



A Life Cycle Analysis of PP and PS Cutlery

FEDERAL POLICY TEAM RESEARCH PUBLICATION

This report calculates the precise effects of single-use plastic cutlery over its lifespan to provide an accurate estimate of the environmental costs it imposes. In addition to reviewing policies from other countries on plastics, this paper outlines the basis for a tax on SUP cutlery, considering the exact environmental damage they cause.

Prepared by: Michael Aaron, Arman Rostomyan, and Shant Ispendjian

Date: February 10, 2026

Published by the Saving the Sea Organization

A Life Cycle Analysis of PP and PS Cutlery

I. Abstract

More than 400 million tonnes of plastic are produced each year, posing significant detriments to the environment (Beat Plastic Pollution). Furthermore, approximately half of this plastic is designed for single use. The consequences of plastic production have imposed great costs on the environment. This paper serves as an assessment of the costs that single-use plastic (SUP) cutlery inflicts on the environment, in contrast with those of biodegradable plastics. This calculated difference lays the groundwork for policy recommendations to shift away from SUP cutlery. Using this framework, countries can implement tax systems that accurately reflect the environmental costs imposed by SUPs, thereby encouraging corporations to produce by directly factoring these costs into their decisions. With these costs included, the United States can identify a market for goods that promote environmental well-being, a crucial metric for all members of society.

II. Introduction

Single-use plastics are prevalent tools in our society, integrated into almost every aspect of our lives. Unfortunately, they also pose significant harm to our environment (Impacts of Plastic Pollution). Although this harm is scientifically proven and not ending anytime soon, the United States still uses SUPs to a significant degree, largely because of their cost-effectiveness (Fact Sheet: Single Use Plastics). A significant issue with the stance of the US plastics industry towards SUPs is that it prefers the cheapness of SUPs despite the environmental costs associated with it to more expensive, sustainable alternatives, with a prime example being SUP cutlery. To understand the costs that SUP cutlery poses to the environment, several paths can be taken, but the best one to understand how each unit of cutlery affects the environment is the life cycle assessment (LCA) (Whitebell). As in its name, this model tracks the entire lifetime of a unit of plastic, noting the exact effect it has on the environment at each stage. Since

this paper is studying the costs of SUP cutlery in direct contrast to biodegradable cutlery, it will look at the differences in environmental impact that the two products have. Due to the focus this study is placing on the environmental consequences of SUPs, the analysis of the detrimental effects of SUPs will be referenced in contrast with that of a sustainable alternative. SUP cutlery is generally derived from two plastic sources: polypropylene (PP) or polystyrene (PS), which will both be discussed in this publication (Disposable Cutlery Guide).

The LCA can be carried out in two phases: 1) identifying exactly what product the LCA is being performed on and what phases of its lifespan will be included in the model, and 2) quantifying the exact numerical inputs and outputs each unit of plastic has relating to the environment throughout its lifespan. A third step can be implemented using the findings of the first two: converting the metrics found in phase two into a dollar value representing the cost to the environment that a unit of SUP has over its lifespan. In a policy proposal, such as a tax-based solution, this phase could be utilized. The life cycle assessment contrasting between PP, PS, and PLA, a biodegradable alternative, demonstrates the high costs to the

environment that SUPs pose, giving precise estimates on the extent to which sustainable plastics are better for the environment.

III. Phase One of the LCA: Determining the Model

For this publication, only certain environmental costs will be counted in the LCA. Listed here are some lifecycle costs that can be included in a life cycle assessment: raw material extraction, production pollution, transportation emissions, recycling costs, clean-up costs, and ecological damage costs.

Polypropylene (Hokadel) and polystyrene (Polystyrene) are both made from natural gas products. While this allows for a large resource of production materials, the extraction of natural gas causes significant harm to the environment, such as methane emissions (Natural gas and the environment). Furthermore, there are many cutlery alternatives available that are not produced from gases. Instead, they draw from sustainable resources, making the extraction of raw materials for polypropylene (PP) and polystyrene (PS) a key focus of this paper.

Although production emissions still exist for biodegradable plastics, they result primarily from the source of energy in the fabrication process, as opposed to the materials emitting carbon (Ghomi).

The carbon emissions of the production of biodegradable plastics will reduce over time as more sustainable alternatives are developed. Therefore, we can find the environmental costs of SUP production by subtracting the total emissions from the energy requirement, giving us only the emissions created by the SUP materials, such as polypropylene or polystyrene (Plastics—Fueling Oil Demand, Climate Change and Pollution).

Although emissions resulting from the transportation of SUPs can pose harm to the environment, these emissions will not count as a cost against the environment in this study. Since more biodegradable plastics also have to be transported with the same emissions costs to the environment, the costs do not differentiate themselves. Therefore, it does not fit the purpose of this paper to include them in the model.

Clean-up and ecological damage costs require an interesting distinction to differentiate between the costs of SUPs and biodegradable plastics. This is because littered plastics, even biodegradable ones, do not degrade well in natural ecosystems (Chen 3). Therefore, the clean-up and ecological damage costs that each unit of biodegradable plastic imposes on the environment are similar to those of a SUP. This paradox of biodegradable

plastics having the same negative effects as SUPs forces these costs outside the model. However, we must make a distinction between the end-of-life consequences of when plastics are properly and improperly disposed of, which is where recycling costs come into play. When officially disposed of, the end-of-life-cycle for SUPs creates much more harm to the environment than it does for biodegradable plastics, causing carbon emissions, the release of microplastics, and taking up space as a pollutant (Rogers). This difference in environmental harm will be a key focus of the model.

Therefore, the factors this model takes into account are raw material extraction, production pollution, and end-of-life costs, as these are the key differences relating to environmental harm between SUPs and biodegradable alternatives. However, it omits energy supply when calculating the production pollution of SUPs.

IV. Phase Two of the LCA

Based on analyses of PP by the American Chemistry Council, the cradle to incoming emissions, which track the emissions resulting from raw material extraction, are 1.275 kg CO₂ eq per kg of plastic (LCA of Polypropylene). These same analyses performed on PS plastics demonstrated emissions of 2.722 kg CO₂ eq per kg of

plastic (LCA of Polystyrene). Since biodegradable plastics are not made from fossil fuels, these numbers represent the difference in emissions between the raw material extraction of SUPs (PP and PS) and biodegradable plastics.

The production of polylactic acid-based products, a more sustainable alternative to SUPs, “generally has higher impacts than the others due to polylactic acid (PLA) resin production...in particular, considerable GHG emissions occur during the corn production phase and are caused by a large amount of fertilizer and herbicides, which are generally used in corn cultivation” (Kamalakkannan et al.). PLA cutlery has a carbon emission of around 0.009 kg CO₂e per kg production phase. This can be compared to PP and PS production to see the increase in emissions from using unsustainable plastics. PP emissions stand at 0.273 kg CO₂ eq per kg plastic, and PS emissions are 0.184 kg CO₂ eq per kg plastic. The PP emission of 0.273 kg CO₂ and PS emission of 0.184 kg CO₂ can be compared to the 0.009 kg CO₂ of PLA, with the difference being the increase in emissions from using fossil fuel-based products.

When calculating the end-of-life outputs, it is important to note that this is only in regard to situations where the plastics

are being properly disposed of and not littered. Unfortunately, SUP cutlery is difficult to recycle because of its design and size, with “many recycling plants refusing to accept plastic cutlery because it falls through gaps in the machinery” (Impact of Plastic Utensils). Furthermore, “most single-use plastic cutlery consists of non-recyclable plastics,” and because of its inconsistent material use, it’s difficult to determine if a piece of plastic cutlery is intended to be recycled. As a consequence, an overwhelming majority of SUP cutlery ends up in landfills, which are environmentally unsustainable. Plastics generally have an 8.7 percent recycling rate, and although there exists no specific data on the recycling rate of SUP cutlery, given its unique challenges of recycling, we can assume a near-negligible amount is being recycled (Plastics: Material-Specific Data). Therefore, we will assume all SUP cutlery experiences its end-of-life cycle in a landfill or is incinerated. Based on estimates from the OECD (Environmental Performance Reviews) and OSTI (Plastic Waste Evaluation) reports, around 76 percent of plastic in America goes to landfills, and 15 percent is incinerated. Since cutlery is a small subfield of plastic waste, these numbers do not perfectly represent the end-of-life cycle; however, since limited research has been conducted on the matter,

these numbers give the best estimate. There are other categories of end-of-life use, but the categories of mismanagement or recycling are not included in this study.

Incineration practices emit 2.9 kg of CO₂e for every kg of plastic burned (Plastic is Carbon). Finding the output damages per input of plastic is more difficult with landfills since the main environmental cost is microplastic pollution. Research regarding microplastic harm is still developing, so an accurate calculation of environmental and human harm is difficult to ascertain. However, for this phase, only inputs and outputs are calculated. Research indicates that 55,000 to 60,000 particles are released from one kilogram of waste (Pratiwi et al.). In a landfill, it is impossible to differentiate which type of waste is contributing to the microplastic release to what extent, so we must estimate that PP and PS cutlery would release microplastics to the same extent.

These numbers yield the difference in environmental harm caused by SUPs, such as PP and PS, and biodegradable plastics. Using these numbers, the US government can enact policies in an informed manner with the exact benefits of biodegradable plastics in mind. Specifically, policymakers can use the Social Cost of Carbon to convert the

emissions difference into monetary terms for a new tax policy.

V. International Efforts to Eliminate SUPs

Efforts from countries around the world to end the reign of SUPs vary from taking no action to implementing taxes to outright banning certain plastics. There are many case studies of countries finding creative ways to shift away from harmful plastics. The United States is aware of these successes, yet the nation struggles with passing efforts due to the economic implications of these policies. However, the harm of SUPs is compounding and is increasingly impeding our society and economy from functioning as it should. In the long run, it is imperative for the United States to look toward the policies of other nations and act swiftly. There have been attempts at further legislation regarding SUPs in the US, such as the REDUCE Act of 2023, which would have imposed a \$0.10 to \$0.20 excise tax on each pound of virgin plastic resin that increased over time (REDUCE Act of 2023). Although this bill ultimately failed, this paper can provide more scientific evidence in favor of similar legislation. However, it is important for the United States to note the efforts of other countries as well.

Canada, like the US, is one of the world's largest oil producers (Oil Production by Country), giving it the foundation

for high usage of SUPs. However, Canada has passed more progressive legislation (Government of Canada), labeling plastics as a “Schedule 1 toxic substance,” which lays the way for bans despite pushback from large oil companies (Liebel). If economic measures continue to fail for the US, the country could follow the path of Canada and make the SUP policy a medical issue instead. This could change the US government’s and even the general public’s stance on SUPs if it is seen as medically harmful to the population. The United States has set a precedent in implementing measures against the sale of medically harmful substances such as cigarettes, which currently carry a \$1.00 excise tax (Tobacco Excise Taxes).

Australia’s political landscape bears many similarities to that of the United States, as both nations comprise states whose governments exercise varying degrees of autonomy. Therefore, it can be difficult to have nationwide policies on SUPs when each state may have different ideas and levels of commitment regarding solving the problem. Nonetheless, each state in Australia has bans on some plastics, each with its own plan to reach the nationally-agreed upon targets for waste and packaging (Phasing Out SUPs). Research indicated that these bans have been highly effective in eliminating SUPs, but they are often being replaced with reusable

plastics, which have a similar effect on marine life when improperly disposed of (Plastic Pollution Country Profile). Given its geography, the United States has less of a focus on marine ecosystems, and the bigger takeaway is likely how Australia passes legislation, as opposed to the setting of national targets for each state to complete individually. This is another policy the United States could learn from, given the differences in plastic use between states.

Developing nations have even implemented strong regulations surrounding SUPs. Despite the higher costs of biodegradable plastics, even developing nations are taking great strides to implement them, paving the way for the US. For instance, Rwanda banned SUP bottles and bags in 2008 (Liebel). Furthermore, most Rwandan citizens participate in mandatory community service that often involves trash clean-up. Now, the capital city, Kigali, is considered the cleanest city in Africa. While US lawmakers cite the inefficiencies of biodegradable plastics as a barrier to sustainability, countries with fewer resources are able to pass effective legislation to mitigate these issues.

VI. Conclusion

The harm of single-use plastics is evident, and so are the opportunities to shift away from their use. This paper

utilizes evidence that clearly demonstrates the threat of SUPs and lays a framework for policies to eliminate them. The awareness of the damage that SUP cutlery brings over the course of its lifetime informs the United States that its measures to eliminate SUPs must be strong. Now, the United States has reached a point where it must take action. It can work on mitigating the emissions of raw material extraction, production, and end-of-life management. This country can follow the paths or ideas of many others, or it can create its own, motivated by the damage SUPs cause to the planet. Specifically, this paper can be utilized by policymakers to convert the outputs listed into monetary costs that SUP cutlery imposes on the environment, creating an excise tax system similar to that of cigarettes.

References

Chen, Hongzhe. "Biodegradable Plastics in the Marine Environment: A Potential Source of Risk?" *Water Emerging Contaminants & Nanoplastics*, September 21, 2022. <https://www.oaepublish.com/articles/wecn.2022.11>.

"Cradle-to-Gate Life Cycle Analysis of High Impact Polystyrene (HIPS) Resin." American Chemistry Council, September 6, 2022.

<https://www.americanchemistry.com/better-policy-regulation/plastics/resources/cradle-to-gate-life-cycle-analysis-of-high-impact-polystyrene-hips-resin>.

"Cradle-to-Gate Life Cycle Analysis of Polypropylene (PP) Resin." American Chemistry Council, September 6, 2022.

<https://www.americanchemistry.com/better-policy-regulation/plastics/resources/cradle-to-gate-life-cycle-analysis-of-polypropylene-pp-resin>.

"Disposable Cutlery Buying Guide - Choose the Right Plastic Silverware." Disposable Cutlery Buying Guide. Accessed November 23, 2025.

<https://www.richmondadvantage.com/shop-by-category/restaurant-supplies/disposable-plastic-cutlery/disposable-cutlery-buying-guide.html>.

"Government of Canada." *Canada Gazette, Part 2, Volume 155, Number 10: Order Adding a Toxic Substance to Schedule 1 to the Canadian Environmental Protection Act, 1999*, May 12, 2021. <https://gazette.gc.ca/rp-pr/p2/2021/2021-05-12/html/sor-dors86-eng.html>.

Hodakel, Boris. "What Is Polypropylene Fabric: Properties, How It's Made and Where." Sewport, 28 Feb. 2019, sewport.com/fabrics-directory/polypropylene-fabric.

"The Impact of Plastic Utensils." Greenprint, June 6, 2025. https://greenprintproducts.com/impact-of-plastic-utensils/?srsltid=AfmBOopm-ykZhMK5-_lp8l1i5dUyc-J_nDILU1tzlTlDWZxuBc7IN-tG.

"Impacts of Plastic Pollution." United States Environmental Protection Agency, 15 May 2025. <https://www.epa.gov/plastics/impacts-plastic-pollution>.

"Increase Excise Taxes on Tobacco Products." Congressional Budget Office, 2024. <https://www.cbo.gov/budget-options/60964>.

Kamalakkannan, Sivappirakasam, Amila Abeynayaka, Asela K. Kulatunga, Rajeev Kumar Singh, Miwa Tatsuno, and Premakumara Jagath Dickella Gamaralalage. "Life Cycle Assessment of Selected Single-Use Plastic Products towards Evidence-Based Policy Recommendations in Sri Lanka." MDPI, October 30, 2022. <https://www.mdpi.com/2071-1050/14/21/14170>.

Liebel, Sophie. "5 Countries on 5 Continents Doing Plastic Policy Right." Earth Day, July 30, 2025. <https://www.earthday.org/5-countries-on-5-continents-doing-plastic-policy-right/>.

"OECD Environmental Performance Reviews: United States 2023" 22 June OECD, 2023. https://www.oecd.org/en/publications/2023/06/oecd-environmental-performance-reviews-united-states-2023_c76b5a61.html.

"Oil Production by Country." Worldometer. Accessed November 23, 2025. <https://www.worldometers.info/oil/oil-production-by-country/>.

"Quantification and evaluation of plastic waste in the United States," OSTI. Accessed November 23, 2025. <https://www.osti.gov/pages/servlets/purl/1866379>.

"Phasing Out Single-Use Plastics." Australian Retailers Association, June 17, 2024. <https://www.retail.org.au/plastics>.

"Plastic Is Carbon." No-Burn. Accessed November 23, 2025. <https://www.no-burn.org/wp-content/uploads/Plastic-is-Carbon-Oct2021.pdf>.

“Plastic Pollution Policy Country Profile: Australia.” Duke Nicholas Institute, 2022. <https://nicholasinstitute.duke.edu/sites/default/files/projects/Plastic-Pollution-Policy-Country-Profile-Australia.pdf>.

“Plastics – Fueling Oil Demand, Climate Change and Pollution.” United Nations. Accessed November 23, 2025. <https://www.un.org/en/climatechange/science/climate-issues/plastics>.

“Plastics: Material-Specific Data.” United States Environmental Protection Agency, 2025. <https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/plastics-material-specific-data>.

“Polystyrene • Plastics Europe.” Plastics Europe, January 20, 2022. <https://plasticseurope.org/plastics-explained/a-large-family/polystyrene-2/>.

Pratiwi, Okky, Umar-Fahmi Achmadi, and Rico Kurniawan. “Microplastic Pollution in Landfill Soil: Emerging Threats the Environmental and Public Health.” ResearchGate, 2024. https://www.researchgate.net/publication/379275319_Microplastic_pollution_in_landfill_soil_Emerging_threats_the_environmental_and_public_health.

Rezvani Ghomi, Erfan, Fatemeh Khosravi, Ali Saedi Ardahaei, Yunqian Dai, Rasoul Esmaeely Neisiany, Firoozeh Foroughi, Min Wu, Oisik Das, and Seeram Ramakrishna. “The Life Cycle Assessment for Polylactic Acid (PLA) to Make It a Low-Carbon Material.” *Polymers*, June 2, 2021. <https://pmc.ncbi.nlm.nih.gov/articles/PMC8199738/>.

Rogers, Kristen. “The Climate Crisis: How Switching to Reusable Flatware Could Reduce It.” CNN, April 22, 2025. <https://www.cnn.com/2025/04/22/health/climate-crisis-plastic-utensils-wellness>.

“S.2844 - REDUCE Act of 2023.” United States Congress, 2023. <https://www.congress.gov/bill/118th-congress/senate-bill/2844/text>.

Staff, EDN. “Fact Sheet: Single Use Plastics.” Earth Day, March 4, 2025. <https://www.earthday.org/fact-sheet-single-use-plastics/>.

“U.S. Energy Information Administration - EIA - Independent Statistics and Analysis.” Natural gas and the environment - U.S. Energy Information Administration (EIA), 2024. <https://www.eia.gov/energyexplained/natural-gas/natural-gas-and-the-environment.php>.

Whitebell, Chris. "What Is Life Cycle Assessment (LCA)?" RIT, 2020.
<https://www.rit.edu/sustainabilityinstitute/blog/what-life-cycle-assessment-lca>.

"World Environment Day." United Nations. Accessed November 23, 2025.
<https://www.un.org/pl/node/71013>.

Publication Team



Michael Aaron

AUTHOR

Federal Team Policy Analyst



Arman Rostomyan

EDITOR

Vice President of Policy



Shant Ispendjian

SENIOR EDITOR

President