THE ECONOMICS OF GREEN BUILDING IN CANADA:

HIGHLIGHTING SEVEN KEYS TO COST EFFECTIVE GREEN BUILDING

By

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We accept this thesis as conforming
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ABSTRACT

There is a widely held perception that the capital cost of green building is significantly greater than conventional building. This thesis considers the economics of green building in Canada by assessing the capital cost premium of five case study buildings in five different provinces across Canada, including buildings certified to the LEED™ Green Building Rating System. It includes the outcome of an e-Dialogue with Canadian green building experts; a brief discussion of sustainability, the impact of buildings on the environment, the concept of economic externalities, and green building activities in Canada; definitions of green building, sustainable building and restorative building; a description of the integrated design process; and a discussion of the case study results and similar research in the United States. There is a strong economic case for green building, and the thesis highlights seven keys to cost effective green building. It also provides recommendations for policymakers and researchers.

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PREFACE

I am not an architect, engineer, building owner, developer, nor a member of any other profession normally engaged in the building industry. I am a person interested in the ability of the natural environment to support and sustain life, including human life, and in the sustainability of human economies and societies.

If you look for it, information abounds about the impact human activity is having on the environment. The most disconcerting message is that every living system on the planet is in decline, and the rate of decline is increasing (Hawken, Lovins & Lovins, 1999; Orr, 1991; Sale 2005). We seem able to identify environmental problems, but unable to identify and agree on the best course of action to resolve these problems.

I first became conscious the impacts our buildings have on the environment in 1999. During that year my employer, an environmental non-profit, retained a designer to transform two floors of a century-old warehouse building into a new office for our organization. I worked with the designer as the ‘green’ advisor, recommending many of the building materials and products used for the renovation.

In the intervening years I have devoured as much information about *green building* as I have had time to ingest and digest. I continue to expand my knowledge of the environmental impacts of buildings, the barriers to green building, and how green building fits with other, or within broader, sustainability initiatives. Some of this knowledge is contained in these pages.

Also contained in these pages—woven throughout in the background—is my new perspective on environmental problems. This new perspective, I realize now, has been a few years in the making. The ‘ah ha’ moment came while recently reading the third from last page of Bob Doppelt’s (2003) *Leading Change Toward Sustainability*. He writes, “One of the most important lessons that I hope to have shared in this book is that my investigation found that persistent environmental and socioeconomic problems are symptomatic of deficiencies of governance and leadership within an organization” (p. 246).

This sentence in Doppelt (2003), as well as the writings of people such as Fritjof Capra (1996) and William McDonough (1993), has forced me to think more deeply about environmental problems. I have come to the conclusion that perhaps there are no environmental problems. Instead, I posit that environmental impacts are the symptoms, or effects, of problems elsewhere in the system.

For Doppelt (2003) the problem is leadership and governance. For McDonough (1993), who believes design is the first human intention, it is a design problem. For Fritjof Capra (1996) the problem is a crisis of perception; we do not see that the all of the problems are interconnected. For Holling, Gunderson and Ludwig (2002) the problem stems from partial world views, based upon different caricatures of how nature works. For Ann Dale (2001) the problem is dominant paradigms, existing values, and a lack of ecological literacy—echoed by Capra. For Daniel Quinn (1992) it is culture. For Herman Daly (1996) the problem is the infatuation with growth and the presence of externalities. For Paul Hawken and Amory & Hunter Lovins (1999) it is that we do not properly value natural capital.

These perspectives, along with still others, are all equally valid—one is not right and another wrong—and they all contribute to the discourse. My interpretation of this discourse is rather than identifying environmental problems, these thinkers are telling us that environmental impacts are the effects of other problems. This interpretation forces one to rethink where the solutions points in a system are located.

Rodney C. McDonald
Royal Roads University, March, 2005

INTRODUCTION

The Problem

The construction and operation of buildings in Canada results in significant impacts on the natural environment (Canada Green Building Council, 2005). However, “the commercial buildings industry is driven almost exclusively by considerations of capital cost and return on investments” (Larsson & Clark, 2000, p. 414) so little attention is paid to these impacts.

Green building is emerging as a strategy for addressing the impacts, but there is a widespread perception in the building design and construction industry that green buildings cost more to build than conventional buildings (Cole, 2000). For example, cost consultants in the U.K. have the perception that “more energy efficient and environmentally friendly buildings cost between 5% and 15% more to build from the outset” (Bartlett & Howard, 2000, p. 318). From my own experience, I know this same perception exists here in Canada. The problem with this perception is that “higher environmental performance goals are often dismissed by the development community, clients and designers without serious exploration” (Cole, 2000, p. 305).

As a result of research in the United States, “there is substantial recent evidence . . . to indicate that building green is less expensive than many developers think” (Kats, Alevantis, Berman, Mills & Perlman, 2003, p. 13). Similar information, especially that which includes buildings in Canada certified under the Leadership in Energy and Environmental Design (LEED™) Green Building Rating System, is not widely available for the Canadian context.

The Question

Given the problem context discussed above, the research question I sought to answer was: What are the economics of green building in Canada?

The objectives were: (1) learn about the cost premium for green building compared conventional construction for a case study sample, (2) from the case study sample determine if there are some common keys to making green building cost effective, and (3) provide policy makers with some recommendation on how to help encourage green building in Canada.

Major Findings

Within the context of the small sample of five Canadian case study green buildings, my research reveals that the average capital cost for green building is approximately 5% less than conventional construction. My findings are contrary to the perceptions in the marketplace, and I think further research will demonstrate the cost effectiveness of green building.

The research revealed that the solutions are not as difficult as loading buildings up with efficient and green technologies and trying to figure how to pay for them. Instead the solutions are as simple as changing the mindset of the building owner and design team, establishing clear environmental goals at the outset and, most importantly, using an integrated design process.

The recommendations to policy makers are designed to support these findings and address some of the issues, such as lack of market demand for green buildings, identified during the research.

1. CONTEXT

This research is set within the context of (1) sustainability and my definition of sustainability; (2) the impacts of buildings on the environment[1]; (3) economics and the presence of externalities, and (4) contemporary green building activities in Canada.

1.1. Sustainability: The Twenty-First Century Imperative

Sustainability is the human imperative of the twenty-first century (Dale, 2001). One challenge in meeting this imperative is the difficulty people have in coalescing around the concept of sustainability—my personal experience is that most people are not familiar with the concept, and those that are do not have a shared meaning (Dale 2001). Holling, Gunderson and Ludwig suggest these multiple meanings stem from alternate world views and caricatures of nature (2002).

Almost 30 years ago the World Commission on Environment and Development established a definition of sustainable development (Bruntland Commission, 1987) that has been widely promoted (Dale, 2001). I prefer *sustainability* to *sustainable development* (I find all definitions of sustainable development (Dale) too anthropocentric) and draw on various concepts and sources to formulate a meaning for myself: Autopoiesis (Maturana & Varela, 1980), Panarchy (Gunderson & Holling, 2002), Co-evolutionary processes (Norgaard, 1994), Systems Thinking (Capra, 1996; Meadows, 1999), Ecological Economics (Daly & Cobb, 1994), Natural Capital (Hawken, Lovins & Lovins, 1999), Ecoeffectiveness (McDonough & Braungart, 1998, 2002), Sustainable Development Imperatives (Dale, 2001) and The Natural Step (Robèrt, 2002).

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[1] In the *Concise Oxford Dictionary*, the *environment* is defined as “the surroundings or conditions in which a person, animal, or plant lives or operates” (Pearsall, 2001, p. 477).

I believe sustainability is not a way of 'doing' but a way of 'being'. It is a state of mind, not a policy or program or destination, and will not be fully realized without a shift in world view (Holling, Gunderson & Ludwig, 2002; Jackson, 2003), perceptions of reality (Bunnell, 2004) and values (Dale, 2001).

For me, sustainability is a holistic perspective based on systemic thinking (Capra, 1996; Checkland & Scholes, 1990; Jackson, 2003; Maturana & Bunnell, 1997). It is a co-evolutionary (Norgaard 1994) and dynamic interconnectedness between natural and human systems, which are strongly coupled (Folke et al., 2002) because we are part of nature, not separate from it (Capra, 1996). In this dynamic interconnectedness, natural systems and human economic and social systems go through adaptive cycles of growth, conservation, release and regeneration (Gunderson & Holling, 2002). Diversity is conserved to maintain and encourage adaptive and learning capabilities (Berkes & Folke, 2002).

Further, decision-making requires integrated solutions, that are based on understanding and wisdom, as well as the best available science, information and knowledge (Gunderson & Holling, 2002). "A minimal integrated solution would involve selected social, economic and ecological actions at the appropriate scales" (Folke et al., 2002, p. 4). This requires the use of collaborative, transdiciplinary networks, and civil society dialogues to transform institutions and share decision-making (Dale, 2001), as well as a commitment to transparency, accountability and information sharing (Gélinas, 2003).

In summary, sustainability is about integrated decision-making, it is a mindset based on systemic thinking, which recognizes the embeddedness of humans in the environment and the co-evolutionary dynamic interconnectedness between natural and human systems.

This is the 21st Century imperative.

1.2. Buildings and Environment: Transforming Resources into Waste

Buildings have an immense impact on the natural environment. Buildings use land, energy, material resources and water, and generate air emissions, solid wastes and wastewater effluent.

According to the Canada Green Building Council (CaGBC, 2005, slide 6), commercial and residential buildings in Canada account for:

- ~ 38% of total Canadian secondary energy use
- ~ 30% of total Canadian greenhouse gas emissions
- 40% (3 billion tons annually) of raw materials use globally

Statistics from the U.S. Green Building Council (USGBC, 2004a, December, slide 5) provide a fuller picture of the environmental impacts of residential and commercial buildings:

- 65.2% of total U.S. electricity consumption
- > 36% of total U.S. primary energy use
- 30% of total U.S. greenhouse gas emissions
- 136 million tons of construction and demolition waste in the U.S. (approximately 2.8 lbs./person/day)
- 12% of potable water consumption
- 40% (3 billion tons annually) of raw materials use globally

One factor that contributes to these impacts is the linear flow of energy, water and materials through buildings over the course of their life (see Figure 1). According to William McDonough, “The industrial idiom of design, failing to honor the principles of nature, can only violate them, producing waste and harm, regardless of purported intention” (1993, p. 8)

This design ideology, similar to the ideology of industrial economies (McDonough & Braungart, 1998; Pearce & Turner, 1990), treats the environment as a warehouse of resources and a sink for wastes. From this perspective it is possible to conceive of buildings as boxes that transform resources into wastes.

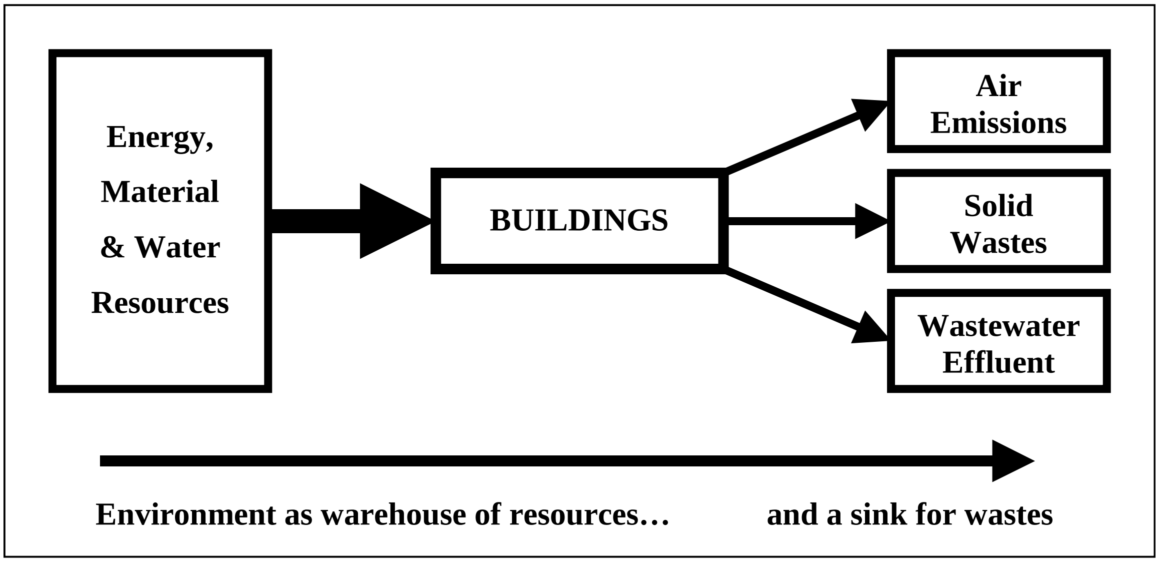


Figure 1. Buildings as transformers of resources into wastes

1.3. Economics & Externalities: Variations on a Theme

Green buildings compete with conventional buildings on an uneven economic playing field. This is evident when one understands ecological economics and the concept of externalities—variations on the theme of economics.

Figure 2 shows that "Standard economics generally addresses itself only to human-human situations. Environmental economics deals with issues relating to the effect of human economic activities on nature—for example, "externalities' such as pollution. Ecological economics is a modern development that attempts to address the whole humanity-nature system in a nonreductionistic, scientific "systems" way" (Peet, 1992, p. 55).

	To human society	***To nature***
From human society	Standard economics	Environmental economics
From nature	Resource economics	Ecology

Ecological economics

Figure 2. Branches of economics included within ecological economics

Note. From *Energy and the Ecological Economics of Sustainability* (p. 55), by J. Peet, 1992, Washington D.C., Island Press. Copyright 1992 by John Peet.

An *externality* occurs when the actions of one person (or firm or community or nation or generation or species) affect another person (or firm or community or nation or generation or species) and no payment or compensation is provided to the affected party (Daly & Cobb, 1994; Martinez-Alier, 1991; Peet, 1992). “If the action is beneficial, it is an *external benefit*; if the action is adverse, it is an *external cost*” (Peet, 1992, p. 119).

This shortcoming is ignored by conventional economics (Suzuki, 2005), so much so that “all conclusions in economic theory about the social efficiency of pure competition and the free market are explicitly premised on the absence of externalities” (Daly & Cobb, 1994, p.55).

Similarly, the economics of conventional building practice is premised on the absence of externalities: the developer does not include in tenant rents the external costs associated with the building, such as stormwater runoff (U.S. Green Building Council [USGBC], 2002); the architect does not consider the external costs of forest depletion (Parfitt, 2000) when specifying lumber; the general contractor does not include the external costs of carbon dioxide emitted during the transport of building materials. These costs are borne by everyone external to the activity without compensation.

The external costs of carbon dioxide can be significant. For example, the Ontario Medical Association (2004) believes that air pollution in Ontario results in thousands of hospital admissions and emergency room visits each year, at an annual estimated cost of $652 million in direct health care costs and $586 million in lost productivity.

According to Canadian Architect (n.d.) “At present, the environment is footing the bill for externalities and it is conceivable that a farmer in the Prairies may be impacted by climate change associated with urban sprawl in Eastern Canada. With respect to sustainable architecture, externalities are important considerations even if they are difficult to quantify” (final ¶).

In addition to shifting the cost burden to others, externalities are problematic because they make all sorts of things seem less expensive (to the buyer) then they really are, which artificially inflates demand (Daly and Cobb, 1994; Peet, 1992).

From this perspective, green buildings—with features like solar power, onsite wastewater systems, and recycled building materials—are a way of internalizing some of the external costs associated with buildings. However, because conventional buildings do not internalize external costs they seem less expensive than their green cousins, making green building look less economically viable (Canadian Architect, n.d.) and artificially inflating demand for conventional buildings. Not an even paying field.

1.4. Contemporary Green Building in Canada

Contemporary green building in Canada is in its infancy but growing quickly (CaGBC, 2005). According to Alex Zimmerman, President of the Canada Green Building Council (CaGBC), "We are nearing the tipping point where soon the question asked on every project will not be, 'Why should we build a green building?' but rather, 'Why are we not building green?'" (O'Reilly, 2004, p. 30).

Although a discussion of the origins of green building in Canada are beyond the scope of this paper, it is worthwhile to mention four initiatives that preceded the launch of the CaGBC.

First, Natural Resources Canada's C-2000 Programme for high performance buildings began in 1994 (Larsson & Clark, 2000; Natural Resources Canada [NRCan], 2004a). It included performance requirements (e.g., energy performance 50% better than the Model National Energy Code for Buildings (MNECB), environmental and other parameters) and process requirements (i.e., integrated design). It was a small demonstration program that is no longer available.

Second, Natural Resources Canada's Commercial Building Incentive Program (CBIP), launched in 1997, is a larger national program focussed only on energy efficiency. Current CBIP funding for buildings is equivalent to two times the expected annual energy savings, up to $60,000, for building that use 25% less energy compared to the MNECB (Larsson & Clark, 2000; NRCan, 2005). This program is available until March 2007.

Third, the Green Building Challenge (GBC) is an "international research, development and dissemination collaborative effort to further understanding of building environmental performance assessment" (Larsson & Cole, 2001, p. 336). The assessment framework for the GBC is software called GBTool (International Initiative for a Sustainable Built Environment IISBE, n.d.b).

Fourth, the popular European BREEAM (Building Research Establishment Environmental Assessment Method) was adopted for use in Canada in 1996 (Environmental Building News, 1997).

The Canada Green Building Council (CaGBC), sister organization to the decade old US Green Building Council (USGBC) was launched in December 2002 (see www.cagbc.org and www.usgbc.org respectively). The CaGBC is currently the best barometer of green building interest and activity in Canada, as evidenced by growth statistics (CaGBC, 2004).

On December 1, 2004 the CaGBC officially launched LEED™ Canada, the Canadian version of the USGBC's popular Leadership in Energy and Environment Design (LEED) Green Building Rating System (see CaGBC, 2004; USGBC, 2002 for full description).

LEED™ awards points, up to 69 points, for meeting performance criteria in five categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, and Indoor Environmental Quality. Based on the total number of points earned, green building projects using LEED™ are certified with one of four ratings—Certified (26-32 points), Silver (33-38 points), Gold (39-51 points) or Platinum (52-69 points).

LEED™ is becoming very popular. *Fast Company* magazine recently rated it number seven of the top 101 trends of 2005 (Lidsky, 2004), and it is rapidly helping green building to become mainstream (Economist, 2004).

2. METHODOLOGY

Set on confirming or confuting the perception that green buildings are too costly, my original intention was to undertake to write the Canadian version of Kats et al. report *The Costs and Financial Benefits of Green Buildings* (2003). My plans changed when I accepted the fact that there are too few LEED™ certified buildings in Canada, and the data required for this analysis is largely unavailable (N. K. Larsson, personal communication, November 23, 2004). According to Kats et al., “a meaningful assessment of the cost of green building requires a comparison of conventional and green designs for the same building only” (p. 14). I also learned that “assessing the costs and benefits of any building – let alone a green one – can be elusive” (Bordass, 2000, p.338) and difficult to determine (McDonald, & Dale 2004).

The methodology then shifted to understanding the economics of green building in Canada—to consider the economic perspective of green building and determine if there is a strategy or strategies for making the economics of green building work.

Canada was chosen as the geopolitical focus for the reason that it is my country of residence and employment.

2.1. Assumptions: The List of Eleven

During the thesis proposal stage I started jotting down some of the assumptions I hold about green building, sustainability and the future.

1. The development of green buildings in Canada is slow because there is a widespread belief that green building (and the greening of almost anything) is too expensive.
2. The capital cost premium for green buildings is in fact not prohibitive.

3. Green builds are a way of internalizing some of the external costs of conventional buildings.
4. Integrating the design process is needed to reduce first costs of green buildings.
5. The emerging process of integrated design can help produce cost effective green buildings, and the more integrated the design process the greater the following economic savings:
    a. lower first-cost premium for green over conventional buildings;
    b. lower building operation costs (e.g., for energy and water); and
    c. lower costs to society (e.g., wastewater treatment, CO_2 emissions).
6. There are three primary groups of actors in the realm of commercial and institutional buildings: (1) the building industry (including building owners, building developers and managers, designers, and product manufacturers); (2) the financial community (lenders); and (3) governments (in their capacity as users of buildings and makers of public policy).
7. Green buildings have less impact on the environment (smaller footprint), in these areas:
    a. material use, including harvesting and extraction of natural resources;
    b. depletion of fossil fuel energy resources, and corresponding generation of greenhouse gases;
    c. use of potable waster resources, discharge of wastewater, and stormwater runoff; and
    d. generation of solid wastes, both during and after construction.

8. Ecological Limits:
    a. there are absolute ecological limits to the planet's ability to act as a storehouse of resources and a sink for wastes. We don't know what these limits are;
    b. the 21st Century will mark the end of the hydrocarbon era; and
    c. there is a looming global water crisis that will affect even water rich countries.
9. Life-cycle analysis will be increasingly utilized to examine the environmental impact of buildings, and governments and the building industry will move towards full-cost accounting in order to make the economic case for small premiums to first costs for green buildings.
10. There are tangible, although perhaps more difficult to quantify, economic and social benefits of green buildings such as increases in employee productivity.
11. Building green is a strategy for building owners to future-proof themselves from:
    a. future increases in energy costs;
    b. future maintenance costs; and
    c. future water scarcity issues and increases in wastewater treatment costs.

2.2. Methods and Research Process

A list of green buildings in Canada (Appendix A) was assembled in order to select five case studies. The information for this list was complied from freely accessible Internet sources, many of which overlap in terms of the buildings listed. The Web sites include: Canada Green Building Council; Natural Resources Canada Buildings Group; Green Buildings BC; a Web site assembled by Terri Meyer Boake, Associate Professor, School of Architecture, University of

Waterloo; Advanced Buildings: Technologies and Practices; International Initiative for a Sustainable Built Environment; and known green building consultants in Canada such as Busy Perkins+Will, Manasc Isaac Architects, and Enermodal Engineering. A spreadsheet of all Commercial Building Incentive Program (CBIP) projects to December 2004 was provided by Natural Resources Canada. For each project the spreadsheet includes the date the expression of interest was signed, the building name, city and province, and the energy efficiency of the building expressed as a percentage over the Model National Energy Code for Buildings.

Presentation: Green Building and the Need for Ecological Engineers

Early in my research, (September 24, 2004) I delivered a presentation on green building at the University of Manitoba Faculty of Engineering's Design Colloquium Series, titled *Green Buildings and the Need for Ecological Engineers* (Mcdonald, 2004). During the ensuing discussion two critical questions emerged from the audience.

1. Capital budgets are often separate from operation & maintenance budgets, which thus restricts someone from spending more on a building up front even when operating cost savings can be demonstrated. What is the solution?
2. One green building strategy is to eliminate or downsize mechanical components. If professional fees for engineers are a percentage of the capital cost of mechanical equipment, isn't green building a disincentive to professionals?

e-Dialogue

An e-Dialogue was used to engage a small group of green building experts from across Canada in a dialogue titled *The Economics of Green Buildings in Canada* (McDonald & Dale, 2004). E-dialogues are synchronous online spaces designed for increasing literacy on critical public policy issues and emerging research methodology, as well as for research dissemination.

The e-Dialogue took place on October 7, 2004 from 3:00 p.m. to 5:00 p.m. Central Time, and was co-moderated by Dr. Ann Dale and myself, Rodney C. McDonald.

For the purposes of my research I chose three research questions:

1. How do you define green building?
2. What are the economic barriers to green building?
3. Is the design process integral to the success of a green building project?

Prior to the e-Dialogue the panellists met via conference call. This built trust amongst the group and provided an opportunity for me to obtain feedback on the structure of the questions. The questions were refined as a result of the feedback.

The panellists are recognized green building leaders in Canada and represent various perspectives from the public, private and non-governmental communities. Seven people, from an original list of 14 invitees participated as panellists.

A Web site was built to provide seminal information to the participants and visitors. The Web address is http://e-dialogues.royalroads.ca/green/green_intro.htm. An e-flyer was also created and distributed widely by e-mail to advertise the dialogue.

An archive of the complete dialogue was prepared for research dissemination and future reference by younger scholars (McDonald & Dale, 2004). This archive is available on the e-Dialgoue Web site.

Case Study Questionnaire

A case study questionnaire was prepared to ensure a minimum number of topics and questions are covered at each case study visit. Similar to the e-Dialogue questions, the case study questions are informed by the literature, the larger research questions, the research objectives and the research context. The case study questions were discussed with and reviewed by two members of my thesis committee. The case study questionnaire is included as Appendix B.

Case Study Selection

Five case studies were selected from the list of green buildings in Canada (see Appendix A). Case study selection was based on three criteria.

1. Third-party recognition: To include only buildings recognized by a third party as green. This includes buildings that are, or will be, LEED™ Certified, buildings meeting the Natural Resources Canada C-2000 standard, or buildings in the Green Building Challenge. This saved the step of developing new criteria.
2. Geographic distribution: To include buildings from Western Canada (west of the Manitoba-Ontario border), Eastern Canada (east of the Manitoba-Ontario border) and Northern Canada (north of the 60 degrees North latitude).
3. Building type/function: To include buildings representing a range of functions.

One of the challenges with selecting case studies is the infancy of green building and the minute number of green buildings in Canada, compared to the total building stock. Newer buildings were selected to be sure that people involved in the project are still available.

Case Study Visits

For four of the five cases studies, the case study questionnaire was completed, and a more general discussion occurred, during an in person meeting with the building owner representative. In three of the four cases, a building tour was part of the on site visit and digital photographs were taken. In the fourth case, building exterior photos were taken by a third party on my behalf.

In the fifth case I knew a member of the building design team and the construction manager, and I toured the building during its construction a few years ago. In this case, a member of the design team, with the building owner's permission, completed the questionnaire.

Some information was gathered from another potential case study. The case study questionnaire was provided for review but a visit could not be coordinated. The building owner representative completed the survey nonetheless and returned it for consideration.

Meet and Speak with Other Professionals

In addition to the research tool described above, I also met and spoke with other professionals involved with building and green building. Three of these individuals are on my thesis committee: Anne Auger, Director of the Buildings Division at Natural Resources Canada, David Rousseau of Archemy Consulting Ltd., and Jonathan Westeinde of Windmill Development Group. I also met with Pierre Guèvremont, Chief of the New Buildings Program at Natural Resources Canada. While at Greenbuild 2004 I met with Bill Reed of Natural Logic. While in Edmonton I met with Derek Heslop of Manasc Isaac Architects. While in Vancouver for the BC case study visit, I met with Pierre St. Jacques of Canada ICI and spoke with Jacques Khouri, President and CEO of VanCity Enterprises. In my normal course of business in Manitoba I have also had informative discussions with Merrell-Ann Phare of the Centre for Indigenous Environmental resources, Stephen Kupfer and Mark Olsen of Pioneer Solutions, and Ryan Bragg with Corbett Cibinel Architects.

3. A DEFINING MOMENT

Before going any further, it is necessary to pause to discuss and clarify the terms used with respect to building and the environment. The more popular terms are: green building, sustainable building, high-performance building, and whole building design. Some people use these terms interchangeably, while others define and use each one differently.

One reason for this confusion, according to McLennan (2004), is that "people are trying to articulate a movement that is still in its adolescence—one that is actively defining itself, its principles, components and philosophy. Another reason . . . is that sustainable design has operated for a long time outside of the mainstream of the design and construction industry… for many, it means unlearning as much as it means learning new things" (p. 3).

I use the terms green building, sustainable building and restorative building to delineate three distinct types of building practice, moving from weak sustainability to strong sustainability. I define these terms in the context of natural capital (Hawken, Lovins & Lovins, 1999), externalities (see Section 1.3), and weak vs. strong sustainability. "'Weak' sustainability allows the substitution of manufactured capital for so-called 'natural capital'—implying, therefore, a common unit of measurement, i.e., money value—while 'strong' sustainability refers to the maintenance of physical natural resources and services" (Martinez-Alier, 2001, p. 4019).

Figure 3, adapted from Reed, Hubbard and Batshalom (2004) shows the increasing sustainability of green building, sustainable building and restorative building. A discussion is available in McDonald and Dale (2004).

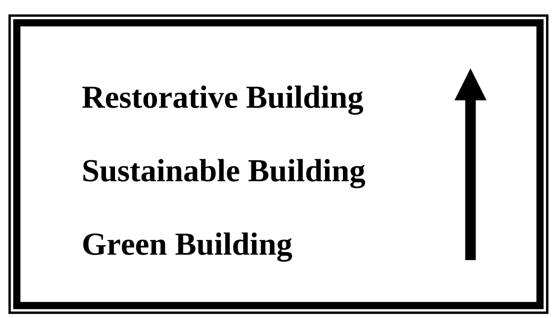


Figure 3. Green, sustainable and restorative building

Note: Adapted from Reed, Hubbard & Batshalom, 2004

3.1. Green Building

There are many definitions of green building in the literature (Cole, 2000, Kats et al., 2003). The Canada and U.S. Green Building Councils define green building as "design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants" (CaGBC, 2005, slide 7; USGBC, 2004a, slide 4).

Including the elements of natural capital and externalities in this definition, I define green building as: design and construction practices that reduce negative impacts on the environment, but which continue to rely on stored stocks of natural capital and produce external costs.

During his presentation at GreenBuild 2004 in Portland, Bob Berkable (2004) of BNIM Architects, and founder of the American Institute of Architect's Committee on Environment, stated that even if every building was a LEED-Platinum building, buildings would still have a negative impact on the natural environment. There is a need to move beyond green building.

Table 1. Defining Green Building, Sustainable Building and Restorative Building

Green Building	Sustainable Building	Restorative Building
▪ Reduces negative impacts on the environment ▪ Continues to rely on stored stocks of natural capital ▪ Some external costs remain	▪ Eliminates negative impacts on the environment ▪ Relies only on current flows of natural capital ▪ No external costs; all external costs are internalized	▪ Positive effect on the environment ▪ Reinvests in and restores natural capital ▪ External or public benefits

◄────────────────────────────►

Weak Sustainability — Strong Sustainability

3.2. Sustainable Building

Drawing on the definition of sustainability provided in Section 1.1, and within the context of natural capital and externalities, I define sustainable building as: design and construction practices that eliminate negative impacts on the environment, do not impede the natural environment's ability to sustain living systems, rely only on current flows of natural capital and internalize all external costs. Sustainable building (and restorative as well) also includes a broader set of social issues (McDonald & Dale, 2004).

3.3. Restorative Building

Following from the definitions of green and sustainable building, I define restorative building as: design and construction practices that have a positive effect on the environment, help the natural environment improve its ability to sustain living systems, reinvest in and restore natural capital and produce external benefits.

I agree with Berkable that green building does not go far enough. At the same time I believe that we are not currently building any sustainable or restorative buildings, as defined above. For this reason I use the term *green building* throughout this thesis.

3.4. Integrated Design Process

Integrated design is integral to green building, since "if we want to change the result, we must first change the process that led to the result" (McLennan, 2004, p. 86). An integrated design process is a holistic, systemic and comprehensive design process that brings all design professionals together, along with the building owner, the occupant, and other direct stakeholders (see Figure 4) to design the building as a team (Kobet, Powers, Lee, Mondor & Mondor, 1999; Larsson, 2002; Lewis, 2004; McLennan, 2004; NRCan, 2004b, October; Reed & Gordon, 2000).

According to Lewis, P.E. (2004), "The integrated design process is crucial to producing a green building" (p. 22). Also, McLennan (2004) believes "Integrated design safeguards against the value engineering process, which is not engineering and does not add value" (p. 223).

In integrated design, the relationships between the design disciplines and the professionals representing those disciplines is more important than the individual disciplines and professionals (B. Reed, personal communication, November 12, 2004).

From a cost perspective, “Dozens of successful projects now attest to the fact that integrated design is an effective approach—perhaps the only effective approach—for creating comprehensive green buildings on a reasonable budget” (Malin, 2004, ¶3).

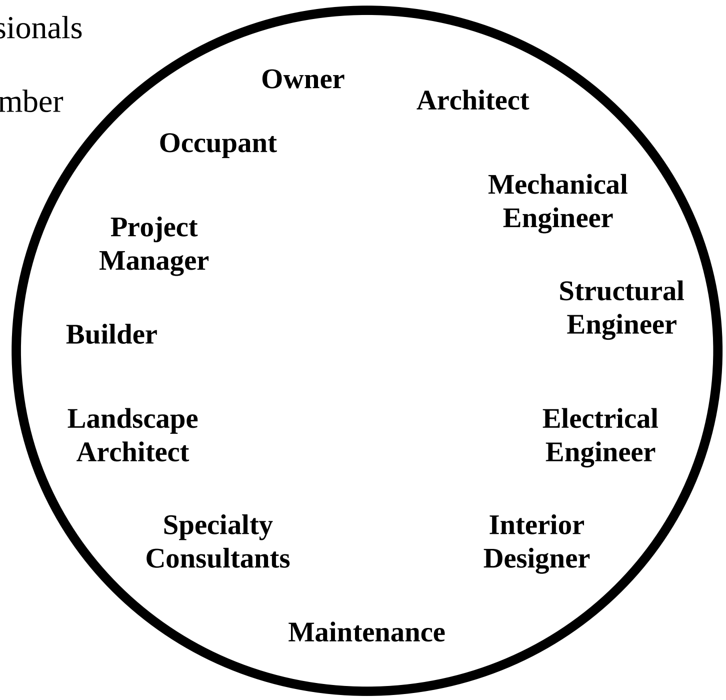


Figure 4. Integrated design process team

4. E-DIALOGUE ON THE ECONOMICS OF GREEN BUILDINGS

The e-Dialogue on T*he Economics of Green Buildings* (McDonald & Dale, 2004) in Canada resulted in four take-aways, namely that (1) there is difference between "green" and "sustainable" building; (2) there is a need to restructure design consultancy fees to pay consultants for their intellectual capital rather than based on a percentage of the total building costs; (3) integrated design is the foundation of green buildings, and (4) it is difficult to determine cost premiums for green buildings since they are simply different and better buildings, and, if designed well, there should be no capital cost premium for these buildings.

An archive of the e-Dialgoue (McDonald & Dale, 2004) is available on the e-Dialgoue Web site (see Section 2.2).

5. TAKING STOCK: CANADIAN GREEN BUILDING CASE STUDIES

Five case studies were examined, all new construction, with three of the five in Western Canada. There are no buildings in Atlantic Canada that fit the selection criteria (see Section 2.2), as the best example is not yet under construction. The provincial locations of the case study buildings include Alberta, British Columbia, Manitoba, Northwest Territories and Ontario.

5.1. Alberta: City of Edmonton South East Division Police Station

Building Type	Third Party Recognition	Capital Cost Premium	Interior Area	Capital Cost per m^2
Administration	LEED™ Silver (38 points)	5%	4,826 m^2	$1,935

The City of Edmonton South East Division Police Station, located at 104 Youville Drive, Edmonton, Alberta, is a LEED™ Silver administration building (opening April 2005). It has a total gross area 4,826 m^2 (incl. 582 m^2 of underground parking and a 327 m^2 expansion area) and perimeter area of 2,444 m^2.

Figure 5. Edmonton South East Division Police Station
Photo source: Rodney C. McDonald

The total capital cost for the building was $9.34 million, or $1,935.35 per square meter. According to the building owner representative, the capital cost premium for the building—the additional premium for green compared to conventional construction—was 5%. This capital cost premium was within the existing construction budget contingency for the project.

The South East Division building is registered to LEED™ version 2.1, and is scheduled to achieve a LEED™ score of 38 points, out of a possible 69 points. The major green features are: use of daylighting, use of sun shades and deflectors, energy efficient envelope and high efficiency boilers, use of grey water from sinks and showers to flush toilets, large underground storage tanks to capture rainwater runoff for irrigation use, an aggressive construction waste management initiative, and the reuse of topsoil and excavation material on an adjacent site.

An energy model prepared during design indicates the building will use 47% less energy than the Model National Energy Code for Buildings (MNECB). This reduces annual energy use by 2,538,156 MJ and annual carbon dioxide emissions by 301.1 tonnes (Keen Engineering, 2003). As a result, the project received $60,000.00 from the Commercial Building Incentive Program (CBIP) and $40,000.00 from the Alberta Plus Initiative. Also, based on 2004 prices, the building will save $40,000.00 to $50,000.00 in energy and maintenance costs per year.

Although this is the first LEED™ project for the City of Edmonton—and the first LEED™ registered police station in Canada—it is not the first energy efficient police station in Edmonton. In 2003, the City built a new North Division Police Station, which achieved energy savings of 43% better than the MNECB. The results of this project—it was completed "within the allotted time schedule and under the initial projected pre-construction estimate of $7 million" (Semchuk, 2004, p. 12)—gave City staff the confidence to try LEED™ on the next project.

The City of Edmonton's economic success with the South East Division LEED™ building is the result of three key factors: (1) establishing clear environmental goals for the project; (2) using an integrated design process; and (3) communicating the green building goals to the contractor and trades by using presentations and detailed specifications

Environmental goals for the project were initiated and driven by the building owner. General goals were established during project conceptualization, before requesting consultant proposals, and detailed goals were established during schematic design with the design team.

An integrated design process allowed the building owner, project manager and occupant to be fully engaged with all of the design consultants during the design phase. This approach allowed building maintenance staff to comment on the design for the mechanical and electrical rooms, which resulted in changes that will make maintenance easier and perhaps less expensive.

Communicating the green building goals of the project was key to getting the contractor and trades on board. A presentation about green building was delivered to the contractor and trades as part of the tendering process—tenders were only accepted from those who attended the presentation—and again, in more detail, to the successful bidder. Clear and concise, yet detailed, specifications where prepared to ensure (a) the LEED™ criteria were adhered to when selecting building materials, and (b) the trades captured the data required for LEED™ certification. This helped to reduce the cost of assembling the LEED™ documentation.

5.2. British Columbia: City of White Rock Operations Building

Building Type	Third Party Recognition	Capital Cost Premium	Interior Area	Capital Cost per m^2
Administration	LEED™ Gold (44 points)	8%	661 m^2	$1,797

The City of White Rock Operations Building is located in an urban setting at 877 Keil Street, White Rock, British Columbia. It is a LEED™ Gold administration building with a total gross area 661 m^2. The building has been occupied since April 2003.

Figure 6. White Rock Operations Building
Photo source: Rodney C. McDonald

The total capital cost for the building was $1.18 million, or $1,797.33 per square meter. The capital cost premium for the building was 8% (City of White Rock, n.d.).

The White Rock Operations Building is certified to LEED™ version 2.1, and obtained 44 points (USGBC, 2003, July). The most significant features of this green building include: reuse of an existing building foundation, daylighting, natural ventilation, use of sun shades and deflectors, energy efficient envelope, solar hot water heating, a green roof, photovoltaic panels, and innovative water management and efficiency measures such as the use stormwater for flushing the dual-flush toilets.

The water and energy efficiency strategies result in “a reduction in site water use by approximately 90 per cent (2 million litres per year); a reduction in building waste usage by over 20 per cent; and a reduction in energy consumption by about 55 per cent” (Maser, 2004, p. 30)

The building is designed to use 56% less energy than the Model National Energy Code for Buildings (MNECB). Although actual energy use data is not yet available, the Greater Vancouver Regional District in considering a detailed study of five or six green buildings in British Columbia, which may include the White Rock building.

5.3. Manitoba: Mountain Equipment Co-op Winnipeg Store

Building Type	Third Party Recognition	Capital Cost Premium	Interior Area	Capital Cost per m^2
Retail	LEED™ Gold (39 points)	-41%	2,527 m^2	$1,011

The Mountain Equipment Co-op (MEC) Winnipeg Store is located at 303 Portage Avenue in downtown Winnipeg, Manitoba. It is a LEED™ Gold retail building with a total gross area of 2,527.8 m^2 (including 390.3 m^2 of unfinished space for a tenant) and perimeter area of 864.31 m^2. The building opened in May 2002.

Figure 7. Mountain Equipment Co-op Winnipeg
Photo source: Gerry Kopelow

The total capital cost for the building was $2.5 million, or $1,011.44 per square meter. According to a member of the design team, who also completed the LEED™ documentation, there was no capital cost premium for this green building. Instead, compared to what the cost would have been for convention construction, there was a capital cost saving of 41.25%.

This saving is largely the result of the reuse of a large amount of existing building materials from the site, rather than purchasing new materials (R. Kula, personal communication, March 8, 2005).

The building is certified to LEED™ version 2.1 and obtained 39 points (USGBC, 2004b, December). The most significant green building features include: a central transit-accessible site, structural materials—brick and wood floor, joists, exterior masonry, and cast iron columns and steel beams—reclaimed/reused from the building site, daylighting, a tight building envelope with insulation values four times that of conventional buildings, energy efficient heating and cooling systems, waterless composting toilets in public use areas, and a green roof.

The MEC Winnipeg Store is only the second retail store in Canada to meet Natural Resources Canada’s C-2000 standard for advanced commercial buildings, which requires a 50% improvement in energy efficiency over the MNECB (NRCan, 2004a). An energy model prepared at the end of design to ensure compliance with CBIP shows the building is 53.4% more efficient than the MNECB. As a result, the total projected annual operating cost saving is $21,984.00.

The building project received a $60,000.00 grant from CBIP and an additional $15,000.00 from the Province of Manitoba’s Sustainable Development Innovation Fund.

The economic success of this LEED™ Gold project is the result of three key factors: (1) a sustainability mindset and a strong commitment to green design demonstrated by MEC, (2) an integrated design process, and (3) reuse of existing materials from the building site.

The strong commitment to green design is a natural extension of the values and principles of Mountain Equipment Co-op, a Canadian retailer of outdoor gear and clothing known for its environmental leadership, and the mindset of the building owner representative. As a result of this commitment, the green design was initiated and driven by the building owner’s representative and environmental goals were established at the very start of the project.

An integrated design process ensured that the building owner, project manager, occupant and design consultants worked together as a team. Also, using the construction management method of project delivery enabled the builder to be involved in the design process.

As mentioned earlier, reuse of a large amount of existing building materials from the site, rather than purchasing new materials, contributed to a significant capital costs saving. The site of the new retail store used to be home to three century-old buildings, two of which were no-longer structurally sound. Rather than the conventional practice of demolishing the buildings and trucking the materials to a landfill, the two buildings were carefully deconstructed so the materials could be reused. About 97% of the building is comprised of these reused materials.

As a result of taking a green building approach, the Mountain Equipment Co-op Winnipeg Store was less expensive to build and will be less expensive to operate because of lower energy and water utility costs.

5.4. Northwest Territories: Yellowknife Government of Canada Building

Building Type	Third Party Recognition	Capital Cost Premium	Interior Area	Capital Cost per m^2
Administration	LEED™ Gold (45 points)	0%	7,000 m^2	$2,600

The Yellowknife Government of Canada Building (GOCB) located in the northern and remote city of Yellowknife, Northwest Territories. It is a four-story LEED™ Gold federal office building with a total gross area 7,000 m^2 and perimeter of 1,890 m^2. The building will open in Summer 2005.

Figure 8. Yellowknife Government of Canada Building

Photos source: Christine Edward

When complete, the building will house 200 Government of Canada staff representing many different departments. It is designed as a central access point to the federal government.

The total capital cost for the building is $18.2 million, or $2,600 per square meter, plus the cost of tenant furnishing and fit-up. According to representatives of Public Works and Government Services Canada (PWGSC), the federal department responsible for real property, there is no capital cost premium for this green building compared to conventional construction.

The preparation of the building site also provided a win-win in terms of economics and environment. A pre-existing building on the site was deconstructed, diverting 91% of materials from landfill at over half the cost of demolition ($450,000 instead of $1 million+), which would have sent almost all of the materials to the local landfill.

The Yellowknife Government of Canada building is registered to LEED™ version 2.1, and is scheduled to achieve a LEED™ score of 45 points. The building is designed to take maximum advantage of daylight in both summer and winter. It also features green building approaches such as photovoltaic panels, a green roof, various energy efficiency measures and careful selection of building materials.

The building does not qualify for the Commercial Building Incentive Program because it is a Government of Canada Building, however the project did receive $310,000.00 from the Technology Early Action Measures (TEAM), which is part of the Government of Canada's Climate Change Action Plan (Government of Canada, 2005).

The success of this Canada LEED™ building is the result of three key factors: (1) having a shared vision of the final outcome; (2) developing environmental goals for the project; and (3) employing a fully integrated design process.

All of the key decision-makers are aligned to a clear and compelling vision of a green building in Yellowknife—a building that is a model of sustainable development in the North (Stewart, 2003). This vision is shared by the Director General (Hum-Hartly, 2004), the Regional Director General and the Regional Director, the PWGSC project staff in the Regional office, the members of the design team and the general contractor. As a result of this vertical and horizontal staff alignment to a shared vision the project is on schedule to meet its environmental goals. These goals were established by PWGSC during the project conceptualization stage, and actively communicated to potential design consultants in the original Request for Proposals.

An integrated design process was used to design the building. This process was used to design the building in a collaborative team setting with the building owner, the project manager, the occupants, the design consultants, an energy modeller, a cost consultant / quantiry surveyor, a building maintenance representative, and a commissioning agent. The project delivery method is design-bid-build, meaning the construction is tendered in an open bidding process once the drawings and specifications are prepared. This method prevents the builder from being part of the design process. To compensate, a building consultant was hired to join the design team.

The design process also engaged the local municipal government, the territorial government, and the Province of Alberta. As well, a visioning workshop was held with stakeholders in the local community early in the design to get community input.

The design team anticipates that the natural light and indoor environmental quality will increase staff productivity and reduce absenteeism. To help ensure the building functions as designed a user manual will be developed to educate all of the occupants of the building on how to use the building properly.

5.5. Ontario: York University Computer Science Building

Building Type	Third Party Recognition	Capital Cost Premium	Interior Area	Capital Cost per m^2
Education	GBC (2000)	0%	10,377 m^2	$2,156

Figure 9. York University Computer Science Building
Photo source: York University

The York University Computer Science Building is located at York's Keele Campus in Toronto, Ontario. It is an education building with a total gross area 4,826 m^2 and perimeter area of 2,700 m^2. It has a lecture theatre, classrooms, computer laboratory, and offices on three floors. The building opened in 2001.

The total capital cost for the building was $22.38 million, or $2,156.19 per square meter. According to the building owner representative, the capital cost premium for green building was 0%. Any additional costs where the result of a scope change, not the green building objectives.

The Computer Science Building was selected as one of three buildings to represent Canada at the 2000 International Green Building Challenge (IISBE, n.d.a). This required the assessment of the building using GBTool (see Section 1.4). The most significant green building features of this project include: natural ventilation using the stack effect and the latent heat/cooling of the concrete structure—the building is designed to use the waste heat from computers and bodies to heat the building—, along with the waste heat from the mechanical rooms, two atriums that bring natural light into the building and function as the stacks, daylight offices, 50% fly ash content in the concrete, and a green roof. Also, there is only one elevator (a hospital size elevator, so it could be used for freight as well) in the building to encourage those who are able to use the stairs.

The building has sensors to open the windows at the top of the atriums, part of the breathing process of the building. One of the principles under which this building works is that all the public space is kept at a lower temperature than the occupied space.

One feature that was proposed but not incorporated into the final design is the *hotelling* of offices, whereby faculty who are on campus for just a few hours a week would share facilities. As is commonly known this is not the norm in office environments and as such there was, understandably, some resistance to the idea by the building occupants. This raises the point that there are social and human constraints that act as barriers to optimizing green building strategies.

Another barrier identified during the building tour is current building and fire codes. One of the stairwells in the building, entirely lit by natural daylight, requires electric lighting during the day because the fire code states that lights must be on in exit areas at all times. From the building owners representative's perspective, addressing codes is a nibbling process; challenging the codes a little bite at a time and, as buildings become more and more advanced, making changes as needed.

6. GETTING TO GREEN WITHOUT BREAKING THE BANK

6.1. Here at Home: Canadian Case Study Results

The results of the case study research, shown in Table 2 and Figure 10, indicate the average capital cost premium of the five case studies is –5.6%.

Table 2. Summary table of five Canadian green building case studies

Case Study (Province)	Building Type	Third Party Recognition	Capital Cost Premium	Interior Area	Capital Cost/m^2
Alberta	Administration	LEED Silver	5%	4,826 m^2	$1,935
British Columbia	Administration	LEED Gold	8%	661 m^2	$1,797
Manitoba	Retail	LEED Gold	-41%	2,527 m^2	$1,011
Northwest Territories	Administration	LEED Gold	0%	7,000 m^2	$2,600
Ontario	Education	GBC 2000	0%	10,377 m^2	$2,156
		Average Capital Cost Premium:	**-5.6%**		

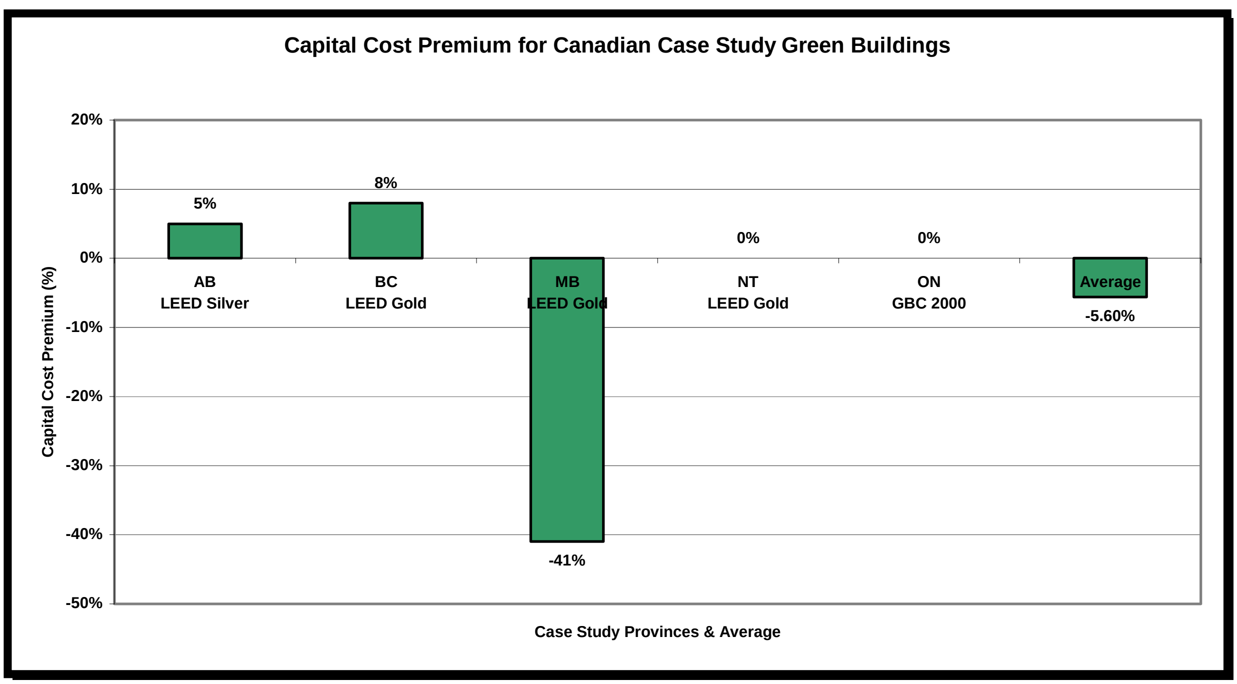


Figure 10. Capital cost premium for Canadian case study green buildings

This means, in the context of this small sample, the capital cost for green building is about 5% less than the capital cost of conventional construction.

The results also reveal other interesting pieces of information. First, there is no relationship between the level of LEED™ certification and the capital cost premium. The highest capital cost premium building is a LEED™ Gold building, while at the same time two of the lowest capital cost premium buildings are LEED™ Gold buildings.

It also is not possible to determine a relationship between the capital cost premium and the interior area or cost per square meter of the building. Although, by pulling out the three administration buildings a pattern does emerge from the relationship between building size and capital cost premium. Table 3 shows that the capital cost premium decreases as the size of the building increases. However, a caveat is necessary here because (a) this does only represent three buildings, (b) the buildings are in three different regions, and (c) one of the three buildings does not have the same level of LEED™ certification as the other two.

Table 3. Administration buildings from Canadian green building case studies

Case Study (Province)	Building Type	Third Party Recognition	Capital Cost Premium	Interior Area
British Columbia	Administration	LEED Gold	8%	661 m^2
Alberta	Administration	LEED Silver	5%	4,826 m^2
Northwest Territories	Administration	LEED Gold	0%	7,000 m^2

The average capital cost premium of –5.6% is of course the result of a significant cost saving for the Manitoba case study building. Realizing that this degree of saving may be unique, it is worthwhile revisiting the cast study saving, the average capital cost premium, and Figure 10.

For the Manitoba case study, removing the saving and restating capital cost premium at 0% changes the average capital cost premium to 2.6% (see Figure 11). This more closely reflects recent research data from the United States.

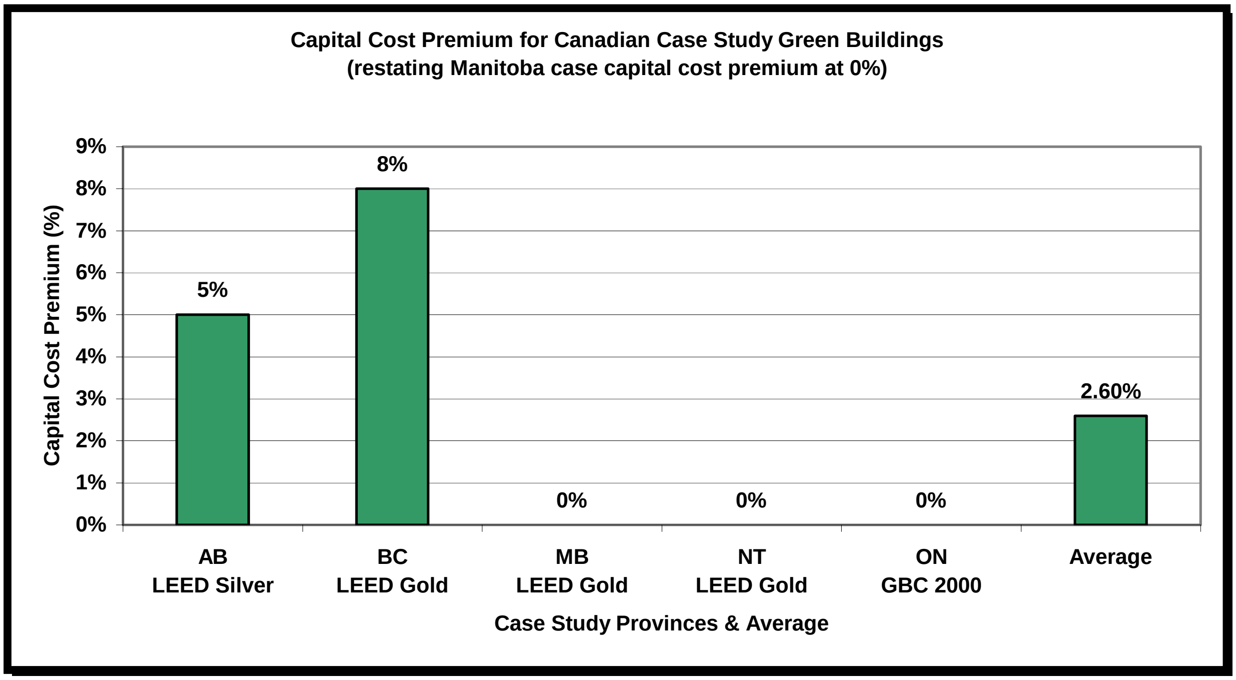


Figure 11. Capital cost premium for Canadian case study green buildings restated

These results fit with research by Larsson & Clark (2000) on the incremental costs of energy efficient C-2000 and CBIP buildings in Canada. First, their research revealed a combined premium for design and construction costs of 3.5%, which is less than a full percentage difference from the adjusted average presented in Figure 11. Second, although the capital cost premium for the Alberta case study is 5%, the building owner representative was sure to point out that this premium was within the construction contingency. This fits with the experience of Larsson & Clark, who found that “Most building developers are quite willing to accept a swing of 5% plus or minus as being an appropriate error band for costing purposes” (p. 417).

6.2. South of the Border: Findings from the United States

In the United States, since October 2003, two popular reports have been published on the economics of green buildings. The first report is *The Costs and Financial Benefits of Green Buildings* by Kats, Alevantis, Berman, Mills and Perlman (2003), prepared for California's Sustainable Building Task Force. The authors examined cost data from 33 LEED™ registered projects and discovered the average cost premium is less than 2%. Eight LEED™ Certified buildings had an average cost premium of 0.66%, 18 LEED™ Silver buildings had an average cost premium of 2.11%, 6 LEED™ Gold buildings had an average cost premium of 1.82% and one LEED™ Platinum building had a cost premium of 6.5% (see Figure 12).

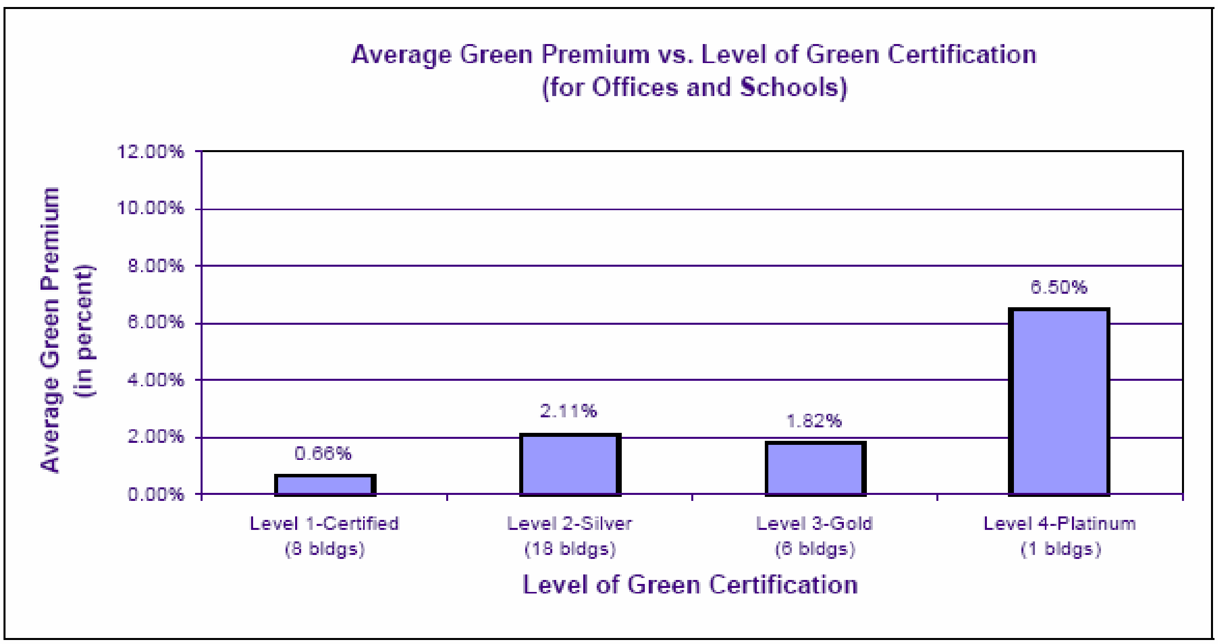


Figure 12. Average cost premium for 33 LEED buildings in California

Note. From *The Cost and Financial Benefits of Green Buildings* (p. 16), by G. Kats, L. Alevantis, A. Berman, E. Mills, J. Perlman, 2003

Kats, et al. (2004) also discovered "there is evidence that building green gets less expensive over time, with experience" (p. 17).

The second report is Costing Green: A Comprehensive Cost Database and Budgeting Methodology by Matthiessen & Morris (2004) of Davis Langdon, a cost consulting company with a database of construction cost information for both green and non-green buildings. This study compares 93 non-LEED and 45 LEED-seeking buildings in three building program types.

The general conclusion from this report is that, in a comparison of all 138 buildings, "the cost per square foot for the LEED-seeking buildings was scattered throughout the range of costs for all building studied, with no apparent pattern of distribution" (Matthiessen & Morris, 2004, p. 19). Matthiessen & Morris discovered "Costs range widely; some projects added significant costs and other actually saved money. In every case, an integrated design process and early commitment to sustainable design enable high achievement" (p. 9).

For many of the LEED-seeking buildings, the budgets were set without regard to sustainable design and the projects met the budget. Similar to the findings in a few of the Canadian case studies, the projects that most easily stayed within the initial budget were the ones that (a) had clear goals established at the start, and (b) integrated the sustainable elements at an early state of the project. Finally Matthiessen & Morris (2004) identified the most significant factor in determining the cost of green building to be "the response of bidders to the green requirements in the contract" (p. 14). This is likely determined by the mindset of the bidders.

6.3. The Lender/Investor Perspective and the Developer Perspective

From the lender/investor perspective the *asset* is the future flow of income from the building, not the building itself. The lender is not interested in the design or construction of the building, besides trusting that the building meets local building code requirements (P. St. Jacques, personal communication, January 21, 2005). Also, individual investors are like markets. "Markets are myopic, they discount the future; they cannot see future uncertain scarcities of resources or sinks” (Martinez-Alier, 2001, p. 4017). The developer is risk averse and, as a rational decision-maker, is therefore more interested in repeating what worked in the past and in trying out new approaches (J. Khouri, personal communication, January 22, 2005). Form the lender/investor perspective there is a need to determine if green building is a better investment from a cash flow perspective, and from a developer perspective there is a need to ensure that green building does not add undue risk to a project.

7. SEVEN KEYS TO COST EFFECTIVE GREEN BUILDING

The result of my discussions with experts and practitioners, the five case studies and my review of the literature leads me to the following recommendations, listed in Table 4 and discussed below.

Table 4. Seven keys to cost effective green building

1. Get into a sustainability mindset;
2. Establish a clear vision and define the goals;
3. Integrate the design process;
4. Diffuse knowledge;
5. Apply life-cycle costing & tunnel through the cost barrier;
6. Compensate for brains not stuff;
7. Follow the money trail.

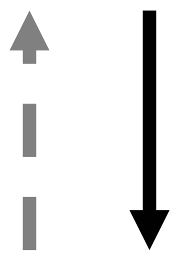
7.1. Get into a Sustainability Mindset

Mindset is “a habitual way of thinking” (Soanes, 2005, para. 1)The importance of a sustainability mindset, and the contribution it can make to cost effective green building, is demonstrated very clearly in the Mountain Equipment Co-op case.

Similarly, speaking from his own experience and referring to only green building projects that met the environmental objectives at no increase in capital cost, Bill Reed says, “the common denominator is the will of the client and design team to succeed. The factor is the mindset—saying we will *do* it, not we will *try* it” (personal communication, November 12, 2004).

Mindest also came up during the Ontario case study visit (T. Mohammed, personal communication, January 6, 2004), during the e-Dialogue (McDonald & Dale, 2004) at Greenbuild 2004 (Lindsey, 2004), and is concluded by Bordass (2000) as one of the factors that has to change in order to make progress with green building.

How mindset fits in with other green building considerations, and the attention it typically receives, is depicted in Figure 13. This figure is adapted from a PowerPoint handout provided at an integrated design process workshop (Reed, Hubbard & Batshalom, 2004) and is also used in the U.S. Green Building Council's Advanced LEED™ Training (Lindsey, 2004).



Mindset (i.e., way of thinking)

Process (e.g., integrated design)

Tools (e.g., LEED™, EE4)

Products (e.g., high efficiency boilers, green carpets)

Figure 13. Mindset in relation to other considerations

Note. Adapted from *Managing the Integrated Design Process [PowerPoint handout]* (p. 10), by B. Reed, G. Hubbard & B. Batshalom, 2004.

The dotted arrow depicts where design teams typically start with a green building project, by first considering product and then tools and then perhaps process. Many teams do not make it to the level of mindset. Instead of following the dotted arrow from the bottom up, as discussed above, it is more effective to begin with mindset, which will inform the process and the tools and the choice of products (B. Reed, personal communication, November 12, 2004).

7.2. Establish a Clear Vision and Define the Goals

It is difficult to plot a course without having a vision of the final destination. I believe this applies to everything, including green building. For example, during discussions with building owner representatives for two of the case study buildings, having a clear vision of the project was considered a key factor of success.

There is a brief discussion of visioning in the context of green building in McLennan's (2004) *The Philosophy of Sustainable Design*. In the business and general literature there are a number of very good discussions and examples of the importance of vision (Blanchard & Stoner, 2004; Doppelt, 2003; Kotter, 1996; Kouzes & Posner, 1987; Senge, 1990).

In *Leading Change*, for example, Kotter (1996) describes vision as "a picture of the future… a good vision serves three important purposes. First, by clarifying the general direction for change, it simplifies hundreds or thousands of more detailed decisions. Second, it motivates people to take action in the right direction. Third, it helps coordinate the actions of different people, even thousands and thousands of people, in a remarkably fast and efficient way" (p. 68).

One of the most well documented examples in Canada of a visioning exercise for the built environment is the Cities^{Plus} initiative. "Cities^{PLUS} (or cities Planning for Long-term Urban Sustainability) developed the 100 year sustainability plan [vision] for Vancouver Canada in a project that involved 500 experts and participants from 30 cities across Canada. This 2-year long exercise, culminated in Team Canada being awarded the Grand Prix at the international Sustainable Urban Systems Design competition in Tokyo June 2003" (Cities^{PLUS}, 2004).

Clear goals flow from a clear vision, and defining goals at the outset is identified as a prerequisite for cost effective green building. In their report titled *Costing Green: A Comprehensive Cost Database and Budgeting Methodology*, one of the conclusions that Matthiessen & Morris draw is "The projects that were the most successful in remaining within their original budgets were those which had clear goals established from the start" (2004, p. 24).

For all five of the case study green building projects, environmental goals were established early during project conceptualization. Many approaches to goal setting are available, such as SMART—Specific, Measurable, Attainable, Realistic, Timely—goals (Nikitina, 2004) and cooperative goals (Kouzes & Posner, 1987).

7.3. Integrate the Design Process

This research confirms the need for integrated design (described in Section 3.4), and demonstrates how critical a good integrated design process is to cost effective green building.

During the e-Dialogue, referring to projects he is familiar with, one of the e-Dialgoue panelists said, “The projects that report using integrated design are generally the projects that achieve the highest energy performance levels. They are also the projects that often report no incremental capital cost for the project” (McDonald & Dale, 2004, p. 21).

Larsson and Clark, in researching the outcome of the first C-2000 projects learned “the designers all agreed that application of the integrated design process required by the C-2000 program was the main reason why high levels of performance could still be reached” (Larsson & Clark, 2000, p. 414). Also, Cole (2000) reports that the research papers presented at *Cost and Value in Building Green*, a two-day symposium held in Vancouver, BC in November 1999, “collectively echo, in a very specific way, the notion of ‘design integration’ as the logical means of delivering higher performance buildings within current cost constraints” (p. 304).

Matthiessen and Morris (2004), who compared 93 non-LEED and 45 LEED-seeking projects, discovered “Costs range widely; some projects added significant costs and others actually saved money. [However], in every case, an integrated design process and early commitment to sustainable design enable high achievement” (p. 9).

The need for integrated design is summarized well by Paul M. Zeigler (2003), P.E., Director, Engineering and Building Technology, Commonwealth of Pennsylvania:

> Many claims that “Going Green” costs more are made by civil engineers, architects, MEP engineers, contractors, construction managers, or developers who have limited experience with green building design and the use of “green”

materials and technologies…and particularly – those who fail to properly implement a truly integrated design process which fully optimizes all building elements and systems (slide 14).

A final note about integrated design is the importance of introducing it as early in the building project as possible. Figure 14 shows that the opportunities for cost effective ecological design solutions decline over time, and the costs of ecological design solutions are greater the later they are incorporated into the design process. The message is, discuss everything early with everyone (B. Reed, personal communication, November 12, 2004).

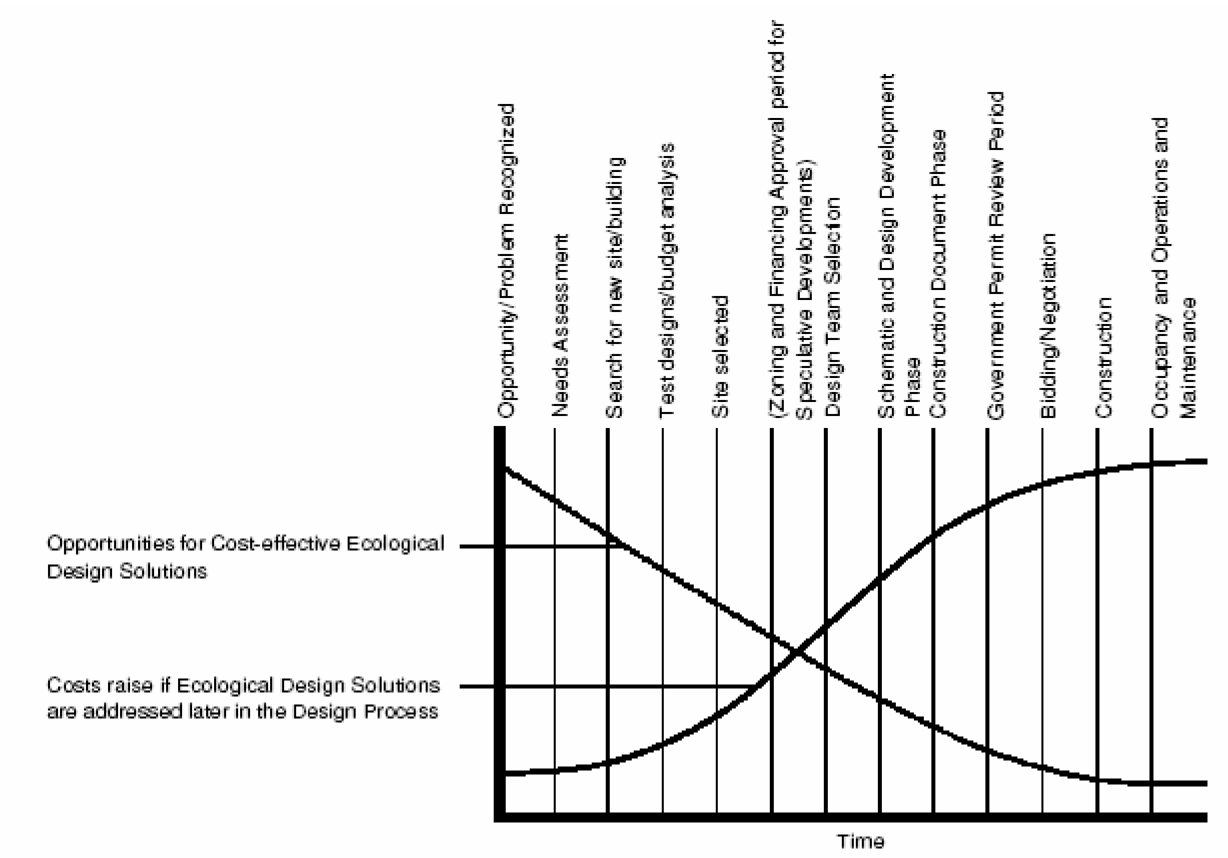


Figure 14. Relationship of cost and ecological design opportunity

Note. From Integrated design and building process: What research and methodologies are needed (p. 329) by W. G. Reed and E. B Gordon, 2000. Copyright 2000, Taylor & Francis Ltd.

7.4. Diffuse Knowledge

It seems that “there are many buildings that have been designed simply for the sake of the designer, without due regard to how people are going to live and work in [and interact with] that place and space” (McDonald & Dale, 2004, p. 6). I think this is happening, in part, because of a focus on efficiency rather than effectiveness (McDonough & Braungart, 2002). For example, it may be more effective to plant trees around a building to protect it from the heat of the summer sun, design for natural ventilation and educate the people in the building when to open the close the windows to let the cool in and keep the heat out, than to install the most efficient mechanical air conditioning system currently available on the market. In a sense, it is like designers have forgotten to include people in the operations systems of buildings.

Also, according to Derek Heslop, Architect, occupants need to better understand what to expect from buildings, and if they understand there is generally no complaint (personal communication, January 27, 2005). Helping occupants come to that understanding could occur, in part, by involving then in the integrated design process.

Diffusing knowledge and educating people, including design professionals, involved in the design and construction of the project is also important, and can help meet the goal of a cost effective green building. For example, in the case of the Edmonton case study, providing education about green building and the project goals to the general contractor and the construction trades, helped to alleviate fear factor costing (adding a premium to compensate for unfamiliarity) and reduced the cost of LEED™ documentation.

7.5. Tunnel Through the Cost Barrier

Tunnelling through the cost barrier challenges conventional thinking about the costs of energy efficiency measures. This thinking is based on the observation that each incremental increase in energy efficiency carries with it a corresponding incremental increase in cost to achieve the efficiency. In conventional economics speak this is the diminishing rate of marginal returns. However, as demonstrated graphically in Figure 15, “saving even more energy can often ‘tunnel though the cost barrier,’ making the cost come *down* and the return on investment go up” (Hawken, Lovins & Lovins, 1999, p. 114).

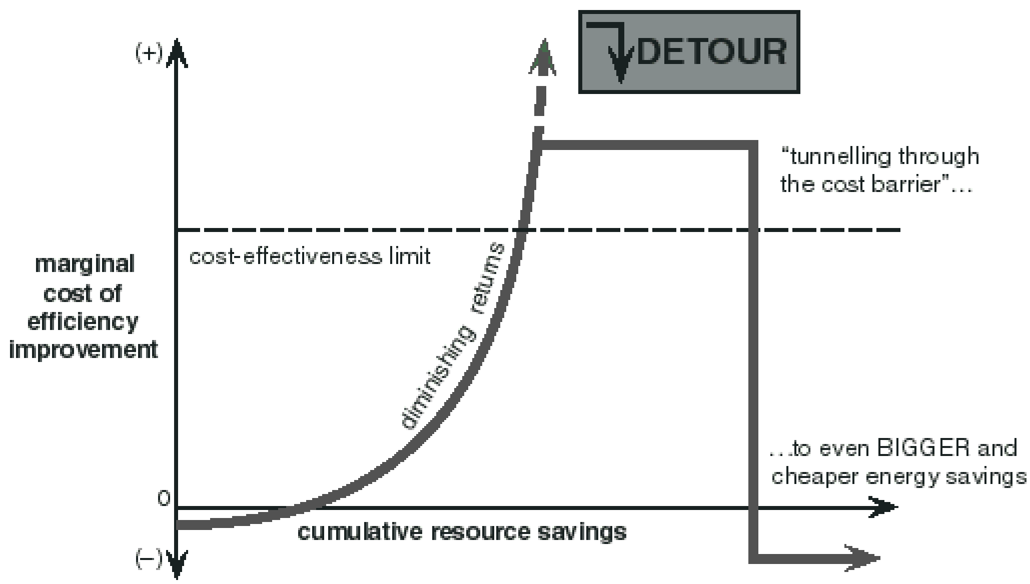


Figure 15. Tunnelling through the cost barrier

Note. From *Natural Capitalism: Creating the Next Industrial Revolution* (p. 114), by P. Hawken, A. Lovins & L. H. Lovins, 1999, Boston, Little, Brown and Company. Copyright 1999 by Paul Hawken, Amory Lovins and L. Hunter Lovins.

How does “tunnelling through the cost barrier” work? During my research I have come across two examples. The first is the State of Pennsylvania Department of Environmental Protection Cambria Office Building (Boecker, 2004; Pennsylvania Governor’s Green Government Council, n.d.; Zeigler, 2003). During an integrated design process, high performance windows were proposed at an additional cost of $15,000.00. Although the developer initially balked at the expenditure, it allowed for the elimination of the perimeter heating system (saving $25,000.00) and a reduction of size of the central heating and cooling system (saving $10,000.00). Thus, spending the additional $15,000.00 on windows resulted in net capital costs savings of $15,000.00 (Boecker, 2004, slide 5).

The second example is a residential example told by Bill Reed. Investing an additional $2,000.00 in better windows and $1,000.00 for more insulation in the exterior walls resulted in the elimination of the perimeter hearting system— a $3000.00 saving equal to the initial investment. Additional cost savings were realized because eliminating the perimeter heating system negated the need for a large boiler (saving $4,000.00), which was replaced by a water heater ($1,000.00) and a heat exchanger ($1,000.00). Therefore, spending the initial $3000.00 resulted in a net savings of $2000.00 (personal communication, November 12, 2004).

7.6. Compensate for Brains Not Stuff

One of the questions asked during my presentation, *Green Building and the Need for Ecological Engineers* (McDonald, 2004), to the students and staff of University of Manitoba's Faculty of Engineering was about design consultant compensation. The conundrum is, currently most design consultants (including mechanical engineers) are typically paid a percentage of the capital cost of the equipment she or he specifies for the building, which is not much incentive to reduce the size of, or eliminate, the equipment. You might say that this encourages some design professionals to have a vested interest in bigger inefficient and more costly, rather than smaller, efficient and less costly.

This question came up again during the e-Dialogue, posted by a developer. The solution is to compensate design consultants for their intellectual capital rather then a percentage of manufactured capital; reward them for their brains not how much stuff they can cram into the building (McDonald & Dale, 2004).

One of the benefits of this solution is that it is an investment in the capacity and knowledge of people rather than building materials and products; it is an investment in human capital in order to reduce the depletion of and degradation of natural capital. This is a social benefit of green building, and increases the intellectual and social capital (Dale, 2001) of the community where the design professionals work and reside.

7.7. Follow the Money Trail

As described in many of the case study examples, financial incentives are available for energy efficiency measures. The most popular is the Commercial Building Incentive Program (CPIB) offered by Natural Resources Canada (see Section 1.4). The program provides a grant to commercial building projects that achieve a 25% improvement in energy efficiency over the Model National Energy Code for Buildings (MNECB).

In some cases these incentives are used to cover the energy modelling or pay for the additional design time required for a team to learn energy efficient design. From an ecological economics perspective these incentives reward those who have taken it upon themselves to internalize some of the externalities associated with buildings (see Section 1.3).

8. RECOMMENDATION FOR CaGBC

8.1. Establish IDP Facilitator Accreditation

According to Reed & Gordon (2000), "a fundamental need exists for a new professional to facilitate [integrated design]. Such a facilitator would have to have a broad interdisciplinary background and be proficient in team leadership" (p. 335).

"To "facilitate" means "to make easy." The purpose of facilitation is to draw people and their ideas out and to connect them (like an alchemist combines substances) with other people in a way that leads to positive outcomes" (Crane, 2002, p. 35). The purpose of an IDP Facilitator would be to bring the design consultants together with the building owner, occupants, builder (if possible), and other stakeholders, to help facilitate the design of a cost effective green building.

An IDP Facilitator Accreditation would help identify the appropriate professional. I have identified five competencies (see Figure 16) for an IDP Facilitator: (1) a solid basis in systemic thinking (Capra, 1996; Checkland & Scholes, 1990; Jackson, 2003); (2) an understanding of sustainability and green building, (3) good facilitation and communication skills, (4) knowledge and understanding of the design and construction disciplines, and (5) strong leadership and coaching skills.

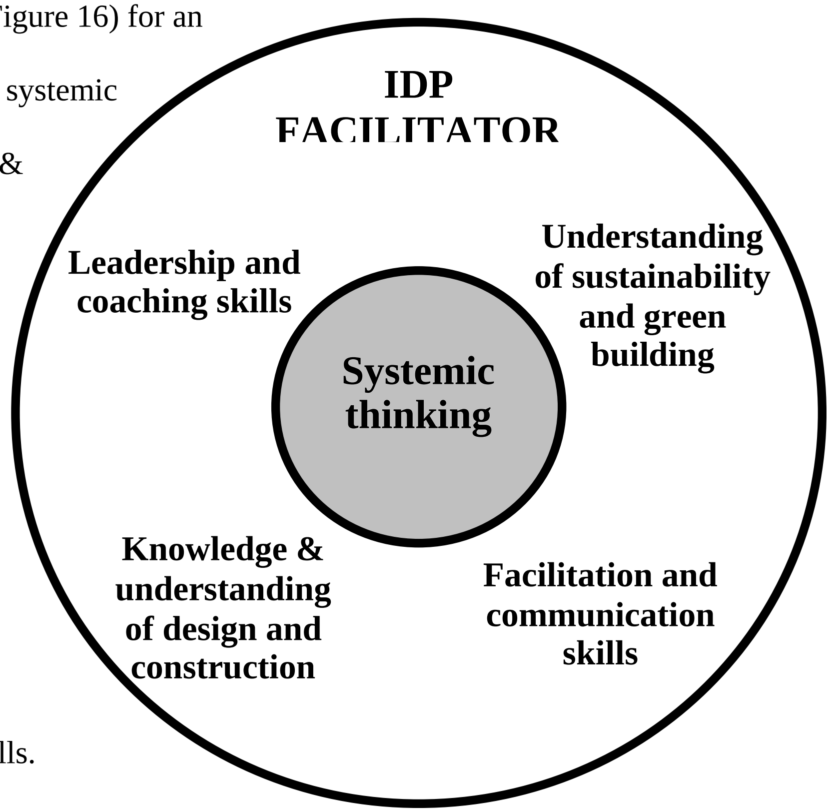


Figure 16. IDP Facilitator competencies

9. RECOMMENDATIONS FOR POLICYMAKERS

In their report titled *Sustainability and the Built Environment*, Upstream (2004) concluded “Despite the commitment of the private sector to sustainable development, it is clear that it is unlikely to be delivered without a partnership with government and the support of an appropriate fiscal and regulatory framework” (p. 3). I believe that government must partner also because the market is currently unable to take the long-term view needed to achieve the objectives associated with sustainability. For these reasons the majority my recommendations are targeted at public sector policy makers.

9.1. Internalize the Externalities

There is no fairer way to level the playing field for green building then to create mechanisms that lead to the internalization of currently external costs resulting from conventional building practices. If this were done, decisions by developers, designers, contractors and other actors in the building community would then be made “in light of full-cost prices” (Daly & Cobb, 1994, p. 55). To get a sense of what this might look like, here is an example from Daly and Cobb (1994) for internalizing the external costs of coal:

> Coal mining companies could be required to pay the full cost of black lung disease among coal miners. To do this they would charges a higher price for coal to cover all medical expenses of minors with black lung disease. All or part of the increased cost is passed on to consumers in the form of a higher price for coal. Economizing on the use of more costly coal means that less will be produced, and the incidence of black lung disease will decline. Internalization creates incentive to reduce the activity that produces the external cost (p. 56).

9.2. Continue to Provide Incentives

Natural Resources Canada programs such as the Commercial Building Incentive Program (CBIP) and C-2000 have been successful at encouraging the design and construction of energy efficient and green buildings, while the market develops the skill to design these buildings (Larsson & Clark, 2000). For example, the CBIP program encouraged the City of Edmonton to build its first energy efficient police station, the success of which led the City to build its first LEED™ police station. To help ensure the market does not become complacent, and to encourage innovation, I suggest the periodic raising of the bar regarding the criteria that must be met by the building to satisfy program eligibility requirements.

9.3. Support and Promote the Provision of Information About Buildings

“A decision maker can't respond to information he or she doesn't have, can't respond accurately to information that is inaccurate, can't respond in a timely way to information that is late” (Meadows, n.d., item 5). This recommendation is to support and promote timely, relevant and accurate information, so that decision-makers in both the pubic and private sectors, as well a civil society, can make sound decisions. One example is to support, with funding, the recommendations made to researchers in Section 10.

9.4. Establish a Building Labelling System

The Government of Canada supports and promotes energy labels for vehicles, major appliances and houses, but there is no equivalent label for buildings. The absence of a standard energy efficiency rating for buildings makes it difficult for investors to factor building energy use and efficiency into a decision-making process. A tool such as this may provide lenders with the third-party verification needed in order to offer preferential rates for energy efficient and green buildings (J. Westeinde, personal communication, November 17, 2004).

An example of such an initiative is Energy Performance Certificates, which is part of a larger energy performance directive of the European Parliament and the Council of the European Union (2002, Article 7). Another option, and perhaps more comprehensive, is a label similar to a food label but for buildings. A label of this type, suggested by Rick Fedrizzi (2004), President of the U.S. Green Building Council during his opening remarks at Greenbuild 2004, could provide all of the environmental information about a building (e.g., energy use, water use, greenhouse gas emissions) on one standard label with standard metrics.

9.5. Help to Create Market Demand by Engaging Institutional Investors

"There is little clear market demand for green buildings. In a market-oriented economy such as North America, it is a truism to say that developers and investors build to suit what they believe the market is willing to pay for, and that they would be perfectly willing to design to much higher levels of energy and environmental performance if there was a market demand for it." (Larsson, 1999, p. 333).

The asset, from the investor perspective, is not the building, but the future flow of cash that can be generated by the building—determined largely by the class of tenant. Intuitional investors, by the nature of the annuity payments they must make, have an incentive to take a longer term view. (P. St. Jacques, personal communication, January 21, 2005).

For these reasons, institutional investors may hold the greatest promise for creating an investor demand for a greener real estate product. It would thus be useful for policymakers to think about how to spur market demand for green buildings by engaging in a dialogue with this investor group about the economic benefits of green buildings.

10. RECOMMENDATIONS FOR RESEARCHERS

Much more research is needed on the economics of green buildings in Canada, not, I believe, for the sake of research, but for use as a communication tool to respond to the economically dominant mindset of the building design and construction industry. I suggest (1) further study of the economics of green building in Canada, (2) a comparative ecological economics study of buildings in Canada, and (3) evaluation of the productivity and health benefits of green buildings.

10.1. Further Study of the Economics of Green Building in Canada

There is a need for further analysis of the capital cost premium of green buildings with more case studies and better data. As more third-party certified green buildings are constructed in Canada, it will be possible to paint a more complete picture of the premium, or lack thereof, for green buildings. An important part of this research should be geared to understanding how the first three keys identified in Section 7—mindset, vision and design process (i.e., integrated or non-integrated; degree of integration) influence capital cost. Reed and Gordon (2000) have identified the importance of gathering more information about the process-cost relationship and offer questions to which substantive answers are needed.

10.2. Comparative Ecological Economic Study of Buildings in Canada

To tell a richer story about the economics of green building, it is necessary to undertake a comparative ecological economic study of buildings in Canada. This study should include three components: first, an analysis and separate report of the external costs and benefits of conventional buildings, with case study examples; second, an analysis and separate report of the external costs and benefits of green buildings, with case study examples; third, a comparative analysis and report of the capital and life-cycle costs of conventional vs. green buildings in Canada, including the data on external costs and benefits.

A study of this nature would be a significant undertaking and perhaps the first of its kind in the World. However, some models of this analysis, also called full cost accounting, already exist and can be drawn upon for guidance (Bebbington, Gray, Hibbitt & Kirk, 2001; Venema & Barg, 2003). I believe this is the only way to get a true picture of the costs and benefits of green buildings, compared to conventional buildings. This information would be useful to political decision-makers responsible for infrastructure portfolios, and to policy makers designing programs and initiatives to encourage green building or discourage conventional building. A study of this nature may raise the question: Can we afford to not build green buildings?

10.3. Evaluation of Productivity and Health Benefits

The market responds to demand, and when there is a demand for green buildings the market will supply green buildings (P. St. Jacques, personal communication, January 21, 2005).

One way to increase demand for green buildings is to communicate the benefits a way that appeals to the tenant/occupant/user. The largest cost for most companies is staff salaries and research shows that green buildings can increase employee productivity (Heerwagen, 2000; Heschong Mahone Group, 2003b; Romm & Browning, 1994). Green buildings can also boost retail sales (Heschong Mahone Group, 2003a). This message, I believe, is not widely communicated, in part because there is a need for more data to support the earlier research.

The best way to accomplish this is detailed post occupancy evaluation that measures employee productivity. A number of post-occupancy evaluations have been undertaken in the U.K. (Derbyshire, 2001), and Canadian researchers can draw on the literature for guidance (Bordass, 2003; Zimmerman & Martin, 2001).

11. CONCLUSIONS

Sustainability is the human imperative of the 21st Century (Dale, 2001). For human societies to realize sustainability requires systemic thinking, integrated decision-making, internalizing externalities, and recognizing that human systems are an embedded system within natural systems in the environment. The co-evolutionary dynamic interconnectedness of the two systems is akin to a dance (Meadows, n.d.), where being in tune with the music is critically important to knowing what steps to take and when.

Buildings, in their current design and configuration, are boxes that transform resources into wastes. For this reason they have an immense impact upon the natural environment's ability to sustain living systems. This must be addressed in the context of sustainability and one emerging solution is green building. However green buildings do not exist on an equal economic plane with conventional buildings, giving a false sense of security and desirability of the economic efficiency and value of conventional building approaches.

It is a myth that green buildings costs more to build. Results from the five case studies reveal that the capital cost of green building is 5% less than conventional construction. Although my case study sample is small, as more green buildings come on line I think further research will only serve to prove my conclusions about the cost effectiveness of green building. Further, as demonstrated by the energy efficiency measures of the case studies, the savings continue throughout the life cycle of green buildings because they are less expensive to operate.

My research also reveals that green building is less about product and more about process. The use of an integrated design process is absolutely critical to cost effective green building. Two of the other six keys to cost effective green building are (1) getting into a sustainability mindset and (2) establishing a clear vision with well defined goals.

Given the importance of integrated design and the unfamiliarity of this process amongst design processionals, there is a call for an integrated design process facilitator accreditation. The task of this professional would be to draw on at least five competencies to help a team of professionals and stakeholders work together to design a cost effective green building.

In his book, *Systems Thinking: Creative Holism for Managers*, Jackson (2003) writes "Managers are best employed focusing on the interactions of the parts rather than controlling the parts directly" (p. 165). For the building design and construction community the corollary is that design professionals are best employed to focus on the interactions between their disciplines rather than on only the parts they represent. Thus, the relationships between the parts are more important than the parts themselves (B. Reed, personal communication, November 12, 2004), for in the end, both natural and human systems rely on relationships for the integrity of the whole being.

The architect William McDonough (2003) writes that design is the first signal of human intention. I believe, however, that thought, or consciousness, is the first signal of human intention. For this reason, a shift to systems thinking, which would naturally lead to integrated decision-making, is necessary in order to move beyond green building along the critical continuum of sustainable building to restorative building. Therefore, the shift required by building design and construction professionals is the same as that required by all of society if we are to meet the human imperatives of this century, it is to choose 'being' rather than 'doing' sustainability.

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APPENDIXES

Appendix A: List of Green Buildings in Canada

	Building	Building Type	City	Prov.	Green Building
British Columbia					
1	Burnaby Mountain School	Education	Burnaby	BC	CBIP (25.46%)
2	City of Vancovuer Works Yard	Administration	Vancouver	BC	LEED Gold
3	C.K. Choi Building	Education	Vancouver	BC	
4	Crestwood Corporate Centre Buildings 2 and 8	Commerical	Richmond	BC	GBC (1998) C-2000
5	Glen Eagles Community Centre	Public Assembly	West Van	BC	
6	Lui Cetnre for Global Issues	Education	Vancouver	BC	
7	Nicola Valley Institute	Educaton	Meritt	BC	GBC (2002) CBIP (27%)
8	North West Community College	Education	Prince Rupert	BC	
9	Revenue Canada Tax Centre	Administration	Surrey	BC	GBC (1998)
10	Richmond City Hall	Administration	Richmond	BC	C-2000 CBIP (26%)
11	Semiahmoo Library & RCMP	Education	Surrey	BC	LEED Gold CBIP (44.3%)
12	Telus Head Office	Commercial	Vancouver	BC	GBC (2000)
13	Vancouver Island Technology Park	Commerical	Victoria	BC	LEED Gold
14	White Rock Operations Building	Administration	White Rock	BC	LEED Gold CBIP (56%)
Alberta					
1	Alberta Urban Municipalities Accociation Buidling	Administration	Edmonton	AB	LEED
2	Banff Community High School	Education	Banff	AB	LEED registered CBIP (28.2%)
3	Country Hills Multi-Services Centre		Calgary	AB	LEED
4	Hinton Town Centre	Administration	Hinton	AB	CBIP (53.6%)
5	Information and Communication Technology Building	Education	Calgary	AB	LEED Silver Equivalent CBIP (26%)
6	North Division Police Station	Administraton	Edmonton	AB	CBIP (43%)
7	South Division Police Station	Administraton	Edmonton	AB	LEED Silver CBIP (47%)
8	St. John's Ambulance	Administration	Edmonton	AB	CBIP (47.8%)
9	The Water Centre	Administration	Calgary	AB	LEED
Saskatchewan					
1	Alice Turner Branch Library	Education	Saskatoon	SK	C-2000 CBIP (64.86%)
Manitoba					
1	Mountain Equipment Co-op Store	Retail	Winnipeg	MB	LEED Platinum C-2000 CBIP (53.9)
2	Red River College Princess Street	Education	Winnipeg	MB	GBC (2002) C-2000 CBIP (48.7%)
3	SC3 Smith Carter Building	Commercial	Winnipeg	MB	C-2000 CBIP (54.9%)
Ontario					
1	Canada Post Place	Administration	Ottawa	ON	
2	Earth Rangers Centre	Education	Woodbridge	ON	LEED registered CBIP (63%)
3	E'Terra Inn	Accommodation	Tobermory	ON	LEED registered CBIP
4	Green on the Grand	Commerical	Waterloo	ON	C-2000
5	Queen's Univeristy Integrated Learnir	Education	Kingston	ON	GBC (2005)
6	Jackson Triggs Winery	Retail/Industrial		ON	GBC (2002)
7	Metro Label Printing Facility	Industrial		ON	LEED-Canada
8	Morningside Heights School	Education	Toronto	ON	
9	Mountain Equipment Co-op	Retail	Ottawa	ON	CBIP (56.2%)
10	Niigon Technology Centre	Industrial	MacTier	ON	CBIP (50%)
11	Pierre Elliot Judicial Building	Administration	Ottawa	ON	LEED-Eligible CBIP (42%)
12	Sir Sandford Fleming College	Education	Peterborough	ON	CBIP (30%)
13	Thunder Bay Regional Health	Health Care	Thunder Bay	ON	
14	Toronto Military Family Centre	Public Assembly	Toronto	ON	
15	University of Ottawa Biology Bldg	Education	Ottawa	ON	CBIP (73%)
16	UTSC Student Centre	Education	Scarborough	ON	
17	York University Computer Sciences	Education	Toronto	ON	GBC (2000)

Appendix B: Case Study Questionnaire

The economics of green building in Canada

Questions for Case Study Projects

Project/Building Name: ____________________

Contact: ____________________ **Phone:** ____________________

Contact Position: ____________________ **Organization:** ____________________

Date of Case Study Visit: ____________________

Street Address: ____________________ **City, Province:** ____________________

Base Building Questions

1. Building Type

- ☐ Commercial Office
- ☐ Administration
- ☐ Education (incl. Library)
- ☐ Health Care
- ☐ Retail
- ☐ Public Assembly

2. Building Owner: ____________________.

3. Building Interior Area (m^2):____________________.

4. Building Dimensions (Footprint) (m^2):____________________.

5. Commencement Date of Building Operation:____________________.

6. Primary Use:____________________.

7. Other Uses: ____________________.

8. Location

   - ☐ Urban
   - ☐ Rural
   - ☐ Northern / Remote

Green Building

9. Why a green building?
   (check primary reason)

   - ☐ Environmental
   - ☐ Economic
   - ☐ Productivity / Human Health
   - ☐ Mandated

10. Is the building LEED Certified?

   - ☐ Yes LEED Score:_____________.
   - ☐ No

11. If Yes to question 10, certified according to:

   - ☐ LEED 1.0 2.1 (circle one)
   - ☐ LEED-BC
   - ☐ LEED Canada

12. If No to question 10, even if the building was not certified, was LEED used as an assessment tool during the design process?

   - ☐ Yes
   - ☐ No

13. If LEED was used (to certify or not) what points were attained:

- ☐ See LEED score sheet (provided instead of circling applicable)

(circle all that apply – number of circled points should equal LEED Score)

SS1.0	SS2.0	SS3.0	SS4.1	SS4.2	SS4.3
SS4.4	SS5.1	SS5.2	SS6.1	SS6.2	SS7.1
SS8.0	WE1.1	WE1.2	WE2.0	WE3.1	WE3.2
EA1.1	EA1.2	EA1.3	EA1.4	EA1.5	EA2.1
EA2.2	EA2.3	EA3.0	EA4.0	EA5.0	EA6.0
M1.1	M1.2	M1.3	M2.1	M2.2	M3.1
M3.2	M4.1	M4.2	M5.1	M5.2	M6.0
M7.0	IE1.0	IE2.0	IE3.1	IE3.2	IE4.2
IE4.3	IE4.4	IE5.0	IE6.1	IE6.2	IE7.1
IE7.2	IE8.1	IE8.2	I1.1	I1.2	I1.3
I1.4	I2.0				

14. Was the building part of Natural Resources Canada's C-2000 Program?

- ☐ Yes
- ☐ No

15. Was the building part of the International Green Building Challenge?

- ☐ Yes Year:_____________.
- ☐ No

16. If Yes to question 15, did the building win an award?

- ☐ Yes Category:______________________.
- ☐ No

Green Building Features (If non-LEED)

17. What characteristics make the building green (adapted from Cole)?
(check all that apply)

- ☐ Reduced Energy Consumption
- ☐ Reduced Water Consumption
- ☐ Improved Material Resource Efficiency
- ☐ Reduced Environmental Impacts
- ☐ Less Impact on Local Infrastructure
- ☐ Easier to Manage

Design Process

18. Were environmental goals established for the project?

- ☐ Yes
- ☐ No

19. If Yes to question 18, at what stage of the project?

- ☐ Project Conceptualization
- ☐ Pre-Design
- ☐ Schematic Design
- ☐ Design Development
- ☐ Construction Drawings
- ☐ Construction

20. How was the green design driven; who initiated it?
(check one)

- ☐ Building Owner
- ☐ Occupant(s)
- ☐ Architect
- ☐ Engineer(s)
- ☐ General Contractor
- ☐ Other(s):____.

21. Was an integrated design process used to design the building? (According to NRCan, integrated design is process whereby all the building design disciplines, plus the owner or owner's representatives, take part in a series of facilitated workshops leading to the completed design of the new project.)

- ☐ Yes
- ☐ No

22. If Yes to question 21, who was part of the integrated design team? (check all that apply)

- ☐ Building Owner
- ☐ Project Manager (Building Owner Representative)
- ☐ Occupant (same as building owner – Y / N)
- ☐ Architect
- ☐ Mechanical Engineer
- ☐ Structural Engineer
- ☐ Electrical Engineer
- ☐ Landscape Architect
- ☐ Interior Designer
- ☐ Builder / General Contractor
- ☐ Specialist facilitator
- ☐ Energy Modeller
- ☐ Cost Consultant / Quantity Surveyor
- ☐ Building Maintenance Representative
- ☐ Other(s):____.

23. If Yes to question 21, did the design team participate in a formal charette? (According to Carnegie Mellon University, a charette refers to a creative process akin to visual brainstorming that is used by design professionals to develop solutions to a design problem within a limited timeframe

- ☐ Yes
- ☐ No

Energy Modelling and Performance

24. Was an energy model prepared for the project?

- ☐ Yes
- ☐ No

25. If Yes to question 24, what software was used to model the building?

- ☐ EE4
- ☐ DOE
- ☐ Other:___________________________.

26. If Yes to question 24, when was modeling used in the process?

- ☐ At the end to ensure CBIP compliance
- ☐ Used during design process to model options
- ☐ Other:____.

27. If yes to question 24, what was the modeled energy usage?_________________.

28. If yes to question 24, what was the reference building usage?________________.

29. What is the operating (or expected operating) energy usage?________________.

Experience

30. What was the previous green design experience of the design team? (circle one)

5	4	3	3	1
Expert				No Knowledge

____.
____.

31. What was the previous green building experience of the general contractor? (circle one)

5	4	3	3	1
Expert				No Knowledge

____.
____.

Project Delivery

32. Project delivery method:

- ☐ Design-Build
- ☐ Design-Bid-Build
- ☐ Construction Management

Contracting

33. Design consultants contract:

- ☐ Percentage of construction cost
- ☐ Fixed price (fee for service)
- ☐ Incentive Based
- ☐ Other:________________________________.

Economic Aspects

CAPITAL COST

34. Was there a cost premium for the capital cost of the building?

- ☐ Yes $_______________(______%)
- ☐ No

35. What was the cost per square meter to construct?: ______________.

36. What would have the cost per square meter been for non-green (conventional)?

______________.

37. Does your organization have a comparable conventional buildings to reference this green project to?

- ☐ Yes
- ☐ No

38. What is the average cost per square meter for this building type?___________.

39. Was additional money provided to build a green building?

- ☐ Yes
- ☐ No

OPERATING COSTS (UTILITIES)

40. What were the expected per square meter operating costs?____________.

41. What ARE the square meter operating costs? (if data available) ____________.

42. What would the square meter operating costs have been for non-green?________.
    Was this comparison done?

- ☐ Yes
- ☐ No

OPERATING COSTS (NON-UTILITIES)

43. What were the expected per square meter operating costs?____________.

44. What ARE the square meter operating costs? (if data available) ____________.

45. What would the square meter operating costs have been for non-green?________.
    Was this comparison done?

- ☐ Yes
- ☐ No

INCENTIVES

46. Did the building receive any economic incentive(s)?

- ☐ Yes
- ☐ No

47. If Yes to question 46, what incentives were received and the amount? (check all that apply)

- ☐ Commercial Building Incentive Program (CBIP) $______________.
- ☐ C-2000 Design Assistance $______________.
- ☐ C-2000 Technologies Funding $______________.
- ☐ FCM Green Funds $______________.
- ☐ Renewable Energy Deployment Initiative (REDI) $______________.
- ☐ Technology Early Action Measures (Team) $______________.
- ☐ Other:_________________________________. $______________.

SAVINGS

48. What economic savings were realised as a result of greening the building?

____.

____.

49. Other economic benefits

____.

____.

FINANCING

50. How was the project financed?

____.

____.

51. Did the green features have any effects on financing, insurance etc?

____.

____.

Environmental Aspects

52. Have the environmental benefits of the building been tracked?
(or, in cases where the building is not yet operational, will they be?)

- ☐ Yes
- ☐ No

53. If Yes to question 52, how?

____.

____.

Social Aspects

54. What is the average cost per square meter for employee salaries? $___________.

55. Was employee productivity tracked before moving to the new building?

- ☐ Yes
- ☐ No

If Yes, is the data available?

56. Has employee productivity been tracked since in the move?
(or, in cases where the building is not yet operational, will it be?)

- ☐ Yes
- ☐ No

57. If Yes to question 56:

When?:____.

How Often?:______________________________________.

Is the data available?

58. Have you compared employee absenteeism days pre and post move in?

- ☐ Yes
- ☐ No

If Yes, is the data available?

____.

59. Are workspaces daylit?

- ☐ Yes
- ☐ No

If Yes, do you think this is having a measurable benefit on productivity?

____.

____.

Has it been measured?

____.

Other Notes/Comments

____.

____.

____.

____.

____.

____.