Factor Four Initiative: Implementation Update

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BCIT® | SCHOOL OF CONSTRUCTION AND THE ENVIRONMENT

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INTRODUCTION

BCIT's School of Construction and the Environment is concerned with the natural environment, the built environment and the relationship between them. The School is therefore interested in the science of ecocity building, how to build cities in balance with nature. In 2009, the School hosted a three day sustainability charrette facilitated by Kirstin Miller, executive director of Ecocity Builders, and Richard Register, founder of the ecocity concept and president of Ecocity Builders. The purpose was to work with staff, faculty and students to apply ecocity principles to envision the transformation of BCIT's Burnaby campus into a living laboratory of sustainability. Over the course of three days, the focus grew from small-scale efforts for immediate implementation to larger scale efforts to reduce energy and materials by a factor of four at the north end of the Burnaby campus (known as the sustainability precinct), to ambitious transformation of the entire campus to achieve factor-ten reductions in energy and materials consumption without compromising service levels.

BCIT's School of Construction and the Environment is concerned with the natural environment, the built environment and the relationship between them.

> *"BCIT's School of Construction and the Environment is seeking to demonstrate the 'science of ecocity building'. The objective is to redevelop an existing area of the Burnaby campus as a "living laboratory of sustainability". The project's overall goal is to achieve a site specific 75% (in approximately 5-10 years) and 90% (in 20 years) reduction in energy and materials consumption. These reductions will be achieved through a combined approach focused on the adaptive restructuring of the Sustainability Precinct's built environment, along with corresponding environmental restoration projects, energy and materials systems restructuring, and through social and behavioral change initiatives."*[1]

In the interest of achieving ecological sustainability, meaning use of ecological goods and services within nature's carrying capacity, the scientific community is calling for a four to ten-fold reduction in global levels of energy and materials consumption. Concerns about energy security coupled with evidence of anthropocentrically induced climate change, habitat degradation and species loss, global fisheries decline, desertification and water shortages point towards the relevance of the scientific community's challenge despite perceptions that such targets are unrealistic from an economic perspective.

BCIT is integral to the economic, social and environmental prosperity of British Columbia. British Columbia is a leader in green building technologies, and BCIT's School of Construction and the Environment (SoCE) is integral to this success. In its ongoing evolution as a leader in sustainability education, SoCE seeks to achieve a four to ten-fold reduction in energy and materials use in the buildings where it teaches, a portion of the BCIT Burnaby Campus previously known as the "Sustainability Precinct" and now called the "Factor Four Area."

[1]Miller, Kirstin and Richard Register. 2010. *The Sustainability Precinct: Establishing the Science of Ecocity Building at the British Columbia Institute of Technology – Burnaby Campus.* An initiative of BCIT in collaboration with Ecocity Builders Inc. Berkeley California: Ecocity Builders.

Located in the Northeast sector of the Burnaby campus the Factor Four Area comprises buildings NE1-NE8. These buildings house the majority of SoCE's programs. Applied research in reducing the ecological footprint of education delivery and campus operations while maintaining or improving the student learning environment serves as a key theme to align the concept of BCIT campuses as living laboratories with the Factor Four Initiative.

The Factor Four Initiative is a means to facilitate collaboration among SoCE research centres and between centres and programs, and between the School and the Administrative Services departments and related functions of the Institute in the creation of an Ecocity fractal, a small-scale example that brings all the elements of an ecocity together in one place. Such a focal point of activity may also help draw attention to the School's leadership capabilities in advancing the state of practice toward sustainability by industry, media and prospective students. "Longer term goals include using this initiative to catalyze a transformation of the entire campus to become a living laboratory of sustainability and to eventually work towards a factor ten reduction in energy and materials consumption."[2]

To date, the Factor Four Initiative has engaged students from several programs within SoCE as well as students from the School of Business and School of Energy. SoCE faculty, instructors and staff have collaborated extensively with staff from BCIT's Research Department specifically through the "Smart Micro Grid" project led by the Group for Advanced Information Technology. Collaboration with Campus Development and Facilities Services has also been essential for the implementation of many Factor Four projects. Both these groups and our industry partners are acknowledged for their leadership in advancing sustainability at BCIT.

All of the projects that comprise the Factor Four Initiative are documented on the Factor Four web pages (www.commons.bcit.ca/factorfour) that include teaching resources such as case studies, videos, working drawings and real-time data feeds to enhance the learning environment for educational programs.

To learn more visit: www.commons.bcit.ca/factorfour.

[2] Moore, Jennie. 2010. *BCIT Sustainability Charrette: Details about Implementation of Recommendations*. Burnaby, BC: British Columbia Institute of Technology, School of Construction and the Environment.

Factor Four at a Glance

Energy | Restoration | Materials

Living Lab = Factor Four

150+ students involved in projects and exercises	**5** Research Projects		**12** BCIT programs involved
15 case studies published	More than **50** stories published	More than **30** architectural, mechanical and electrical drawings made available to faculty and students	More than **10** engineering reports ready to be used in class
More than **4,000** views on the educational website since January 2014	Used in at least **4** online courses	**10** educational videos produced	**19** meters providing real-time data to students and researchers

$500,000/yr in energy cost savings once all projects are implemented or 30,000 GJ/yr

$185,000/yr of energy cost savings to date or 11,000 GJ/yr → **$240,000/yr** with wood waste-to-energy or 15,000 GJ/yr

More than **$3 Million** of external funds injected in the project to date → This amount will go up to **$3.8 Million** with wood waste-to-energy

Factor Four Financial Bottom Line

SoCE Programs and Research Centres

The School of Construction and the Environment is a leader in sustainability education and applied research, delivering solutions for one planet living. SoCE encompasses both technologies and trades programs that cover ecosystems, natural resources, the built environment, and engineered systems, spanning the full cycle of energy and material flows. Together this suite of programs comprises four educational portfolios:

- Building Design and Construction Technology
- Building Design and Construction Trades
- Engineering and Natural Resources
- Industrial Construction

The School maintains a suite of applied research centers and industry services that advance the state of practice and contribute to Factor Four efforts. These include:

- BCIT Rivers Institute
- Center for Energy Systems Applications
- Center for Architectural Ecology
- Building Science Center of Excellence

The School is also the lead educational partner with Ecocity Builders on developing the International Ecocity Framework and Standards (www.ecocitystandards.org). Factor Four is a strategic initiative by the school that engages students, faculty, instructors and staff in educational opportunities and applied research to explore how a community adaptively restructures their built environment and changes behavior to support a 75% reduction in energy and materials consumption.

> *"The School of Construction and the Environment has several research centers that will continue to participate with the Sustainability Precinct initiative. BCIT will also invite a range of talented and knowledgeable faculty from their architectural, engineering, ecological restoration and other departments for further consultation and support. Their aim is to draw upon their own resources as much as possible in order to build a culture of commitment to the initiative, reaching outward as well when needed. One of the advantages of a continued collaboration with Ecocity Builders, an internationally recognized NGO, is that BCIT can directly contribute to, and be acknowledged for, the worldwide advancement of the 'science of ecocity building' as they move through the Sustainability Precinct's phases of conceptualization, design and implementation."*[3]

[3] op. cit.

From 2009 Charette to Today

After the three day sustainability charrette in 2009, a steering committee was struck to review charrette outcomes and develop a strategy for implementation. Outcomes from the charrette included recommendations for BCIT's Campus Master Plan and for moving forward within SoCE. The Steering Committee comprised those faculty and staff that participated in the charrette namely: the Director of Sustainable Development and Environmental Stewardship who chaired the meetings, the Directors of the SoCE research centres, faculty from the Architectural Science Program, and the Directors of Campus Development and Facilities Management.

Following the structure of the charrette, the committee approached implementation of the then called "Sustainability Precinct" initiative through actions for:

i. Immediate Implementation
ii. Factor Four (mid-term implementation over the next five to ten years)
iii. Factor Ten (long-term implementation over the next twenty years)

The committee also agreed to change the name of the overall initiative from "Sustainability Precinct" to something more welcoming and representative of the long-term vision that this effort should serve as a catalyst to transform the entire campus, not just a portion thereof. Eventually the name "Factor-Four Initiative" was adopted because it reflected the mid-term focus for action over the next five to ten years. It was not too ambitious to envelope the whole campus, but bold enough to express the intent by the School to transform the educational space it occupies into a living lab of sustainability, specifically showcasing the Schools capabilities in ecocity building: concerned with the natural environment, the built environment, and the relationship between them.

The committee agreed that actions for immediate implementation within the precinct should be bound by priority initiatives to: a) daylight Guichon Creek, and b) transform NE1 into an ecocity fractal. These priority initiatives were seen as the catalysts to larger scale transformation and should be bridged by the physical space in between, i.e., the buildings along Smith Street. Actions included establishing baseline data for energy and materials consumption and applying street repair techniques to improve the look and feel of the area. These quick wins would build momentum towards achieving the longer term goals of factor four and factor ten reductions in energy and materials consumption.

The committee agreed that implementation efforts should focus on four initial projects:

i. Daylight Guichon Creek,
ii. Rethink NE1
iii. Reduce energy and materials through-put in buildings NE2-NE8
iv. Improve the look and feel of Smith Street.

Sustainability Icons — Sustainability at BCIT

BCIT aims to reduce its ecological footprint through pursuit of seven sustainability goals. Factor Four is one way that SoCE is striving to meet these goals to become:

Green House Gas Neutral: Eliminate or absorb all carbon-based emissions from fossil fuel combustion and decomposing vegetable waste related to campus activities.

A Net Energy Producer: Produce carbon-free, on-site power that meets or exceeds needs for campus facilities operations and staff, faculty and student use. Manage energy and materials demand efficiently.

Zero Waste: Eliminate or reduce to the maximum possible all wastes associated with campus activities and affiliated facilities and operations. End the use of toxics and persistent pollutants not readily assimilated into the environment on-campus or in the atmosphere, downstream, or in groundwater.

Water Balanced: Eliminate storm sewer discharge and reduce or eliminate potable water purchases through rainwater harvesting on-site, and maximize ground water recharge through integrated stormwater management.

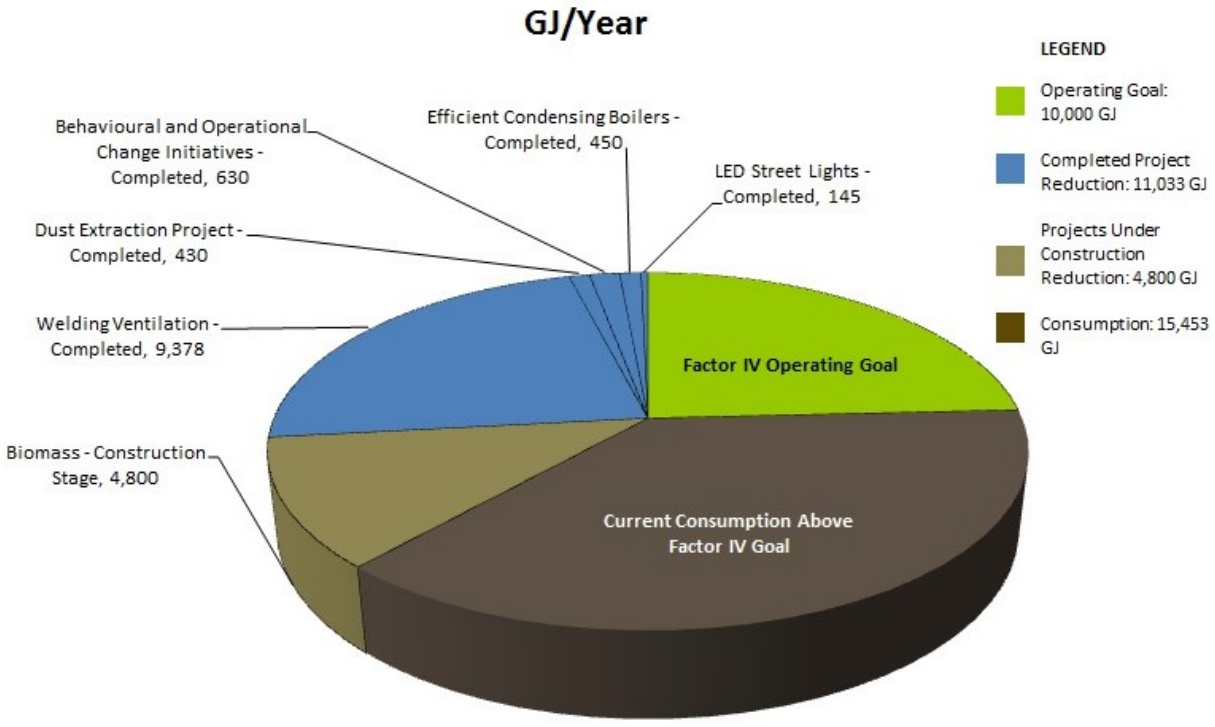
Ecologically Restored: Re-establish full functioning of original ecosystem capacity equivalent to predevelopment levels, including number and vitality of habitat and plant and animal species, while preserving student and personal safety. Provide for species and habitat preservation and restoration in bio-geoclimatic zones off-campus affected by campus-related activities.

Equitable and Socially Responsible: Achieve ethical treatment of and behaviour by students and personnel when making consumer or lifestyle choices. Offer learning opportunities about full cost accounting and lifecycle assessment in purchasing, construction, and maintenance and operations (including academic/extracurricular activities and healthy work environments).

Accessible to All Students and Faculty: Provide students and personnel opportunities to engage in learning activities and campus greening initiatives that accommodate students' and personnel's diverse needs and beliefs.

ENERGY

Factor Four aims to reduce energy throughput by 75% without compromising service levels and with a majority of projects completed under the living lab concept, allowing students to learn as we implement solutions. For Factor Four's energy piece to achieve this mandate the following statements have to be true once the initiative is completed: buildings operate on 25 % of the energy relative to 2008/2009 fiscal year, the area remains a diverse community where trades and technology programs are delivered, the instructors working conditions and the quality of their services were not compromised due to the Factor Four energy projects, BCIT students from varied programs were involved in all projects at different levels, key staff is aware of Factor Four's projects and energy reduction targets and all Factor Four projects can be replicated and are financially viable.



Real Time Metering

Completed 2011

You can't manage what you don't know. In order to understand how much energy is used in Factor Four, meters at the building level were installed to measure all types of energy going into Factor Four's buildings. The data can be used to create a consumption baseline, track progress, and assign a budget in order to drive change through cost accountability. The data can also be used as the foundation of numerous behavioural change campaigns as they relayed real-time feedback to users with regards to their progress. In addition to building awareness of energy conservation, real-time monitoring provides building operators the ability to address concerns more timely and more effectively.

The project included installation of electrical smart meters, hot water meter, modules to existing natural gas meters and integration with the Smart Micro Grid's Energy Management System (EMS).

Quick Facts:

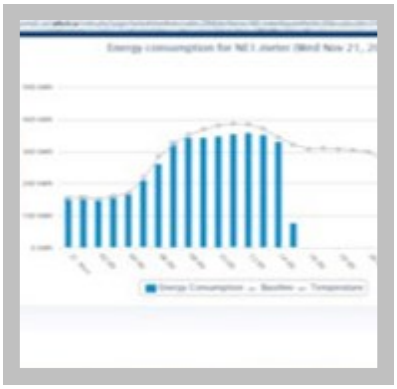
- This project is a partnership with BCIT's GAIT group
- This project received support from Itron and Tantalus
- A total of 19 meters were installed to monitor all Factor Four buildings

Real Time Metering

Schneider Electrical Meter

Siemens Hot Water Meter

Itron ERT 100G Natural Gas Module



The data is retrieved by the GAIT EMS system

Wood Dust Extraction System Retrofit

Completed 2010

The Joinery and Carpentry shops are run throughout the year and provide a learning space for a cohort of up to 64 students per building at any given time. The Joinery shop alone has approximately 150 work stations. To maintain air quality, the shops use a dust extraction system: a ventilation system specifically designed to remove dust. The retrofit included the replacement of an old constant-volume that used to operate all day even when no work was being done. The new on-demand system operates only when and where dust is created, substantially reducing electricity needed to run the fan.

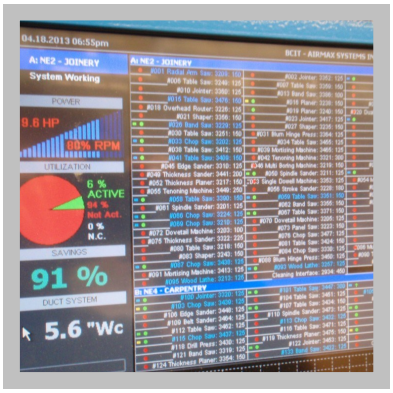
Quick Facts:

- The new system uses 80% to 90% less electricity than an equivalent constant volume system, saving 120,000 kWh per year, the same amount of energy that would be produced by 600 solar panels installed.
- The total project cost was $750,000 with $71,000 of incremental cost.
- BCIT received a $45,000 grant from BC Hydro Power Smart program to support this energy efficient project.

Wood Dust Extraction System Retrofit

2 fans (20 and 50 hp)

2 VFDs (one per fan)



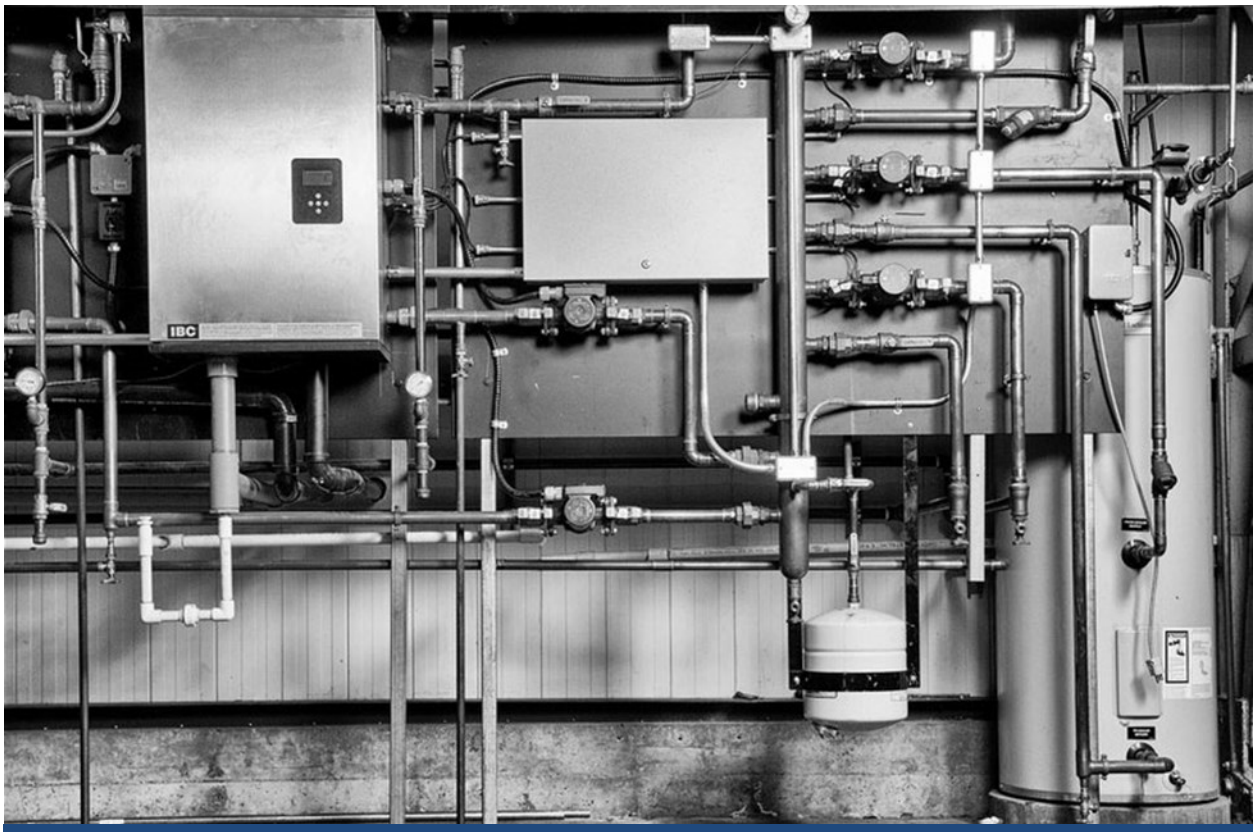
Zoom on HIM – Each workstation has a line

General indoor layout

Actuator and gate (detail)

Each workstation equipped with an actuator and a gate.

Condensing Boiler System in Piping Building



Completed 2011

The piping building is occupied by students and faculty of the Piping Foundation and Apprenticeship programs. Piping includes plumbing, steam-fitting, gas-fitting, and sprinkler-fitting. This is BC's largest piping trades training facility, offering the widest scope of programs, and has been the leading provider of training for the last 50 years. A state of the art, energy efficient condensing boilers system was proposed and installed by the staff and students of the piping program in their building. The condensing boilers are used for domestic hot water heating and space heating of the piping workshop and also serve as showcase for the technology. Unlike atmospheric boilers, condensing boilers use the waste heat from the flue gas to preheat the cold water entering the boiler. This leads to better efficiencies, up to 98%.

Quick Facts:

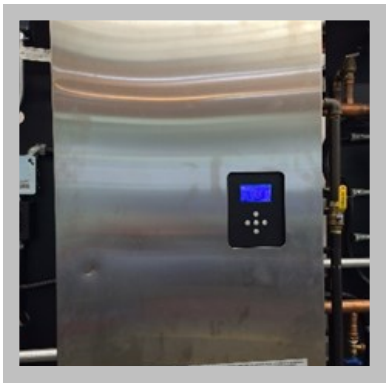
- Total annual energy savings are approximately 450 GJ/year. This is equivalent to the energy contained in 1,163 BBQ Propane tanks and offsets 23 tonnes of CO_2eq per year.
- The FortisBC Light Commercial Energy Star Boiler program provided a total of $1,500 to install these boilers.
- Boilers were donated by IBC technologies, a local boiler manufacturer.

Condensing Boiler System in Piping Building

Smart circulation pump

Distribution header

Circulation pump



Packaged boiler

Behavioural and Operational Change Initiatives

Completed 2011

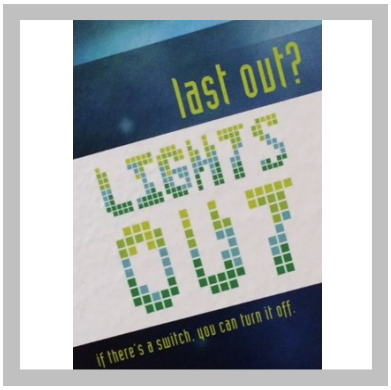
In Factor Four two successful initiatives have taken place that reduced energy consumption without capital costs: the light savers and heat savers campaigns. The light savers is about turning off lights and heat savers is about turning down the heat. The campaigns are complemented by operational changes when needed. For example, by rewiring the lighting system so that one bank of lights was left on at all times it made it possible to turn off the lights at night and still maintain safe lighting in the Joinery shop. During the heat savers campaign it was discovered that the Carpentry students were often quite hot during the winter months as they do manual labor during the day and had to open the large bay doors to keep cool. By setting the heat level down to 16°C students are more comfortable and energy is saved. Changes were also made guarantying that if the bay doors were open, the heat level dropped to 12°C.

Quick Facts:

- 100,000 kWh of electricity per year are saved, enough to power eleven average lower mainland homes each year.
- 270 GJ of natural gas per year are saved, the equivalent of the energy contained in 658 BBQ Propane tanks.
- BCIT received the support from Fortis BC ($5,000) and BC Hydro Power Smart ($5,000) to implement the campaigns.

Behavioural and Operational Change Initiatives

Light Savers Campaign ad.

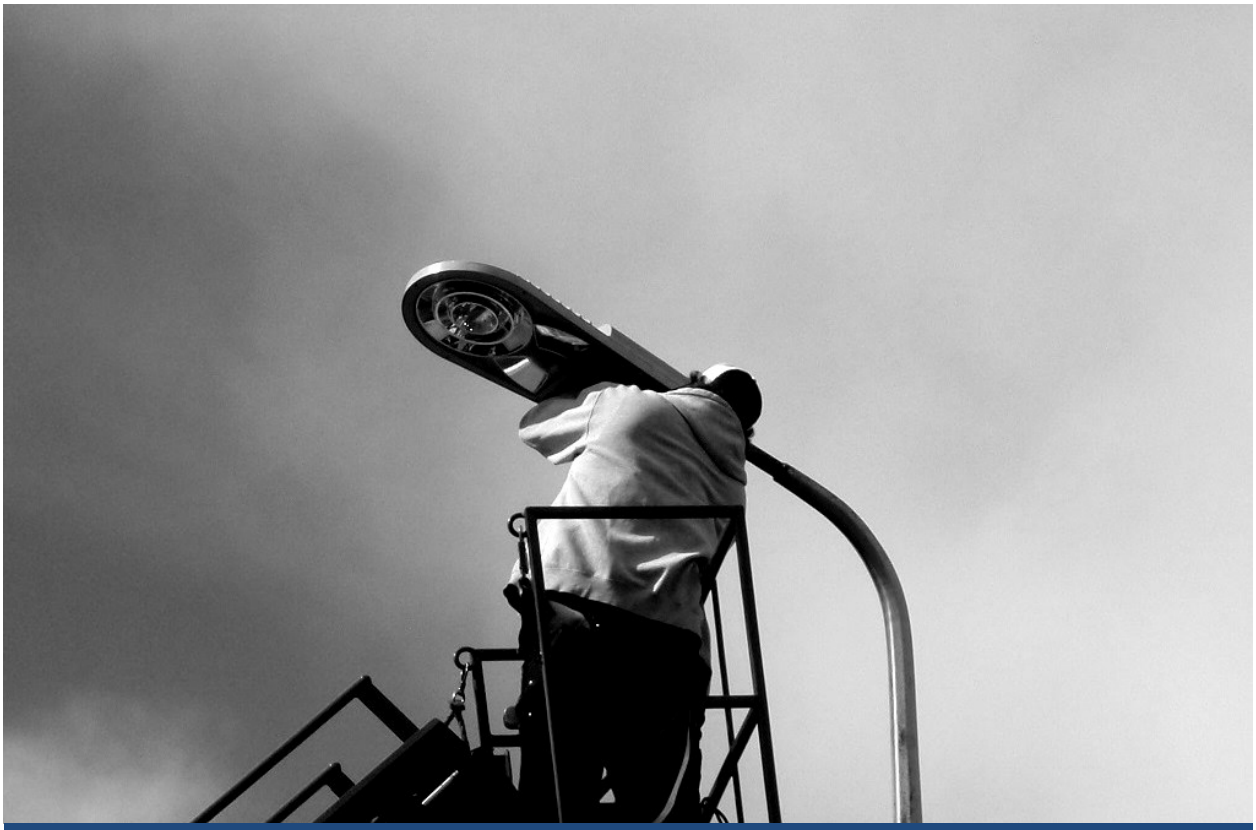


Light Savers Campaign wall decal.

Heat Savers Campaign ad.

Heat Savers Campaign wall decal.

LED Outdoor Lighting



Completed 2013

All the old lights (HID – 250 Watts) on Smith Street were replaced with new LED lights (142 Watts). All exterior wall mounted lights were also replaced with LED, going from an average of 150-70W to 40-13 W. The new LEDs save electricity (and associated costs) but they also make maintenance easier. On average, an HID lamp will operate for approximately 15,000 to 20,000 hours before burning out. In contrast, the new LED lights are expected, on average, to last for approximately 50,000 to 60,000 hours. The longer LED life expectancy means that approximately 3 lamp changes per lighting fixture can be avoided using LEDs.

Quick Facts:

- Electricity reduction of 40,000 kWh/yr the same amount of energy that would be produced by 150 solar panels installed.
- Project total cost in the Factor Four Area was $30,000.
- In total 10 Cobra heads (100 watt), 40 wall mounted (110 watt) and 20 door lights (57 watt) were installed.

LED Outdoor Lighting

Cobra

Smith Street

Door Light

Wall Light

On-demand Welding Ventilation Retrofit

Completed 2013

This upgrade replaced the outdated ventilation and HVAC systems in the Welding building with a high-efficiency, demand control system that allows for selective, localized ventilation in each welding booth. The new system enables ventilation fans to run at speeds that correspond with the amount of air that needs to be vented, saving electricity. Additionally, less air from inside the building is exhausted resulting in less heat required for the make up air that is vented, saving natural gas. Students and instructors benefit from the expanded training facility, decreased ambient noise, and improved air quality. Provisions to add heating coils that would receive hot water from the Factor Four wood waste to energy project were included. The day the biomass boiler and thermal grid are built, the Welding shop could become close to being carbon neutral.

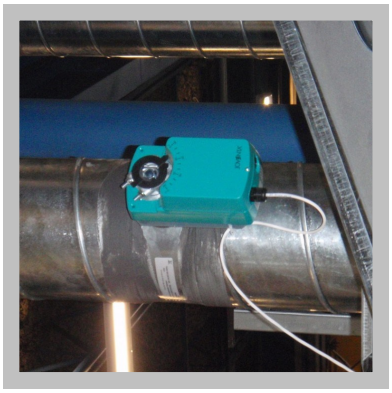
Quick Facts:

- The new system uses 80% less electricity, saving 800,000 kWh/yr, the same amount of electricity used in 89 Lower Mainland homes every year.
- Natural gas reduction consumption of 6,500 GJ/yr are achieved, reducing 350 tonnes CO_2 emission, that's equivalent to CO_2 emissions from 150,000 litres of gasoline consumed every year
- The project cost was $2.7 million, funded by the Ministry of Advanced Education, with an incremental cost of $500,000
- BC Hydro provided an incentive of $175,000

On-demand Welding Ventilation Retrofit

General view of work in progress on the roof.

Local air extraction using telescoping arm



Actuator for damper – The new system is demand-controlled

Student using the new ventilation system.

AFRESH Home HVAC Retrofit

Completed 2014

The AFRESH home is a demonstration house that showcases residential construction and energy conservation and energy production technologies. The heating of the house is provided by a geo-exchange system. The HVAC system was renovated to use the geo-exchange system also for cooling during the summer months. A bypass of the piping system in the crawl space was done to allow the geo source water to run through the coils in air conditioning mode, this approach has the potential to have very high efficiency (COP over 6.0). Additionally new fan coils designed to work at the usual temperatures of a geo-exchange system and variable speed fans will make the system perform more efficiently during the heating season.

Quick Facts:

- The project cost was $10,000

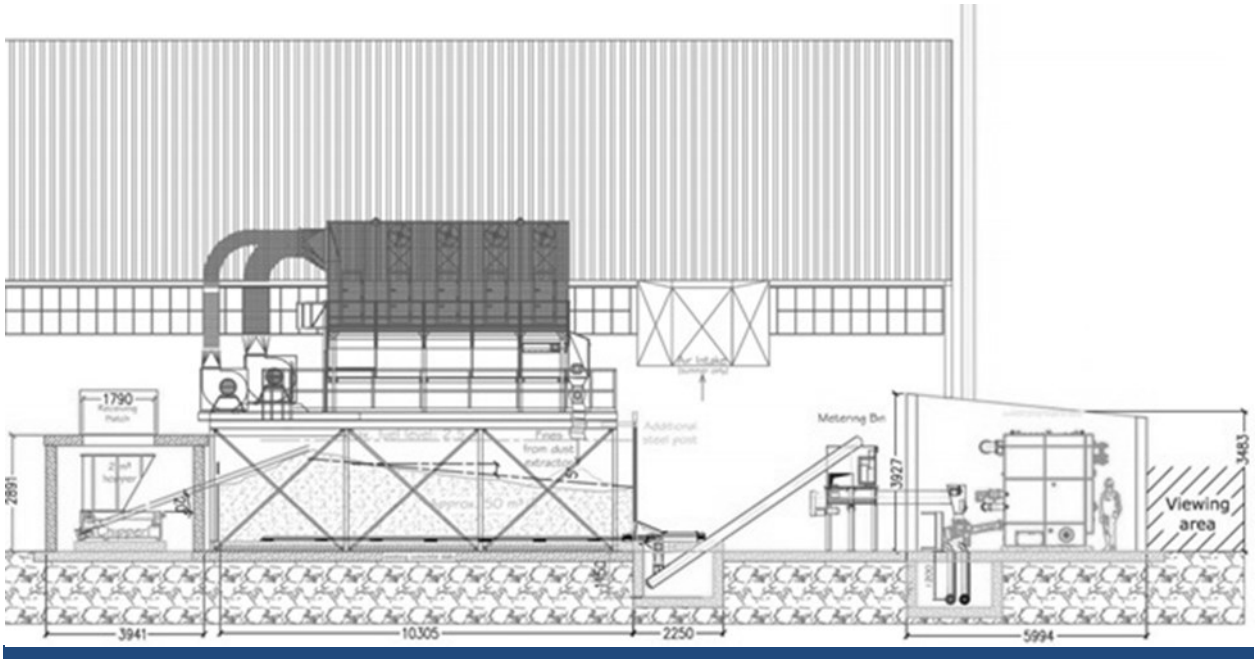
AFRESH HOME HVAC RETROFIT

Geoexchange System Heat Pump

Geoexchange System Air Handling Unit

Geoexchange System Heat Recovery Ventilation

Waste-to-Heat Biomass System



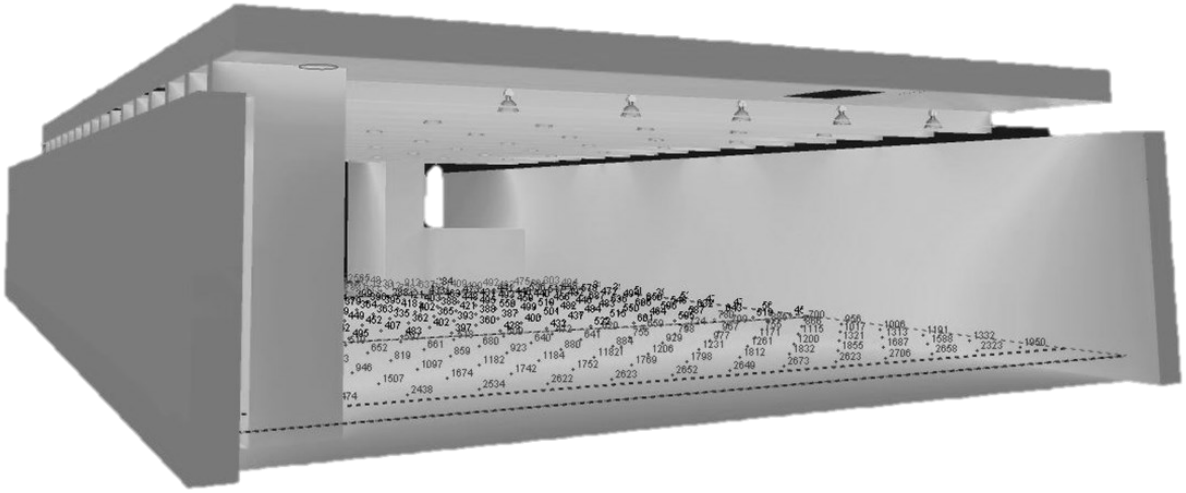
Construction Starting Fall 2014

The design and installation of a waste-to-heat biomass facility is a BCIT Factor Four Initiative and will integrate into the Burnaby Campus heating distribution system. The facility will house a 200 kW biomass boiler. The project targets waste reduction of 250,000 kg per annum, and greenhouse gas emission reduction of 240 tonnes of CO2eq annually. Functioning as a "Living Laboratory", the building will include an outdoor interpretative teaching space, technology viewing windows, and displays. Programs that will benefit from this project include: Sustainable Energy Management, Environmental Engineering, Joinery, Carpentry, Environmental Health, Occupational Health, Stack Testing and Mechanical Systems.

Quick Facts:

- Approximately 4,800 GJ of natural gas displaced
- More than 240 tonnes of CO2eq avoided
- One waste hauling truck removed from campus each week
- 250,000 kg of wood waste with a new purpose
- More than 10 school programs involved in the project
- Estimated cost of project is $840,000 (100% external funding)
- Estimated savings of $50,000 per year

Daylighting the Carpentry Canopy



Not Started (Study Phase)

BCIT's Carpentry students construct and assemble many projects under a large outdoor canopy. However, even though they are outside, there is not enough daylight for them to work safely. Artificial lighting is therefore needed under the canopy roof even on a blue sky day. The good news is that the canopy was designed with the option to install skylights or solar tubes or a combination in the future. Skylights and/or solar tubes along with daylight sensors only activate artificial lighting when there is not enough natural light which will greatly reduce Carpentry's electrical use.

Quick Facts

- Estimated savings of 27,000 kWh per year
- Estimated cost of project is $160,000

VIRTUAL WELDING

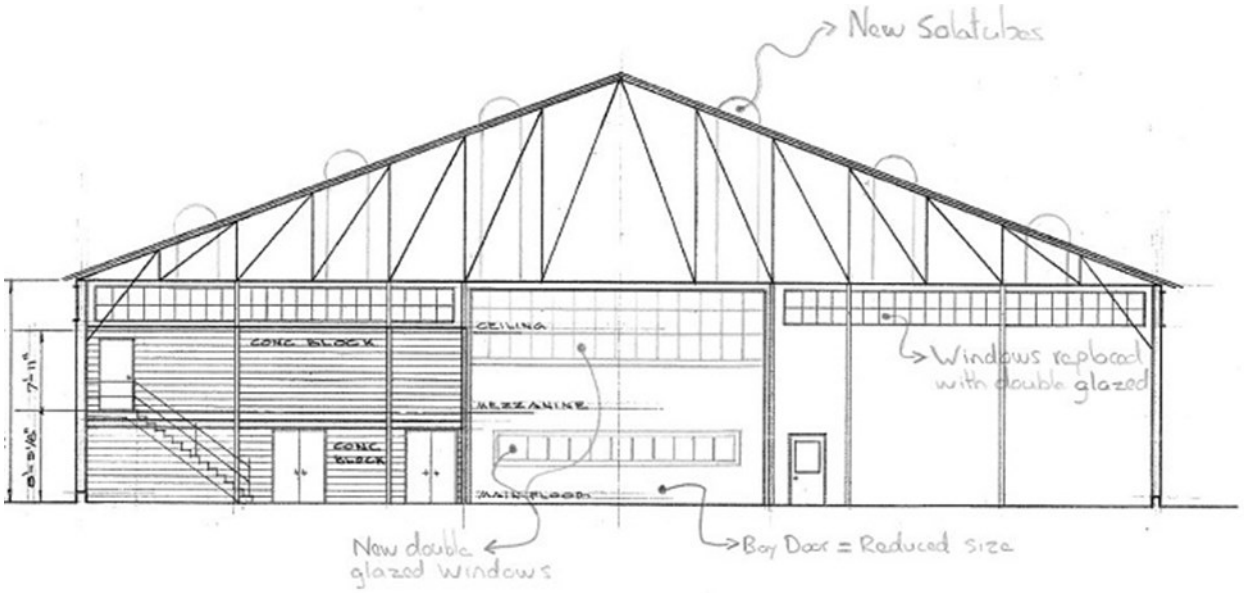
NOT STARTED (STUDY PHASE)

Currently the new ventilation system extracts air from a welding booth only if someone is welding, but additional energy savings can be realized by moving to virtual welding for a portion of the Welding program. This method would reduce natural gas and electricity use. Power welding guns use electricity and implementing a virtual system can help save energy by only using a fraction of the electricity. Additional energy savings can also come from ventilation as it is not required for virtual welding. Also, materials are reduced, as metal, shield gas, rods and other consumables are not needed with virtual welding.

Quick Facts

- Estimated energy savings of 54 GJ per year
- Estimated cost of project is $60,000

LIGHTING REDESIGN



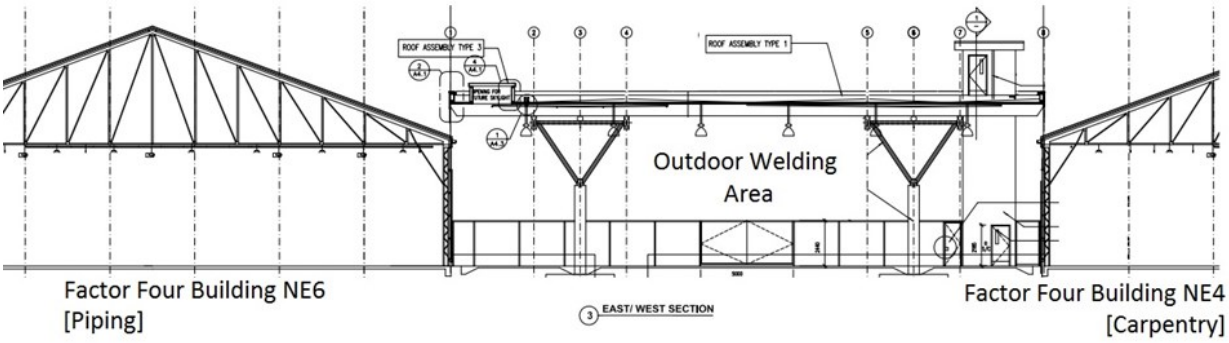
NOT STARTED (STUDY PHASE)

The goal of the lighting redesign project is to increase lighting efficiency in NE2, NE4 and NE6. This would involve retrofitting the current fluorescent lighting system controlled by a main switch to using a mix of natural light and a higher efficiency lighting system. Instead of having one central light switch/control, lighting can be turned on by motion sensors, timers or other customized controls to reduce the use of artificial lighting. Another part of this project is de-lamping and re-lamping areas. This involves removing unnecessary lighting and adding lights to areas that are in need for better lighting.

Quick Facts

- Estimated cost of project is $200,000.
- Estimated savings of 60,000 kWh/year.

Outdoor Welding



Not Started (Study Phase)

This building is occupied by students and faculty of the Piping Foundation and Apprenticeship programs. Piping includes plumbing, steam-fitting, gas-fitting, and sprinkler-fitting. This is BC's largest piping trades training facility, offering the widest scope of programs, and has been the leading provider of training for the last 50 years.

Currently students of the Piping program are welding indoors and as a solution to their ventilation problem, the garage door to the facility is constantly opened to circulate fresh air. This in turn increases the amount of energy used to heat the building. A solution to this issue is to building an undercover area for students to weld outside. This will create a workspace that will be a safer, healthier, reduces energy usage and creates a more realistic learning environment for students.

NE1 as a Passive Building

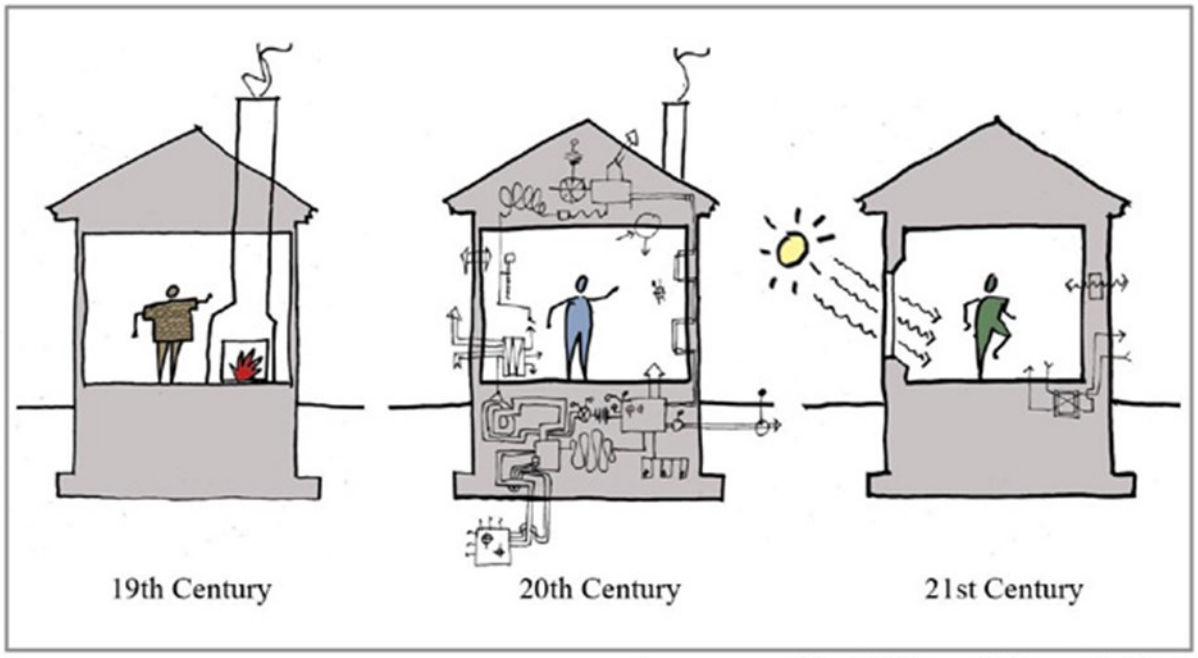


image source: Albert, Righter and Tittmann Architects

Not Started (Study Phase)

NE1 is the largest building of all Factor Four buildings and it houses multiple BCIT programs. The long term plan for NE1 is replacement with a new building due to major deficiencies. There is the interest to build the new building to the very low energy intensity dictated by the Passivhaus Standard, which also has the advantages of creating space with excellent comfort levels and lower maintenance cost due to the simplicity of the design. As part of a Passivhaus learning strategy, the Factor Four Energy Plan recommends retrofitting a smaller building (i.e. Center for Architectural Ecology) first, in order to learn about the standard.

In the meantime, there is an opportunity to look as some short term interventions that could improve the energy consumption of NE1 (with the concepts of passive buildings in mind. Any fixes with a payback shorter than the remaining life of the building could be considered. Our consultant worked with Faculty, students and staff in the spring of 2014 to identify a list of intervention that could help with the Factor Four objectives in the short term. According to the building simulation, separating conditioning from ventilation, adding operable, double-glazed windows on the North façade, adding internal insulation along the building façade, adding heat recovery ventilation and making some changes to the lighting system could lead to an energy reduction in the range of 70 to 75%.

Quick Facts

- Estimated savings of 12,700 GJ per year (3,500,000 kWh per year)
- Estimated reduction of 450 CO2eq per year
- Estimated $200,000 per year of energy and GHG cost savings

RESTORATION

In order to achieve a 75% reduction in energy and material throughput, the Factor Four Initiative is encouraging a sense of place as well as ecological restoration. These efforts are spearheaded by two groups.

Urban Restoration: The Eco-Streets group is focusing on Urban Renewal, changing the look and feel of the area and increasing walkability. This group is comprised of staff and faculty from a variety of departments and programs.

Ecological Restoration: The Ecological Restoration group focuses on the daylighting of Guichon Creek and creating a functional aquatic ecosystem. This group is spearheaded by BCIT River's Institute and programs such as the Fish, Wildlife and Recreation and Ecological Restoration.

Pedestrianization of Smith Street

Completed 2013

Smith Street runs for 200 meters through the Factor Four Area. This is the main road that services the buildings in the Factor Four Area, as well as a pedestrian route across campus. Originally the road had a sidewalk on the North side of the road, and travel on the South side of the road was obstructed by garbage, recycling and wood waste bins.

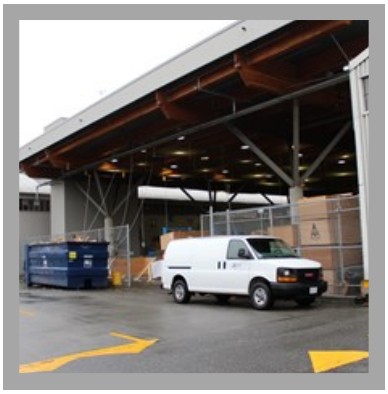
The Urban Restoration group within Factor Four worked with Campus Planning, Facilities and students in the Interior Design program to create a more pedestrian friendly streetscape. Based on the ideas of the interior design students the bins were relocated and a pedestrian walkway on the South side of the road was created by planters and paint. The planters are self-watering and consistent with other planters across campus. This ensures they can be repurposed or relocated if necessary. The plants are all native to our community and require low maintenance. The physical barriers created by the plants increase safety for pedestrians by separating them from vehicle traffic. The pavement treatment guides the pedestrian and adds color to the street. Combined with the educational signs located by the doors, the new walkway invites visitors to look through the window to see our students and faculty in action.

Quick Facts

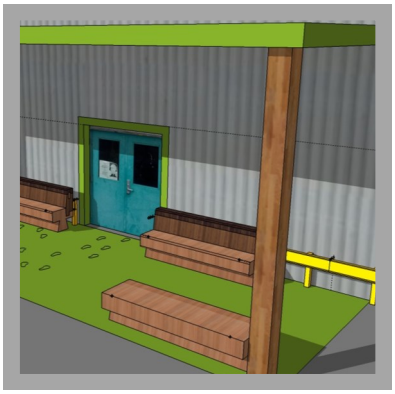
- The new pathway creates a safe convenient access to the Piping, Carpentry, and Joinery buildings as well as the Elevated Research Platform (green roof).
- The 10 planters provide additional greenery; they are self-watering and can be repurposed if necessary.
- This is part of a long term goal to make this area more pedestrian friendly, and to encourage a sustainable, creative industrial feel reminiscent of Granville Island.

Pedestrianization of Smith Street

Smith Street before improvements.



Prior to improvements bins and vehicles blocked the path.



Pedestrianization ideas from Interior Design Students.

Pedestrianization ideas from Interior Design Students.

A walkway offers a clear, safe path for students.

Planters add colour and greenery to Factor Four.

Guichon Alley — Creek Awareness

Construction Starting Summer 2014

Guichon Creek runs across BCIT's campus, open on the South side and culverted on the North. Guichon Alley, is located on the north side of campus and runs through the Factor Four Area. Phase one of the Guichon Alley project is about bringing awareness of the value of well-preserved urban creeks. Originally unnamed, this alley now serves to remind people that Guichon Creek flows underground. Yellow Fish, indicates that storm drain runoff goes into creeks, have been added to all drains on campus by students in the Ecological Restoration program.

The alley is closed to most traffic and provides a walking path and outdoor space for students in the Piping and Welding buildings. A new design for the space has been created by Interior Design students. A mural will celebrate the Creek's past and our hopes for its future, while benches will provide student space. This project will be partially built by the Steel Trades and Carpentry students in the summer of 2014.

Quick Facts

- Renaming the alley and adding a mural that celebrates the creeks future brings attention to Guichon Creek and the goal of one day daylighting it.
- Yellow Fish designs by storm drains remind people that anything poured down the drains affects local streams.
- Interior Design students came up with a design to transform the alley into a new student space.
- The goal is to transform this into a student space that brings attention to Guichon Creek and the goal of one day daylighting it.

Guichon Alley — Creek Awareness

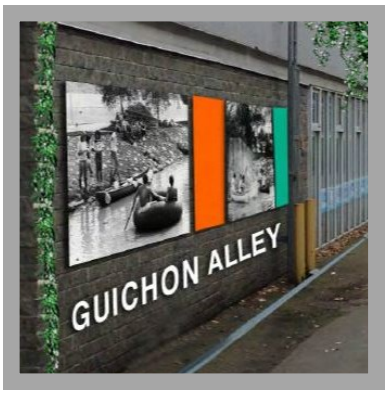
Guichon Creek in 1964, prior to being culverted.

Guichon Alley before improvements.

There is limited seating for students on break.

Students in Ecological Restoration apply Yellow Fish.

Alley design concept by Interior Design students.



Mural concept by Interior Design students (detail).

Architectural Ecology

In Progress

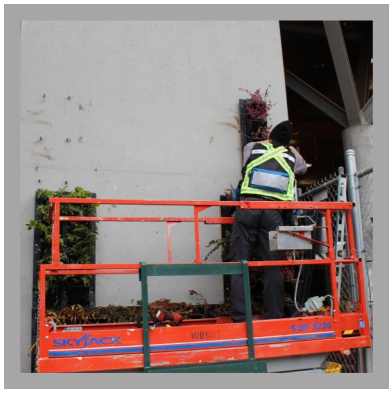
The Centre for Architectural Ecology, with the support of Campus Planning and Facilities Management, improved access to the elevated platform in 2013. A elevated platform classroom deck, interactive living walls, green façades and green roof learning plots, real-time display monitor of storm water and thermal performance of green roofs, and a rainwater harvesting system to support the living architecture are planned and going through the approval process. The students of Carpentry and Piping will be involved in the installation of the deck and rain water harvesting system. The goal of Factor Four is to work with the Centre for Architectural Ecology to highlight the research that is done by the Centre within the School of Construction and the Environment.

Quick Facts

- There is a 25 square metre living wall installation on the lower north wall of the stairwell.
- The fence beside the living wall will be vegetated with a prototype planter/climber system. The green fence will demonstrate how quickly and easily green streets can be and possible implementation across campus.
- A display monitor will be installed in the middle of the living wall. The display monitor will be connected to a video camera placed on the green roof and to a series of sensors and meters. The monitor will display real-time performance data of living building systems and information on current Centre activities.
- Living Wall Project: Contractor: Architek, Supplier: Modulogreen, Structural Constultant: RJC Engineering, Funding: School of Construction and the Environment, Center for Architectural Ecology and Factor Four Initiative.

Architectural Ecology

Living Wall design.

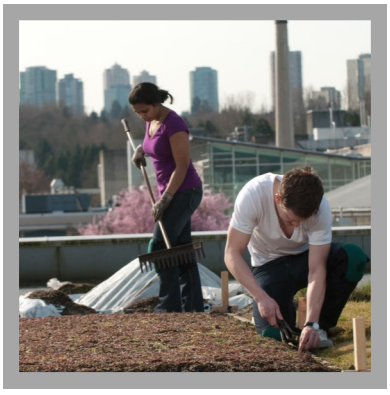


Installation of the new living wall.

Living wall panels (detail).

The living wall and Elevated Lab.

Roofing Evaluation Models for energy performance.



Students experience research on the Elevated Lab.

Façade Improvement

In Progress

BCIT is working to improve the facades of the buildings on Smith Street. Campus Planning and Facilities will be considering a new façade for NE1 that will reduce energy consumption. The doors on the shops in the Factor Four Area are also at end of life, and we are working with Facilities and Campus Planning to choose doors that that will reduce heat losses, will bring more natural light inside the buildings and most importantly, will allow us to celebrate who we are and what we do. Indeed, the new door design, in combination with the new Smith Street south walkway and educational signs, will allow the shops and the students working to be visible to pedestrians. The interior design students also recommended using paint to highlight architectural elements and bring a fresh look to the area.

Quick Facts

- The AFRESH home will be repainted in the summer of 2014.
- The garage doors on NE 6, NE 4, and NE 2 will be replaced with doors that offer natural light and showcase the student learning.
- The goal is to improve the look and feel of the Factor Four Area and get students and faculty excited about the challenge of energy and material reduction, as well as creating a positive social space.

Façade Improvement

Campus Planning will consider a new façade for NE1.

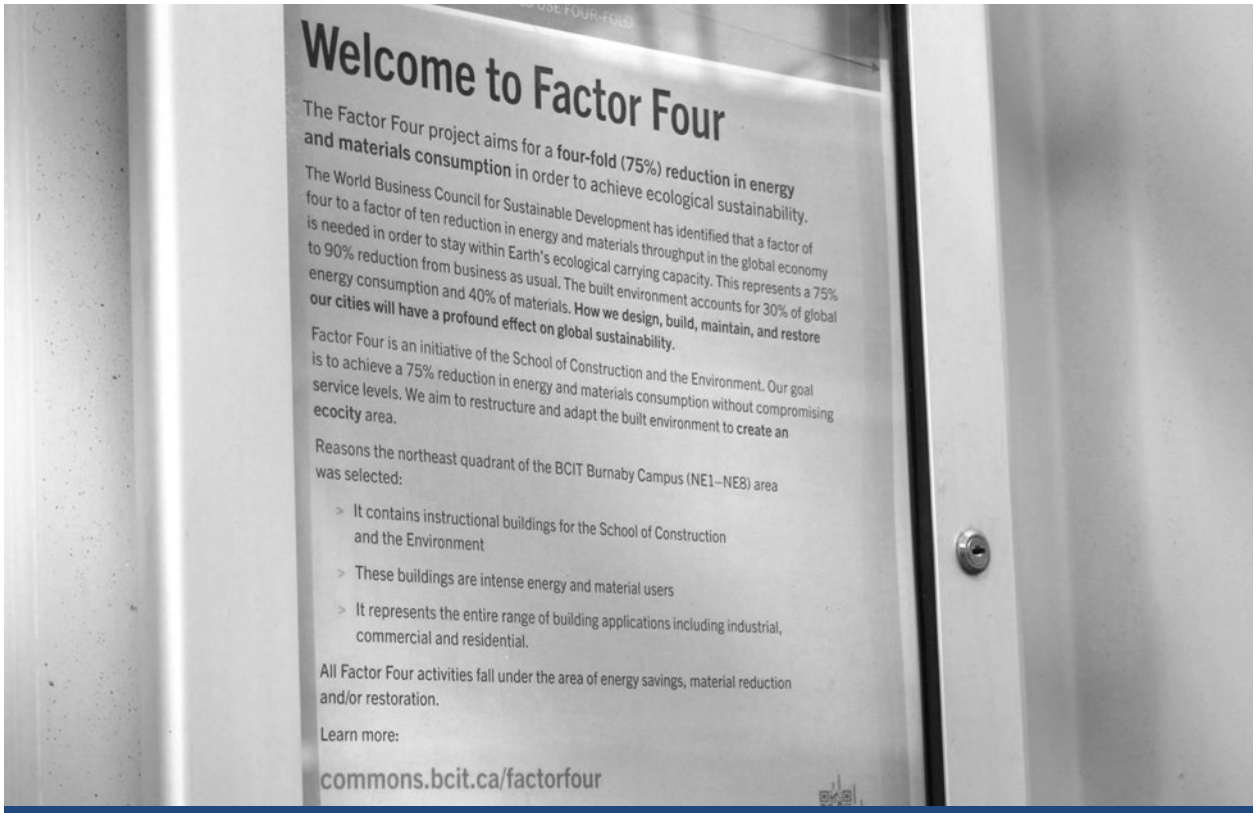
New paint will refresh the AFRESH Home.

Campus Planning will improve the garage doors.

Concept from the Interior Design Students for Façade Improvement.

Concept from the Interior Design Students for Façade Improvement.

EDUCATIONAL SIGNAGE



COMPLETED 2012

As part of the educational goals of the Factor Four Initiative 15 signs have been placed on the exterior of the buildings in this area. These signs help explain how we are reducing energy and materials in the Factor Four Area. Some of the signs give more information on specific projects, such as the wood dust extraction system, while some help identify the programs within the Factor Four Area and how they are contributing to the project. The signs were chosen with sustainability in mind, as they are easy to update as work progresses, and can be repurposed. A Self-Guided Tour brochure has been created identifying the location of the signs so people can tour the area on their lunch break or with their students and learn what's happening in the Factor Four Area.

Signage has also been added to the AFRESH home to make it easier to identify technology and understand how it functions. This allows instructors to tour students through the house.

Quick Facts

- 15 signs give more information on specific projects, such as the wood dust extraction system, while some help identify the programs within the Factor Four Area and how they are contributing to the project.
- There is a Self-Guided Tour that lets people to explore the Factor Four Area on their own.
- Signage in the AFRESH home makes it easier to identify technology and understand how it works.

Daylighting Guichon Creek

Not Started

Guichon Creek transects the east side of BCIT's Burnaby Campus and is a fish bearing stream at its south end. Near the mid-point on campus, Guichon Creek spills into a large concrete culvert and travels underground through the north-east quadrant of the campus. Recent studies by the BCIT Fish, Wildlife and Recreation Program faculty and students indicate that trout and salmon cannot navigate upstream through the underground section of the culvert, hence the upper reaches of Guichon Creek are currently inaccessible to trout and salmon migrating upstream from the Fraser River through the Brunette River, Burnaby Lake and through Still Creek, of which Guichon Creek is a tributary. BCIT's Campus Development Plan identifies daylighting the entire length of Guichon Creek as an important objective that supports the Institute's sustainability goal to become ecologically restored and a functional aquatic ecosystem. Phase two of the Guichon Alley will include work from the BCIT Rivers Institute, BCIT Ecological Restoration program and Campus Development to assess whether or not it would be possible to daylight this portion of Guichon.

Quick Facts

- Trout and salmon cannot navigate upstream through the underground section of the culvert without daylighting portions.

AFRESH HOME SUSTAINABLE GARDEN

NOT STARTED

The AFRESH home, is a demonstration house that showcases innovations in sustainable housing construction and energy efficiency. The concept behind the sustainable garden demonstration project is to introduce a template of sustainable landscape practices which members of BCIT's community can benefit from, while improving the landscape of the area. The goal in showcasing these approaches is to highlight the environmental, social and economic benefits of these systems and practices so that they may be incorporated in the residential or commercial environment. While employing these elements, the garden will beautify the Factor Four Area and provide higher learning for our community.

Quick Facts

- A rain garden, rain chains, native plants and worm composting will reduce energy consumption and waste generation.
- The introduction of mason bees and companion plants will create a habitat for wildlife and pollinators.
- Raised bed gardens and vertical gardens will showcase maximized production for small spaces.
- A $5000 contribution from TD Friends of the Environment Foundation was secured for this project.

MATERIALS

Construction and demolition of buildings creates a tremendous amount of waste. Modular building techniques that enable design for deconstruction can help reduce the amount of waste that is generated when a building is demolished. A long term goal for the building industry is to achieve zero waste resulting from the built environment. The Factor Four Initiative aims at reducing material throughput by 75% as well as reducing toxins present in the materials we use.

Sustainability in the Joinery Program

Completed 2009

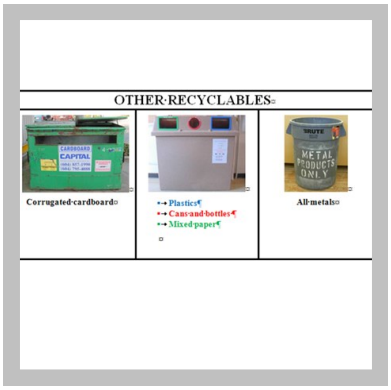
The National Occupational Analysis (NOA) outlines curriculum requirements for all Canadian trades programs, but in Joinery it does not include the topic of sustainable materials and practices. The Joinery program is addressing the absence of a sustainability competency by using sustainable materials and practices on our shop floor. The Joinery department has implemented an aggressive recycling program which diverted approximately 345 cubic yards of waste from the landfill in 2013. The department has also discontinued the use of solvent-base contact cement and switched to a water-base product. The other adhesive Joinery uses extensively is polyvinyl acetate (PVA), which is also a water-base product.

Quick Facts

- Approximately 345 cubic yards of waste from the landfill in 2013
- 7,220 board measure of solid wood purchased in 2013 and 67% were Forest Stewardship Council (FSC) certified (Note: 1 board measure = 1 square foot of 1" thick material)
- 840 sheets of panel product purchased in 2013 and 78% of these had no-added-urea-formaldehyde (NAUF)
- 14 Apprenticeship classes (224 students/yr), 4 Foundation classes (64 students/yr), 6 Trades Discovery classes (120 students/yr) and 4 Interior design classes (96 students/yr)

SUSTAINABILITY IN THE JOINERY PROGRAM

Recycling Program.



Recycling Program.

Water-based product.

Water-based product.

Next Steps

The Factor Four Initiative demonstrates BCIT's long-standing commitment to the concept of campuses as living labs, providing hands-on learning opportunities for students. The four strategic areas of focus have met with varying degrees of success. Recall that they are:

1. Daylight Guichon Creek,
2. Rethink NE1,
3. Reduce energy and materials throughput in NE2-NE8,
4. Improve the look and feel of Smith Street.

The urban restoration efforts to date have been very successful, contributing to an improved look and feel along Smith Street and raised awareness about BCIT's long-standing commitment to daylight Guichon Creek. However, actual daylighting of the creek remains a far-off goal. It has been determined that a blockage in the culvert renders it un-navigable by fish. Nevertheless, salmon have migrated as far as the north side of Canada Way, at the entrance to the culvert that traverses the north end of BCIT's Burnaby Campus. Taking steps towards improved ecological restoration in the Factor Four Area, including the eventual daylighting of the north end of Guichon Creek remains an important objective.

Staff and faculty have worked with leading-edge consultants to determine a strategy to rethink NE1 as a demonstration "passive house" and have confirmed that at least a 60% reduction in energy throughput could be achieved within the existing structure. Longer term, NE1 may be replaced and the hope is that whatever building stands in its place will be an example of passive design, using zero fossil fuel energy for thermal conditioning and lighting. Opportunities to further pursue a vision for the replacement of NE1 with a state-of-the-art passive building is an important area of focus going forward.

Efforts to reduce energy and materials throughput by 75-90% without compromising service levels are being rewarded. To date, energy efficiency projects in NE2 and NE8 have surpassed the factor four goal, achieving between 80-90% reductions. Overall, the Factor Four Area has achieved a 30% reduction in energy consumption and strategies have been identified to achieve the overall 75% reduction target. Less progress has been made in the area of materials reduction. This is an important area of focus going forward. Future priorities include completing the biomass wood-waste to energy project and securing funding for emissions monitoring equipment that can be used to test the potential for different types of deconstruction waste to be used in energy generation.

Next steps include reconvening the Factor Four Steering Committee to review progress to date and identify opportunities for moving forward with the next phase of the Factor Four Initiative, specifically addressing proposals for daylighting of Guichon Creek, rethinking NE1 (or its future replacement) as a passive building, continuing the progress being made to reduce energy and materials throughput, with a stronger emphasis on developing a strategy for reducing materials throughput. The early success of the energy efficiency efforts indicate that potential also exists to explore whether/how efforts towards achieving factor-ten reductions in energy throughput could be tackled.

APPENDIX

Energy Projects

Real Time Metering		Completed 2011
Wood Dust Extraction System Retrofit		Completed 2010
Condensing Boiler System in Piping Building		Completed 2011
Behavioural and Operational Change Initiatives		Completed 2011
LED Outdoor Lighting		Completed 2013
On-Demand Welding Ventilation Retrofit		Completed 2013
AFRESH Home HVAC Retrofit		Completed 2014
Waste-to-Heat Biomass System		Construction Fall 2014
Daylighting the Carpentry Canopy		Not Started
Lighting Redesign		Not Started
Outdoor Welding		Not Started
NE1 as a Passive Building		Not Started
Virtual Welding		Not Started

Restoration Projects

Pedestrianization of Smith Street		Completed 2013
Guichon Alley — Creek Awareness		Construction Summer 2014
Architectural Ecology		In Progress
Façade Improvement		In Progress
Educational Signage		Completed 2012
Daylighting Guichon Creek		Not Started
AFRESH Home Sustainable Garden		Not Started

Materials Projects

Sustainability in the Joinery Program		Completed 2009