INSTITUTE FOR LIFECYCLE ENVIRONMENTAL ASSESSMENT

Paper vs. Plastic Bags

Franklin Associates, Ltd., 1990

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Franklin and Associates completed a life-cycle energy analysis comparing the two common grocery bags. There were two critical measures. The first is the total energy used by a bag, which includes both the energy used to manufacture a bag, called process energy, and the energy embodied within physical materials, called feedstock energy. The second measure is the amount of pollutants produced. Using energy and pollutants from all stages of a bag's life, both measures result in favor of plastic bags.[i]

Compensating for size differences, Franklin and Associates found that most carrying-capacity differences are between 1.5-to-1 and 2-to-1 plastic to paper. Volume and weight capacity were included, and also suboptimal bagging techniques. In assessing each criterion ILEA, to be conservative, compared two plastic bags to one paper.

The bags were also compared on a varying degree of recycling rates, a key element in determining which bag is more energy efficient. Franklin Associates defines recycling rate as recycled bags which are used to manufacture the same product: a closed loop system. An open loop system is when recycled materials are used in different products. This is more realistic but very difficult to model. According to the EPA, Americans currently recycle 0.6% of plastic bags and 19.4% of paper bags.[ii]

In assessing the energy used to produce a bag, all elements are considered. Energy used in transportation, electricity, fuel extraction and processing, and the energy within the feedstock are all converted into energy units, in this case kilojoules (kJ).

Paper bags use high amounts of wood, petroleum, and coal. A single paper bag uses the energy equivalent of 550 kJ of wood as feedstock. It also uses 500 kJ of petroleum and 350 kJ of coal for process energy. The total amount of energy used by a single paper bag is 1,680 kJ.

The feedstock materials in plastic bags are natural gas and petroleum. Two plastic bags use 990 kJ of natural gas, 240 kJ of petroleum, and 160 kJ of coal. The energy used for two plastic bags is 1,470 kJ. Two plastic bags use 87% the amount of energy used by one paper. Though plastic is preferred at current recycling rates, as recycling rates change, the energy efficiency of each bag also changes. Initially paper bags use more energy than plastic to produce. However as both recycling rates increase, paper bags save greater quantities of energy than plastics. The table below shows at what recycling rate each bag is more energy efficient. Paper bags need a recycling rate of at least 50% to be more energy efficient than twice the number of plastics.

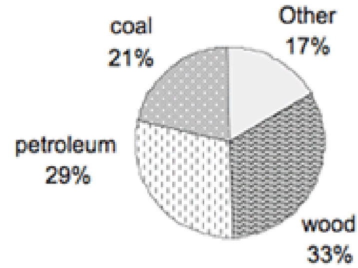


Figure 1 – Energy distribution for paper bags at current recycling levels.

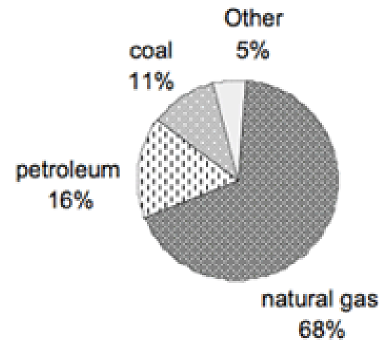


Figure 2 – Energy distribution for plastic bags at current recycling levels.

Recycling Rates for Paper Bags \ Recycling Rates for Plastic Bags	0-25%	25-50%	50-75%	75-100%
75-100%	Paper	Paper	Paper	Either
50-75%	Paper	Either	Plastic	Plastic
25-50%	Plastic	Plastic	Plastic	Plastic
0-25%	Plastic	Plastic	Plastic	Plastic

Table 1 - Choice table. Determines bag preference at varying recycling rates. Either was used when the difference between energy efficiencies are inconsequential.

The recycling rate's impact on bag preference comes from differing proportions of feedstock energy. Through the recycling process, feedstock energy is reduced. Wood use in paper bags can be reduced to zero. In plastic bags natural gas can be reduced in half, and petroleum can be cut by a quarter. Because a paper bag uses much more energy in feedstock than plastic it has a greater reduction in energy as it's recycled. Still paper's energy reduction isn't sufficient enough to favor it at equivalent recycling rates. Though more energy is cut out through the recycling process, it isn't enough to favor a plastic bag. Pollutants are divided into three categories: solid, atmospheric and waterborne waste. Each category accounts for both production and postconsumer waste including fuels used in electricity generation and transportation. Solid waste deals with the product after arriving at the landfill and also trimmings thrown out in manufacturing. Atmospheric and waterborne waste concern materials discharged after receiving emissions control or wastewater treatment. In each category, two plastic bags produce less pollution than one paper.

Plastic bags, having less mass than paper, produce less solid waste. At current recycling rates two plastic bags produces 14 g of solid waste while one paper creates 50 g. Two plastic bags produce 72% less solid waste than their paper bag equivalent. As the recycling rate increases, postconsumer waste decreases accordingly, so if 25% more bags are recycled, the solid waste decreases by 25%. Every recycled bag avoids contributing to postconsumer solid waste. However when recycling rates increase, pre-consumer solid waste increases for plastic though it decreases for paper. Still because paper creates substantially greater quantities of solid waste, two plastic bags never surpass a third of the solid waste from one paper bag.

For atmospheric waste, again plastic produce substantially less pollutants. In comparing the bags, two plastic bags produce 1.1 kg while one paper bag produces 2.6 kg. As the recycling rate improves, paper bags produce half as much atmospheric waste, but never better than two plastics. At best a paper bag still produces 35% more atmospheric waste. Again, despite the recycling rate, two plastic bags always create less airborne pollution.[iii]

Waterborne pollutants are high for a paper bag. Waterborne waste consists of pollutants which harm ecosystems.[iv]Two plastic bags account for only seven percent of the waterborne waste of one paper sack. Where paper produces 1.5 g, plastic produces 0.1g. Furthermore, as recycling increases, a paper bag's waterborne waste increases. The additional waste is from reprocessing paper product. Because of this, in terms of waterborne waste, plastic will always be preferred regardless of the recycling rate.

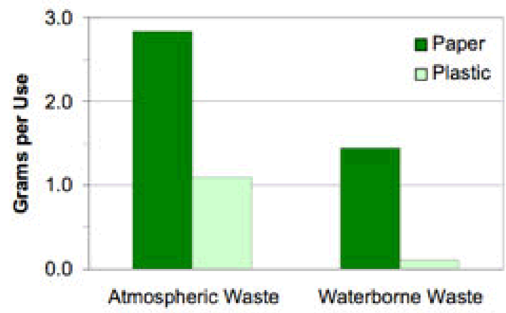


Figure 1 – Grams of atmospheric and waterborne waste at current recycling rates. Atmospheric waste contributes to smog and acid rain. Waterborne waste disrupts associated ecosystems.

Through a lifecycle energy analysis, plastic is the better bag. At current recycling rates two plastic bags use less energy and produce less solid, atmospheric, and waterborne waste than a single paper bag. Moreover future improvements only increase preference in plastic bags. Increasing recycling rates and reducing the 2-to-1 ratio through proper bagging techniques would further the energy preference for plastic bags.

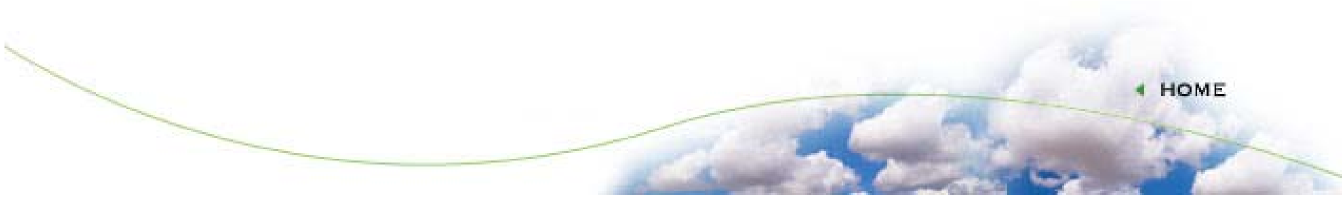
[i] This review leaves out many details of the summarized work. Opinions expressed by ILEA may not be the same as those of the original author(s). Consult the authors' original work for a full treatment of their analysis and perspective. Franklin and Associates Inc., Resource and Environmental Profile Analysis of Polyethylene and Unbleached Paper Grocery Sacks, 1990.

[ii] Recycling rates are from U.S. EPA, Municipal Solid Waste in The United States: 2000 Facts and Figures. June 2002

[iii] In the Franklin analysis, atmospheric waste primarily consists particulates, hydrocarbons, sulfur oxides, nitrogen oxides and carbon monoxide

[iv] In the Franklin analysis, waterborne waste primarily consists of suspended solids, dissolved solids, biological oxygen demand, and acids

Last Modified on October 28, 2004.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