



# **THE ENVIRONMENTAL IMPACT OF SOFT DRINK DELIVERY SYSTEMS**

A Comparative Analysis  
(1995 Update)



In 1988, the National Association for Plastic Container Recovery\* (NAPCOR) commissioned a study by Franklin Associates, a nationally recognized research firm, to compare the environmental efficiency of three packaging materials for soft drinks – aluminum, glass, and polyethylene terephthalate plastic (PET). Franklin Associates conducted a “cradle-to-grave” analysis of all energy consumed and all wastes produced in the complete life cycle of each packaging system, from raw material through finished product to recycling or disposal. The study showed that PET soft drink containers were the most environmentally efficient of the three systems. Franklin Associates repeated the study in 1993 but expanded its review to include liquor, fruit juice and salad dressing containers. The study again found that, in virtually every instance, PET is the most environmentally efficient packaging.

\* Now known as National Association for PET Container Resources

## **INTRODUCTION**

As Americans grow more environmentally aware, they take special notice of the materials in which the products they buy are packaged. Responding to this interest, manufacturers are reducing the amount of packaging used to deliver their products and favoring materials that can be reused or recycled.

With this growing awareness, debate naturally arises about which types of packaging are more or less friendly to the environment. Many factors must be considered, including both the weight and volume of solid wastes generated, the energy consumed in manufacturing and delivering various types of packaging, the airborne and waterborne pollutants emitted during manufacturing, and dozens of other factors.

It is not unusual for a type of packaging to be very attractive by one measure and unattractive by another. Often, choosing a packaging is a question of tradeoffs. For manufacturers, these tradeoffs include price and a wide variety of characteristics such as transparency, tamper-resistance, shatter-resistance, weight and possible interactions between the packaging and its contents.

Because it is lightweight, transparent, shatter-resistant, inexpensive and effective at protecting the products stored in it (such as keeping the fizz in our favorite soft drinks), polyethylene terephthalate (PET) has become one of America's favorite packaging materials. Best known as the material used to make two-liter soft drink bottles, PET currently accounts for about a third of all plastic bottles produced in the United States.

Used PET is also in great demand for recycling. Although 34 percent of PET plastic bottles were recycled in 1994 – a total of 565 million pounds – market demand exceeded supply by nearly 131 million pounds. As a result, PET is more valuable than any other recyclable material except aluminum.

But the processing, manufacturing, filling, distribution and disposal of all containers use energy and create environmental emissions. Increasingly, consumers and manufacturers want to know how various types of containers actually stack up against one another in terms of environmental impacts.

## **THE STUDY'S METHODOLOGY**

Franklin Associates has done extensive work in the solid waste, energy and environmental areas. Its analyses of municipal solid waste, including studies for the U.S. Environmental Protection Agency, have been regarded as definitive. The firm also has done total system and energy analyses on a wide range of consumer products, including aluminum and paper containers.

In 1993, Franklin Associates conducted a "cradle-to-grave" analysis of aluminum, glass and PET soft drink containers. It also conducted a "cradle-to-grave" analysis of PET

and glass containers for liquor, fruit juices and salad dressing. Researchers collected and evaluated data on all energy consumed and all wastes produced in each material's life cycle. For soft drinks, the analysis covered every step from extraction of raw materials, processing, manufacturing and filling of primary containers to secondary packaging and distribution. For liquor containers, the analysis includes filling, but does not include distribution. For juice and salad dressing containers, neither filling nor distribution is included.

The study takes into account the energy value of the petroleum products used to make PET. It also gives each material credit for that portion of the packaging that is recycled, in proportion to each material's own recycling rate. That portion of the packaging that is not recycled or reused is included as part of the calculation of the environmental impacts of disposal.

The study evaluates each soft drink container system in terms of its impact in delivering 1,000 gallons of soft drink to the marketplace: the average annual consumption of 22 people. Because the size of a container greatly affects its efficiency in delivering the product, the study evaluates each container size separately.

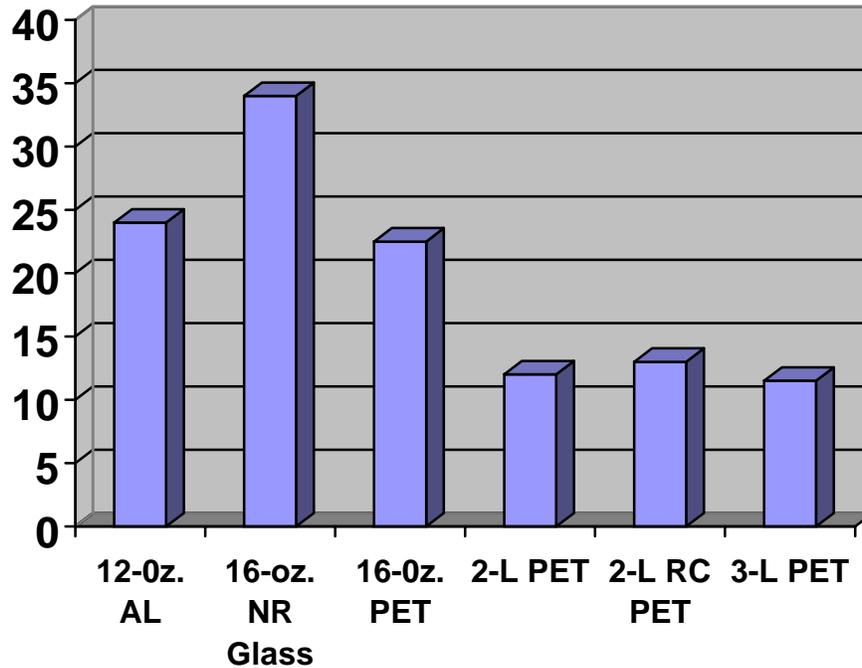
Data are reported in four categories: energy consumption, atmospheric emissions, waterborne wastes and land-disposed solid wastes.

It is important to note that when comparing the energy efficiency of various sizes and types of container systems, the study states that differences of 10 percent or less are not considered significant. Therefore, containers whose energy consumptions are within 10 percent of one another are considered to be equivalent. For solid waste products, only differences of more than 20 percent are considered significant in terms of the study.

## **THE STUDY'S CONCLUSIONS**

Conclusion 1: *When comparing the energy efficiency of like-sized PET (16-ounce), glass (16-ounce) and aluminum (12-ounce) soft drink containers, PET and aluminum containers are 32 percent more efficient than glass in delivering 1,000 gallons of soft drink to the consumer. 16-ounce PET bottles are equivalent to aluminum cans in terms of energy efficiency. Because of their superior packaging-to-product ratio, however, two-liter and three-liter PET bottles are 47 percent more energy efficient than 12-ounce aluminum cans and 63 percent more energy efficient than 16-ounce glass bottles.*

**TOTAL ENERGY REQUIREMENTS  
FOR SOFT DRINK CONTAINERS  
AT CURRENT RECYCLING RATES, 1991 (1)**  
(Million Btus per 1,000 gallons of product)



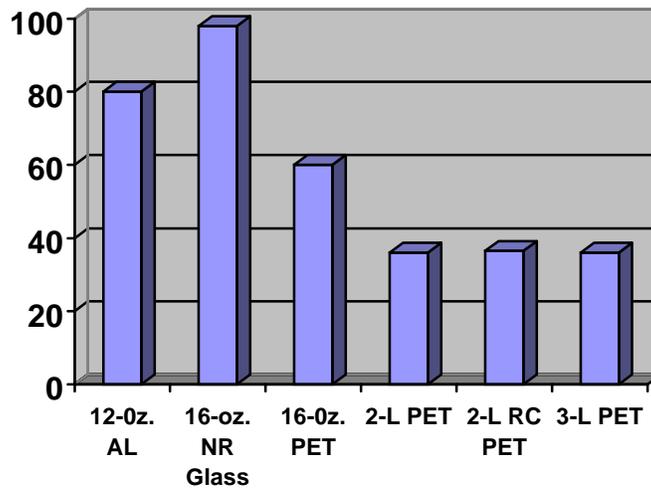
(1) The 1991 recycling rates are as follows: 12-oz. AL=62%, 16-oz. NR Glass=34%, 16-oz. PET=36%, 2-L PET=36%, 2-L RC PET=36%, 3-L PET=36%.  
In 1994, the PET recycling rate climbed to 34%.

This comparison demonstrates that two-liter and three-liter PET plastic bottles are the most energy-efficient containers for soft drinks. Even taking into account the energy value of the petroleum used to make plastic, PET containers are as good a choice or better for efficiently using renewable energy resources as glass or aluminum containers.

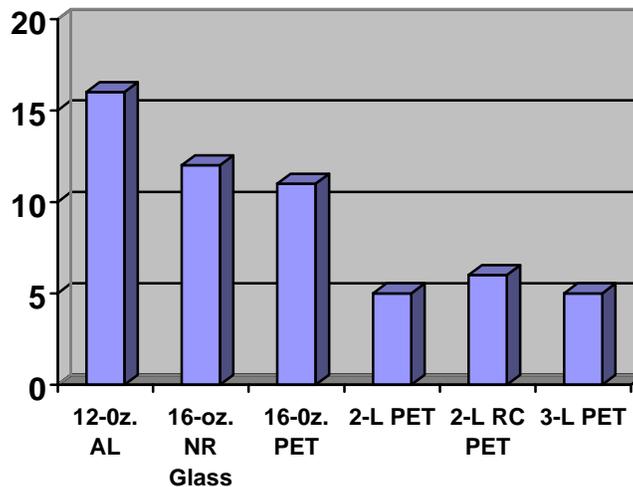
Conclusion 2: *PET containers have the least environmental impact of all soft drink container systems in terms of the total weight of both total air emissions and total waterborne wastes.*

**SUMMARY OF ATMOSPHERIC AND WATERBORNE EMISSIONS FOR DELIVERY OF SOFT DRINK AT 1991 RECYCLING RATES (1)**  
(Pounds per 1,000 gallons of soft drink)

**ATMOSPHERIC EMISSIONS (pounds):**



**WATERBOURNE WASTES (pounds)**



(1) The 1991 recycling rates are as follows: 12-oz. AL=62%, 16-oz. NR Glass=34%, 16-oz. PET=36%, 2-L PET=36%, 2-L RC PET=36%, 3-L PET=36%.

Source: Franklin Associates

As the Franklin Associates study points out, different container systems generate different types and amounts of atmospheric and waterborne emissions. The relative impact of different pollutants on the environment is the subject of widespread and heated debate. However, the total weight of airborne and waterborne pollutants generated by PET soft drink container systems is significantly less than that generated by either glass or aluminum.

When compared to 16-ounce PET bottles, 12-ounce aluminum cans generate 32 percent more atmospheric emissions and 16-ounce glass bottles generate 58 percent more. When compared to two- and three-liter PET bottles, aluminum cans generate approximately 175 percent more atmospheric emissions, while glass bottles generate approximately 230 percent more.

When compared to 16-ounce PET bottles, 12-ounce aluminum cans generate approximately 45 percent more waterborne emissions and 16-ounce glass bottles generate approximately 10 percent more waterborne emissions, making glass and PET equivalent for purposes of the study. When compared to two- and three-liter bottles PET bottles, aluminum cans generate approximately three times as much waterborne waste by weight, while glass bottles generate more than twice as much.

Conclusion 3: *16-ounce PET bottles contribute 68 percent less solid waste than 16-ounce glass by weight and are statistically equivalent to glass by volume. 16-ounce PET bottles contain 18 percent less solid waste by weight, when compared to the 12-ounce aluminum can.*

**SOLID WASTE FOR THE DELIVERY OF SOFT DRINK  
AT 1991 RECYCLING RATES (1)**  
(Basis: 1,000 gallons of soft drink)

	INDUSTRIAL PROCESS WASTES		FUEL WASTES		POSTCONSUMER WASTES		TOTAL WASTES	
	(lb)	(cu ft)	(lb)	(cu ft)	(lb)	(cu ft)	(lb)	(cu ft)
<b>12-oz. AL</b>	279	5.6	232	4.8	254	17.5	775	27.9
<b>16-oz. REF</b>	23	4.7	113	2.3	1,646	25.4	1,996	32.4
<b>16-oz. PET</b>	23.1	0.5	158	3.2	451	43.3	632	47.0
<b>2-L PET</b>	9.43	0.2	83.5	1.7	202	22.1	295	24.0
<b>2-L RC PET</b>	7.32	0.1	85.5	1.7	181	19.6	274	21.4
<b>3-L PET</b>	9.74	0.2	90.0	1.8	199	21.8	299	23.8

(1) The 1991 recycling rates are as follows: 12-oz. AL=62%, 16-oz. NR Glass=34%, 16-oz. PET=36%, 2-L PET=36%, 2-L RC PET=36%, 3-L PET=36%.

Source: Franklin Associates

When evaluating solid wastes, both weight and volume are important. The more a waste weighs, the more expensive it is to transport to a landfill. And the more space a waste occupies, the faster it fills up a collection truck or a landfill. PET has always been recognized as the low-weight material, but some have criticized its high volume-to-weight ratio for contributing disproportionately to the solid waste crisis.

The new Franklin Associates study, however, shows that PET soft drink containers have significantly less impact than like-size glass bottles by weight and are equivalent to glass by volume. 16-ounce PET is equivalent to like-size aluminum cans by volume, but has 60 percent less weight. When compared to the highly efficient two- and three-liter containers, however, both glass and aluminum contribute significantly more solid waste in terms of both weight and volume.

Conclusion 4: *Custom PET containers for liquor, fruit juices, and salad dressing consistently consume less energy and generate fewer solid, atmospheric and waterborne wastes than like-size glass containers.*

The 1993 Franklin Associates study for the first time compared the relative impacts of containers for products other than soft drinks. Specifically, the study looked at like-size custom PET and glass containers for liquor, fruit juices, and salad dressings. None of these products are packaged in aluminum.

Once again, both systems were compared in terms of their relative impacts in delivering 1,000 gallons of product. Each material's impact was adjusted for its specific recycling rate for containers used to deliver the specific type of product being considered.

When comparing 1.75-liter liquor containers, the study found that PET containers consume about 45 percent less energy than glass containers, generate 46 percent less solid waste by volume than glass containers and approximately half as much atmospheric and waterborne emissions as glass containers.

When comparing 64-ounce juice containers, the study found that PET containers consume about 25 percent less energy than glass. The two container systems generate approximately the same amount of solid waste by volume, but glass generates approximately 60 percent more atmospheric emissions and 23 percent more waterborne wastes than PET.

When comparing 16-ounce salad dressing containers, the study found that PET containers consume about 45 percent less energy and generate about 35 percent less solid waste than glass. Glass salad dressing containers also generate more than three times as much atmospheric waste and nearly 70 percent more waterborne emissions by weight than the PET containers do.