

# Plastic: PET (#1)

## COMMODITY PROFILE

North Carolina Department of  
Environment and Natural Resources  
DIVISION OF POLLUTION PREVENTION AND  
ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



### OVERVIEW

One of the most prevalent resins used by the plastics industry is PET (polyethylene terephthalate). It is used in a wide variety of applications from strapping to fibers, but is perhaps most visible as the ubiquitous plastic soda bottle. PET, also known as polyester in the plastics industry, often ends up as polyester fiber in items such as clothing and carpeting. Much of the growth in PET use has been attributed to its aggressive capture of market share in the soft drink container business. The fastest growing market for PET bottles is single-serve containers, especially 20-ounce soft drink bottles.<sup>1</sup>

### SUPPLY

#### **Current Generation**

The Environmental Protection Agency (EPA) has estimated the generation of discarded and recovered PET in the United States. Figure 1 presents EPA estimates per product category along with extrapolated estimates for North Carolina's

share of national generation. North Carolina estimates are based on its share of the United States population being 2.78 percent, and these estimates are rounded to the nearest 100 tons. Because significant differences in generation exist from state-to-state, North Carolina estimates should be considered rough estimates. Correspondingly, APC figures for 1996 indicate the packaging market comprised 2.4 billion pounds (1,200,000 tons) of PET.<sup>2</sup> Adding EPA's estimates of the categories "soft-drink bottles," "other plastic containers," and "other plastics packaging" produces a packaging estimate of 1,180,000 tons, in close agreement with APC's figures.

#### **Focus on PET Bottles**

As Figure 1 indicates, soft drink bottles represent 40 percent of all generated PET. Other plastic containers, much of which take the form of "custom" PET bottles (such as for juices), constitute another 23 percent of generated PET. Thus, recovery efforts such as curbside recycling programs

**Figure 1. PET 1996 Generation (tons)<sup>3</sup>**

Product Category	Estimated United States Generation	Estimated North Carolina Share
Durable goods	340,000	9,500
Non-durable goods*	180,000	5,000
Soft drink bottles	680,000	18,900
Other plastic containers	390,000	10,800
Other plastics packaging**	110,000	3,100
<b>Total Generated PET</b>	<b>1,700,000</b>	<b>47,300</b>

Source: EPA, *Characterization of Municipal Solid Waste in the United States: 1997 Update*

\*Includes plastics in disposable diapers, clothing, footwear, etc.

\*\*Other plastic packaging includes coatings, closures, caps, trays, shapes, etc.

**Figure 2. National PET Bottle Sales and Recovery (tons)**

	1994	1995	1996
<b>Sales</b>	837,000	975,000	1,099,900
<b>Recovery</b>	282,500	311,000	286,000
<b>Recovery Rate</b>	34%	32%	26%

Source: Schmidt, L.B. "PET recycling: The view from NAPCOR." *Resource Recycling*. February 1998.

**Figure 3. 1996 Extrapolations for North Carolina (tons) from Figure 2**

North Carolina portion of national PET bottle sales	30,600
Theoretical share of national recovery	8,000

targeting PET bottles would address the largest portion of generated PET (although other forms of PET are recoverable).

Another way to estimate the generation of plastic wastes is to examine the use of the resin in non-durable goods. Plastics industry literature shows the use of PET for making containers is growing dramatically. *Modern Plastics* magazine has estimated that PET use in soft drink bottles increased by 15 percent from 1996 to 1997 to an annual use rate of 1,828 million pounds (914,000 tons). PET use in custom bottles (included in "other plastic containers" in EPA estimates) increased by 22.3 percent in the same time frame, to a total annual use of 1,322 million pounds (661,000 tons).<sup>4</sup> These estimates are about one-third greater than those found in EPA generation estimates. EPA estimates may not have kept up with the rapid increase of the use of PET in packaging and probably do not include exported bottle resin.

Figure 2 illustrates the rapid increase in PET bottle sales between 1994 and 1996. PET is gaining market share in bottle sales, especially from glass, and it is changing the mix of containers in the waste stream awaiting recovery. Figure

2 also presents national recovery estimates for PET, documenting a decline in recovery from 1995 until 1996. With PET usage climbing so rapidly, increases in recovery still can result in a decreased recovery rate.

Figure 3 presents extrapolated figures for North Carolina based on estimates from the National Association of PET Container Resources (NAPCOR) presented in Figure 2, including the theoretical recovery North Carolina should be achieving if at the national rate. Note that the tonnage reported in Table 3 corresponds closely to 29,700 tons for PET bottles and containers listed in Figure 1.

### Future Generation

Domestic consumption of PET bottle grades grew at rates between nine and 18 percent from 1992 until 1996.<sup>5</sup> (See Figure 4.) This growth is due to PET overtaking market share in some items traditionally packaged in glass or aluminum. Other thermoplastic polyester consumption grew at rates between eight and 39 percent.<sup>6</sup> (See Figure 4.) Although PET bottle manufacturers are attempting to penetrate the beer packaging market, there is some indication that the rapid increase in PET packaging use will slow down. In fact, SPI figures indicate that total sales and captive use of

**Figure 4. PET Domestic Consumption by End-Use**

Year	PET Bottle Grades		All Other Grades	
	Millions of Pounds	Percent Increase	Millions of Pounds	Percent Increase
1992	1435	N/A	558	N/A
1993	1567	9.2	604	8.2
1994	1854	18.3	839	38.9
1995	2003	8.0	916	9.2
1996	2294	14.5	1032	12.7

Source: SPI Year-End Statistics for 1997, PRODUCTION, SALES & CAPTIVE USE, 1997 vs. 1996, table in Society of the Plastics Industry Web site July 7, 1998. <http://www.socplas.org/>

**Figure 5. Sales and Captive Use**

Year	Millions of Pounds	Percent Increase during Previous Year
1992	2441	N/A
1993	2546	4.301516
1994	3154	23.8806
1995	3425	8.592264
1996	3962	15.67883
1997	4063	2.549218

Source: SPI Year-End Statistics for 1997, PRODUCTION, SALES & CAPTIVE USE, 1997 vs. 1996, table in Society of the Plastics Industry Web site July 7, 1998 page 84 for 1992-1996 and Society of the Plastics Industry Web page: <http://www.socplas.org/industry/stat3.html> for 1997 figure.

**Figure 6. PET Generation (tons)<sup>7</sup>**

Product Category	Estimated 1996 North Carolina Generation	Assumed Annual Growth Rate	Estimated 2002 North Carolina Generation
Durable goods	9,500	10%	16,800
Non-durable goods*	5,000	10%	8,900
Soft drink bottles and other containers	29,700	10%	52,600
Other plastics packaging**	3,100	10%	5,500
<b>Total Generated PET</b>	<b>47,300</b>		<b>83,800</b>

Source: EPA, *Characterization of Municipal Solid Waste in the United States: 1997 Update*

\* Includes plastics in disposable diapers, clothing, footwear, etc.

\*\* Other plastic packaging includes coatings, closures, caps, trays, shapes, etc.

thermoplastic polyester increased at a rate of 2.5 percent from 1996 to 1997. (See Figure 5.)

Figure 6 projects the 1996 North Carolina generation figures (from Figure 3) to 2002 using a modest annual increase of 10 percent.

### Recovery

National recovery of PET containers increased dramatically through the early 1990s before suffering a decline in 1996. (See Figure 2.) According to RW Beck, national PET bottle recovery in 1996 was estimated to be 320,000 tons (640 million pounds), an increase of 57 percent from 1992.<sup>8</sup> In 1996, RW Beck figures also estimated that 26.7 percent (320,000 tons) of all PET packaging was recycled,

including 12.6 percent of custom bottles.<sup>9</sup> NAPCOR estimates the amount of recycled PET produced from recovered bottles, and thus reported a slightly lower figure of 286,000 tons or 26 percent of their estimated sales of PET bottles. (See Figure 2.)

Local government recovery of PET bottles in North Carolina, by far the leading mechanism of PET recovery, enjoyed a similar increase in the same time period (as shown by Figure 7). In keeping with the national trend, however, PET bottle recovery in North Carolina declined in 1996. Recovery of 7,342 tons in fiscal year 1996-97 represented 24 percent of the estimated 30,600 tons of PET bottles and containers generated in North Carolina during 1996 (Figure 8).

**Figure 7. North Carolina Local Government Recovery of PET (tons)**

	Fiscal Year 1992-93	Fiscal Year 1993-94	Fiscal Year 1994-95	Fiscal Year 1995-96	Fiscal Year 1996-97
<b>PET</b>	4,857	5,308	6,883	9,660	7,342

Source: NC DENR. *NC Solid Waste Management Annual Report, July 1, 1996 to June 30, 1997.* p. 29.

**Figure 8. North Carolina Generation and Recovery Estimates for 1996**

Estimated Generation	30,600 tons
Recovery	7,342 tons
Recovery Rate	24%

The drop in PET recovered during fiscal year 1996-97 by local governments is explained by two factors. Low market prices for some resins caused some local government programs to scale back or drop their plastics collection efforts. In addition, fiscal year 1996-97 reports included some reporting of commingled materials, which are not reflected in these numbers.

Most PET material recycled is in the form of soda bottles and other food and beverage containers typically recovered through local government programs. Private sector recovery of PET bottles is assumed to be minimal in North Carolina.<sup>10</sup>

## **MARKET DYNAMICS: PRICES AND CAPACITY**

The two major elements of PET market dynamics are prices and capacity. A general discussion of how these two elements affect markets for plastic resins overall can be found in the introductory section to this chapter.

### **Price History**

As with other recyclable commodities, recycled PET demand and pricing is very sensitive to fluctuations in virgin and off-spec markets. These fluctuations in turn are strongly tied to general global economic conditions and to specific overall global supply/demand balances for PET resin. For example, when PET suppliers reacted to the growing world wide demand for PET by installing new virgin production capacity, the resulting oversupply of PET resins led to dramatic declines in PET prices. As a natural economic reaction, PET recovery rates fell.

PET markets went from record high prices of \$354 per ton in 1995 to historical low prices for baled bottles of between \$40 to \$80 per ton in December 1996. The cause for the drastic downward price movement in 1996 was "large increases in virgin capacity."<sup>11</sup> A combination of higher price for post-consumer resin (PCR) and availability of relatively cheap virgin resin has had a sobering effect on

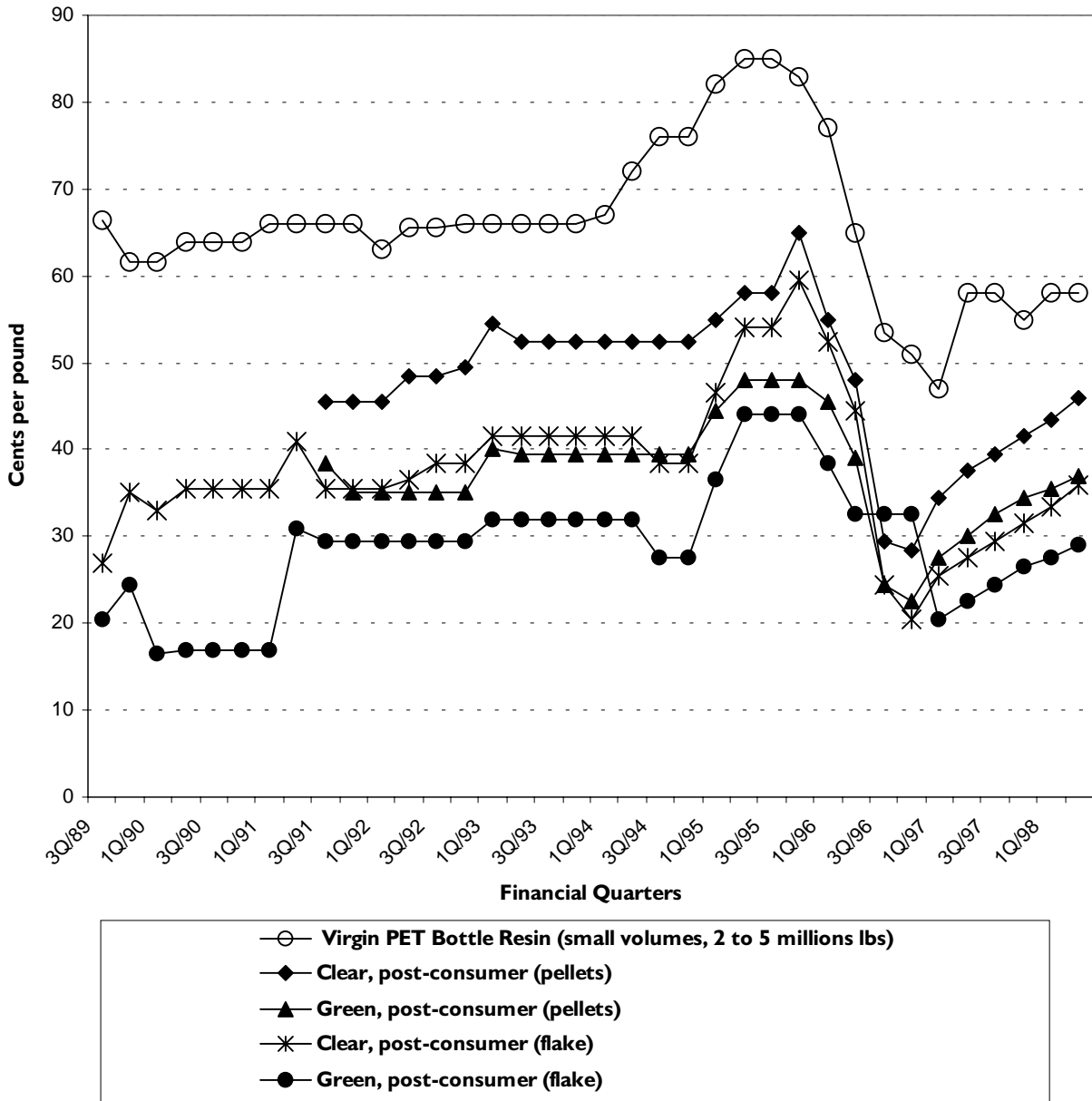
the willingness of product manufacturers to use recycled PET. In addition to the relatively cheap virgin resin supply, depolymerization proved too expensive a method for processing PCR for food grade use, causing companies such as Coca-Cola and Pepsi to abandon the use of post-consumer resin in their bottles. A new method of processing known as super-cleaning might make PCR viable for use in food contact applications as more processing capacity using this method comes online.<sup>12</sup>

Recovered PET prices rebounded somewhat in 1997 to \$118 per ton. The 1997 increases came from strong PET demand and removal of some old, inefficient virgin capacity. Virgin prices began to rise, bringing along recycled prices. With strong polyester carpet sales due to a healthy economy, integrated PET reclaimers and end users had trouble sourcing enough baled PET scrap. In early 1998 prices remained steady or rose slightly.<sup>13</sup> Markets have expanded to meet the huge virgin capacities that came online during the past two years, and the supply/demand balance has tightened. As a result, both virgin and recycled resin prices are increasing about a penny per month.<sup>14</sup>

It will be interesting to see if an increase in recovered PET could begin to cover a greater percentage of future market expansion. Although recovery tonnage has increased recently, the generation of PET waste is growing even faster due to the increase in the PET share of the packaging market. One difficulty is the inelasticity of the recovery rate due to the time required to expand recycling programs. This inability to expand quickly into a growing market for PET resin might cause manufacturers to be wary of depending on recycled resin supply.

Prices for recycled PET will continue to be tied very strongly to the fate of virgin PET. In the coming decades, the PET industry will have to choose among several options for meeting the apparent persistent rise in PET use: by adding virgin capacity, by participating in recovering more discarded PET, or by some combination of the two. Continued low

**Figure 9. PET Price History Comparisons**



recovery rates for PET may force state and federal governments to add pressure in making that decision.

Figure 9 illustrates the price history of both recycled and virgin PET.<sup>15</sup> As discussed in the introduction to this chapter, recycled resin prices remain below the price for virgin off-spec. Prices were obtained for virgin PET bottle resin and are included as a reference for the recycled grades, which include clear and green post-consumer pellets and clear and green post-consumer flake. Pellets command a higher price because of the additional processing and resulting higher quality (i.e., lower contamination) than found in flake.

Predictions on the future of PET markets are made by in-

dustry representatives in plastics industry literature. A few of these remarks are included here to provide a flavor of what the market may hold for recycled PET. The following remarks on PET prices were found in *Plastics News* in January 1998.<sup>16</sup>

“This year’s outlook for recycled resins includes restrained optimism from recyclers of PET. “PET is a function of the economy,” Tess said. [Randy Tess is president of Catenation, Inc., in Green Bay, Wisconsin, which recycles PET and high density polyethylene.] “PET prices will increase this year but that depends on the [virgin resin] plants that come on line. One big opening could put us back where we were.”

**Figure 10. Demand for Recycled PET to 2005 (tons converted from pounds in original)**

	<b>1985</b>	<b>1989</b>	<b>1995</b>	<b>2000</b>	<b>2005</b>
<b>Recycled PET demand</b>	50,000	90,000	262,500	450,000	725,000
<b>Percentage growth rate from previous listed year</b>	NA	80%	192%	71%	61%
<b>Overall virgin plastic demand</b>	22,100,000	26,900,000	35,550,000	41,800,000	48,300,000
<b>Recycled PET as a percentage comparison with virgin plastic demand</b>	.22%	.33%	.73%	1.07%	1.5%

Source: <http://freedoniagroup.com/ppv-scripts/>

Dennis Sabourin, vice president of post-consumer procurement and recycling industry affairs for Wellman Inc. of Shrewsbury, New Jersey, agrees. "PET prices are recovering and should remain firm through 1998," he said.

"Prices today are still as high or higher than they have been historically," said Gary Pratt, president of P&R Environmental Industries, Inc., Youngsville, North Carolina. His firm recycles all post-consumer plastic bottles. He expects PET prices to increase during the first quarter. "You can't compare current prices to an anomaly," he said, referring to the precipitous drop from 1995 to 1996.

When virgin resin is plentiful and prices drop, it puts pricing pressure on recycling firms and companies using post-consumer resin as an alternative.

"The PET recycling rate will drop slightly or remain the same with [as] 1997," said Sabourin. "[This year,] the number of pounds of material will increase. About 50 million more pounds will be recycled in 1998."

"Public apathy is still a concern," but Sabourin added, "Sooner or later, something will happen to change the pendulum. It may not be an oil crisis or a garbage barge, but something will get the public's attention."

## DEMAND

According to some sources, nominal demand for recycled PET resin is expected to increase dramatically in the future. The Freedonia Group, in a report entitled *Plastic Recycling to 2000*, provides the estimates listed in Figure 10. The figure shows an optimistic view of recycled PET demand into the next century; not only is the raw tonnage estimate of recycled demand rising, it also is rising in relation to overall virgin plastic demand.

Additionally, APC reports wash capacity for PET in the south-east region (defined as Maryland, Virginia, North Carolina, South Carolina, Kentucky, Tennessee, Georgia, Florida, and Alabama) to be 520 million pounds (260,000 tons).<sup>17</sup>

Recovered PET is used for a variety of end uses including the following: engineered resins, fiber, food and beverage containers, non-food containers, sheet, film, and strapping. Figure 11 presents NAPCOR's estimates of the recycled resin demand in each of these categories in 1995 and 1996. Figure 12 presents growth rate estimates in certain end-uses between 1996 and 1997 as reported in *Modern Plastics*.

Many factors affect the markets and price for recycled plastics, one of which is the capacity of the plastics industry to use recycled resin. When industry representatives express that markets for recycled PET are strong, they are making the important distinction between price and capacity described in the introduction to this section. The capacity exists if the cost of getting the resin to market is less than the price of off-spec resin. The following quotes are from representatives of APC.<sup>19</sup>

"When people tell me there [aren't] markets, they are wrong," said Ron Perkins, APC director of resource management issue analysis. "The problem is that we as a society or an industry have not cost-effectively figured out how to collect it."

A large buyer of PET bottles, Image Industries, Inc., in Summerville, Georgia, has been able to find the raw material supply it needs, although supplies have gotten tighter in the past six months, company officials said.

"Demand continues to outstrip supply in the PET market," said Luke Schmidt, president of NAPCOR in Charlotte, North Carolina "The focus on the PET industry needs to be on collection."

**Figure 11. Recycled PET Consumption (tons)<sup>18</sup>**

End Use	1996	1997	Percent Change
Engineered resins and molding compounds	12,000	13,000	8
Fiber	146,000	160,000	10
Food and beverage containers	12,000	20,500	71
Non-food containers	35,500	26,500	-25
Sheet and film	34,500	35,500	3
Strapping	33,000	29,500	-11
Other	500	500	0
Domestic Subtotal	273,500	285,500	4
Export	67,000	46,000	-31
Total Consumption	340,500	331,500	-3

Source: Luke B. Schmidt, "PET Recycling: The View from NAPCOR," *Resource Recycling*, v.17 n.2, Feb. 1998, p. 39.

**Figure 12. Recovered PET resin end uses (tons)**

Reclaimed resin end-use market	Tons in 1997	Change from 1996
Polyester fiber	129,000	-.8%
Food Bottles	12,000	+4.3%
Non-food bottles	32,500	+1.6%
Strapping	27,500	-1.8%
Sheet	30,000	0%
Alloys and compounds	12,500	0%
Export	60,000	0%
Other	1,500	+50%
<b>Total</b>	<b>302,500</b>	<b>-.8%</b>

Source: "Plastics Use Rises," *Resource Recycling*, v. 17 n. 2, Feb. 1998, p. 11

In terms of domestic recycling capacity, NAPCOR reports that at the beginning of 1998, 18 PET recycling plants were operating in the United States. Five plants were recently closed, three under construction, two expanding, and five were for sale. Altogether, NAPCOR has estimated domestic PET reclamation capacity is slightly more than one billion pounds annually.<sup>20</sup> NAPCOR also reports that "annual PET bottle recycling capacity in the United States is 865 million pounds, a level that exceeds collections by more than 20 percent."<sup>21</sup>

## SUPPLY / DEMAND RELATIONSHIPS

Figure 13 attempts to characterize the "marketability" of North Carolina-generated PET by comparing Freedonia's demand projections to the estimated supply of PET in the state. North Carolina's generated PET would obviously be competing with PET generated in other states and countries. The lower the percentage of North Carolina tons to total demand, theoretically the better chance North Carolina tons have of being successfully marketed.

Factors such as proximity to market and resin price must also be considered when characterizing the marketability of North Carolina generated PET. APC estimates of processing capacity in North Carolina in 1998 reflect that regional capacity is strong (Figure 13).

Demand for bottle flake could dramatically increase due to the "Letter of No Objection" from the Food and Drug Administration in January of 1998 for use of post-consumer PET in all types of beverage and food containers.<sup>24</sup> The process, which Philadelphia-based Crown Cork & Seal (the largest blow molder in America) has been developing for more than two years, uses advanced cleaning procedures.

Image Industries, Inc., one of the largest PET recyclers in the United States, is investing \$30 million to expand capacity for recycled resin to more than 200 million pounds annually in its Georgia plants. This company has the ability to take post-consumer bottles through processing to the manufacture of new fiber. In addition, the company reclaims fiber from post-industrial waste.<sup>25</sup>

**Figure 13. Estimated “Marketability” of PET Recovered in North Carolina**

	<b>1996</b>	<b>2002</b>
<b>Estimated North Carolina generated tons (Figure 6)</b>	47,300	83,800
<b>Freedonia demand estimate<sup>22*</sup></b>	300,000	560,000
<b>North Carolina generated tons as a percentage of projected overall demand</b>	16%	15%
<b>Processing capacity in Southeast<sup>23</sup> (1998)</b>	260,000	N/A
<b>North Carolina generated tons and percentage of processing capacity</b>	18%	N/A

\* Numbers from Freedonia interpolated to match years for generated estimates.

## CONCLUSION

Although recycled PET prices were very low in 1996, they have since rebounded, reflecting perhaps what plastics trade associations see as more-than-adequate capacity and demand for recycled PET. Due to high capacity, recovered PET prices are not expected to drop due to an increased recovery rate. However, the price is capped by the price of off-spec virgin resin. So, increased recovery will not adversely affect markets. In fact, economies of scale in collection and processing costs could increase the profit margin earned by recycled resin.

Much of the current recovery of PET from the waste stream has occurred through curbside and drop-off programs targeting residential generators. These programs have room for improvement in North Carolina from the 24 percent recovery rate realized in 1996. Additionally, there are other forms of PET that also are recoverable.

The ability of PET markets to handle the current and projected supply of material generated in North Carolina appears to be more than adequate. However, the price paid for recycled PET is based to a large extent on the capacity and price paid for virgin and off-spec PET at any given point in time. For there to be consistent, long-term increases in the recovery of PET resin, a commitment must be made by industry to make the purchase of recycled PET a priority. At the same time, state and local governments, along with private collectors of recycled materials, should make every effort to provide their citizens/customers with incentives and services that maximize the recovery of PET. In addition, governments and individuals need to close the recycling loop by purchasing products made from recycled PET.

## RECOMMENDATIONS

The following recommendations are based on the study of generation, recovery and markets for PET in North Carolina presented in this section.

- The plastics industry should continue to provide technical assistance to communities on ways to recover more plastic bottles, including researching ways to reduce collection and processing costs.
- The plastics industry should do more to fulfill growing demand for PET resin from recycled sources rather than virgin, helping to avoid the market situation that occurred in 1995-96. Capacity shifts from virgin to recycled, or at least meeting new PET resin demand with recycled resin, will strengthen and stabilize PET markets and send strong signals to collectors and processors to recover more PET.
- North Carolina's local governments should reinvigorate their efforts to recover PET bottles, including enhancing participation in current collection programs and targeting new areas for collection. Improved education and promotion, plus implementation of Pay-as-You-Throw programs (unit or variable rate pricing), should be important aspects of these efforts. Increased collection can be realized through collection of all plastic bottles and use of plastic compaction on collection vehicles. Increased recovery will decrease the per ton cost of collection of plastics.
- The state also should consider increasing the availability of financial incentives to enhance PET recovery and use, including grant funding for capital purchases that improve collection efficiencies and economic development incentives or technical assistance for PET end-users to use recycled PET.
- If consistent improvement in PET recovery is not achieved by 2002, the state should consider implementing statutory mechanisms such as take-back requirements (e.g., bottle bills), mandated recycled-content targets, and other command-and-control approaches.

- <sup>1</sup> Schmidt, Luke B., "PET Recycling: The View from NAPCOR," *Resource Recycling*, v.17, n.2, Feb. 1998, p. 39.
- <sup>2</sup> Toloken, Steve, "Supply vs. Demand Stirs Recycling Debate," *Plastics News*, May 25, 1998, p. 13.
- <sup>3</sup> The Society of the Plastics Industry (SPI) provides data on apparent consumption of various resins in its *1997 Facts and Figures of the US Plastics Industry*. SPI's estimates would put total bottle/container tonnage for PET in NC at around 27,702 tons annually, which is slightly lower than 29,700 tons, represented in EPA's soft drink and other container categories in Figure 1.
- <sup>4</sup> "Plastics Use Rises," *Resource Recycling*, v. 17, n. 2, February 1998, p. 11.
- <sup>5</sup> Society of the Plastics Industry, *Facts & Figures of U.S. Plastics Industry*, 1997 edition, p. 85.
- <sup>6</sup> Ibid.
- <sup>7</sup> The Society of the Plastics Industry (SPI) provides data on apparent consumption of various resins in its *1997 Facts and Figures of the US Plastics Industry*. SPI's estimates would put total bottle/container tonnage for PET for NC at around 27,702 tons annually, which is slightly lower than 29,746 tons, represented in Franklin's soft drink and other container categories in Figure 1.
- <sup>8</sup> RW Beck, Inc. as reported in *Resource Recycling*, Feb. 98, p. 19.
- <sup>9</sup> Steve Toloken, "News," *Plastics News*, March 2, 1998, p. 24.
- <sup>10</sup> "Private recovery" is defined as recovery that takes place outside of any actual public sector collection or collection by private companies through contracts with local governments.
- <sup>11</sup> Lucyshyn, J and Craggs, R., "A Five Year History of Recycling Market Prices," *Resource Recycling*, v. 17, n.2, Feb. 1998, p. 20.
- <sup>12</sup> Sandi Childs, NAPCOR, personal communication, October 5, 1998.
- <sup>13</sup> Schmidt, Luke B., "PET Recycling: The View from NAPCOR," *Resource Recycling*, v.17 n.2, Feb. 1998, pp. 37-42
- <sup>14</sup> Block, Debbie G., "Recycled PS Prices Go Up and Down," *Plastics Technology*, March 1998, p. 65.
- <sup>15</sup> <http://www.plasticsnews.com/subscriber/rprices.phtml>
- <sup>16</sup> Smith, Sarah S., "Recyclers Looking Up, Despite Downside," *Plastics News*, January 19, 1998, p. 10.
- <sup>17</sup> Judy Dunbar, American Plastics Council, personal communication, July 14, 1998.
- <sup>18</sup> Converted to tons from original listed in millions of pounds.
- <sup>19</sup> Toloken, Steve, "Supply vs. Demand Stirs Recycling Debate," *Plastics News*, May 25, 1998, p. 13.
- <sup>20</sup> Schmidt, Luke B., "PET Recycling: The View from NAPCOR," *Resource Recycling*, Feb. 1998. v. 17 n. 2, pp. 37-42
- <sup>21</sup> "Plastics bottle recycling capacity on the rise," *Resource Recycling*, January 1998, p 64.
- <sup>22</sup> <http://freedoniagroup.com/ppv-scripts/>
- <sup>23</sup> Judith Dunbar, APC, July 14, 1998 personal communication. Southeast Region is defined as Maryland, Virginia, North Carolina, South Carolina, Kentucky, Tennessee, Georgia, Florida and Alabama.
- <sup>24</sup> "FDA OKs more recycled PET in containers," *Plastics News*, February 23, 1998, p. 3.
- <sup>25</sup> Smith, Sarah S., "Recycler Image Spends \$30 Million on Growth," *Plastics News*, October 20, 1997, p. 24.