GREEN BUILDING IN NORTH AMERICA

OPPORTUNITIES AND CHALLENGES

SECRETARIAT REPORT TO COUNCIL UNDER ARTICLE 13 OF THE NORTH AMERICAN AGREEMENT ON ENVIRONMENTAL COOPERATION

CEC · CCA · CCE

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PREFACE

The Commission for Environmental Cooperation (CEC) is an international organization created by Canada, Mexico, and the United States under the North American Agreement on Environmental Cooperation (NAAEC). The CEC was established to address regional environmental concerns, help prevent potential trade and environmental conflicts, and promote the effective enforcement of environmental law. The Agreement complements the environmental provisions of the North American Free Trade Agreement (NAFTA).

At the behest of Executive Directors William Kennedy and Adrián Vázquez, Tim Whitehouse and Geoff Garver of the CEC Secretariat prepared this report pursuant to Article 13 of the NAAEC. Article 13 is a section of the NAAEC that gives the CEC Secretariat authority to prepare reports on important environmental issues and present them to the governments and people of Canada, Mexico, and the United States.

Previous Article 13 reports have addressed the effects of transgenic maize in Mexico, environmental challenges and opportunities of an evolving continental electricity market, an agenda for preserving transboundary migratory bird habitat on the Upper San Pedro River, an agenda for cooperation to address long-range transport of air pollution in North America, and the death of migratory birds at the Silva Reservoir in Guanajuato, Mexico.

The CEC Secretariat would like to acknowledge the many individuals and organizations that contributed time and energy to the successful completion of this report. Special mention goes to the CEC Advisory Group on Green Building, chaired by Jonathan Westeinde, whose members have worked under a very tight deadline to develop the Statement and Advice on Recommendations that represent the core of this Secretariat report (see listing of Advisory Group members on page 10). The Secretariat would like to thank each one of them for their extraordinary dedication and collegiality over the course of the last two years. The Secretariat would also like to thank the authors of the background papers that were developed as part of this process (see list on page 11) and the many government and public participants who provided comments at the workshop and the symposium.

A draft of this report was provided to the NAAEC Parties, the Advisory Group and the background paper authors for confidential review and comment. Comments were received from Martin Adelaar, Jennifer Atlee, Alison Kinn Bennett, Odón de Buen, Guillermo Casar, Roger Peters, José Picciotto, Marta Niño Sulkowska, Leanne Tobias, Cesar Trevino, Douglas Webber, Jonathan Westeinde, and Fernando Mayagoitia Wintron. Environment Canada and the US Environmental Protection Agency provided additional comments from interagency reviews of the draft report.

The CEC Secretariat would also like to thank Nils Larsson and Jean Cinq-Mars of iiSBE and Joel Ann Todd, a green building consultant, for their advice in designing the study, selecting the Advisory Group and authors of the background papers, and preparing for and conducting the first Advisory Group meeting in June 2006. Finally, the Secretariat would like to thank the Secretariat staff members who helped in the development of this report. These include: Doris Millan, Sophia Noguera, Katia Opalka, José Otero, Paolo Solano, and Jeffrey Stoub.

EXECUTIVE SUMMARY

INTRODUCTION

In this report, the Secretariat of the Commission for Environmental Cooperation (CEC) recommends that North American leaders make green building a foundational driver for environmental, social, and economic improvement in Canada, Mexico, and the United States.

What is green building and how can it become such an important instrument for change?

Green building[1] refers to the use of environmentally preferable practices and materials in the design, location, construction, operation and disposal of buildings. It applies to both renovation and retrofitting of existing buildings and construction of new buildings, whether residential or commercial public or private.

By continually improving how we locate, design, build, operate, and retrofit buildings, North American leaders can significantly improve the well-being of North America. Advanced energy-saving technologies applied in buildings can result in enormous reductions in demand for fossil fuels and emissions of greenhouse gases (GHG). Better design and building practices can also help address environmental challenges such as natural resource depletion, waste disposal, and air, water, and soil pollution. Green building can also help achieve gains in human health and prosperity.

Despite this potential for transformation, green building represents only a small percentage of building in North America. By some estimates, green building currently accounts for about two percent of the new non-residential building market in the United States and 0.3 percent of the residential market. In Canada, green building trends are generally thought to be similar to those in the United States. In Mexico, there are no reliable figures showing the extent to which green building exists in the marketplace. Although the green building market is expected to grow rapidly in all three countries in the coming years, a substantial shift from the status quo is needed to make these high-performance buildings the norm in North America.

GREEN BUILDING AND THE ENVIRONMENT

In Canada, Mexico, and the United States, commercial and residential building operations account for about 20, 30, and 40 percent of the primary energy consumption, respectively. They typically also account for 20 to 25 percent of the landfill waste and 5 to 12 percent of the water consumption. The United States Green Building Council estimates that green building, on average, currently reduces energy use by 30 percent, carbon emissions by 35 percent, water use by 30 to 50 percent, and generates waste cost savings of 50 to 90 percent.

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 at $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.

Buildings also affect our quality of life, infrastructure development, and transportation systems. Beyond individual buildings, poor site development often leads to inefficient land use, resulting in greater energy consumption and travel time, loss of productivity, polluted runoff to surface water and wastewater treatment systems, loss of agricultural lands, fragmented habitats, and fiscal stress to local communities.

1 The CEC uses the term "edificación sustentable" as the Spanish translation of "green building," although a more precise translation of "edificación sustentable" might be "sustainable building." "Sustainability" generally encompasses environmental, economic and social aspects. While the focus here is on the environmental aspects of buildings, we emphasize that to be sustainable, construction and development must also account for economic and social concerns.

BUILDINGS AND CLIMATE CHANGE

Reports from leading scientists throughout the world underline the need for urgent action on climate change. The Intergovernmental Panel on Climate Change (IPCC) projects that without more immediate action to limit greenhouse gas emissions, global warming could cause irreversible and possibly catastrophic consequences.

Every year, the energy used by buildings in North America causes more than 2,200 megatons of CO_2 to be released into the atmosphere, about 35 percent of the continent's total. Recent studies by the Intergovernmental Panel on Climate Change (IPCC), McKinsey & Company (an international consulting firm), and Vattenfall (a Swedish utility company), indicate that improved building practices are some of the quickest and cheapest ways to reduce significantly greenhouse gas emissions, often with net economic benefit. An increasing number of organizations, institutions, and government entities in North America are calling for aggressive energy performance improvements in the building sector. In short, green building represents some of the ripest "low-hanging fruit" for achieving significant reductions in climate change emissions.

A background study commissioned by the CEC Secretariat as part of this study signals the tremendous possibilities in terms of energy improvements and greenhouse gas emissions reductions in the building sector by 2030 and suggests a path forward toward zero net-energy and carbon-neutral buildings. A rapidly increasing market uptake of currently available and emerging advanced energy-saving technologies could result in annual reductions of 1711 megatonnes (MT) of CO_2 into the atmosphere in North America by 2030, compared to a business-as-usual approach. This is nearly equivalent to the 1756 MT of CO_2 emissions from the transportation sector in the United States in 2000. With these dramatic reductions in energy requirements, renewable energy could provide additional energy needs, making the widespread adoption of zero net-energy and carbon-neutral buildings possible.

MOVING THE GREEN BUILDING AGENDA FORWARD

In the United States and Canada, many efforts are currently underway to accelerate the market uptake of green building. Economics are helping to drive these changes. Studies show that the cost premium to deliver sustainable properties to the market has declined considerably in recent years, and that experienced teams are delivering them at costs competitive with conventional buildings. There is, however, a cost to organizations to gain the experience necessary to achieve this. In addition, studies show that the significant life-cycle financial benefits of green design more than make up for the additional initial cost associated with green building. Unfortunately, in many cases, due to policy, ownership, and business structures, the benefits of green building do not accrue to those making the investment. Research presented in the background papers to this report shows how governments at all levels are working to address these and other obstacles to influence the uptake of green building through the integrated use of building codes; zoning regulations; tax-based incentives; and preferential treatment for green developers (such as fast-track permitting). In addition, green building practices are also being spurred by demand offset programs (in which a developer reduces energy and water demand as a condition of permitting); preferred purchasing; tax shifting; and government-supported research, development, and educational programs.

Mexico has a tradition of architecture that favors environmentally sensitive, small-footprint building practices and designs. Policy efforts to promote green building are relatively new and generally focused on the housing sector. The country's National Housing Commission (*Comisión Nacional de Vivienda*—Conavi) is documenting green practices and working to define criteria for green homes. Infonavit, a large housing fund in Mexico supported by mandatory employer and employee contributions, has created a "green mortgage" program.

The *Comisión Nacional para el Ahorro de Energía* (National Commission for Energy Efficiency—Conae) recently began work to implement a solar water heater program. This initiative, along with green procurement guidelines, leasing and public sector services, is sure to play a part in the process. Also, new hotels in some environmentally sensitive areas are integrating technology to reduce their environmental footprint and a number of private corporations are designing their headquarters to be more environmentally efficient.

Current market forces and government programs alone, however, will not drive the necessary changes in the building industry. Key barriers to a market transformation in North America include: the predominant practice by governments and institutions of separating capital and operating budgets instead of using life-cycle budgeting; the split incentive problem, where the one who pays for the green features often does not realize its benefits; a tendency to rely on business-as-usual approaches in view of the perceived cost, risk, and uncertainty of green building; limited awareness and knowledge of green building; and lack of coordination and consistency in government policies affecting building.

In Mexico, additional barriers include the paucity of urban planning and building regulations that address sustainability issues, the lack of a widely-used certification system for green building practices, limited implementation of existing standards, and the lack of data on energy and water use in buildings.

PROMOTING MUTUALLY BENEFICIAL COOPERATION

Similarities and differences within North America present an opportunity for governmental and nongovernmental institutions and industry in the three countries to work to improve the building sector. This effort can help strengthen the economies of North America by spurring new markets and business opportunities for manufacturers, utilities, and other companies. Europe has strong green building programs and segments of Asia and Latin America are beginning to embrace green building. Green building will help ensure North American competitiveness in the global market for products, technologies, and practices essential to North America's future. These include more efficient heating and cooling systems, advanced building materials, water-reclamation systems, high-efficiency appliances, advanced insulation systems, energy-efficient lighting, and many more.

RECOMMENDATIONS FOR NORTH AMERICA

With these drivers and barriers, regional variations and global changes pushing and pulling the markets in different directions, what can North American leaders do to help ensure green building becomes standard practice in North America?

As part of the development of this report, the CEC Secretariat's Green Building Advisory Group issued a Statement and Advice on Recommendations for the Secretariat. The Advice on Recommendations sets forth a specific path for how North America can accelerate the market uptake of green building and make it the standard practice for all new and existing buildings. The CEC Secretariat has adopted the Advisory Group's Advice on Recommendations as its recommendations for this report. These recommendations are designed to support and build on the many ongoing efforts already occurring in North America by the federal, state/provincial and local governments as well as many industry, trade and nongovernmental organizations.

Among other things, these recommendations call upon North American government, industry and nongovernmental leaders to:

(1) Work together to develop a lasting and achievable vision for green building in North America. This vision will help drive targets and strategies for green building and could result in the creation of a common set of principles and planning tools for green building, with each country having region/context-appropriate policies and programs to address differences in building codes, regulatory environments, climate, and economic and social conditions.

To work toward this vision, the recommendations call for the creation of national, multi-stakeholder task forces in each of the three countries, coordinated by the environment or other appropriate ministry of each country and linked internationally through a cooperative mechanism such as the CEC. These task forces would promote aggressive and consolidated approaches for accelerating the achievement of this vision at the North American level, with united and integrated participation of representatives of all components of the building sector and civil society.

(2) Set clearly defined targets with the goal of achieving the most rapid possible adoption of green building in North America, including setting aggressive, realistic targets for carbon-neutral or net zero-energy buildings. Modeling should be conducted and targets set for other environmental parameters such as water use, wastewater generation, land conversion, use of environmentally-preferable materials, embodied energy and waste loads, and to monitor performance for continual improvements.

(3) Implement a set of strategies for enhancing, accelerating and integrating ongoing or new efforts in support of green building. These strategies should include efforts to promote private sector financing and proper valuation methods, and to increase knowledge through research and development, capacity building, outreach, and the use of labels and disclosures on green building performance. These efforts are particularly important for Mexico, considering its urgent need for affordable housing and the need for widely recognized green building rating systems and a nationally-coordinated framework that will support and enhance existing Mexican policies and programs that favor green building.

North American governments at all levels should build on their progress to date and, as swiftly as possible, adopt comprehensive and ambitious policies requiring all government procurement in the building sector to achieve high levels of green building performance, with a firm commitment to continual improvement over time.

These efforts should also push for continual improvement in policies, regulations, and codes and develop and enforce effective mechanisms to monitor implementation. These include tax and other financial incentives, such as graduated utility rates that encourage conservation, non-tax incentives like expedited permitting, priority plan review, and density bonuses, among others. Over time, government should emphasize the appropriate use of mandates, in addition to incentives, with the view toward the advancement of green building performance targets. It is critical that all policies and programs related to green building be integrated with comprehensive urban development programs geared toward the development of sustainable communities.

Finally, the recommendations call for North American leaders to promote North American and global cooperation in green building in such areas as trade in materials, conducting joint or coordinated research programs, and to promote the sharing of data, information, and best practices.

SEATTLE CITY HALL
SEATTLE, WASHINGTON

1 INTRODUCTION

PHOTO: ERIK STUHAUG

1 INTRODUCTION

THIS REPORT PRESENTS NORTH AMERICAN LEADERS WITH A TRINATIONAL PLAN FOR MAKING GREEN BUILDING A FOUNDATIONAL DRIVER FOR CHANGE IN CANADA, MEXICO, AND THE UNITED STATES. THE REPORT WAS PREPARED OVER TWO YEARS, WITH THE HELP OF LEADING NORTH AMERICAN EXPERTS ON GREEN BUILDING AND INPUT FROM THE NAAEC PARTIES AND THE PUBLIC. THROUGH THIS PROCESS, THE CEC SECRETARIAT IDENTIFIED THE KEY OPPORTUNITIES AND CHALLENGES FACING GREEN BUILDING IN NORTH AMERICA.

THE PROCESS

To examine the status of green building in North America, as well as some of the drivers and barriers to its development and implementation, in February of 2006 the Secretariat of the CEC initiated this study.

Throughout, the Secretariat has relied heavily on the input and work of an international Advisory Group convened by the Secretariat (see listing below), background papers developed by leading experts in Canada, Mexico, and the United States (see page 11), and materials presented and input received at two Secretariat-sponsored public meetings.

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GREEN BUILDING BACKGROUND PAPERS

PAPER 1: Green Building Energy Scenarios for 2030	
Marbek Resource Consultants (Martin Adelaar and Mark Pasini), Lawrence Berkeley Laboratory (Stephen Selkowitz), Odón de Buen	
PAPER 2: Toward Sustainable Financing and Strong Markets for Green Building	
Sinergia Capital (Luis Antonio García Díaz)	Paper 2a: Green Building Market and Finance in Mexico
Malachite LLC (Leanne Tobias)	Paper 2b: US Green Building Finance Review
Chris Corps	Paper 2c: Valuing Sustainability
PAPER 3: Institutional Efforts for Green Building	
Mario Molina Center	Paper 3a: The Case of Mexico
Alex Wilson, Jennifer Atlee, Halsall Associates (Doug Webber)	Paper 3b: Approaches in Canada and the United States
PAPER 4: Residential Green Building in North America	
Fernando Mayagoitia	Paper 4a: Working Toward Accessible and Sustainable Housing in Mexico
Steven Winter	Paper 4b: Promoting Residential Green Building in North America: A Perspective from the United States
The Sheltair Group (Innes Hood)	Paper 4c: The Benefits of a North American Strategy: A Perspective from Canada

Advisory Group members included prominent developers and architects, sustainability and energy experts, real estate appraisers and brokers, together with local and national government representatives. The Advisory Group provided direction to the Secretariat throughout the development of this report. It also developed a Statement and Advice on Recommendations that provides a vision, targets, and strategies for making green building a reality in North America. Throughout this report, we have borrowed heavily from the Advisory Group Statement and adopted their advice to us on the recommendations to include in this report.

The background papers address the impact by 2030 of several building energy scenarios, financing and market consolidation of green building, institutional efforts for increasing green building, and issues associated with accessible and sustainable housing. The background papers provide detailed information and analysis on many of the issues discussed in this report. The complete set of background papers is available on CEC's website at <www.cec.org/greenbuilding>.

The public meetings included a workshop in Mexico City in February of 2007 and a symposium held in conjunction with a meeting of the CEC's Joint Public Advisory Committee in Seattle in May of 2007. These meetings provided a unique opportunity for a wide-ranging dialogue with Advisory Group members, authors of the background papers, government and industry leaders, and interested members of the public on the status and progress of green building in North America and on ideas for improving the market penetration of green building.

CONTENT OF THIS REPORT

This report has eight sections. After this introduction, the second section looks at the development of green building principles in North America; the third section examines how the benefits of green building can be a powerful tool to improve the well-being of North America; the fourth section looks at buildings and their role in the climate change crisis; the fifth section examines green building energy scenarios for 2030 and the enormous potential for green building to achieve energy efficiency improvements and greenhouse gas reductions; the sixth section looks at the policies and practices behind the momentum toward green building and some of the barriers that impede the more widespread uptake of green building; the seventh section examines some of the benefits of promoting green building cooperation on a North American-scale; and the last section provides the CEC Secretariat's recommendations, which adopt the Advice on Recommendations put forth by the Secretariat's Advisory Group on green building.

WHAT THIS REPORT DOES NOT ADDRESS

Due to resource and time constraints, this report focuses largely on energy-related environmental issues associated with green building. It spends less time addressing topics such as water use and wastewater generation, land conversion, use of environmentally-preferable materials, embodied energy and waste loads, and issues associated with how green building can help improve worker health and productivity.

Non-energy-related environmental issues are an integral part of green building. To address these issues in greater detail, this paper recommends that an appropriate organization carry out modeling similar to the modeling carried out in background paper 1: *Green Building Energy Scenarios for 2030* for these other environmental aspects, along with related policy analysis.

A NOTE ON DATA

A notable lack of geographic balance exists in the literature and data on the benefits and environmental performance and market penetration of green building. Much of the data and information in this report comes from the United States, followed by Canada and then Mexico: reflecting the general availability of green building information in the three countries. The report's recommendations suggest how to address some of these data gaps.

111 SOUTH WACKER DRIVE
CHICAGO, ILLINOIS

2 GREEN BUILDING IN NORTH AMERICA

PHOTO: JAMES STEINKAMP PHOTOGRAPHY

2 GREEN BUILDING IN NORTH AMERICA

THROUGHOUT NORTH AMERICA, GREEN BUILDING DESIGNERS AND BUILDERS ARE CREATING BUILDINGS THAT DRAMATICALLY LOWER ENERGY CONSUMPTION, USE RENEWABLE ENERGY, CONSERVE WATER, HARNESS NATURAL SOURCES OF LIGHT AND VENTILATION, USE ENVIRONMENTALLY PREFERABLE MATERIALS, MINIMIZE WASTE, AND CREATE HEALTHY AND PRODUCTIVE ENVIRONMENTS.

A. FEATURES OF GREEN BUILDING

Modern building practices often demonstrate little regard for energy efficiency or the larger economic, environmental or social impacts of the built environment. Green building attempts to break with these practices. Early efforts to bring change to the building sector in the 1960s through the 1980s generally focused on single issues such as energy efficiency and conservation of natural resources. Green building now integrates a wide range of building design, construction, and operation and maintenance practices to provide healthier living and working environments and minimize environmental impacts. Crucial to the success of green building has been the application of integrated design principles—a whole-building-systems approach, which brings together the key stakeholders and design professionals as a core team to work collaboratively from the early planning stages through to the building's occupation.

Green building features can include high-tech, modern practices such as (to name only a few) sensor-controlled and compact fluorescent lighting, high-efficiency heat pumps, geothermal heating, photovoltaic cell arrays and solar chimneys, on-site cleaning and reuse of wastewater; as well as simple and often time-tested practices like attention to building orientation and design, increased use of fresh air and natural light, improved insulation, radiant cooling systems that take advantage of naturally occurring conditions, managed forest or salvaged lumber products, recycled concrete aggregates, green roofs, rainwater collection, waterless urinals, facilities for bicyclists, permeable pavers, cork flooring, and use of local products.

Current green building practices are not limited to one type of building or market niche, geographic location or business model. Increasingly, green building is seen as part of comprehensive urban development programs geared toward development of sustainable communities with emphasis on integrating green building with sustainable urban infrastructure for transportation, gas and electric utilities, potable water, waste disposal and recycling, storm water and wastewater management and sewage.

B. HOW WIDESPREAD IS GREEN BUILDING?

The number of green buildings certified as part of voluntary rating programs, market surveys, and anecdotal evidence indicate tremendous growth in this field, although that number remains very small. Without widespread performance data and agreed upon performance benchmarks for comparison, no method exists to determine precisely how many buildings are green.

By some estimates, green building currently accounts for about 2 percent of the new non-residential building market in the United States and is expected to grow to between 5 and 10 percent by 2010. The estimates for green residential buildings are even smaller, at 0.3 percent of the market; this market is also expected to grow due to high consumer confidence and a growth in the number of green builders.[2] The increased number of green building organizations is evidence of the growing interest and enthusiasm in this sector. The largest green building organization in the United States, the US Green Building Council (USGBC), has over 12,000 member organizations and estimates the green building industry—almost non-existent a decade ago—is now worth upwards of $12 billion. While similar surveys on the green construction market have not been conducted in Canada, green building trends generally are considered to be similar to those in the United States. The Canada Green Building Council (CaGBC), launched in 2002, has 1400 members.

In Mexico, there are no current estimates on the number of green buildings. However, the country has a tradition of architecture that favors environmentally sensitive, low impact building practices and designs. Over the past three decades, a growing network of teachers, researchers, and practitioners has developed in the field of solar and bioclimatic architecture. This effort resulted in the creation in 2002 of the *Red Nacional de Arquitectura Bioclimática*, which has been active in Mexico and throughout Latin America. That same year, the Mexico Green Building Council was formed (MxGBC). It was re-launched in 2005 in Monterrey but, with 32 members, remains quite small in comparison to the USGBC and the CaGBC.

2 Green Building Smart Market Report, McGraw Hill Construction and USGBC, 2006 <http://construction.ecnext.com/coms2/summary_0249-229622_ITM_analytics>.

C. RATING SYSTEMS

Since the early 1990s, a number of organizations in the United States and Canada have developed green building rating systems that provide specific performance objectives and frameworks for assessing overall building design and/or performance.

Each of these rating systems allocate points in areas such as energy use, water use, pollution, material and product inputs, indoor air quality and occupant comfort, transport, site ecology, and other sustainable design features. Many of these organizations are looking at ways to move from rating only building design to evaluation of actual performance over time. Their differences stem from the standard development process, philosophy on particular issues, and stringency, rather than the areas the rating systems evaluate.

D. A PROCESS OF CONTINUAL IMPROVEMENT

In all three countries, efforts are underway to collect broad quantitative information to better assess the performance of buildings and the life-cycle environmental impacts of the materials and systems they incorporate. There remains a shortage of data regarding the real performance and impacts of building design and operation strategies. Increased access to this kind of data will help ensure that green buildings actually perform in a manner superior to conventional buildings, and help to identify ways to push for continued improvements in the building sector.

The process of continual improvement has the potential to dramatically change the building sector. Most current green building efforts focus on minimizing environmental impacts. With proper organizational leadership and policy drivers, buildings in the future could be designed for disassembly, reuse and recycling, and have systems that clean the water and air, provide habitat for plants and wildlife, and generate and release renewable energy into the electrical grid.

EXAMPLES OF GREEN BUILDING RATING SYSTEMS

→ The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™, developed and managed by the USGBC, is the most widely used rating system in North America. Buildings are given ratings of platinum, gold, silver, or "certified," based on green building attributes. LEED is evolving rapidly; in the United States, at least nine types of specific programs exist, including those for new commercial construction and major renovation projects, existing building operation and maintenance, commercial interiors, homes, schools, neighborhoods and retail. USGBC is also developing LEED® for Healthcare, and LEED for Labs.

- The Canada Green Building Council has a license from the USGBC to administer LEED in Canada. A number of the original US LEED products have been modified to suit the Canadian market. The CaGBC is now in the process of developing a more integrated set of LEED products that rely on the measured performance of completed buildings as a basis for setting performance targets.

- The Mexico Green Building Council is working to adapt to Mexico the LEED rating system for commercial buildings in Mexico by 2008.

→ Green Globes, formed by groups in Canada and the United States as an alternative to LEED, emphasizes ease of use, low cost and user education through its web-based application.

→ The Building Owners and Managers Association (BOMA) Canada launched a variant of Green Globes, GoGreen, which rates existing commercial office buildings.

→ The Built Green Society of Canada manages Built Green, a certification program for new single-family homes and row houses. It currently operates in Alberta and British Columbia.

→ The National Association of Home Builders (NAHB) and the International Codes Council are partnering with the American National Standards Institute on residential green standards by late 2008.

HEIFER INTERNATIONAL HEADQUARTERS
LITTLE ROCK, ARKANSAS

3 A FOUNDATIONAL DRIVER FOR CHANGE

PHOTO: HEIFER INTERNATIONAL

3 A FOUNDATIONAL DRIVER FOR CHANGE

IF WE CONTINUALLY IMPROVE HOW WE DESIGN, LOCATE AND CONSTRUCT OUR BUILDINGS, GREEN BUILDING CAN BECOME A DRIVER FOR FUNDAMENTALLY IMPROVING THE WAY WE LIVE.

A. THE NEGATIVE ENVIRONMENTAL IMPACTS OF CURRENT BUILDING PRACTICES

Environmental impacts of buildings occur throughout all life stages of a building—site selection, design, location, construction, use, renovation, and demolition. Building decisions made throughout these life stages also affect business value, worker health and productivity, and social or "quality of life" issues.

Direct environmental impacts that result from the construction and operation of buildings include greenhouse gases and other air emissions related to energy use, water use and discharge, storm water runoff, impacts related to building materials, solid waste from various stages of a building's life, and indoor air quality. Secondary impacts are generally associated with building product life-cycles, infrastructure development, and transportation systems.

Data collected from Canada, Mexico and the United States illustrate these impacts.

In Canada, buildings are responsible for:

- 33 percent of all energy used;
- 50 percent of natural resources consumed;
- 12 percent of non-industrial water used;
- 25 percent of landfill waste generated;
- 10 percent of airborne particulates produced; and
- 35 percent of greenhouse gases emitted.[3]

In Mexico, buildings are responsible for:

- 17 percent of all energy used;
- 25 percent of all electricity used;
- 20 percent of all carbon dioxide emissions;
- 5 percent of potable water consumption; and
- 20 percent of the waste generated.[4]

In the United States, buildings account for:

- 40 percent of total energy use;
- 12 percent of the total water consumption;
- 68 percent of total electricity consumption;
- 38 percent of total carbon dioxide emissions; and
- 60 percent of total non-industrial waste generation.[5]

3 *CaGBC Municipal Green Building Toolkit*, Chapter 1, p. 2.
4 E-mail from David Morillón Gálvez, *Universidad Nacional Autónoma de México,* 13 August 2007.
5 See <http://www.epa.gov/greenbuilding/pubs/whybuild.htm>.

The impact is especially profound in terms of greenhouse gas emissions. Every year, buildings in North America cause more than 2,200 MT of CO_2 to be released into the atmosphere, about 35 percent of the continent's total. Hundreds of coal-fired power plants, a key source of greenhouse gas emissions, are currently on the drawing boards in the United States. According to one report, 76 percent of the energy produced by these plants will go to operate buildings.[6]

Beyond individual buildings, poor patterns of building development often lead to congestion and inefficient use of land, resulting in greater energy consumption and travel time, loss of productivity, polluted runoff to surface water and wastewater treatment systems, loss of agricultural lands, fragmented habitats, and fiscal stress to local communities. Two case studies from Toronto indicate that residents of sprawling neighborhoods tend to emit more greenhouse gases per person and suffer more traffic fatalities.[7]

Urban water run-off is another important building-related impact. Buildings, and transportation infrastructure that serve them, replace natural surfaces with impermeable materials, typically creating runoff that washes pollutants and sediments into surface water. Urban runoff is the fourth-leading cause of impairment of rivers, third-leading for lakes, and second for estuaries in the United States,[8] and a significant problem in many parts of Mexico and Canada as well. In Mexico City, most rainwater flows on impermeable surfaces to the city drainage system; only a small proportion (11 percent) is recharged into the aquifer, causing a greater dependence on neighboring basins and increasing the risk of flooding.[9]

B. BENEFITS OF GREEN BUILDING

The benefits of green building are well-documented. The USGBC estimates that green building, on average, currently reduces energy use by 30 percent, carbon emissions by 35 percent, and water use by 30 to 50 percent, and generates waste cost savings of 50 to 90 percent.[10] In addition, green building can help foster stronger communities and provide important benefits to human health and productivity.

The following profiles are offered as examples of new and retrofitted construction in different climates in the three countries as a modest attempt to illustrate something of the variety possible in commercial, institutional, and residential green building. Further information about the buildings profiled is available on the CEC website at <cec.org/greenbuilding>.

6 See <www.architecture2030.org/2030_challenge/index.html>.
7 Comparing High and Low Residential Density: Life-Cycle Analysis of Energy Use and Greenhouse Gas Emissions, *J. Urban Plng and Devel*, 132(1), pp. 10–21 (March 2006).
8 *National Water Quality Inventory: 2000 Report*. US Environmental Protection Agency. 2000. <www.epa.gov/305b/2000report>.
9 *Agua y Sustentabilidad en la Ciudad de México.* See <http://redalyc.uaemex.mx/redalyc/pdf/312/31204702.pdf>. *Estudios demográficos y urbanos, El Colegio de México*, 2001.
10 See <http://www.usgbc.org/News/USGBCInTheNewsDetails.aspx?ID=3288>.

SAVING ENERGY

Green building addresses climate change and other energy-related air emissions in two basic ways: first (and most importantly), by reducing the amount of energy used to light, heat, cool and operate buildings and their appliances, and second, by substituting for what currently is mostly carbon-based energy with alternatives that do not involve the production of greenhouse gases and other harmful air emissions. It is common now for more advanced green buildings to routinely reduce energy usage by 30, 40, or even 50 percent over conventional buildings, with the most efficient buildings now performing more than 70 percent better than conventional properties.

1 THE CORPORATIVO INSURGENTES 553
Mexico City, Mexico

Photos: José Picciotto

➔ BY EMPHASIZING NATURAL LIGHTING AND TEMPERATURE CONTROL, EXTERIOR BLINDS AND BUILDING ORIENTATION, THE CORPORATIVO INSURGENTES 553, HOTEL FIESTA INN, IN MEXICO CITY, IS ABLE TO REDUCE ENERGY CONSUMPTION FOR AIR CONDITIONING BY 30 PERCENT AND FOR LIGHTING BY 10 PERCENT OVER A CONVENTIONAL BUILDING.

2 THE LEWIS AND CLARK BUILDING
Jefferson City, Missouri, United States

➔ THE LEWIS AND CLARK BUILDING OF THE MISSOURI DEPARTMENT OF NATURAL RESOURCES, BUILT ON A RELATIVELY MODEST STATE BUDGET, IS 59 PERCENT MORE ENERGY EFFICIENT THAN CONVENTIONAL BUILDINGS AND USES SOLAR PANELS TO GENERATE 2.51 PERCENT OF THE BUILDING'S ENERGY USAGE.

Photos: Scott Myers/Missouri Department of National Resources

3 THE NOW HOUSE™
Toronto, Ontario, Canada

➔ THE NOW HOUSE™ IN TORONTO IS A RETROFIT OF AN EXISTING HOME. SOLAR PANELS FOR HEATING WATER, IMPROVED INSULATION, NEW WINDOWS AND APPLIANCES, A HEAT RECOVERY SYSTEM, AND PHANTOM LOAD SWITCHES WILL REDUCE ANNUAL GREENHOUSE GAS EMISSIONS FROM THE HOUSE BY 60 PERCENT, FROM 9.7 TONNES TO 3.7 TONNES.

Photo: The Now House™ Project

IMPROVING WATER USAGE

Green building uses a number of techniques to improve water quality and availability. These techniques can help reduce water usage, provide for on-site cleaning and reuse of wastewater, and on-site filtering of storm water. Water management is a significant cost and an important environmental issue in all three countries. Water stress is particularly high in parts of Mexico, the United States, and western Canada.

4 ALBERICI CORPORATION HEADQUARTERS
Overland, Missouri, United States

➔ AT THE ALBERICI CORPORATION HEADQUARTERS IN OVERLAND, MISSOURI, THE REUSE OF RAINWATER, ALONG WITH THE USE OF WATER-EFFICIENT FIXTURES, RESULTS IN A 70-PERCENT REDUCTION IN POTABLE WATER USE, SAVING 500,000 GALLONS OF WATER ANNUALLY. SPECIFICS INCLUDE:

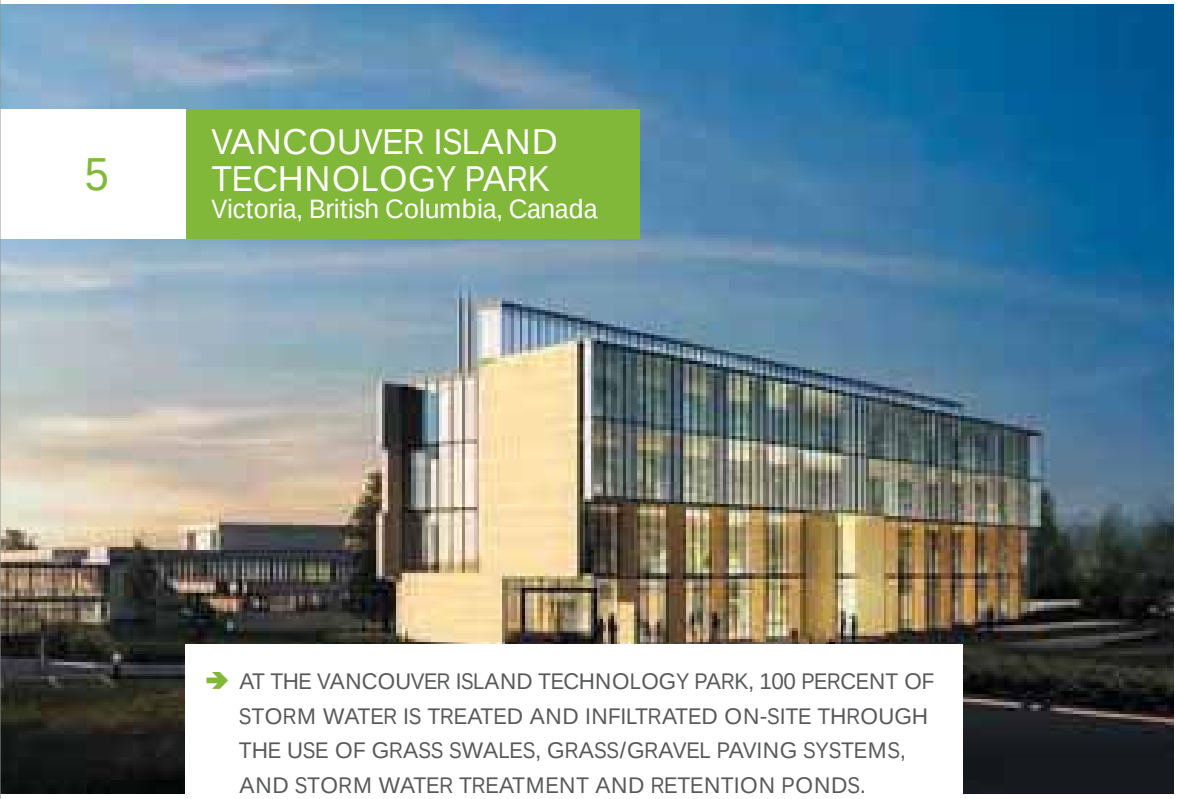
→ INDOOR POTABLE WATER USE: 288,000 GAL/YR (1,090,000 LITERS/YR);

→ OUTDOOR POTABLE WATER USE: 0 GAL/YR (0 LITERS/YR);

→ TOTAL POTABLE WATER USE: 288,000 GAL/YR (1,090,000 LITERS/YR);

→ POTABLE WATER USE PER OCCUPANT: 1,390 GAL/YR (5,250 LITERS/YR).

Photos: Alise O'Brien (Interiors), Debbie Franke (Exteriors)



5 VANCOUVER ISLAND TECHNOLOGY PARK
Victoria, British Columbia, Canada

➔ AT THE VANCOUVER ISLAND TECHNOLOGY PARK, 100 PERCENT OF STORM WATER IS TREATED AND INFILTRATED ON-SITE THROUGH THE USE OF GRASS SWALES, GRASS/GRAVEL PAVING SYSTEMS, AND STORM WATER TREATMENT AND RETENTION PONDS.

Photos: Cannon Design

6 CINEPOLIS HEADQUARTERS
Morelia, Michoacán, Mexico

➔ ONE RECENT AREA OF FOCUS IN MEXICO HAS BEEN ON GREEN ROOFS AS A WAY TO RECHARGE AQUIFERS, REDUCE STORM WATER RUN-OFF, FILTER POLLUTANTS OUT OF RAIN WATER, PROVIDE WILDLIFE HABITATS, IMPROVE ROOF AESTHETICS, AS WELL AS REDUCE THE HEATING AND COOLING LOADS OF BUILDINGS AND THE URBAN HEAT ISLAND EFFECT. WHEN FINISHED IN 2008, THE CINEPOLIS HEADQUARTERS IN MICHOACÁN WILL FEATURE EXPANSIVE GREEN ROOF TECHNIQUES.

Photos: KMD Architects

REDUCING WASTE

Reducing waste through better product design, recycling, and re-use of materials will result in tremendous reductions in both raw material usage and also in associated environmental impacts, as well as the cost to the private sector and local governments of disposing of these materials. Building-related construction and demolition debris totals approximately 136 million tons per year in the United States, accounting for nearly 60 percent of the total non-industrial waste generation there.[11] An estimated 20 to 30 percent of building-related construction and demolition debris is recovered for processing and recycling. In Canada, construction, renovation, and demolition waste accounts for about 17 to 21 percent of the total mass of waste landfilled annually.[12] The volume of demolition waste in Mexico City is estimated between 3,500 and 5,000 tons a day.[13] Reducing construction waste and creating reusable and recyclable building components are key strategies in addressing these environmental impacts.

7

HEIFER INTERNATIONAL HEADQUARTERS
Little Rock, Arkansas, United States

Photos: Heifer International

➔ THE HEIFER INTERNATIONAL HEADQUARTERS IN LITTLE ROCK, ARKANSAS, PROVIDES AN EXAMPLE OF HOW A GREEN BUILDING CAN WORK TO REDUCE WASTE AND CONSTRUCTION DEBRIS. SIXTY PERCENT OF THE ORIGINAL 22-ACRE SITE WAS PAVED. USING AN INDUSTRIAL CRUSHER, HOWEVER, THE PROJECT TEAM GROUND THE EXISTING WAREHOUSE BUILDINGS AND PAVING INTO FILL MATERIAL FOR USE ON THE PROJECT. APPROXIMATELY 97 PERCENT OF THE EXISTING BUILDING AND PAVING MATERIAL, BY WEIGHT, WAS RECYCLED, GENERATING SAVINGS IN FILL MATERIAL THAT PAID FOR THE MAJORITY OF DEMOLITION. DURING THE CONSTRUCTION PHASE, THE PROJECT TEAM RECYCLED 75 PERCENT (BY WEIGHT) OF THE BUILDING'S CONSTRUCTION WASTE.

11 See <www.epa.gov/greenbuilding/pubs/gbstats.pdf>.
12 See <www3.gov.ab.ca/env/waste/aow/crd/publications/CRD_Report_All.pdf>, citing information from Statistics Canada.
13 *Soluciones para Residuos de la Construcción* <http://www.guanajuato.gob.mx/iee/expo-pdf/soluciones.pdf>. *Instituto de Ecología del Estado de Guanajuato*.

BUILDING STRONG COMMUNITIES

Green building is a key component to building healthy, vibrant, and economically strong communities. Leading communities throughout the world recognize that people want to live in places with a strong sense of community, attractive and comfortable homes, walkable streets, and plentiful green spaces, and proximity to transit, shops, and work.

8

DOCKSIDE GREEN
Victoria, British Columbia, Canada

Photos: Windmill Development Group

➔ DOCKSIDE GREEN IS AN EXAMPLE OF A COMPREHENSIVE GREEN DEVELOPMENT. THIS 1.3 MILLION SQ. FT. MIXED-USE SUSTAINABLE COMMUNITY IS UNDER DEVELOPMENT ON A 15-ACRE FORMER BROWNFIELDS SITE IN VICTORIA, BRITISH COLUMBIA. THE PROJECT INCLUDES RESIDENTIAL, OFFICE, AND COMMERCIAL SPACES, AS WELL AS LIGHT INDUSTRIAL ASSETS. IT IS A PEDESTRIAN- AND BIKE-FRIENDLY NEIGHBORHOOD LOCATED BETWEEN THE CITY'S DOWNTOWN AND THE UPPER HARBOR. THE BUILDINGS ARE BEING DESIGNED TO USE 45 TO 55 PERCENT LESS ENERGY THAN THE CANADIAN MODEL NATIONAL ENERGY CODE SPECIFIES. ALL SEWAGE GENERATED IS TREATED ON-SITE. POTABLE WATER USE IS 65 PERCENT LESS THAN IN TRADITIONAL DEVELOPMENTS. ENVIRONMENTALLY-FRIENDLY PRODUCTS ARE USED THROUGHOUT, AND THE DEVELOPMENT HAS A GOAL TO REUSE OR RECYCLE 90 PERCENT OF THE CONSTRUCTION WASTE ON-SITE.

IMPROVING HUMAN HEALTH AND PRODUCTIVITY

While energy-related issues drive much of the green building policy discussion, for many businesses, energy costs represent a marginal cost of doing business as compared with the salaries of employees. Substantial research supports the benefits to human health and productivity from green features such as daylighting, increased natural air ventilation, and moisture reduction, and the use of low-emitting floor carpets, glues, paint and other interior finishes and furnishings.[14]

Poor indoor air quality exacerbates asthma, allergies, and the spread of influenza, and is the cause of sick building syndrome and contributes to Legionnaires' disease. 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 worker performance in the United States by creating offices with better indoor air.[15]

9

CK CHOI BUILDING
Vancouver, British Columbia, Canada

➔ THE CK CHOI BUILDING IN VANCOUVER IS AN EXAMPLE OF POTENTIAL HEALTH BENEFITS OF GREEN BUILDING. THE OCCUPANTS ENJOY NATURAL DAYLIGHTING AND FRESH AIR AT ALL TIMES. AIR QUALITY IS ENHANCED THROUGH CAREFUL MATERIAL CHOICES; CARPET WAS LAID WITHOUT ADHESIVES, MILLWORK WAS CONSTRUCTED FROM FORMALDEHYDE-FREE BOARDS, AND FINISHES ARE SOLVENT-FREE/LOW EMISSION PRODUCTS.

Photos: UBC Sustainability Office/ Matsuzaki Architects Inc.

14 See <http://gaia.lbl.gov/IHP/>.
15 See <http://www.aia.org/aiarchitect/thisweek05/tw1021/tw1021plantsatwork.cfm>.

10

THE SOLAIRE
Battery Park City, New York, United States

Photos: © Jeff Goldberg/Esto

➔ THE SOLAIRE IN NEW YORK CITY IS A LEED GOLD RESIDENTIAL BUILDING FOR WHICH A RENT PREMIUM OF FIVE PERCENT OVER NEARBY COMPARABLE BUILDINGS HAS BEEN ATTRIBUTED TO HEALTH BENEFITS DUE TO THE BUILDING'S HIGH INDOOR AIR QUALITY.

F10 HOUSE
CHICAGO, ILLINOIS

4 CLIMATE CHANGE CRISIS AND BUILDINGS

PHOTO: DOUG SNOWER PHOTOGRAPHY

4 CLIMATE CHANGE CRISIS AND BUILDINGS

A PROCESS OF CONTINUALLY IMPROVING THE PERFORMANCE OF BUILDINGS CAN FUNDAMENTALLY ADDRESS THE CLIMATE CHANGE CRISIS.

A. GREEN BUILDING AND GHG EMISSIONS

Reports from leading scientists throughout the world underline the need for urgent global action on climate change. The IPCC projects that without more immediate action to limit greenhouse gas emissions, global warming could cause irreversible and possibly catastrophic consequences.

Three recent reports illustrate that energy-efficient buildings are one of the quickest and cheapest ways to reduce significantly greenhouse gas emissions.

MITIGATING CLIMATE CHANGE WITH NET ECONOMIC BENEFIT

According to a recent IPCC report,[16] buildings represent the greatest opportunity for considerable reductions in CO_2 emissions. Its fourth assessment report states that about 30 percent of the projected global greenhouse gas emissions in the building sector can be avoided by 2030 with net economic benefit. According to the report, limiting CO_2 emissions would also improve indoor and outdoor air quality, improve social welfare, and enhance energy security.

CURBING GLOBAL ENERGY DEMAND GROWTH

A recent study by the international consulting firm McKinsey & Company indicates that building energy efficiency measures are some of the cheapest and most cost-effective ways to reduce carbon emissions worldwide.[17] It also notes that these measures would require no reduction in quality of life or comfort.

THE COSTS OF CUTTING CARBON IN DIFFERENT WAYS

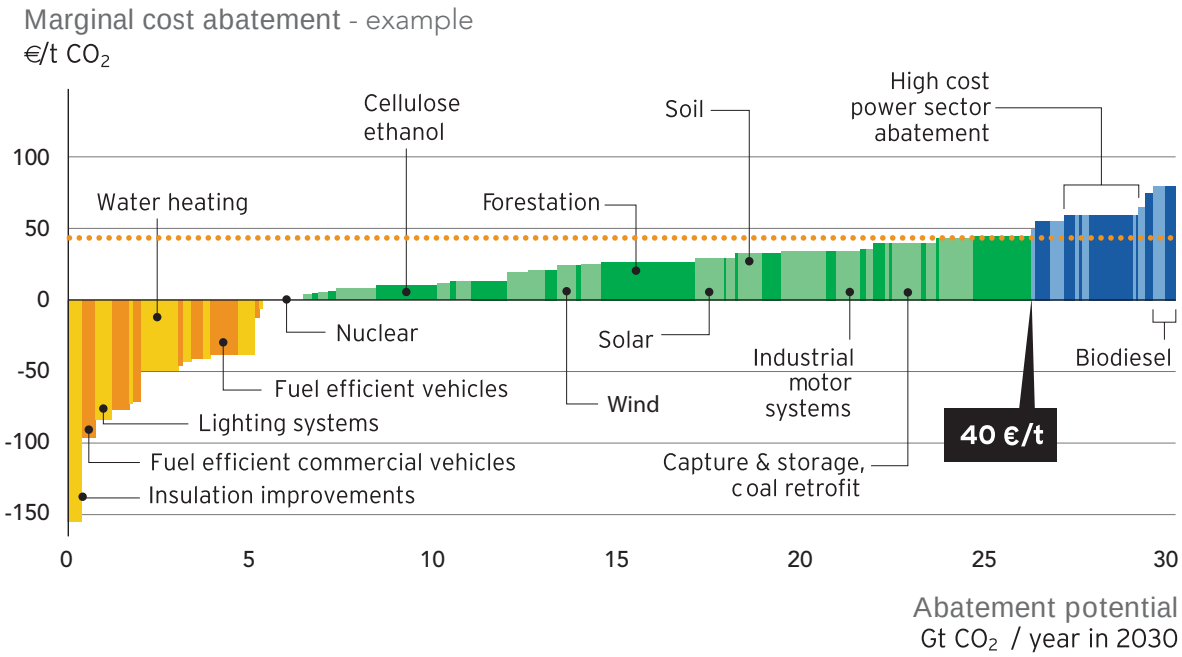
A study by a Swedish power utility finds that energy efficiency measures, such as improving insulation and water heaters and switching to low-energy lighting systems, can save money and cut tremendous amounts of greenhouse gas emissions. Insulation improvements alone could save more than 1.7 gigatonnes of CO_2 by 2030, lighting improvement could eliminate close to 0.4 gigatonnes, and water heating improvements of about 0.5 gigatonnes. According to the study, the investment costs to achieve these savings would be more than compensated for by a decrease in the costs for the energy.[18] See Figure A.

16 Background paper 2b, *Institutional Efforts for Green Building: Approaches in Canada and the United States.* IPCC, *2007, Climate Change 2007: Mitigation of Climate Change.* Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds.), Cambridge University Press, United Kingdom and New York, NY USA. See <www.ipcc.ch/SPM040507.pdf>.

17 *Curbing Energy Demand Growth, The Energy Productivity Opportunity,* May 2007, McKinsey & Company, <http://www.mckinsey.com/mgi/publications/Curbing_Global_Energy/index.asp>.

18 *Climate Map,* Vattenfall, 2007. See <http://www.vattenfall.com/www/ccc/ccc/569512nextx/573859globa/574118cost/index.jsp?origin=search>.

FIGURE A. Global Cost Curve



Source: <http://www.vattenfall.com/www/ccc/ccc/569512nextx/573859globa/574118cost/index.jsp?origin=search>.
Used by permission of Vattenfall.

B. CALLING FOR AGGRESSIVE IMPROVEMENT IN NORTH AMERICA

An increasing number of organizations and institutions in North America are calling for aggressive energy performance improvements in the building sector. A number of important efforts are looking at ways to achieve widespread adoption of carbon-neutral and net zero-energy buildings in North America. These terms are defined in the following box.

WHAT IS MEANT BY "CARBON-NEUTRAL" AND "NET ZERO-ENERGY"?

Definitions vary and are often used interchangeably but "carbon-neutral" buildings are generally understood to be those that require no GHG-emitting energy to operate. They do this by combining on- and off-site renewable energy generation with ultra-efficient building materials and equipment.

A number of definitions exist for net zero-energy. Generally, however, the term is used to designate buildings that generate as much energy as they use over the course of a specific period of time, usually a year, but they can use carbon-based energy from the grid when needed. The carbon-based energy would then be replaced with surplus renewable energy when the latter is generated on-site.

Both terms consider only the energy used to operate a building, not the energy involved in producing the building materials, which can be significant. The common factor between these terms is that to achieve the goals they embody will require considerable forethought and efficiency in the energetic design and practice for the building.

AIA 2030 CHALLENGE

In 2005, the American Institute of Architects (AIA) issued the 2030 Challenge, which sets forth a target and schedule to be achieved by carbon-neutral buildings by 2030. The Royal Architectural Institute of Canada (RAIC), the US Council of Mayors, and the International Council for Local Environmental Initiatives (ICLEI) have joined this initiative. In addition, over 650 US cities have adopted it.[19] In 2007, the AIA, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRE), Architecture 2030, the Illuminating Engineering Society of North America (IENA), and the US Green Building Council, supported by the United States Department of Energy, signed a memorandum of understanding focusing on designing net zero-energy buildings, with a final goal of carbon-neutral buildings by 2030.[20]

WBCSD

The World Business Council for Sustainable Development (WBCSD) began working in 2006 toward developing a path to net zero-energy buildings by 2050. The WBCSD effort is initially targeting China, India, Brazil, the United States and the European Union for creation of these buildings. The core group of companies supporting this effort includes United Technologies, LaFarge, CEMEX, Kansai, EDF, Philips, Dupont, Gaz de France, Sonae Sierra and Tokyo Electric Power Company.[21]

OTHER CALLS FOR AGGRESSIVE IMPROVEMENTS

In 2006, the Canadian government launched the first phase of a net zero-energy housing initiative. This initial phase is part of a five-year, community-scale demonstration aimed at completing 1,500 net zero-energy homes across Canada by 2011.[22] The Living Building Challenge, operated by the USGBC's Cascadia Chapter, requires a number of performance benchmarks, including the requirement that 100 percent of the building's energy needs must be supplied by on-site renewable energy on a net annual basis.[23]

The United States Department of Energy's Building America program conducts research in partnership with the private sector to produce homes on a community scale that consume on average 30 to 90 percent less energy than conventional homes, with the goal of developing by 2020 zero energy homes (ZEH) that produce more on-site renewable energy than they consume from the grid.[24] The California Solar Initiative, launched in 2007, aims for installation of 3,000 megawatts of new, solar-produced electricity at one million new and existing residential and commercial buildings by 2017.[25]

19 See <www.architecture2030.org>.
20 See <www.usgbc.org/News/PressReleaseDetails.aspx?ID=3124>.
21 World Business Council for Sustainable Development. *The True Cost of Green Building,* <www.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MjU5NTM>.
22 See <http://cmhc.ca/en/en_001.cfm>.
23 See <http://www.cascadiagbc.org/news/lbc/living-site-1.0.pdf>.
24 See <http://www.eere.energy.gov/buildings/building_america/>. For additional information on research toward the ZEH goal by organizations such as the National Association of Home Builders Research Center, see <http://www.toolbase.org/ToolbaseResources/level3.aspx?BucketID=2&CategoryID=58>.
25 See <http://www.gosolarcalifornia.ca.gov/>.

US EPA NATIONAL COMPUTER CENTER
RESEARCH TRIANGLE PARK, NORTH CAROLINA

5 GREEN BUILDING ENERGY SCENARIOS FOR 2030

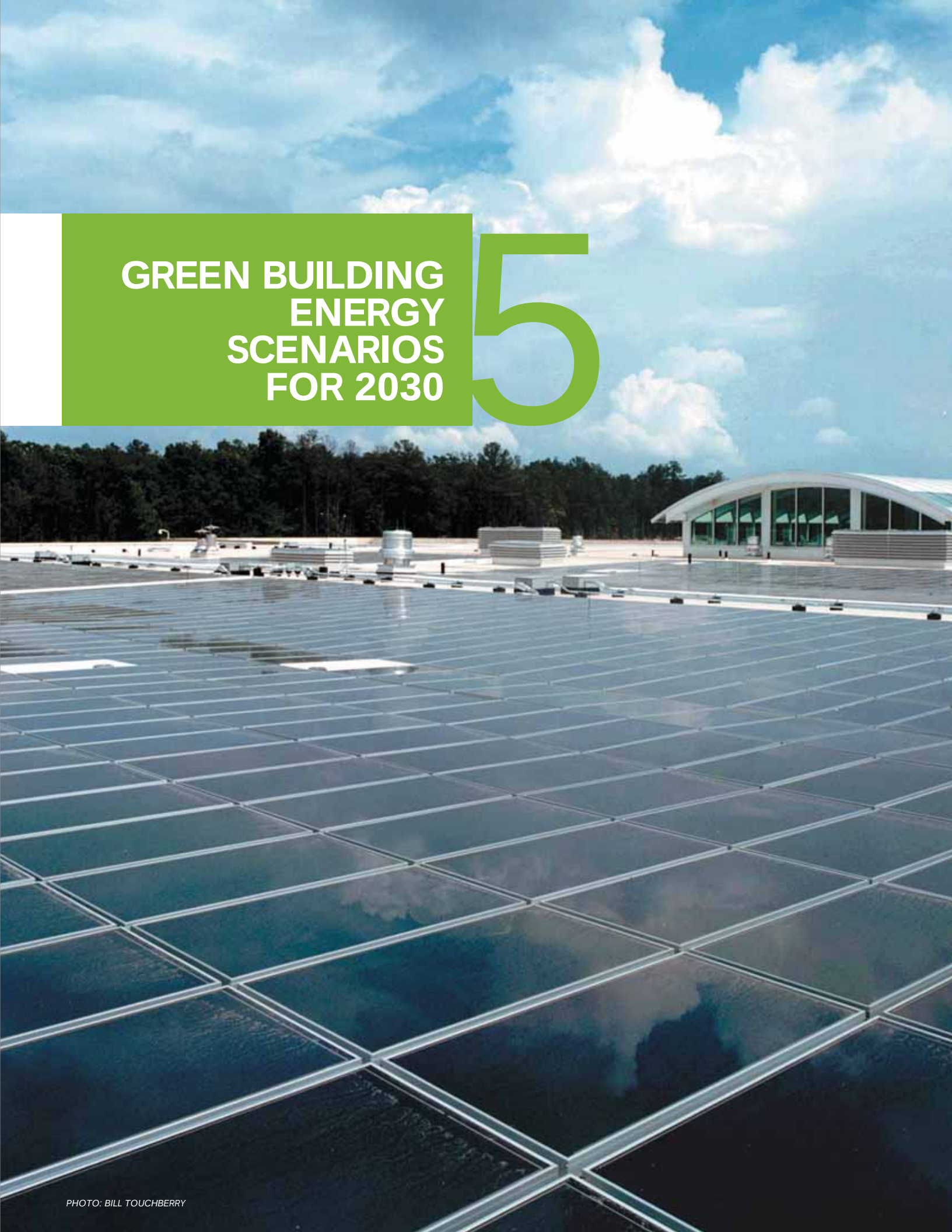


PHOTO: BILL TOUCHBERRY

5 GREEN BUILDING ENERGY SCENARIOS FOR 2030

WHAT WOULD BE THE ENVIRONMENTAL BENEFITS OF SIGNIFICANT MARKET PENETRATION OF CARBON-NEUTRAL OR NET ZERO-ENERGY BUILDINGS? A BACKGROUND PAPER SUPPORTING THIS REPORT, *GREEN BUILDING ENERGY SCENARIOS FOR 2030*, EXAMINES THE POTENTIAL ENERGY PERFORMANCE IMPROVEMENTS ATTAINABLE BY 2030 IN THE NORTH AMERICAN BUILDING MARKET. THE STUDY FINDS THAT ENORMOUS REDUCTIONS IN ENERGY USE AND GREENHOUSE GAS EMISSIONS FROM NEW AND EXISTING BUILDINGS ARE TECHNICALLY ACHIEVABLE BY 2030 WITH AGGRESSIVE MARKET UPTAKE OF EXISTING AND EMERGING TECHNOLOGIES AND CONSTRUCTION METHODS.

A. MODELING AGGRESSIVE ENERGY-SAVING SCENARIOS

The authors of the background paper modeled energy usage and GHG emissions projections to 2030 in three scenarios, called for purposes of this paper the Business-as-Usual scenario (BAU), the AIA or 2030 Challenge scenario, and the Deep Green scenario.

BUSINESS-AS-USUAL SCENARIO

The Business-as-Usual (BAU) scenario models energy and GHG emissions projections by using an extrapolation of current stock growth rates coupled with energy use intensities typical of new construction today, and assumes no significant policy initiatives that would fundamentally change current trends with respect to either new building codes or retrofit or renovation initiatives.

AIA OR 2030 CHALLENGE SCENARIO

The AIA or 2030 Challenge scenario uses modeling assumptions based on the AIA's 2030 Challenge, which sets out a schedule of continually improving energy performance targets based on reductions in the amount of fossil fuel needed to operate buildings. The scenario adopts a carbon-neutral end state for new buildings and greatly reduced fossil fuel use for existing buildings that undergo major renovations and retrofits.

DEEP GREEN SCENARIO

The Deep Green scenario relies on a rapidly increasing market uptake of specific and currently available and emerging advanced energy savings technologies based on building archetypes, which are physical depictions of "representative" buildings (see box).[26]

26 The Deep Green scenario was developed by the authors of background paper 1: *Green Building Energy Scenarios for 2030* (Marbek Resource Consultants Ltd., Odón de Buen and Lawrence Berkeley National Laboratory). For more information, consult that paper.

Establishing this scenario involves modeling an accelerating market penetration of two advanced-performance building archetypes—"Super-Efficient" 1 (SE1, the most efficient building) and "Super Efficient" 2 (SE2, a highly efficient building), for new commercial and residential buildings and for renovations and retrofits to existing commercial and residential buildings.[27] Each archetype embodies current and emerging yet proven technologies and building practices commercially available today. Modified versions of the savings estimates associated with each efficient building archetype were used for modeling the United States scenarios to address the range of climates throughout the country.

By modeling energy improvements based on building archetypes, the Deep Green scenario helps test the feasibility of achieving the fossil fuel reduction targets modeled in the AIA or 2030 Challenge scenario. In establishing the Deep Green scenario, the authors did not presuppose that it would result in greater energy savings and CO_2 reductions than the AIA or 2030 Challenge scenario.

ABOUT THE BUILDING ARCHETYPES

The SE1 archetypes for new buildings achieve roughly 80 to 85 percent improvement for residential, and 60 to 65 percent for commercial, in whole-building energy savings relative to the base year archetype. The SE1 archetypes represent the best available technical performance using state-of-the-art building envelope construction materials and methods as well as state-of-the-art energy consumption equipment.

For both new commercial and residential buildings, the SE2 archetypes achieve roughly 50 to 60 percent whole building energy savings relative to the base year archetype. The SE2 archetypes use more cost effective and conventional equipment to achieve building performance well beyond current conventional practice.

Using a combination of modeling and judgment, the efficiency improvements for SE1 and SE2 archetypes for renovations and retrofits of buildings were assumed to be between 40 and 75 percent, depending on the archetype and whether a renovation or retrofit was undertaken.

27 The background paper describes in detail the commercial and residential building categories modeled for each country, as well as the main energy end uses for commercial and residential buildings.

To complete this scenario, the authors developed the roll-out schedules for uptake of the various archetypes based on a series of progressively greater uptake of advanced energy-saving technologies to 2030. For the United States, the results were adopted to US climates based upon the US author's engineering judgment.

The methodology described in these three scenarios does not attempt to predict the specific impacts of evolving policy and attitudes on investments in efficiency in the building sector. This study illustrates potentials for change rather than predictors of what the future will look like and helps identify policy and technical issues that must be explored more exhaustively in the future.

B. COUNTRY-SPECIFIC RESULTS

Figures B, C and D show the results of modeling the greenhouse gas emissions for the Business-as-Usual, AIA or 2030 Challenge, and Deep Green scenarios. They also provide 1990 GHG emissions levels as a point of reference for the Kyoto targets.[28]

THE RESULTS EXPLAINED BY COUNTRY

The Business-as-Usual projections, when applied to the North American buildings stock and factoring in predicted stock growth and the existing patterns of stock energy consumption, indicate that aggregate energy use and associated carbon emissions will continue to grow, as follows:

- In Canada, a Business-as-Usual approach will result in a 28-percent increase in energy consumption in the residential sector and 39 percent in the commercial sector. This will result in an additional 46 MT of CO_2 released to the atmosphere in 2030 compared with current emissions.
- In Mexico, a Business-as-Usual approach will result in a 152-percent increase in energy consumption in the residential sector and 144 percent in the commercial sector. This will result in an additional 119 MT of CO_2 released to the atmosphere in 2030 compared with current emissions.
- In the United States, a Business-as-Usual approach will result in 23-percent increase in energy consumption in the residential sector and 36 percent in the commercial sector. This will result in an additional 680 MT of CO_2 released to the atmosphere in 2030 compared with current emissions.

For comparison, in 2000, the transportation sector in Canada was responsible for the release of 173.7 MT of CO_2 into the atmosphere; in the United States, it was responsible for the release of 1756.8. MT; in Mexico, the amount was 110.6 MT.[29]

28 Refer to background paper 1 (section 2.3.2) for a general explanation of how the energy use figures cited below were derived. Data supporting the energy use percentages given here come from Figures 3.31 through 3.50. The coefficient for converting these data to carbon emission equivalents is discussed in section 2.3.4 of that paper. Note also that data on 1990 commercial GHG emissions were not available for Mexico.

29 See <http://unfccc.int/di/DetailedByParty/Setup.do>.

The AIA or 2030 Challenge scenario results in enormous reductions in energy used and greenhouse gases emitted:

- In Canada, the AIA or 2030 Challenge scenario results in an annual energy-use reduction of 77 percent in the residential sector and 46 percent in the commercial sector by 2030, compared to the Business-as-Usual scenario. This is equivalent to annual reductions of 112 MT of CO_2 released to the atmosphere compared to the Business-as-Usual approach.

- In Mexico, the AIA or 2030 Challenge scenario results in an annual energy-use reduction of 56 percent in the residential sector and 62 percent in the commercial sector by 2030, compared to the Business-as-Usual scenario. This is equivalent to annual reductions of 103 MT of CO_2 released to the atmosphere compared to the Business-as-Usual approach.

- In the United States, the AIA or 2030 Challenge scenario results in an annual energy-use reduction of 27 percent in the residential sector and 41 percent in the commercial sector by 2030, compared to the Business-as-Usual scenario. This is equivalent to annual reductions of 980 MT of CO_2 released to the atmosphere compared to the Business-as-Usual approach.

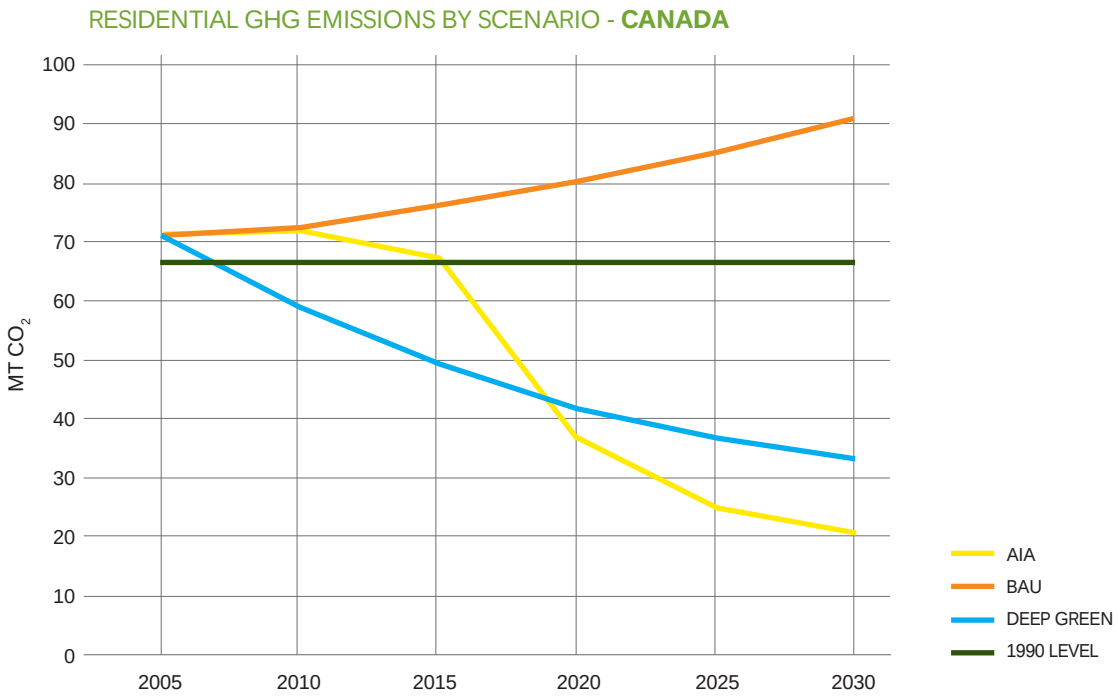
The Deep Green scenario also results in enormous reductions in energy usage and greenhouse gases. These savings are generally in-line with the savings in the AIA or 2030 Challenge scenario, although they can differ based on country and building type, and the modeling assumptions regarding the market penetration of new buildings and the percentage of existing buildings undergoing renovations or retrofits.

- In Canada, the Deep Green scenario results in an annual energy-use reduction of 62 percent in the residential sector and 51 percent in the commercial sector by 2030, compared to the Business-as-Usual scenario. This is equivalent to annual reductions of 103 MT of CO_2 released to the atmosphere, compared to the Business-as-Usual approach.

- In Mexico, the Deep Green scenario results in an annual energy-use reduction of 70 percent in the residential sector and 55 percent in the commercial sector by 2030, compared to the Business-as-Usual scenario. This is equivalent to annual reductions of 120 MT of CO_2 released to the atmosphere, compared to the Business-as-Usual approach.

- In the United States, the Deep Green scenario results in an annual energy-use reduction of 50 percent in the residential sector and 50 percent in the commercial sector by 2030, compared to the Business-as-Usual scenario. This is equivalent to annual reductions of 1488 MT of CO_2 released to the atmosphere, compared to the Business-as-Usual approach.

FIGURE B : CANADA
Predictions by Scenario for Canada's Residential and Commercial GHG Emissions



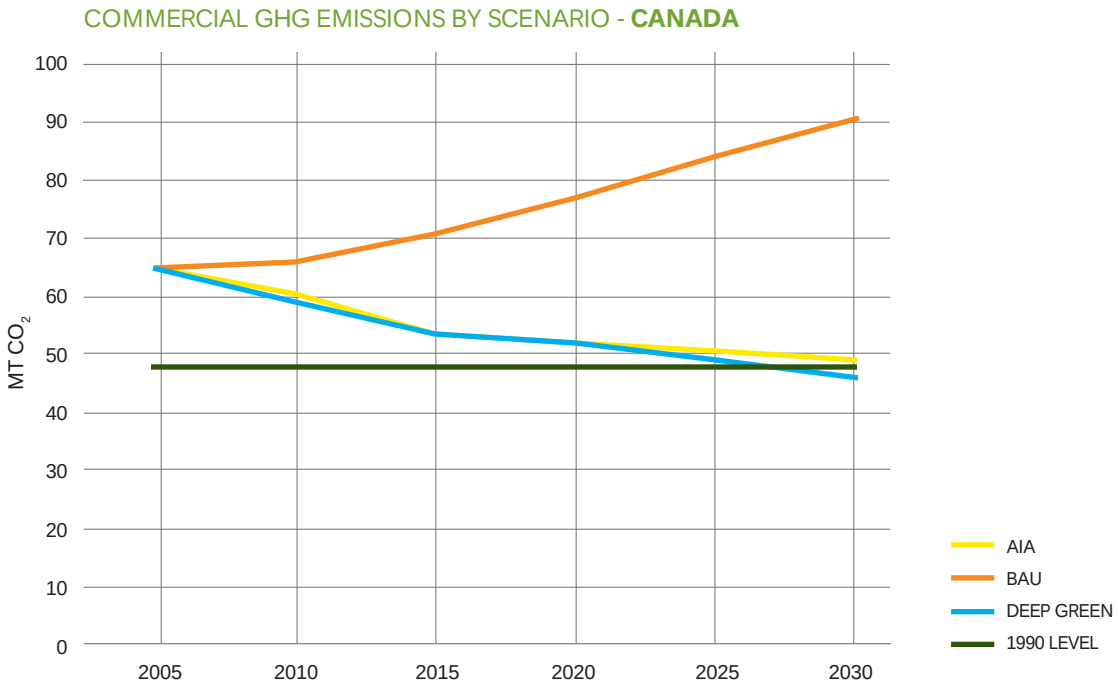
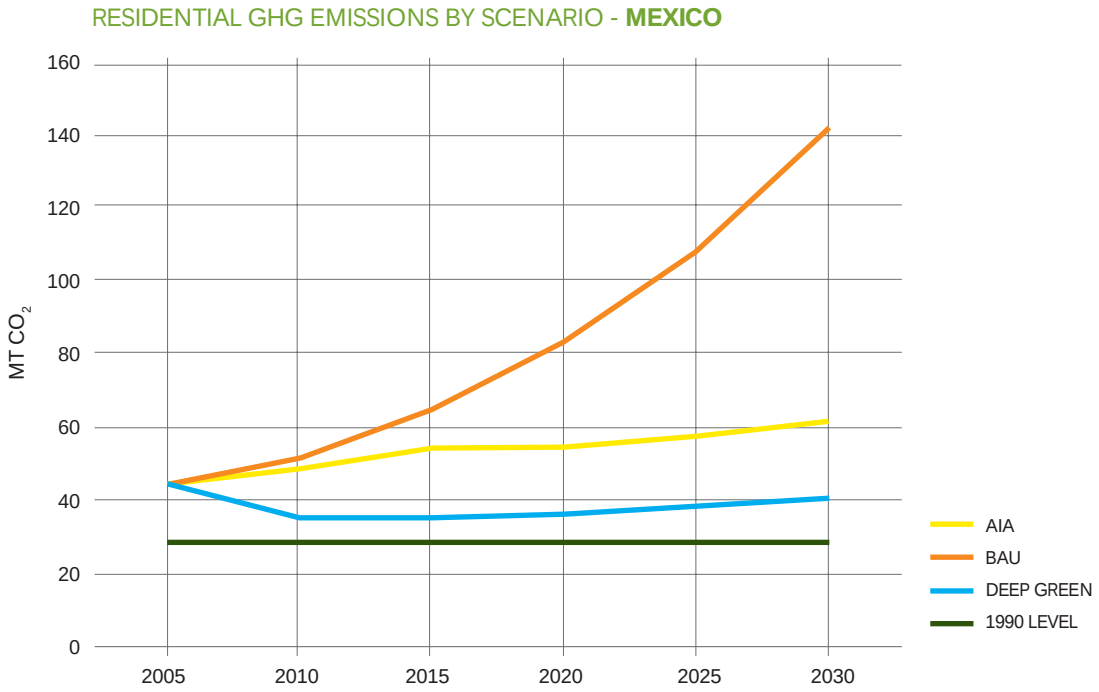


FIGURE C : MEXICO
Predictions by Scenario for Mexico's Residential and Commercial GHG Emissions



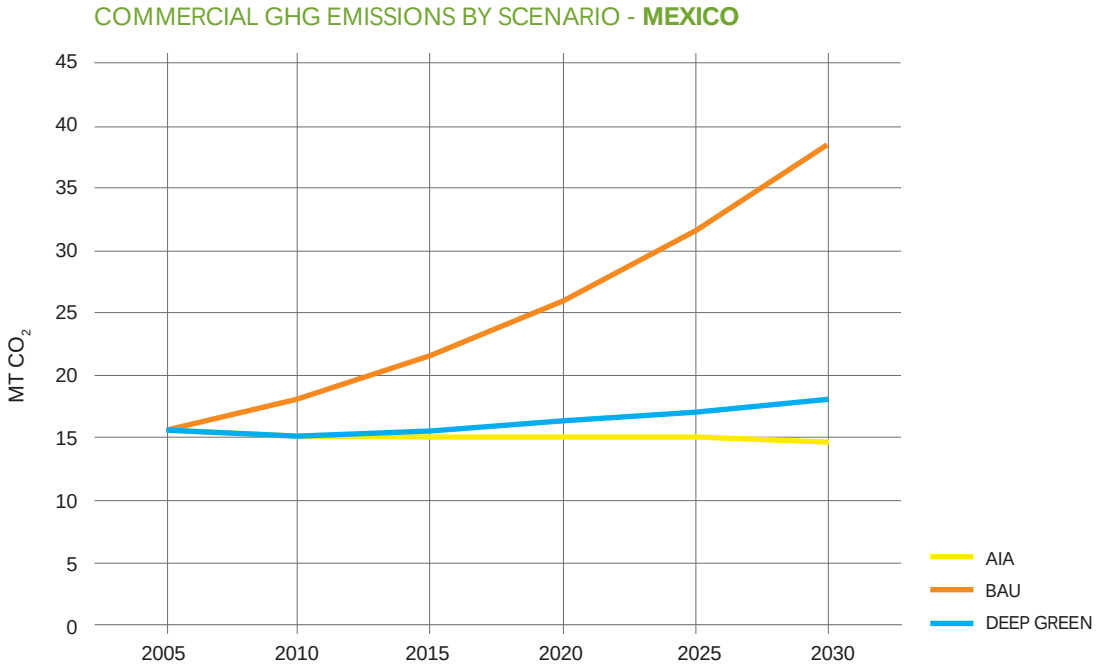
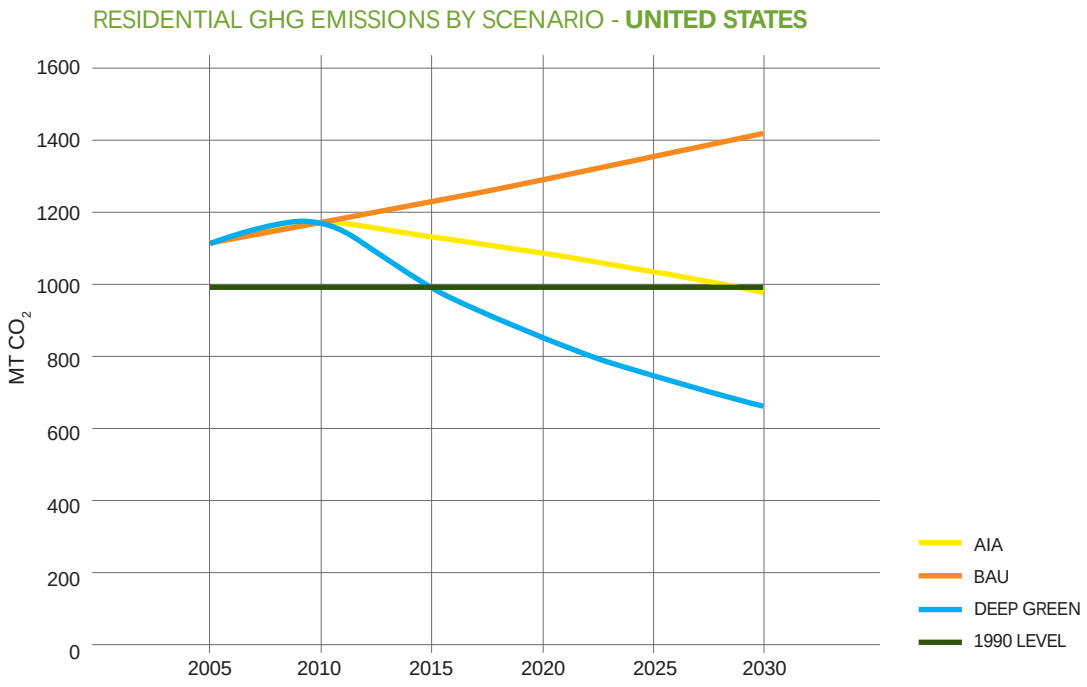
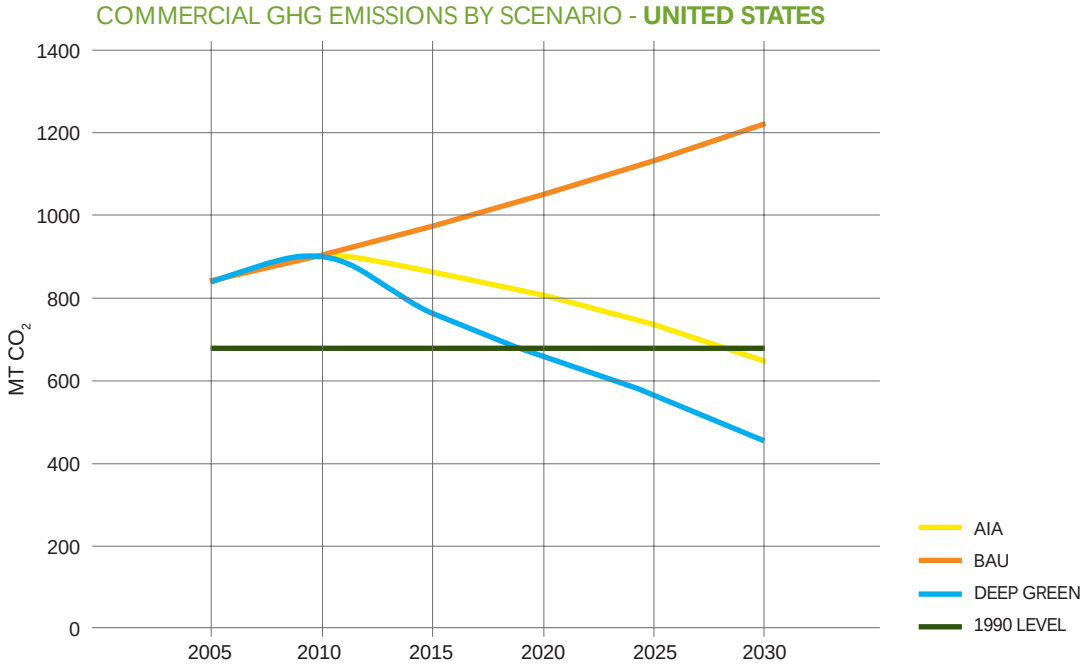


FIGURE D : UNITED STATES
Predictions by Scenario for US Residential and Commercial GHG Emissions





C. GENERAL CONCLUSIONS

The study underscores several important points:

1 Enormous energy improvements and greenhouse gas reductions in the building sector are possible using existing and emerging technologies. A rapidly increasing market uptake of currently available and emerging advanced energy savings technologies could result by 2030 in annual reductions of CO_2 into the atmosphere in North America of 1711 megatonnes, compared to a Business-as-Usual approach. This is nearly equivalent to the 1756 MT CO_2 emitted by the entire transportation sector in the United States in 2000.

2 Widespread use of ultra-efficient building materials and equipment, like those found in SE1 and SE2, coupled with improvements in design process, financing, construction and operations, will help pave the way for net zero-energy and carbon-neutral buildings by drastically reducing the amount of energy needed to run a building. With these dramatic reductions, renewable energy could provide the additional energy needs making the widespread adoption of net zero-energy and carbon-neutral buildings possible.

3 The challenge facing policy makers is how to establish the conditions needed for these significant changes to take place over a relatively short span of time. The technologies incorporated into the new and renovated SE1 and SE2 archetypes currently represent a small share of the market and the integration strategies and other process changes needed are not yet common practice.

4 Although the study indicates that the greatest energy improvements for individual buildings compared to conventional methods are in new construction, it underscores that, overall, the majority of potential efficiency gains in Canada and the United States lies in renovating or retrofitting the existing building stock. In Mexico, new construction represents the majority of efficiency gains.

5 The Deep Green and AIA or 2030 Challenge scenarios would allow the United States and Canada to reduce greenhouse gases produced by the building sector to below 1990 levels; in Mexico, greenhouse gas emissions would remain above 1990 levels because of the growth projected in the residential and commercial sectors.

LOUIS-CHARLAND BUILDING
MONTRÉAL, QUÉBEC

6 DRIVERS AND BARRIERS TO IMPROVEMENT

PHOTO: JEFF STOUB/CEC

6 DRIVERS AND BARRIERS TO IMPROVEMENT

WHILE THE CLIMATE CHANGE CRISIS HAS BEEN AN IMPORTANT FACTOR IN RAISING AWARENESS AND INTEREST IN GREEN BUILDING, THE SECTOR REMAINS RELATIVELY SMALL AND LARGE BARRIERS EXIST TO ITS RAPID EXPANSION IN THE MARKETPLACE.

A. MOMENTUM TOWARD GREEN BUILDING IN THE UNITED STATES AND CANADA

Significant momentum exists toward green building in the United States and Canada. Many in the real estate community are beginning to sense that green building represents a broad structural change in the market that demands a strategic response. This structural change results from increasing demand for green real estate and changing patterns of government policy and regulation that are leading to increased information on green building, better green materials, a more experienced construction industry, and enhanced efforts by nongovernmental organizations, the government, and the financial sector to promote green building.

MARKET FORCES

Economic forces are helping to drive these changes. Studies show that the cost premium to deliver sustainable properties to the market in the United States and Canada has declined considerably in recent years; they can be delivered at costs competitive with conventional buildings. In addition, case studies show that the life-cycle financial benefits of green design significantly outweigh the additional initial cost associated with green building.[30]

Corporations that drive building decisions through their selection of properties to lease and/or buy are showing great interest in green building.[31] In addition, private real estate investors have dramatically increased their interest in sustainable real estate. A number of green real estate investment funds have been formed, or are in formation. Major pension fund investors in Canada and the United States are targeting sustainable investments and major real estate investment trade associations are escalating their educational efforts to their members. Although green standards for single-family housing are relatively new and the market remains incredibly small at 0.3 percent, surveys indicate a marked increase in green residences certified under voluntary regional and national programs.[32]

30 See background paper 2b for a more detailed discussion.

31 In a May 2007 McGraw/Hill/Siemens survey of 190 corporate real estate executives (84 percent of which were CFOs or CEOs), 60 percent saw value in sustainability now and 88 percent expected to see value in three years. In an early 2007 survey of 300 corporate real estate executives at a Jones LaSalle/CoreNet summit in Asia, 64 percent of respondents expressed an interest in spending more for greater sustainability. Sources: Ben Breslau and Reic H. Fowles, "Sustainability Perspectives and Trends in Corporate Real Estate," Jones Lang LaSalle and CoreNet Gobal, 2007.

32 *Green Building Smart Market Report*, McGraw Hill Construction and USGBC, 2006. See <http://construction.ecnext.com/coms2/summary_0249-229622_ITM_analytics>.

In addition to the traditional rationale of cost savings and productivity benefits, reputation, recruiting benefits, and new sustainability reporting requirements promulgated by groups such as the Global Reporting Initiative and Carbon Disclosure Project are driving these changes. Other factors include corporate leadership from the World Business Council for Sustainable Development, the Climate Group, the United Nations Environment Program's Property Working Group and Sustainable Building and Construction Initiative, CoreNet Global (Corporate Real Estate Executive's primary trade group), and recent real estate decisions by many leading multinational corporations.

GOVERNMENT PROGRAMS

Government regulations and programs are helping to drive the market. These programs are generally driven in large part by a desire to save energy and water costs and to improve living and working conditions. Research presented in the background papers to this report shows how governments at all levels are working to address these, and other, obstacles to influence the uptake of green building through the integrated use of building codes, zoning regulations, tax-based incentives, and preferential treatment for green developers (such as fast-track permitting). In addition, green building practices are also being spurred by demand offset programs (in which a developer reduces energy and water demand as a condition of permitting), preferred purchasing, and government-supported research, development, educational programs, and tax shifting.

Federal, state, and provincial governments' preferred-purchasing policies in the construction, buying, leasing or renovating of buildings are helping to provide market pull by creating demand for new products and services and leading to the development of educational resources and tools that other consumers can use. In the past two years, the United States and Canada have set specific standards for sustainability and energy efficiency throughout their federal building stocks. For example, the Energy Independence and Security Act, adopted in December 2007, aims to cut energy use in federal buildings in the United States by 30 percent by 2015 and requires new and renovated federal buildings to significantly reduce their reliance on energy from fossil fuels. Compared with existing federal buildings, federal buildings built or renovated in 2010 must cut their fossil-fuel dependency by 55 percent and by 2030, new or renovated federal buildings must eliminate their use of fossil fuel energy.[33]

Many state, provincial, and local governments have also adopted or moved to adopt legislation to address environmental impacts of buildings. Municipal programs have helped accelerate the dissemination and use of green technologies through the use of local codes and programs. Most of these have required that public buildings meet minimum levels of green building design or performance; increasingly a number of jurisdictions have begun to impose green building requirements for private construction.

33 See <http://www1.eere.energy.gov/femp/sustainable/news_detail.html?news_id=11500>

Government and nongovernmental research programs and challenges are also extremely important in moving the market forward. The US EPA's Lifecycle Building Challenge is designed to encourage innovation toward buildings designed for adoption and disassembly with the aim of full recovery of systems, components, and materials.[34] The goal of the Living Building Challenge, developed and implemented by USGBC's Cascadia Chapter, is to create true sustainability in buildings. Examples of some of the 16 performance requirements are:

1. Net zero-energy—100 percent of the building's energy needs supplied by on-site renewable energy on an annual basis.
2. Net zero-water—100 percent of occupants' water use must come from captured precipitation or reused water that is appropriately purified without the use of chemicals.
3. Sustainable water discharge—100 percent of the storm water and building water discharge must be handled on-site.

Other performance requirements include materials selection and use, indoor air quality requirements, transport limitations and construction waste management.

B. MOMENTUM TOWARD GREEN BUILDING IN MEXICO

In Mexico, urban growth pressures, housing needs, corporate social responsibility strategies, and certain tourist developments are helping to build greater interest in green building. While in Mexico many buildings and residences already embody green building practices, such as energy efficiency and water conservation, the widespread institutional drivers that exist in the United States and Canada do not, for the most part, yet exist.

Mexico is facing tremendous urban growth pressures. Mexico City has seen an influx of 4.7 million people in the past 25 years, compared to 1.9 million in Toronto or 0.5 million in Houston. Other large cities located along the US-Mexico border, particularly on the Mexican side, have seen an even larger relative population increase. For example, Tijuana tripled its population between 1980 and 2005, while San Diego saw a 45 percent increase over the same period. In Canada, cities such as Toronto and Vancouver, where immigration drives growth, populations have increased more than 50 percent since 1986. In Mexico, per capita income and gross domestic product (GDP) are substantially lower than in the United States or Canada, compounding serious housing and infrastructure needs due to the accelerated population growth in urban areas.

The number of households in Mexico is projected to double by 2030. The government has set a goal of providing 1,000,000 new housing units per year by 2010 and continuing at that rate through 2030. This extraordinary growth will put enormous pressures on infrastructure and urban services, particularly in the hot and arid coastal and northern areas, where a significant portion of this new growth will occur.

34 See <http://www.epa.gov/region09/waste/solid/construction/lifecyclebuilding/>.

In Mexico, water availability is a national security issue. Eighty percent of the population lives in hot, arid environments. More than 20 percent of Mexico's housing units have no connection to municipal wastewater systems and almost 15 percent lack piped water. Estimates are that Mexico receives 3,845 cubic meters of water per inhabitant per year,[35] which is less than the 5,000 cubic meters per inhabitant threshold that the World Health Organization considers low.

The government is responding by instituting a number of efforts to promote the uptake of green principles and practices in the residential sector, particularly in housing developments with government involvement. Mexico's National Housing Commission (Conavi) has been documenting green practices and is working on defining criteria and regulations for homes to receive government subsidies to incorporate water and energy conservation technologies (such as thermal insulation and efficient lighting), and the use of solar energy for hot water, and on-site power generation.

Also, Infonavit, a large housing fund supported by mandatory employer and employee contributions, has created a "green mortgage" program ("hipoteca verde") that will increase the amount of credit available towards the purchase of a home and grant longer mortgage repayment terms for homes that integrate "green" elements. An example of the type of construction the government is trying is promote is the "casa ecológica," built in Ciudad Juárez in 2000.[36] Built as part of a social housing project for the climatic extremes of northern Chihuahua, it features the following bioclimatic innovations:

1. Solar chimney, to draw out hot air generated indoors.
2. Induction of fresh air taken from the outside and carried underground to the inside.
3. Ceiling heat trap to provide heating in winter, which allows heat generated during the day to be used at night.
4. Optimal façade orientation.
5. Water-saving devices in bathroom furnishings.
6. Energy-efficient lamps.
7. Greywater treatment.
8. Solar water heating panels.
9. Manual for proper system usage.
10. Housing system behavior monitoring.

These strategies are already being considered in large developments, such as Valle las Palmas in Tijuana, Baja California, where close to ten thousand homes for low income families will be built in the next decade.

35 See <http://www.fao.org/nr/water/aquastat/main/index.stm>.
36 Designed by the architectural firm of CONDAK – PULTE S. de R. L. de C.V., Armando Deffis C., contractor.

Mexico City currently is considering green building legislation, the first of its kind in Mexico. It allows developers to increase the construction potential between 140 to 210 percent on a site provided they implement energy and water efficient technologies.[37] In addition, both municipal and national officials are expressing an interest in the development of green building rating systems for Mexico.

The National Energy Savings Commission (*Comisión Nacional para el Ahorro de Energía*—Conae) recently began work to implement a solar water heater program. This initiative, along with green procurement guidelines, is sure to play a part in the process.

The tourism industry has great potential to introduce green products and build strong markets for green building. According to statistics from its Tourism Secretariat (Sectur), Mexico received 21.35 million international visitors in 2006. Revenue generated by these tourists reached a record high of US$12.18 billion. The Loreto Bay resort currently under development aims to produce more energy from renewable resources than it consumes, harvest or produce more potable water than it uses, and create more biodiversity, more biomass, and more habitat than existed on-site before development started. However, some observers have expressed concern that certain regions in Mexico will see a significant increase in vacation homes and tourist developments targeting people from the United States, Canada, and elsewhere, who will seek properties with air conditioning and other features that can drive up energy demand.

C. BARRIERS TO GREEN BUILDINGS

Despite momentum in all three countries, significant barriers impede green building growth and result in a tendency to rely on business-as-usual approaches. In Mexico, these barriers are further compounded by the lack of building regulations, codes, urban planning tools, and consensus-based, widely accepted green building rating systems.

Some of the barriers identified for all three countries are:

SEPARATE CAPITAL AND OPERATING BUDGETS

Many governments at the federal, state, and local level, as well as public and private institutions, appropriate funds for real estate acquisitions independently from funds for property operations. This separation creates an accounting scenario where the savings from the operation of green buildings is not used to offset any initial higher construction costs.

Understanding the life-cycle costs of a building is still a significant challenge. A building's initial construction costs typically may represent only 20 to 30 percent of the building's entire costs over its useful life, underscoring the need to consider not just the initial cost of the building but also the year-to-year operating costs. As well, owners of investment property typically evaluate construction and operating costs over a holding period of ten years or fewer.

37 *Proyecto de Norma de Ordenación General para la Producción de Vivienda Sustentable de Interés Social y Popular* <http://www.seduvi.df.gob.mx/programas/descargas/proyectosendesarrollo.pdf>. *Secretaría de Desarrollo Urbano y Vivienda del Distrito Federal.*

SPLIT INCENTIVES

Often the one paying the bill and the one capturing the benefits differ. A developer may not be interested in paying for green features when the benefits will be passed on to the new owners or tenants—unless, of course, he is able recoup the additional cost of green features in the sale price or project income realized. The split incentive problem is particularly evident for new homes and condominiums and for non-owner-occupied existing commercial buildings where, because of high turnover rates, owners may want short payback periods on energy-saving investments.

HIGHER PERCEIVED—OR ACTUAL—FIRST COSTS

Higher perceived or actual first costs of many green building strategies and technologies are a significant disincentive. A survey released in August 2007 by the World Business Council on Sustainable Development found that key players in the real estate industry overstated the cost of green building by an average of 300 percent, estimating the cost to be 17 percent above conventional construction, more than triple the cost estimated by the study's authors of 5 percent. Researchers interviewed 1,423 people in Japan, China, Brazil, the United States, Spain, France, and Germany.[38]

Another key cost barrier is the uncertainty that developers, real estate professionals, and some capital providers feel about green building. Developers and other decision-makers may have contractors, subcontractors, materials, and service providers lined up for traditional building or retrofitting; moving to green building may require new service providers, materials vendors, and the implementation of an integrated design process in order to build green at a comparable cost.

RISK AND UNCERTAINTY

Although investments and interest in green building are growing rapidly, for a number of complex and varied reasons, the financial case for green building has not yet firmly taken hold in the real estate and development community. Background paper 2b, *Toward Sustainable Financing and Strong Markets for Green Building: US Green Building Finance Review,* outlines the following risks that exist in the real estate community regarding green buildings:

- → Uncertainty over reliability of green building technologies;
- → Uncertainty over costs of developing of green real estate;
- → Uncertainty about the economic benefits of green real estate; and
- → Uncertainty about green building performance over time.

38 World Business Council for Sustainable Development. *The True Cost of Green Building,* <www.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MjU5NTM>.

The author notes that in the United States, while capital is beginning to move into green commercial real estate investment, "many green developers report that lenders and investors are reluctant to recognize additional investment value in green features with respect to energy cost savings or consumer appeal." Similarly, many commercial real estate lenders and investors feel that they are 'flying blind' when asked to assess the value of green commercial real estate projects, noting the lack of lending and investment guidelines dealing specifically with green buildings.

LACK OF EXPERIENCED WORKFORCE

One impediment cited repeatedly by many during the Secretariat's green building consultations but not explored well in the literature and research, is rapid industry expansion threatening to compound the problem of the lack of experienced workers and thus increasing the risk of inexperienced or untrained service providers entering the green building market in search of a premium on their services.

LACK OF COORDINATION AND CONSISTENCY IN GOVERNMENT POLICIES AFFECTING BUILDING

The background papers on the topic of *Institutional Efforts for Green Building* (topic 3) discuss how the lack of coordination and consistency in government policies can act as a barrier to green building. For example, building codes can hinder the use of alternative building materials and innovative design strategies, unintentionally require environmentally harmful practices, and fail to require environmentally preferable practices.

In terms of financial incentives, Canada lacks a comprehensive federal act directed at individuals like the Energy Policy Act in the United States and provincial efforts are not always well coordinated. In Ontario, for example, municipalities are not permitted to mandate any performance requirements *above* those required by the Ontario Building Code.

LACK OF RESEARCH INVESTMENTS

A recent report found that US funding for research related to green building practices averaged $193 million per year from 2002 to 2005. This represents only 0.02 percent of the estimated annual value of US building construction and 0.2 percent of all federal research.[39] Advances in green building research can result in significant consumer savings and a strong return on investments. The United States National Academy of Sciences found a number of remarkable returns-on-investments associated with green building features. For example, a DOE investment of $4 million in development of low-emissivity glazing yielded cumulative consumer cost savings of $8 billion through 2000. With electronic ballasts for fluorescent lighting, DOE invested $6 million and consumers realized cumulative savings of $15 billion through 2000.[40]

39 US Green Building Council, *Green Building Research Funding: An Assessment of Current Activity in the United States* (April 2007). See <http://www.usgbc.org/ShowFile.aspx?DocumentID=2465>.

40 National Academy of Sciences, 2001, *Energy Research at DOE: Was it Worth It? Energy Efficiency and Fossil Fuel Research, 1978-2000*. See <www.nap.edu/catalog.php?record_id=10165>.

ISSUES SPECIFIC TO MEXICO

In Mexico, policy initiatives to address energy use in buildings did not begin until the mid-1990s when the National Energy Savings Commission (Conae) promoted the design and implementation of mandatory energy efficiency standards for lighting and the building's envelope in non-residential buildings.

In practice, authority for building regulations lies with municipalities. Of the 2,500 municipalities, only 72 have their own building regulations. Absent local regulations, the municipalities use state regulations. In many cities (even in the largest ones) certain aspects of building regulations, such as those related to water and electrical systems, are not always fully enforced due to their quantity and technical complexity and the lack of capacity and unawareness of municipal officials. In general, building regulations in Mexico are highly variable from a topical and technical standpoint, and still lack the basic elements of a comprehensive or systematic focus for green building success (in particular, those that relate to energy efficiency and the use of renewable energy).

Lack of specific data on energy and water use in buildings has been a significant issue, as it tends to make policy initiatives and benchmarking of building performance more difficult. In addition, the fact that the Federal Electricity Commission (*Comisión Federal de Electricidad*—CFE) classifies a large part of electricity consumption in commercial buildings—offices, hospitals, schools, shopping centers, hotels and department stores—as industrial (reporting them accordingly in the national energy reports), leads to a significantly diminished importance of these buildings in energy consumption records, and thus is a major barrier to awakening interest in specific policy initiatives and independent certification.

An especially important issue in Mexico is the limitation of land use planning and real estate tax assessment, which lack environmental criteria, such as building height restrictions, densities, etc., necessary to attain green building objectives. Green housing regulations have been regarded as a driving factor, though they are still in the early draft stages. Initially, these regulations will apply only in the Federal District, which will cause disadvantages vis-à-vis other metropolitan areas in Mexico.[41]

Finally, another factor is that although buildings use electricity, their air quality impacts are not always well understood by local authorities because the power generation sources may come from outside their communities. However, climate change concerns and Mexico's international commitments and its large dependence on fossil fuels for power generation have made policy-makers there more aware of the importance of the energy and environmental impacts of buildings.

41 See <http://www.funtener.org/importayconsumo.html>.

CARNEGIE INSTITUTION FOR SCIENCE,
DEPARTMENT OF GLOBAL ECOLOGY
PALO ALTO, CALIFORNIA

7 PROMOTING MUTUALLY BENEFICIAL COOPERATION

PHOTO: PETER AARON/ESTO

7 PROMOTING MUTUALLY BENEFICIAL COOPERATION

The relative newness of green building efforts presents an opportunity for the three countries to work together to improve the building sector. The building industry is changing rapidly. Product standards are increasingly international, with ongoing efforts to harmonize performance metrics across national boundaries. Building components designed in the United States may be manufactured in Mexico and assembled on-site in Canada.

These types of changes underscore the benefits that can come from a North American effort to share resources and information, to promote international trade in environmentally-preferable building products and proven-yet-underutilized technologies, to support eco-labeling programs, to pursue joint research opportunities, and to disseminate research and training information. For example, work could be done to contribute to and harmonize Canadian, Mexican, and US building data via existing life-cycle inventory databases, analyze building material trade flows among the countries, support bioregional mapping efforts for use by standards developers in regionalizing national rating systems, develop life-cycle scenario modeling for building products, explore opportunities for reuse and recycling of construction debris among the countries, and promote technology and knowledge transfer among all three countries.

This effort can help strengthen the economies of North America by spurring new markets and business opportunities for manufacturers, utilities, and other companies. The rest of the world is moving forward. Europe has strong green building programs and segments of Asia and Latin America are beginning to embrace it. In December 2006, the United Kingdom announced its goal that, by 2016, all new homes will be net zero-energy buildings,[42] while Swedish residents are aiming to cut their GHG emissions in half by 2050[43] and municipalities are switching off oil-based heating even on the darkest days of winter.[44] Asian economies are undertaking actions: LEED-India recently certified its first government sector green building by incorporating an evaporative cooling technique[45] and China, the world's largest construction market, adopted a new design standard mandating energy-saving technologies in public buildings.[46] The world's biggest solar energy producer is Germany, a country not known for sunny, hot weather.

Green building will help ensure North American competitiveness in the global market for products, technologies, and practices essential to North America's future. Such products, technologies, and practices include heating and cooling systems, advanced building materials, water-reclamation systems, high efficiency appliances, energy efficient lighting, construction and demolition debris recycling, and many more.

42 See <http://aec.ihs.com/news/uk-tech-guidance.htm>.
43 Climate policy, see <*http://www.sweden.gov.se/sb/d/5745/a/21787*>. Government Offices of Sweden.
44 Swedish municipalities going fossil fuel free, *Post Carbon Cities*, 20 June 2007, see <*http://postcarboncities.net/node/261*>.
45 IGP Office, Gulbarga – India's first green building in the government sector. GreenHabitat, September 2007, <*http://www.igbc.in/igbc/mmbase/attachments/1651/Green_Habitate_newsletter.pdf*>.
46 China pushing for energy-efficient buildings. Worldwatch Institute, 25 January 2007. <http://www.worldwatch.org/node/4874>.

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ANNAPOLIS, MARYLAND

8 RECOMMENDATIONS FOR NORTH AMERICA

PHOTO: PRAKASH PATEL

8

RECOMMENDATIONS FOR NORTH AMERICA

With these drivers and barriers, regional variations, and global changes pushing and pulling the markets in different directions, what can North American leaders do to help ensure green building becomes standard practice in North America?

As part of the development of this report, the CEC Secretariat's Green Building Advisory Group issued a Statement and Advice on Recommendations for the Secretariat.[47] This advice sets forth a specific path for how North America can accelerate the market uptake of green building and make it the standard practice for all new and existing buildings. The CEC Secretariat has adopted the Advisory Group's advice as its recommendations for this report.

Today, there is strong and increasing momentum supporting green building. These recommendations are designed to support and build on the efforts already underway in North America at the federal, state/provincial and local governmental levels, as well as among the many industry, trade and nongovernmental organizations. Efforts to implement these recommendations should begin right away and should not be cause for delaying or slowing any ongoing federal, state/provincial or local initiatives. Building decisions made today will have consequences that last for generations.

With strong leadership, a clear vision, and the right mix of policies and practices, North America can make green building standard practice for all new and existing buildings. There is today strong and increasing momentum supporting green building. We must capitalize on that momentum.

47 The Advisory Group's statement is found in the appendix. The entire Statement and Advice on Recommendations can be found at <www.cec.org/greenbuilding>.

THE SECRETARIAT'S RECOMMENDATIONS ON MAKING GREEN BUILDING STANDARD PRACTICE IN NORTH AMERICA

Our top recommendations are to develop: 1) a common vision for green building in North America, 2) targets for enhancing building performance, and 3) strategies for helping to drive profound change in the North American building sector.

1. Develop a Lasting and Achievable Vision

North American government, industry and nongovernmental leaders should work together to develop a lasting and achievable vision for green building in North America. This vision could help drive targets and strategies for green building and could result in the creation of a common set of principles and planning tools for green building, with each country having region/context-appropriate policies and programs to address differences in building codes, regulatory environments, climate, and economic and social conditions.

1.1 Adopt a vision. Our vision is that green building will evolve to be not only a way to "do less bad" environmentally, but into a continuous process for creating materials, buildings and communities which are healthy, restorative, and regenerative and for strengthening the economic, environmental, and social fabric of North America.

1.2 Work toward the vision. We recommend the creation of multi-stakeholder national task forces in each of the CEC countries, coordinated nationally by the environment or other appropriate ministry of each country and linked internationally through a cooperative mechanism such as the CEC, to promote aggressive and consolidated national approaches for accelerating the achievement of this vision at the North American level, with united and integrated participation of representatives of all components of the building sector.

2. Set Targets to Enhance Performance

North American leaders should set clearly defined targets, with the goal of achieving the most rapid uptake of green building possible in North America. These targets will help drive performance by providing a means to measure progress toward a stated vision.

2.1 Set aggressive, realistic targets for carbon-neutral buildings. We recommend that national and subnational governments in North America set aggressive and realistic targets to reach carbon neutrality for all buildings, new and existing, understanding that the timeframe for achieving these targets may differ regionally or nationally based upon political, economic, and environmental considerations. We applaud and support the action of the more than 500 cities in the United States that have signed the United States Conference of Mayors' Climate Protection Agreement and those who have adopted the carbon–neutral building targets set forth in the American Institute of Architects and the Royal Architectural Institute of Canada's "2030 Challenge." We recommend that Canada and the United States adopt targets at least as strong as the targets in the 2030 Challenge. Noting that buildings in Mexico currently have a lower unit carbon footprint than those in Canada and the United States, and that the 2030 Challenge does not yet have institutional recognition in Mexico, we recommend that Mexico adopt the most aggressive target practicable for carbon-neutral buildings.

2.2 Conduct modeling and set targets for other environmental parameters. Noting the critical importance of environmental challenges in addition to energy and climate change, we recommend that modeling similar to that presented in the CEC background studies for greenhouse gas reductions associated with green building be used to establish aggressive and technically-achievable targets for other environmental parameters, such as water, land conversion, use of environmentally-preferable materials, embodied energy and waste loads. These targets should aim to:

- → meet water needs within the capacity of local watersheds;
- → maximize urban renewal and development of brownfields and minimize conversion of undeveloped or agricultural land;
- → ensure that non-renewable materials are 100 percent recycled;
- → minimize embodied energy in buildings; and
- → eliminate emissions of toxic substances into the air, water and land.

2.3 Monitor performance to support continual improvement. We recommend that national and subnational governments implement monitoring and testing protocols to track progress on achieving these targets for green buildings and to gather information to support continual improvement in implementation and policy development, including any necessary changes to targets and to policy and regulatory approaches. Results of monitoring should also be used to enhance the foundation for life-cycle analysis and costing of buildings.

3. Implement Strategies to Drive Change

North American leaders should implement an integrated set of strategies to transform the market to push for accelerated, continuous uptake and improvements in green building. We acknowledge the growing government and private sector activity in support of green building throughout North America and the progress made to date, and make the following recommendations with a view to enhancing, accelerating and integrating those efforts.

3.1 Promote private sector financing and proper valuation methods. We are convinced that the net benefits of developing green building should be sufficient to attract existing capital at market prices for green building. We recommend that governmental and private sector leaders, with appropriate support from independent nongovernmental organizations:

- cooperate to promote the development and adoption of life-cycle assessment and costing tools that integrate capital and operating budgets;
- pioneer special financing vehicles, performance contracts, guarantees and leasing arrangements that favor green building and remove barriers such as "split incentives," long payback periods, and other risks and uncertainties;
- support efforts to develop fundamental valuation and underwriting information, methods and practices for the proper valuation of green building; and
- support the gathering and analysis of post-occupancy financial and environmental information that will improve knowledge of green building features and financing.

3.2 Raise awareness and knowledge through research and development, capacity building and outreach. Transforming the market requires raising the level of awareness and knowledge of building design, engineering and construction professionals, developers, building owners and users, investors, building valuation and finance experts, academics, and government officials at all levels about the vision, targets, and strategies for green building and on the particular benefits of integrated design and other issues that green building may raise for each of these market actors. We recommend that government and nongovernmental leaders promote awareness and knowledge of green building practices and benefits, by:

- making a strong commitment to a comprehensive and integrated program of research, development, and demonstration on green building topics;
- funding and conducting training, outreach, and education campaigns;
- developing partnerships involving government, the building and development sector, academic institutions, and nonprofit organizations; and
- supporting the use of labels and disclosures on green building performance.

These efforts are particularly important for Mexico, considering its urgent need for affordable housing and the need for widely-recognized green building rating systems and a nationally-coordinated framework that will build on and support existing Mexican policies and programs that favor green building.

3.3 Lead by example. As significant market actors in building, buying, renovating and leasing building space, governments should play an important role in shaping the development of the market for green building in North America, at the same time achieving both significant environmental benefits and long-term cost savings on behalf of North American taxpayers. We recommend that government at all levels build on their progress to date and, as swiftly as possible, adopt comprehensive and ambitious policies requiring all government procurement in the building sector to achieve high levels of green building performance, with a firm commitment to continual improvement over time.

3.4 Push for continual improvement in policy. Governments at all levels should engage the private sector and civil society in instituting a cycle of policies and programs that support continued market development of green building, with a view to accelerated expansion of green building to the entire building sector. These policies and programs must address not only energy consumption, but also water, waste, land use, and other issues in both new and existing buildings.

We recommend that:

- → The national governments, with appropriate coordination with sub-national levels of government, should adopt new, or enhance existing, national policies and laws that will support the fastest possible uptake of green building, including mechanisms that create incentives for green building.
- → Governments at all levels should enhance the authority of municipal authorities to adopt and implement coherent, comprehensive and integrated policies and codes to promote or require green building and high energy performance in the private sector.
- → Existing policies and regulations on energy efficiency and green building should be fully implemented and enhanced periodically as technology advances and sector performance improves.
- → Tax and other financial incentives for green building be based on proof of performance, as opposed to amount of investment.
- → Graduated utility rates that encourage conservation and penalize excessive consumption should be utilized as well as non-tax incentives such as expedited permitting, priority plan review, density bonuses, preferential lending and insurance rates and preferential waivers for green building projects.
- → Effective mechanisms to monitor implementation of policies and codes related to green building should be developed and enforced.
- → Over time, government should emphasize the appropriate use of mandates in addition to incentives, with a view to continual advancement toward green building targets and performance.

We also recommend the development and use in each country of comprehensive, rigorous green building rating and certification systems, with a view to integrating them into government policies, programs, and mandates. Government and civil leaders should cooperate to compile and continually update information on best practices and policies on green building, and promote dissemination and use of this information.

It is critical that all policies and programs related to green building be integrated with comprehensive urban development programs geared toward development of sustainable communities, with emphasis on integrating green building with sustainable urban infrastructure for transportation, gas and electric utilities, potable water, waste disposal and recycling, storm water and wastewater management and sewage. This requires special attention to extending green building to the many areas in North America facing shortages in affordable housing, including those with climatic conditions or other circumstances that present unique challenges.

3.5 Promote North American and global cooperation. The CEC and other organizations are well-placed to promote cooperation on green building at a North American level. We recommend that the governments of Canada, Mexico, and the United States engage the CEC and other appropriate organizations to promote North American use of green building materials, equipment, and services and joint or coordinated research on priority topics related to green building. The three countries, through the CEC and other appropriate organizations, should:

- → support the exchange of data and information on green building in North America, with a focus on facilitating the exchange of ideas and best practices among North American municipalities;
- → facilitate linkages between the North American region and other regions of the world in regard to best practices and policies on green building; and
- → promote cooperation on education and training information to enhance private and public sector knowledge of green building in North America, with a special focus on and increasing knowledge, expertise, and awareness of green building practices, programs, and policy approaches in Mexico by building upon existing mechanisms, capacity, and programs.

APPENDIX: ADVISORY GROUP STATEMENT

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(Excerpted from Advisory Group Statement and Advice on Recommendations, CEC's Green Building in North America Study, 8 November 2007)

PREAMBLE

We are standing on the threshold of the largest opportunity in human history to increase significantly the quality of life for all citizens of North America and the vitality of our social, economic and environmental systems.

North America is facing unprecedented challenges in areas such as climate change, concerns regarding the security of energy supplies and the depletion of water and natural resources.

These challenges are not insurmountable. Canada, Mexico and the United States have the resources, wealth and ingenuity to overcome these challenges and create a sustainable, healthier and more productive North America.

Success, however, will require a fundamental shift in the way we think about our environment. At the heart of this thinking should be a plan to make green building a foundational driver for change in North America.

Green building is a generic term that refers to the use of environmentally-preferable practices and materials in the design, location, construction, operation, re-use and disposal of buildings. It applies to both renovation and retrofitting of existing buildings and construction of new buildings, whether residential or commercial. Green building is a key component of building healthy, vibrant and economically strong communities.

We note that the CEC uses the term "*edificación sustentable*" as the Spanish translation of "green building," although a more precise translation of "*edificación sustentable*" may be "sustainable building." Sustainability generally encompasses environmental, economic and social aspects. While the focus here is on environmental aspects of building, we emphasize that to be sustainable, building must also account for economic and social concerns.

THE URGENCY OF GREEN BUILDING

Green building designers and builders are already creating buildings that dramatically lower energy consumption, use renewable energy, conserve water, harness natural sources of light and ventilation, use environmentally preferable materials, minimize waste and create healthy and productive environments. Examples highlighted in the CEC report and portfolio of green buildings in North America, and in a growing body of other information sources, demonstrate the potential of green building to achieve these benefits on a wide scale.

For example, a large state office building in Jefferson City, Missouri uses highly efficient mechanical systems, advanced building envelop design, lighting with sensors and photovoltaic roof collectors, resulting in 59% more energy efficiency than a conventional building.

The museum and visitor center at the Xochicalco archeological site in Mexico uses 100 percent on-site solar power and is self-sufficient for water nine months of the year. A university research facility in Vancouver, British Columbia needs no sewer connection, employing wastewater reduction strategies to cut waste by 90 percent.

Despite clear benefits, green building represents only a very small portion of the North American building market. One key barrier to greater uptake of green building is the predominant practice of separating capital and operating budgets instead of using life-cycle budgeting.

There is also a tendency to rely on Business-as-Usual approaches in view of the perceived cost, risk and uncertainty of green building. Other barriers include limited awareness and knowledge of green building and lack of coordination and consistency in government policies for building. Change will require significant and sustained action, not just by individuals, but by all sectors of society.

The risks of not acting are too great. These risks include climate change crises with the potential for catastrophic events; continued and worsening energy dependency with attendant security implications; serious water shortages in several regions in North America; loss of economic vitality and competitiveness; and threats to human health and quality of life.

Green building is an essential, potent tool to combat all of these problems. We are convinced, for example, that green building is one of the quickest and cheapest ways to address climate change, with the potential to reduce significantly greenhouse gas emissions. We note the following:

- According to the United Nations' Intergovernmental Panel on Climate Change, buildings represent the greatest opportunity for considerable reductions in CO_2 emissions, with net economic benefit;
- A report by an international consulting firm indicates that building energy efficiency measures are some of the most cost-effective and cheapest ways to reduce carbon emissions worldwide. The report also notes that these measures would require no reduction in quality of life or comfort. In our view, many of these measures in fact would increase our quality of life and public health;
- Background research undertaken in connection with the CEC Secretariat's report on green building finds that with aggressive market uptake of existing and emerging technologies and methods for construction, renovation and retrofitting of buildings, enormous reductions in energy use and greenhouse gas emissions from new and existing buildings are technically achievable by 2030.

Green building will also help ensure North American competitiveness in the global market for products, technologies and practices essential to North America's future. Such products, technologies and practices include heating and cooling systems, advanced building materials, water-reclamation systems, high efficiency appliances, energy efficient lighting, advanced insulation systems and many more.

BUILDING TODAY IN NORTH AMERICA

Buildings have a massive economic and environmental footprint. Every day we learn more about how the design, location, construction and operation of buildings deeply impact economic productivity, human health and our natural world.

Currently, over 125 million commercial and residential buildings exist in Canada, Mexico and the United States. In the United States alone, the total built floor space covers over 27 billion square meters, or more than five and a half times the size of Grand Canyon National Park. Just within Mexico City, there are more than 3 million meters of high quality commercial office space, an area more than 170 times larger than the city's zócalo square.

Every year several million new buildings are constructed on the continent. In Canada, more than 123,000 new single-family homes were built in 2006. In the United States, an average of 1.24 million single-family homes are built every year. Mexico projects an average of one million new homes every year for the next twenty-five years.

Building—including material manufacturing and shipping, design and engineering jobs, construction, real estate, facilities management, and investments in buildings—comprises a significant part of the economies of Canada, Mexico and the United States. According to the Organization for Economic Cooperation and Development, the building and construction industry typically represents 5 to 10 percent of total employment and 5 to 15 percent of national gross domestic product.

In Mexico, Canada, and the United States, commercial and residential buildings account for about 23 percent, 30 percent, and 40 percent of energy consumption, respectively. Every year, buildings in North America cause more than 2,200 megatons of CO_2 to be released into the atmosphere, about 35 percent of the continent's total CO_2 emissions. That makes the building sector one of the leading contributors of greenhouse emissions in North America. Canada's residential building sector is responsible for approximately 80 megatons of CO_2 emissions annually and its commercial building sector for approximately 69 megatons of CO_2.

In the United States, residential buildings account for approximately 1,210 megatons of CO_2 per year while commercial buildings are responsible for approximately 1,020 megatons of CO_2. In Mexico, residential buildings account for approximately 42 megatons of CO_2 emissions annually, while commercial buildings are responsible for approximately 20 megatons of CO_2. In 2001, the carbon associated with energy services to United States buildings alone constituted 8 percent of total global emissions of CO_2, equal to all emissions from Japan and the United Kingdom combined.

Buildings contribute significantly to the use of key resources such as energy and water. For instance, in the United States, building operations consume 12 percent of fresh water supplies. In Canada, the building sector consumes half of all natural resources used and generates a quarter of all landfill waste. Worldwide, buildings consume around 40 percent of all raw materials.

Poor indoor air quality exacerbates asthma, allergies and the spread of flu, and is the cause of sick building syndrome and illnesses such as legionnaire's disease. In the United States, the annual cost of building related sickness is estimated to be $60 billion. According to researchers, green building has the potential to generate an additional $200 billion annually in worker performance improvements by creating offices with better indoor environmental quality, including air and natural light.

Beyond individual buildings, our patterns of development also often lead to congestion and inefficient land use, which results in greater energy consumption and travel times, loss of productivity, polluted runoff to streams and waste water treatment systems, loss of agricultural lands, fragmented habitats, and fiscal stress on local communities.

With strong leadership, a clear vision, and the right mix of policies and practices, North America can make green building standard practice for all new and existing buildings. There is today strong and increasing momentum supporting green building. We must capitalize on that momentum.

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