



## **Embodied Carbon**

Carbon emissions reflect our carbon footprint when we burn oil and gas, for example. Embodied – or “upfront” carbon - reflects our carbon footprint when we construct a building or manufacture products.

When it comes to buildings, embodied carbon defines the carbon dioxide (CO<sub>2</sub>) emissions associated with materials and construction processes throughout their whole lifecycle.

It includes any CO<sub>2</sub> created during the manufacturing of building materials, the transport of those materials to the job site, and the construction practices used.

Embodied carbon is the carbon footprint of a building or infrastructure project *before* it becomes operational.

Together, building materials, construction, and building operations account for 40 percent of total global annual CO<sub>2</sub> emissions. Of that, we can attribute a third to embodied carbon.

## **The Building Sector**

In Canada the building sector is the third largest GHG emitter. There are two categories:

1. Upfront (embodied) emissions: the portion of GHGs resulting from materials and construction processes up to completion. It includes resource extraction, transportation, refining and manufacturing before delivery, delivery to customer, construction, installation and construction waste; and once built - maintenance, renovation, demolition and disposal.
2. Operational emissions: they result from heating, cooling, lighting and powering the mechanics and systems in a building.

Upfront carbon emissions in the building sector account for 11% of global greenhouse gas emissions.

## **Upfront Carbon Emissions**

These emissions vary with the type of building materials. The most carbon intensive materials are concrete, steel, aluminum, and insulation. World-wide, concrete is the biggest source of embodied carbon - 8%.

Steel is also high in embodied carbon. Aluminum is the most carbon intensive of all building materials. Aluminum is used for example, for framing for high rise windows and window walls. Its life cycle is limited; then it needs to be replaced. High-rises are by far the most carbon intensive buildings for both embodied and operational emissions.

High rises require a lot of concrete and steel for stability. The taller the building, the more concrete, and the more steel are needed.

Tall buildings are clad with window walls and curtain walls (a wall that encloses the space within a building, but does not support the roof). They have the highest carbon intensity of all building cladding, because the framing is aluminum.

Tall buildings require more energy to *operate* because they typically have a large glass area which is difficult to heat and cool. They also require services that raise water, coolant, people and air to great heights; and these heights must be offset by deep underground foundations.

Toronto has the third highest number of skyscrapers in North America. Typically, in large cities, buildings are built – and buildings are torn down. Demolition comes with its own heavy carbon footprint.

### **What Needs to Change?**

Cities must include upfront carbon in their carbon budgets. One case study recommends that governments change the rules of development to reduce the impact of the industry. They would require a carbon budget for each new development. They would not approve buildings beyond a scale that can be made carbon neutral. This should include benchmarks for what is currently permissible. But more to the point, their targets and timelines must include what will be permitted in the future.

In this way, we could see at least a 50% reduction in embodied carbon emissions by 2030.