



ENERGYBAG PROGRAM

END-OF-LIFE SOLUTIONS FOR HARD-TO-RECYCLE PLASTICS

LIFE CYCLE ASSESSMENT FACT SHEET

INTRODUCTION

The Hefty® EnergyBag® program was developed to help advance a circular plastics economy by diverting hard-to-recycle (H2R) plastics from landfills and giving them new life. The Hefty® team has identified and investigated multiple alternative end-of-life (EOL) solutions for the material the program collects. Three of these stand out as being the most promising.

To determine whether the environmental impacts of these three solutions were more favorable than landfilling, the Hefty® team commissioned specialists Sustainable Solutions Corporation to conduct an independent life cycle assessment (LCA) comparing the impact of landfilling with each alternative.¹

THIS FACT SHEET SUMMARIZES THE RESULTS OF THE ASSESSMENT.

NOTES ON SUSTAINABLE SOLUTIONS CORPORATION'S LIFE CYCLE ASSESSMENT

The Hefty® EnergyBag® Life Cycle Assessment was designed to enable informed decisions about the EnergyBag® program. Its purpose was to determine the environmental impacts of three alternative end-of-life (EOL) options for EnergyBag® materials compared to the same materials placed in a traditional Hefty® flex trash bag sent to landfill.

The analysis was conducted according to International Organization for Standardization (ISO) 14044 International Standard. Results were characterized into impact indicator categories using the US Environmental Protection Agency's Tools for the Reduction and Assessment of Chemical and other environmental Impacts v2.1 factors.²

These categories include:

- | | |
|--------------------------|---------------------|
| Global Warming Potential | Respiratory Effects |
| Acidification | Eutrophication |
| Carcinogens | Ozone Depletion |
| Non-Carcinogens | Ecotoxicity |
| Smog | |

¹Sustainable Solutions Corporation and S&C, Hefty® EnergyBag® Program Life Cycle Assessment, August 2020. For more information, see the report available at heftyenergybag.com

²Bare, J.C TRACI 2.0. The Tool for the Reduction and Assessment of Chemical and other environmental Impacts. *Clean Technologies And Environmental Policy*. Springer-Verlag, New York, NY, 13(5):687-696, (2011).

WHAT IS ...

Life Cycle Assessment (LCA)

A standardized method used to measure the environmental impacts of a product throughout its entire life, from sourcing of raw materials and production processes to its use, disposal, and EOL waste management. In other words, from cradle to grave.

Global Warming Potential (GWP)

A measure of how much a given gas warms the Earth compared to carbon dioxide (CO₂) over a given period of time, typically 100 years. By definition, the GWP of CO₂ is 1. The larger the GWP, the more a given gas warms the Earth.

Cutoff Distance

The distance – from the collection location to the end market – at which the global warming impact of an end-of-life alternative for Hefty® EnergyBag® materials equals the impact associated with the landfill option. If the impact of a particular solution is greater than that of landfilling, no cutoff distance applies.

The findings presented here:

- **are based on specific facilities within each sector**, and given the wide range of technologies in use and ongoing advancements, should not be used to draw conclusions about cement kilns, pyrolysis, or recycling in general.
- **focus on the EOL processes of each option**. For complete life cycle findings, see the full LCA report.¹
- **do not consider the lifespan of the hard-to-recycle end products realized** through using the unique pyrolysis technology or recycling into concrete aggregate. The end products would require separate LCAs.

THE FINDINGS

Alternative #1: Cement Kiln Fuel

EOL Process: Hefty® EnergyBag® materials replace coal as a fuel to produce the heat energy required to make cement.

GWP: 466% reduction over landfilling

- **Favorable/Unfavorable impact categories:** Favorable across ALL environmental categories studied, particularly in smog, acidification, and respiratory effects.

Sorting Required: NO. Contaminant materials are accepted but may lower the heating value of the plastics. However, hazardous materials are never accepted in the orange bags.

Benefits as Coal Alternative:

- Avoids the greater impacts of coal production and processing
- Holds a higher heating value than coal – that is, accepted EnergyBag® program materials contain more energy than coal – so the same amount of heat can be produced with less material
- Requires less electricity to process, which contributes significantly to the more favorable environmental impact

Cutoff Distance vs. Landfilling: > 5,000 miles.

Bottom Line: This alternative is favorable to landfills across ALL environmental impact categories, whenever the kiln site is less than 5,000 miles from the collection site – in other words, across the entire continental United States.

Alternative #2: Unique Pyrolysis Technology

EOL Process: Converts Hefty® EnergyBag® materials into fuels using unique pyrolysis technology.

GWP: 31% reduction over landfilling

- **Favorable/Unfavorable impact categories:** Favorable in all categories except smog, acidification, and respiratory effects. These results are largely attributable to the electricity required for the process, which accounts for most of the impact.

Sorting Required: YES. The process has low tolerance for some materials, including metals and paper.

Benefits as Fuel Alternative:

- Reduces the need to extract petroleum and produce conventional petroleum-derived fuels

Cutoff Distance vs. Landfilling: 274 miles. Lowering the electricity required for the process through improved efficiency could increase this distance significantly.

Bottom Line: This alternative is favorable to landfills in global warming potential and holds the potential – through energy efficiency and technological advances – to become even more advantageous in the future.

¹Sustainable Solutions Corporation and S&C, Hefty® EnergyBag® Program Life Cycle Assessment, August 2020. For more information, see the report available at heftyenergybag.com

Alternative #3: Concrete Aggregate

EOL Process: Recycles Hefty® EnergyBag® contents into an aggregate material used in concrete masonry blocks.*

GWP: 77% higher than landfilling

- **Favorable/Unfavorable impact categories:** Produces higher levels in most impact categories, particularly in smog, respiratory effects, and acidification. These results are largely attributable to the electricity required for processing (shredding, etc.) the plastics.

Replaces gravel or sand used in conventional concrete blocks

- Gravel and sand are abundant and require little processing
- Produces lighter weight blocks with additional thermal benefits³

Sorting Required: YES. The process has low tolerance for some materials, including paper and glass.

Cutoff Distance vs. Landfilling: Not applicable.

Bottom Line: This alternative shows greater environmental impact than landfilling. Ongoing process improvements and more availability of this and other H2R plastic recycling options could someday make this alternative more favorable.

SUMMARY TABLE

Feature	Landfill (Baseline)	Alternative 1 Cement Kiln Fuel	Alternative 2 Unique Pyrolysis Technology	Alternative 3 Concrete Aggregate
Converts EnergyBag® materials into ...	—	Heat energy for cement manufacturing	Fuels and other petroleum-derived products	Aggregate material used in concrete masonry blocks
Resource(s) replaced	None	Heat energy from bituminous coal	Extracted petroleum and conventional petroleum-derived products	Gravel or sand
Sorting Required	NO	NO	YES	YES
GWP vs. Landfill GWP**	100%	-466%	-31%	+77%
Cutoff Distance**	—	>5,000 miles	274 miles	N/A

CONCLUSION

The Hefty® EnergyBag® Life Cycle Assessment shows that the incineration of plastics at highly efficient, strictly regulated cement kilns holds multiple environmental advantages over landfilling and also over the pyrolysis and the recycling options investigated in the study. The findings support the program’s selection of cement kilns as a viable end market for the hard-to-recycle plastics collected. At the same time, the LCA also supports ongoing evaluation of pyrolysis along with other potential recycling options for EnergyBag® materials as technological advancements continue to emerge and more facilities are able to convert more H2R plastics into new plastics.

*Note the analysis centered on an international facility. The Hefty® team completed a trial with EnergyBag® materials at pilot scale to confirm viability.

**Based on end-of-life processes only. For complete life cycle findings, see the full LCA report.

³N.Thirugnanasambantham ,et. al. *Manufacturing and Testing of Plastic Sand Bricks*, International Journal of Science and Engineering Research (IJOSER), Vol 5 Issue 4 April -2017, retrieved from joser.org/Files/1401.pdf