DEMONSTRATING THE BENEFITS OF LIFE CYCLE ASSESSMENT

REDUCING THE IMPACT OF THE BUILT ENVIRONMENT

The goal of green design is to achieve sustainability by designing and building structures that use less energy, water and materials, and minimize impacts on human health and the environment.

Life cycle assessment (LCA) supports this by providing an assessment of the resource consumption — including energy, emissions and waste — throughout the building's life. It means adding up the inputs and outputs for every framing member, panel, fastener, finish material, coating and other materials used in the building.

Pacific Autism Family Centre, Photo: Derek Lepper

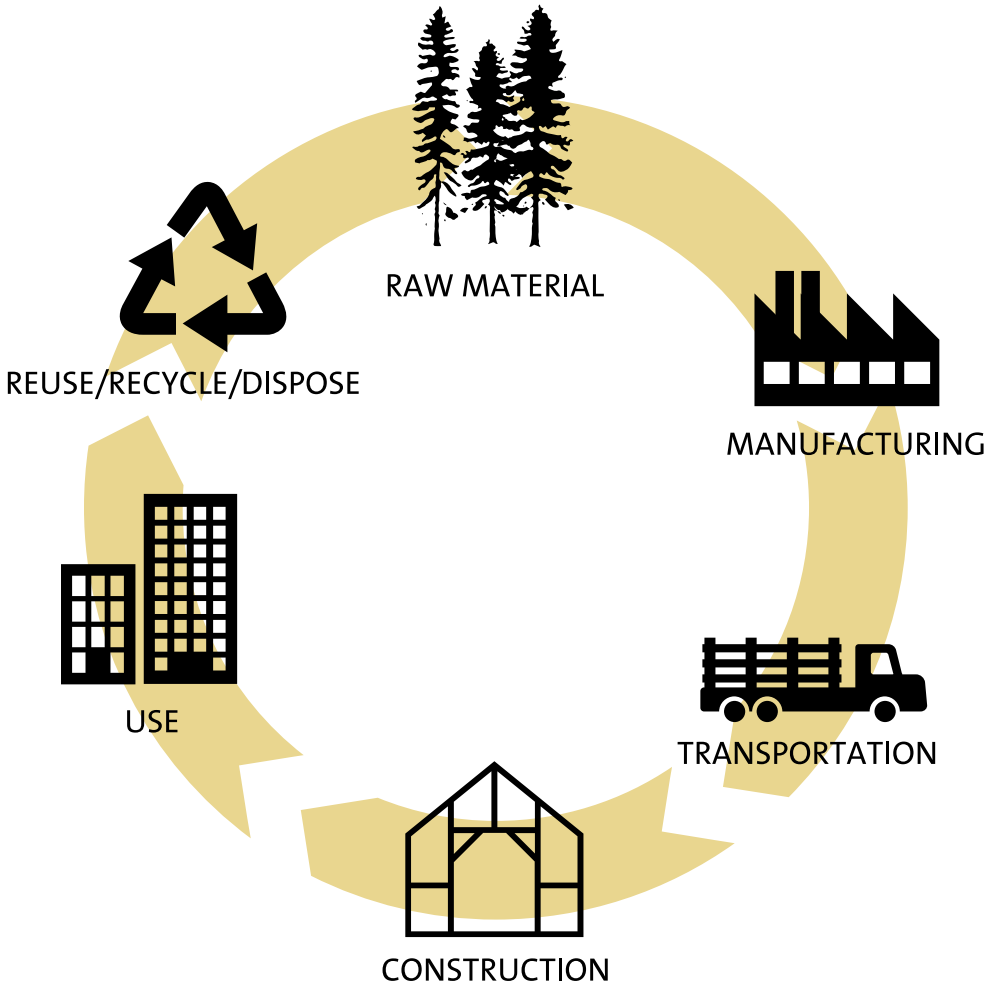
Using LCA to support the best environmental choice

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.

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 impartial comparison of materials and assemblies over their entire lives.

The most widely accepted scientific method to compare design choices and building materials effectively is 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.

Pacific Autism Family Centre, Photo: Derek Lepper



What is life cycle assessment?

LCA is a performance-based approach to assessing the impacts building material choices have on the environment at every stage of life — from the extraction of raw materials through manufacturing, transportation, installation/construction, use, maintenance, and reuse/disposal/recycling.

LCA is accepted around the world, and is a powerful tool for illustrating the full life-long environmental impacts of choosing one building material over another. It is incorporated into many green building rating systems.

LCA impact categories

The LCA studies for the following three projects followed LEED (Leadership in Energy and Environmental Design) v4 whole-building LCA credit requirements. Each began with a cradle-to-grave building LCA study that looked at product and construction, use and end-of-life, and then compared the environmental impacts of the original baseline design and a new proposed design.

The impact categories included:

- **Global warming** estimates the potential impact of emitted greenhouse gases, such as methane and nitrous oxide, which trap heat in the Earth's atmosphere and cause atmospheric warming.
- **Ozone depletion** estimates the potential impact of emitted gases such as chlorofluorocarbon (CFC), hydrochlorofluorocarbon (HCFC) and halons that break down the protective zone within the stratosphere and allow ultraviolet solar radiation to enter the Earth's atmosphere. This has a negative effect on crops and human and animal health.
- **Acidification** estimates the potential impact of emitted gases such as nitrogen oxides (NOx) and sulphur dioxide (SO_2) that cause acid rain and increase acidity in the soil that, in turn, has a negative effect on ecosystems and human health.
- **Eutrophication** estimates the potential impact of emitted substances such as nitrates, phosphates and ammonia that can increase nutrient levels of surface water, causing excessive algae growth that, in turn, can reduce oxygen in water, damaging aquatic ecosystems and increasing water toxicity.
- **Smog potential** estimates the potential mass of ground-level ozone produced by nitrogen oxides (NOx), emitted from fossil fuel combustion, and volatile organic compounds (VOCs), commonly found in solvents, when they are exposed to the heat of the sun, creating ground-level ozone that affects plant, animal and human health.
- **Non-renewable primary energy** estimates how much non-renewable primary energy is needed to transform or transport raw materials into building products, such as natural gas used to produce plastic materials.

While all the categories are important, global warming potential and use of non-renewable primary energy generally have the greatest environmental impact for building construction.

Bella Coola Valley, B.C., Photo: Michael Bednar

Tsleil-Waututh Administration & Health Centre, Photo: KK Law

Estimating the environmental impacts of three B.C. projects

This factsheet shows how design teams can use LCA to identify ways to reduce environmental impacts, focusing on three innovative structures in British Columbia:

- **Pacific Autism Family Centre, Richmond**
- **Tsleil-Waututh Administration & Health Centre, North Vancouver**
- **The Heights, Vancouver**

The LCA for each project followed the LEED v4 whole-building LCA credit, which awards points for reductions in environmental impact to encourage designers to explore early design alternatives. LEED promotes sustainability focused practices in the building industry.

The LCA credit uses six impact categories, defined on the previous page, to compare the environmental performance of two functionally equivalent designs. The **proposed** design must demonstrate a lower environmental impact relative to a hypothetical early stage design of the building, referred to as the **baseline** design, so it can earn the LEED whole-building LCA credit points.

Pacific Autism Family Centre

The Pacific Autism Family Centre, which opened in 2016, brings together resource, education and recreation facilities to address the growing challenge of autistic spectrum disorder, the most common neurological disorder in children in British Columbia.

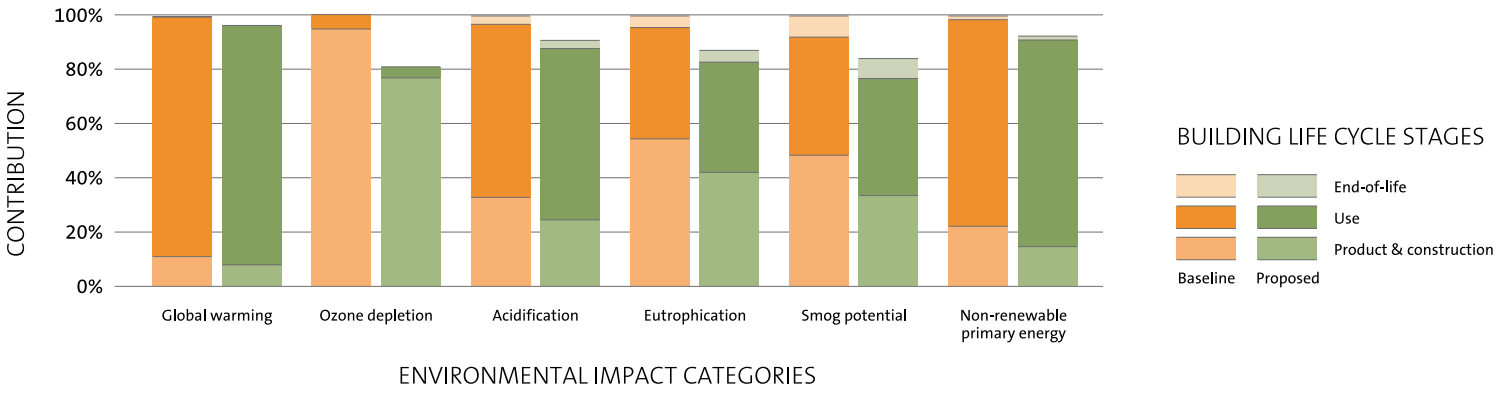
The three-storey, 5,600-square-metre structure in Richmond was designed to present a calming environment, including oversized waiting areas to prevent feelings of claustrophobia or confinement. Wood reinforced the welcoming atmosphere, and offered a cost-effective structural solution with long spans that could accommodate future reconfiguration should the needs of autism research and treatment change.

Comparing environmental impacts

The Pacific Autism Family Centre, on average, had an environmental impact that was 11% lower than the baseline design — with improvements in all six impact categories. This was achieved primarily by using engineered and solid wood floor and roof systems supported on engineered wood beams and columns. The baseline design recommended composite metal floor and roof systems supported on wide flange steel beams and columns.

By using engineered and solid wood floor and roof systems, the Pacific Autism Family Centre reduced its global warming impact related to material use in the structure (embodied carbon) by 27% or 600 tonnes CO_2 equivalent.

Comparison of building life-cycle impacts for Baseline and Proposed designs



Pacific Autism Family Centre, Photo: Derek Lepper

Tsleil-Waututh Administration & Health Centre

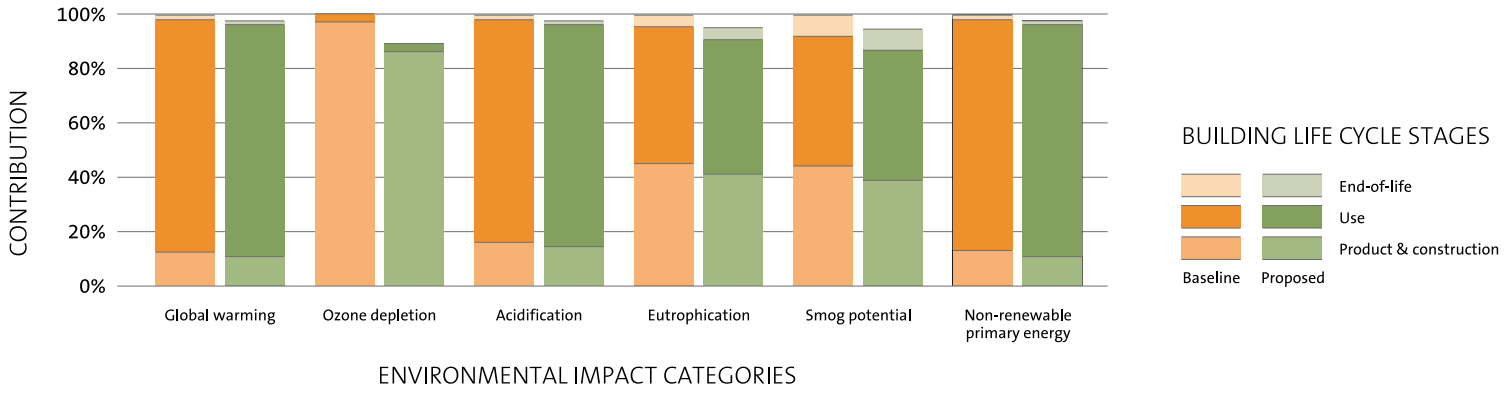
The 2,900-square-metre Tsleil-Waututh Administration & Health Centre, which opened in North Vancouver in 2017, is a hub for the Nation's administration, governance, health and social services. It is expressive of Tsleil-Waututh's philosophy and cultural heritage, and the undulating roof celebrates in architectural form the symbiotic relationship between the Tsleil-Waututh people and the sea. Wood is featured prominently in the structure and finishes, emphasizing the relationship to the natural world — and allowing the use of both traditional and innovative building techniques.

Comparing environmental impacts

The Tsleil-Waututh Administration & Health Centre, on average, had an environmental impact that was 3% lower than the baseline design with improvements in four of the six impact categories. This was achieved by using wood studs and I-joists and nail-laminated timbers rather than the steel studs and joists and concrete suspended slabs proposed in the baseline design.

By using wood studs and I-joists and nail-laminated timbers, the Tsleil-Waututh Administration & Health Centre reduced its global warming impact related to material use in the structure (embodied carbon) by 16% or 200 tonnes CO_2 equivalent.

Comparison of building life-cycle impacts for Baseline and Proposed designs



Tsleil-Waututh Administration & Health Centre, Photo: KK Law

The Heights

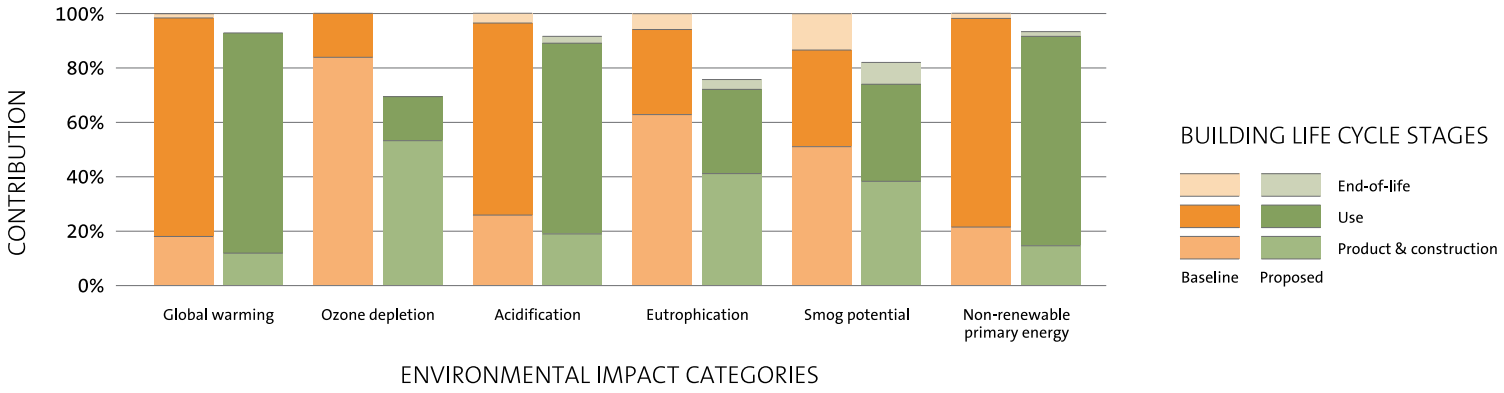
The Heights is a six-storey, mixed-use building that opened in 2017 in the Vancouver Heights neighbourhood. The basement parking garage and street level retail space are built with concrete, and this is topped by five storeys of wood-frame residential accommodation. The 5,600-square-metre structure has 85 apartments and is the largest Passive House certified building in Canada. Wood-frame construction is both the most economical choice for this structure and contributes to the overall performance of the building envelope.

Comparing environmental impacts

The Heights, on average, had an environmental impact that was 16% lower than the baseline design with improvements in all six impact categories. This was achieved by using engineered and solid wood floor and roof systems instead of reinforced concrete.

By using engineered and solid wood floor and roof systems, the Heights reduced its global warming impact related to material use in the structure (embodied carbon) by 31% or 800 tonnes CO_2 equivalent.

Comparison of building life-cycle impacts for Baseline and Proposed designs



The Heights, Photo: Cornerstone Architecture

Getting started with LCA

The good news is that user-friendly LCA tools provide life cycle impact information for many generic building assemblies, and these can be used to develop a whole-building LCA. Data is also available for many products in the form of easy-to-understand, standard format environmental product declarations (EPD).

Simplified whole-building LCA tools operate on a bill of materials and other information about the building, providing cradle-to-grave LCA results without requiring users to have LCA expertise.

Providing measurable details about a building's environmental impacts offers wide benefits. Its primary benefit is to equip the design team with the information needed to reduce environmental impacts over a business-as-usual design. It gives design teams a competitive advantage by positioning them as industry leaders. Clients can use the information to inform their marketing and climate change mitigation strategies.

As green building programs in North America shift from prescriptive to performance provisions, they turn to LCA and other analytical tools to award credits.

LCA Checklist

- ☐ LCA tools
- ☐ Design drawings
- ☐ LCA data
- ☐ Bill of materials

The Heights, Photo: Cornerstone Architecture

The wood grain featured in this factsheet is Douglas fir.

FOR MORE INFORMATION

For more information on Life Cycle Assessment and the innovative use of wood in B.C. buildings, visit www.naturallywood.com.

- Green Building
- Life Cycle Assessment
- Project Gallery

This life cycle assessment summary is published by Forestry Innovation Investment, the Government of British Columbia's market development agency for forest products.

For more examples of innovative wood building projects, visit

naturallywood.com