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ServerFarm

Whole Building Life-Cycle Analysis Report

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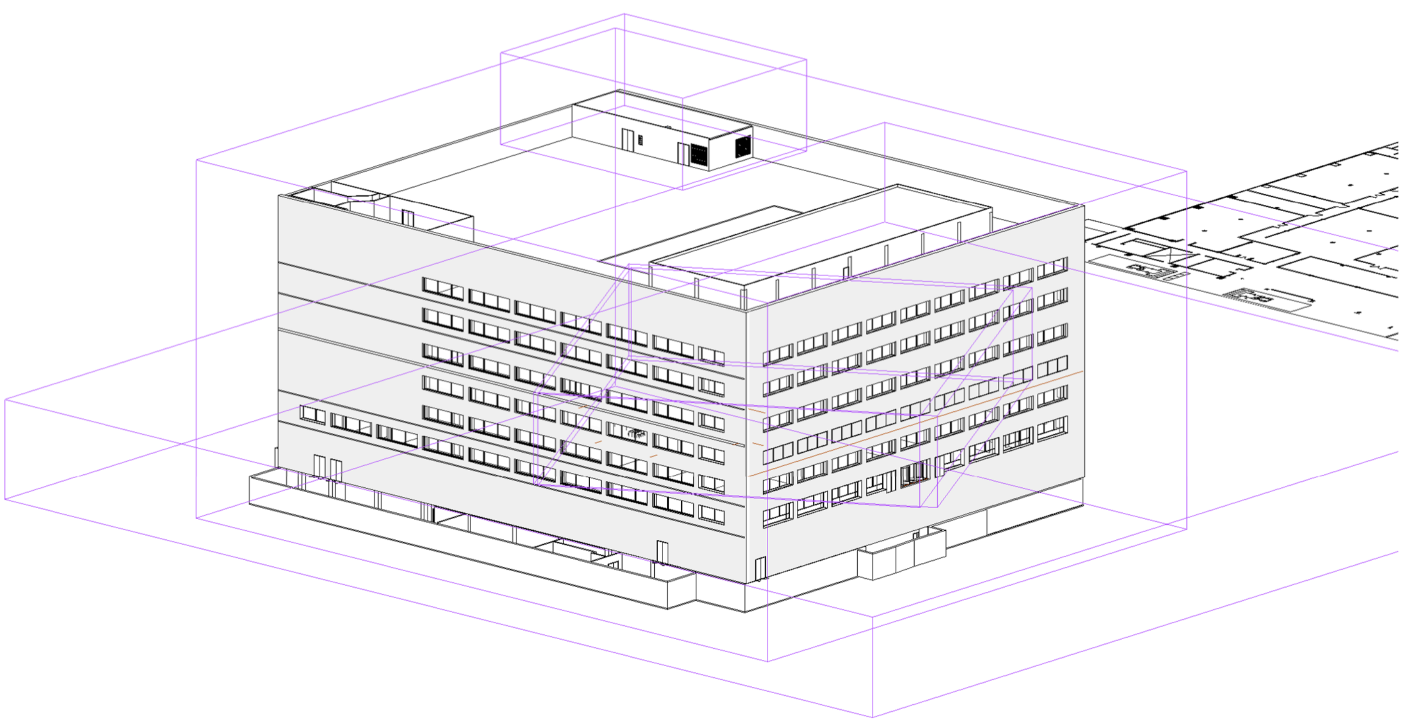
Executive Summary

The building being analyzed is an existing data-center in Chicago, Illinois. This building is 6-stories tall and includes data halls, office spaces, electrical equipment, basement, and other auxiliary spaces. The materiality of this building is assumed to be the industry standard for newly constructed data centers. As such, it is considered to have a concrete structure, concrete precast panels for the enclosure, and epoxy flooring in the data halls.

The purpose of this Whole Building Life-Cycle Analysis is to (1) create a baseline for a standard newly constructed data center, (2) compare it with a low carbon concrete option and with a building reuse option, and (3) draw conclusions applicable to the industry at large that can further reduce CO_2 emissions. Concrete is the most significant contributor to the embodied carbon of this building, so the analysis looked at the impact of low carbon concrete.



Methodology Used and Results

To perform the Whole Building Life-Cycle Analysis, the team used the software Tally, which is an application that allows architects and engineers to quantify the environmental impact of building materials. Tally combines an extensive library of industry standard Environmental Product Declarations (EPD) with information supplied by a Revit building model to model the environmental impact of a particular building.

Based on the results obtained from the Whole Building Life-Cycle Analysis performed, **reusing this building eliminates the carbon emissions for a standard new construction building resulting in a modeled 88% embodied carbon emission reduction.** The elimination of the embodied carbon associated with building reuse is equivalent to the operational carbon of 200 server cabinets operating in a year. The equivalency of reusing a building compared to a new construction is the same as the operational carbon in a year of 2-3 commercial office buildings.

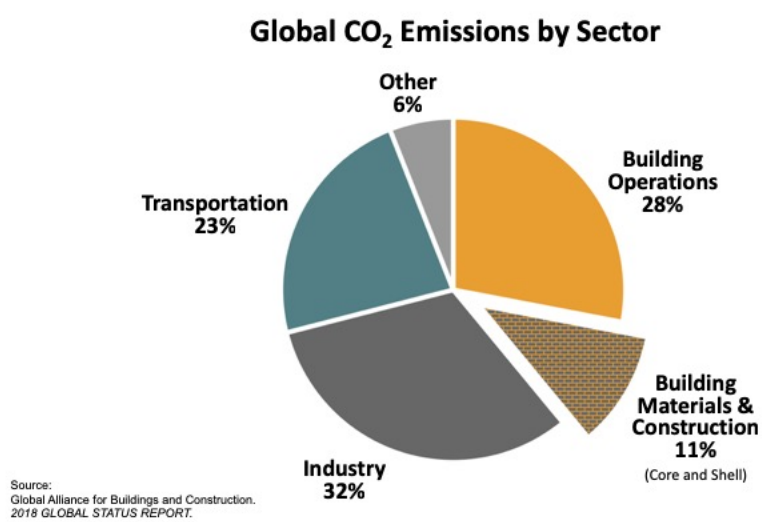
Building Carbon Emissions

Embodied Carbon and Climate Change

Buildings and construction directly represent around 39% of all annual global greenhouse gas emissions. These emissions can be divided into two categories, building operations and building materials & construction. Each represents the operational carbon and the embodied carbon of buildings respectively. Operational carbon is all carbon emissions associated with the fuels needed to power any building. Embodied carbon is the amount of CO_2e emitted during manufacture, transport, construction, maintenance and end of life/disposal of building materials. Operational carbon has been addressed for years now, by promoting energy saving measures and renewable energy sources. Embodied carbon on the other hand has been generally ignored and is now starting to gain attention. According to the Architecture 2030 and The Carbon Leadership Forum, annually the embodied carbon of building structure, substructure, and enclosures are responsible for 11% of global GHG emissions and 28% of global building sector emissions. Eliminating these emissions is key to addressing climate change and meeting Paris Climate Agreement targets.

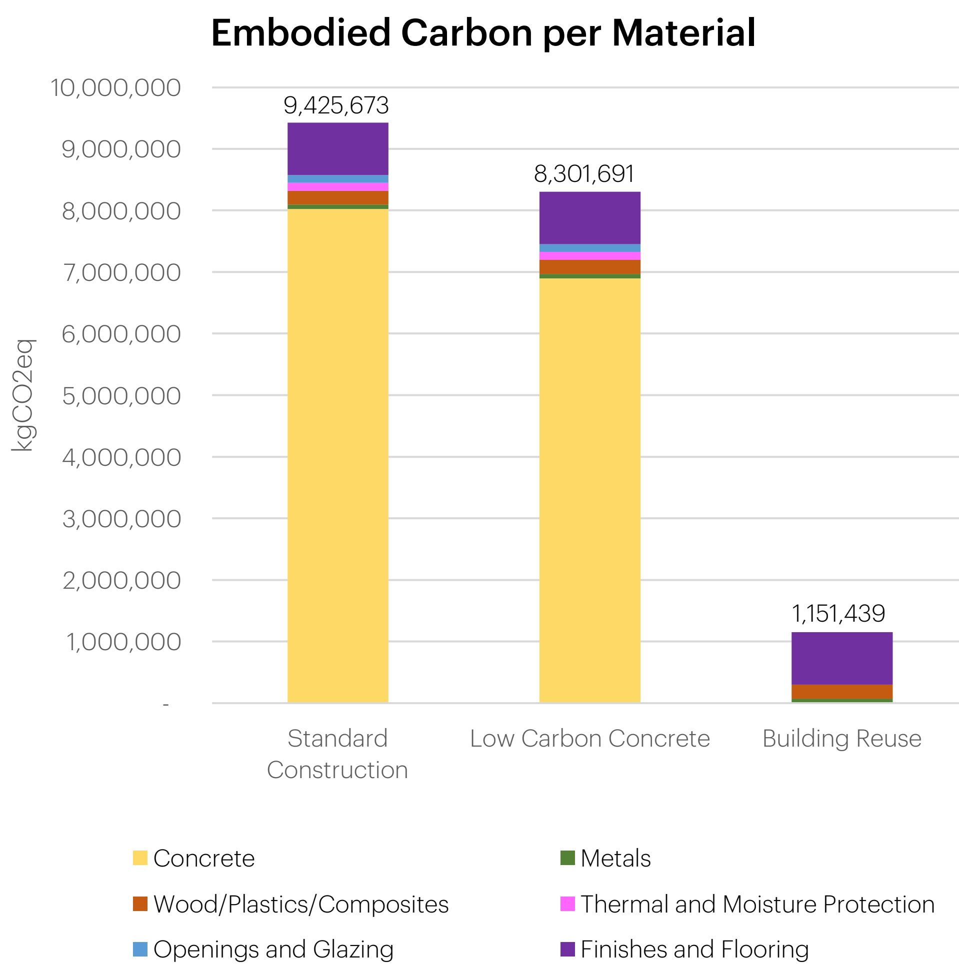
It is of great importance to address both type of carbon emissions, but especially embodied carbon as it represents an upfront amount of emissions associated with a building. By reducing these emissions, we can generate meaningful impact quickly, compared to the long-term emissions associated with operational carbon. Another argument to address embodied carbon is that the energy industry is tending towards a carbon neutral grid, which would eliminate the operational carbon of buildings in the future, while embodied carbon of materials will remain constant.

Figure 1—Global CO2 emissions by sector, https://architecture2030.org/buildings_problem_why/



Embodied Carbon

The graph shows the embodied carbon for the same building in three different scenarios. The first one is a standard new construction, the second is a standard new construction with a low carbon concrete, and the third is reusing an existing building. These scenarios are broken down per material, showing how concrete is the main contributor of embodied carbon in this case.



Material Breakdown per Scenario

Standard Construction
Structure
- Concrete (0-19% fly ash/slag)

Floors
- Epoxy flooring in server halls

Roofs
- Polyisocyanurate board
- SBS modified bitumen

Partitions
- Metal studs
- Gypsum boards

Exterior enclosure
- Precast concrete panels (0-19% fly ash/slag)
- Extruded polystyrene

Low Carbon Concrete
Structure
- Concrete (50% fly ash/slag)

Floors
- Epoxy flooring in server halls

Roofs
- Polyisocyanurate board
- SBS modified bitumen

Partitions
- Metal studs
- Gypsum boards

Exterior enclosure
- Precast concrete panels (50% fly ash/slag)
- Extruded polystyrene

Building Reuse
Floors
- Epoxy flooring in server halls

Partitions
- Metal studs
- Gypsum boards

Other Environmental Impacts

In a Life-Cycle Analysis, embodied carbon is only one of the environmental impacts that are studied. The other impact categories are the following:

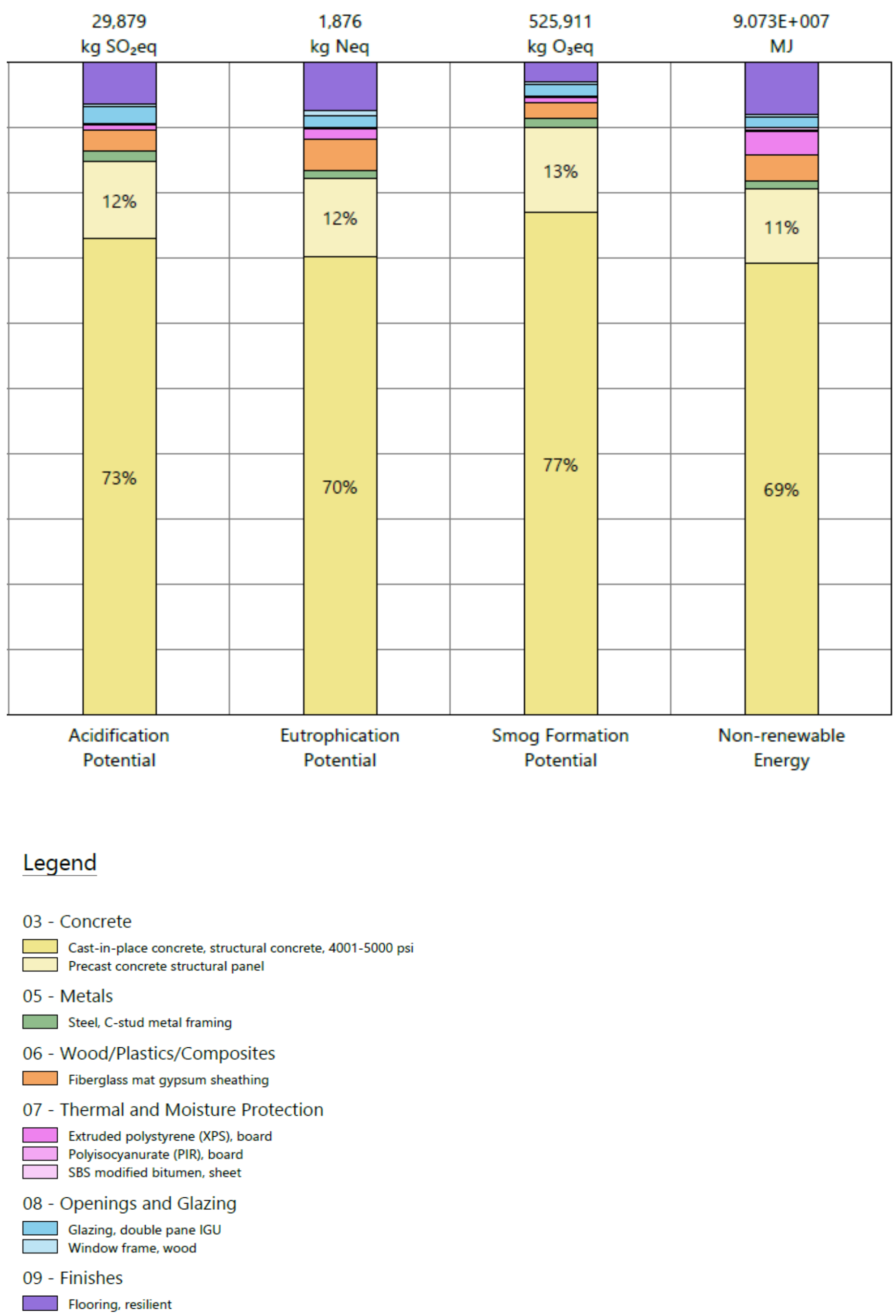
Acidification Potential: Emissions which Increase acidity of water and soils. Most common form of deposition is as acid rain.

Eutrophication Potential: The pollution state of aquatic ecosystems in which the over-fertilization of water and soil has turned into an increased growth of biomass.

Smog Formation Potential: Increased formation of ground level ozone. Can have effects on human health and vegetation.

Non-renewable Energy: Source of energy that eventually will run out.

Standard Construction



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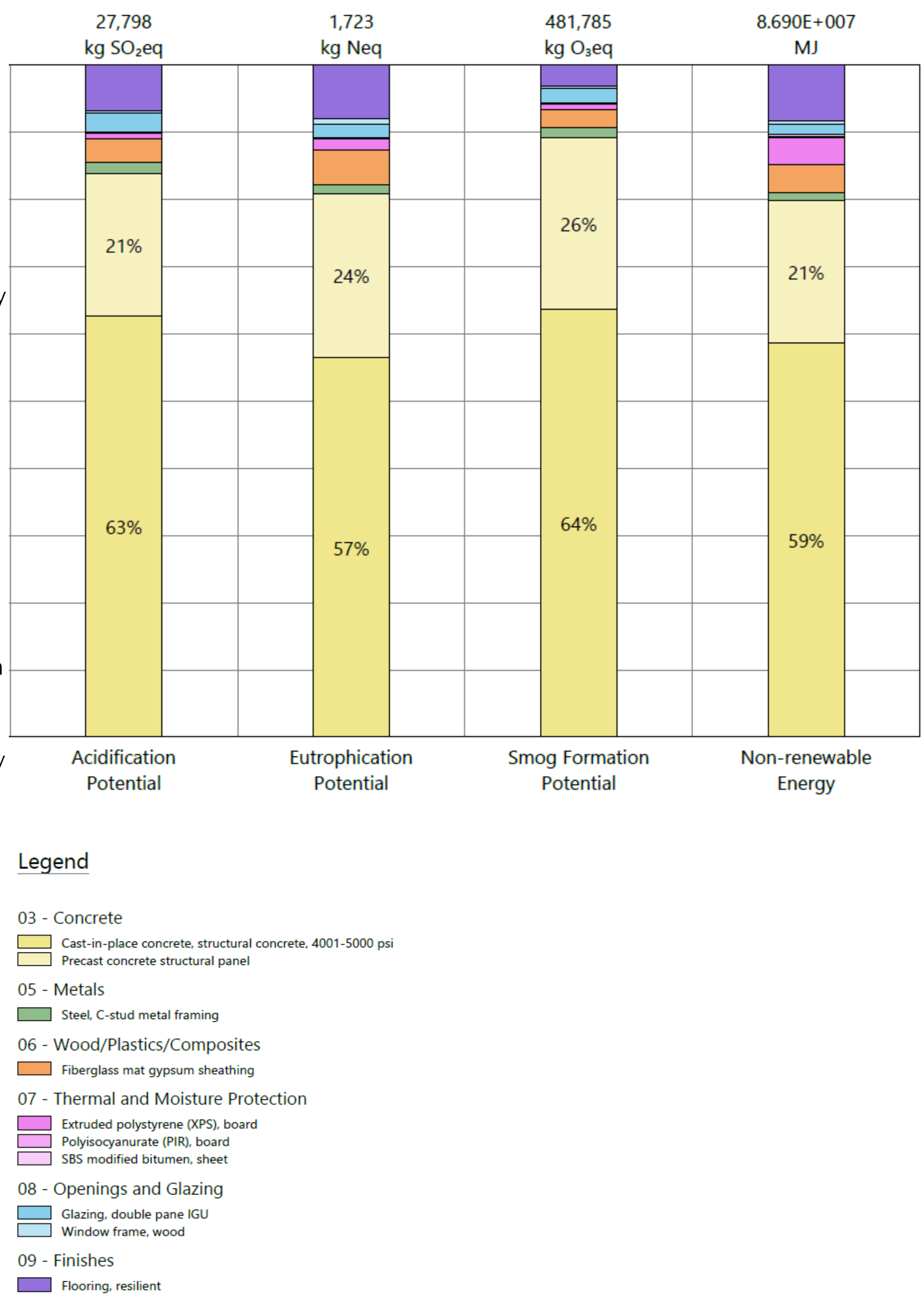
Low Carbon Concrete



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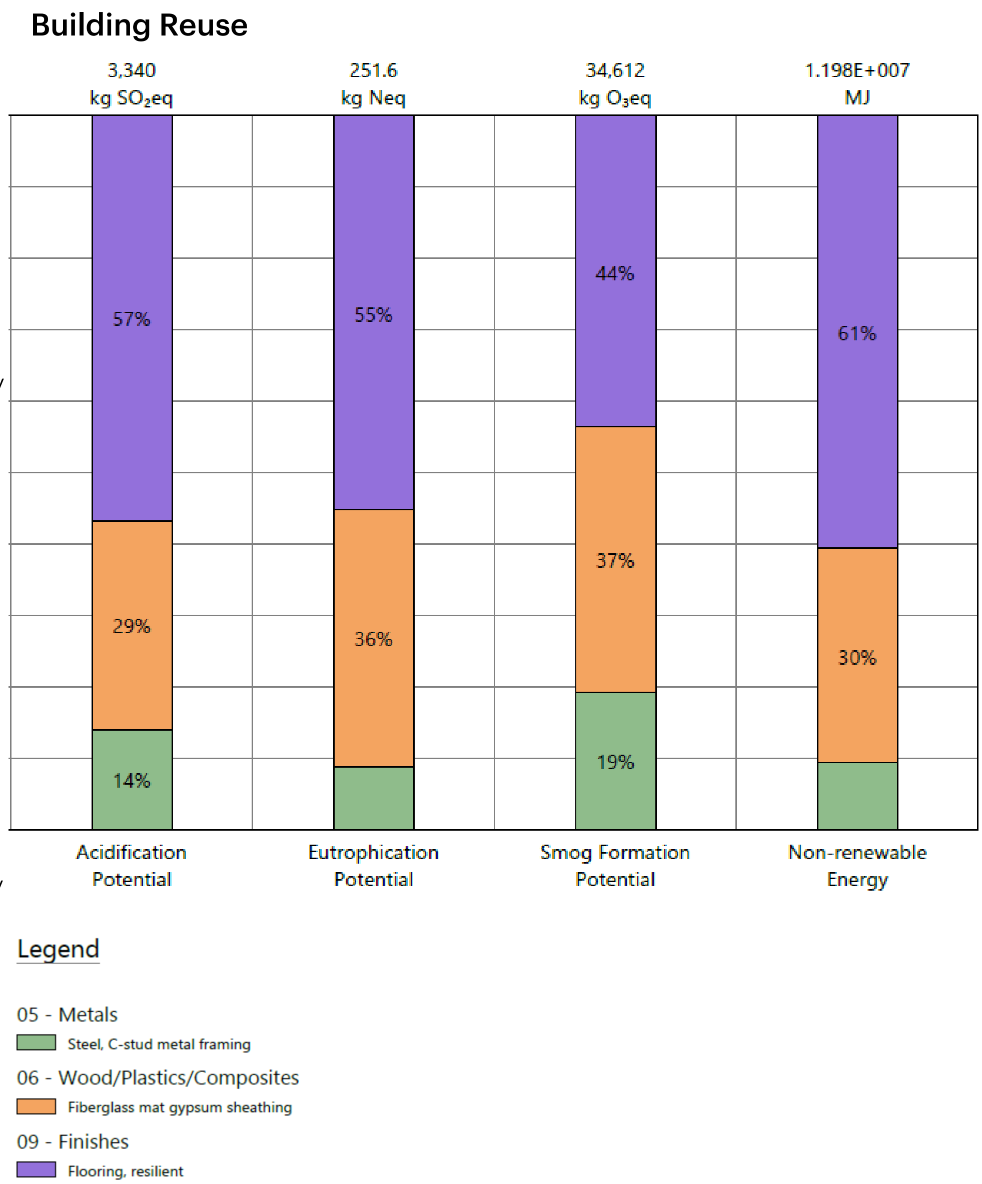

Appendix

Complete results from the Whole Building Life-Cycle Analysis.

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