



# Journal of Sustainability Perspectives

journal homepage: <https://ejournal2.undip.ac.id/index.php/jsp/>



## Strategies for Energy and Climate Management at the British Columbia Institute of Technology

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### Article Info

**Received:**

15 March 2021

**Accepted:**

25 May 2021

**Published:**

1 August 2021

**DOI:**

*Presented in The 6<sup>th</sup>  
International (Virtual)  
Workshop on UI GreenMetric  
World University Rankings  
(IWGM 2020)*

**Abstract** The British Columbia Institute of Technology (BCIT) is Canada's premier polytechnic. In 2008, BCIT partnered with its local electricity utility to hire a full-time energy manager. The following year, BCIT's School of Construction and the Environment initiated a campus-as-living-lab of sustainability project called Factor Four in the seven buildings it occupies on BCIT's main campus in Burnaby. The purpose was to explore whether a four-fold (75%) reduction in materials and energy use could be achieved without compromising service levels. By 2016, the project achieved a 50% reduction in energy use and associated greenhouse gas emissions. Factor Four attracted over four million dollars in funding, engaged over 250 students from 12 educational programs, and produced over \$200,000 savings annually. In 2017, BCIT set an ambitious target to reduce its annual greenhouse gas emissions 33% below 2007 levels by 2023, and 80% by 2050, across all five of its campuses. BCIT's ultimate goal is to become both greenhouse gas neutral and a net energy producer. By setting ambitious targets and systematically implementing energy efficiency improvements, utilizing waste-heat exchange, fuel switching, and developing on-site renewable energy, BCIT is on track to achieving its energy management and climate change goals.

**Keyword:**

factor four, energy management, climate action, living lab, sustainability

### 1. Introduction

The British Columbia Institute of Technology (BCIT) is Canada's premier polytechnic comprising six schools distributed across five campuses in metropolitan Vancouver. BCIT offers applied education in trades and technologies covering business, computing and academics, construction and environment, energy, health, and transportation. With a student body reaching 59,000 annual full-time and part-time students, the Institute's operations are diverse. The largest campus is located in Burnaby, a suburban municipality adjacent to the City of Vancouver. The Institute's administrative offices and a majority of the schools' programming is delivered here. The campus comprises 54 buildings located on 3

square kilometers. BCIT's Downtown Campus comprises an eight story building in the heart of Vancouver's business district. It caters to business, computing and academic studies. Three campuses provide training in transportation including BCIT's Aerospace Campus, located in Richmond BC, BCIT's Marine Campus, located in North Vancouver, BC, and a shared campus with the Vancouver Community College located on Annacis Island that caters to heavy duty equipment training including rail.

BCIT's Facilities and Campus Development department has a long history of energy management, that started in 1990 with savings from energy efficiency improvement projects being re-invested in additional energy savings initiatives. The program was successful in conserving energy and generated significant cost-savings. However, by 2006 most of the technology-led savings that could be achieved had been implemented. With an eye towards continuous improvement, the Institute engaged its community in a new vision for Campuses as Living Laboratories of Sustainability [1]. A hallmark of BCIT's education model is skills training through hands-on learning. BCIT's campuses have always served as both indoor and outdoor learning environments that encourage students to learn by doing. This approach to the entire campus as a living laboratory of sustainability aimed to spur a new cycle of innovation by engaging BCIT faculty, students and industry partners in energy management solutions.

## **2. Campuses as Living Laboratories of Sustainability**

### **2.1 Partnerships and Pursuits**

Emphasis was given to adopting behaviours aligned with the Institute's energy conservation goals that could be delivered through a variety of demand-side management programs. Whereas utilities in North America had historically focused on supply-oriented programs that emphasized infrastructure development aimed at meeting increasing demands for services and resources, demand-side management focused on reducing demand through a combination of education, incentives and disincentives to shape attitudes and behaviours. Fortunately, BC Hydro, the provincial utility that provides BCIT's electricity was already recognized as a world-leader in demand-side management programs. The utility was offering large electricity clients, like BCIT, an incentive program to hire an energy manager to help them curb their energy demand.

BCIT participated in the program and hired its first energy manager in 2008. Simultaneously, BCIT partnered with BC Hydro to create the Province's first sustainable energy management curriculum designed to train would-be energy managers hired through the BC Hydro funded program. The partnership was, therefore, double-fold with the aim of helping BCIT improve its performance while simultaneously incorporating the insights gained from this experience into development of an educational program to build capacity for a work-force to be trained as energy managers to work with large energy users across the Province.

**BCIT's Sustainable Energy Management Advanced Certificate** teaches an approach based on demand-side management. It takes a holistic approach that incorporates the technical aspects of energy management addressing capital investment and operational changes and marries it to the social aspects of behavior and changes in business practice. Following the four "Rs" of community energy planning developed by then BC Hydro staff Robyn Wark and Jorge Marques, students learn to approach energy management by focusing on i) *reducing demand* first, followed by identifying opportunities for ii) *re-using waste heat* for buildings and water, then exploring iii) *renewable heat sources* that can be

used for heating and cooling, and lastly identifying opportunities to generate iv) *renewable electricity* [2]. Taken together, this approach incorporate designing buildings and communities for low energy consumption through creating dense and compact, mixed use spaces that allow people to meet their daily needs for work, education, shopping and recreation by walking, cycling or taking transit. Buildings and streets are designed to appropriately capture sun angles for passive heating, natural daylight, and cooling through shading. Choice of materials also plays a role as heat insulators, collectors, or conductors. Attention to energy efficiency is important to enable maximum benefit from energy that is collected, stored and conveyed in the building envelopes, mechanical systems, and infrastructure that connects them. Attention to how people use their buildings and whether the design enables them to be efficient in their use of energy and choice of appliances is also considered.

**A School of Construction and the Environment Factor Four Initiative** was conceived the following year, in 2009, as an applied research project to explore whether a four-fold (75%) reduction in materials and energy use could be achieved without compromising service levels in the seven buildings it occupies on BCIT's main campus in Burnaby. This project also provided an important opportunity to test the ideas being taught in the Sustainable Energy Management Program and further refine the curriculum as new insights were learned. The Factor Four target stems from a 1997 report to the Club of Rome by the same title that claims the technologies to achieve a four-fold reduction in energy and materials throughput in the built environment already exist [3]. The School's motto is: "concerned with the natural environment, the built environment, and the relationship between them." The School's leadership in sustainability education was gaining momentum and again in collaboration with the BC Hydro utility, a small amount of funds were obtained to initiate a project on campus to transform the seven buildings in which the School delivers most of its courses into a leading sustainable energy example that could potentially catalyze a transformation across BCIT's Burnaby campus as well as the surrounding neighbourhood comprising businesses, large institutional head offices and residential areas. Starting with a small \$5,000 grant from BC Hydro, the initiative has grown to attract over \$4 million in funding and generate over \$200,000 annually in energy savings. Using 2009 as a base year, the initiative achieved a 50% reduction in energy use and associated greenhouse gas emissions by 2016 [4]. A pathway to achieve the 75% reduction target was also identified, but this would require a major retrofit of a building currently slated for demolition. Nevertheless, the initiative proved the argument made by the authors of Factor Four that indeed it is possible to achieve substantial energy savings with existing technology and the right social approach to engaging people in changing behaviours. Over 250 BCIT students from 12 School programs spanning civil and environmental engineering, architectural building design, interior design, carpentry, joinery, welding, piping, electrical trades, and ecological restoration, to name a few, contributed ideas, research, and hours of voluntary work. BCIT's Student Association contributed funding, the School provided administrative support, and BCIT's service departments led by facilities and campus development and supported by finance, marketing and communications lent support to achieve the goal.

## **2.2 Institutionalizing Through Policy**

In 2014, BCIT officially institutionalized its sustainability ambitions through adoption of Policy 1010: Economic, Social, and Environmental Sustainability [5]. The policy was spearheaded jointly by BCIT's Vice President of Academics and Vice President of Finance

bringing the educational and operational arms together through shared commitment to achieve sustainability in education and operations. The policy provides a high-level articulation of BCIT's vision for sustainability and articulates seven goals to become:

1. Greenhouse gas neutral (i.e., avoid, reduce, absorb, offset emissions)
2. A net energy producer (i.e., generate more energy on campus than we use)
3. A Zero waste organization (i.e., rethink, reduce, reuse, recycle, and eliminate toxics)
4. Water balanced (i.e., staying within the capacity of natural hydrological flows)
5. Ecologically restored (i.e., restoration of campus ecosystems and native species)
6. Equitable and socially responsible
7. Accessible and safe to all students, faculty, employees, alumni, contractors, and visitors

With the Institute's goals for energy and climate management now enshrined in policy, BCIT embarked on a new cycle of leadership aimed at achieving campus-wide emissions reductions and development of onsite renewable energy generation.

### **3 Energy and Climate Management**

#### **3.1 Policy Alignment and Ambitious Target-Setting**

Aligned with Policy 1010, BCIT energy management staff, now including an energy specialist to support the energy manager, embarked on 13 energy management studies and completed 22 energy conservation measures between 2013 and 2016. These measures targeted BCIT's most energy intensive buildings across all five campuses and generated annual savings of 2.4 million kilowatt hours in electricity, 12.5 thousand Giga joules in natural gas, 686 tonnes equivalent of carbon dioxide emissions, and \$366,212 [6].

By this time, a new energy manager has been hired, a graduate of BCIT's Sustainable Energy Management program. Bringing all the skills of the demand-side management approach to the task at hand, and following the four "Rs" of community energy planning, BCIT is aggressively targeting continued energy and greenhouse gas emissions reductions through a holistic approach. Buildings and infrastructure are viewed as extensions of a continuous energy management system. Energy efficiency is being pursued through modernization of equipment and smart, fuel switching strategies that integrate waste-heat recovery. For example, BCIT's Downtown Campus was recently upgraded to install heat-recovery systems in its data centre. The technology enables the information technology data centre processors to vent heat for reuse in the building. This enables much needed cooling of the data centre processors without requiring additional electricity. A new energy dashboard has been created to enable all employees to see BCIT's energy use in real-time. Installation of photovoltaics, solar-thermal water heating, and geexchange contribute to 5% on-campus renewable energy generation across BCIT's five campus locations.

**BCIT is reaching its energy and climate change management goals** through a process that combines setting ambitious greenhouse gas emissions reduction targets combined with modernization of buildings and infrastructure on campus to improve energy efficiency, waste-heat exchange, smart fuel switching, and on-site renewable energy technology installation. Additional efforts include working with various campus operations departments to improve efficient use of appliances, adapt purchasing practices, and engage staff and students in stewardship programs. The results are helping BCIT achieve its goal to become a sustainability leader, ranking within the top 20 for energy and climate management in the UI Green Metric program.

### 3.2 Looking forward to 2023

In 2017, BCIT committed to a goal of reducing Institute GHG emissions by 33% by 2023. This goal is based on total BCIT emissions in 2007 as a baseline, or 8,700 tonnes of carbon dioxide equivalent. A 33% reduction would mean an annual GHG emissions inventory of approximately 5,800 tonnes of carbon dioxide equivalent. However, in 2017, BCIT's total energy demand increased by 16% over 2013 levels due to a combination of colder weather and new facilities at the Annacis Island campus, accounting for 4% increase in energy demand. Nevertheless, BCIT is committed to staying the course and upholding its commitments.

Looking farther into the future, BCIT is also committing to an 80% reduction in emissions by 2050. This goal is important to achieve global climate stabilization targets which are already accelerating, with a call from the Intergovernmental Panel on Climate Change to achieve zero emissions by this date. The task is daunting, but knowing what has already been achieved through the Factor Four initiative, BCIT is ready to be both a leader and learner, following the campuses as living laboratories of sustainability approach. If we achieved a 50% reduction in emissions in seven years, perhaps we can eliminate the other 50% in coming decades.

## 4 Summary/ Concluding Remarks

BCIT's energy and climate management story covers many decades and reveals the importance of flexibility and commitment to continuous improvement to achieve ambitious goals. Moving from a technology and cost-savings approach to a deeper social engagement strategy unlocked new opportunities for BCIT to expand the scope and reach of its energy management program. This in turn yielded concomitant greenhouse gas emissions reductions. A willingness to try new ideas and engage in novel approaches through partnerships has also enabled BCIT to not only benefit operationally through its energy and climate management endeavours, but academically as well.

BCIT's Sustainable Energy Management Advanced Certificate continues to train energy management professionals, and the Factor Four initiative continues to inspire ambitious targets beyond what conventional wisdom deems possible. Looking forward, BCIT continues to aim high and maintains its commitment to continuous improvement with the ultimate goal of becoming both a greenhouse gas neutral and net energy producing institution.

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