Sustainability in Professional Engineering and Geoscience:

A Primer

Picture courtesy of Michael Sherman
www.msphoto.ca/

Part 3: Practice-Specific Module - Buildings

Developed by the Sustainability Committee of the
Association of Professional Engineers and Geoscientists of British Columbia
APEGBC

www.apeg.bc.ca

www.sustainability.ca

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Part 3: Practice-Specific Module - Buildings

2003 Edition

Picture courtesy of Michael Sherman
www.msphoto.ca/

The CK Choi Building is still considered one of the best examples of sustainable building design, even though it was completed in 1996. Significant achievements in the building include: composting toilets and water conservation measures such that the building is not hooked up to the sewer system, a 7000 gallon rain cistern for storing rain water for use during the summer, 100% reused brick cladding, 65% reused 70-year old large timber as structural components, natural ventilation, approximately 23% less energy consumption than ASHRAE 90.1 standards, and a recycling program that diverted 95% of the construction waste from going to landfills.

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1 Introduction

APEGBC Sustainability Guidelines

Core to APEGBC's articulation of sustainability are the Sustainability Guidelines that state that, within the scope of a Member's task and work responsibility each Member, exercising professional judgment, should:

1) Develop and maintain a level of understanding of the goals of, and issues related to, sustainability .

2) Take into account the individual and cumulative social, environmental and economic implications

3) Take into account the short- and long-term consequences.

4) Take into account the direct and indirect consequences

5) Assess reasonable alternative concepts, designs and/or methodologies

6) Seek appropriate expertise in areas where the Member's knowledge is inadequate

7) Cooperate with colleagues, clients, employers, decision-makers and the public in the pursuit of sustainability.

The Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) has developed a Sustainability Primer as part of its implementation of a Sustainability Management System (SMS). The Primer's purpose is to act as an initial step in raising knowledge of sustainability, and to function as a simple, readily accessible resource on sustainability for engineers and geoscientists. It is not meant to be a comprehensive manual on "how to engineer sustainably", but rather is intended as an aid to help engineers and geoscientists implement sustainability principles in the course of their everyday activities.

Part I: Introduction of the Sustainability Primer outlines general issues that provide context to all our sustainability activities as professional engineers and geoscientists.

Part 2: Applying the Guidelines develops some suggested approaches to applying APEGBC's Sustainability Guidelines (left) across the spectrum of engineering and geoscience activities.

This document, ***Part 3: Practice-Specific Module for Buildings***, provides additional resources for engineers and geoscientists working in the building sector.

Acknowledgements

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2 Review of the APEGBC Sustainability Guidelines

The APEGBC Sustainability Guidelines presented in Part 2 of the Primer provide guidance on how to systematically incorporate sustainability into engineering and geoscience practice. As a quick summary, the APEGBC Sustainability Guidelines encompass the following. For further details, please see the Primer Part 2 Module.

2.1 Increasing Awareness of Sustainability

Guideline # 1:	*Develop and maintain a level of understanding of the goals of, and issues related to, sustainability.*

Guideline #1 encourages continual learning or education as an important aspect of sustainability. APEGBC has identified awareness (among all stakeholders) as one of the primary barriers to the implementation of sustainability in the province. In its Communication Plan, the Sustainability Committee identified Members as its current main target group for increasing awareness. Once Members have the information they need to begin implementing sustainable solutions, the communications focus can shift toward clients, employers and wider audiences.

Many of the resources and links found in this Primer are offered with the goal in mind that engineers and geoscientists will use them as starting points for their own research and continuing education on sustainability.

2.2 Fully Investigating the Impacts of Potential Actions

"In every deliberation, we must consider the impact on the seventh generation."

From the Great Law of the Haudenosaunee (Six Nations Iroquois Confederation)

Guideline # 2:	*Take into account the individual and cumulative social, environmental and economic implications.*
Guideline # 3:	*Take into account the short- and long-term consequences.*
Guideline # 4:	*Take into account the direct and indirect consequences.*

These three guidelines address the short and long-term, direct and indirect impacts of our designs and activities. They encourage us to think outside of traditional project boundaries and to consider the greater temporal and spatial impacts of our designs and projects. As we learn more about the way our world works – the way humans and ecosystems interact – we learn more about what it takes to ensure

that we do not compromise the well being of current and future generations and ecosystems.

"These ideas veer sharply away from thinking in terms of "trade-offs," human vs. ecosystem wellbeing. There are obviously hundreds of small trade-offs in any practical application: between interests, between components of the ecosystem, across time and across space. However, in a macro sense, the idea of sustainability calls for each of human and ecosystem wellbeing to be maintained or improved over the long term. Maintaining or improving one at the expense of the other is not acceptable from a sustainability perspective because either way, the foundation for life is undermined."[1]

2.3 Weighing the Impacts of Alternative Solutions

"When we engineer….let us think that we engineer forever."

Department of Civil & Environmental Engineering University of Auckland, New Zealand

Guideline # 5: Assess reasonable alternative concepts, designs and/or methodologies.

Conventional engineering solutions often rely on historical data and a linear approach to problem solving. Many problems are 'solved' by plugging in a standard formula 'proven' throughout the ages, irrespective of the uniqueness of that problem's particular setting, its timeframe, the people and the ecosystems involved. However, the process of even sketching out and evaluating various solutions, with the contribution of other professionals and from all affected communities of interest, can ultimately help save money, increase public acceptance and build relationships and job satisfaction.

At the heart of the assessment of any alternative lies the consideration of whether the design contributes to human *and* ecosystem wellbeing together. "The 'positive contribution to sustainability' criterion is different from though built upon the 'mitigation of adverse effects' criterion that is the focus of traditional environmental and social impact assessments. The implications of the shift are two-fold. On the one hand, the positive orientation opens the door to a much fuller recognition of benefits that result from engineering and geoscience activities than has traditionally been the case with impact assessment approaches. On the other, the same positive orientation sets the bar higher- it is harder to demonstrate a contribution than it is to mitigate a negative."[2]

[1] Tony Hodge, PEng, PhD, "APEGBC Sustainability Policy", Draft 2, April 2003.
[2] Ibid.

2.4 Fostering Consultation and Partnerships

Guideline # 6: Seek appropriate expertise in areas where the Member's knowledge is inadequate
Guideline # 7: Cooperate with colleagues, clients, employers, decision-makers and the public in the pursuit of sustainability.

Partnerships with fellow professionals on areas we are unfamiliar with comprises only half of our responsibility to consult with others – the second, arguably more important aspect requires us to actively solicit local community values on what's important. Experts can often help answer "what could be", but it's up to the public to answer, "what should be".

3 Buildings: The Context

"Building construction, renovation and operation consume more of the earth's resources than any other human activity. Each year, as much as 40% of the raw materials and energy produced in the world are used in the building sector."

ATHENA Sustainable Materials Institute.

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In order to appreciate what can be accomplished in the building industry, it is useful to first understand the state of resource use and greenhouse gas production in Canada and where buildings fit into this larger picture.

Key findings of a report that compares Canada to other Organization for Economic Cooperation and Development (OECD) nations in terms of a number of general indicators are presented below.[3]

Energy Consumption

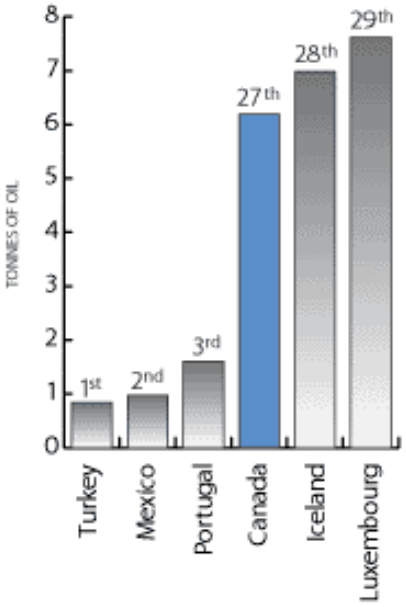


Figure 1: Tonnes of oil equivalent consumed per capita. Source: OECD Environmental Data 1999

Canada has the third highest per capita energy use of the 29 OECD nations, at 6.19 tonnes of oil equivalent per capita. This is almost double the OECD average of 3.18 and five times the world average. Total energy consumption grew by 20.3% between 1980 and 1997.

[3] David R. Boyd,"Canada vs. the OECD: An Environmental Comparison." Prepared for the Eco Research Chair of Environmental Law and Policy at the University of Victoria, 2001; http://www.environmentalindicators.com/htdocs/about.htm

Energy Efficiency

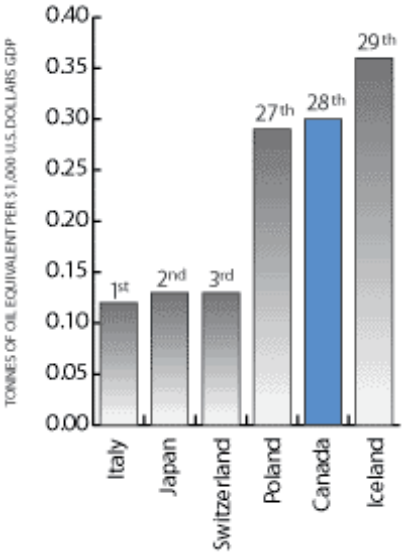


Figure 2: Energy consumption, in tones of oil equivalent per $1000US dollars of GDP. Source: OECD Environmental Data 1999

Canada ranks second worst in terms of energy efficiency. We use 0.30 tonnes of oil equivalent to generate $1000US of GDP. This is almost double the OECD average. Canada is even 33% less efficient than the US.

Greenhouse Gas Production

Canada ranks 3rd worst for its production of CO_2, the most dominant of the greenhouse gases. We produce 16.84 tonnes of CO_2 per capita. This is 48% above the OECD average and four times the global average. In terms of total CO_2 production, only four nations produce more: the US, Japan, Germany, UK.

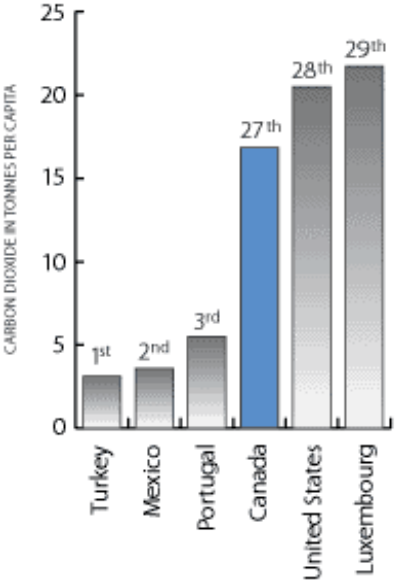


Figure 3: Emissions of Carbon Dioxide in tonnes per capita. Source: OECD Environmental Data 1999

Water Consumption

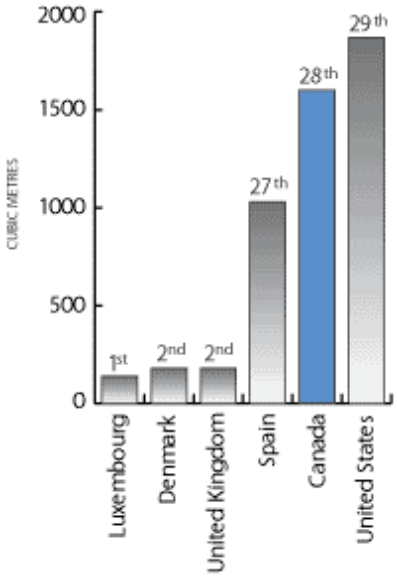


Figure 4: Freshwater Abstractions per capita in cubic metres. Source: OECD Environmental Data 1999

Canada has the 2nd highest per capita water consumption, at 1600m^3 per capita. This is 65% above the OECD average, and represents an overall increase of 25.7% since 1980. Overall increases within the OECD average 4.5%, although several nations actually decreased their overall water consumption, including the US, UK, Sweden, and the Netherlands.

The Building Industry

So what do all these statistics have to do with buildings specifically? According to the ATHENA Sustainable Materials Institute as much as 40% of the raw materials and energy produced in the world are used in the building sector.[4] Canada's energy efficiency, water consumption and greenhouse gas emissions records are therefore significantly affected by the building industry. In addition, 30% of newly-built or -renovated buildings suffer from "sick building syndrome," exposing occupants to stale or mold- and chemical-laden air.[5]

The Government of Canada's Action Plan 2000 on Climate Change identifies buildings as a key sector for moving Canada toward meeting its Kyoto Protocol targets. It specifically targets the heating of

[4] www.athenasmi.ca
[5] David Malin Roodman and Nicholas Lenssen: Worldwatch report, "A Building Revolution: How Ecology and Health Concerns Are Transforming Construction", 1995.

*At a Continuing Professional Development seminar on sustainable buildings in February 2003, Blair McCarry, PEng, Senior VP Keen Engineering, asked the attendees if anyone thought climate change was **not** happening. None raised a hand. From an engineer's perspective, then, Blair continued, the questions we may ask ourselves are:*

- *Are we going to contribute to make the future we want happen;*
- *Are we going to just wait and see what type of future happens, or*
- *Are we going to ask, when the future arrives, what happened?*

In order to create the future we envision, Blair underscored the need to do things differently. It will not be enough to simply tweak the system.

buildings, which accounts for 10% of total greenhouse gas emissions in Canada.

Furthermore, Canada's building industry statistics are similar to the US, where commercial and residential buildings account for 65% of the nation's total electricity consumption[6], 36% of the total primary energy used[7], 30% of total greenhouse gas emissions[8], 12% of potable water consumption[9], and the production of 136 Million tonnes of construction and demolition waste per day (approximately 2.8lbs/person/day)[10].

It is clear that buildings have a significant impact on resource use. There are correspondingly significant- and in many cases, easy and inexpensive- gains that can be made in the design and operation of buildings that will not only improve their energy and resource efficiency, but also worker comfort and productivity, environmental impact, and even corporate image.

[6] U.S. Department of Energy, Energy Information Administration, March 2001, *Monthly Energy Review*.
[7] Ibid.
[8] U.S. Department of Energy, Energy Information Administration, "Emissions of Greenhouse Gases in the United States 1999."
[9] U.S. Geological Service, 1995 data.
[10] U.S. EPA, 1998, "Characterization of Building-Related Construction and Demolition Debris in the United States."

4 Engineers' and Geoscientists' Roles in Building

4.1 Roles and Responsibilities

Engineers and geoscientists assume a range of roles and responsibilities within the building industry, including:

- Project Managing/Consulting
- Development
- Codes and Standards Verification/Enforcement
- Design Consulting
- Estimating
- Geotechnical consulting
- Electrical Engineering Design/Operation
- Mechanical Engineering Design/Operation
- Water/Wastewater Systems Design
- Energy Systems Modeling
- Structural Engineering
- Building Envelope Design/Retrofitting
- Commissioning/Decommissioning/Re-commissioning

Not only are engineers and geoscientists involved in nearly every aspect of the building industry, they also hold a very high level of responsibility, as evidenced most noticeably by their implication in high profile structural failures or the recent leaky condo crisis. This level of responsibility naturally extends to the design of sustainable buildings. Clearly, engineers and geoscientists have a central role to play in both maintaining industry integrity and motivating successful market transformation.

4.2 Scope of Influence

Engineers and geoscientists influence all phases of a building's life cycle, from design through procurement and construction; maintenance & operations; retrofits, and decommissioning. As the subsequent sections will demonstrate, it is important that engineers and geoscientists consider the impacts of their work on all of these phases when they design for sustainability.

5 Sustainable Buildings

Buildings that incorporate sustainability are referred to as sustainable buildings, green buildings or high-performance buildings. Many professionals prefer the latter term, since it reflects the ultimate benefits to the owner and users.

The defining quality of new high performance buildings is *integrated design*.

5.1 Integrated Design

In conventional building design, structural engineers design for structural integrity and safety. Mechanical engineers ensure that the HVAC and other heating and cooling systems function according to specifications. Electrical engineers do the same for cabling and wiring systems.

Typically, the primary contractor will separately engage professionals to carry out different aspects of the building design and construction. Each group, therefore, operates in isolation of the other.

It is often, then, left to the contractor to reconcile incompatibilities when the actual construction progresses. This can lead to both short-term delay costs and long-term costs caused by non-optimal system design and operation.

Integrated design, on the other hand, is the process whereby design and construction professionals become engaged in the design at an early stage and are able to collaborate with one another to find a design that optimizes *all* features of the building. The result of a successful integrated design process is a building that is “future proof” (less dependant on outside utilities), durable, robust, and less draining on resources and the environment.

The integrated design approach realizes savings for the owner in long-term energy use and well as potential short-term expenditures such as materials. Furthermore, it has implications for all phases of a buildings’ life cycle, from design to procurement, construction, maintenance and operations (including retrofits) through to decommissioning.

The Approach

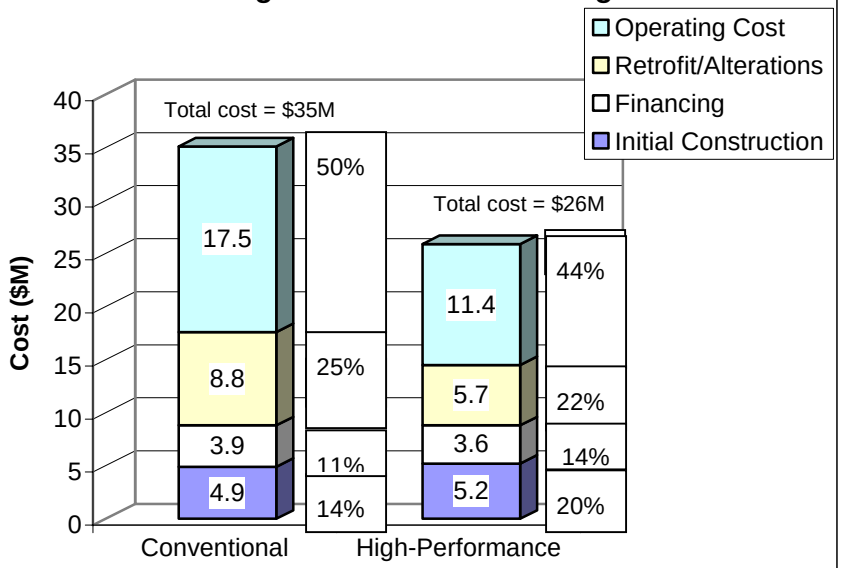
According to Craig Patterson, BEng, LEED™ Accredited Professional, Business Development Manager VEL Engineering, there are four key considerations for the design of high performance buildings:

- *Use integrated design process to build a better building*
- *Recognize that design costs are shifted upfront but are decreased toward the end of a project*
- *Make crucial decisions early in the design process (capital costs vs lifecycle costs)*
- *Leverage the benefits of energy modeling and other computer design tools*

In conventional building design, most of the emphasis is placed on the initial costs of construction. However, construction only represents a small proportion of the building's total life cycle costs and an overemphasis on initial construction costs generally leads to a more expensive building over the long term. For a $35M total 40-year project cost, for example, construction would typically account for approximately $5M, or 14% of the total.

Suppose, now, that operating energy was a key consideration in the design phase. For example, simple choices related to building placement, orientation and shape can result in a significant improvement in energy efficiency with minimal associated cost. The graph below demonstrates the differences between the two approaches.

Figure 5: 40-Year Project Costs for Conventional vs. High-Performance Building



This graph shows that a higher percentage of the 40-year project costs for a high performance building goes into the initial construction phase; however, the operating costs are significantly reduced and the total project cost is reduced. In this model, construction still costs approximately $5M, but total project costs are only $26M.

As this example demonstrates, the emphasis in integrated design is on the *early involvement* of those who will build, use and maintain the

building, as well as a collaborative approach from the design professionals to maximize all systems. The further along in the design and construction process, the less of an impact can be made on high-performance design.

The Components

"It is much easier and cheaper to maximize the benefits of green planning and design by addressing issues in the initial stages of a project"

-Rocky Mountain Institute, 1998

In general, integrated design of new buildings must address five key elements:

1. Site
2. Water Efficiency
3. Energy Efficiency
4. Materials and Resources
5. Indoor Environmental Quality

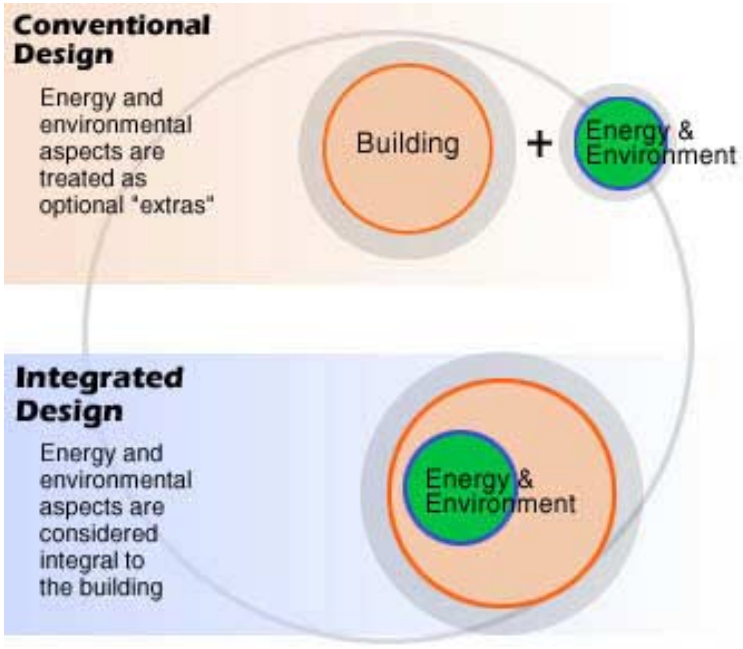


Figure 6: Schematic from the City of Fort Collins' Harmony Library resource page, http://www.fcgov.com/harmonylib/lev2/design/fr2designintegrateddesign.htm

What this schematic shows is that energy and environmental considerations for conventional building designs are typically afterthoughts, or add-ons. This linear approach results in non-optimized building design and operation as well as cost increases down the road.

Below are some sample design considerations in each of the five key areas:[11]

1. Site

Orientation to the sun to maximize natural daylight and heating
Choice of brownfield site over greenfield
Utilization of previous building footprint
Layout to minimize footprint
Location of site to utilize existing infrastructure (utilities and transportation)
Provision of alternative transportation services such as bicycle storage, alternative fuel refueling stations, showers and changing rooms
Minimization of impervious areas on-site to reduce run-off
Landscaping to reduce heat island effect

2. Water Efficiency

Use of low flow, water efficient fixtures, waterless urinals, dual flush toilets etc
Use of native plants to eliminate/reduce irrigation needs
Grey-water reuse, on-site treatment

3. Energy Efficiency

Use of renewable energy
Use of energy efficient fixtures
Effective use of insulating materials, glazing, etc
On-site energy generation
Use of energy modeling to optimize heating/cooling systems

4. Materials and Resources

Use of local/regional materials
Use of recycled materials
Construction waste reduction/reuse/diversion
Storage and collection of recyclables
Use of durable materials
Reuse of existing building shell

5. Indoor Environmental Quality

Use of low-emitting materials (adhesives, sealants, paints, carpets, composite wood products)
Maximized percent of daylighted spaces
Maximized ventilation performance
Management of Indoor Air Quality during construction

[11] Several of these design considerations are part of the LEED™ performance criteria (see p.21); several have been employed by other high-performance projects or recommended by other organizations.

Monitoring of CO_2
Design for controllability of systems

As these examples show, it is difficult to consider these components in isolation. Indeed, improvements in one area typically result in spin-off improvements in another. Some benefits realized by high-performance buildings include:

- Lower operating costs
- Lower lifecycle costs
- Longer lasting building
- Reduced impact on the environment
- Increased occupant comfort, health
- Increased occupant productivity / satisfaction
- Higher building value
- Lower vacancy rate
- Enhanced corporate image

Resources for Integrated Design

Guide to Value Analysis and the Integrated Green Design Process
http://www.greenbuildingsbc.com/new_buildings/pdf_files/value_analysis_dp_guide.pdf

This guide to integrated design was produced by the BC Building Corporation and presents a four-step process for design teams wishing to approach the design process in an integrated fashion.

East Clayton Headwaters Project
http://www.sustainable-communities.agsci.ubc.ca/projects/Headwaters.html

The James Taylor Chair in Landscape and Livable Environments at UBC is responsible for information management and project facilitation of the East Clayton Headwaters Project – a proposed sustainable neighborhood in Surrey. The initial design charette that was used to create the Clayton Neighborhood Concept Plan is a good example of integrated design teamwork. Click on "Summary", on the above web link, and then scroll down the webpage to find an interesting discussion on the design process that was used for East Clayton

5.2 Tools

Guidelines

A number of jurisdictions, municipalities and organizations have created building design guidelines to help industry incorporate sustainable building practices into design, construction and operation. Here are four example guidelines:

****BC Building Corporation Guide to Green Buildings Resources**
http://www.greenbuildingsbc.com/new_buildings/resources_guide/index.html

An excellent resource that provides links to other websites and information on financial incentives, other building guidelines, energy, water, landscape, materials, waste, construction practices, indoor environmental quality, economic performance resources, life cycle assessment resources, and resources specific to designing schools. Updated regularly.

City of Santa Monica Green Building Guidelines
http://greenbuildings.santa-monica.org/index.html

These Guidelines provide designers, builders and developers with easily accessible guidelines and best practices on green building design. A group of consultants and experts from British Columbia were primary consultants on the development of the guidelines. A unique feature is the “Design Advisor” which allows the user to search for documents, reports and guidelines based on the type of building (school, hospital, library…) and activity type (new building, retrofit, operation & maintenance…).

New York City Department of Design and Construction High Performance Building Guidelines
http://www.ci.nyc.ny.us/html/ddc/html/highperf.html

The New York City High Performance Building Guidelines are organized into: City Process, Design Process, Site Design & Planning, Building Energy Use, Indoor Environment, Material and Product Selection, Water Management, Construction Administration, Commissioning, and Operations and Maintenance.

Retrofitting a City: A Guide for Municipalities to Implement a Building Retrofit Program
http://www.cmhc-schl.gc.ca/en/imquaf/hehosu/sucopl/loader.cfm?url=/commonspot/security/getfile.cfm&PageID=42236

The Canada Housing and Mortgage Corporation published this guide, which includes guidance on: defining the scope and delivery method

of your retrofit program, staffing requirements, funding options, regulations, and promotion.

Sustainability Matrix

The Sustainability Matrix was initiated by the David and Lucile Packard Foundation when they were planning a new Foundation Office. The result was a decision-making tool that would clearly demonstrate the aesthetic, environmental, schedule, and economic impacts implied by a range of sustainability goals for the proposed building. The Matrix is a graphical summary of the findings contained in the Sustainability Report. It compares six different options, from "market" (typical big box design) to "living building" (a net-energy generating building). It details and compares all of the following:

- site plan
- wall section
- energy consumed and generated to operate building
- grid reliance
- pollution from building operation
- external cost to society
- schedule
- construction cost
- furniture, fixtures, and equipment
- design and management fees
- net present value for 30-, 60-, and 100-year models.

The Sustainability Matrix and Report are excellent resources that show very clearly the relationships between all aspects of building design, construction, and decommissioning. They can be viewed and downloaded from http://www.packard.org/index.cgi?page=building.

Leadership in Energy and Environmental Design (LEED™)

The LEED™ Green Building Assessment tool is technically an assessment tool, but many professionals also use it as a design tool. It will be discussed in more detail in the Measuring/Assessment section.

Other Green Building Initiatives

BC Building Corporation's Green Buildings Program
http://www.greenbuildingsbc.com

This website is an excellent source of information on green building design. There are two separate programs: New Buildings Program

and the Retrofit Program. The site contains information on BC case studies, green building design guidelines, financial incentive programs, and integrated design process guidelines.

BetterBricks
http://www.betterbricks.com

BetterBricks is a not-for-profit initiative designed to help commercial building professionals achieve sustainable high performance buildings. Includes guidelines, tools and case studies.

Better Buildings for Greater Vancouver
http://www.betterbuildings.ca

A portal hosted by the GVRD, with building-related information on: case studies, environmental facts and information, financial incentives and programs, online discussion forums, and web links.

Canada Green Building Council (CaGBC)

The newly formed Canada Green Building Council will take over LEED™ administration from the USGBC and address green building issues specific to Canada. Memberships are now being issued. To join or request further information, contact Joe VanBelleghem at jvanbelleghem@vitp.ca.

City of Seattle Sustainable Building Program
http://www.cityofseattle.net/sustainablebuilding/

The City of Seattle's sustainable building program contains some useful reports and guidelines to help practitioners incorporate sustainable building practices into design. Note that the City of Seattle requires all new city-financed buildings and major remodels to be certified LEED™ Silver or better (for information on LEED™, see page 21).

Federation of Canadian Municipalities (FCM) Municipal Building Retrofits program
http://www.fcm.ca/scep/support/building_retrofit/mbrp_index.htm

The FCM will provides guidance through all stages of the building retrofit process from help in developing a business case, overcoming barriers, to finding additional funding. Also available are several case studies.

Green Buildings Canada
http://www.greenbuilding.ca/

Soon to be called Sustainable Buildings Canada, Green Buildings Canada is Canada's national green building initiative. The website

contains a number of tools, including a building assessment program called GBTool.

GBTool
GBTool is an assessment tool that measures the environmental performance of a building. It is designed as part of the Green Building Challenge (GBC) - an international collaboration of countries working together to research and develop GBTool. GBTool, an Excel program, is free and can be downloaded from the Green Buildings Canada webpage.

US Green Building Council (USGBC)
http://www.usgbc.org

The USGBC is the primary American green building organization, which is responsible for organizing the LEED™ framework (see next section). The USGBC consists of regional chapters and branches including the very active Vancouver Branch, which holds monthly meetings/presentations to which all are welcome. (www.usgbc.org)

6 Measuring / Assessment

A crucial feature of building for sustainability is the ability to evaluate the performance of both conventional and sustainable buildings. There are now several tools and assessment methods available to measure the performance of new and existing buildings.

6.1 Leadership in Energy and Environmental Design (LEED™)

LEED™, which stands for Leadership in Energy and Environmental Design, is a building assessment tool that can be used to measure the environmental performance of a building.

Building assessment tools are used to evaluate the environmental performance of buildings. LEED™, which stands for Leadership in Energy and Environmental Design, is an increasingly popular building assessment tool developed by the US Green Building Council (USGBC – http://www.usgbc.org), and the most widely applied within BC and the US. A BC-adapted version of LEED™ is currently being developed and will be available soon, although the US version of LEED™ has been and is being used for a number of projects within BC. The recently formed Canada Green Building Council (CaGBC) will eventually take over this role from the USGBC, but is still in the early stages of organization.

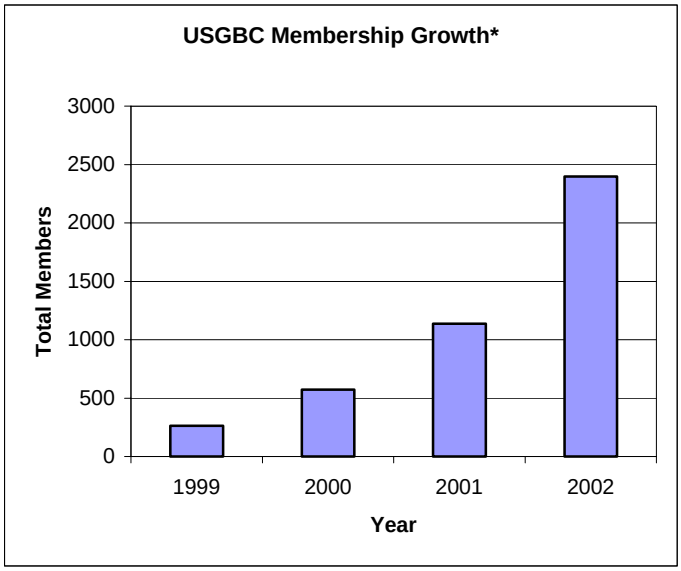


Figure 7: USGBC Membership Growth 1999-2002. Source: www.usgbc.org. *A member represents an individual, a company, or an organization.

LEED: Frequently Asked Questions

Blair McCarry, PEng, points out the strong influence that engineers have over the design of sustainable buildings. In each of the six LEED™ categories, engineers can influence the following portion of the available credits:

- *Sustainable Sites: 5/14*
- *Water Efficiency: 5/5*
- *Energy and Atmosphere: 17/17*
- *Materials and Resources: 8/13*
- *Indoor Environmental Quality: 11/15*
- *Innovation & Design: any of the 5 available*

How does LEED™ work?

LEED™ measures and ranks a building's environmental performance in terms of 6 general categories:

- Sustainable Sites,
- Water Efficiency,
- Energy & Atmosphere,
- Materials & Resources,
- Indoor Environmental Quality, and
- Innovation & Design.

Points are awarded for achieving specific goals clearly outlined in each category. The total number of points possible is 69. A score of 26-32 points achieves basic certification; 33-38 achieves Silver; 39 – 51 Gold; and 52+ achieves Platinum certification.

LEED™ Scorecard for Vancouver Island Technology Park

This is the LEED™ scorecard for the Vancouver Island Technology Park, which was awarded a LEED™ Gold rating. For each of the six categories, points are awarded for meeting certain criteria such as meeting certain energy performance levels.

LEED

Vancouver Island Technology Park
LEED Project # 0113
LEED Version 2.0 Certification Level: GOLD
February 3, 2002

41 Points Achieved — Possible Points: 69
Certified: 26 to 32 points; Silver: 33 to 38 points; Gold: 39 to 51 points; Platinum: 52 or more points

10 Sustainable Sites — Possible Points: 14

Y	Prereq 1	Erosion & Sedimentation Control
1	Credit 1	Site Selection
	Credit 2	Urban Redevelopment
1	Credit 3	Brownfield Redevelopment
1	Credit 4.1	Alternative Transportation, Public Transportation Access
1	Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms
	Credit 4.3	Alternative Transportation, Alternative Fuel Refueling Stations
1	Credit 4.4	Alternative Transportation, Parking Capacity
1	Credit 5.1	Reduced Site Disturbance, Protect or Restore Open Space
1	Credit 5.2	Reduced Site Disturbance, Development Footprint
1	Credit 6.1	Stormwater Management, Rate and Quantity
1	Credit 6.2	Stormwater Management, Treatment
1	Credit 7.1	Landscape & Exterior Design to Reduce Heat Islands, Non-Roof
	Credit 7.2	Landscape & Exterior Design to Reduce Heat Islands, Roof
1	Credit 8	Light Pollution Reduction

4 Water Efficiency — Possible Points: 5

1	Credit 1.1	Water Efficient Landscaping, Reduce by 50%
1	Credit 1.2	Water Efficient Landscaping, No Potable Use or No Irrigation
	Credit 2	Innovative Wastewater Technologies
1	Credit 3.1	Water Use Reduction, 20% Reduction
1	Credit 3.2	Water Use Reduction, 30% Reduction

8 Energy & Atmosphere — Possible Points: 17

Y	Prereq 1	Fundamental Building Systems Commissioning
Y	Prereq 2	Minimum Energy Performance
Y	Prereq 3	CFC Reduction in HVAC&R Equipment
2	Credit 1.1	Optimize Energy Performance, 20% New / 10% Existing — 2
2	Credit 1.2	Optimize Energy Performance, 30% New / 20% Existing — 2
2	Credit 1.3	Optimize Energy Performance, 40% New / 30% Existing — 2
	Credit 1.4	Optimize Energy Performance, 50% New / 40% Existing — 2
	Credit 1.5	Optimize Energy Performance, 60% New / 50% Existing — 2
	Credit 2.1	Renewable Energy, 5% — 1
1	Credit 2.2	Renewable Energy, 10% — 1
	Credit 2.3	Renewable Energy, 20% — 1
1	Credit 3	Additional Commissioning — 1
	Credit 4	Ozone Depletion — 1
1	Credit 5	Measurement & Verification — 1
	Credit 6	Green Power — 1

7 Materials & Resources — Possible Points: 13

Y	Prereq 1	Storage & Collection of Recyclables
1	Credit 1.1	Building Reuse, Maintain 75% of Existing Shell — 1
	Credit 1.2	Building Reuse, Maintain 100% of Existing Shell — 1
	Credit 1.3	Building Reuse, Maintain 100% Shell & 50% Non-Shell — 1
1	Credit 1.4	Construction Waste Management, Divert 50% — 1
1	Credit 1.5	Construction Waste Management, Divert 75% — 1
1	Credit 1.6	Resource Reuse, Specify 5% — 1
	Credit 1.7	Resource Reuse, Specify 10% — 1
1	Credit 1.8	Recycled Content, Specify 25% — 1
	Credit 1.9	Recycled Content, Specify 50% — 1
1	Credit 1.10	Local/Regional Materials, 20% Manufactured Locally — 1
1	Credit 1.11	Local/Regional Materials, of 20% Above, 50% Harvested Locally — 1
	Credit 1.12	Rapidly Renewable Materials — 1
	Credit 1.13	Certified Wood — 1

9 Indoor Environmental Quality — Possible Points: 15

Y	Prereq 1	Minimum IAQ Performance
Y	Prereq 2	Environmental Tobacco Smoke (ETS) Control
1	Credit 1	Carbon Dioxide (CO_2) Monitoring — 1
1	Credit 2	Increase Ventilation Effectiveness — 1
	Credit 3.1	Construction IAQ Management Plan, During Construction — 1
	Credit 3.2	Construction IAQ Management Plan, Before Occupancy — 1
1	Credit 4.1	Low-Emitting Materials, Adhesives & Sealants — 1
1	Credit 4.2	Low-Emitting Materials, Paints — 1
1	Credit 4.3	Low-Emitting Materials, Carpet — 1
1	Credit 4.4	Low-Emitting Materials, Composite Wood — 1
1	Credit 5	Indoor Chemical & Pollutant Source Control — 1
	Credit 6.1	Controllability of Systems, Perimeter — 1
	Credit 6.2	Controllability of Systems, Non-Perimeter — 1
1	Credit 7.1	Thermal Comfort, Comply with ASHRAE 55-1992 — 1
	Credit 7.2	Thermal Comfort, Permanent Monitoring System — 1
	Credit 8.1	Daylight & Views, Daylight 75% of Spaces — 1
1	Credit 8.2	Daylight & Views, Views for 90% of Spaces — 1

5 Innovation & Design Process — Possible Points: 5

1	Credit 1.1	Innovation in Design: Construction Waste Management 80% — 1
1	Credit 1.2	Innovation in Design: Recycled Content 100% — 1
1	Credit 1.3	Innovation in Design: Reuse Historic Building — 1
1	Credit 1.4	Innovation in Design: Green Building Demonstration Project — 1
1	Credit 2	LEED™ Accredited Professional — 1

How is a building certified?

At the moment, official LEED™ certification is organized through the USGBC. The USGBC LEED™ website (http://www.usgbc.org/LEED/LEED_main.asp) provides a summary of the three steps to certification. The CaGBC will eventually take over certification of Canadian projects, but is still in the early stages of organization. Any certification earned under the USGBC until that point will be honoured by the CaGBC.

The City of Vancouver is currently considering the merits of adopting a minimum LEED™ standard for all new public buildings. The City of Seattle, as another example, already requires new public buildings be LEED™ Silver or better.

Is LEED™ mandatory?

NO. LEED™ is a voluntary building assessment tool. Some jurisdictions like the City of Seattle; however, have adopted a minimum LEED™ standard for all new public buildings as a matter of policy. The City of Vancouver is currently considering the merits of adopting a minimum LEED™ standard for all new public buildings, and is currently piloting its new Vancouver City Works Yard as either LEED™ Silver or Gold. The City of Calgary is also moving toward requiring a minimum of LEED™ Silver for all new public buildings.

Does LEED™ cost more?

The answer to this will come over time as more case studies are documented. The USGBC took a first stab at the question by issuing a memo in August 2001 summarizing a number of case studies. In general, they found initial capital costs to be 1-4% higher than conventional buildings while long-term costs were “significantly lower”. However, many professionals are now finding that initial costs can even be lower than for conventional buildings as professionals become more comfortable to the technology and process. For more information on the costs-benefits of LEED™ buildings, see page 31.

What types of buildings is LEED™ most applicable to?

LEED™ is most applicable to existing and new commercial, institutional and high-rise residential buildings. The underlying concepts embodying the LEED™ process are also very relevant and useful for smaller residential building design. Draft guidelines for Existing Buildings are now available on the USGBC website.

Some benefits of LEED™

- Simplicity–final results are summarized on a one-page ‘scorecard’;
- Not overly prescriptive – room for interpretation;
- Potentially significant long-term cost benefits;
- Modifiable – can be modified to local conditions & regulations;
- Marketable – as it becomes more popular, consumers will begin to recognize the LEED™ label as a measure of environmental performance.

Current LEED™ Certified and Registered Projects

Certified: http://www.usgbc.org/LEED/Project/project_list.asp

Local certified projects include the Vancouver Island Technology Park.
Registered:
http://www.usgbc.org/LEED/Project/project_list_registered.asp
There are numerous projects within BC currently registered on the LEED™ project list, meaning that these projects are either still in progress or have not yet received certification. The list includes links to detailed project information (when available) as well as project team and contact information. They include:

- BC Cancer Research Centre, Vancouver
- City of Vancouver Chess Street Works Yard
- International Terminal Building, YVR, Richmond
- River St. Water Treatment Plant, Kamloops
- Semiahmoo Library and RCMP, Surrey
- Spring Creek Fire Hall, Whistler
- The Conservatory, Kelowna
- TIF III Research Facility, UBC, Vancouver
- UBC Life Sciences Centre, Vancouver
- VanCity Savings and Credit Union, North Vancouver
- Victoria Centre Facility, Victoria
- Whistler Conference Centre Renovation
- White Rock Operations Building

APEGBC LEED™ Implementation Task Force

At the 2001 AGM, APEGBC Council passed a motion that LEED™ should be the preferred method for building environmental assessment in British Columbia. It also committed to taking a proactive role in encouraging the Association's membership to address sustainability issues such as those identified in the LEED™ model. The LEED™ Implementation Task Force (LITF) was struck to determine the best ways to enact these commitments.

This module and the following FAQs are results of the LITF's work. The full report and recommendations can be downloaded at: www.sustainability.ca/index.cfm?body=SourceView.cfm&ID=186.

6.2 Cost Benefit Analysis

"We are breaking into two camps:

- *commoditized work*
- *value-based ideas work*

Clearly the latter is where we would like all engineers to practice."

Kevin Hydes, P.Eng.
President, Keen Engineering

There is no definitive answer to whether 'green' buildings cost more or less than standard buildings. The first difficulty in answering this question is defining a standard building. One general observation is that while capital costs may be slightly higher (say 1-5%) than in a standard building, long-term operational costs are less and eventually compensate for any additional upfront costs. Some reports and anecdotal comments from practitioners suggest that there are minimal additional upfront costs and maybe even savings once consultants have gained some experience and are comfortable designing green buildings.

Geoff McDonell, P.Eng. a mechanical engineer, has compiled a list of studies and anecdotal comments/articles (See Appendix A) on the costs of LEED™ buildings. His observations from this background research:

> "All of the articles and studies indicated that even with additional design and construction costs (which never seemed to exceed 5% over a conventional building), there was a payback of days or months due to energy savings and building occupant/employee productivity increases. Typical energy savings for a LEED™ Certified building range from 25%-50% over a conventional building, and LEED™ Buildings showed employee productivity gains of between 5% to 10%, with some detailed studies indicating up to 16% gains in employee productivity. All studies indicate that life-cycle costing of the construction methods and materials is extremely important, and new information on environmental impact costing is being discussed. Old accounting and costing methods of line-by-line, item-by-item costing does not result in an integrated design approach. Many LEED™ building designs show more money being spent on some building components to save money and/or energy from other systems (use high performance glazing and skin materials to reduce mechanical system costs and energy costs)."
>
> Geoff McDonell, P.Eng.

Cost-benefit Resources

Buildings of the Future: The Costs and Benefits of LEED™ Green Buildings, by Robin Kelley
Contact: City of Vancouver Planning Department
http://www.city.vancouver.bc.ca/commsvcs/planning/index.htm (webpage) planning@city.vancouver.bc.ca (email)

Robin Kelley, a graduate student at the UBC School of Community and Regional Planning, completed this report for the City of Vancouver. The report presents an excellent discussion of the costs and benefits of LEED™ green buildings, drawn from case studies in Canada and the United States.

Institute for Market Transformation
http://www.imt.org/papers.htm

This US-based organization publishes a number of papers relating to real estate development and property valuation, including: "Recognition of Energy Costs and Energy Performance in Commercial Property Valuation" and "Hidden Value: Recognizing the Asset Value of High Performance Buildings".

Quantifying the Business Benefits of Sustainable Buildings, by Alan Yates
http://www.usgbc.org/docs/LEEDdocs/BREbusiness%20benefits%20summary.pdf
Contact: Centre for Sustainable Construction
This article summarizes the existing research findings (as of 2001) on the business benefits of sustainable buildings, including easily quantified benefits such as energy and construction costs and not so easily quantified benefits such as image and profitability.

6.3 Life Cycle Assessment

Life Cycle Assessment (LCA) is an analytical technique for quantifying and comparing the direct and indirect energy, material, and economic impacts of alternative approaches to meeting a given need. LCA measures these impacts over the entire life cycle of a product or activity. An increasing number of LCA tools are available for the building industry.

General LCA Resources

E917-02 Standard Practice for Measuring Life-Cycle Costs of Buildings and Building Systems
http://www.astm.org

This standard can be ordered through the ASTM website. A summary can be found by searching the standards database.

Environmental Management Accounting International Website
http://www.emawebsite.org/

EMA is a management tool for addressing the often hidden or ignored financial costs associated with impacts on the environment. The site offers a list of resources and tools for environmental management accounting as it relates to decision making in private and public sector organizations.

LCAccess – US Environmental Protection Agency
http://www.epa.gov/ORD/NRMRL/lcaccess/index.htm

Another good website on LCA, with a list of data sources that can be used to research the energy and material impacts of a product or activity over its life cycle.

LCA Guide – European Environment Agency
http://reports.eea.eu.int/GH-07-97-595-EN-C/en

A report on LCA – history of LCA, relationship to sustainability, applications, methodology, and information sources.

Life Cycle Assessment Links
http://www.life-cycle.org/

A comprehensive list of web links and other resources on LCA.

Specific LCA Tools

Specific LCA tools created for the building industry:

ATHENA Sustainable Materials Institute
http://www.athenasmi.ca

The Athena Sustainable Materials Institute was incorporated as a not-for-profit organization in early 1997 to carry forward work started in 1991 by Forintek Canada Corp. with the support of Natural Resources Canada. The Athena Environmental Impact Estimator is a modeling tool that assesses the environmental implications of building and assembly designs. It can model 95% of the building stock in North America.

BEES
http://www.bfrl.nist.gov/oae/software/bees.html

BEES (Building for Environmental and Economic Sustainability) is a software program that measures the environmental performance of building products by using the environmental life-cycle assessment

approach specified in ISO 14000 standards. Economic performance is also measured using the ASTM standard life-cycle cost method, which covers the cost of initial investment, replacement, operation, maintenance and repair, and disposal.

7 Financial Incentives

Below are some web links to potential funding sources (most related to energy).

BC Building Corporation's List of Financial Incentive Programs
BCBC has a good list of financial resources for both new and retrofit projects.

New buildings:
http://www.greenbuildingsbc.com/new_buildings/resources_guide/1.0_financial_resources.html

Retrofit buildings:
http://www.greenbuildingsbc.com/retrofit/funding_opportunities.html

Better Buildings
http://www.betterbuildings.ca

The GVRD Better Buildings program has a list of financial incentive programs.

Climate Change Action Fund
http://www.climatechange.gc.ca/english/actions/action_fund/index.shtml

The Climate Change Action Fund was established in 1998 by the Federal Government to help Canada meet its commitments under the Kyoto Protocol to reduce greenhouse gas emissions. Some building-related activities may qualify for funding.

Commercial and Industrial Building Incentive Programs (CBIP/IBIP)
http://cbip.nrcan.gc.ca/cbip.htm- check link

CBIP and IBIP are Natural Resources Canada programs offering financial assistance for incorporating energy efficiency features in new commercial and institutional buildings, retail food stores and arenas. Program requirements are based on the Model National Energy Code for Buildings and the CBIP Technical Guide. Awards of up to $60,000 are granted.

C 2000
http://www.buildingsgroup.nrcan.gc.ca/projects/c2000_e.html

The C-2000 Program provides funding for high-performance buildings and is organized by the CANMET Energy Technology Centre (CETC), Natural Resources Canada. The program focuses on energy and

environmental performance, but other parameters are also considered.

Green Municipal Enabling Fund
http://www.fcm.ca/scep/support/Gmef/gmef_index.htm

The Federation of Canadian Municipalities, in partnership with the Government of Canada, provides grants for feasibility studies to improve air, water or soil quality, protect the climate or promote the use of renewable resources. Applications can be made in the categories of energy & energy services, water, solid waste management, sustainable transportation and sustainable community planning.

Renewable Energy Deployment Initiative (REDI)
http://www2.nrcan.gc.ca/es/erb/english/View.asp?x=455

Organized by Natural Resources Canada, REDI provides an incentive for specific renewable energy systems for space and water heating and cooling. Participants are eligible for a refund of 25% of the purchase and installation costs of a qualifying system, up to a maximum of $80,000.

8 Case Studies

Below are a few case studies or links to lists of case studies for projects around BC.

Large Development Sites

"Burnaby Mountain (SFU UniverCity Development) involves some significant changes in the standard practice of land development and stormwater management. The uncertainty associated with these changes breeds fear and doubt among local government engineers, planners, developers, and senior government agencies. Overcoming this fear and doubt has been a major struggle for the Burnaby Mountain process, something others could learn from."

Kim Stephens, P.Eng.
KSA Consultants Ltd.

The East Clayton Headwaters Project
http://www.sustainable-communities.agsci.ubc.ca/projects/headwaters.html

In January 1999, Surrey's Department of Planning and Development entered into a partnership agreement with UBC's James Taylor Chair, the Pacific Resources Centre, and a multi-constituent advisory committee involving various levels of government to create the Headwaters Project. A key component of this project is the integrated design process, which is described on the James Taylor website.

Southeast False Creek, City of Vancouver
http://www.city.vancouver.bc.ca/commsvcs/currentplanning/sefc/sefc.htm

An 80-acre former industrial site near downtown Vancouver, the City is planning to build a complete sustainable community, one component of which will likely be the requirement that all buildings meet a minimum LEED™ standard.

UniverCity Development, Simon Fraser University
http://www.univercity.ca/

A 160-acre neighborhood that will accommodate 10,000 residents is being built atop Burnaby Mountain. The overall guiding theme for the development is the 4 E's: environment, education, equity and economy. The project demonstrates some interesting examples of engineers and geoscientists working to incorporate sustainability ideas into the development's design.

Buildings

BC Building Corporation's Green Building Case Studies

BCBC's website contains a list of approximately 17 case studies for both new and retrofit buildings.

New Buildings:
http://www.greenbuildingsbc.com/new_buildings/case_studies.html

Retrofit

http://www.greenbuildingsbc.com/retrofit/case_studies.html

Better Buildings
http://www.betterbuildings.ca

The GVRD's Better Buildings website also contains case studies.

CK Choi Building
http://www.iar.ubc.ca/choibuilding/matsuzaki.html

Completed in 1996 and still considered to be one of the best examples of green building design in Canada and North America, the CK Choi Building at UBC is impressive in many respects. A few notable achievements: no connection to the sewer system, 100% reused brick cladding, 65% reused big timber for structural components, and 7000 gallon rain cistern for collecting rainwater.

Cranberry Commons Co-housing Project
http://www.cranberrycommons.ca/sustainability.pdf

The Cranberry Commons Co-Housing development in North Burnaby incorporated several sustainable design features on a limited budget. The article linked above describes the design features of this development.

Doors to Sustainability 2001 and Sustainability 2003 Exhibitions
http://www.sustainability.ca/index.cfm?body=SourceView.cfm&ID=86

The Doors 2001 Exhibition consisted of 32 sustainability case studies from architects, professional engineers & geoscientists, landscape architects, and interior designers. The exhibition was organized by APEGBC and AIBC with help from the GVRD and Litchfield – a demolition and recycling company. A 2-page summary from each exhibitor is available on the APEGBC Sustainability website – web link above. The Sustainability 2003 Exhibit is expected to begin touring in the fall of 2003.

The Vancouver Island Technology Park
http://www.vitp.ca/

The first LEED™ Version 2.0 Gold building in Canada!

9 More Building Resources

General

Building Green
http://www.buildinggreen.com/index.html

An excellent resource containing information on building materials and a well-respected newsletter called Environmental Building News.

EcoDesign Resource Society
http://www.vcn.bc.ca/edrs/

The EcoDesign Resource Society (EDRS) is a not-for-profit BC organization which promotes environmentally responsible design, planning and development practices through research, education and communication. EDRS has an active list serve, with members from across the province, but mostly within the Greater Vancouver area.

Green Pages
http://eco-web.com/

A large database of products and services on: water and wastewater treatment, water management and recycling, cleanup and soil rehabilitation, air and noise pollution, and energy.

Green Buildings Company Directory
http://www.ei.gov.bc.ca/greenbuildings

Search this site for BC companies involved in green buildings. Extensive directory arranged by sector and alphabetically.

International Federation of Consulting Engineers
http://www.fidic.org
http://www2.fidic.org/resources/sustainability/

Some excellent resources on sustainability in engineering consulting – especially for large international projects.

Sector Reports, United Nations Environmental Program
World Summit on Sustainable Development
http://www.uneptie.org/outreach/wssd/sectors/reports.htm

22 industry reports prepared for the 2002 World Summit on Sustainable Development. Some relevant industry reports include: construction, consulting engineering, information & communications technology, iron and steel, refrigeration, road transport, waste management and water management.

Sustainable Construction Panel
UK Institute of Structural Engineers
http://www.istructe.org.uk/technical/index.asp?page=49

The group aims to create a forum for sharing information and experience, and to promote best practice.

Sustainable Sources
http://www.greenbuilder.com/

Sustainable Sources was created in 1993 to provide a one-stop online resource center for green building, sustainable agriculture, and responsible planning. Also contains information on green real estate and a bookstore.

Technologies/Techniques

Advanced Buildings Technologies and Practices
http://www.advancedbuildings.org

Detailed descriptions and supporting case studies for 90 technologies and practices to improve energy and resource efficiency of commercial and multi-unit residential buildings. Specific technologies and techniques are included within the following comprehensive categories: building structure, finishes & furnishings, heating & cooling, plumbing & water heating, lighting & daylighting, load management, electricity production, ventilation & air quality, site services, and motors % equipment.

BetterBricks
http://www.betterbricks.com

BetterBricks is a not-for-profit initiative designed to help commercial building professionals achieve sustainable high performance buildings. Includes technical information on heat recovery systems, underfloor air, mechanical systems design guidelines, daylighting, commissioning.

Green Roofs for Healthy Cities
http://www.greenroofs.ca/grhcc/index.html

A network of private and public organizations providing information and services to landscape architects, roofing and landscaping contractors and consultants, manufacturers of green roof systems and accessories, horticulturalists, engineers, governments and non-profit organizations. Includes technology descriptions, installation information and other resources.

Materials

Aggregate, Recycled Concrete
http://www.metrokc.gov/procure/green/concrete.htm

A primer on demolition and recycling of concrete for use as aggregate. Prepared by Seattle's King County.

Construction Materials Report: Toolkit for Carbon Neutral Developments
http://www.bioregional.com

Construction materials report for the Beddington Zero Energy Development (BedZED) in London, England. A 13-page summary is available on the website and includes details on the project's local sourcing policy, material choices and tracking of project resource flows. The full report describes all the materials used in the construction of BedZED and shows how the project team reduced the embodied environmental impact of the development by 20-30% by selecting reclaimed, recycled, local and low impact materials.

EcoSmart™ Concrete
http://www.ecosmart.ca/

The objective of the EcoSmart™ Project is to minimize the greenhouse gas signature of concrete by maximizing the replacement of Portland cement in the concrete mix with Supplementary Cementing material (SCM) within the parameters of cost, performance, and constructability.

Steel or Wood Framing: Which Way Should We Go?
http://www.buildinggreen.com/features/svw/steel_vs_wood.html

An excellent report on the costs/benefits comparing steel and wood.

Sustainable Development in the World Steel Industry
http://www.sustainablesteel.com

An initiative of the International Iron and Steel Institute. Contains market news, conference information, papers and other publications.

Land Development and Urban Issues

Low Impact Development in Puget Sound
http://www.wa.gov/puget_sound/Programs/lid_cd/LID_resources.htm

A relatively new idea for land development, low impact development (LID) focuses on developing land such that post-development hydrologic conditions are as close to pre-development conditions as possible.

Low Impact Development and Stormwater Management Conference, Capital Regional District, Victoria BC, February 2002
http://www.crd.bc.ca/es/education/download.htm

The Capital Regional District organized a LID conference in February 2002. Presentations on stormwater management and LID techniques can be downloaded from the conference website.

SmartGrowthBC
http://www.smartgrowth.bc.ca

A BC organization working on issues related to urban development and building sustainable communities.

Stormwater Managers Resource Centre
http://www.stormwatercenter.net/

The Stormwater Manager's Resource Center is designed specifically for stormwater practitioners, local government officials and others who need technical assistance on stormwater management issues. Very well laid out with guidelines on how to implement low-impact stormwater management designs and techniques.

Stormwater Planning: A Guidebook for BC

http://wlapwww.gov.bc.ca/epd/epdpa/mpp/stormwater/stormwater.html

This guidebook is an excellent resource of best practices for stormwater management within BC. Particularly useful for municipal governments, with an emphasis on implementing early actions.

10 Appendix A

Is there a premium or extra costs to use LEED™ Certification for Building Construction?

Review of current studies and anecdotal information by Geoff McDonell P.Eng, May, 2002

Source:	Design Costs	Construction Costs	Comments
USGBC, August 2001	No comment	1-4% increase for initial construction costs	Based on a study of seven LEED™ Certified buildings. Source: August, 2001 USGBC Staff memo.
Rocky Mountain Institute	Postulates that there would be no additional design costs when integrated design approach is used.	Their research indicates that no additional capital costs would result from an integrated design incorporating sustainable elements	No specific building studies cited. Article at http://www.rmi.org/sitepages/pid198.php
Miriam Landman: Summary of Thesis Findings and Recommendations – Breaking Through the Barriers to Sustainable Building		Study indicates that different costing methods required with life cycle costs used rather than straight capital costs	Full document at: http://www.egret.net/tufts/summaryoffindings.htm
City of Portland Green Building Study	"Some" additional design costs found but not specified, estimated at an add of 0.5% to the initial construction costs	Initial costs for three City buildings reviewed and found that –0.3% to 2.2% cost differences existed.	Limited study for 3 buildings only. Source document at: http://www.newsdata.com/enernet/conweb/conweb56.html
Informal discussions with other local "green" architects	Small additional amount of work required depending on LEED™ rating points being applied for- additional documentation needed- adds up to 300 man-hours.	Initial projects incurred slight premiums (up to 3%-4%) but subsequent designs and project costs showed reduced costs compared to conventional building approaches	Learning curve indicates that after performing LEED™ design on three or more projects, they found reduced design costs to be the same as conventional building approach, and initial construction cost of LEED™ building was equal or less than a conventional building

All of the articles and studies indicated that even with additional design and construction costs (which never seemed to exceed 5% over a conventional building), there was a payback of days or months due to energy savings and building occupant/employee productivity increases. Typical energy savings for a LEED™ Certified building range from 25%-50% over a conventional building, and LEED™ Buildings showed employee productivity gains of between 5% to 10%, with some detailed studies indicating up to 16% gains in employee productivity. All studies indicate that life-cycle costing of the construction methods and materials is extremely important, and new information on environmental impact costing is being discussed. Old accounting and costing methods of line-by-line, item-by-item costing does not result in an integrated design approach. Many LEED™ building designs show more money being spent on some building components to save money and/or energy from other systems (e.g. using high performance glazing and skin materials to reduce mechanical system costs and energy costs).

Other sources:

http://www.ce.cmu.edu/GreenDesign/research/price.html

Journal of Construction Engineering and Management- Nov/Dec 1999 – Article: "Selecting Cost-Effective Green Building Products- BEES Approach" by Barbara C. Lippiatt.