Key Elements of Green Design
What is Green Design?

“Green building is the practice of increasing the efficiency with which buildings use resources - energy, water, and materials - while reducing building impacts on human health and the environment during the building’s lifecycle, through better siting, design, construction, operation, maintenance, and removal.”  

The ultimate goal of a green design is to achieve sustainability and open up new opportunities to design and build structures that use less energy, water and materials, and minimize impacts on human health and the environment.

Green design incorporates environmental considerations into every stage of a building’s life – from the earliest planning through site development, design, construction, operation and maintenance and, eventually, decommissioning, reuse or disposal. It involves countless decisions about materials, systems and methods.

Green design embodies a holistic, integrated and multidisciplinary approach in which every decision is evaluated against multiple criteria to find the best solution. As the understanding of green design has increased in sophistication over the last two decades, the strategies adopted have evolved, and the quantitative performance of buildings has improved.

Basics of Sustainable Development

Green design fits within the overarching objective of global sustainable development, as defined by the 1992 World Commission on Environment and Development (the Brundtland commission):

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

To achieve this objective, it is necessary to practise environmental stewardship and manage renewable resources responsibly to meet the growing needs of the planet. Sometimes this means using less, and often it means choosing naturally renewable products that have a lighter footprint and come from responsibly managed and sustainable sources.

Also fundamental to sustainable development is the consideration and evaluation of all the potential impacts of buildings, whether economic, social or environmental.
Constructing and operating buildings has an immense environmental impact. Globally, buildings are responsible for 20 per cent of all water consumption, 40 per cent of all energy use, up to 30 per cent of greenhouse gas emissions and 30 per cent of solid waste generation.²

The extraction and processing of raw materials for use in buildings is also a significant cause of environmental degradation, and these materials can be a major source of the environmental contaminants that contribute to health problems for building occupants.

Building professionals can reduce impacts on the environment and human health in key areas, including:

- **Site design:** Green design encourages the use of building sites that maximize passive solar heating and cooling, conserve natural resources such as trees and wildlife habitat, and minimize soil disturbance and erosion. Both location and design can encourage the use of alternate transportation methods such as mass transit, cycling and walking.

- **Water quality, conservation and efficiency:** Green design uses on-site mechanisms such as rainwater harvesting, water-conserving fixtures, waste water treatment and recycling, green roofs and controlled storm water discharge. This ensures water is used efficiently, and reduces the burden on municipal or other infrastructure to supply potable water, collect and discharge storm water, and treat and dispose of waste water.

- **Energy efficiency and renewable energy:** Green design addresses building massing and orientation, and may incorporate high levels of insulation, capture of heating and cooling energy from geothermal or other natural sources, renewable energy installations (such as photovoltaics, biomass, wind turbines or solar hot water heating systems), energy-efficient equipment and appliances, careful envelope design to harvest daylight, and the use of solar shading devices, daylight and occupancy sensors.

- **Conservation of materials and resources:** Green design considers the environmental impacts of materials and products across their entire life cycle. It gives preference to those with low environmental impact and embodied energy in their extraction or manufacture; that are self finished, non-toxic, multi-functional, durable, and easily salvaged and recycled at the end of a building’s service life.

- **Indoor environmental quality:** Green design aims for high levels of natural ventilation and daylight in all occupied areas of the building. It also strives for high indoor air quality through construction protocols aimed at eliminating airborne and surface contaminates, and through the specification of materials that contain no chemicals or compounds harmful to human health.


Regenerative Design is an emerging alternative to current design and construction practices. While green buildings try to reduce harmful environmental impacts, regenerative buildings seek to go beyond that by improving both the natural environment and the lives of their human inhabitants.

Centre for Interactive Research on Sustainability (CIRS), University of British Columbia, Vancouver, B.C.
Architect: Perkins+Will Canada Architects Co.
Photo: Don Erhardt
Let government regulators, building professionals and consumers embrace green building with confidence. In some cases, codes are written so local governments can adopt them as bylaws to reduce the local environmental impact of buildings.

Green building codes are legal requirements that mandate prescriptive or performance requirements as part of building codes. Two examples are:

- CALGreen (California’s Green Building Standards Code)
- International Green Construction Code (USA)

Green building rating systems are voluntary certification programs that award points for prescriptive or performance requirements. Two examples are:

- LEED (Canada, USA)
- Green Globes (Canada, USA)
The choice of products used to build, renovate and operate structures of all types has a huge impact on the environment, consuming more of the earth’s resources than any other human activity, and producing millions of tonnes of greenhouse gases, toxic emissions, water pollutants and solid waste.

Obviously, building with the environment in mind can reduce this negative impact. But to be effective, decisions need to be based on a standardized, quantified measurement system that allows an impartial comparison of materials and assemblies over their entire lives. Prescriptive approaches to green design often focus on a single characteristic, such as recycled content, with an assumption it will yield the greatest environmental advantage.

The most widely accepted scientific method to compare design choices and building materials effectively is life cycle assessment (LCA). It has existed in various forms since the early 1960s, and the protocol for completing life cycle assessments was standardized by the International Organization for Standardization (ISO 14040-42) in the late 1990s.

What is Life Cycle Assessment?

Life cycle assessment is a performance-based approach to assessing the impacts building choices have on the environment. LCA can be used to analyze potential impacts of a product or structure at every stage of its life, including:

- fossil fuel depletion
- other non-renewable resource use
- global warming potential
- water use
- acidification
- stratospheric ozone depletion
- ground level ozone (smog) creation
- eutrophication
- hazardous and non-hazardous waste

Life cycle assessment is accepted around the world as a way to evaluate and compare the environmental impacts of different building materials, products and complete structures over their lifetime – from resource extraction through manufacturing, transportation, installation, building operation, decommissioning and eventual disposal.

It enables an objective comparison to be made between alternate materials and assemblies over their lifetime, based on quantifiable indicators of environmental impact. Life cycle assessment clarifies the environmental trade-offs associated with choosing one material over another and, as a result, provides an effective basis for comparing alternate designs in a specific geographic location.

Designers can make informed environmental decisions using life cycle assessment tools such as BEES (Building for Environmental and Economic Sustainability) and the Athena Impact Estimator for Buildings or EcoCalculator. BEES evaluates the environmental performance of individual products whereas the Athena software tools deal primarily with whole building design.

Since its inception in 1997, the Athena Sustainable Materials Institute has focused on bringing rigorous quantification to the pursuit of sustainability in the built environment. Athena works with product manufacturers, trade associations, green building associations, and architectural and engineering firms to help quantify environmental impacts and to demystify and assist teams with LCA.
Life Cycle Assessment and Wood

Life cycle assessment studies worldwide have consistently shown that wood products yield clear environmental advantages over other building materials. Wood buildings can offer lower greenhouse gas emissions, less air pollution, lower volumes of solid waste and less ecological resource use.

A comprehensive review of scientific literature looked at recent research done in Europe, North America and Australia pertaining to life cycle assessment of wood products.1 It applied life cycle assessment criteria in accordance with ISO 14040-42 (now combined into ISO 14044) and concluded, among other things, that:

- Fossil fuel consumption, the potential contributions to the greenhouse effect and emissions to air and water are consistently lower for wood products compared to competing products.
- Wood products that have been installed and are used in an appropriate way tend to have a favorable environmental profile compared to functionally equivalent products made out of other materials.

The environmental performance of the WIDC building, compared to the baseline building, was reduced by 10% or more in six of the seven reported categories, when both operational energy use and materials were considered. Eutrophication potential was the only category which did not improve by more than 10%. When considering impact contributions from materials alone, environmental performance improvements for WIDC were 10% or more for all environment indicators compared to the baseline building. Environmental performance differences between the two buildings were largely due to differences in the structural system used (wood versus concrete).

Results from the LCA suggest that multi-storey office buildings with mass timber structural systems and LVL curtain wall structures such as WIDC can outperform reinforced concrete structural systems with aluminum curtain wall structures in terms of environmental impact.

Wood Reduces Environmental Impact of Buildings

When assessing building material sustainability, it is not enough to just look at recycled content. Its complete environmental profile should be taken into consideration. That is best achieved by using life cycle assessment (LCA).
The Importance of Energy

As much as one third of the energy produced in North America is used to heat, cool and operate buildings. Since much of the energy consumed to build and operate buildings comes from burning fossil fuels, this releases a significant amount of greenhouse gases.

Types of Energy
Three types of energy are considered through life cycle assessment:

- **Initial embodied energy** – The energy required to extract and process raw materials, fabricate or manufacture them into building components, transport them to site, and install them into the building.

- **Recurring embodied energy** – The energy required to maintain, upgrade or replace, and eventually dismantle and dispose of, materials and components throughout the service life of the building.

- **Operating energy** – The energy required to heat, cool, and ventilate the building, and provide hot water, lighting and power for services and equipment on an ongoing basis.

Wood is low in embodied energy. It’s produced naturally and requires far less energy than other materials to manufacture into products. Much of the energy used to process wood in Canada, such as the energy needed for kiln drying, also comes from renewable biomass, including chips and sawdust – a self-sufficient, carbon-neutral energy source.

Energy Consumption in Buildings

Wood has low thermal conductivity and good insulating properties, and light wood-frame technology lends itself readily to the construction of buildings with low operating energy.

A study conducted for the Canadian Wood Council\(^1\) compared the environmental impact of a typical wood-frame house to that of similar houses built with steel or concrete poured into insulated forms. It looked at the total embodied and operating energy consumed over a 20-year period for each building type. Compared to wood construction, steel and concrete embody and consume 12 per cent and 20 per cent more energy, and emit 15 per cent and 29 per cent more greenhouse gases.

Mass timber construction techniques such as cross-laminated timber and glulam have the potential to increase the thermal mass of a building. An increase in thermal mass helps to moderate temperature fluctuations within a building; increasing occupant comfort and reducing operational energy consumption over the life cycle. The addition of thermal mass can be particularly effective in cooling dominated climates, such as the southwest United States desert areas where there are large day-night temperature variations.

The wood industry is investing in research to increase energy efficiency through continual improvement, developing building systems that offer greater air tightness, less conductivity and more thermal mass where appropriate—including prefabricated systems that contribute to the low energy requirements of Passive House and Net Zero designs.

In many scenarios, the variations in operating energy consumption between otherwise identical wood, steel and concrete buildings are small, and they are becoming less significant as insulation levels increase and building envelope technology becomes more sophisticated. However, the reverse is true with embodied energy.

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\(^1\) Canadian Wood Council 1997: Wood the Renewable resource No. 4 ‘Comparing the Environmental Effects of Building Systems’
In the mid 1990s, when the building professions in Canada first began to take an active interest in improving the energy performance of buildings, the primary focus was operating energy. At that time, energy consumption in Canadian buildings was high compared to most other developed countries, and the relative contribution of embodied energy to total life cycle consumption was only around 15 per cent for a typical commercial building.2

According to the Architecture 2030 Challenge3, “The Building Sector is responsible for almost half of the energy consumption (49%) and greenhouse gas (GHG) emissions (47%) in the U.S. While the majority of this comes from building operations (such as heating, cooling, and lighting), the embodied energy and emissions of building materials and products are increasingly having a significant impact. The raw resource extraction, manufacturing, transportation, construction, usage, and end-of-life stages of building products consume significant amounts of energy, each generating associated GHG emissions. For a new building, on the first day it is occupied, 100% of its energy consumption and GHG emissions come from building materials and construction. Over the first 20 years of occupancy, 45% will be attributed to building materials and construction and 55% to operations. As buildings improve from an operational perspective, the embodied energy and emissions associated with building materials and construction will become more important.”

A recent case study of the Eugene Kruger Building at Laval University in Quebec4—carried out by Athena Sustainable Materials Institute—determined that the all-wood solution adopted for this 8,000-square-metre academic building resulted in a 40 per cent reduction in embodied energy compared to steel and concrete alternatives.

Embodied Plus Operating Energy Over 60 Years

Wood buildings of all sizes and types can be easily designed to meet or surpass energy standards in any climate. Energy performance depends more on insulation, air sealing and other factors than the choice of structural material. Most new homes are insulated well, so they tend to have essentially comparable energy performance. However, embodied energy is very much affected by structural material so it is important to look at both operating and embodied energy when evaluating structural materials in terms of energy consumption.

Wood Buildings Can Surpass Energy Standards

The data for this chart comes from a life cycle assessment study of different house framing by the Athena Institute for the Canadian Wood Council.5 The homes are identical 2,400-square-foot typical homes designed according to standard local practice. The concrete house used insulated concrete forms.

4 For more information www.grap.arc.ulaval.ca/attaches/Potvin/ASES-Kruger.pdf
5 A comparative environmental impact assessment of alternative material single-family home designs, January 2004. P. 5
A Wood Building is Easier to Insulate

While a good thermal assembly can be created with any structural material, wood is a better natural insulator than steel and concrete.

Due to its cellular structure and lots of tiny air pockets, wood is 400 times better than steel and 10 times better than concrete in resisting the flow of heat. As a result, more insulation is needed for steel and concrete to achieve the same thermal performance.

The graph above shows energy performance in two buildings near Chicago. The 2002 study prepared by the National Association of Home Builders Research Center Inc. compared long-term energy use in two nearly identical side-by-side homes, one framed with conventional dimensional lumber and the second framed with cold-formed steel. It found the steel-framed house used 3.9 per cent more natural gas in the winter and 10.7 per cent more electricity in the summer.

The steel building has significantly more insulation than the wood building yet it still did not perform as well. It also has more embodied energy, which is not reflected in the graph.

The data was measured for one year and also simulated with software in order to normalize and validate results. Both houses have fiberglass insulation between the studs.

Green buildings

- Mitigate climate change
- Use less energy and water
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Using Resources Wisely

Responsible resource management is essential if we are to reach the goal of true sustainable development. Sometimes this will mean using less, but it will always mean choosing products with the lightest carbon footprint possible.

When it comes to building construction and renovation, this means identifying materials, manufacturing processes and design strategies that:

- minimize the use of non-renewable resources
- minimize waste during the extraction and manufacturing process
- minimize the use of fossil fuel energy during extraction and manufacturing
- use products that are flexible, adaptable and durable
- enable the reuse of materials and products from dismantled buildings
- recycle materials only when no longer fit for their original purpose
Benefits of Wood

Selecting wood building products offers the following advantages related to resource conservation:

1. **Wood is 100 per cent renewable.** When grown and harvested according to internationally recognized sustainable forest management practices, it is the only major construction material that can be regenerated for the benefit of future generations.

2. **Wood is produced efficiently.** The portion of harvested wood volume entering primary processing mills in North America that is converted to marketable products, or converted to useful energy, is near 100 per cent. In other words, the wood waste at these mills is near 0 per cent; therefore, in terms of wood use, these are zero-waste facilities. Secondary processing plants are similarly diligent in utilization of raw materials.¹

3. **Wood has low embodied energy.** Wood has the least embodied energy of all major building materials². In other words, the energy consumed to grow, harvest, transport and manufacture wood products is less than for other products. Not only does wood require less energy to manufacture into products, half of that is generated from wood waste such as chips and sawdust. Burning wood waste for energy is considered carbon neutral because it only releases the carbon sequestered in the wood during the growing cycle.

4. **Wood is versatile and adaptable.** A building’s structural design and spatial subdivision determines its ability to be flexible in use, and adaptable so it can meet new requirements. Separating these functions makes it easier to reconfigure the space. Wood lends itself to this design approach, especially through the use of post-and-beam structures (in solid sawn lumber or engineered wood) and non-load-bearing partitions made up of smaller members (either solid laminated or in stud frame construction).

5. **Wood lends itself to dismantling,** a fact borne out by the continued predominance of wood and wood products in the architectural salvage market. It can generally be reclaimed without diminishing its value or usefulness for future applications. This contrasts with materials like concrete, which is usually crushed for future use as aggregate or ballast, or brick, which can be easily damaged when cleaned for reuse, and which can rarely be reassembled with the original precision.

6. **Wood can be reclaimed and reused** for the same or similar purpose with only minor modifications or wastage. If desired, the same material can be remilled and fashioned into other products, such as window and door frames, curtain wall components and cladding. A recent celebrated example is the Materials Testing Facility in Vancouver, designed by Perkins+Will Canada Architects Co., which features reclaimed lumber from a demolished warehouse in each of these applications. Short lengths of lumber that may be a byproduct of the remilling process can typically be used for bracing and blocking elements. Wood components too small to reuse and leftover wood chips and sawdust can be processed into mulch for landscape use or to provide organic material to promote decomposition in landfills.

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²Werner, Frank and Richter, Klaus. Scientific Journals April 2007: Wooden Building Products in Comparative LCA: A Literature Review.
Green buildings

- Mitigate climate change
- Use less energy and water
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- Are healthy for people and the planet

Private residence with reclaimed douglas fir post and beams; reclaimed douglas fir fireplace mantle; reclaimed douglas fir ceiling decking; reclaimed douglas fir flooring (milled and stained to give appearance of antique wood).
Photo: Peter Powles

Reclaimed wood: C.K. Choi Building, Institute of Asian Research, University of British Columbia, Vancouver, B.C.
Architect: Matsuzaki Wright Architects
Photo: Don Erhardt

On the cover:
WoodWave panel, Richmond Olympic Oval, Richmond, B.C.
Architect: Cannon Design
Photo: Martin Tessler
Durability and Adaptability
The Service Life of Buildings

In North America, we have historically chosen not to exploit the potential longevity of buildings, instead assigning a higher priority to other factors. As a consequence, with the exception of the few that are designated ‘post-disaster’ structures (see opposite page for description) most buildings have a service life of less than 50 years.

Most structures are demolished because of external forces such as zoning changes and rising land values – often the building fabric itself may still be in good condition. When one considers the embodied energy in these structures and the implications of material disposal, it is clear that these premature losses have a considerable negative environmental impact.

New buildings can be designed for flexibility and adaptability, and the full service life can be extracted from building materials if they are reclaimed and reused as much as possible. In this way, architects can assume the role of curators, not just creators, of the built environment.

Durability of Materials and Structures

Designers can get maximum performance and service life out of every building material as long as they understand the necessary steps. Improperly detailed masonry and concrete may spall or crack, steel may rust, and wood may deteriorate. In each case, this compromises the integrity of a building and reduces its life expectancy.

Used properly, all of these materials are inherently durable and can endure for decades or even centuries. The most ancient wood buildings still in existence include eighth century Japanese temples, 11th century Norwegian stave churches, and the many medieval post-and-beam structures of England and Europe. These buildings endure partly because of their cultural significance, and partly because they were built and maintained properly.

For example, long posts supporting the multi-tiered roofs of stave churches were air dried for up to two years to prevent shrinkage and distortion after they were installed. Wood foundation beams were laid on a gravel-filled trench to protect the structure from long-term contact with water. Vertical planked walls were protected from the weather by large overhanging eaves, and shingle roofs were steeply pitched to shed rain and snow.

Although we need a more sophisticated understanding of building physics to ensure the integrity and longevity of materials and structures, the same basic principles still apply.

A recent example is the design of Vancouver’s Millennium Line transit stations by a consortium of architects. They wanted to promote the use of wood in the platform canopy structures for its visual warmth and regional character but were concerned about durability in these highly exposed and largely unsupervised structures. As a result, they established the following parameters:

- To discourage vandalism wood members should be kept above a 10’ datum level.

*Continued on next page....
Resilience and Post-disaster Design

The Millennium Line stations were designed as post-disaster structures for a 100-year service life, and had to be capable of resisting lateral forces 50 per cent higher than those specified in the building code. In recent years, wood has also become the structural system of choice in many other post-disaster facilities, notably fire halls and other public service buildings.

Wood lends itself to the construction of simple and economical shear walls that are a key component of post-disaster construction, and the lightness of wood structures reduces the amount of seismic forces the structure will attract in the event of a major earthquake – an important consideration particularly on the West Coast and in other regions prone to earthquakes.

Following earthquakes in Asia, anecdotal reports indicate that wood structures best maintained their structural integrity and contributed least to injury and loss of life.

On Vancouver Island, B.C., wood provided a cost-effective option for construction of the rural fire hall that houses the volunteer Oyster River Fire/Rescue Department in Comox. It meets a post-disaster standard, and has metal cladding on the exterior and the roof, drywall on the interior and a monitored alarm system.

The results are obvious throughout the line. At Brentwood Skytrain Station (shown at top of page), curved composite ribs support the roof structure, steel giving way to glulam at the 10’ datum level. At Rupert, opposing glulam beams are connected by a steel knife plate that bridges the opening above the guideway. At Braid, projecting glulam beams are protected from weather by castellations in the metal roof.

Collectively these structures represent a significant contribution to a new composite architecture in Canadian public buildings, where the best attributes of wood and other materials are combined in a manner that contributes to the overall expression of the building.

Wood is versatile and flexible, which makes it an easy construction material for renovations. The “Ardencraig” heritage house in Vancouver, British Columbia was renovated to create three separate residences in 2000.
Flexibility and Adaptability

Designing for flexibility and adaptability is also critical to secure the greatest value for the net energy embodied in building materials. Wood structures are typically easy to adapt to new uses because the material is so light and easy to work with. The inherent structural redundancy in light-weight wood-frame structures provides many opportunities for adaptation, while post-and-beam structures provide complete flexibility in the reconfiguration of non-load bearing partitions. The interior of the Wood Innovation and Design Center ("WIDC") in Prince George, B.C. is designed to be flexible and adaptable to accommodate tenants needs.

Wood also lends itself to dismantling. The structural concept used in WIDC is a “dry construction” design, virtually eliminating the use of concrete above the foundation with the exception of the mechanical penthouse. Dry systems help with the end-of-life story of the project. The building can be disassembled at the end of its functional life, and the wood products can be reused.

Green buildings

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On the cover:
Bow River Pedestrian Bridge, Banff, AB
Structural Engineer: Fast + Epp Structural Engineers
Photo: StructureCraft Builders Inc.

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Health and Well-being

MODULE 6
Impacts of Buildings on Human Health

Green building objectives are broader than just environmental effects, and have come to embrace human health issues as well, including performance. In the developed world where people spend much of their time inside buildings, the design of the indoor environment is of critical importance to human health.

Within the context of green design, measures frequently explored for a better indoor environment include:
• monitoring of carbon dioxide levels
• ventilation effectiveness
• management of dust and contaminants during construction
• control of indoor chemical and pollutant sources
• personal control of environmental systems
• provision of daylight and views

Designing for Human Well-Being

Health and well-being embraces both physical health, and the psychological aspects of human performance.

Over time, physical issues have been dealt with incrementally through legislation that has banned the use of toxic or otherwise dangerous substances in buildings. In addition, new standards have been introduced to ensure adequate ventilation, reduce condensation and inhibit the growth of mould and mildew.

Designers are also interested in potential psychological and related physiological benefits of environmental design factors. For example, intuition tells us that a connection to nature improves our sense of well-being when indoors. This can be achieved through access to daylight or views, or by providing a visual or tactile connection with natural materials such as wood and stone.

For many years, research has shown the human health benefits of forests. The benefits of time spent in forests include reduced stress, lower blood pressure, and improved mood. Medical research shows exposure to forests can boost our immune system and may even correlate to lower cancer rates. The benefits of forests are strongly recognized in some cultures. In Japan, the term “forest bathing” refers to time spent in the forest atmosphere and is encouraged by public policy. New research is beginning to show that the visible use of wood in buildings provides human health benefits as well.

A recent study at the University of British Columbia and FPInnovations identified a link between the use of wood and human health. The study compared the stress levels of participants in different office environments with and without wood finishings.

The results found that “Stress, as measured by sympathetic nervous system (SNS) activation, was lower in the wood room in all periods of the study.” Studies have shown that SNS activation increases
blood pressure and heart rate while inhibiting digestion, recovery, and repair functions in the body. People that spend a lot of time in a state of SNS activation can demonstrate evidence of physiological and psychological impact. The use of visual wood surface can reduce SNS activation and promote health in building occupants.

The Critical Care Tower (CCT) at Surrey Memorial Hospital provides strong evidence that Canada’s healthcare sector now recognizes the important role that can be played by wood in the creation of healing environments. “Sustainable design goes hand-in-hand with healthcare design,” says Bill Locking, senior partner with CEI Architecture and partner in charge on the project. In January 2015, Surrey Memorial Hospital achieved LEED Gold certification.

Architect Bing Thom said he chose wood for key structural components in the retail and commercial development at Central City, Surrey, B.C. “to provide a warm and tactile contrast to the smooth, synthetic environment of the modern high-tech work space.”

The growing knowledge of the health benefits of building with visual wood surfaces is being incorporated into healthcare environmental to support patient recovery, school environments to support student learning, and offices to support employee health.

Wood and Interior Air Quality

Dust and Particulates
Solid wood products, particularly flooring, are often specified in environments where the occupants are known to have allergies to dust or other particulates. Wood itself is considered to be hypo-allergenic; its smooth surfaces are easy to clean and prevent the buildup of particles that are common in soft finishes like carpet.

Off-Gassing
Interior wood panel products, such as particleboard, medium density fibreboard (MDF), and hardboard, were once identified as having a negative impact on indoor air quality because of their use of urea-formaldehyde (UF) glues. The concern was that, if panels were left unsealed, volatile organic compounds would be released into the air.

In 2004, the Composite Panel Association (CPA) (www.pbmddf.com) introduced an Environmentally Preferable Product (EPP) Certification Program to lower formaldehyde emissions from wood-based panels intended for interior use. EPP-designated products have since been third-party certified as complying with the environmental criteria referenced in the U.S. Environmental Protection Agency’s Guidelines for Environmentally Preferable Purchasing. Compliance requires rigorous quarterly audits at the manufacturing site and independent third-party product emission testing.

The Composite Panel Association’s EPP Certification Program is the first EPP certification program accredited by the American National Standards Institute (ANSI).

Some manufacturers also produce formaldehyde-free panel products, made with an urethane-type (MDI) resin. Once cured, MDI-based wood panel products are very stable, without measurable off-gassing.

Humidity Control
The use of wood products can also improve indoor air quality by moderating humidity. Acting like a sponge, the wood absorbs or releases moisture in order to maintain equilibrium with the adjacent air. This has the effect of raising humidity when the air is dry, and lowering it when the air is moist – the humidity equivalent of the thermal flywheel effect.

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1 Wood panels certified to CPA’s EPP Certification Program must demonstrate that they are made from 100% recycled or recovered fibre and meet emissions of maximum 0.2 parts per million of formaldehyde.
Green buildings

• Mitigate climate change
• Use less energy and water
• Use fewer materials
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Left Image:
Canadian Cancer Society Kordyban Lodge, Prince George, B.C.

The lodge’s hybrid structure consists of engineered glulam timber frame, conventional light wood framing and prefabricated wall panels. On the exterior the predominant material is Western red cedar siding.

Architect: NSDA Architects
Photographer: Derek Lepper Photography

Sources


On the cover:
King David High School, Vancouver, British Columbia
Acton Ostry Architects Inc
Photo: Martin Tessler
Meeting Social Needs

Social sustainability relies on a collaborative approach to building and community development, one that involves all stakeholders, reinforces social networks, and allows people of every age and ability to reside and participate in their community throughout their life. Sustainable communities make it easier for people to travel by foot, bicycle and mass transit, and they bring together residential, commercial and retail development.

The objective of green design is to create communities where people will want to live and work now and in the future. Where appropriate, there should be preference given to renewable and recyclable materials that are regionally harvested or manufactured, and can be installed and maintained by local labour.

Once again, life cycle assessment has a key role to play in identifying the most appropriate product choices. There may be times when local materials are not the most environmentally sound choice; and it may be better to import products that have lower extraction, processing and disposal impacts.

Sustainable Development

Green building supports a built environment that is socially, environmentally and economically responsible. These are the three pillars of sustainable development.

While it is important to promote environmental sustainability, there is also a need to consider social and economic issues. Buildings must be designed with people in mind – and this will lead to thriving and vibrant communities.
A green design may cost more but often saves operating costs throughout the life of the building – through more efficient lighting and better windows, smaller and less costly HVAC, better use of materials, and reduced demolition costs. A green building is also likely to maintain a higher value.

In 2014, the Canadian Green Building Council commissioned the research report “Canada Green Building Trends: Benefits Driving the New and Retrofit Market” by McGraw Hill Construction. The report stated:

“Like their counterparts in the U.S. and around the world, Canadian building owners, architects and contractors report that green buildings significantly decrease operating costs in the first year after construction, and that their impacts on operating costs continue to increase over five years. Operating cost savings are no doubt impacted by the energy and water savings reported. 
• 82% of building owners/developers report decreases in energy consumption compared to similar buildings. 
• 68% of owner/developers report decreases in water consumption.

The Canadian respondents also report reasonable payback periods of eight years for new green building projects and seven years for green retrofits and renovations. They also find that their green retrofit/renovation efforts contribute to increased building values, with a median increased value of 4%.”


Meeting Economic Needs

Designers and builders can use their buying power to improve forest management by choosing wood products they know are from legal, sustainable sources. This demonstrates their corporate social responsibility and shows customers they care about the environment.

Illegal logging is an urgent global problem that leads to the loss of wildlife habitat and public revenues. Lower prices for illegal forest products distort global markets and discourage sustainable forest management.

Private and public procurement policies are increasingly requesting proof that forest products are derived from known and legal sources.

Through its comprehensive governance structures, British Columbia is a world leader in forest products that are harvested legally and sustainably. Voluntary third-party forest certification systems used in B.C. also contribute to assuring buyers as evidence of these values.

Responsible Forest Products

Illegal logging is an urgent global problem
In Canada, forest products provide economic opportunities for people in resource-dependent communities. More than 300 Canadian communities, many of them in remote areas, depend on the forest sector for at least half of their base income. About 80 per cent of Aboriginal peoples live in forested regions. There are 1,400 Aboriginal-owned businesses involved with Canada’s forest sector, and about 17,000 Aboriginal people work in the industry.
Looking at the Complete Picture

While a building’s operation over time has the greatest environmental impact, there is also energy consumed in extracting, manufacturing and transporting the materials and components used for the building construction, installing them, and their ongoing maintenance. In combination, these energy inputs are referred to as embodied energy.

Calculating the amount of embodied energy is a complex issue. Not all green building rating systems measure embodied energy, but some offer credits if life cycle assessments are carried out to determine the impact building material choices have on embodied and operating energy.

There may be times when sourcing local products yields the most environmental benefit. But the decision should not be based on one factor alone, such as transportation impacts. Other aspects of embodied energy – and issues such as pollution or environmental degradation – may be of far greater significance in product selection than transportation energy. Life cycle assessment takes away much of the guesswork by calculating outcomes based on quantifiable indicators.
It is natural to expect that locally sourced products would be more environmentally responsible than those shipped a great distance. But this is usually based on the assumption that transportation energy contributes a lot to the overall energy equation – and life cycle assessment can prove that this is usually not the case.

While buying local may help the local economy, it is not necessarily the best environmental choice. In many cases, transportation energy is a very small component of overall energy consumption.

For example, the figure below shows that in a typical wood frame house in Vancouver, transportation energy represents less than five per cent of the total embodied energy in the building.

Life cycle assessment also accounts for the mode of transportation, not just the distance. For example, shipping products a long distance by train or ship, a typical method of transportation for B.C. forest products, may result in a light environmental footprint as these modes of transport are usually very efficient.

The above graphic illustrates embodied energy consumption related to the manufacture, construction and operation of a typical Vancouver, B.C. home. In other words, it is the energy used to make the materials, get them to the site, build with them, and maintain or replace them over 60 years of the structure’s life. Life cycle assessment ensures that all slices of the pie are considered, enabling decisions based on sound knowledge.

Energy consumption to operate the home (such as heat) is not shown as it is not relevant to the evaluation of using local materials, and would dominate the graph, making it hard to see the transportation effects at all.

Source: The sample “R-2000 house” file that comes with the Athena Impact Estimator for Buildings life cycle assessment software. The example is a typical new 2,200-square-foot wood-frame home in Vancouver.
Green design requires careful choices. Life cycle assessment can help determine whether a product coming from a sustainably managed forest versus a rapidly renewable product that is high in processing emissions and transportation emissions is the better choice.
The Fourth Assessment Report, released by the Intergovernmental Panel on Climate Change in 2007, states: “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.”

The consequences of climate change are difficult to predict because of the complexity of environmental systems that determine climate, but some of the trends are already clear:

- Changes in natural habitats will result in the loss of plant and animal species.
- Species that carry tropical diseases, such as mosquitoes (malaria), will spread and settle into new areas.
- Sea levels will continue to rise, with catastrophic results for those living in coastal or river delta area, or low-lying land.

To mitigate climate change, it is necessary to reduce greenhouse gas emissions and store more carbon. A well-managed forest can do both.

As trees grow, they absorb carbon dioxide and store it. When they decompose or burn, much of the stored carbon is released back into the atmosphere, mainly as carbon dioxide, and some of the carbon remains in the forest debris and soils.

Wood products continue to store much of the carbon absorbed during the tree’s growing cycle, while the regenerating forest once again begins the cycle of absorption. Manufacturing wood into products also requires far less energy than other materials, and most of that comes from residual biomass (such as bark and sawdust).

Using Wood Can Help Tackle Climate Change

Greenhouse Gases, Carbon, and Forests

The Greenhouse Effect

The glass panels of a greenhouse let in light and keep heat from escaping, providing warmth for the plants growing in them. A similar process occurs when the sun’s energy reaches the Earth – some is absorbed by the Earth’s surface, some radiates back into space, and some is trapped in the Earth’s atmosphere, which keeps the planet warm enough for life to flourish. This is called the greenhouse effect.

The carbon cycle affects the amount of energy trapped in the atmosphere. Plants absorb carbon dioxide and emit oxygen during photosynthesis; oceans also absorb carbon dioxide. Humans and other animals inhale oxygen and exhale carbon dioxide. Carbon dioxide is emitted when substances decompose or burn.

Scientists agree this natural balance has been upset. The biggest human cause is the amount of carbon dioxide being released into the atmosphere through the burning of non-renewable fossil fuels, such as oil, natural gas or coal. Carbon dioxide accounts for more than 75 per cent of total greenhouse gas emissions.

Close to eight billion tonnes of carbon dioxide are emitted every year – most of this through fossil fuel combustion and deforestation in tropical regions. Some is absorbed by water bodies, some is absorbed by forests – and some is emitted into the atmosphere.

If too much carbon is emitted, it causes the atmosphere to trap more heat, warming the planet. Rising temperatures may, in turn, produce changes in weather, sea levels, and land use patterns, commonly referred to as climate change.
Using wood products that store carbon instead of building materials that require large amounts of fossil fuel energy to manufacture can help to reduce greenhouse gases in the atmosphere. Trees grow naturally, and the little waste generated during processing is often used to meet the energy needs of the mill. At the end of their first life, forest products can be easily reused, recycled or used as a carbon-neutral source of energy.

A typical 2,400-square-foot wood-frame house contains 29 metric tonnes of carbon, which is the equivalent of offsetting the greenhouse gas emissions produced by driving a passenger car for five years (about 12,500 litres of gasoline). No other material offers this kind of carbon credit.

Around the world, government and business leaders are developing policies and procurement processes that encourage the use of more forest products from well-managed forests.

Life cycle assessment is the appropriate tool for examining the carbon footprint of building materials because it considers the greenhouse gas emissions associated with their production, transportation, construction, use and eventual disposal.

- In this graph, the embodied effects are shown for two typical, identical homes, one made with wood and one with concrete. (Embodied effects are the environmental impacts associated with manufacturing, transporting and constructing the houses – heating and cooling the houses are not included);
- It shows that the concrete-block house resulted in 31 per cent more greenhouse gas emissions than the wood-frame house.

Data: Consortium for Research on Renewable Industrial Materials (CORRIM).

Green buildings

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- Use less energy and water
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- Are healthy for people and the planet

Library Square, Kamloops, B.C.
Architect: JM Architecture
Photo: Martin Knowles

Library Square is a six-storey mixed-use development that includes five stories of wood-frame housing over a 20,500-square-foot library and 15,000 square feet of retail space.

WOOD STORES CARBON

Library Square, Kamloops, BC - a 6-storey mixed-use development, stores 2,340 metric tons of CO₂.

2,340 METRIC TONS OF CO₂

EQUIVALENT TO THE ENERGY USED TO OPERATE A HOME FOR 620 YEARS

Use the carbon calculator to estimate the carbon benefits of wood buildings. Visit woodworks.org.
Forest Carbon

MODULE 10
Forests play a critical role in filtering and renewing our air. Trees absorb carbon dioxide (CO₂) and water (H₂O), and release oxygen (O₂). The carbon absorbed is stored until the trees die and decay or are burned in a wildfire, at which point the carbon is released back into the atmosphere. Some of the carbon absorbed by trees is stored for a long period of time within the forest.

Less known is the fact that trees use carbon (C) to produce wood, and that products made from wood continue to store carbon for as long as they exist. In fact, one-half the weight of wood is carbon.

There is growing awareness among building designers that using wood can reduce a building’s carbon footprint, provided it comes from a sustainably managed forest. At the core of wood’s carbon benefit is the fact that as trees grow they absorb CO₂ from the atmosphere and incorporate the carbon into their wood, leaves or needles, roots and surrounding soil. Over time, one of three things happens:

- When the trees get older, they start to decay and slowly release the stored carbon.
- The forest succumbs to wildfire, insects or disease and releases the carbon quickly.
- The trees are harvested and manufactured into products, which continue to store much of the carbon. In the case of wood buildings, the carbon is kept out of the atmosphere for the lifetime of the structure—or longer if the wood is reclaimed at the end of the building’s service life and either re-used or remanufactured into other products.

The unique benefits of wood result from how it is made – within forests using solar energy. Solar energy drives the process of photosynthesis and wood formation. Transformation of wood into useful building materials takes relatively little additional energy.

**Carbon Cycle: Sustainable Forest Management and Wood Products**

Growing forests absorb carbon dioxide and release oxygen

- Carbon absorbed CO₂
- Oxygen released O₂
- Gradual release CO₂
- Carbon storage plateaus in older forests and can slowly be released as trees decay or burn

Wood buildings store carbon and it remains stored over the lifetime of the building.

Harvesting for wood products ensures that carbon continues to be stored.


**US Environmental Protection Agency Equivalencies Calculator.

Note: C02 on this chart refers to C02 equivalent. Figures calculated May 2016.

①Brock Commons Phase 1, University of British Columbia. 18-storey wood building, estimated completion in August 2017.
Carbon stored and avoided greenhouse gas emissions: 2,432 metric tons of CO₂. Equivalent to 511 cars off the road for a year.

Carbon stored and avoided greenhouse gas emissions: 2,940 metric tons of CO₂. Equivalent to 618 cars off the road for a year.
“In the long term, a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fibre or energy from the forest, will generate the largest sustained mitigation benefit.”


Forests - Natural Ecosystems, Wildlife Habitat, Renewable Products and Carbon Storage

Unlike mines and farms, forests are diverse ecosystems. As a result they provide many amenities. Forests provide a wide variety of habitats for wildlife species – from mammals and birds to reptiles and amphibians – and influence marine and fish habitats. They filter water for communities and local businesses. They offer areas for recreation, relaxation and enjoyment of nature – places for quality time with friends and families. And, they provide food, fiber and building products that support our quality of life.

Wood is also renewable. As long as forests are managed sustainably, trees can be grown, harvested, replenished, and then harvested again and again in an ongoing cycle of harvest, renewal, and growth.

A great deal of research has been undertaken to determine how forests can be managed to maximize their carbon benefits. According to a new report from the Society of American Foresters², numerous studies of forest carbon relationships show that a policy of active and responsible forest management is more effective in capturing and storing atmospheric carbon than a policy of hands-off management that precludes periodic harvests and use of wood products.

While acknowledging that it is not appropriate to manage every forested acre with a sole focus on carbon mitigation, the report’s authors conclude (among other things), that:

- Wood products used in place of more energy-intensive materials, such as metals, concrete and plastic reduce carbon emissions, store carbon, and can provide additional biomass that can be substituted for fossil fuels to produce energy.

- Sustainably managed forests can provide greater carbon mitigation benefits than unmanaged forests, while delivering a wide range of environmental and social benefits including timber and biomass resources, jobs and economic opportunities, clean water, wildlife habitat, and recreation.

As with all aspects of forestry, choosing not to manage also has consequences, and this also impacts forest lands carbon. Young, healthy forests are carbon sinks because they’re actively absorbing carbon dioxide as they grow. As forests mature, they generally become carbon cycle-neutral because primary productivity declines. Many continue to store substantial amounts of carbon indefinately— old growth forests in the U.S. and Canada represent significant carbon sinks—but the probability of massive carbon loss also increases. Where forests are killed by large-scale natural disturbances (such as wildfires and insect or disease infestations), they emit their stored carbon without providing the benefits available through product and energy substitution.

According to the Food and Agriculture Organization of the United Nations, “Several aspects of the forest industry’s activities are not adequately captured by looking at only the emissions and sequestration accomplished in the value chain. For example, the use of wood-based building materials avoids emissions of 483 million tonnes of CO₂ equivalent a year, via substitution effects. In addition, by displacing fossil fuels, the burning of used products at the end of the life cycle avoids the emission of more than 25 million tonnes of CO₂ equivalent per year, which could be increased to 135 million tonnes per year by diverting material from landfills.

“Wood products are manufactured from renewable raw material; they are reusable and biodegradable, and they continue to store carbon throughout their lifetime. These characteristics make wood an excellent alternative to many of the materials that are now widely used in construction and consumer goods, which leave a much larger ‘carbon footprint’ and include concrete, steel, aluminum and plastic. Increasing production and consumption of wood products will therefore be part of a sustainable future.”³


³ State of the World’s Forests – 2012 United Nations Food and Agriculture Organization
Green buildings

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Canada has most of its original forest area. More than half of Canada’s forest are naturally reforested, and this is supplemented by the planting of 600 million seedlings per year.
Forest Practices in Canada
A Snapshot of Canada’s Forests

Canada has more than 348 million hectares (860 million acres) of forest land. Canada has 9 percent of the world’s forests, including 24 percent of the world’s boreal forests.

The area of Canada’s forests that is managed for timber production or other uses is 232 million hectares. In 2014, 0.72 million hectares were harvested, contrasted with 20.3 million hectares damaged by insects and 4.2 million hectares burned in wildfires. Wildfire and insect affect much more forest land than harvesting.¹

Most of Canada’s forest land—92 percent—is publicly owned and managed by the federal, provincial or territorial governments. Each province and territory has strict regulations that fully characterize what sustainable forest management (SFM) means and what actions may take place on public land, with regulations and laws that are among the most stringent on earth.²

Defining Forest Sustainability

Forest sustainability was first described in the book *Sylvicultura oeconomica* by German author Hans Carl von Carlowitz, published in 1713—and, while our understanding of what constitutes sustainability has evolved significantly in 300 years, it has long been a cornerstone of forest management. Von Carlowitz’s work planted the seed for what we now know as sustainable development, defined in the landmark 1987 report of the World Commission on Environment and Development (the ‘Brundtland Report’) as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”³

The United Nations Food and Agriculture Organization (FAO) defines sustainable forest management as “the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biological diversity, productivity, regeneration capacity, vitality and their potential to fulfill, now and in the future, relevant ecological economic and social functions, at local, national and global levels, and that does not cause damage on other ecosystems.”³

In Canada, forest sustainability is measured against criteria and indicators that represent the full range of forest values, including biodiversity, ecosystem condition and productivity, soil and water, global ecological cycles, economic and social benefits, and social responsibility. Sustainability criteria and indicators form the basis of individual country regulations as well as third-party sustainable forest certification programs.

Managing Diverse Forests

Canada’s forest laws ensure its rich forest resources are managed in a way that maintains their many values today and for future generations, while providing a wide range of quality products to meet the needs of domestic and international markets. Companies harvesting public lands must consider and accommodate all forest values—which means environmental values such as wildlife habitat, biodiversity and water resources, and social values such as scenery and recreation, as well as timber production. They must reforest each site, and remain responsible for it until there is assurance it will grow into a new, healthy forest.

Deforestation in developing countries accounts for about 18 percent of annual global greenhouse gas emissions. Canada has 91 percent of its original forest cover and its rate of deforestation has been virtually zero for more than 20 years. Very little forest land has been permanently converted to other uses such as agriculture and urban development.

Growing New Forests

A silviculture system covers all management activities related to growing forests – from early planning through harvesting, replanting and tending the new forest. Forest managers consider a variety of factors when choosing a silviculture system, including the tree species, their age and condition, soils, local ecology, and possible impacts on values such as wildlife habitat, water quality and scenery. They also look at economic and social factors, including cost, timber productivity and worker safety.

Canada’s diverse forests are generally managed under one or a blend of three silvicultural systems:

- The clearcut system removes most of the trees from an area, with patches of trees and buffers left to protect other values.
- The shelterwood system harvests trees in stages over a short period of time so the new forest grows under the shelter of the existing trees.
- The selection system removes timber as single trees or in small groups at relatively short intervals, repeated indefinitely. This is done carefully to protect the quality and value of the forest area.

Clearcutting is used when the young trees of a species need an abundance of sunlight to germinate and to compete successfully with grasses and other plants. It is usually used to grow tree species that historically found open sunlight by following large natural disturbances such as windstorms or wildfire. It provides the direct sunlight needed to effectively grow some native species, while helping to create a mix of forest ages across the landscape, including the young forests preferred by certain wildlife.

Conserving Forest Values

Biological diversity, or biodiversity, refers to the variety of species and ecosystems on earth and their ecological systems. An important indicator of forest sustainability, it enables organisms and ecosystems to respond to and adapt to environmental change.

Conserving biodiversity is an essential part of forest sustainability and involves strategies at different scales. At the landscape level, networks of parks and protected areas conserve a range of biologically and ecologically diverse ecosystems.

Since Canada created its first park in 1872, it has designated 100 million hectares (250 million acres) of terrestrial protected areas, which are managed for multiple values, including resource conservation, public education, preservation of culturally significant sites, research, and wildlife and habitat conservation.
Responsible Stewardship

Canada’s forest policy, based on sustainable forest management principles, guides its reforestation practices and sustainable harvest rates, ensuring the country retains its healthy forests for today and tomorrow’s generations.

Rigorous Legal Framework

The Canadian legal system holds companies and professionals accountable for their practices through strict forest management planning and approval processes, regulation of professionals, monitoring, and enforcement.

Voluntary Third-Party Forest Certification

In addition to strong stewardship and strict legal framework, Canada has 168 million hectares of land certified to one of three market-driven forest certification systems. Canada leads the world in third-party certification, with more land certified to voluntary, market-based forest programs than any other country.

Wood is the only building material that has third-party certification programs in place to demonstrate that products being sold have come from a sustainably managed resource. North America has more certified forests than any other jurisdiction.

Accredited third-party certification bodies issue a certificate to an organization once they determine its planning, procedures, systems and the performance of its on-the-ground operations conform with a predetermined standard. Forest certification can also be complemented with a chain-of-custody certification, which is a mechanism used to track fibre from a certified forest through all production stages to the product on the shelf.

The three certification programs used in Canada—the Canadian Standards Association’s Sustainable Forest Management Standards (CSA), the Forest Stewardship Council (FSC), and the Sustainable Forestry Initiative (SFI)—all promote sustainable forest management through principles, criteria and objectives consistent with government processes around the world. All three are recognized worldwide, and the CSA and SFI standards have met the rigorous requirements of the Programme for the Endorsement of Forest Certification (PEFC), the world’s largest forest certification umbrella organization.

Green buildings

- Mitigate climate change
- Use less energy and water
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- Are healthy for people and the planet

"Forest certification is a tool for demonstrating to customers and consumers that forests are being well-managed and that key local, regional and national forest values are being taken into account in the management of forests.”

Canadian Council of Forest Ministers


On the cover:
Indian Point River, Bowron Valley, B.C.
Photo: Moresby Creative

Each of the three certification standards depend on third-party audits by accredited certification bodies.

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Finding the Right Tools

While the increased interest in sustainable building design has encouraged research into building products and performance, it continues to be a challenge to measure the overall impact of buildings on the environment over the course of their service lives – and advice is often contradictory.

Product directories, rating systems and other tools are available to support design and construction decisions. However, these must be evaluated carefully to ensure they meet the specific needs of each application, and to identify any limitations. For example, some green building rating systems may be too narrowly focused, ignoring the importance of far-reaching strategic decisions, while rewarding less important ones disproportionately.

Green building tools include:

- Product labelling by third-party certifiers such as independent forest certification programs
- Rating systems that evaluate products/designs such as LEED (Leadership in Energy and Environmental Design), Green Globes and the National Association of Home Builders (NAHB) National Green Building Standard
- Practice guidelines such as green home building guidelines
- Software such as the Athena Institute’s EcoCalculator and Impact Estimator
- Procurement policies such as the U.S. Environmental Protection Agency’s environmentally preferable purchasing
- Environmental Product Declarations (EPDs)

Green design requires smart tools to decipher all the conflicting information, lack of clarity on definitions, and a constantly changing landscape as the field evolves and expands.
Green Building Rating and Assessment

Environmental rating systems can help building industry professionals evaluate and differentiate their product or design. The standards set by rating systems generally exceed those required by building codes.

The best systems measure performance rather than prescribe solutions, and are based on life cycle assessment. They offer a credible, consistent basis for comparison, evaluate relevant technical aspects of sustainable design, and should not be too complex or expensive to implement or confusing to communicate.

Most developed countries have adopted one or more green building rating systems, beginning with the United Kingdom, which introduced the BREEAM (Building Research Establishment Environmental Assessment Method) in 1990. In North America, green rating systems include LEED, Green Globes and the NAHB National Green Building Standard. A choice in rating systems helps to strengthen green design, with processes to meet the diversity of building needs, sizes and budgets. It also encourages market competition, ensuring continuous improvement.

The LEED green building rating system, developed by the U.S. Green Building Council, addresses specific building-related environmental impacts using a whole building environmental performance approach. In addition to LEED-NC (for new construction and major renovations), there are versions for existing buildings, commercial interiors, core and shell, homes, and neighbourhood development. In 2013, the US Green Building Council (USGBC) released the latest version of the LEED green building rating system (LEED v4). For information in the United States: www.usgbc.org/LEED/. For information in Canada: www.cagbc.org

Green Globes is a web-based environmental assessment and certification system that bills itself as offering an effective, practical and affordable way to assess and improve the sustainability of new and existing buildings. In the U.S., it is offered exclusively by the Green Building Initiative (GBI) who initiated the first ANSI standard for commercial green building. In Canada, the federal government uses the Green Globes suite of tools and it is the basis for the Building Owners and Managers Association of Canada’s (BOMA) “Go Green Plus” program. For information in the United States: www.thegbi.org. For information in Canada: www.greenglobes.com

The NAHB National Green Building Standard is the first green building rating system to be approved by the ANSI. Building on the Model Green Home Building Guidelines developed by the NAHB Research Centre, it provides a common benchmark for recognizing and rewarding green residential design, development, and construction practices in the United States. Known as ANSI/ICC 700-2008, the National Green Building Standard is a joint effort between the International Code Council and NAHB. More information is available at www.nahbgreen.org

Product Labelling and Certification

As demand grows for products and designs that represent a sound environmental choice, more companies are labelling their products as “green.” TerraChoice Environmental Marketing has produced a report called the Seven Sins of Greenwashing (www.sinsofgreenwashing.org) that offers criteria to help consumers judge whether a product or program is environmentally beneficial. It includes a list of some of North America’s most credible eco-labels – including third-party forest certification labels, cleaning products and organic certification.

TerraChoice President and CEO Scott McDougall says a 2009 survey of 2,219 consumer products in Canada and the U.S. showed that 98 per cent of companies committed at least one Sin of Greenwashing, and some marketers are creating fake labels or false suggestions of third-party endorsement. “Despite the number of legitimate eco-labels out there, consumers will still have to remain vigilant in their green purchasing decisions,” he says.

Wood is one of the few building products backed by well-established third-party certification programs, and Canada has more certified lands than any other country.
Software

Life cycle assessment software allows a designer to capture and account for the breadth of environmental and economic considerations in one application.

The **Building for Environmental and Economic Sustainability (BEES)** software program was created by the U.S. National Institute of Standards and Technology. BEES has 10 impact categories: acid rain, ecological toxicity, eutrophication, global warming, human toxicity, indoor air quality, ozone depletion, resource depletion, smog and solid waste. For more information: [www.wbdg.org/tools/bees.php](http://www.wbdg.org/tools/bees.php)

The **Athena Institute** is a non-profit organization that provides life cycle assessment services and tools to support green building. Its Impact Estimator for Buildings is a full-capability tool that allows designers to evaluate the environmental impact of each decision as they go through the process of putting a building together conceptually. Its EcoCalculator is a simplified tool, where hundreds of common building assemblies have been pre-calculated, requiring minimal input from the designer. For more information: [www.athenasmi.org/our-software-data/overview/](http://www.athenasmi.org/our-software-data/overview/)

Globally, governments are introducing policies to reduce greenhouse gas emissions and support their sustainability programs. Examples include:

- In The Netherlands, the 2012 building code requires LCA data to be submitted for each new building, and a total ‘environmental shadow cost’ must be calculated per square meter of building area in order to get a building permit.

- The UK government will require new homes to be ‘zero carbon’ beginning in 2016, and is considering extending this to all buildings as of 2019.

Other policies go further, explicitly recognizing the benefits of forestry and wood use:

- In France, the government requires that new public buildings have at least 0.2 cubic meters of wood for every 1 square meter of floor area.

- In New Zealand, wood or wood-based products must be considered as the main structural material for new government-funded buildings up to four floors.

- The Japanese government introduced a law requiring wood to be considered as the primary building material for any government-funded project up to three stories, and for any privately funded building used in a public manner such as elderly care facilities.

- In Canada, the governments of British Columbia, Ontario, and Quebec have policies that encourage the use of wood in public buildings.

*The Squamish Adventure Centre, designed by Iredale Group Architecture, is a landmark building that welcomes visitors along the scenic Sea-to-Sky Highway between Vancouver and Whistler, British Columbia. Solid sawn timber has the lowest embodied energy of any major building material, and local harvesting, milling and fabrication minimize transportation energy while providing economic benefits to the region.*
The U.S. Green Building Council (USGBC) and the Canadian Green Building Council are non-profit organizations that aim to transform the way buildings and communities are designed, built and operated, enabling an environmentally and socially responsible, healthy, and prosperous environment that improves the quality of life. USGBC has developed the LEED rating system. For more information: www.usgbc.org (United States) www.cagbc.org (Canada) www.worldgbc.org (international)

The National Association of Home Builders (NAHB) is a trade association for the housing and building industry in the United States. NAHB is a federation of more than 800 state and local associations. Its affiliates include the Home Innovation Research Laboratory. For more information: www.nahb.org

The Green Building Initiative is a not-for-profit education and marketing initiative dedicated to accelerating the adoption of building practices that result in energy-efficient, healthier and environmentally sustainable buildings by promoting credible and practical green building approaches for residential and commercial construction. For more information: www.thegbi.org

The American Institute of Architects (AIA) serves as the voice of the architecture profession and the resource for their members in service to society. For more information: www.aia.org

The Royal Architectural Institute of Canada (RAIC) is a voluntary national association representing professional architects, and faculty and graduates of accredited Canadian Schools of Architecture. For more information: www.raic.org

The Architectural Institute of British Columbia is an independent, professional self-regulatory body established in 1920 by provincial statute – the Architects Act. It is the AIBC’s mandate to regulate the profession of architecture within the province in the public interest. For more information: www.aibc.ca
Other Resources

Energy Star
(www.energystar.gov) is an international standard for energy-efficient consumer products. First created as a U.S. government program in 1992, it operates in Canada, Europe, Japan and Australia. Energy Star rates energy-related value for products in more than 35 categories, including HVAC systems, lighting fixtures, office equipment, roofing products, windows, doors and skylights.

The U.S. Environmental Protection Agency’s Environmentally Preferable Purchasing
(www.epa.gov/opptintr/epp) rates building materials and products based on pollution prevention, life cycle analysis, comparison of environmental impacts, environmental performance, and environment/price performance ratio. Product categories include: paints, plumbing, HVAC, lighting, gypsum board, carpets, concrete, coatings, sealants, flooring, doors, and windows.

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## Key Websites

<table>
<thead>
<tr>
<th>Website</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Canadian Wood Council</strong></td>
<td>The Canadian Wood Council maintains high credibility with architects, engineers and builders through its participation in codes and standards and its independent research of wood attributes and performance in today’s modern building systems. The website includes a section on sustainability and case studies related to green building.</td>
</tr>
<tr>
<td><a href="http://www.cwc.ca">www.cwc.ca</a></td>
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<tr>
<td><a href="http://www.wood-works.ca">www.wood-works.ca</a></td>
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<tr>
<td><strong>Forest Products Association of Canada</strong></td>
<td>Represents Canada’s wood, pulp and paper producers nationally and internationally on a wide variety of issues, particularly those related to economy, trade and the environment.</td>
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<tr>
<td><a href="http://www.fpac.ca">www.fpac.ca</a></td>
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<tr>
<td><strong>naturally:wood</strong></td>
<td>A comprehensive information source that brings together the latest, most reliable data about wood performance, green building and life cycle assessment, as well as British Columbia’s wide variety of forest products, manufacturers, sustainable forest practices, certification of forests, wood products and more.</td>
</tr>
<tr>
<td><a href="http://www.naturallywood.com">www.naturallywood.com</a></td>
<td>Links to related topics provide architects, builders, wood, pulp and paper manufacturers and their customers the ability to explore further resources on wood products. A product supplier directory and certification search engine enable convenience and informed choice when sourcing wood, pulp and paper products.</td>
</tr>
<tr>
<td><a href="http://www.youtube.com/user/naturallywood">www.youtube.com/user/naturallywood</a></td>
<td>Naturallywood.com is a product of Forestry Innovation Investment (FII), a Crown Agency of the Province of British Columbia (B.C.), Canada.</td>
</tr>
<tr>
<td><strong>Forest in Mind</strong></td>
<td>Forest in Mind is a fact-based communications program of the Canadian Council of Forest Ministers (CCFM) to position Canada as a world leader in sustainable forest management and environmental stewardship in order to protect and enhance market access for Canadian forest products.</td>
</tr>
<tr>
<td><a href="http://www.sfmcanada.org">www.sfmcanada.org</a></td>
<td>SFMCanada.org contains comprehensive information on Sustainable Forest Management (SFM) in Canada, including fact sheets in 10 languages and a link to their YouTube channel that presents 10 videos on SFM in Canada in 5 languages.</td>
</tr>
<tr>
<td><a href="http://www.youtube.com/user/sfmcanada">www.youtube.com/user/sfmcanada</a></td>
<td></td>
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<tr>
<td><strong>FPInnovations</strong></td>
<td>A not-for-profit organization that creates scientific solutions in support of the Canadian forest sector’s global competitiveness, performing research to innovate, and to deliver state-of-the-art solutions for every area of the sector’s value chain, from forestry operations to consumer and industrial products.</td>
</tr>
<tr>
<td><a href="http://www.fpinnovations.ca">www.fpinnovations.ca</a></td>
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</tr>
</tbody>
</table>
## Case Studies

**Canadian Wood Council**
- [www.cwc.ca/publications/](http://www.cwc.ca/publications/)
- [www.naturallywood.com/resources](http://www.naturallywood.com/resources)

## Wood Products

**naturally:wood**
- [www.naturallywood.com/wood-products](http://www.naturallywood.com/wood-products)

**BC Supplier Directory**
- [www.naturallywood.com/supplierdirectory/](http://www.naturallywood.com/supplierdirectory/)

**Architects Tool Kit**
- [www.naturallywood.com/architectstoolkit](http://www.naturallywood.com/architectstoolkit)

## Wood Products and Environmental Impacts

**naturally:wood**
- [www.naturallywood.com/resources](http://www.naturallywood.com/resources)

## Forests and Environmental Impacts

**Canadian Forest Service**
- *Does harvesting in Canada’s forests contribute to climate change? 2007*
  - [www.sfmcanada.org/images/Publications/EN/CFS_DoesHarvestingContributeToClimateChange_EN.pdf](http://www.sfmcanada.org/images/Publications/EN/CFS_DoesHarvestingContributeToClimateChange_EN.pdf)
- *Deforestation in Canada: What are the Facts? 2008*

**naturally:wood**
- [www.naturallywood.com/resources](http://www.naturallywood.com/resources)

**Canadian Council of Forest Ministers**
- *Is Canada’s Forest a Carbon Sink or Source? 2007*
  - [www.sfmcanada.org/images/Publications/EN/C02_Sink_EN.pdf](http://www.sfmcanada.org/images/Publications/EN/C02_Sink_EN.pdf)
- *Sustainable Forest Management Policies in Canada*
- *Forest Certification Standards in Canada*
- *Making the Case for Sustainable Forest Management Certification*
- *Building Green and the Benefits of Wood*
### Third-party Forest Certification

<table>
<thead>
<tr>
<th>Certification Canada</th>
<th>Data and information about third-party forest certification in Canada, and a search tool so buyers can learn more about forest certification in Canada and find certified products.</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://www.certificationcanada.org">www.certificationcanada.org</a></td>
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