5. Markets and Packaging Changes for Recycled Plastics

5.1 Recycled Resin Demand

The demand for recycled resins is expected to rise significantly in the next three years, according to the study, "The Market for Plastics Recycling and Degradable Plastics," by Find/SVP, a New York market research firm. HDPE and PET are estimated to comprise 65% of the recycled resin market for 1990. It is expected that the amount of recycled HDPE and LDPE will nearly double between 1990 and 1991, from 252 to 498 million pounds, and from 87 to 163 million pounds, respectively [Charnas, 1990]. It is estimated the HDPE recycle will exceed 1 billion pounds by 1994. Figure 5.1 shows the recycled resin demand for the six primary thermoplastics by type from 1988 to 1993. The combined total of recycled resin for the six plastics by the end of 1993 are projected to be 3.5 times the 1990 levels.

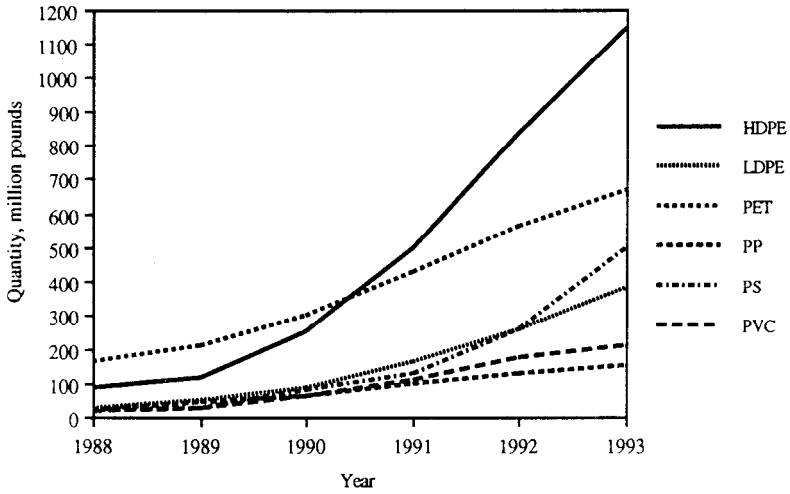

Figure 5.1 U.S. Demand of Recycled Resin, by Type, from 1988 to 1993 [Charnas, 1990]

Recycled resin prices for various stages of processing are shown in Table 5.1. The pricing information is derived from a weekly plastics publication pricing chart during middle 1990 and interviews with recyclers, resin brokers and traders. In the long term, the

price of recycled resin floats relative to virgin resin prices. A common price for a baled mixture of clear and colored HDPE bottles and PET bottles which have been cleaned of foreign material is 2-4 cents per pound. Prices for off-specification, cleaned post-consumer clear HDPE pellets are at 60-70% of virgin resin prices. Cleaned, post-consumer clear HDPE flakes now float at 50% of virgin resin prices [PRC, 1990b]. It is believed that the price of recycled resin will approach that of virgin resin in the near future due to the demand from large users such as the Coca-Cola company, Procter & Gamble and Lever Brothers.

The effect of colored recycled resin on price can be seen in Table 5.1. While clean green regrind PET is selling at 17¢/lb, clear is selling for twice as much. Overall, the two major recycled resins, PET and HDPE, continue to hold or appreciate in value against

Table 5.1 Recycled Plastic Resin Prices (in cents per pound) [a] [Plastics News, 1990b]

Resin Type	Baled	Clean Regrind or Flake	Pelletized
HDPE			
Homopolymer, natural	8 - 11	28 - 31	32 - 39
Copolymer, mixed colors	5 - 8	22 - 23	28 - 31
LDPE/LLDPE Film			
Printed	5 - 9	-	19 - 23
Non-Printed:			
Opaque	7 - 12	-	-
Clear	10 - 14	-	22 - 29[b]
Filter	12 - 16	-	-
Drool	5	-	-
PET			
Clear	8 - 10	33 - 35	42 - 45
Green	7 - 8	17	-
PP Homo/Copolymer	-	8 - 20	20 - 30
PS			
Crystal	-	16 - 18	26 - 27
High Impact	-	20 - 23	30 - 33
PVC			
Blister Pack	-	8 - 10	-
Clear bottles	6-10	12-25	-

a. Prices surveyed during mid-1990.
b. Low end is for random color contamination, high end is for natural material.

the same virgin resin, and are expected to rise in the future. While the price of virgin HDPE declined in 1990, the prices for clean HDPE regrind has remained relatively constant in the range of 22-30¢/lb. The price for recycled PET increased during 1989 and 1990, and prices for PS and PVC remained constant. The prices for clean regrind are generally about half that of virgin material. LDPE, LLDPE and PS are expected to increase in value sooner than other plastics primarily because major plastics suppliers are involved in converting polyethylene and PS waste into reusable material.

Occidental Chemical Corporation has established a buy-back program for post-consumer PVC bottles. For baled material in lots of 5,000 lb and up, with 90% minimum PVC content and without caps, prices paid during the fourth quarter 1990 were as follows: clear PVC bottles with wash removable labels, 9¢/lb; mixed colors and clear PVC bottles with non-wash removable labels, 6¢/lb; clear 5 gallon PVC water bottles, cut in half and nested for shipment, 10¢/lb. Freight is paid by Occidental and truckload quantities greater than 20,000 lbs receive an additional 1¢/lb.

5.2 Packaging Changes to Increase Recycle Rates

Plastic is often not included in recycling because the costs of collection and processing do not offset the revenues gained. A thrust in plastic recycling today is to decrease the post-use processing necessary to achieve separated resins for reuse. The cost to process resins with acceptable levels of foreign plastic and non-plastic contaminants may only be marginally less than the value of the processed resin. It is desirable for collected plastics to be separated from each other so there is greater value in the material and broader application potential. As a consequence, modification of plastic packaging design methods is necessary to obtain a higher value product for recycling following consumer/industry use. Guidelines for packaging design to minimize its contribution to the solid waste stream and add more plastics to the recycle stream have been proposed [Selke, 1990]:

- *Use reusable packages*
  If a package can be reused in its original application, it can be very effective at waste reduction by eliminating disposal requirements for several cycles. Obviously other considerations must enter into this decision. If the package is not returned, it cannot be reused, so the cooperation of the user is crucial. This option is likely much easier to implement for distribution packages than for consumer ones. Costs and energy requirements of returning and cleaning containers must also be analyzed. In many cases, containers will have to be stronger to permit reuse and therefore will use more material. The net benefits must be carefully calculated.

- *Use a single material, wherever possible*
  Multimaterial packages are, in general, less suited to recycling than single material packages. All plastic containers are preferred to plastic with paper and/or aluminum. Single resin plastic containers are preferable to multi-resin plastic containers.

- *Use materials that are either easily separable or compatible if a single material cannot be used*
  If a multimaterial structure is needed, the goal is to design that structure in a way that does the least damage to recycling potential for that package. The HDPE base cup on a PET beverage bottle is not a serious problem for recycling because a relatively simple water flotation process will separate lighter than water HDPE from heavier than water PET.

- *Use recycled materials where possible*
  The existence of markets for recycled materials is a key part of any recycling operation. It does no good whatsoever to separate and process materials if they do not find uses in new products. The packaging industry has an obligation to increase its use of recycled materials. While there obviously are applications for which only virgin materials are suitable, they should not be specified unless valid reasons for the exclusion of recycled materials exist. Writing specifications based on performance rather than material content may aid in avoiding the unnecessary exclusion of recycled materials.

- *Eliminate toxic constituents*
  Packaging designs should incorporate only nonhazardous materials whenever possible. In particular, heavy metals used in additives, colorants and inks should be eliminated. If a company cannot achieve the desired color without heavy metals, perhaps a change in color coupled with a publicity campaign to let the public know the reason for the change could actually greatly enhance sales.

Modification of plastic packaging using the above methods has the potential for increasing the quantities of plastics recycled and improving the economics of the recovery process. Plastic bottle recycling can serve as one example for illustrating the potential benefits. A municipality with a recycling program may work with local plastic bottle producers to improve bottle design so that after collection, plastic bottles could be sent directly to end users without expensive processing, and more desirable resin materials such as PET and HDPE would be used. Design criteria similar to the above guidelines have been submitted to support such an effort in plastic bottle production [Anderson and Brachman, 1990]:

- Bottle products in clear rather than colored resins (with the color on the label if necessary)

- Do not use adhesives on the labels (use shrink wrap, for example) or utilize easily soluble adhesives
- Use non-aluminum caps made from the same resin and with the same viscosity as the bottle body
- Provide easily recognized labeling of plastic type
- Use industry supported campaigns to educate the public to flatten plastic containers

The first three criteria are initially subject to front end product testing to ensure safe packaging, while the remaining two criteria are tied into post-consumer use. Part of the incentive in developing future consumer plastic packaging which has higher value due to uniform resin composition is the processing which could be eliminated. This will achieve the greatest value from the recycled plastic by allowing a manufacturer which uses recycled content resin to directly purchase waste plastics without the cost of an intermediate processor. This would also allow municipalities to bypass intermediate processors and go directly to end users. This process is conducted in some municipality/company arrangements with the recycle of clear HDPE bottles which are often baled or reground by a recycling program and sold directly to a manufacturer which uses secondary plastics.

5.3 Markets in Primary Recycling

Primary recycling, or the converting of otherwise waste plastic into products similar to the original product, is generally the most favored form of recycling. It is desirable because it is not necessary to create a new market niche for a product and because the need for virgin resins are reduced. The plastic manufacturing industry regularly recovers waste "trim scrap" generated in-house because it is convenient to do so, and because the scrap material is contaminant free and of a known composition. The packaging industry is moving beyond in-house recycle of plastic scrap by manufacturing bottles containing a certain portion of post-consumer plastic products primarily because of its market appeal and recycling goals set at the federal, state, and local levels.

Plastic users have made a market for recycled plastic by modifying machinery for two and three layer coextrusion heads. Coextrusion is a method applied primarily to HDPE and sandwiches a recycled plastic layer in between virgin resins. It is used because it produces a uniform appearance of bottle exteriors and a market safe container. Coinjection stretch blow molding of PET is another fabrication method being looked at. It is capable of producing multi-layer bottles with recycle PET sandwiched in between. Examples of

recycled resin in packaging are shown in Table 5.2, a majority of them being bottle coextrusion processes.

5.4 Markets in Secondary Recycling

Secondary recycling is the recycle of plastic resins into new products with less demanding physical and chemical characteristics than the original application. Mixed plastics are applied most easily in the secondary recycling market because less separation of resin types and less complicated production methods are necessary to achieve a finished product. The most readily recognized secondary plastic product is "plastic lumber" (thick extrusion molded slabs of resin in which some types of resins act as fillers). Plastic lumber is used to make park benches, fence posts, boat docks, playground equipment and the like. The fabrication of mixed plastic lumber is discussed in Part II of the book.

Examples of other value-added products which can be made (via secondary recycling) include products such as recycling containers, refuse containers, flower pots, greenhouse potting trays, traffic cones, speed bumps, downspout splash blocks, etc. Rubbermaid is producing a variety of refuse containers containing 10-25% HDPE regrind and office accessories and food service trays containing 10-50% PS regrind. Another company, Utility Plastics of Brooklyn, NY, is injection molding traffic cones and barriers containing waste HDPE.

Some recovered post-consumer and post-industrial resins are for sale in pellet form for manufacturers to utilize in production. Table 5.3 shows producers/companies which produce such pellets.

Table 5.2 Primary Recycling of Post-Consumer Plastic Resins

Company	Resin	Description
Astro Valcour	LDPE	Air bubble cushion packaging containing 20% post-consumer and 30-40% in-house scrap
Dolco Packaging	PS	Egg carton manufacture
Drug Plastics & Glass	HDPE	10 - 30% recycle material in a stock bottle made using coextrusion
Jennico	HDPE	50% recycle detergent containers made on extrusion/blow molding machines
Johnson Controls	PET	100% recycle motor oil, transmission fluid and other non-food product container; the product is stretch blow molded
Lever Brothers	HDPE	25 - 35% recycle in multiple detergent and fabric softener containers produced using coextrusion
Mobil Chemical	HDPE	Post-consumer grocery sacks used to re-manufacture grocery sacks
PCL & Eastern Packaging	LLDPE HDPE	Post-consumer grocery bag sack used to manufacture film bags
Plax	HDPE	Two and three layer household chemical and motor oil bottles
Procter & Gamble	HDPE	20 - 30% recycle in multiple detergent and fabric softener containers produced using coextrusion. Supplier companies are Plastipak Packaging, Owens-Brockway Plastic Products and Continental Plastic Containers
	PET	100% recycle in one floor cleaning product bottle
Sonoco Graham	HDPE	15 -20% recycle content in motor oil bottles
	HDPE	Post-consumer grocery sacks used to manufacture bottles, pipe
Vangaurd Plastics	HDPE	Post-consumer grocery sacks used to re-manufacture grocery sacks
American Mirrex	PVC	Rigid vinyl packaging films made 30% post-industrial recycled vinyl

Table 5.3 Suppliers of Recycled Plastic Resin

Company	Resins Available	Comments
Denton Plastics Portland, OR	HDPE PP PS ABS	(503) 257-9945
Envirothene Chin, CA	HDPE LDPE PP	Primarily HDPE available for sale. Plant start-up 1/91. (714) 465-5144
Georgia Gulf Plaquemine, LA	PVC	(504) 685-1235
Polymerland Itasca, IL	ABS Polycarbonate (PC) PC/Polybutylene-alloy	3 grades ABS available (800) 752-7842
Reprean Waterbury, CT	Flexible and rigid thermoplastics	(203) 753-5147
Secondary Polymers Detroit, MI	HDPE PET	Colored and natural HDPE flake (313) 922-7000
Soltex Polymer Houston, TX	HDPE	"Fortiflex XF855" contains 25% post-consumer HDPE
United Resource Recovery Findlay, OH	HDPE	Off-white pellets from PC milk bottles and black pellets from PC colored bottles. (419) 424-8237