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Assessing the Regional End-of-Life Impacts of Wood Waste in the United States

BACKGROUND

Biogenic construction materials such as wood products have the potential to reduce greenhouse gas emissions on a global scale. Life cycle assessment (LCA) studies of the environmental impacts of wood products have mainly focused on the production and construction stages; however, **less data exists for the end-of-life (EOL) stage**.

This research focused on estimating the **environmental impacts** of construction & demolition (C&D) **wood waste treatment** in the U.S. in four EOL scenarios: **recycle, compost, incinerate, and landfill**. The evaluated impacts were global warming potential (GWP_{100}), acidification potential (AP), eutrophication potential (EP), ozone depletion potential (ODP), and smog formation potential (SFP). This LCA focused on the EOL stage of the product life cycle, which is composed of waste transportation (C2), waste processing (C3), and waste disposal (C4) (Fig. 1). The impacts and benefits of creating new products from waste wood were also evaluated (Module D).

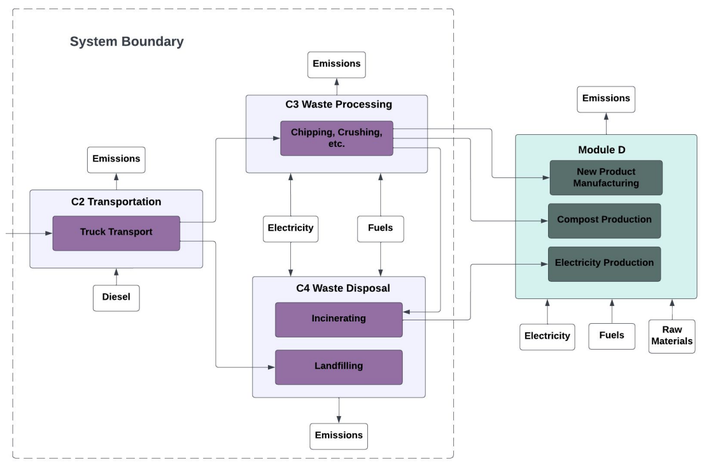

Figure 1. System boundary of wood waste treatment.

OBJECTIVES & METHODS

Objective 1: Wood Waste Distribution
Distribution of wood waste to each EOL scenario on a national level was derived from statewide C&D waste characterization studies [1].

Objective 2: Transportation Modeling
Transportation distances from large cities to C&D waste processing facilities were modeled in ArcGIS Pro v3.2.1 using the "Closest Facility" tool in the "Network Analyst" toolbox.

Objective 3: Environmental Impacts
Environmental impacts of each EOL scenario were estimated using data from the EPA Waste Reduction Model, published LCAs, and LCI databases. 100-year carbon storage benefits were estimated by compiling assumptions about the amount of carbon present in wood products after waste processing or disposal. Lastly, substitution benefits of replacing fossil products with products made from wood waste were estimated using data from published LCAs.

Objective 4: Case Study
The environmental impacts, carbon storage benefits, and substitution benefits of disposing one metric ton of C&D wood in the U.S. were estimated using the findings from the first three objectives, including the average waste distribution, transport distances, and impacts.

RESULTS

Objective 1: Wood Waste Distribution
The analysis revealed a high distribution of wood waste to the landfill scenario, and lower distribution to the remaining three scenarios (Fig. 2). The calculated average distribution from this analysis was comparable to the national average distribution listed by the EPA [2].

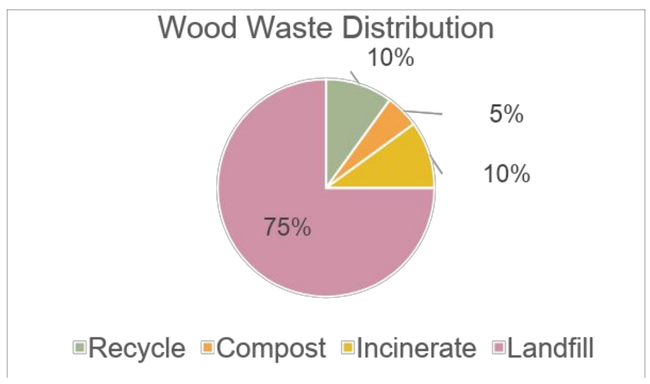

Figure 2. National average U.S. wood waste distribution to four EOL scenarios.

Objective 2: Transportation Modeling
National average transportation distances are shown in Fig. 3. The landfill scenario had the shortest distance, due to the large number of landfills *(n = 2,308)* compared to recyclers, composters, and incinerators *(n = 1,864, 311,* and *72,* respectively).

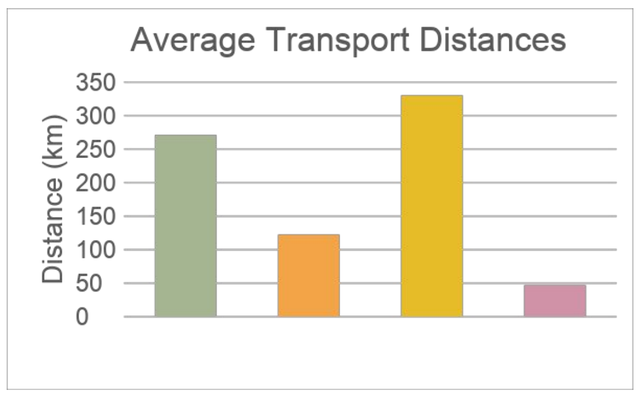

Figure 3. National average U.S. wood waste transportation distances for four EOL scenarios.

Objective 3: Environmental Impacts
Environmental impacts for each EOL scenario (Modules C2-C4) are shown in Table 1. These results were then summed with the impacts and substitution benefits of Module D, then ranked from lowest (1) to highest (4) for each impact category (Table 2). The scenario with the highest impact in each category is bolded in both tables. Unlike other impact categories, the GWP_{100} impacts can be combined with the carbon storage benefits. These results are shown alongside the substitution benefits in Fig. 4.

Table 1. Sum of environmental impacts from Modules C2-C4 for four EOL scenarios.

Scenario	GWP_{100}	AP	EP	ODP	SFP
Recycle	0.04	1.69E-4	5.67E-5	1.58E-10	4.38E-3
Compost	0.02	9.08E-5	5.10E-5	1.34E-10	2.13E-3
Incinerate	0.04	**4.64E-4**	7.43E-4	8.98E-10	**1.42E-2**
Landfill	**0.18**	1.18E-4	**7.23E-3**	**4.10E-9**	3.25E-3

Table 2. Ranked results for each impact category across four EOL scenarios, from lowest (1) to highest (4) impacts.

Scenario	GWP_{100}	AP	EP	ODP	SFP	Average Score
Recycle	1	1	1	**4**	1	*1.6*
Compost	3	2	3	2	1	*2.2*
Incinerate	**4**	3	2	1	3	*2.6*
Landfill	2	**4**	**4**	3	**4**	*3.4*

RESULTS (cont.)

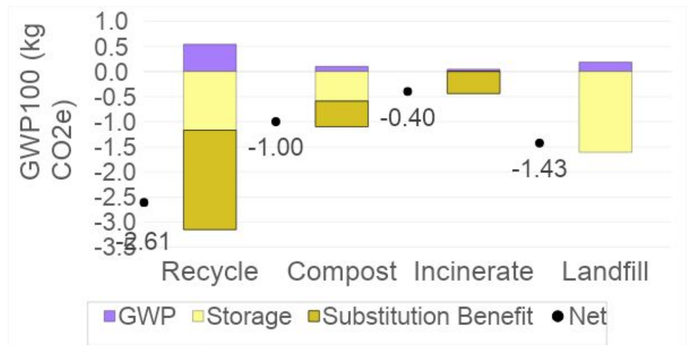

Figure 4. Climate impact factors for treating 1 kilogram of wood in four EOL scenarios.

Objective 4: Case Study
The environmental impact results of treating of one metric ton of wood waste in the U.S. are shown in Fig. 5.

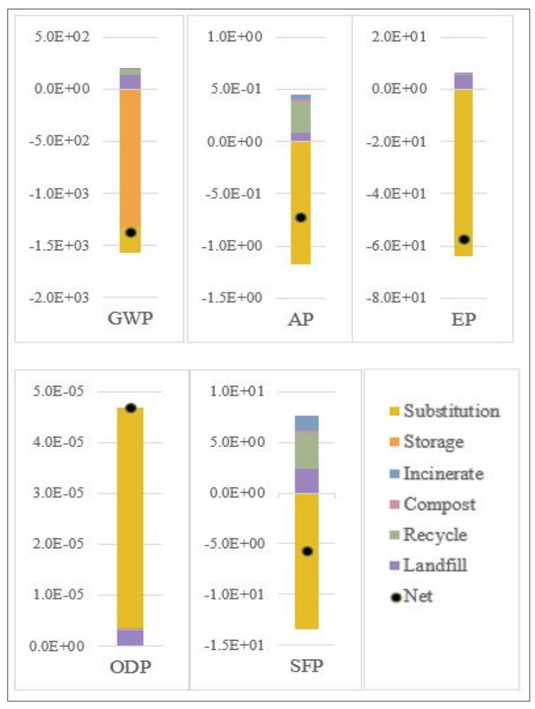

Figure 5. Climate impact factors for treating 1 metric ton of wood in four EOL scenarios.

KEY TAKEAWAYS

- In the U.S., most C&D wood waste is landfilled, resulting in a high number of facilities and low transportation distances for this scenario.
- When substitution benefits are accounted for, the recycle scenario has the lowest impacts on average of the four EOL scenarios, while the landfill has the highest. Accounting for carbon storage benefits further illustrates the carbon advantages of recycling wood waste.
- Modeling waste treatment for one metric ton of wood in the U.S. highlights how the environmental benefits of wood waste treatment offset the impacts for a net negative impact in most impact categories.

REFERENCES

1. EPA. (2015, September 22). U.S. State and Local Waste and Materials Characterization Reports [Collections and Lists]. https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/us-state-and-local-waste-and-materials
2. EPA. (2018). Advancing Sustainable Materials Management: 2018 Fact Sheet. United States Environmental Protection Agency. https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/advancing-sustainable-materials-management