

# IS RECYCLING GOOD FOR THE ENVIRONMENT?

Allan L. Griff, Consulting Engineer  
5101 River Rd, Bethesda, MD 20816  
(301)654-1515 -- fax (301)654-1414 - [algriff@griffex.com](mailto:algriff@griffex.com)

## Abstract

Recycling is considered “good for the environment,” but “it ain’t necessarily so.” Conservation of resources, energy, air and water pollution, and psychological and political aspects are often competitive, and what may help in one arena may be harmful in another. Recycling beverage containers into other products may save energy, help to reduce landfill siting pressures, and make people feel better about consuming their contents. Chemical recycling back to monomer is thermodynamically enviro-negative, and “closing the loop” is often an environmental handicap, rather than a benefit. The real environmental value of recycling depends on replacement of new material and comparative environmental savings, not on the good feeling we may get from doing it.

Unchallenged acceptance of recycling is a diversion from the basic issue of consumption. We can accept “waste not, want not” in principle, but can’t yet deal with “drink not, use not, waste even less.” We are addicted to consumption and growth, and this cancer is killing us slowly

## Objective

The objective of this paper is to make us more aware of environmental effects of recycling, and to challenge the image, shared by the public, industry and government, of recycling as the “good guy,” thereby distracting us from the greater (and connected) issues of real environmental protection and reduced consumption.

## Discussion

### Background

Around the time of the first Earth Day in 1972, it was commonly and publicly believed that refillable glass beverage bottles were “good” for the environment, even though it takes so much energy to make a glass bottle, and even more energy to transport them. Plastics are so much lighter, so why shouldn’t it be better for the environment to use a plastic bottle? In those days, there was still a strong push to keep refillable bottles, even though it was obvious to any open-minded and well-informed person that refillables (even plastic ones) were often enviro-negative, especially inland, where sterilization liquids could not easily be dumped into fresh-water lakes and rivers.

Over thirty years have passed, and recycling has replaced refillables as the aim of “green” packaging. It is

underpinned by the states with deposit laws, because when there is money to be recovered, more people bring containers back. Recycling has become a guide that can be desired by one and all, as a good thing to do. Packagers can still put their products in whatever they choose, and consumers can choose whatever they want.

## The Question

But is recycling really a good thing to do – good for the environment, that is?

First of all, “the environment” extends over time as well as space. What is good for one region or one country may not be so good for another, and what may help in 20 years may have both environmental and economic costs today. And the environment is not a single thing -- conservation of resources, energy, air and water pollution, and psychological and political aspects are often competitive, and what may help in one arena may be harmful in another.

## Beverage Containers

This is a very large volume application, and as such has been able to support a large amount of research and development – especially in the 1965-1975 period when refrigerators were getting larger, consumption rates were rising, and larger glass bottles were seen as safety hazards they were. The result and eventual “winner” was the 2-liter PET bottle, the subject of the famous du Pont patent (3,733,309 to Wyeth, 1973), and the progenitor of today’s single-service soft-drink bottles, as well as PET bottles for juices and oils, and jars for peanut butter and other foods. None of these others would have been economically viable without the huge technical and manufacturing base provided by beverages.

Once the bottlers were convinced that filling speeds were adequate, the economics were OK, and the public really wanted these safe, large-volume (hence cheaper-per-ounce) containers, they began to take over. The first bottles had base cups to ensure stability and allow cheaper (lower-IV) resins to be used, but as we know now, the cup-less footed bottle – which was seen in

smaller sizes in Europe as far back as 1965 – became the standard and remains so today.

The contribution of Goodyear to this success should not be overlooked. This company already had a background in PET fibers for tire cord, knew how much it cost to make, and priced the first bottle compounds (to Pepsi in 1974) low enough to avoid an insurmountable cost barrier at bottler level. They recognized that the market was there right now, and chose to forego the usual gradual development process – more cost now, eventual lower cost when big-volume resin plants go in.

Despite (or maybe because of) the success of the PET bottle, there was little concern with its environmental impact beyond their being one-way containers, similar to cans and most glass at that time. That objection gave rise to the deposit laws enacted in approximately 20% of the USA, first in Oregon (1972) and later in such populous states as Michigan and New York. California's entry to deposit-land was more gradual, but eventually just as effective, and it was soon established that deposit laws get bottles back into the recycle stream, whatever other impacts they may have.

This seemed to be enough to justify their recycling, but what about The Question -- is recycling of PET beverage bottles really good for the environment?

There are (at least) six competitive arenas noted above: -- conservation of resources, energy, air pollution, water pollution, political and psychological aspects. Let's look at each in turn.

### Conservation of Resources

Glass sand and aluminum ore are among the most abundant materials on earth, and therefore there has been little concern that we will run out, or even run so low that costs will rise out of hand. Plastics seem to be made of petroleum, but that won't run out either – even a small rise in gasoline and fuel prices is enough to restrain consumption enough to leave more for packaging, and even push petrochemical companies toward such uses. Compare gasoline prices of around \$0.15/lb based on crude oil at \$0.09/lb to PET resin prices of \$0.60 or more. There is a political side to the petroleum question, too – the more we use, the more we either have to import or take from reserves, but that comes later.

### Conservation of Energy

This is perhaps the most quantifiable of all the arenas, as all materials issues can be expressed as energy consumption. It takes energy to melt the glass and separate metals from their ores, as well as transport everything from well and mine and forest and quarry to the lips of the consumer.

Here we can look at actual figures. Between 1970 and 1980, this author published five book-length studies of the place of plastics in beverage packaging (1). These studies compared energy costs to make a variety of containers (see Table I), and showed 2-liter PET bottles

and recycled 12-oz aluminum cans as the most energy-conserving, other than the astonishing, premature and short-lived "Merolite" beer pouch – 3 g of PVDC-coated PET film plus 7 g of paper, to hold ¼-liter of beer.

### Water Pollution

There is also the issue of water pollution, such as the fresh-water vs salt-water problem noted above. This is no longer a significant matter here in the USA, where refillables are a minor component of the product mix, but in Canada (beer) and elsewhere, refillables are more important. This is a good example of selective environmentalism, as in the interests of saving resources (glass) and avoiding disposal costs, as well as tradition and public perception (beer tastes better in glass), a system has been maintained and (most importantly) invested in. The investment is important, as in a refillable system, the bottle cost is lower, but there is added cost related to the float (the bottles and cases in use at any one time) washing and sterilizing, as well as the transport of glass bottles from pickup sites to the central processing locations (and when full, back to the retail outlets). The weight and size of the bottles matter; as a rough estimate, a truck can carry one-half the product volume in refillables compared to cans or large plastic bottles, thus more trucks for the same consumption.

### Air Pollution

This is yet another environmental argument against refillables. The increased fuel consumption and exhaust of the larger trucking fleet, made worse by the increased time needed to unload the containers and reload the empties, needs to be considered. But, as with water pollution, tradition (psychology and politics) wins, and people can feel right about wanting glass refillables ... if only they weren't so heavy and such a nuisance to return. (Add in the fuel for the personal vehicles that return them, and it's even worse. Ian Boustead, in a classic study in Britain (2), showed that the worst environmental aspect of packaging was not the package itself, but the need to go to the shop to buy it (moving a two-ton car around, several times a week).

Air pollution has another aspect, this time linked more directly to recycling: if we recycle, we avoid the option of incineration, which is perceived as putting "noxious fumes" into the air, and thus harming us more than the incineration might help us by generating energy (another plus of plastics over glass and metal), saving space and providing sanitary disposal.

There has been enough junk science put out by certain environmental wolves in sheep's clothing and linked to the term "dioxins:" that consumers think that any plastic can produce them and in great and toxic amounts. PET cannot produce dioxins (which are chlorine compounds); nor can PE or PP as used in labels and carriers. No matter, we are agents of the devil.

## Solids Pollution

If we don't burn it, we may have to bury it. This is feared by many who think inert package materials were somehow dangerous to us when buried. The science junkies are out here too: the same people who consider glass pure and sacrosanct are also in favor of chemical decomposition of other products (they call it degradability) under other circumstances. Degradability, bio- or otherwise, has some serious environmental drawbacks (3). If containers do somehow end up in a really sanitary landfill, it doesn't matter, as nothing degrades. Professor Rathje told us this over 20 years ago (4), and we all said "yes, yes," but went on hyping the image of degradability as good for the environment. And what if the landfill isn't so sanitary? Then we have a bacteria farm, which is even worse.

It may be useful to recall an interesting case history here. Around 1970, a chemical company developed an additive called WS-7 which would sterilize beer, making it unnecessary to pasteurize it to kill remaining yeast cells (as Pasteur did for wine). A few breweries actually started to use this additive, which was shown to naturally decompose into ... water, carbon dioxide and ethyl alcohol, just the ingredients that are in beer! However, one lab took a look at the chemical path by which the additive decomposed, and discovered that in one of its reactive stages it could also react with beer components to produce an allegedly carcinogenic substance, which didn't go away when everything else did. It didn't take long for the breweries to stop using the additive, but the public (and much of the industry) is still blindly wedded to the idea that degradability is inherently good, and if we don't do it, it has to be for economic or shelf-life issues, not environmental or toxicological ones.

Yet another and very current issue is the irradiation of foods. The same people who want our packages to degrade and ignore the lesson of WS-7, are the ones who say "too little research has been done on the chemicals that have been formed in irradiated food" (5). This apparent illogical and contradictory behavior can be explained by this common factor: the reluctance to face the fact that we live in a chemical and physical world. Make the waste disappear and don't monkey with the food. Let us get sick the old-fashioned ways, but when we do, it's OK to use new-fashioned technology to cure us.

## Psychology

The argument that "natural is good" is so full of holes that it is amazing that people cling to so passionately (look at natural products like tobacco smoke and snake venom, vs manufactured ones like insulin and cell phones). But this very disparity deserves much more attention: "why do the nations rage so furiously together, and why do the people imagine a vain thing (6)?"

It may just be that reluctance to face the chemical/physical nature of the bodies and the environment we live in. The environment doesn't have feelings, it has actions and reactions.

## Politics

The issue of degradability leads to this major arena which often obscures the rest, the political one of how we collect garbage, and how we dispose of it. And when landfills are used -- still the dominant disposal method in the USA -- the politicians must remember that they represent people who don't want it in their "back-yards," which is really an issue of where do we put the garbage. And recycling makes it easier to deal with this problem everyone, which accounts for its strong appeal.

## Eco-Indices

With all these conflicting and often competing issues, it would seem sensible to set up some sort of weighted rating, like our credit bureaus do, to judge the overall environmental desirability of a particular container. This has indeed been proposed by Boustead (7) and others, but it hasn't taken hold, as people still want the flexibility of favoring what they see as right. *My mind's made up, don't bother me with facts*, says a desk plaque which we don't see much any more, perhaps because it is scarily all too true. What has happened is that because of computers, improved technology, and the Internet which democratizes information on a World scale, we now have access to so many facts that is impossible for not just the average person, but any person, to weigh them all and come to a reasonable conclusion. Boustead, in (7), agrees.

Does that leave us free to toss facts aside and act according to our feelings, our belongings (the groups we belong to) and our perceived interests? Even the latter is equivocal: whose interest should we be protecting, our own, our children's or the World's?

## Recycling and the Environment

Now, where does recycling fit into all this? It is well known that it eases the political pressure on siting landfills, and avoiding incineration and "export" of garbage. But that is still just out-of-sight/out-of-mind. What effect does recycling itself have on the environment?

To deal with this question, we need a definition of recycling: the re-use of a product in a way that replaces the use of other material. By this measure, converting bottles to strapping or carpets is recycling, as the products would otherwise have made from virgin materials. Then we can set off the environmental cost of a package, such as in Table 1 above, against the environmental saving by replacing the new material with the old. It isn't always that direct, however; e.g., if recycled film is used as

agricultural mulch, we have to include water savings and crop yield increases among the benefits. Further, we need to consider the usefulness of the product we are making: would it have been made if we didn't have recycle to make it with? Is it then not really a replacement of other material?

To the public, recycling means a place they can take certain wastes, or someone who comes to get them, and take them to a good home. Out of sight, out of mind, and if the degree of waste is reduced by some sort of re-use, so much less the guilt for wasting in the first place. Doesn't anyone remember the saying "waste not, want not" or the "good old days" when our foremothers used to sew pieces of old clothing into quilts to keep us warmer at night, when the fire was banked and put on hold till the morning? Of course, those good old days left us little choice, little discretionary time. Now we have more time to seek more things to fill our heads (through eyes, ears and mouth) and replace the work we don't have to do, in short: to consume.

Recycling doesn't stop this, nor do we even agree that it should be stopped. There is a work ethic that still exists as a sort of mythology, but except for small pockets of enthusiasts, it isn't very popular any more. That's why TGIF is a successful name. The social pressure to separate work and play (read "pain" and "pleasure") is enormous. And consumption, specifically the freedom to consume what we want, when we want, is the means and ends rolled into one.

Since recycling feels good, we support it with words, as a sort of prayer. It is harder to support with the extra time needed to separate, wash and sometimes bring, but we do that, too. But do we ever ask if it is good for the environment? Don't ask, don't tell; just do it.

Such "blind faith" leads to the environmentally unsound idea of "closing the loop." If the objective is to re-use resources and replace new materials, what difference does it make what we use the materials for? Loop closing is neat, but may in fact force us to use recycled materials in ways where new materials would be environmentally as well as economically better.

### Chemical recycling

Here is another example of how non-science got into the minds of industry and environmental activists alike, and was only reined in by economics. Chemical recycling refers to the chemical breakdown of, e.g., PET beverage bottles, back to monomer, with subsequent manufacture of new bottles from the recovered and purified monomers. This is thermodynamically enviro-negative, as chemical bonds must be broken, and it costs much more energy to do this than to keep the PET in solid, polymerized form, and just clean and re-extrude or

remold it into some other useful(?) products. Didn't anyone know this already? It's disgraceful either way – either people knew it was an energy-loser and didn't want to let it be known, or else they didn't bother to figure it out at all. Such assessments are essential if we are to be responsible managers of our present and the future of our children, our countries and our World. If it's landfill siting that is driving our actions, let's see it as such and not make believe that we're doing something beneficial for the air, water, or our resources.

### Environmentally Responsible Recycling

This is a matter of degree. Some recycling may be more beneficial to the environment than others, and some (like chemical recycling) may be negative if energy is the primary issue. There is a question of time, too – designing durable goods for disposal, and setting up systems to collect and recycle them may be laudable, but is it justifiable in terms of energy saved over time, or air pollution, or even psychological and political concerns? Don't rob Paul (our future) to pay Peter (our present). (Biblical Peter was old enough to be Paul's grandfather.)

Just the raising of this question is upsetting, but responsible stewardship of the Earth demands its answers; however imperfect, they are better than seeing only what we want to believe. Know the environmental costs to pick up bottles or film or computer parts, to separate and clean and grind, and to re-form them into useful (not frivolous) products like fibers, strapping and lumber. Then, we can compare with the equivalent environmental assessments using new materials, and thus see more of the real environmental cost of recycling. It won't be crystal clear, but at least it won't be buried either. This may have already been done, but results haven't been widely publicized and certainly have not impacted public opinion.

Even if recycling a container is enviro-negative compared to new, it may still be worth the trouble, not only for solid-waste-disposal reasons, but also for the feeling of being more responsible. Feelings count, too – that is part of the quality of life that we all work to maintain. But just as using only numbers to justify an action is un-human, using feelings alone (don't bother me with facts) is equally extreme. Balancing these factors is hard, and sure to be controversial, but needs to be done nevertheless, as either extreme is too dangerous.

### Conclusion

All the above observation leads to one basic conclusion: use less. What do we need it all for? Our economy and culture has become addicted to growth and change, and can't deal well with the concept of sustainable levels. We are like a teen-ager who has been growing all his/her life and now stops, and must instead deal with matters of personal growth rather than physical,

inside rather than outside. No growth certainly doesn't mean no change.

Many years ago, we learned that buying stock is lending money to a company with the expectation that the company pay some of its profit back to the lenders as dividends. Now, the purchase of stock implies the expectation of its price rising, with profit (the investor's not the company's) being made that way. There are even laws now that require a trustee responsible for investing someone else's money to invest in growth as well as dividends! That's how deep the addiction to growth has taken hold.

Supporting this habit is the need to consume, and thus the pressure to recycle, partly as a device to justify the consumption that has become economically and psychologically necessary. The attention to packaging is a distraction to divert us from thinking about the contents.

Some people believe that "freedom" means the right to buy whatever they want, as much as they want, and whenever they want. And since "freedom" is good, anything that restricts it must be bad. This is a dangerous point of view, and it is doubtful that its exponents would apply it to their employees, their children or their pets. Freedom is defined as much by what we restrict as by what we allow. We need to find a way we can thrive and prosper without the addiction to consumption. Recycling can play a big role in this quest. Let's go on with eyes open, not minds closed.

Tables on following pages.

## References

- (1) Griff, A. L., *The Plastic Coca-Cola Bottle (1970), The Plastic Beer Bottle (1972), The Plastic Can (1975), Plastic Containers for Soft Drinks, Beer & Liquor (1978, 1980)*, Edison Technical Services: New York and Washington.
- (2) Boustead, Ian, *Problems in Packaging - the environmental issue*, Ellis Horwood:Chichester/John Wiley:New York (1984).
- (3) Tilley, Kate, "Australian report questions benefit of biodegradables," *Plastics News*, dateline Dec. 17, 2002.
- (4) Rathje, William, & Cullen Murphy, *Rubbish!The Archaeology of Garbage*, U of Arizona Press, Tuscon (2001).
- (5) *Washington Post*, November 4, 2002, page E-1.
- (6) Psalm 2, 1-2, as used in Handel's oratorio, *The Messiah*, Novello: London (1992).
- (7) Boustead, Ian, "Eco-labels and eco-indices: do they make sense?" *Fourth International Ryder Transpak Conference*, Brussels (1999). For a pdf copy of this paper and much more by Boustead, see the publications section of his web site, <http://www.boustead-consulting.co.uk>.
- (8) Hannon, Bruce, "System Energy & Recycling: A Study of the Beverage Industry," U of Illinois, Urbana, IL (1971).

Table I: Energy costs of beverage containers from mine or wellhead to household

Source: *The Plastic Beer Bottle*, a multiclient report by Allan L. Griff, Edison Technical Services, 1972, based on work done by Hannon (8). He provided the concept of calories per gram of container weight, as well as figures for non-plastic containers; the author calculated equivalents for plastics (see Table II) and applied them all to actual beverage containers. A few current containers have been added (*in italics*).

<u>Contents</u>		<u>Container</u>	<u>Weight</u>	<u>Energy, Kcal/KJ</u>		
ounces	liters		grams	per container		per 12 oz /0.355L
68	2.0	PET with PE base cup	88	2983	12485	526 2202
68	2.0	PET with feet 1980	71	2670	11175	471 1971
<b>68</b>	<b>2.0</b>	<b><i>PET with feet 2002</i></b>	<b>58</b>	<b>2197</b>	<b>9196</b>	<b>388 1624</b>
<b>68</b>	<b>2.0</b>	<b><i>PET 2002 30% recycle</i></b>	<b>58</b>	<b>1534</b>	<b>6421</b>	<b>271 1134</b>
68	2.0	Glass Plastishield	920	5045	21116	890 3725
68	2.0	Standard Glass	1080	5622	23698	992 4152
51	1.5	European PET	65	2454	10344	577 2415
34	1.0	PET with base cup	60	2144	9038	757 3168
20	0.59	<i>PET soft drink</i>	27	1081	4525	649 2716
34	1.0	Glass Plastishield	455	2554	10690	901 3771
15	0.45	Swedish 3-pc beer w alu ring	60	1072	4487	858 3591
15	0.45	Swedish Rigello Pak	27	570	2386	456 1909
12	0.355	Glass light for beer	170	905	3788	905 3788
10	0.295	Glass standard soft drink	200	1058	4428	1270 5316
12	0.355	Steel 3-pc can, aluminum end	50	941	3939	941 3939
12	0.355	Steel 2-pc can, aluminum end	37	771	3227	771 3227
12	0.355	Steel 2-pc can, steel end	41	537	2248	537 2348
12	0.355	All-aluminum can, no recycle	19	1237	5177	1237 5177
12	0.355	All-alu can, 25% recycle	19	928	3884	928 3884
12	0.355	<b><i>All-alu can, 50% recycle</i></b>	<b>15</b>	<b>521</b>	<b>2181</b>	<b>521 2181</b>
8.5	0.25	Plastona PET can, alu end	20.5	898	3759	1268 5307
8.5	0.25	ICI Merolite pouch	10	165	691	233 975

Table II – Energy Factors for Various Materials, in Kilocalories/gram

Source: *The Plastic Beer Bottle*, a multicient report by Allan L. Griff, Edison Technical Services, 1972, Figures for non-plastics from Hannon, 1971, op.cit. Figures for plastics calculated by author.

Glass	5.1 Kcal/gm	21.4 KJ/gm	HDPE	23 Kcal/gm	96 KJ/gm
Paper	9.7 Kcal/gm	40.6 KJ/gm	PVC	23 Kcal/gm	96 KJ/gm
Steel	13.1 Kcal/gm	54.8 KJ/gm	PP	24 Kcal/gm	100 KJ/gm
Aluminum	65.2 Kcal/gm	273 KJ/gm	PS	29 Kcal/gm	121KJ/gm
LDPE	14 Kcal/gm	59 KJ/gm	PET	36 Kcal/gm	151 KJ/gm