Canadian Consulting Engineering Awards 2011

# UBC CAMPUS ALTERNATE ENERGY FEASIBILITY STUDY

## VANCOUVER, BRITISH COLUMBIA

CATEGORY: F. SPECIAL PROJECTS

Stantec

# UBC Campus Alternate Energy Feasibility Study, Vancouver, British Columbia



The University of British Columbia (UBC) has embraced sustainability as an integral component of its vision. UBC is the first academic institution in Canada to achieve Kyoto level greenhouse gas (GHG) emissions reductions. Looking forward, UBC has committed to reduce Greenhouse Gasses by an additional 33 percent from 2007 levels by 2015, reduce Greenhouse Gasses to 67 percent below 2007 levels by 2020, and eliminate 100 percent of Greenhouse Gasses by 2050. Stantec was retained by The University of British Columbia (UBC) to develop strategies and policies to achieve these ambitious targets.

This plan identifies strategies for UBC to transform the existing energy system from a Greenhouse Gas intensive system to a system that is Greenhouse Gas neutral, enabling the University to achieve its goals to become the first carbon neutral campus in North America. Some of the key strategies include: building enclosure retrofits and mechanical system upgrades to reduce space heating consumption; replacement of the existing steam based district heating system with a medium temperature hot water network to reduce thermal losses and permit an expanded range of thermal energy supply alternatives; electrical demand side management to extend the service life of the existing distribution network and potentially eliminate the need for increased distribution system capacity, and replacement of the aging natural gas boilers with alternative energy technology.

Outstanding engineering achievements of this assignment include balancing technical feasibility, financial viability, and social acceptance of GHG mitigation strategies. The project embraced a sustainability perspective that balanced a range of objectives to deliver solutions that are elegant, economic, and enhances the livability and resilience of UBC.

The project working group and client committee was comprised of a large number of individuals, each with busy schedules. This created scheduling challenges for the project delivery. In addition, scope creep became a significant challenge as there was a need to fully explore a full range of technologies and strategies.

Structured decision making and adherence to the project management plan were critical to keeping the project on task and on budget.

The University of British Columbia (UBC) has embraced sustainability as an integral component of its vision. UBC was the first academic institution in Canada to achieve Kyoto level greenhouse gas (GHG) emissions reductions. Looking forward, UBC has committed to:

1. Reduce GHGs an additional 33 per cent from 2007 levels by 2015;
2. Reduce GHGs to 67 per cent below 2007 levels by 2020;
3. Eliminate 100 per cent of GHGs by 2050.

UBC retained Stantec to develop strategies and policies to achieve these ambitious targets.

This plan identifies strategies for UBC to transform the existing energy system from a GHG intensive system (Figure 1) to a system that is GHG neutral (Figure 2), enabling UBC to achieve its goals to become the first carbon neutral campus in North America. Key strategies include:

1. Building enclosure retrofits and mechanical system upgrades to reduce space heating consumption;
2. Replacement of the existing steam based district heating system with a medium temperature hot water network to reduce thermal losses and permit an expanded range of thermal energy supply alternatives;
3. Electrical demand side management to extend the service life of the existing distribution network, and potentially eliminate the need for increased distribution system capacity;
4. Replacement of the aging natural gas boilers with alternative energy technology.

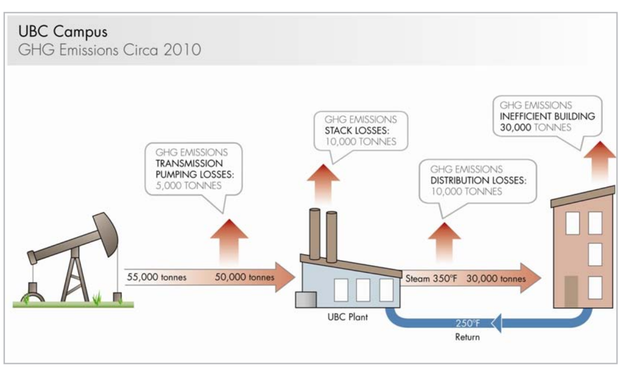



Figure 1: UBC Energy System Circa 2010

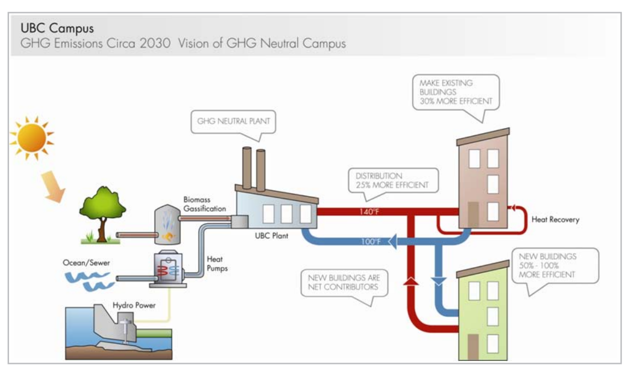
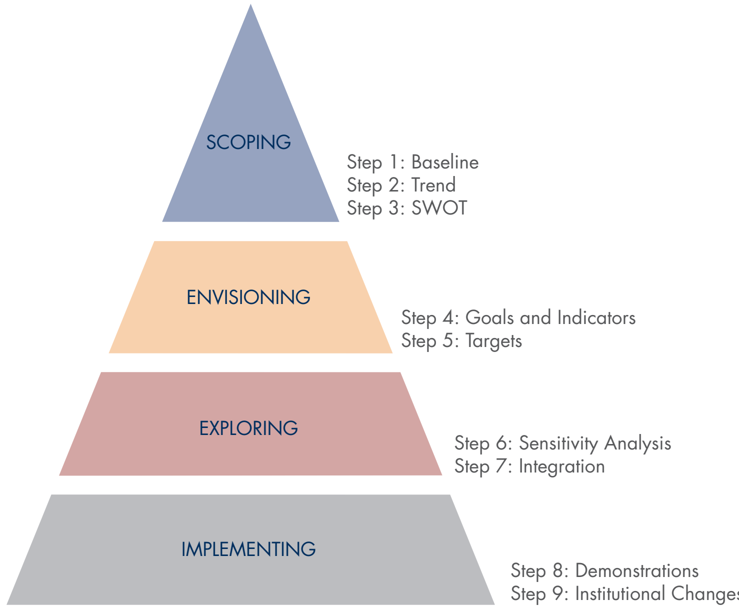



Figure 2: UBC Energy System 2030

## NEW APPLICATION OF EXISTING TECHNIQUES/ ORIGINALITY/ INNOVATION

### 1. Does the entry represent some kind of breakthrough in technology or science?




Stantec implemented a sustainability framework to identify and prioritize of strategies within the plan. The sustainability framework is based on a "One System Approach" which provides a logical hierarchy to achieve sustainable outcomes using a systems analysis approach.

A range of alternative energy supply options were evaluated as part of this study. Energy sources considered and criteria used to evaluate them are summarized below. Of these energy sources, three (and one combination) were shortlisted and compared to the business as usual option of continued use of natural gas fired steam boilers.

| Energy Source Options | Evaluation Criteria |
|---|---|
| • Natural gas<br>• Biomass<br>• Electric boilers<br>• Heat pumps<br>• Municipal waste to energy<br>• Biogas<br>• Solar heat and power<br>• Wind<br>• Wave and tidal<br>• Deep geothermal<br>• Combined heat and power | • Eliminate GHG emissions<br>• Minimize energy consumption<br>• Maximize the present value of investments<br>• Minimize risk (financial and operational)<br>• Minimize operations risk<br>• Achieve net positive energy performance (consistency with vision)<br>• Maximize the opportunities for research, teaching and learning<br>• Minimize stakeholder impact<br>• Minimize the need for lengthy and complicated regulatory requirements |

The short listed alternative energy sources include:

1. Biomass
2. Electric boilers
3. Heat pumps (ocean or sewer heat recovery)
4. Combined biomass and ocean heat pump

## 2. Does the entry represent a unique mix of different techniques, materials or equipment?

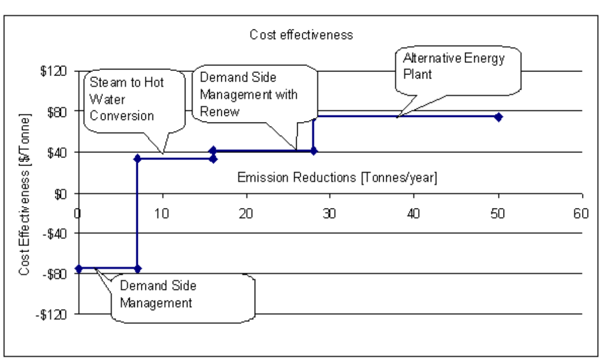
A unique process was implemented in this assignment called the "One System Approach" which has been pioneered by Stantec staff to identify and prioritize sustainability solutions.

### Financial Analysis of Alternative Energy Options

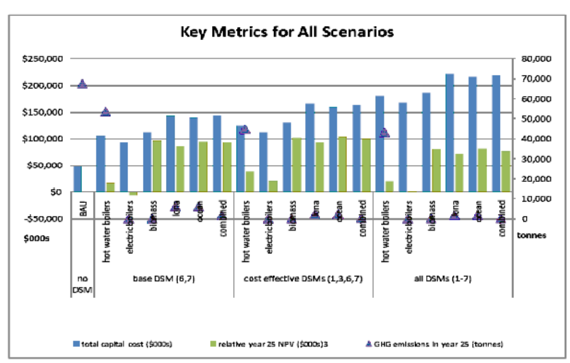
Achieving GHG neutrality will require significant capital investment. However, investment in energy efficiency and alternative energy will reduce operating expenditures and result in an immediate positive cash flow for UBC for the short listed options (biomass, ocean loop, Iona and combined biomass and ocean loop).

Three combinations of thermal demand side management measures and alternative energy options were analyzed:

1. **Base DSM:** this set of demand side management measures include only those required to convert to heating water distribution (hot water conversion and absorption chiller replacement).
2. **Cost Effective DSM:** this set of demand side measurement measures include those for which unit costing analysis showed that the present value of the cost of saving a MWh of heat was less than the present value of the cost of delivering a MWh of heat to the UBC buildings. Four thermal demand side measures met this test: hot water conversion, absorption chiller replacement, building recommissioning, and ventilation heat recovery.
3. **All DSM:** this set of demand side measures includes all seven thermal measures identified as the most beneficial candidates for implementation at UBC.

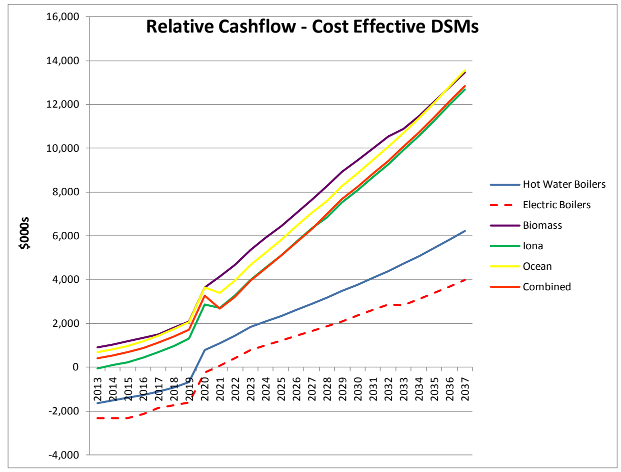



*Cost effectiveness and Impact assessment of GHG management*




*Understanding Options*

Continued use of the steam boilers will require investment of $48 million to accommodate growth and equipment replacement. Investment in more efficiency technology will incur additional capital (up to $220 million if all demand side management measures were to be implemented), but will result in significant and immediate operational savings. The cash flow and net present values of alternative energy options were compared to the business as usual (natural gas fired steam boilers) option to derive relative cash flow and relative net present value. A graphical comparison of relative cash flows for the alternative energy options combined with the cost-effective demand side management measures is presented in The Cashflow of Energy Alternatives




*The Cashflow of Energy Alternatives*

The biomass, heat pump (ocean loop and Iona), and combined options integrated with the cost-effective demand side management measures provide the strongest business case, while hot water boilers, electric boilers, and the business as usual options show relatively poor financial performance across all levels of demand side management.

## 3. Does the entry advance the state of the engineer's art and skills?

A key innovative feature of this work was the expanding role performed by the project to explore technology options in the context of financial constraints and value trade-offs. A range of GHG neutral solutions were identified which met the technical objectives of the project but required trade-offs of values such as noise, traffic congestion, and perception of environmental responsibility. These value tradeoffs were made explicit through a decision analysis process conducted with the client and project steering committee to ensure recommendations were transparent and defensible.

## COMPLEXITY

## 1. Does the entry involve very complex criteria or types of problems?

While energy efficiency is not highly complex, integration of a sustainability framework into the development and delivery of the project created an additional level of complexity, particularly as it relates to communication among stakeholders, the client group, and the consultant. Engaging a range of stakeholders through establishment of a working group and frequent and ongoing project meeting with the client meant that the complexity of communicating technical information to groups with a range of backgrounds was completed with a high degree of learning achieved among all parties.

### 2. Were extraordinary problems of site, location, hazardous conditions present?

Due to its nature as a planning study, no extraordinary problems of site, location or hazardous conditions were present.

## ENVIRONMENTAL IMPACT

### 1. Does the entry provide environmental benefits?

The recommendations in the report are currently being implemented at The University of British Columbia. A strategy to move from high temperature steam to medium temperature water is currently being designed, resulting in a 40% reduction in GHG emissions. The campus has initiated a process to implement a range of alternative energy technologies, and is currently constructing a biomass gasification plant. Finally, the campus is expanding building retrofits, which are expected to reduce emissions an additional 30%.

A cornerstone of this assignment is the client's and consulting team's commitment to supporting sustainable development at The University of British Columbia. The assessment of alternative energy options is ongoing. In the next phase, a public process to identify and evaluate value trade-offs will be conducted.

### 2. Does it conserve energy and have a low carbon footprint?

The intent of this assignment was to provide a technology and financial pathway to eliminate GHG emissions and reduce energy consumption by over 40%.

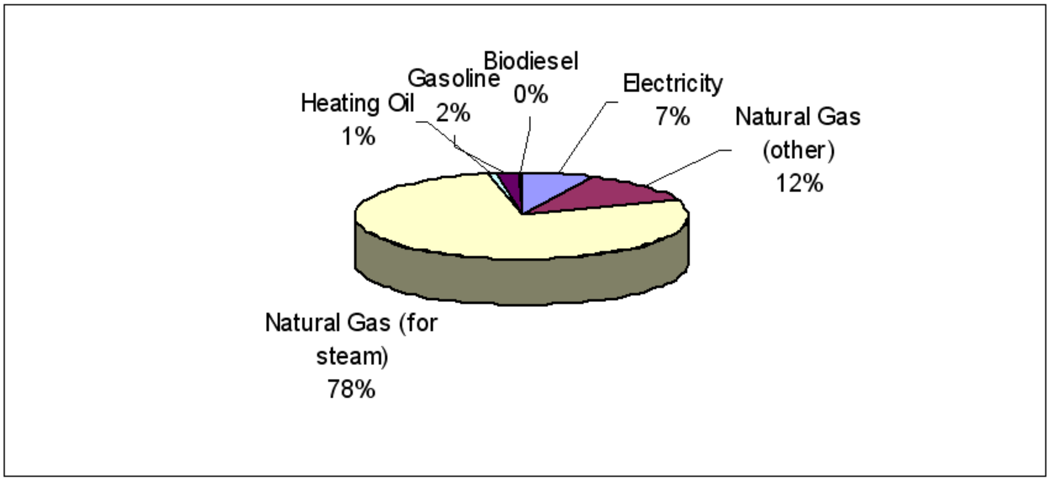
### 3. Does it conserve or improve land, restore or improve air quality, water systems, ecosystems, etc.?

Implementation of this plan will eliminate combustion of fossil fuel at UBC resulting in improvement in local air quality.

## SOCIAL AND ECONOMIC BENEFITS

### 1. Does the entry provide any social or economic benefits?

Greenhouse gas emissions and the impact of global warming poses one of the most significant threats to human security. Developing a comprehensive strategy to achieve GHG neutrality at UBC has direct impacts on reducing emissions in the Lower Mainland. As a centre for teaching and learning and with a commitment to act as an agent of change, the strategies developed and implemented at UBC will ripple throughout the community.




*GHG Profile*

### 2. Are additional benefits realized as a spin-off?

The savings in energy costs and elimination of GHG emissions are the major benefits attributable to this project.

## MEETING AND EXCEEDING OWNER'S/CLIENT'S NEEDS

### 1. Is it an economical and cost-effective solution?

As noted above, the strategy developed in this study is cashflow positive, and as a result, the client will save costs immediately. Therefore, the strategy is highly cost effective.

### 2. How did final cost relate to original budget estimate?

The final costs have not been determined since the project implementation is ongoing.

## 3. How closely does the solution meet the overall goals of the owner/client?

The Client's objective was to define the most cost effective strategy to achieve greenhouse gas neutrality. A comprehensive sustainability framework was developed and implemented to identify mitigation and adaptation strategies to reduce, and then eliminate GHG emissions. A triple bottom line analysis was completed to determine financial, environmental, and social impacts of alternative GHG neutrality pathways.

Stantec has implemented a robust project management planning process. Implementation and adherence to the project management plan was conducted by senior project staff to ensure milestones were achieved.

## 4. Did the entrant meet the client's schedule?

The project budget and schedule were maintained. A core component of the team's approach was to develop a project management plan which defined roles and activities throughout the project delivery.