Building Green with Wood in B.C.

MODULE 3

Energy Conservation

The Importance of Energy

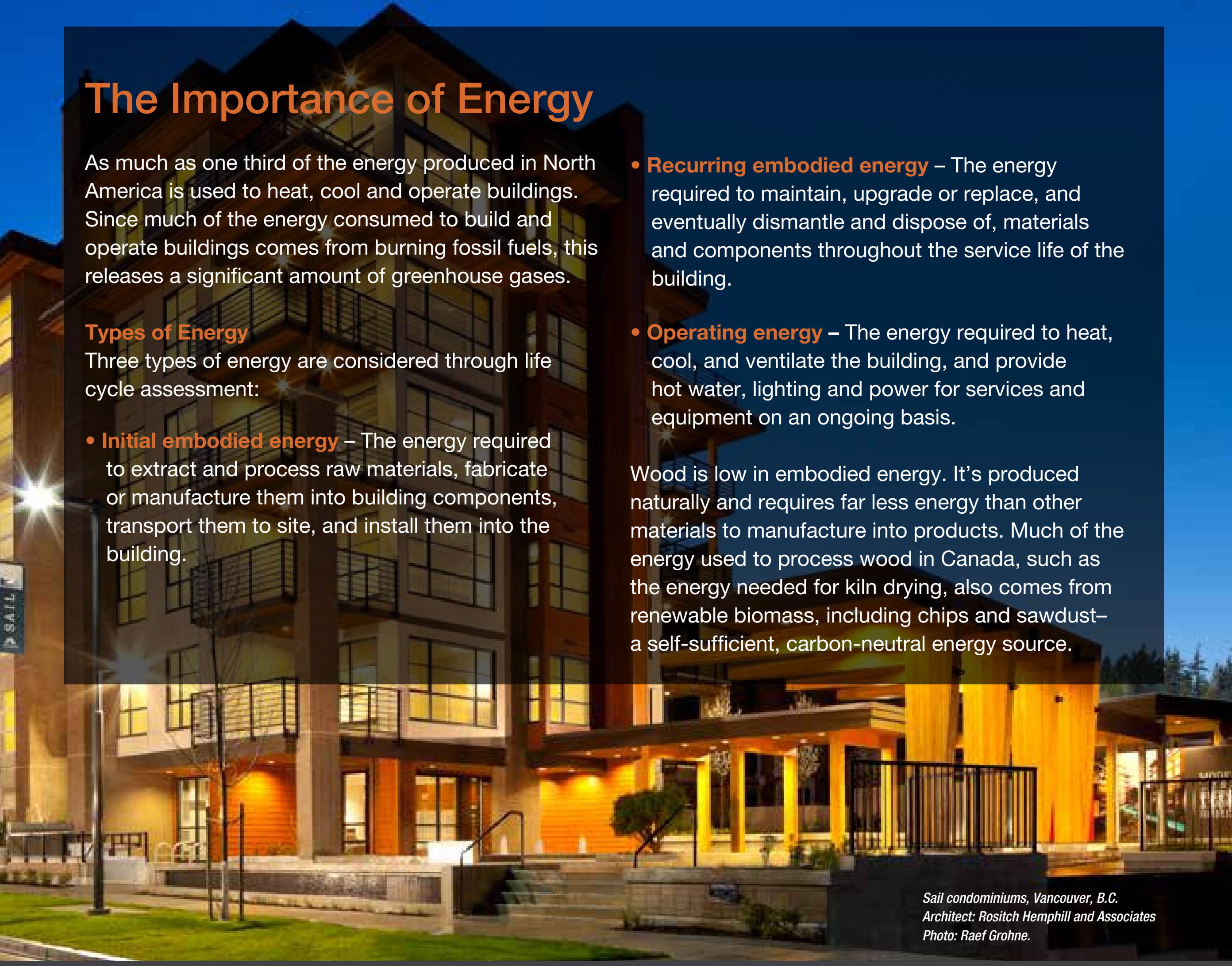
As much as one third of the energy produced in North America is used to heat, cool and operate buildings. Since much of the energy consumed to build and operate buildings comes from burning fossil fuels, this releases a significant amount of greenhouse gases.

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.



Sail condominiums, Vancouver, B.C.
Architect: Rositch Hemphill and Associates
Photo: Raef Grohne.

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 Unites 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.

[1] Canadian Wood Council 1997: Wood the Renewable resource No. 4 'Comparing the Environmental Effects of Building Systems'

Private residence
Whistler, B.C.
Photo: Peter Powles

The Evolving Relationship between Operating and Embodied Energy

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 Challenge[3] , "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."

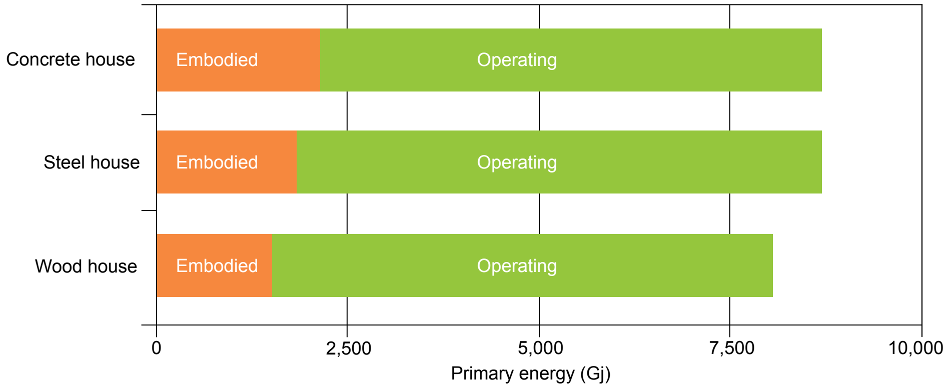
A recent case study of the Eugene Kruger Building at Laval University in Quebec[4] – carried out by Athena Sustainable Materials Institute – determined that the all-wood solution adopted for this 8,000-square-metre academic building resulted in a 40 per cent reduction in embodied energy compared to steel and concrete alternatives.

[2] 1.Cole, R.J. and Kernan, P.C. (1996), Life-Cycle Energy Use in Office Buildings, Building and Environment, Vol. 31, No. 4, pp. 307-317.

[3] 2030 CHALLENGE FOR PRODUCTS, http://www.architecture2030.org/files/2030products_cp.pdf

[4] For more information www.grap.arc.ulaval.ca/attaches/Potvin/ASES-Kruger.pdf

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.

[5] A comparative environmental impact assessment of alternative material single-family home designs, January 2004. P. 5

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.

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.[6] 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.

[6] NAHB Research Centre Inc, 2002: 'Steel versus Wood: Long Term Thermal Performance Comparison http://www.huduser.org/portal/publications/destech/steelval.html.

Green buildings

- Mitigate climate change
- Use less energy and water
- Use fewer materials
- Reduce waste
- Are healthy for people and the planet

On the cover:
Bioenergy Research & Demonstration Facility, University of British Columbia.
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British Columbia wood. Sustainable by nature. Innovative by design.