moved on site in the future. The CEH also provides students and faculty with a relevant and useful research setting to assess the viability of energy-efficient and carbon-neutral systems, all while serving the role of housing these people. Being a test site located at a major research institution, it also yields valuable data and knowledge to potentially affect future research and development discussions regarding sustainable homes and its regulation.

The project also attempts to address the issue of shortage in skilled labour. By employing alternative methods of construction over traditional masonry construction, the project taps into

new sources of labour. In a similar vein, the project also attempts to address affordability of new homes for first time buyers. Knowledge derived from the research into low cost material and life cycle performance cost and energy use that is conducted can be utilized by industry to realize low cost homes (University of Nottingham, 2012).

2.3. Harvard University Hamilton Hall

2.3.1. Case Study Description

For our final case study our group has decided to look at the Hamilton Hall, a 48,000 square foot dormitory for MBA students at the Harvard Business School as picture in Figure 7 below (Harvard). The building was originally constructed in 1926. However, full gut renovation began in 2005, and was completed in the summer of 2006 with the result achieving a LEED Gold rating. Hamilton Hall has four levels, as well as a basement, including 72 dorm rooms, 6 kitchens and 8 lounges in addition to dedicated recycling storage areas and other support spaces (Harvard). From very early in the design process it was decided the building would be an example of green residential design for Harvard University. The following section investigates the social, economic, and environmental aspects of Hamilton Hall.



Figure 7. Hamilton Hall

2.3.2. Economic Assessment

Unfortunately, economic figures regarding budget and costs have not been released to the public, and information could not be found. However we do know that the system is expected to save over \$11,000 in energy costs, with a ten-year payback period (Harvard). Also, additional energy savings come from reducing domestic hot water demand by 22% (Harvard).

2.3.3. Environmental Assessment

In regards to its environmental aspects, Hamilton Hall could be considered a milestone for those who strive for sustainability at Harvard University. Upon the building's renovation in 2006, the building was ranked as a LEED Gold project for its outstanding achievements in water and energy consumption reduction (Harvard). Originally designed as a residence for business students in the late 1920s, Hamilton Hall has evolved to illustrate the progression that can be achieved regardless of the constraints and parameters that surround a region. There are many significant factors to consider when we regard the environmental aspects of such a building. The first is water consumption – there has been a 38% overall reduction in the usage of domestic water given that toilets, showers, and sinks alike have all been equipped with water management systems that narrow down the necessary water output required (Harvard). The toilets, for example, are installed with dual flush systems and the showerheads have been altered to output a smaller water flow rate. There has also been a rather unconventional solution provided for the outdoor irrigation – a system where the plants are watered according to data provided by a weather station. By adhering to a system based on real time climate information, the University has managed to reduce water output in sprinklers by 64.8% (Harvard).

Another area that has been vastly improved upon for the building is that of energy. With new digital thermostats that are made standard in each room, the building automatically detects if occupants are in a specific area and in response compensates its level of heating so that heat need not be wasted when residents are out of the building. The installation of high efficiency glazing has also been carried out in order to make sure that the heat is distributed more effectively within the confinements of the structure (Harvard).

There are other significant factors to consider that made the building earn its LEED Gold status. One of the most important is the fact that the building was primarily made using local materials - 71% of the materials originated from within a 500-mile (804.7km) radius. The recycling process for the building also made strong contributions to the awarding of its LEED certificate. Out of all materials used for the building's construction, 10.4% of the paid materials originated from recycling plants. In addition, 97% of the waste generated was salvaged as recycling material while only 3% ended up in a landfill (Harvard). As the building was one that was undergoing renovation, the older doors, cabinets, sinks and other furnishings were donated to "Food for the Poor," and as a result shipped to Nicaragua. Finally, in order to sustain the health of the construction workers and future inhabitants, the building was designed using paints, adhesives, and other building supplies that were produced in order to emit minimal chemical quantities (Harvard).

2.3.4. Social Assessment

During the construction of Hamilton Hall 71% of materials were manufactured within 500 miles (Harvard). Having all the materials manufactured locally helped with boosting the local economy. Being able to have all the materials manufactured locally for the Sustainability College will be beneficial to local businesses of Vancouver. Also, Hamilton is in close proximity to several public transportation options, allowing alternatives to driving (Harvard). Having these same options will be extremely important in when planning the layout of the sustainable housing. Providing the students with different options other than driving alone will help promote better sustainable living amongst the community at the sustainable college housing.

3. CONCLUSIONS AND RECOMMENDATIONS

Though there are a myriad of factors that influence the legitimacy of a sustainable college, it is evident that the prolonged benefits of such a structure outweigh any negative implications that may arise in the short term. In regards to the consideration of a triple bottom line assessment, we can confidently state that for all significant factors (economic, environmental and social), there is a positive net effect that engulfs the essence of the sustainable college.

Taking the economic aspect into consideration, we see from gathered statistics that the construction of a sustainable building would evidently be more expensive than that of a conventional residence. However, when one considers factors such as resale value and energy consumption costs, it is clear that the long-term benefits significantly outweigh any initial investments that are made.

In addition to economic benefits, there are a multitude of environmental advantages that exemplify the project's validity. Based on case studies conducted in recent decades, it is clear that although consumption of water and electricity cannot be reduced in its entirety, it is a completely realistic goal to reduce water consumption near 40% and that of electricity by comparable levels. Considering aspects of a larger scale, the Sustainability College serves to reduce its carbon footprint even further by fully utilizing the extent of arable land that is available within the constraints of the region.

This brings us to our third pillar of assessment - the social aspect. Given that the building encompasses a focus on sustainability, it is logical to conclude that its residents will also be passionate about such initiatives. With that in mind, the social aspect should theoretically flourish given that tenants will likely share and develop their ideas regarding future prospects on sustainability. With common farming land available to every resident, this idea is exemplified given that individuals will feel a sense of contribution to the primary initiative of the entire project. In conclusion, the future outlook of UBC's sustainable college is that of a positive nature and all considerations regarding our triple bottom-line assessment serve to reinforce this impression.

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