PACIFIC INSTITUTE FOR CLIMATE SOLUTIONS

SUSTAINABLE BUILDING DESIGN

NOVEMBER 2008

Buildings and Climate Solutions

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The Pacific Institute for
Climate Solutions gratefully
acknowledges the financial
support of the Province of
British Columbia through the
BC Ministry of the Environment.

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1 EXECUTIVE SUMMARY

British Columbia is at the forefront of environmental leadership in Canada, setting aggressive targets for net-zero greenhouse gas emissions, new investments in green innovation, and ambitious energy conservation and eco-efficiency targets. In doing so, it sets legal, economic, political and social frameworks for the large, complex and distributed industries serving the built environment.

This White Paper's scope is buildings and their stakeholders as critical elements in an effective climate change strategy. The sector comprises government; industry; building owners, occupants and users; utilities; non-governmental organizations; universities; colleges and schools. Buildings are part of the multi-scale urban system, so this paper complements the PICS White Paper entitled "Climate Change and Sustainable Communities" (Robinson et al. 2008).

The operation of buildings is responsible for emitting more than 30% of the world's greenhouse gases. When we consider the energy embodied in producing and transporting construction materials to the building site, it becomes clear that buildings are both the largest users of energy and the largest emitters of greenhouse gases of any sector.

Innovations in building design, construction and operation represent an efficient and economical means of reducing greenhouse gas production, energy costs, water consumption and waste. Such innovations have become widely known as the *Green Building* movement. Research is showing that green buildings can also increase the productivity of inhabitants and increase health and well-being. However, there has been little research into actual green buildings and not enough data has been collected to confirm and predict actual performance on a system level.

We outline elements of a strategy that would enable British Columbia to realize the full potential of building innovation. Highlights include:

- A multi-faceted role for government in regulation, example setting, providing and facilitating incentives and raising public awareness. In particular, government faces the welcome challenge of partnering with the current enormous personal, societal, professional and industrial will for change. Collaboration with industry and non-governmental organizations (NGO's) will result in much greater effects than unilateral action.

- A call for NGO's and industry to greatly expand their voluntary programs and rating schemes as these amplify the effect of all other sectors. Such programs require verification of their effects through research.

- Recommendations to assertively develop BC's most important asset in dealing with climate change – sound knowledge and skill widely held across the building industry. Through a focus on research that verifies designs, technologies, processes and policies BC can ensure that its actions will achieve intended outcomes and avoid unintended consequences.

- Universal information access, public communication and outreach programs. Through daily actions, building users account for much of the climate change impacts of buildings. Of all mitigation strategies, awareness is the simplest, most effective and most economical.

2 INTRODUCTION

The built environment is a multi-scale system. Its subsystems include regions, cities, neighborhoods, buildings, furnishings and equipment. It is served by infrastructure that is itself multi-scale and multi-function, and includes elements such as roads, power, public transit, telecommunications, water, sewage, waste and recycling. Changes in one system invariably affect many others. For example, road system expansion encourages real estate development. This, in turn, affects the building types that are designed and constructed. Conversely, improvements in telecommunications can encourage information and knowledge-based workers to operate from home, reducing road use but requiring additional space in residential buildings.

The built environment plays a significant role in climate change.

- Our cities and communities are responsible for approximately 75% of the world's energy and generate 80% of its greenhouse gases. Properly designed and maintained sustainable communities can reduce energy consumption, vehicle travel, air pollution, water pollution and greenhouse gas emissions by as much as 40%.
- Buildings produced approximately 12% of British Columbia's total greenhouse gas emissions in 2006 and more than half of this amount can be attributed to the use of fossil fuels for space and water heating and gas-fired appliances in residences[1] (LiveSmart BC, 2008, p. 36).
- In parts of North America, buildings are an even larger source of greenhouse gas (GHG), representing more than 30% of total emissions. The American Institute of Architects (AIA) estimates the contribution of buildings to be as high as 48% when considering the GHG embedded in the extraction, manufacturing and distribution of building products. Every year in North America, buildings release some 2200 megatons of carbon dioxide into the atmosphere (Lucuik, 2005, p. 5).
- Office equipment and home electronics are significant and rapidly growing consumers of energy and resources. Sustainable Development Technology Canada Corporation estimates that "Between 1990 and 2004, the auxiliary equipment load rose by about 105%, and in 1999 surpassed lighting as the second-largest load in commercial buildings." (Stern, 2007, p. 24).

According to Mazria (2006), by combining the energy required to operate residential, commercial, and industrial buildings with both the energy embodied in producing construction materials and the energy needed to transport them to the building site, it becomes clear that buildings are both the largest consumers of energy and the largest emitters of greenhouse gases of any sector. Table 1 illustrates the range and breadth of environmental impacts created by buildings.

Society pays for and benefits from buildings in a variety of ways. Among many factors, buildings are measured by their initial costs, energy performance, contribution to productivity, operating cost, greenhouse gas emission, societal effects and contribution to urban design. It is generally the case that improvements in one criterion can have effects on others, making building design a balance among competing interests and forces. These multiple concerns are reflected in a fragmented industry with many stakeholders (See Section 5).

1 This figure is substantially reduced in comparison to other Canadian provinces due to the abundance of hydroelectric power in BC

	Canada	United States
Energy Consumed in Operations	33%	40%
Natural Resources Used	50%	
Non-Industrial Water Used	12%	12%
Landfill Waste	25%	
Airborne Particulates Produced	10%	
Greenhouse Gases Emitted	35%	38%

Table 1: The Impact of Buildings (CEC, 2008, p. 22)

Buildings are long-lasting artifacts with average life exceeding 40 years. Investment in change therefore yields gradual, but cumulative effects. At an (uncompounded) renovation/replacement rate of 2.5%, it would take 20 years for a policy to affect 50% of existing stock. Growth accelerates the rate of change, at least in relative terms. An (uncompounded) growth rate of 2.5% per annum (this is within historical patterns) yields a 50% presence of new buildings in 20 years. Applying both renovation/replacement and growth implies that 75% of building stock can be affected by policy within a 20-year horizon.

Changes in the built environment can have unexpected consequences, and the structure of the industry makes predicting such consequences difficult. Urea-formaldehyde foam insulation, sick building syndrome, spalling façade failure and leaky condo syndrome were all unintended and unforeseen consequences of industry decisions. They were very expensive systemic failures that could have been avoided with a combination of improved research, technology/knowledge transfer and regulatory foresight.

It is clear that changes to the built environment can ameliorate some of the causes of climate change. It is also clear that there is considerable personal, social, professional, industrial and governmental commitment to such changes. What are less clear are the best changes to make.

The term "Green Building" has become a *de facto* label for buildings with high overall environmental performance that address aspects of climate change, resource consumption and wellness. While there are many views regarding what green buildings are and might be, the essential difference is that green building designers, constructors and occupants take active steps, within current knowledge and practice, to make buildings healthier, more comfortable and of decreased ecological footprint. Four major issues, perhaps the major issues for research, are (1) extending the boundaries of knowledge of workable designs, (2) improving design practice, (3) confirming that strategies to produce green buildings achieve their intended effects, and (4) devising, modeling and verifying policy that can accomplish needed change.

The concept of "Sustainability" labels a process that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN, 1987). Authors such as Robinson (2004) have established the now widely-accepted view that achieving sustainability is necessarily a social and political process in which new scientific understanding and technological prowess plays only one of several needed roles. Buildings, in and of themselves, cannot be sustainable, but can be designed to support sustainable patterns of living.

The lack of research and development of highly qualified personnel in the built environment is a serious constraint. According to the U.S. Green Building Council, *"... research on green building constituted only about 0.2% (two-tenths of one percent) of all federally-funded* *research from 2002 to 2004 – an average of $193 million per year. ... Levels of building research pale in comparison to amounts being invested in other sectors, and building research funding is fundamentally fragmented and thus not conducive to creating integrated solutions."* Society pays dearly with decreased capability for innovation and foregone opportunities to ameliorate climate change.

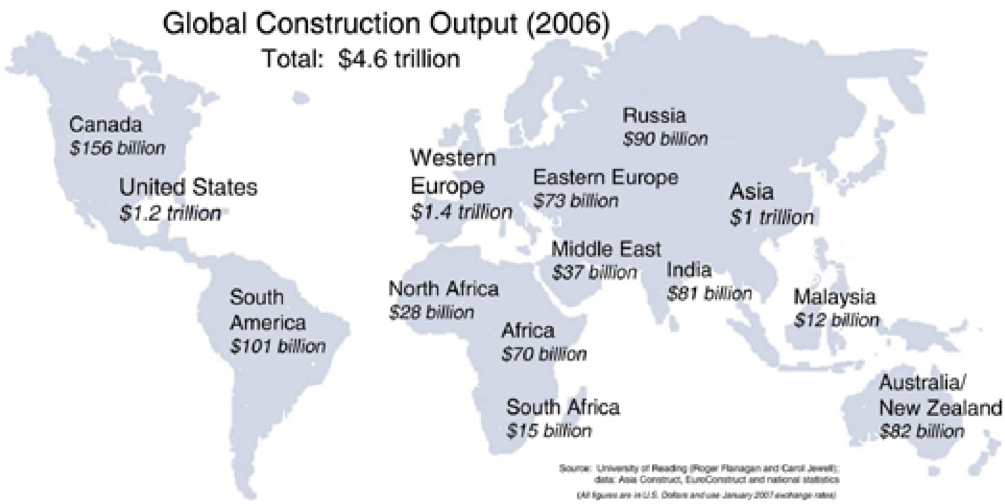


Figure 1: The Global Construction Market in 2006

3 THE MARKET: NEW CONSTRUCTION, AMELIORATION & RENOVATION

The world construction market is expected to grow to $4.8 trillion dollars in 2008. In Canada, $160 billion will be spent on construction this year alone. While the total value of construction in British Columbia averages about $15 billion per year, in November of 2007 the Major Projects Inventory of British Columbia reported that the value of major and proposed construction projects in the province had reached a record high of $134.5 billion. However, these figures tell only part of the story.

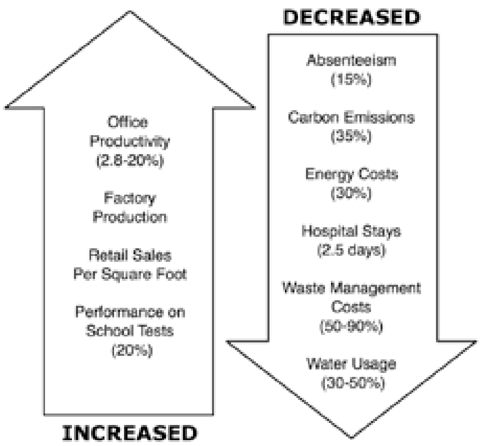
The total value of existing building stock in Canada is $5 trillion dollars, of which there are billions of dollars worth of economically inefficient and environmentally damaging properties.

Residential energy use and greenhouse gas (GHG) emissions account for 17% and 16% of Canada's totals respectively. Developing innovative and economical means for retrofitting millions of existing houses to meet net-zero energy targets is a key element to energy security and climate change mitigation (CMHC, 2008). Estimates suggest that by simply retrofitting existing building stock with current, economically-justified technology, Canada could reduce its climate change impacts by 40% and with new technology by 60%.

4 PERCEIVED AND ACTUAL BENEFITS OF GREEN BUILDINGS

Green buildings can

- reduce energy consumption,
- reduce greenhouse gas emissions,
- increase population and individual health and well-being,
- increase productivity in workplaces and schools, and
- decrease demand on services such as water and waste.



- **Figures 3 & 4:** Summary of the Benefits of Green Buildings (Source: Kevin Hydes, Past Chair World Green Building Council). When Adobe retrofitted their existing headquarters in California they were able to save $1 million a year and reduce water usage by 75%.

5 ENVIRONMENTAL & ECONOMIC BENEFITS

The Canada Green Building Council (CaGBC) has identified a goal of creating carbon neutral communities by 2030. In particular, the CaGBC has the aspiration to reduce the energy and water consumption of 100,000 buildings and 1 million homes by 50% by 2015. Achieving this goal will result in a 50 megatonne reduction of greenhouse gases emissions annually. According to the Council, such a reduction represents an enormous environmental, economic and social benefit that would result in the following savings:

- $10 billion annually in energy cost reductions for corporate and government building owners
- $2.5 billion annually in energy cost reductions for homeowners

- Elimination of the need for 15,000 megawatts of new generation capacity. This is the equivalent of about nineteen, 800 megawatt coal plants costing some $28 billion.

6 LIFE CYCLE & PRODUCTIVITY BENEFITS

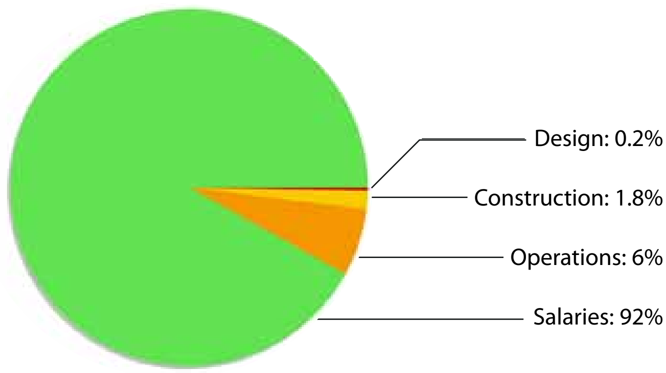


Figure 1: Life Cycle Costs of a Building over 30 Years (Public technology, 1996)

Design, construction, operations, renovations and demolition all contribute to the environmental and economic impact of a building. In assessing the economic benefits and market potential of green buildings, it is important to set them within a life-cycle context. What is immediately obvious from Figure 1 above is that the cost of salaries for building inhabitants far outweighs any other expense. Green buildings may have their most dramatic economic impact in this area. As the Commission for Environmental Cooperation reports:

> *Substantial research supports the health and productivity benefits of green features, such as daylighting, increased natural air ventilation and moisture reduction, and the use of low-emitting floor carpets, glues, paints and other interior finishes and furnishings. In the United States, the annual cost of building-related sickness is estimated to be $58 billion. According to researchers, green building has the potential to generate an additional $200 billion annually in the United States in worker performance by creating offices with improved indoor air quality. (CEC, 2008, p. 4)*

Note that $200 billion is larger than the size of the entire Canadian construction market, which was $156 billion in 2006. As this potential benefit becomes more widely understood, countries with a comprehensive range of green products will have a competitive advantage in the global marketplace.

7 INDUSTRY STRUCTURE

The architecture/engineering/construction, and associated industries around the built environment comprise a wide range of stakeholders. These include the following.

Government: Regulates, fosters, advocates and provides incentives and penalties through building codes, grants and funding for research and education. Sets standards by exemplary building design, construction and operation. Government has an important but indirect role in the large majority of decisions affecting the built environment. Government policy and funding lead their effects in society, but are just as necessarily based on prior experience. In a rapidly changing context, government action needs access to expertise in order to maintain a clear focus for creating positive change, and to avoid repeating mistakes made in other jurisdictions.

Industry: Innovates, develops, deploys and delivers buildings, building products and services. Industry is the key source of new designs, products, services and processes. It turns research concepts into built reality. It is historically poor at evaluation, largely due to the complex structure of ownership, the scope of contracts and long time lags between construction and ongoing use. This often translates into unwillingness to transfer business resources out of short-term marketing, into building performance evaluation that could drive research-based design improvement and could help build verifiable reputations for excellence in design and sustainability. Industry struggles when trying to act upon climate change imperatives, because design is fast and science slow. This means that needed scientific expertise is seldom present at the decision-making table in a timely or usable manner. In addition, percentage fee structures favour designers that specify high-cost mechanical equipment, which reduces motivation to minimize equipment-related energy use. Industry lacks solid ground for making wise decisions about potential climate change impacts, and can benefit from organized research in the area.

Building Owners: Make and implement key decisions about location, program, cost, operation and renovation. Create supply of space. Owners and occupants are often different parties, leading to a tendency to favour short-term economic return over life-cycle benefitz. Building innovation can improve the market value of building stock.

Building Occupants (the legal entities that occupy buildings): Make ongoing decisions about refit and operations that can materially affect building performance. Create location-based demand for building space. Depending on contractual structure, either occupants or owners may operate and maintain building infrastructure. Occupants may have insufficient awareness or knowledge to implement wise environmental decisions.

Building users (the people using buildings): Through daily decisions, can have a large effect on the efficient operation of buildings. Users are typically willing to make changes but often lack the information and tools needed to do so.

Utilities: Provide services and incentives. For many years, and in most sectors, conservation has been the best source of increased utility capacity. Utilities such as BC Hydro actively promote conservation through programs such as Power Smart. Utilities lack information on the long-term effect of their decisions. They also lack an integrated view of energy use in society, because they naturally focus only on their specific energy commodity. In utilities, corporate concentration is potentially good for climate change. Near monopolies such as BC Hydro have greater motivation, opportunity and resources to impact climate change in their sector.

Non-Governmental Organizations: Build consensus and momentum to act; collect and transfer knowledge; and create and foster communities of practice. Key among these NGO's are the building councils such as the Canada Green Building Council. The recent role of NGO's has been critical in gaining industry momentum towards sustainable buildings. In fact, such momentum leads the role of government standard setting in many ways. For example, the Leadership in Energy and Environmental Design (LEED®) green building rating system can (but is not guaranteed to) encourage buildings that greatly exceed code standards in their performance. NGO's lack feedback on the effectiveness of their programs.

Universities: Educate professionals, create advanced and practical knowledge, verify and evaluate the knowledge needed for informed decision making, and build tools for understanding. Universities are the best mechanism yet invented for seeking truth: they have an essential role in validation of technology, practices and policy. Universities operate on a longer time frame than industry. Their chief societal product is highly educated people, and such "production" takes several years. The production of new knowledge through research requires significant time to produce robust results. Acting with somewhat shorter time horizons are highly public demonstration projects such as the current SFU/Waterloo/Ryerson entry to the Solar Decathlon 2009 (an international solar house competition). The longer time horizon is the primary reason that universities typically lack sufficient connection with the rapidly changing situation in the built environment sector.

Colleges: Educate and train for specific industry functions, and create practical knowledge. The focus on training means that colleges can lack adequate mechanisms to ensure that training is conducted on the most relevant and current practice. Colleges offer the most efficient means of initial practical training. They face the challenge of providing effective re-training in the face of industry innovation. Colleges are an essential component of any expansion of green buildings: they reach the constructors, operators and managers of buildings.

Schools: Raise awareness, and contribute to community understandings of stewardship. Schools often lack suitable educational material that is up-to-date and that focuses on important issues as they change.

Traditionally the companies, such a developers and contractors, that finance and construct most buildings are not the same ones that operate them. This structure amplifies the importance of capital costs and discounts operating cost savings. Since changes to buildings that ameliorate climate change effects typically imply increased capital costs and lower operating costs, the very structure of the industry is a challenge to change.

Decision-making is diffuse and extends beyond the building design professions (designers, architects and engineers). It also includes developers, financiers, contractors, sub-contractors, facility managers, building departments, owners and tenants. This fragmentation is one of the key challenges to realizing the potential of green buildings, although, to some extent, recent developments in design processes (usually labeled as the *Integrated Design Process*) address these concerns.

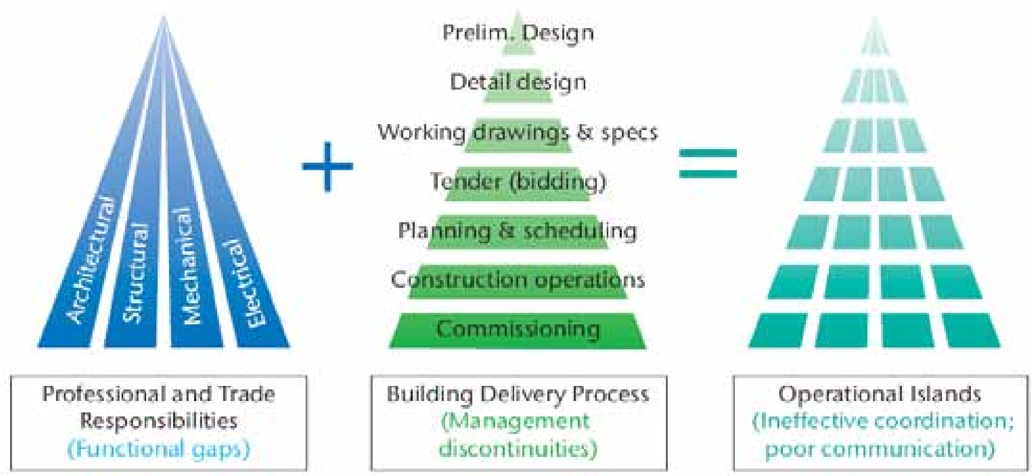


Figure 2: *Fragmentation in design and delivery acts as a barrier (Source: World Green Building Council).*

The building industry is mature and, as such, can be resistant to change. Its relatively low technology, low barriers to entry and the large importance of location mean that it is relatively undercapitalized. It is a risky and conservative business, in which macroeconomic causes amplify effects: boom-and-bust is normal in the industry. Contributing to risk is the relative size of projects compared to a firm's capital. It is not uncommon for the value of a single project to greatly exceed the value of the firms engaged in it. All of this means that life cycle costs, environmental effects and sustainable management are poorly captured in the financial structure of the industry.

8 ISSUES AND CHALLENGES

Despite the economic and environmental advantages of green buildings there are serious challenges to their wide scale deployment in BC. These include issues of business, perception and, particularly for this report, of knowledge and capability.

9 PROGRESSIVE BUILDING CODES

Building code regimes are rapidly changing in many jurisdictions. California, for example, has recently adopted comprehensive "green" provisions in its code, with progressive mandatory implementation and a commitment to annual updating. Such rapid change in regulation is likely to be the norm for the foreseeable future, as both technology and societal understanding grow. Building are interdependent systems, so it will be particularly important to expend research effort in predicting unintended consequences of new code provisions.

10 CHANGE IN SOCIETAL UNDERSTANDING

Building design, construction and operations will continue to change and evolve, as will the human activities that buildings serve. More importantly, what society expects from buildings will change. There is need for both scholarship on these changing patterns and public dialogue on sustainable strategies.

11 TRANSFORMATION OF DESIGN PROCESSES

Contemporary design and construction processes hobble efforts to build sustainably. Sustainable outcomes require that component systems interact successfully. Interdisciplinary communication is thus a vital part of ensuring that building systems are both effective and efficient. The current solution, the Integrated Design Process, needs further refinement, verification against outcomes and much broader dissemination through education, professional development and training. Expertise in group design processes must become an essential part of every design professional's suite of skills.

12 RELIABLE PERFORMANCE DATA

Measuring building energy intensity is technically easy – at a minimum requiring reading the meter once a year and knowing the floor area. While more sophisticated building performance evaluation protocols are readily available (for example, see (Ecosmart, 2008)), the basic step of measuring and sharing building energy intensity data should be the starting place. Overcoming industry resistance to transparent reporting of building energy performance will require effort, but this step may flow, at a policy level, from educating about the importance of mitigating the stress placed on the environment by buildings. As building systems become more sophisticated, new techniques must be developed to accurately gather, store, compare and analyze data about buildings. For example, the relative contribution, in actual operation, of passive solar collection, heat storage, air-tightness and advanced mechanical systems are seldom verified in a given project. All techniques need to be scientifically validated if they are to be reliable bases for policy and action. This crucial and often under-resourced task is best served by research universities.

13 UNCERTAINTY OF COMFORT MODELS

Research over the last twenty years has challenged notions and models of human comfort that have long been the basis of building design. It is clear that contextual factors such as building siting, visual access to the outside, operable windows, availability of public amenities (such as nearby transit stops, outdoor patio spaces, landscaping and secure bicycle storage) and expectations account for much of the variation in perceived comfort. In addition, perceived comfort throughout the day and by activity differs from that anticipated at design. While there have been some advances in control systems in response to this research, there remains considerable scope for gains in adjusting interior building conditions to serve perceived rather than objective measures of comfort.

14 CHANGING OCCUPANT BEHAVIOUR

Significant reductions in energy consumption can be achieved by simply changing the way occupants inhabit and use buildings, with little or no additional costs. According to Potvin at l'Université Laval (2008), building performance depends on architecture (25%), systems (50%) and occupant behaviour (25%). By occupant behaviour, we mean the ways in which people constantly interact with buildings by opening and closing shades, windows and doors; and, with systems by adjusting thermostats and switching lights. These impacts have been significantly underestimated in the past. Studies have shown that consumers will reduce their energy consumption by as much as 12% (Wood, 2003) when provided with monitoring and metering systems that clearly and effectively communicate energy usage. Of all mitigation strategies, awareness is the simplest, most effective and most economical.

15 RELIABILITY OF RATING SCHEMES

Green building rating systems such as LEED® are increasingly moving to life cycle and performance-based certification, which creates the need for reliable, accurate monitoring and measurement systems that can easily be deployed in existing buildings. While these voluntary systems have been tremendously successful in raising awareness of and action in green building design, construction and operation, it is less certain that they can deliver their intended climate change effects within the necessary time-frame. Nor have their evaluation methods been sufficiently validated at arms-length from the organizations hosting them and the designers using them.

16 USABLE AND ACCURATE PREDICTIVE TOOLS

The last major energy crisis (1970-80's) caused rapid development of computational tools for predicting the environmental performance of buildings. With few exceptions, these have found little widespread application at the early stages of design processes where they can have the greatest effect on design decisions. The three main reasons for this are lack of human expertise, requirements for more precise information than is available at the early stages of design, and absence of allowance for such services in standard design contracts. Recently, vendors of computer-aided design systems have directed increased attention to making such tools more accessible and easy to use by design professionals. Similarly, systems for monitoring and understanding building performance in actual operation currently have significant industry attention. All of this is compounded by current climate change – tools must be predictive in both contemporary and future climate regimes.

17 AGGREGATE MODELS

Green buildings are designed and built singly or as part of larger developments, yet it is their collective environmental impacts that are of consequence. There are inadequate models for predicting the economic and climate change impacts of systemic changes in design, construction, operation and regulatory regimes. For example, studies of programs for upgrading insulation in buildings have shown surprisingly low benefits of particular program features.

18 IMPLEMENTATION

Although the construction industry can be resistant to change and self-improvement, the effective design and construction of green buildings demands significant changes to current approaches. Awareness, education, professional development and training are critical and necessary components of any green building program.

19 GREENWASH

Regrettably, more claims to "green" are currently made regarding green building performance than are true. Although LEED® has provided one measure to counter such claims, society requires complementary mechanisms such as public access to building energy intensity data as a basic component of green claim assessment.

20 RESOURCE POSITIVE BUILDINGS

Leading proponents in industry and NGO's such as the Cascadia Green Building Council (2008) (of which BC is a part) have voiced the challenge of "Resource Positive Buildings." The aim is for buildings to produce more energy than they consume, as well as to help regenerate the environment through measures such as the purification of rainwater and wastewater, and the use of green roofs, walls and other measures to restore air quality and create natural habitats for plant and animal species. Serving as demonstrations towards this goal, "net-zero" buildings that produce as much energy as they consume can now be constructed using existing technologies. Part of this net-zero goal is feasible and attainable though sharing of energy and resources in small building networks using existing and new civil infrastructure systems. The claims made for such buildings and systems need to be confirmed on a case-by-case basis as well as systematically across the design, construction and operation strategies used.

21 BRITISH COLUMBIA: CHALLENGES & ADVANTAGES

Recent reports from the Institute of Chartered Accountants of British Columbia suggest that construction is driving the province's economy across all its regions, but that there is need for ongoing analysis. British Columbia's *Energy Efficient Building Strategy* and its *Climate Action Plan* provide a foundation that can be used to position the province as an international leader in green building design and construction. This would, in turn, lead to significant export, commercialization, research and education opportunities. Such a strategy, however, should address the unique and particular challenges and advantages of the building design and construction industry in the province.

22 CHALLENGES

In addition to the general challenges to green buildings noted above, a key challenge to sustainable design in British Columbia is that low suburban density imposes transportation and infrastructure costs that reduce the relative effect of building solutions. A second challenge is the involvement of the forestry industry both in terms of the provision of construction materials in a time of economic uncertainty and the use of pine beetle infected wood.

23 COMPARATIVE ADVANTAGES

The province has the significant advantages of an advanced green building industry and knowledge; a receptive population; a wood industry that creates opportunity for regionally-specific innovation; and high inner urban density (compared to most North American cities) that enables solutions involving density and transportation reduction. Not the least of these advantages is the leadership role played by the province in environmental issues, targets and initiatives. Examples of this leadership include the following.

- BC is home to cities with the highest concentration of existing and planned green buildings. Victoria, for example, has the highest number of LEED® registered buildings in Canada. Many of these are in quasi-public ownership (at UVic, SFU and UBC, for example) and are thus publicly available as exemplars.
- British Columbia hosts some of Canada's most accomplished green architects and engineers – there are too many to mention here.
- British Columbia is home to internationally recognized green building researchers such as Dr. Ray Cole, Director of the School of Architecture and Landscape Architecture, UBC; Dr. John Robinson, Project Leader Centre for Interactive Research on Sustainability (CIRS), UBC; and Maureen Connelly, Research Program Head Green Roof Research at BCIT.
- In British Columbia, UBC has professional and post-professional Master's programs in architecture that include green building design and BCIT offers diplomas and degrees in architectural science and technology. However, no university in British Columbia currently offers a doctoral degree in architecture, nor is there an undergraduate major in sustainable design.
- UBC will be home to the Centre for Interactive Research on Sustainability (CIRS) dedicated to research, collaboration and outreach that lead to workable solutions for the challenges of urban sustainability. When it opens in 2010, CIRS will be among the most innovative and high performance sustainable buildings in North America, demonstrating leading edge research on sustainable design practices, products, systems and policies.
- The Canada Green Building Council (CaGBC) with offices in Ottawa and Vancouver plays a critical leadership role in green buildings and in the development and management of LEED®-Canada. The CaGBC is currently working on the next generation of LEED® in Canada through the LEED® Canada Initiative and has also launched the Green Building Performance Initiative to develop an

affordable and easily accessible tool for energy and environmental management for new and existing buildings. Both initiatives will enable large-scale reduction in greenhouse gas emissions, energy savings, and other environmental benefits for all building types and communities across Canada.

24 RECOMMENDATIONS

In making recommendations, we are constrained by the issues and challenges presented by rapidly developing innovation in building design, construction and operation. Particularly, as we have argued above, policy needs to be grounded in reasonable certainty of its effects and this requires ongoing research. We have thus refrained from over-specification – we recognize that the "devil is in the details". Each recommendation requires a thorough implementation plan. With appropriate consultation, such plans can be quickly prepared, but are beyond the scope of this White Paper.

While we have divided our recommendations into categories, we recognize that these are clearly interdependent.

Government

Government should take leadership roles by progressive regulation and planning, setting examples with its own building stock, providing and facilitating financial incentives, and raising public awareness.

Government should continue to improve mandated standards, through such regulations as the BC Building Code. The trend to performance-based building codes is an excellent example of policy that fosters innovation. Code provisions that require actual performance verification should be seriously considered. However, the current high level of awareness and commitment across all sectors of society indicates a general will to exceed mandated standards. Government should provide incentives for demonstrated success and should further enable the organizations committed to it.

Many of the best technological solutions are more effective at scales intermediate between single buildings and entire cities. Government should seek means to move land use planning and infrastructure provision towards integrated block, neighbourhood and district energy, water and sewage systems.

Government should demonstrate leadership through its own actions. For example, requiring new publicly-funded buildings in the province to meet ambitious GHG emission goals can be a catalyst for both industry change and societal acceptance. Current salutary policies include requiring all new provincially owned or leased facilities to be built to LEED® Gold standard (LiveSmart 2008, p. 40) and the net-zero targets for new public and residential buildings (Slusarchuk 2008, p. 21). However, government could amplify such policy by requiring verification of performance. Such action could significantly enhance both government and NGO efforts to mitigate climate change.

Industry is the prime source of innovation, so government should financially support current and emerging industry-led initiatives (such as Built Green). It should seek ways to foster

BC's green building industry and to ensure that appropriate kinds and amounts of research and development are undertaken to both encourage and ensure that industry action achieves societal goals.

Government should facilitate incentives such as mortgages with favourable terms for green construction, preferential utility rates for efficient buildings and buy-back provisions for produced electricity. Prior to introduction, such measures should be subject to rigorous modeling and analysis to ensure that they will deliver their intended effects.

It is particularly important to support NGO's in their roles as facilitators and disseminators of green building innovation. The return on investment in organizations with proven track records of success (for example, the Cascadia Green Building Council and the Canada Green Building Council) is likely to be very high. Such organizations are natural partners with government.

Since decisions affecting the impact of buildings on climate are highly distributed across all building users, outreach and awareness programs will be a critical part of any successful climate change program. These must be grounded in fact – people need to be asked to undertake the most effective actions and need to be provided with the best information to enable them to do so.

Government should require universal public release of building energy performance data akin to the real-time energy displays and Display Energy Performance Certificates that are now mandated in the United Kingdom. Such a requirement, which could be implemented in time for the 2010 Olympics, would stimulate the development of improved building design and operational practices, would appropriately advantage competent players, and would reduce or at least provide a disincentive for energy-related greenwashing within the industry. The savings in marketing costs alone could fund a transformation of design practices in the province. An immediate reduction in existing building energy use could be expected due to increased awareness and operation changes prompted by the comparison of visible energy use data.

Buildings are only part of a climate change solution. In the complex, multi-scale urban system, government policy and action needs to be coherent at many levels. For whatever level of policy is addressed, accurate performance information, broadly shared, is a necessity for effective action. Government is a natural collector and disseminator of such information and should ensure that accurate information is widely available.

Industry, Associations and Non-Governmental Organizations

The building industry in BC has a comparative advantage given by location, green expertise and societal support for sustainability. Industry thus has opportunities to further foster innovation in the design, manufacture, construction and operation of buildings.

Industry is already innovating voluntarily on a large scale and across the province. However, the biggest challenge to further advance green building practices is capacity building among professionals. Knowledge and skills are the keys to producing and operating buildings to their highest efficiency. Organizations such as the CaGBC and industry associations, along with colleges and universities can play lead roles if supported properly to take on this task. There is particular opportunity for industry/government action through programs such as regionally-based science and technology councils (BCSTRN – British Columbia Science and Technology Regional Networks). Most recently, the Okanagan Science and Technology Council (a member of the BCSTRN) has established a regional cluster in Clean Tech Construction and this model could be used elsewhere.

Programs such as LEED® and its recent extensions to neighourhoods (LEED® for Neighborhood Development) and homes (LEED® for Homes) are major drivers (perhaps the major drivers) of voluntary change. These programs are worthy of much wider dissemination. Key to this will be continuing professional education to ensure that green knowledge and skill is widely present in the industry. The associations sponsoring such programs should ensure that they advance new knowledge and technology and that they receive independent research scrutiny.

Industry should support the development of new green technology and manufacturing of low/zero-carbon products through demonstrations of innovative new buildings and community developments in BC (e.g., Dockside Green). These will be excellent long-term investments in the green economy.

Universities and Colleges

In the face of high levels of industry innovation, academic emphasis should be on production of highly qualified personnel; and research to model complex systems, confirm effects, understand the complex interactions of building use, develop and prototype technology with long-term potential, and predict unintended consequences.

Academic research should be explicitly interdisciplinary and seek strong industry connections – such research necessarily reflects the breadth of the building industry. Organizing for interdisciplinarity and industrial relevance tends to favour research groups and centres over individual researchers. The Pacific Institute for Climate Solutions should play an important role in structuring such interdisciplinary research. To do this, it must be active in fostering the collaboration that is needed for progress in the field and in networking among the many capable stakeholders outside of academia.

While BC has several excellent researchers, its academic institutions lack the critical mass needed to develop and maintain world-class research, graduate programs and undergraduate education. Academia, government and industry should seek to build such critical mass. Vehicles such as targeted government funding for new or expanded academic programs in sustainable design, and a Leading Edge Endowment Fund Chair in sustainable design would greatly enhance and accelerate research and industry capability. It is important to concentrate effort – a research group will accomplish more than the same number of academics distributed across several institutions. The Pacific Institute for Climate Solutions should play an active role in building needed critical mass, both by providing research funding to support programs and by networking among research groups at different universities.

Graduate programs should actively seek industry partners, through joint research and such programs as NSERC Collaborative Research and Development, Accelerate BC Graduate Internship and BC Innovation Scholars programs. Programs should develop highly qualified personnel in key areas of building research such as occupant behaviour, modeling of policy effects, and new technologies and information systems for user-occupant-building interaction. The Pacific Institute for Climate Solutions should work with NSERC, Accelerate BC, and the BC Innovation Council to establish programs connecting academic research and industry.

At the undergraduate level, there is clear need and demand to develop professional expertise through new undergraduate programs in sustainable design and through strengthening existing professional design and environmental engineering programs at the University of British Columbia, the University of Victoria and Simon Fraser University. There is both need and demand for new university places in the hundreds here. The Pacific Institute for Climate Solutions should conduct an annual undergraduate design competition and symposium (similar to the Ecologez competition in Quebec). The benefits to education and public awareness would dwarf the modest cost involved.

Colleges should expand programs in green building technology, operations and management. In doing so, they face atypical challenges in ensuring program relevance in the face of rapidly changing knowledge and technology. Continuing education and training are likely to play a large role for colleges – in the face of rapidly changing knowledge and standards, those currently in industry will need continuous updating of skills.

Academic projects that combine research, design and the creation of prototypes (such as exemplary solar houses) can be highly public catalysts to change and are natural partnering and networking events for all parties. By combining research, student projects and internships, with industry, NGO's and government, they can create awareness and help set goals for all stakeholders in the building sector. To be effective, these must be widely communicated and must be shown in highly public locations.

Knowledge Translation and Outreach

All parties should encourage change through programs such as Live Smart (BC government) and Power Smart (BC Hydro); through developments such as Dockside Green, UniverCity (SFU) and Millennium Water; and through community groups and community-based developments such as Central Green in Kelowna.

There is clear need for improved communication among all stakeholders in the industry. The current tremendous motivation and effort of many parties could be greatly amplified by coordinated communication and outreach programs. The nine regional councils of the BCSTRN and ScienceWorld are natural channels for such programs. Finally, active development of school outreach programs, in particular engagement with both researchers and designers, should form a key component of ongoing educational approaches.

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