MITOS Scope 3 Greenhouse Gas Emission Factors: **Construction**

Emissions Calculation Documentation

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Motivation

The purpose of estimating MIT's emissions from building construction is to enable MIT to transparently report emissions contributions, to raise awareness of impacts and to identify opportunities for reduction. The evaluation of scope 3 greenhouse gas (GHG) emissions at MIT, particularly those related to construction, constitutes a fundamental aspect of MIT's Fast Forward initiative. Fast Forward: MIT's Climate Action Plan for the Decade, requires MIT to evaluate and expand its greenhouse gas portfolio accounting to include priority scope 3 emissions (e.g., purchased goods and services, sponsored MIT business travel, construction). Calculating scope 3 GHG emissions enables MIT to make comparisons across different scope 3 categories and with scope 1 and 2 emissions over time, thereby enabling data-driven decision-making around priority areas to target for GHG emissions reductions. Following GHG protocol, we looked at category 2, capital goods, to evaluate MIT's scope 3 emissions related to construction projects on campus.

Scope

The scope of MIT's construction GHG emissions includes all construction done on MIT's campus. This category breaks down into three groups; new construction, renovations, and maintenance. New construction refers to all newly constructed buildings on MIT's campus. Renovations refers to all construction projects on existing MIT buildings. Maintenance encompasses minor modifications done to existing buildings on MIT's campus. While Scope 3 emissions factors category 2, capital goods, encompasses all costs related to construction works, including the cost of equipment and insurance, these expenses are not included in MIT's total expenditures for construction works. MIT's construction GHG emissions focuses solely on what is contributed from MIT only, such as the materials used. Since equipment and insurance is usually covered by the contractors, this would not be included under MIT's contribution.

Approach

There are two primary approaches for calculating GHG emissions. The first approach is process-based life cycle assessment (LCA), which uses data about construction quantities and building energy consumption. This detailed data is not consistently reported in MIT construction projects. The second approach is environmentally extended input-output (EEIO) LCA, which uses data about the amount spent on construction. Process-based LCA is preferable for decisions about specific buildings and their respective projects. EEIO LCA is an effective way to evaluate overall trends in emissions and compare them against other types of activities. Data on MIT construction is available from the Campus Services and Stewardship Office. The office tracks total spending across multiple projects, but it does not collect data on equipment used or insurance purchased. For simplicity, a good assumption is that 65% of project costs are directly related to construction (the other 35% is soft costs for design service, insurance and project management related costs). For our calculations, we looked solely at this 65% of the total expenditures reported. As such, we use the EEIO LCA approach to estimate GHG emissions. Our approach relies on one main equation, which allows us to calculate GHG emissions using spending:

$$GHG\ Emissions_{Activity} = Cost_{Activity} * GHG\ Emission\ Factor_{Activity}$$

Construction activities are separated into three categories; new construction, renovation, and maintenance. The GHG emission factors associated with these activities are [from the United States Environmentally-Extended Input-Output (USEEIO)] modeling framework, developed by the US Environmental Protection Agency (EPA). The USEEIO activities are organized by North American Industry Classification System (NAICS) codes.

The USEEIO model is based on input-output data from the year 2021, so evaluating data from different years necessitates adjusting prices to account for inflation. To do this, we use the equation:

$$Expense_{reference\ year} = Expense_{fiscal\ year} * \frac{CPI_{reference\ year}}{CPI_{fiscal\ year}}$$

For our calculations, the reference year is held constant at 2021 and the fiscal year ranges from 2019 to 2023. 2021 was used as the reference year because it allowed us to match the USEEIO emission factors to the expenses since v2.0 of the USEEIO is based on the economy in 2021. With all of the expenses adjusted for inflation, based on the 2021 model, we were able to compare GHG emission factors across all years.

Data Sources

Data on MIT construction expenses is extracted from the Vice President for Campus Services and Stewardship (VPCSS) for new constructions and renovations, and one from MIT Facilities for maintenance-specific costs. Both data sources provide the total amount of expenses spent on each project/category, but they do not go into detail as to how the total expense was divided up throughout the project.

Table 1: Mapping MIT Construction Expense Categories to USEEIO v2.0 NAICS Codes and Emissions Factors

Construction Categories	NAICS Codes for USEEIO Emissions Factors	CO_2 Emission Factors (provided by USEEIO) (in tons of CO_2 per dollar)
New Construction	233262	0.256
Renovations and Renewals	230301	0.283
Maintenance	230301	0.283

Visualizations

Calculated emissions and spending totals are presented in a dashboard created using Tableau. The dashboard includes construction GHG emissions and spending for fiscal years starting with FY2015. GHG emissions and spending can be compared directly to demonstrate that they are not proportionally identical. That is, high spending in one type of activity does not necessarily correspond to high GHG emissions in that category.

Here is the dashboard visible on [MIT's Sustainability Datapool Website](#):

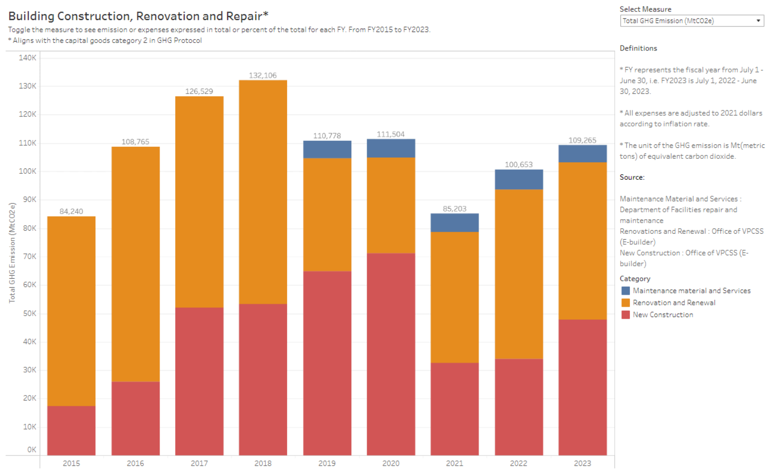

Figure 1: Building Construction, Renovation and Repair

Uncertainty

As the significance of scope 3 emissions becomes increasingly clear, access to data and improvements to reporting will likely follow suit. The estimation of GHG emissions from spend data using the EEIO LCA approach presents several sources of uncertainty. While the approach provides a comprehensive estimate of the interdependent contributions of various sectors of the economy to a particular sector of interest, it is an approximation of an entire sector. Hence, it does not enable analyses of specific products or processes. In addition, the use of a US model assumes that all activities took place in the US and the spending followed US inflation trends, which is likely not correct for all construction. We have not been able to calculate the exact amount of uncertainty due to these factors, but it is clear that the GHG estimates should be viewed as approximations that can be used to identify trends over time, make high-level comparisons of different activity categories, and identify priority activities for decarbonization. Once priority areas have been identified, more detailed analyses can be done using process-based LCA methods.