Oregon University System – Climate Action Planning
Embodied Greenhouse Gas Emissions in OUS Purchased Goods and Services
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OVERVIEW AND RESULTS

A life-cycle greenhouse gas (GHG) analysis using Carnegie Mellon's *Economic Input-Output Life-Cycle Assessment (EIO-LCA)* model was conducted for all supply chain purchases (including goods, food and services) by the Oregon University System's (OUS) seven institutions in fiscal year 2008. This analysis estimates the quantity of GHG emissions produced during the course of raw material extraction, production and transportation of goods and services, up to the point of retail.

The responsibility for embodied emissions in purchases is not equal to the responsibility for emissions produced directly by operations and owned equipment, such as the combustion of fossil fuels. The embodied emissions are clearly *shared*, as the responsibility for the activities is in the hands of both vendors (who control the production processes directly) and OUS institutions, which purchase (and rely upon) the fruits of these labors.

Figure 1 presents the scale of the embodied emissions estimated in this analysis. It compares the embodied emissions in OUS's purchased goods, food and services (Scope 3 – supply chain) to all other OUS fiscal year 2008 emissions sources (Scopes 1, 2 and all other Scope 3 sources required by ACUPCC), aggregated by Scope category. As can be seen, the embodied emissions at ~232,000 metric tons of carbon dioxide equivalent (MT CO_2e) are almost equal to all Scopes 1 and 2 emissions combined (~244,000 MT CO_2e). This result may be surprising, but consider that this estimate of embodied emissions includes purchases totaling more than $600 million.

Figure 1: Embodied emissions in the OUS supply chain versus other GHG inventory emissions sources.

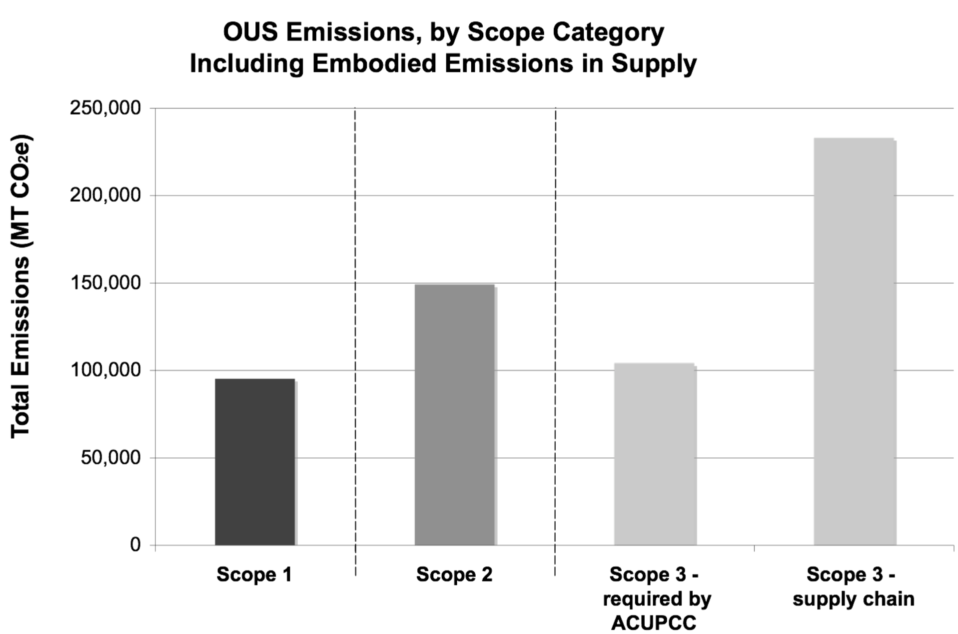


Figure 2 presents the results of the analysis in greater detail. Expenditures for fiscal year 2008 are shown in the center column, while total emissions for each individual university are shown in the far right-hand column. The scale of embodied emissions for each institution roughly correlates with the scale of expenditures. As such, 66% of the estimated embodied emissions result from the purchases of OUS's two largest institutions, Oregon State University and the University of Oregon, that together represent about 65% of purchases considered here.

Figure 2: Fiscal year expenditures and embodied emissions in purchases, by institution.

Institution	2008 Fiscal-Year Expenditures (included in analysis) $	Total Emissions MT CO_2e
Eastern Oregon University	$7,595,934	**3,465**
Oregon Institute of Technology	$19,441,690	**7,208**
Oregon State University	$212,949,292	**84,917**
Portland State University	$123,938,519	**42,394**
Southern Oregon University	$31,089,760	**12,897**
University of Oregon	$188,347,875	**69,809**
Western Oregon University	$29,188,263	**12,228**
OUS Totals:	**$612,551,332**	**232,917**

Figure 3 presents the total embodied emissions from five aggregated purchasing categories. The first four categories listed below are large discrete categories (buildings, resale merchandise, information technology, printing) of individual expense accounts grouped by like items, while the last is a catchall category for items that do not fit into any of the first four categories.

- **Buildings:** Includes the labor and materials used in building construction, renovation and maintenance as well as the rental of various types facilities.
- **Resale Merchandise:** Includes all items purchased for resale at on-campus stores. This group includes a wide variety of items including foods, health care products, clothing, computers, books, etc.
- **Information Technology:** Includes computer and telephone hardware, software and associated services.
- **Commercial Printing:** Includes commercial printing, materials duplication (copying), book publishing and book, reference materials and periodical purchases.
- **Other Goods and Services:** Includes "all other" goods and services that were not included in the first four categories and were not large enough to be grouped into a separate category. This category includes widely disperate economic sectors that include: laboratory chemicals and equipment, office supplies, vehicles, furniture, catered food, medical services, legal services, insurance, veterinary services, advertising, real estate services and office administration.

Figure 3 shows that building-related embodied emissions are the largest aggregated category, contributing 43% of OUS's embodied emissions. This is typical for organizations with large building portfolios, such as higher education institutions or municipal governments. The next largest large discrete category is resale merchandise at 15%, which is not surprising considering that OUS institutions spent nearly $40 million procuring items for resale, of which about 75% are food items that generally have large emissions factors.

Due to space limitations in this memo the full detail of EIO-LCA analysis is not included. The process is fully captured and transparent in an accompanying Excel spreadsheet that is available upon request.

Figure 3: FY2008 embodied emissions by purchasing category.

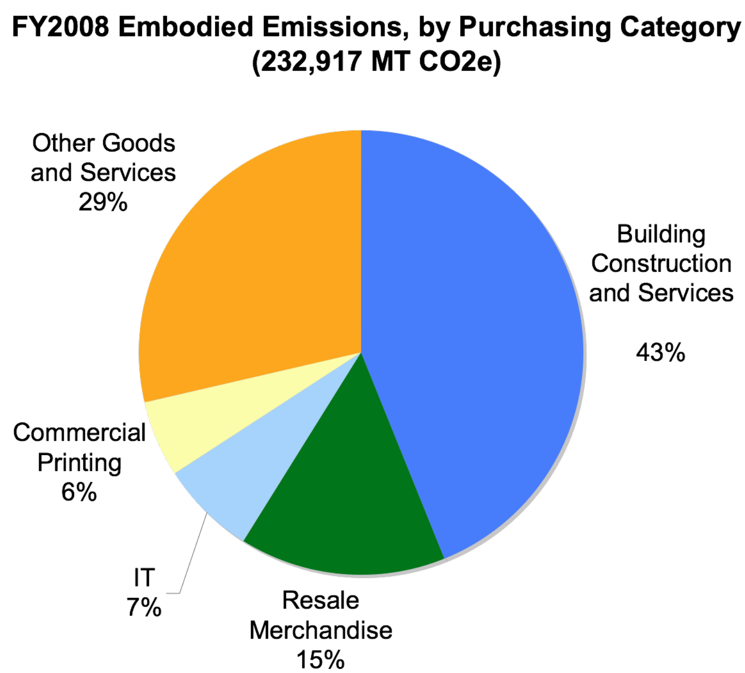


Figure 4 presents the results of the analysis in full detail.

Figure 4: Embodied emissions in purchased goods and services, by institution and purchasing category.

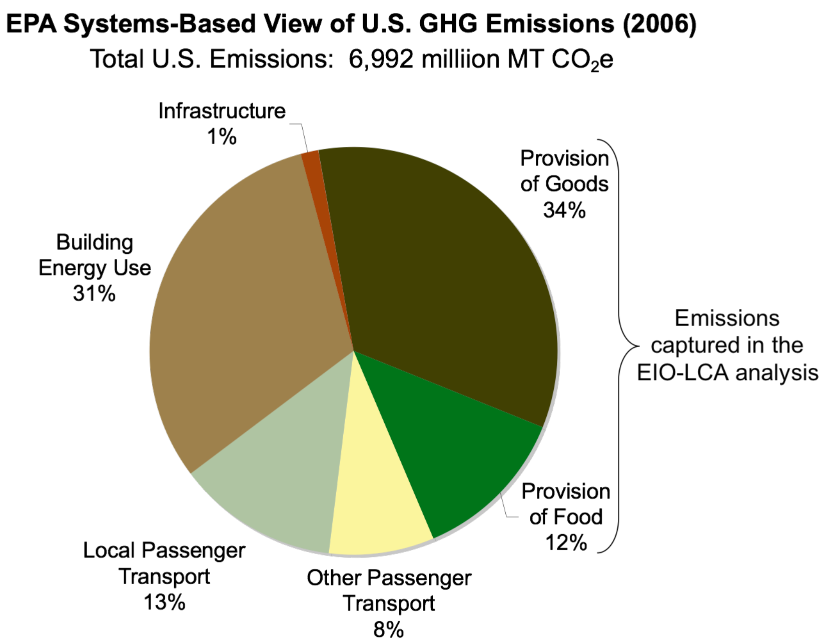
Institution	2008 Fiscal-Year Expenditures (included in analysis)	Buildings (Construction, Renovation, Maintenance, Rental)	Resale Merchandise	Information Technology	Commercial Printing	Other Goods and Services	Total Emissions
	$	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e	MT CO_2e
Eastern Oregon University	$7,595,934	889	679	310	159	1,427	**3,465**
Oregon Institute of Technology	$19,441,690	3,193	1,207	354	332	2,122	**7,208**
Oregon State University	$212,949,292	33,946	9,450	6,722	4,336	30,463	**84,917**
Portland State University	$123,938,519	25,492	3,095	2,774	1,419	9,612	**42,394**
Southern Oregon University	$31,089,760	4,995	4,176	868	467	2,391	**12,897**
University of Oregon	$188,347,875	29,170	12,387	4,505	5,912	17,835	**69,809**
Western Oregon University	$29,188,263	4,715	3,518	1,027	362	2,606	**12,228**
OUS Totals:	**$612,551,332**	**102,399**	**34,513**	**16,561**	**12,987**	**66,456**	**232,917**
% of Emissions Total:		44.0%	14.8%	7.1%	5.6%	28.5%	

CONTEXT AND MOTIVATION

The emissions generated by the manufacture and distribution of goods, food and services are a large share of total emissions for the U.S. economy and for other economies, and the summary results above reflect this fact. This result will surprise some readers because common practice for GHG inventories has typically excluded these difficult-to-quantify emissions sources that lie beyond the day-to-day operations and direct control of entities that purchase these goods, foot and services.

A recent EPA analysis provides the motivation for including the supply chain in GHG inventories. The accompanying graph (Figure 5) provides the core insight: the production of good and food together make up nearly half of all US GHG emissions.

Figure 5: Overview of U.S. GHG emissions in 2006.



Source: *Unpublished analysis (2008 draft) by US Environmental Protection Agency Office of Solid Waste and Emergency Response.*

This insight, however, poses a challenge. How does a purchaser – whether an individual, business, government agency or higher education institution – address this complex portion of the carbon footprint? Indeed, the analysis herein provides little guidance for action because of the complexity of this segment of OUS' carbon footprint.

The scale of these emissions requires that a thorough GHG inventory and climate action plan address them, even if with less precision than enjoyed in the quantification of other emissions sources. Given that universities and colleges are part of the economy-wide systems that emit greenhouse gases, it is imperative that ACUPCC signatories begin to assign a sense of scale to these emissions. We must build our knowledge and intuition today to be able to identify strategies for GHG reduction tomorrow.

DESCRIPTION OF METHOD

This analysis method used for this analysis follows the EIO-LCA method described in UC Berkeley's *Climate Action Partnership Feasibility Study 2006-2007 Final Report*, but refines UC Berkley's method by correcting for inflation.

The approach used for this estimate is Carnegie Mellon University – Green Design Institute's *Economic Input-Output Life Cycle Assessment* (EIO-LCA), U.S. 1997 Industry Benchmark model. Researchers at the Green Design Institute have developed this free online tool (available online at www.eiolca.net) to estimate life-cycle greenhouse gas emissions of economic activity in each of 491 sectors of the U.S. economy.

The model is valuable for simple, cost-effective emissions *estimates*. The strength of the model is its ability to provide comprehensive estimates by using aggregate values for all goods and services in the 491 sectors. Its weakness is that it cannot provide a detailed estimate for specific processes. In order to accurately estimate embodied emissions for a specific purchase, that product's specific supply chain must be assessed. This alternative is typically extremely time-consuming and often relies on data from many private sources.

The model has several significant sources of uncertainty. The first is that it is based on United States industry averages. These averages do not include the influence of major U.S. trading partners such as China on emissions factors, nor does the model have the ability to account for specific sourcing practices such as a higher than average percentage of post-consumer recycled content in paper products. Second, the model relies on a relatively old data set from 1997, which will not capture recent efficiency improvements or best practices that result in lower emissions for specific industrial sectors. This data set also requires adjustments to be made to account for inflation (see below). Finally, organizational accounting codes don't always directly map to the economic sectors included in the model.

Carnegie Mellon does not provide an estimate of uncertainty. Still, even if the level of uncertainty were quite high (say, ±50%), correcting the point estimate (of 232,917 MT CO_2e) would give a low end of the range of 116,459 MT CO_2e. This low estimate is still be greater than all of OUS's Scope 1 emissions sources combined (95,164 MT CO_2e).

In broad terms, the EIO-LCA method consists of utilizing the following equation to estimate total CO_2-equivalent emissions for various areas of expenditure:

$$\frac{CO_2e}{\$} \cdot \$ = CO_2e$$

In other words, the estimate stems from multiplying the carbon intensity of a given economic sector per dollar of output (the first term) by the quantity of purchases (the second term). This product is summed across purchasing categories, which differ in both carbon intensity and total dollars spent.

It is noted that the EIO-LCA model asks for the production cost of each item, but the retail price (price paid for any given item) is what is readily available and was used in the 2008 Inventory. It is also noted that this calculator is last updated in 1997 and means that some simple refinements need to be made in the method. The initial calculations suffer from the distortions of price level, as described above. While this is rarely a problem over a short period (a year or two), the decade between the EIO-LCA database's creation and this inventory's calculations created an issue. We therefore attempt to correct for this change in price level.

Price-level refinements to EIO-LCA model

The initial calculations suffered from the distortions of price level, as described above. While this is rarely a problem over a short period (a year or two), the decade between the EIO-LCA database's creation and this inventory's calculations created an issue. We therefore attempted to correct for this change in price level.

Specifically, we made two corrections. First, for the large bulk of purchases (excluding those related to construction), we adjusted the calculations by the Consumer Price Index[1], the standard and official measure of retail inflation for the US economy. Second, we adjusted all construction expenditures (one of the largest areas of procurement) by a construction price index (Turner Building Cost Index[2]) that, while not official government data, is well known and has decades of history.

The results of these corrections made a significant difference, lowering the general (non-construction) procurement footprint estimate by more than 20% and lowering the construction-related procurement footprint by more than 40%. Because of the central role of prices for purchased goods in using the EIO-LCA methodology, these corrections are likely to bring the overall estimate much closer to the truth.

EIO-LCA Method

The following steps were used to conduct this analysis for the OUS analysis.

1. Received fiscal year 2008 expense report from Oregon University System's central accounting department. This report included annual expenses by OUS account codes for each of the seven OUS institutions.
2. The raw data was reviewed and certain account codes were removed to avoid double counting (electricity, fuels, etc.) as well as account codes that were accounting functions with relatively large expense (employee salaries, taxes, etc.). These accounting functions were removed because the low carbon intensity of the function combined with a large expense would overestimate emissions.
3. The remaining account codes were assigned to economic sectors found in the EIO-LCA tool. In some cases there was no direct match, so multiple economic sectors were averaged to create an emissions factor for the account code.
4. The EIO-LCA model[3] is used to generate an emissions factor (GHGs / million dollars) for each assigned economic sector.
5. The EIO-LCA emissions factors are captured in a spreadsheet and emissions are calculated for each economic sector.
6. Calculated emissions are corrected for inflation using the CPI and Turner Cost Index.

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[1] More information on the Consumer Price Index may be found on the Bureau of Labor Statistics website at http://www.bls.gov/CPI/.
[2] To download a copy of the Turner Building Cost Index report visit http://www.turnerconstruction.com/corporate/content.asp?d=20.
[3] The Economic Input-Output Life-Cycle Assessment model may be accessed at www.eiolca.net.