Building Green with Wood

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, provide hot water, lighting and power for services and equipment on an ongoing basis.

In Canada, much of the energy used to process wood, such as kiln drying, comes from burning on-site residues, including chips and sawdust. This is a self-sufficient, carbon-neutral energy source and, as a result, wood is low in embodied energy.

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, emit 15 per cent and 29 per cent more greenhouse gases, release 10 per cent and 12 per cent more pollutants into the air, and generate 300 per cent and 225 per cent more water pollutants.

Wood also does well when compared with concrete systems. Concrete can reduce the cost of cooling in climates like the southwest United States desert areas where there are large day-night temperature variations. Wood buildings with a high mass exterior finish, such as brick facing, can achieve the same benefits, potentially with less embodied energy.

In many scenarios, the variations in operating energy consumption between otherwise identical wood, steel and concrete buildings are small, and 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'

Green design reduces both operating and embodied energy. A typical concrete house has nearly as much energy embodied in the materials as it takes to run the house for 20 years.

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]

Now, high-performance commercial buildings are using 50 to 60 per cent less operating energy. As a result, embodied energy has assumed much greater importance – and may make up as much as 30 per cent of the overall life cycle energy consumption. In Europe, performance standards dictate even higher operating energy efficiency.

Studies such as the U.S. LCI Database Project[3], undertaken by the ATHENA Sustainable Materials Institute, have consistently demonstrated that buildings built primarily with wood will have a lower embodied energy than those built primarily with brick, concrete or steel.

A recent case study of the Eugene Kruger Building at Laval University in Quebec[4] – also carried out by ATHENA – determined that the all-wood solution adopted for this 8000-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 For more information please contact the ATHENA Sustainable Materials Institute or visit www.athenaSMI.ca and the National Renewable Energy Laboratory at http://www.nrel.gov/lci.

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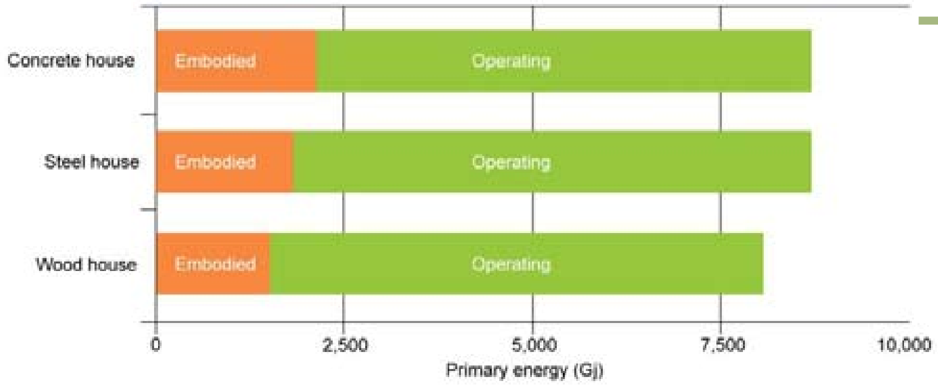
Wood Buildings Can Surpass Energy Standards



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 www.cwc.ca/NR/rdonlyres/FBEC3574-62E5-44E0-8448-D143370DCF03/0/EnergyAndEnvironment.pdf.

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. All houses are typically 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.

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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 in most climates than steel and concrete.

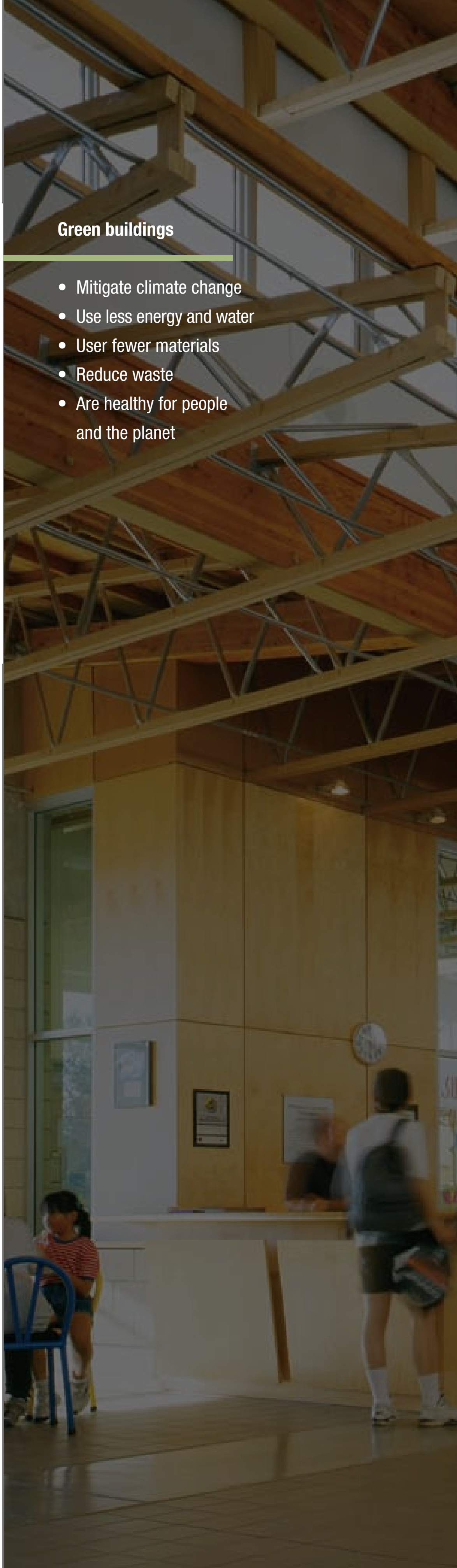
Due to its cellular structure and lots of tiny air pockets, wood is 400 times better than steel and 10 times better than concrete in resisting the flow of heat. As a result, more insulation is needed for steel and concrete to achieve the same thermal performance as with wood framing.

This graph shows the 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 NHBA Research Centre Inc, 2002: 'Steel versus Wood: Long Term Thermal Performance Comparison;



Green buildings

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