
POST-INDUSTRIAL AND POST-CONSUMER VINYL RECLAIM

MATERIAL FLOW AND USES IN NORTH AMERICA

A final report to

Chlor-Vinyl Steering Group

An initiative of the Vinyl Institute and Chlorine Chemistry Council

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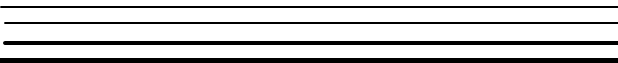
Principia Partners 

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Executive Summary

Vinyl is an important plastic material

Polyvinyl chloride (vinyl) is an important thermoplastic resin with an estimated 17.4 billion lb of compound (12.85 billion lb of virgin resin) consumed in the United States and Canada in 1997. The majority of vinyl resin is consumed in rigid applications, which are largely building and construction end uses. House siding, window lineals, and drain pipe are all familiar vinyl building products. Although flexible vinyl represents a smaller share of the market, these products are just as familiar. Garden hose, 3-ring binders and checkbook covers, shower curtains and swimming pool liners are all flexible vinyl products.

Conversion of vinyl into useful products is highly efficient

Reclamation and recycling of vinyl scrap is a long established and well developed business in North America. A high percentage of all vinyl process scrap generated is ultimately reused; less than 180 million lb of the 17.4 billion lb of vinyl compound was not consumed in finished products in 1997, yielding only 1% waste. An extensive network of scrap brokers and reprocessors facilitate the movement of scrap from generators to end users, along with major scrap generators selling directly to large post-industrial reclaim users. Vinyl reclaim substitutes for virgin vinyl in essentially all industrial applications; packaging uses to a very limited extent; and not at all in medical applications.

Vinyl is used for highly durable, long-lived products

Further, the majority of vinyl is used in long-lived durable applications, limiting the amount of product entering the solid waste stream each year. An estimated 10% of all vinyl produced in a year is available for post-consumer reclamation within a one year period. The remaining volume continues to serve a useful purpose. The post-consumer vinyl scrap that is generated can be reclaimed and reused, just as the post-industrial scrap is. Post-consumer vinyl finds use in identical applications to post-industrial reclaim, and for identical reasons; the material is purchased and used either for resin content (rigid scrap) or for resin and plasticizer content (flexible scrap).

Supply and demand for scrap vinyl in balance

Supply and demand are in balance for most scrap vinyl products, including both post-consumer and post-industrial forms. The Asian market is an important export market for vinyl reclaim, and has recently been depressed due to economic conditions in that region and other factors. The lower volume of exports has yielded lower average market prices for reclaim domestically; however, essentially all scrap available is sold for re-use. Growth in demand for reclaim will be driven by growth in these end uses, a resurgence of the export markets, or a significant shift in the production economics of virgin resin production.

Executive Summary

More than 540 million lb of post-industrial scrap reused

Processing of 11.3 billion lb of rigid vinyl compounds generated a total of 711 million lb of scrap in 1997, of which 370 million lb were reused in closed-loop recycling. The remaining 341 million lb was available for recycling. Processing of 6.0 billion lb of flexible vinyl generated a cumulative 535 million lb of scrap in 1997, of which 155 million lb was recycled in closed-loop systems. The balance of 380 million lb is the available supply of flexible post-industrial reclaim. Although vastly different volumes of resin are used in rigid and flexible end uses, the volume of reclaim available from each is similar.

High recycle rate for post-industrial rigid (79%) and flexible (71%) vinyl

Total North American supply, including exports, of available post-industrial vinyl reclaim is estimated at 720 million lb in 1997, evenly split between rigid and flexible types. Of the 341 million lb of rigid vinyl reclaim available, a total of 270 million lb was sold for reuse in 1997, including 27 million lb exported. Of the 380 million lb of flexible vinyl reclaim available, 271 million lb were sold for reuse, including 37 million lb exported.

Majority of scrap collected from extrusion operations

Of the three key manufacturing processes used for both rigid and flexible vinyl, the extrusion process, which consumes the greatest volume of virgin vinyl, generates the largest volume of post-industrial scrap. The calendaring process generates an equal volume of scrap as does extrusion for rigid vinyls. For flexible compounds, both the calendaring and molding processes yield relatively minor volumes of scrap, as shown in the table below:

North American Supply of Post-Industrial Vinyl Reclaim, 1997				
Million lb - a				
Process	Rigid Vinyl	Flexible Vinyl	TOTAL	% Of total
EXTRUSION	126	215	341	63%
CALENDERING	124	34	158	29%
MOLDING	20	22	42	8%
TOTAL	270	271	541	100%

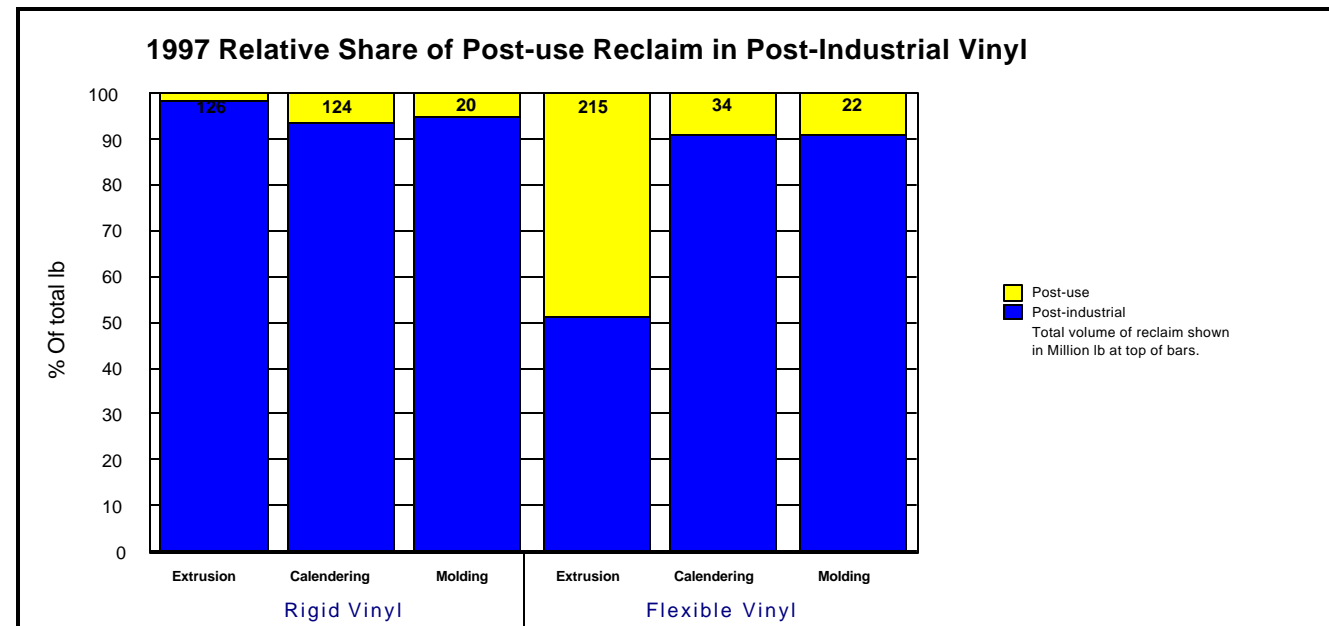
a - Compound basis; cumulative scrap from all value-added stages of production.

Executive Summary

Post-use vinyl primarily in flexible extrusions

A subset of post-industrial scrap is termed post-use material. This segment comprises vinyl products that have been combined with one or more dissimilar materials, and therefore create additional difficulties in the reclamation process. Post-use scrap—that portion of post-industrial scrap that is combined with other materials—is most prevalent in the flexible extrusion segment, largely due to reclaim from wire & cable production. A portion of the scrap from each of the processes (both rigid and flexible) can be classified as post-use scrap. The following chart shows the share of total post-industrial scrap that is post-use.

Extrusion applications account for majority of post-use vinyl reclaim

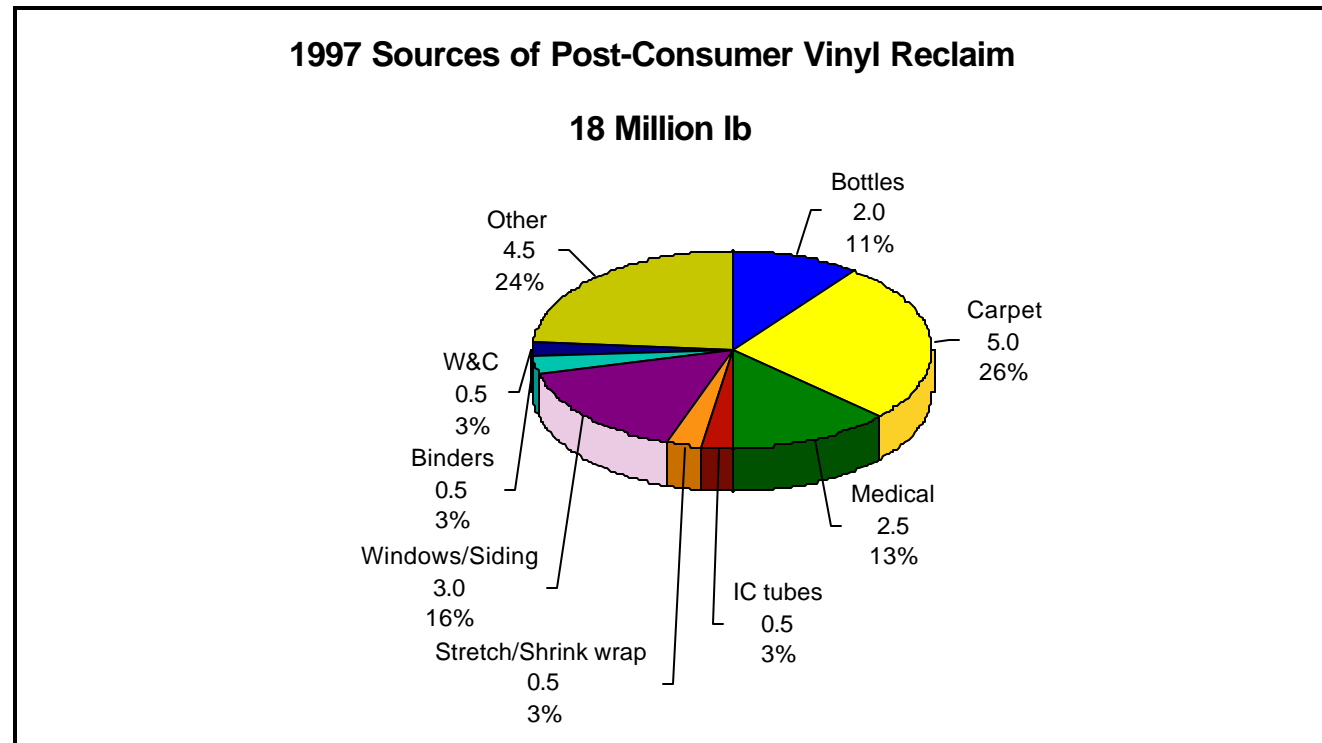


As with post-industrial, equal volumes of rigid and flexible post-consumer scrap are reclaimed

An estimated 18 million lb of post-consumer vinyl was recovered and recycled into useful products in 1997. Approximately 11 million lb, or 60% of total volume was identified during the course of this sponsored study; specific companies attributed to these volumes are listed in Appendix IV. Sources for post-consumer vinyl are comprised of both rigid and flexible types in about even quantities, as shown in the graph on the following page.

Executive Summary

Total of 18 million lb of post-consumer vinyl recycled in 1997



Post-consumer recycling is driven by dedicated programs

Most current post-consumer vinyl programs underway reflect the efforts of a few companies who have made a commitment to recycling or entrepreneurs who recognize the value of the material. Carpet backing is recovered from commercial carpet installations by two contract carpet producers. Windows/siding is collected from dated inventory, and job sites to a lesser extent, by builders and distributors under programs sponsored by major OEMs. Medical IV bags/tubing are reclaimed by a few entrepreneurs from local area hospitals. Bottles are collected from MRFs, blow molders, and consumer product companies by brokers and reprocessors to augment their supply of post-industrial materials.

Executive Summary

Post-consumer vinyl recycling is still embryonic

Post-consumer recycling of vinyl products accounts for a small portion of vinyl usage in North America. A ready market exists for post-consumer vinyl; that is, the same users of virgin vinyl resin and post-industrial reclaim are also likely buyers of post-consumer vinyl. Reprocessors involved in post-industrial vinyl reclaim generally have the capability to recycle post-consumer vinyl reclaim. However, collection and separation are the two greatest obstacles limiting the opportunity due to contamination and high recovery costs/logistics issues.

Brokers and reprocessors facilitate recycling

An extensive network of brokers and reprocessors purchase post-industrial vinyl scrap from collectors and generators and supply end users with usable materials. Some of the brokers and reprocessors are also involved in post-consumer vinyl scrap. This network effectively covers the entire United States and Canada, and provides a very necessary service to move scrap from the sources, upgrade the scrap to a usable form, and supply to end users. This network is not exclusive to vinyl. Most of the brokers and reprocessors handle additional materials, particularly olefins (PE, PP), polystyrene, PET (bottle resin), and other scrap materials. Vinyl is the predominant or sole scrap type handled by a select few companies.

Freight costs drive area served for each scrap type

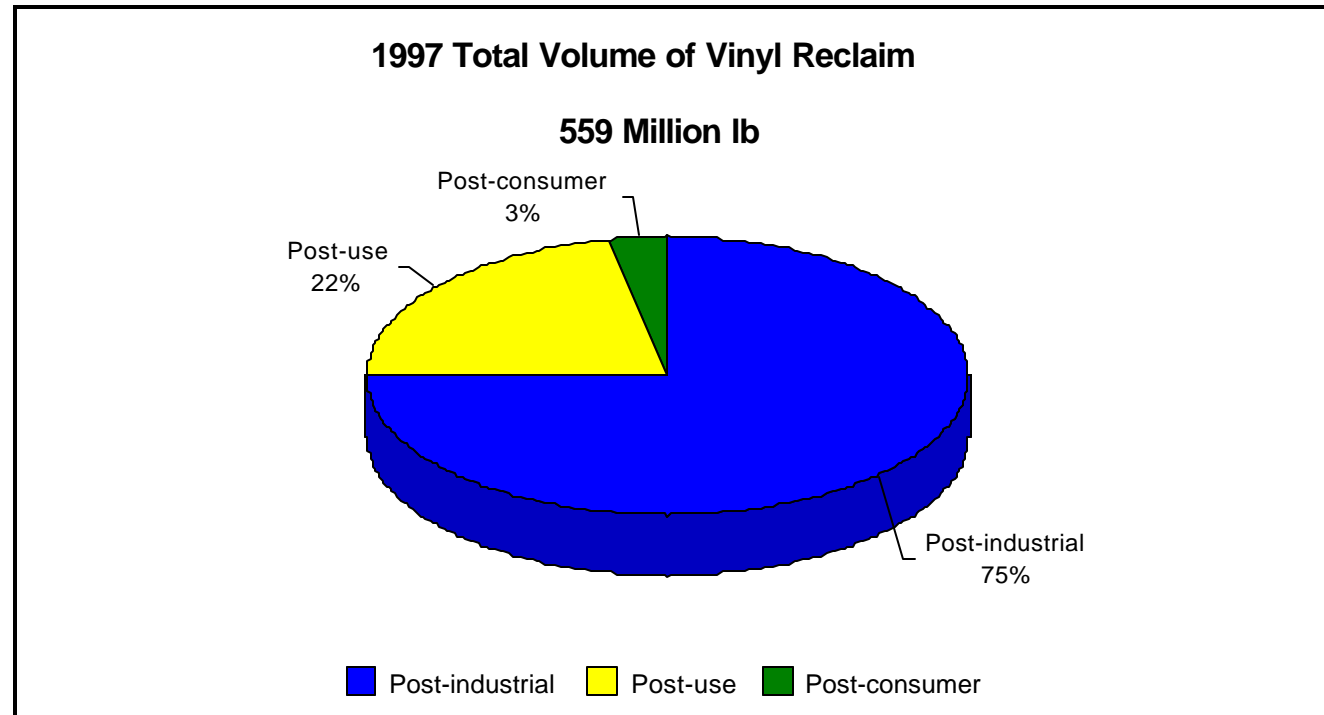
Most vinyl reclaim is collected, reprocessed, and used within a 250-mile radius. Freight costs are often the overriding driver of territory served. For low-value scrap (i.e. contaminated or mixed sources), freight may be the sole cost of the material and a broker/reprocessor will not move the material far. Higher value scrap (e.g., medical tubing, rigid sheet) can effectively be collected and sold within a 600-mile region.

Vinyl reclaim used to reduce cost

Currently, the primary driver for using vinyl reclaim—whether post-industrial or post-consumer—in any product is cost reduction. Further, the vinyl reclaim replaces prime vinyl resin or compound. For the most part, vinyl reclaim does not compete with other resins in established uses, nor does it enable new applications to be served.

Executive Summary

Nearly 560 million lb of vinyl recycled in 1997



Increased use of reclaim will occur in existing applications

Opportunities for post-industrial reclaim exist in all current applications. Each of the end uses examined can accommodate larger volumes of vinyl reclaim, and organic growth in several end uses (e.g., fencing/decking, sound deadening) will create demand for larger quantities of reclaim. A few new end uses represent major outlets for reclaim; these applications could yield incremental demand. Examples include: bases for A/C or heat pump units (rigid) and flooring (flexible).

Introduction

Analysis of post-industrial and post-consumer vinyl

This report presents the results of two market research programs commissioned by the Chlor-Vinyl Steering Group to analyze the structure of the post-industrial and post-consumer vinyl reclaim business and evaluate the flow of material from reclaim generator to end users. The Chlor-Vinyl Steering Group is an initiative of the Vinyl Institute and the Chlorine Chemistry Council. One of the Group's tasks is assessing the role and value of vinyl recycling, and heightening the public's awareness of any successful programs in the recycling of vinyl.

Focus on sources and users of reclaim

In support of these efforts, an accurate assessment of the total volume of post-industrial and post-consumer vinyl reclaim processed (1997 base line) is required. This program addresses a number of questions:

Identify players throughout the supply chain

- T How much post-industrial and post-consumer vinyl reclaim is generated annually?
 - & What is the volume of each type (e.g., rigid v. flexible)?
 - & What are recent market prices for reclaim by type?
 - & What are the key end uses for these materials?

- T Who are the key players at each step in the supply chain?
 - & What companies generate vinyl scrap?
 - & Who are the middle men (e.g., reproducers, brokers)?
 - & Who is buying these materials and why?

Post-industrial defined

All sources and users of vinyl reclaim are covered in the program, including post-industrial, post-use, and post-consumer. Post-industrial reclaim includes merchant and captive compounding operations, rigid and flexible vinyl processors (e.g., extrusion, calendaring, and molding operations), and industrial end users of converted vinyl products (e.g., window producers, thermoformers, automotive and furniture OEMs, bookbinders).

Introduction

Closed-loop recycling not considered post-industrial reclaim

Only reclaim that is commercially available as a merchant product is considered to be post-industrial volume. Reclaim that is reused within a producer's operations is considered closed-loop recycling. Closed-loop recycling also includes any generator's scrap that is toll processed specifically for the generator. One major exception is rigid post-industrial vinyl reclaim sold into thermoforming applications where a major reprocessor (e.g., Ex-Tech, Richmond, IL) sells proprietary post-industrial recycle content film/sheet and also converts customer-specific reclaim back into film/sheet for the same customer.

Post-use reclaim is a subset of post-industrial

Post-use material is a subset of post-industrial reclaim. This material has yet to be used for its intended purpose; however, it has been combined with other [dissimilar] materials, necessitating a reclamation process similar to post-consumer materials. For example, vinyl-coated wire requires separation of the vinyl from a copper wire. All post-industrial volumes include post-use material, except where specifically noted.

Post-consumer reclaim has been used for its intended purpose

All sources and uses of post-consumer vinyl reclaim are covered in the program. Post-consumer is defined as vinyl products that have been used for their intended purpose. For example, medical IV bags that had been filled with saline and have passed the expiration date, and are subsequently reclaimed, are considered post-consumer material.

Qualitative methodology used

To accomplish the objectives of this study, Principia Partners employed a qualitative interviewing and analysis methodology. This technique comprises two separate and distinct research phases: Secondary Research and Primary Interviewing.

Public information used to develop a foundation

In the first phase of the research, a broad and detailed search of publicly available information was conducted. This effort entails a thorough search of:

- % Trade and general business publications
- % On-line data bases (e.g., scrap brokerage web sites, plastics industry sites)
- % Industry association reports and published statistics
- % Government publications and data bases
- % Brokers' and reproducers' published materials and price lists
- % Companies' published product literature and general business press releases
- % Other publicly available information on vinyl reclaim and current applications

Introduction

The search of secondary sources establishes a foundation of information to be used during the primary interviewing phase. Information on recent prices for various types of scrap, volume of vinyl resin consumed in various markets, and lists of scrap generators and end users were developed during the secondary research phase.

Primary research used to complete all data

During the primary research phase—conducted from February through April 1998 for post-industrial reclaim and from September through November 1998 for post-consumer reclaim—Principia Partners conducted unstructured, qualitative telephone interviews with a broad range of companies to determine their role, if any, in the vinyl reclaim business. Typically one individual from any given company was interviewed; however, in certain cases, multiple representatives from one company were contacted to collect and confirm the data required. Across all companies, numerous functional groups were interviewed including engineering, purchasing, sales/marketing, product development, production management, among others.

No confidential information sought

Respondents were informed of the objective of the research, and were asked if their company would desire their company-specific information be distributed publicly, or maintained as proprietary. Details provided by any company that indicated their company-specific information is proprietary are not explicitly noted in this report, but are included in the overall industry data. No attempt to gather company confidential information was made. Companies interviewed during this phase included:

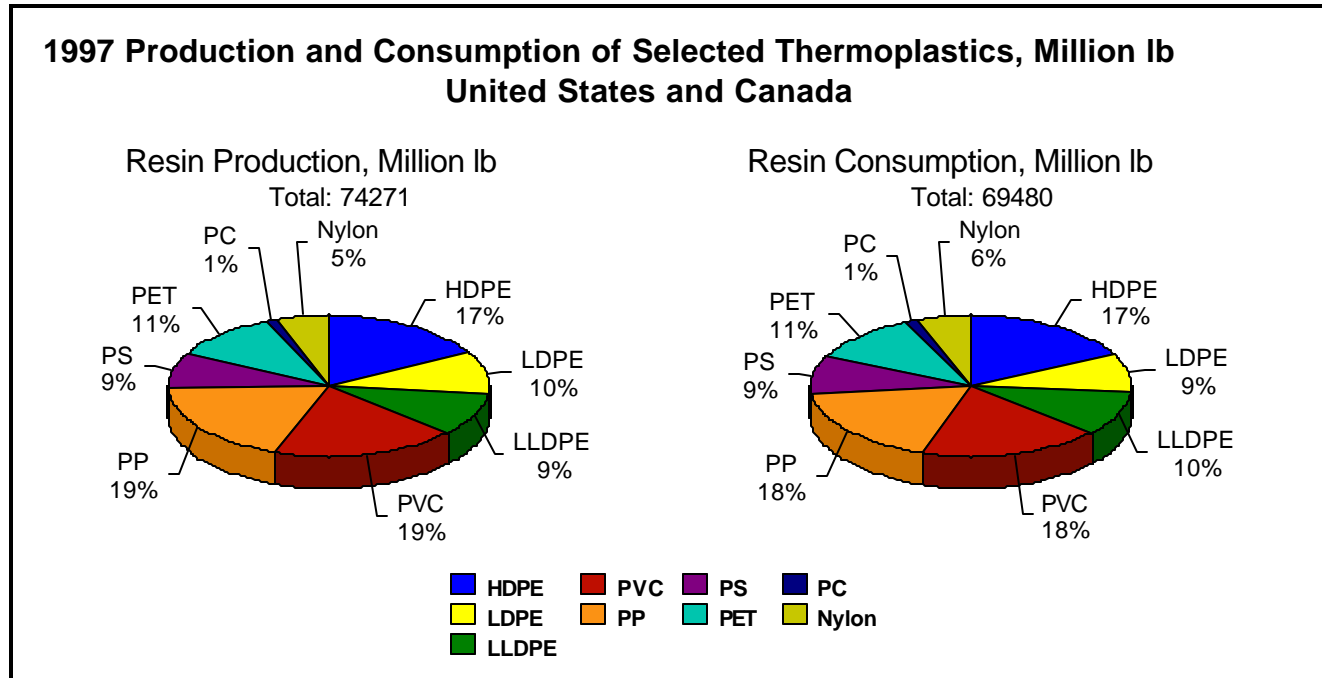
- % Vinyl processors/reclaim users
- % Vinyl product end-users
- % Post-industrial and post-consumer reclaim brokers and reproprocessors
- % Other trade factors

Recycling Overview—Volume Thermoplastics

Vinyl is the largest resin category in production and consumption

Imports and exports represent difference between production and consumption

With 19% and 18% share of total thermoplastics production and consumption, respectively, vinyl (PVC) is the single largest volume thermoplastic in North America. Polypropylene (PP) very closely follows, and high-density polyethylene (HDPE) represents the third highest volume of resin produced. Polyethylene terephthalate (PET) resin—which is used for clothing and carpet fiber, soda bottles, photographic film, among other applications—is a large-volume product. Low-density polyethylene (LDPE) and linear low-density polyethylene (LLDPE) are

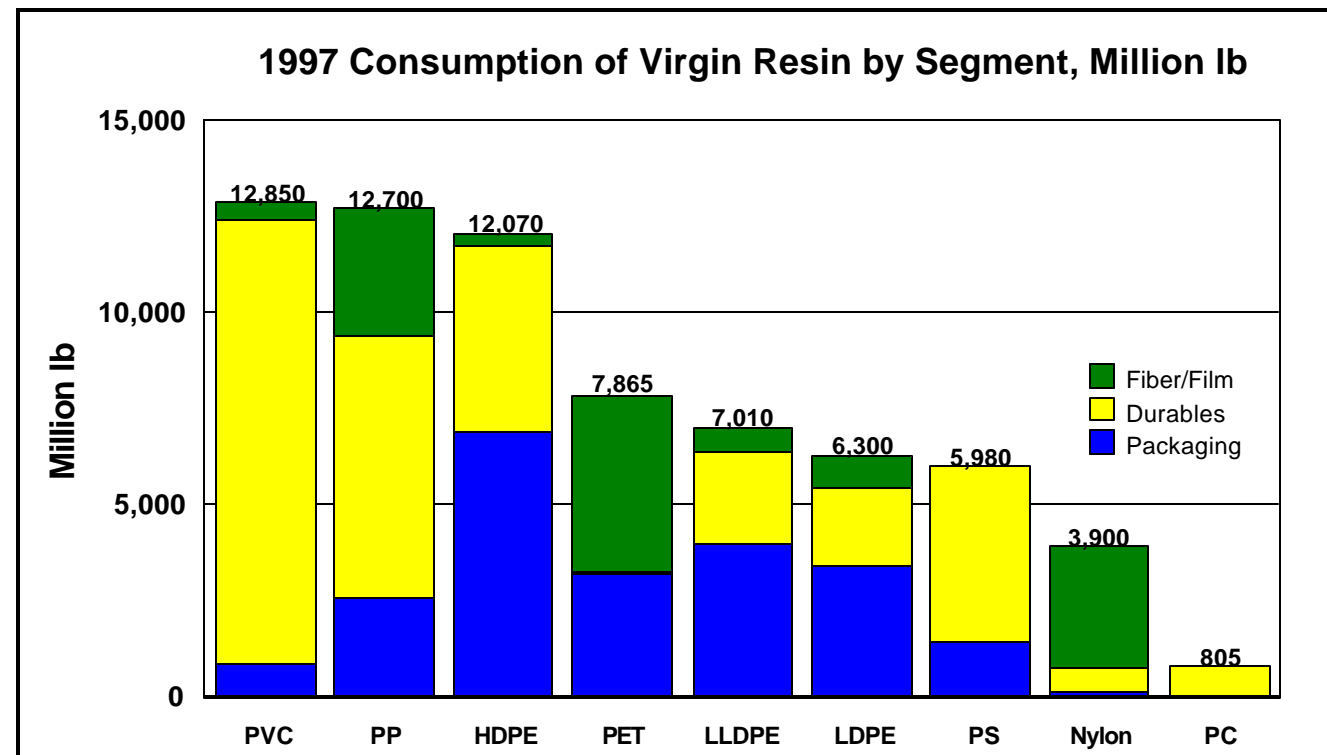


closely related to HDPE in chemistry and end application, and these two materials combined represent a significant share of the total thermoplastics demand in North America. Polystyrene (PS) is also a significant material. Polycarbonate (PC) and nylon are both high-volume products; however, both serve more specialized end markets than the other resins analyzed, and therefore total consumption is lower than the commodity resins.

Recycling Overview—Volume Thermoplastics

Vinyl is predominantly used in long-lived durables applications

The mix of end use markets are markedly different across the various materials. The vast majority of vinyl is used in durable applications, including building & construction, appliances, automobiles, and other long-lived products. A small portion of all vinyl resin is used in packaging applications, such as bottles and blister packs. All other materials, except PC and nylon, have a far higher share of total consumption in the packaging segment. PP, PET, and nylon have a significant share of volume used in fiber applications, including clothing, carpets, and industrial fabrics. PET is also used in a wide variety of films for adhesive tape, photographic and X-ray film, and video/audio recording tapes. The various polyethylenes are largely packaging resins. However, each is also used in a wide range of durable consumer products and film uses.

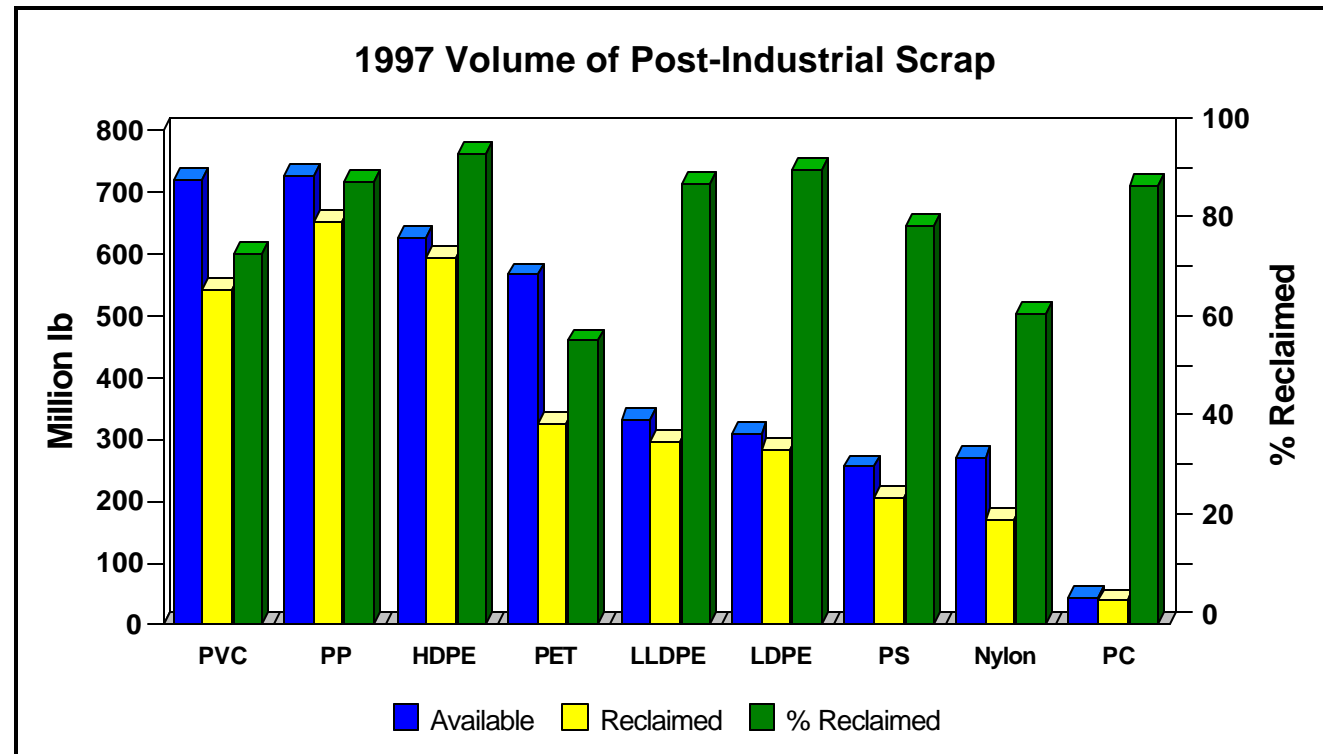


Recycling Overview—Volume Thermoplastics

Post-industrial scrap is efficiently reclaimed for all resins

In-process waste contributes little to the solid waste stream

The recycling rate for post-industrial scrap for each of these materials is high. Due to the various manufacturing processes employed and the combination of value-added steps involved in manufacturing finished goods from the resins, an average of 5.5% of all resin is scrapped at one point in the production process. Typically, greater than 80% of this scrap will be reclaimed in a post-industrial recycling program. PET and nylon have lower than average recycling rates, due to the high volume of low-denier fiber produced with these resins and the difficulty of

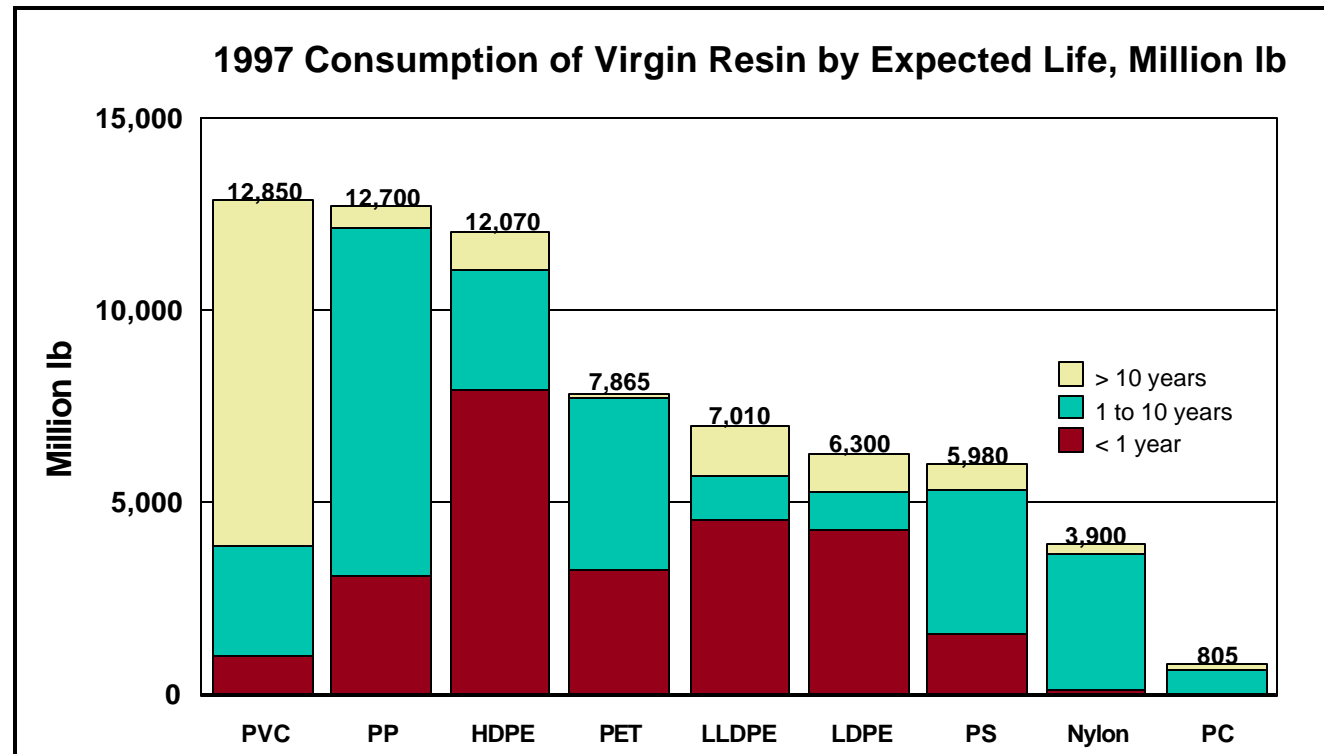


recycling these small diameter filaments. Fiber production yields scrap rates as high as 15% and only an estimated 50% of this scrap can be reclaimed. The difference between scrap generated and scrap reclaimed is the post-industrial contribution to the solid waste stream for each material. PET contributes the largest volume at 250 million lb, followed by vinyl with 180 million lb.

Recycling Overview—Volume Thermoplastics

Expected useful life of products made from these plastics varies dramatically from less than 1 year to more than 30 years

The vast majority of each resin produced in a given year reaches the final consumer; waste generated in the manufacturing process represents less than 1% of all resin produced. As shown previously, the resin is converted to packaging, durable goods, or a fiber or film product. The average useful life of the products made from each resin vary significantly, and directly influence the amount of material available for post-consumer reclamation. All packaging products have a useful life of less than 1 year; the packaging itself is used from the time the

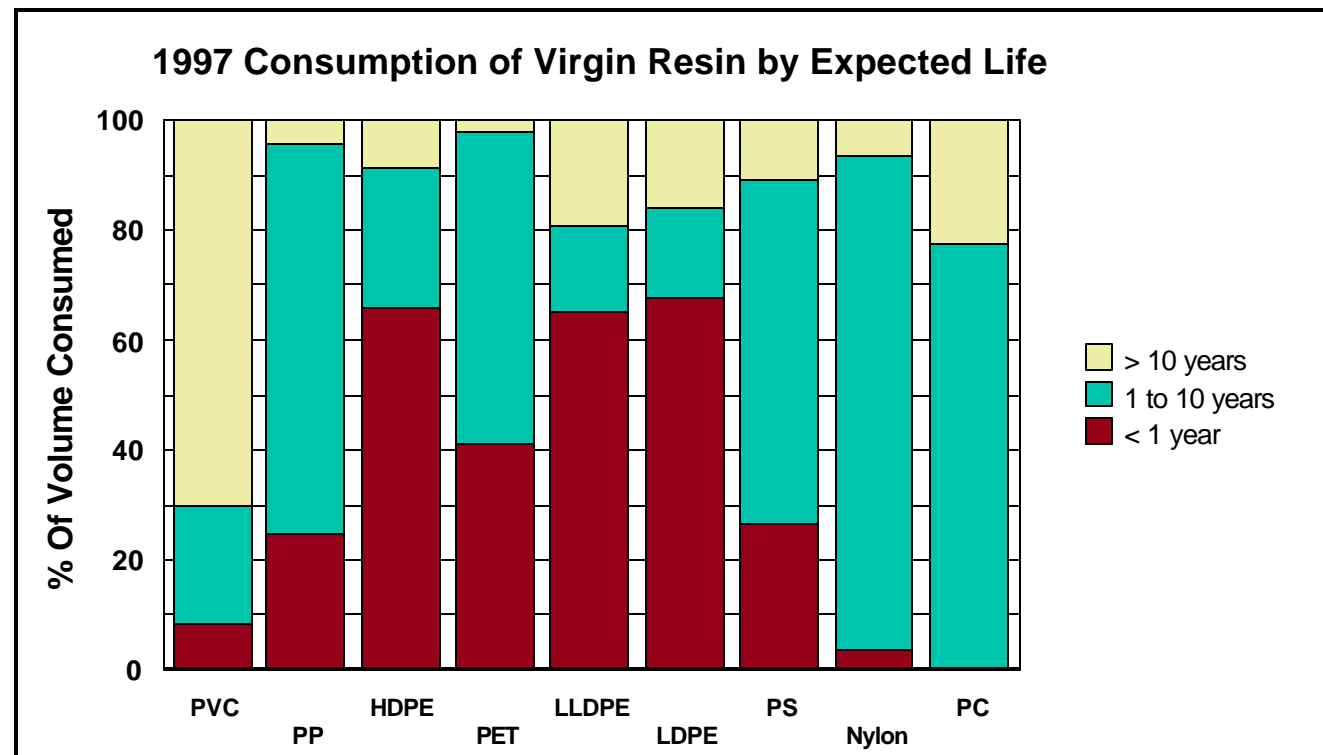


product is made to the final purchase. Most durable goods have a useful life greater than 1 year, often as much as 10 years, and some products are expected to be useful for 20 years or longer. Fiber and [non-packaging] film applications vary widely in useful life, but are predominantly within the 1 to 10 year life span.

Recycling Overview—Volume Thermoplastics

70% of all vinyl will serve a useful purpose for more than 10 years

A large portion of vinyl is consumed in long-lived applications. Essentially 70% of all vinyl resin produced in 1997 will stay in service for more than 10 years, and some for greater 25 years. No other resin has greater than 25% of all volume in the long-lived applications (>10 years useful life). Conversely, more than 60% of HDPE, LDPE, and LLDPE resin is used in products with an expected useful life of less than 1 year. Greater than 20% of PP, PET, and PS consumption is in short-lived applications. A small share of nylon and no PC is used in packaging/short-lived applications.



Recycling Overview—Volume Thermoplastics

Expected life of products vary, but categorization is viable

The following bullet lists provide typical applications served by each resin in the various expected life categories. The actual expected life for specific products in the categories will vary. For example, vinyl pipe has an expected life of greater than 30 years, while vinyl automotive interior components (e.g., arm rest, dashboard) have an expected life of 12 years. Further division of the categories yields no difference in the analysis or conclusions concerning the contribution of each material to the solid waste stream.

Vinyl is widely used in the building & construction, automotive, and consumer goods markets:

- % > 10 yrs (Durables) Pipe/fittings, Siding, Window lineals, Electrical boxes, Wire & cable, Auto parts
- % 1 to 10 yrs (Durables, F&F) Flooring, Toys, Hose, Credit cards, Pool liners, Curtains
- % < 1 yr (Packaging) Bottles, Stretch film, Shrink wrap, Blister pack

Polypropylene is used to make many durable consumer goods (e.g., appliances), clothing, automotive exterior parts (e.g., bumpers), and short-lived consumer goods:

- % > 10 yrs (Durables) Major appliances, Pipe, Auto parts
- % 1 to 10 yrs (Durables, F&F) Battery cases, Carpet back/face fiber, Furniture, Toys, Clothing
- % < 1 yr (Packaging, Durables, F&F) Bottles, Caps, Straws, Syringes, Diaper stock, Cotton/Tobacco wrap

HDPE is predominantly used for packaging and similar short-lived products; however, a significant volume is used for blow-molded tanks, toys, and housewares:

- % > 10 yrs (Durables) Pipe, Wire & cable, Gas tanks
- % 1 to 10 yrs (Durables, F&F) Ag tanks, Toys, Housewares, Truck bed liners, Totes/bins
- % < 1 yr (Packaging) Bottles/Pails/Drums, Closures, Grocery sacks/bags, Can liners

PET is best known for its use in soda bottles, which represents a large and growing share of total demand. However, PET is widely used in carpets, clothing, and various films:

- % > 10 yrs (Durables) Major appliances, Power tools
- % 1 to 10 yrs (Durables, F&F) Magnetic media, X-ray film, Carpet, Textiles, Tire cord, Rope, Zippers
- % < 1 yr (Packaging, F&F) Bottles, Photographic film, Adhesive tape

Recycling Overview—Volume Thermoplastics

Each resin has its place in the end markets, based on cost and performance

LLDPE/LDPE are produced using different process technology; however, the two materials overlap in the applications served. Like HDPE, both resins are largely used in short-lived end uses, including trash bags and retail store shopping bags:

- % > 10 yrs (Durables) Pipe, Wire & cable
- % 1 to 10 yrs (Durables, F&F) Housewares, Toys/Sporting goods, Ag films
- % < 1 yr (Packaging) Trash bags, Stretch film, Sacks/bags, Food containers, Diaper stock

Polystyrene is well known for its use in food service foam packaging and egg cartons. The resin is also used for a wide array of relatively low-cost consumer products and as a foam in building insulation:

- % > 10 yrs (Durables) Building insulation, Major appliances
- % 1 to 10 yrs (Durables) Video/Audio cassette cases, Toys, Business equipment
- % < 1 yr (Packaging) Egg cartons, Service ware

The largest single application for nylon is carpet fiber, followed by fiber for clothing and upholstery. However, this resin is widely used in high-performance consumer products such as power tools and lawn & garden equipment, as well as sporting goods.

- % > 10 yrs (Durables) Major appliances, Lawn & Power tools, Wire & cable, Seat belts, Auto parts
- % 1 to 10 yrs (Durables, F&F) Carpet, Textiles, Tire cord, Sporting goods
- % < 1 yr (Packaging, F&F) Meat & cheese film, Weed trimmer line, Fishing line

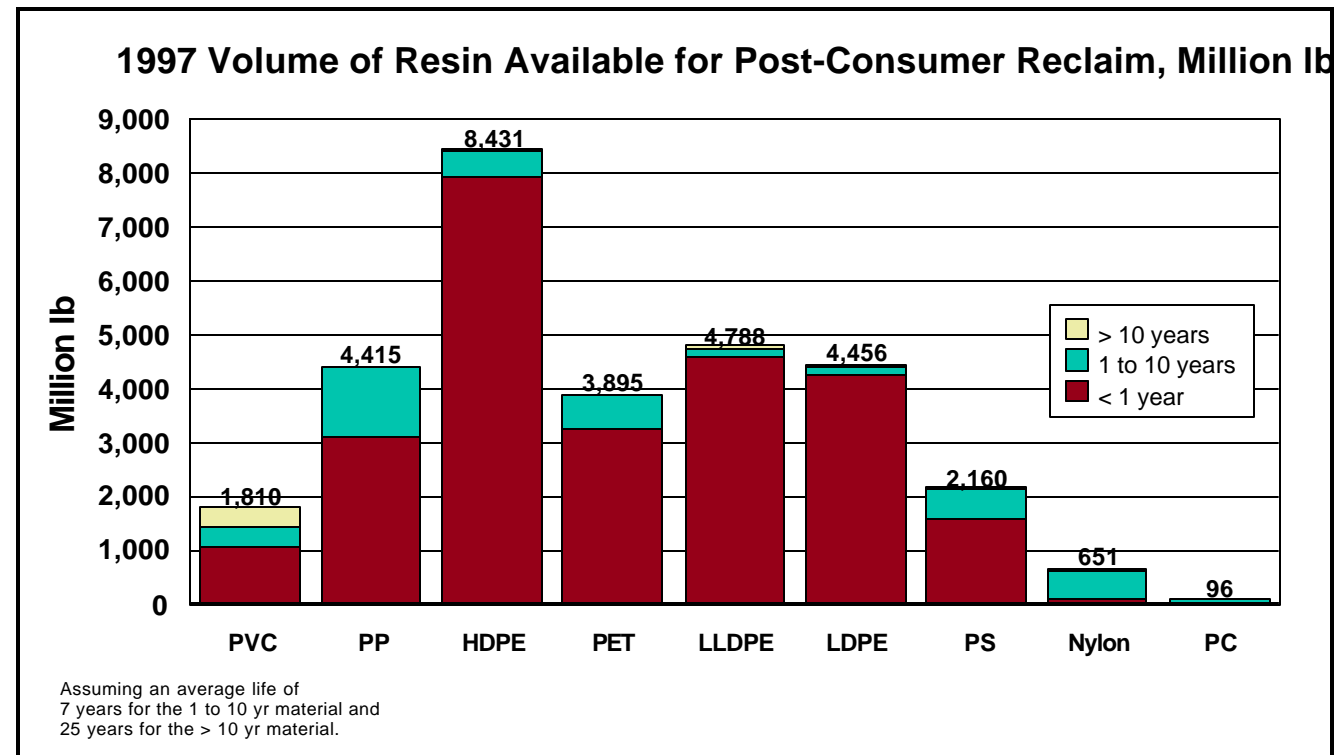
Polycarbonate is a relatively high cost material, and is predominantly used where its clarity is required. The material is the substrate for CDs and the new DVDs, and is used for automotive headlights, refrigerator drawers, and bullet-proof windows:

- % > 10 yrs (Durables) Major appliances, Glazing, Lighting
- % 1 to 10 yrs (Durables, F&F) CDs, Business equipment, POP displays/signage, Water bottles
- % < 1 yr --- N/A

Recycling Overview—Volume Thermoplastics

Only 15% of vinyl resin produced is available for post-consumer reclaim within one year

Due to the average life expectancy of products made with vinyl, a relatively low share of the total resin produced in any given year becomes available for post-consumer reclamation. In fact, the share is lower than all resins analyzed except for polycarbonate, which similarly is used predominantly in durable applications. Conversely, the common packaging resins—HDPE, LDPE, LLDPE, and PET—have a very high percentage of total annual production used in products with short weighted average useful lives. The polyethylene resins, in particular, are



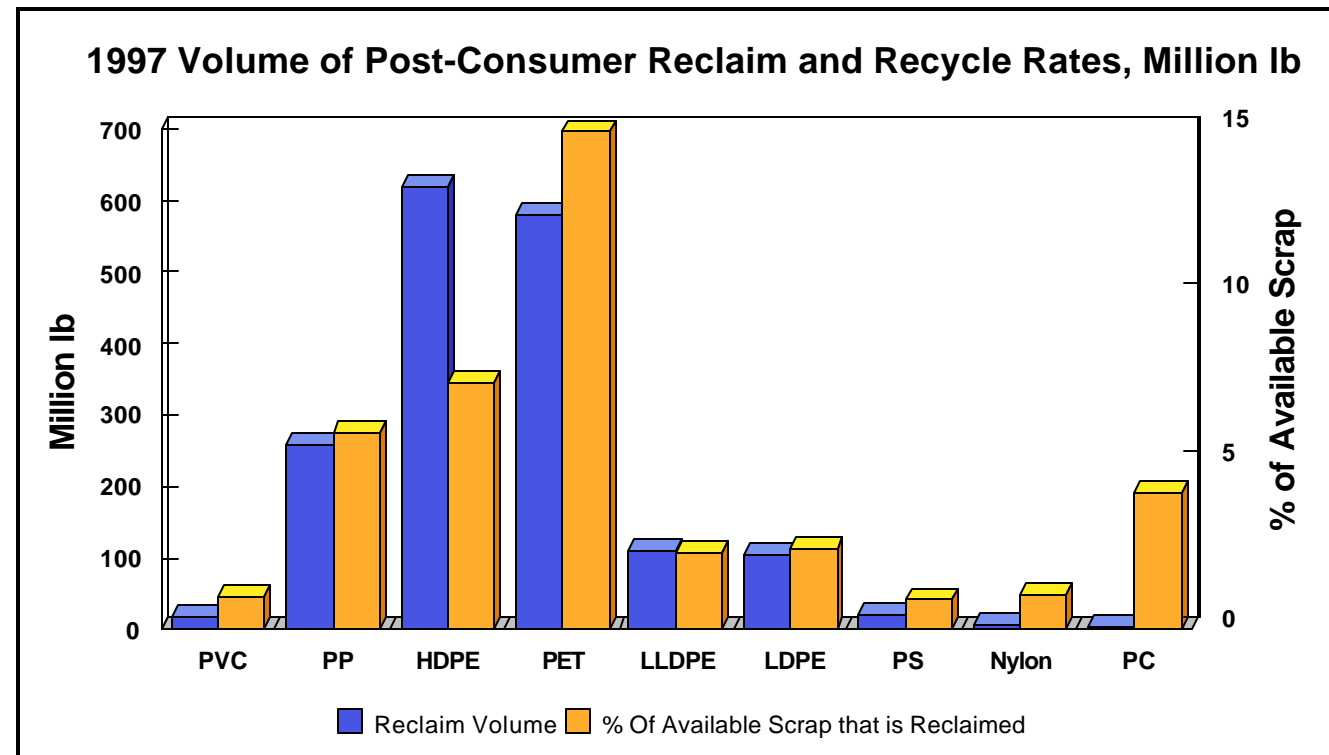
most frequently used in short-lived applications, with 70% of total resin production converted to post-consumer scrap within one year. Polypropylene and polystyrene each have a moderate share of total consumption in durable applications, and therefore approximately 35% of total resin production becomes available for post-consumer reclamation in any given year.

Recycling Overview—Volume Thermoplastics

18 million lb of post-consumer vinyl scrap is recycled

Less than 5% of available is reclaimed, except for PP, HDPE, and PET

Although a relatively small portion of all vinyl resin produced becomes available for reclamation, less than 5% of the material that does enter the solid waste stream is recycled. Most resins have similar track records. LLDPE, LDPE, PS, nylon, and PC all have recycling rates lower than 5%. Three other resins—polypropylene, HDPE, and PET—have better recycling rates, ranging from 5% to 15%. As shown in the pie charts on the following page, each of these resins has one or more applications with a high concentration of demand. These “*star*” applications

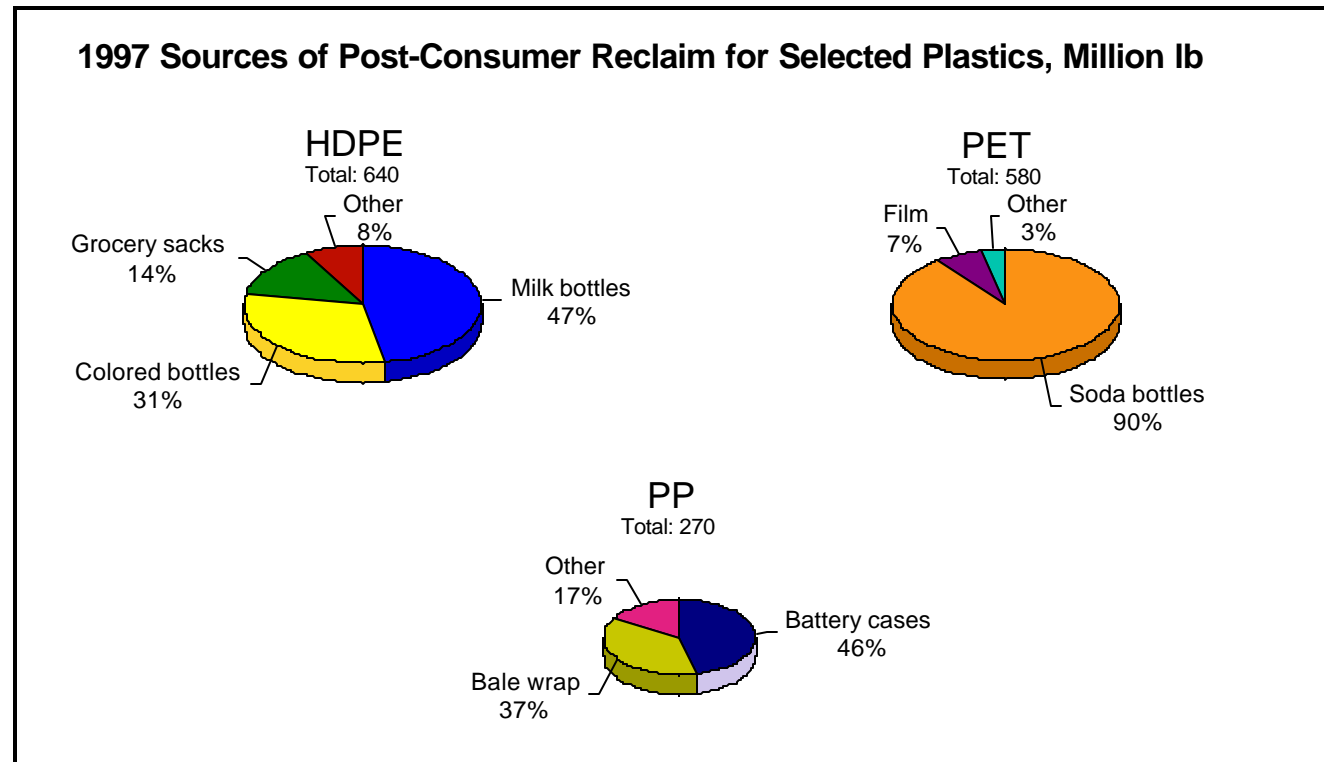


are easily identifiable products, which are readily collected and separated from the solid waste stream. The key products for all other resins are either too diverse to readily identify and separate (e.g., custom bottles), or in a form that is not conducive to separation (e.g., packaging films).

Recycling Overview—Volume Thermoplastics

Several large volume uses represent majority of PE, PET, and PP recycling

A few major applications account for the majority of post-consumer volume reclaimed from the three high profile thermoplastics. Three end uses—milk/drink bottles, household chemical [colored] bottles, and grocery sacks—represent over 90% of post-consumer HDPE recovered. PET is even more highly concentrated with one use—soft drink bottles—accounting for nearly 90% of post-consumer PET reclaimed. A couple of end uses—automotive battery cases and bale wrap used for cotton and tobacco—contribute to nearly 85% of post-consumer PP

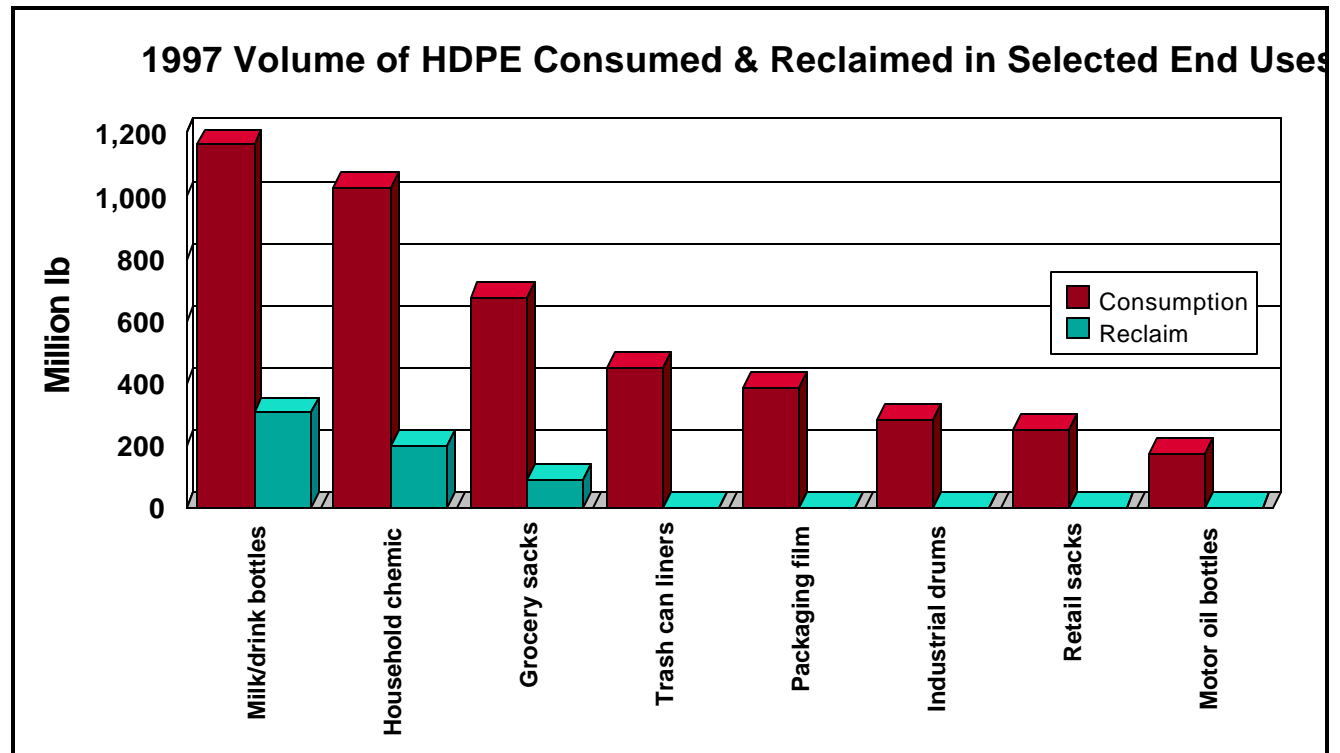


recovered in 1997. Beyond these large concentrated applications, the recycling rate for these resins is typical of all other volume thermoplastics evaluated in this study. All minor or fragmented applications pose difficulties in terms of collection, identification, and separation of the material in preparation for recycling.

Recycling Overview—Volume Thermoplastics

All post-consumer HDPE recyclate is associated with the three largest uses

For example, beyond the three largest applications for HDPE—milk/drink bottles, household cleaner bottles, and grocery sacks—the volume of resin reclaimed is negligible. The recycling rate for HDPE in other applications, including relatively large volume uses such as trash can



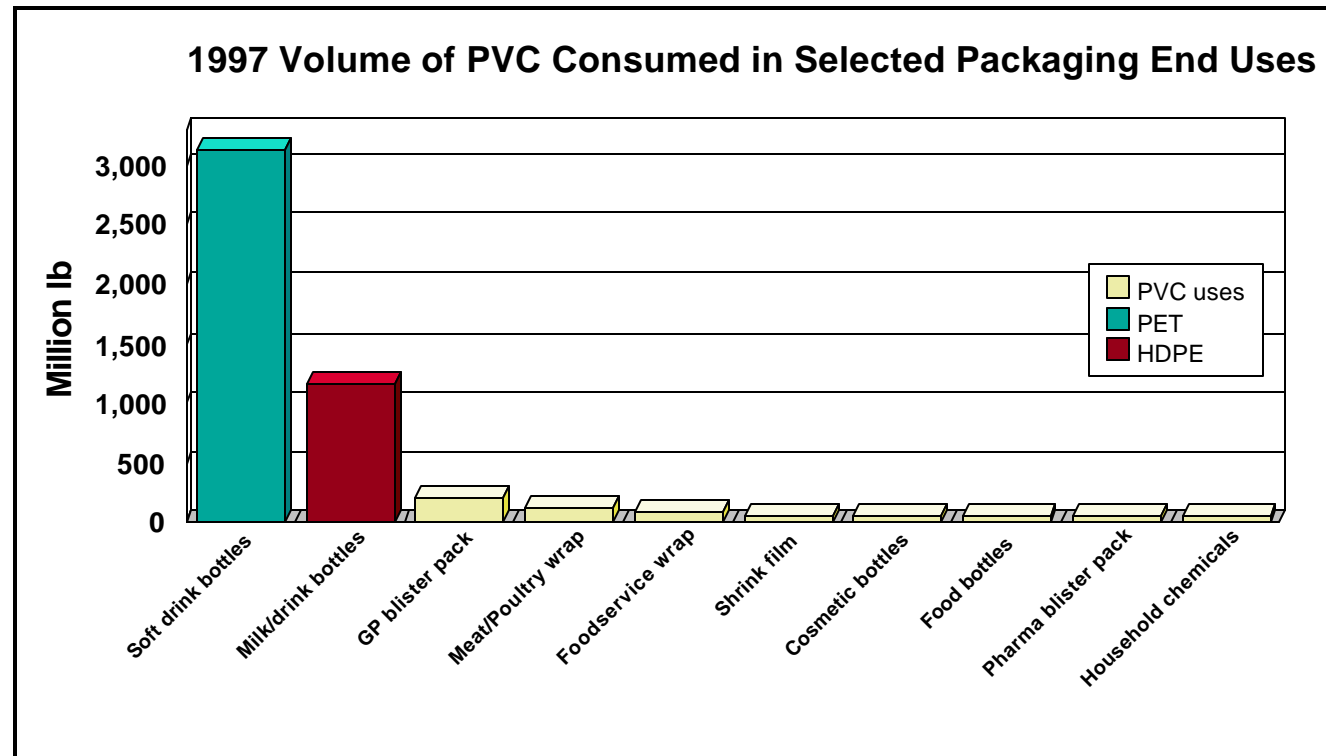
liners and industrial drums, is less than 1% of total resin consumption in these applications.

Recycling Overview—Volume Thermoplastics

Consumption of PET in soft drink bottles and HDPE in milk/drink bottles is significant

Vinyl does not have any 'star' application in packaging/short-lived end uses

Relative to the large-volume packaging applications for PET and HDPE, the use of vinyl in packaging is quite limited. Vinyl volume in any one application is fairly small compared to such "star" applications as soft drink bottles and milk/drink bottles. The single largest packaging application for vinyl is blister pack used, for example, to package over-the-counter medications. This end use consumes less than one-quarter the volume of HDPE used in milk bottles and less than one-tenth the volume of PET consumed in soda bottles. The distinct appearance of soft

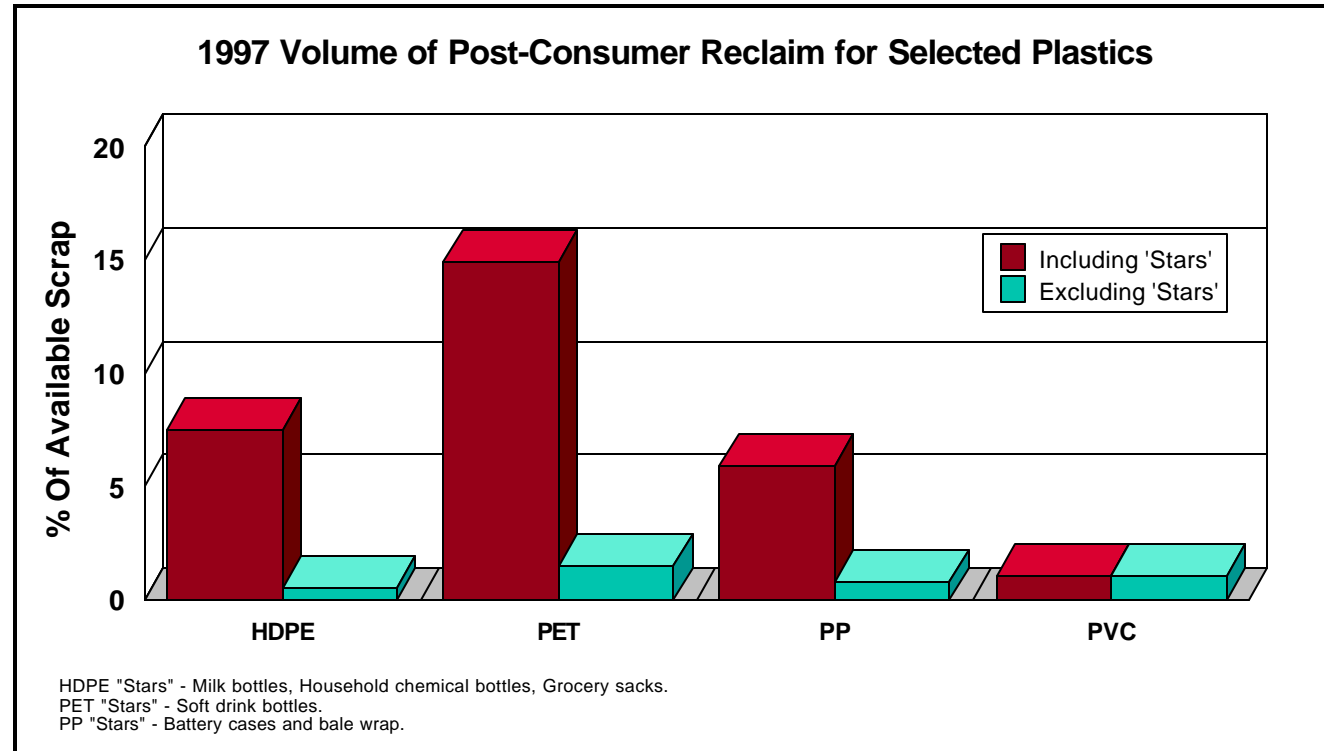


drink bottles and milk bottles allows consumers and reprocessors to easily collect and segregate these containers. Vinyl is primarily used in film/sheet where packaging forms are quite varied and visual detection nearly impossible. Recycling of blister packaging is further hampered by the dissimilar materials that are adhered to the vinyl film to make an effective package.

Recycling Overview—Volume Thermoplastics

Excluding “*star*” end uses, all materials have comparable recycling rates

Comparing the post-consumer recycling rates for the four largest volume resins excluding the “*star*” applications clearly shows comparable success for these materials. In fact, vinyl is exceeded only by PET in this analysis. The lack of a large volume, clearly identifiable and short-lived product form is the primary reason for the low post-consumer recycling rate of vinyl.



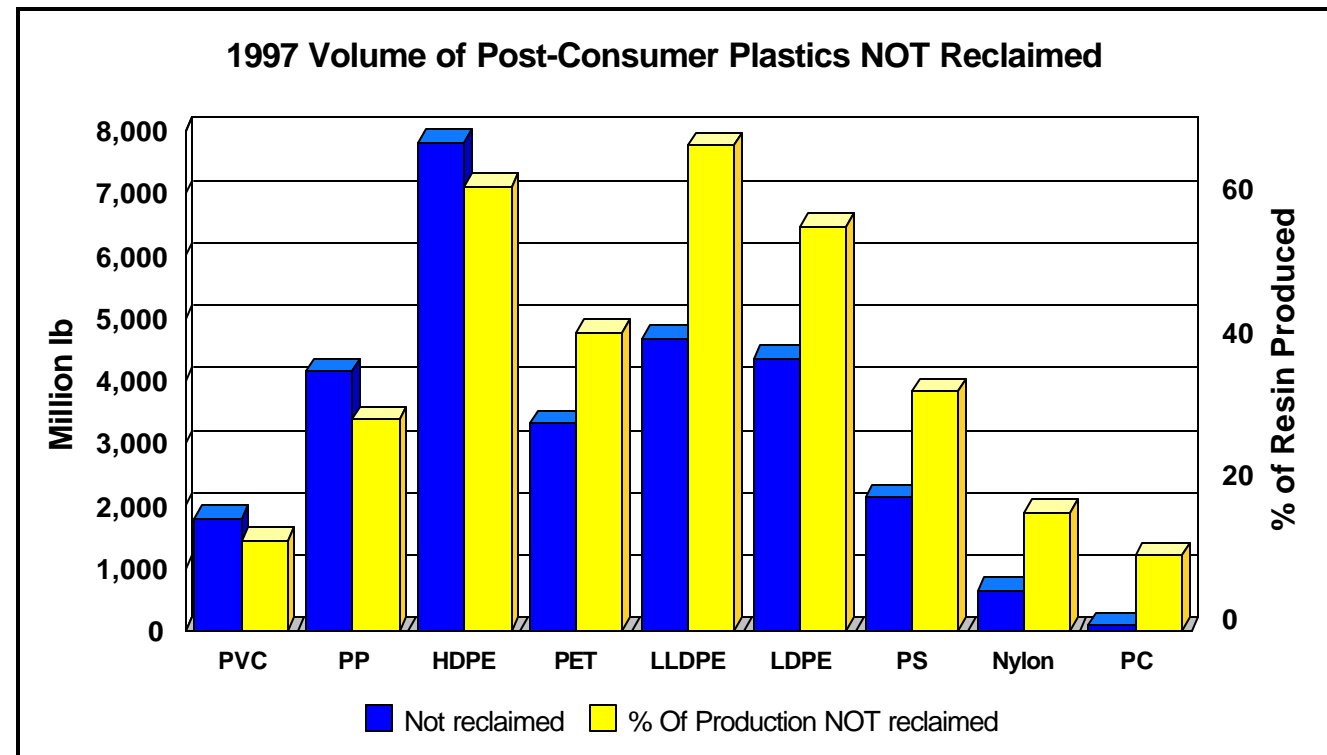
The “*star*” applications for vinyl are pipe, siding, and window lineals. As these products begin to enter the post-consumer waste stream at the end of their useful lives of 20+ years, significantly higher post-consumer recycling rates for vinyl are expected.

Recycling Overview—Volume Thermoplastics

Vinyl contributes very little to the solid waste stream when compared to other volume thermoplastics

Use in durable uses v. packaging is chief reason

Less than 20% of all vinyl produced annually is not reclaimed. This rate is excellent when compared to all other high-volume thermoplastics, and even against such selected engineering thermoplastics as nylon and polycarbonate, which primarily serve durable markets. The low contribution to the solid waste stream is chiefly a result of vinyl's use in long-lived durable applications (i.e. building & construction). Although other thermoplastics analyzed have higher post-consumer recycling rates, the absolute volume of resin that becomes available for

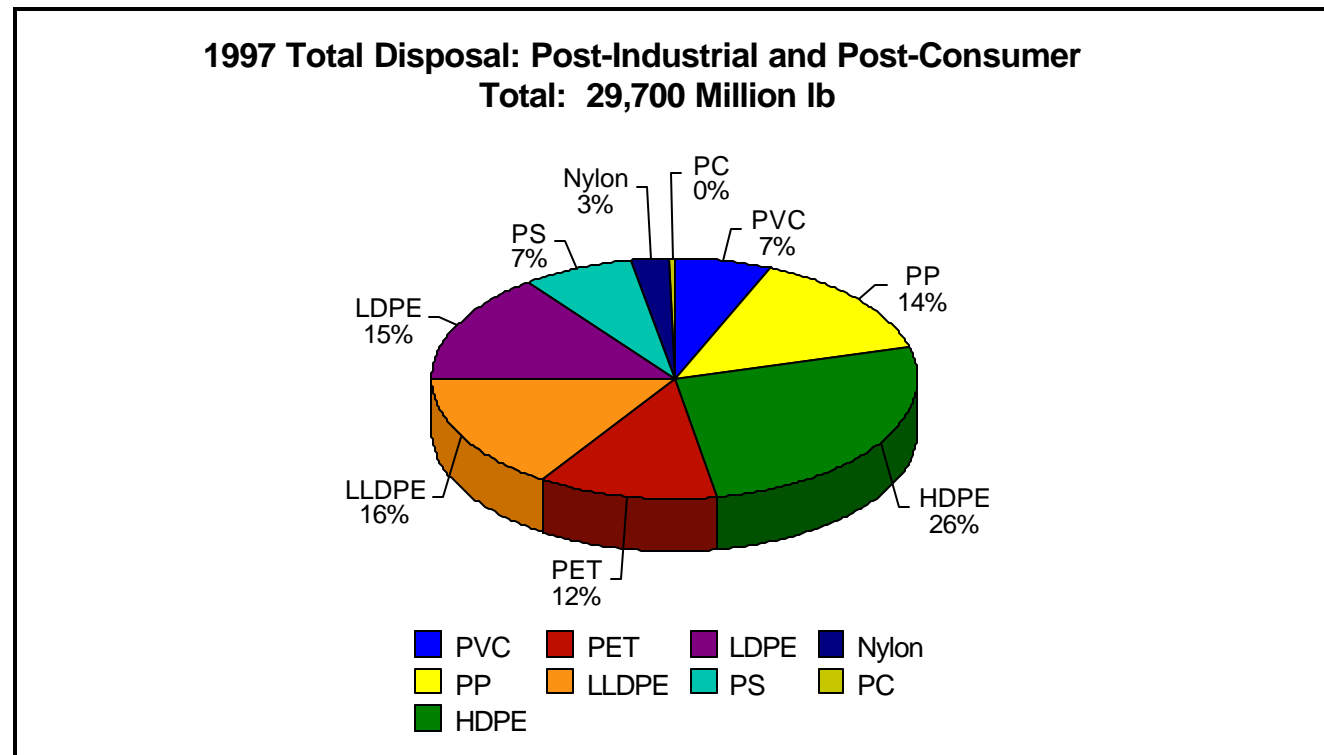


recycling but is not recovered is higher than vinyl for each resin, except for nylon and polycarbonate. The relative share of resin produced in a given period that enters the solid waste stream in a short period of time (e.g., one year) is higher for all resins analyzed, except for polycarbonate.

Recycling Overview—Volume Thermoplastics

Vinyl represents only 7% of volume thermoplastic waste in 1997

The combination of post-industrial and post-consumer waste that is not reclaimed represents the total volume of each thermoplastic that is disposed. Nearly 30 billion lb of the thermoplastics considered in this study were disposed of in 1997. Post-industrial waste that is not reclaimed is relatively minor for all materials compared to the volume of post-consumer scrap that is not reclaimed. As previously demonstrated, the 'short-lived' resins contribute far greater volumes of waste than the 'durable' resins such as vinyl, nylon and polycarbonate, both



in absolute terms and as a percentage of resin produced. The volume of each thermoplastic used in fragmented (i.e. difficult to identify) applications or in product forms that are difficult to collect and separate (e.g., films) is largely discarded.

Vinyl Reclaim Market—Rigid Post-Industrial

Rigid post-industrial reclaim limited by significant amount of closed-loop recycling

The rigid vinyl business generates relatively low levels of post-industrial reclaim relative to its significant market size. Most rigid applications have a large but concentrated producer base, and products typically are manufactured in a single value-added step. These factors limit the amount of scrap generated. Most of the rigid scrap generated occurs in instances where two value-added steps exist.

Rigid compounds are resin 'rich'

Formulations for rigid vinyl tends to be resin-rich, while flexible vinyl is plasticized and therefore the resin is further 'extended.' The 10.2 billion lb of vinyl resin consumed in rigid applications yields an estimated 11.4 billion lb of vinyl compound.

One value-added step for most rigid products

Most rigid vinyl applications are served by a concentrated group of large-volume processors. The large volume products have simple geometry and shape (e.g., pipe) and only one industrial value-added step, which minimizes the amount of scrap (raw materials, unusable processing trim, reject parts) generated.

340 million lb of rigid post-industrial reclaim

Extrusion and calendaring account for majority of rigid post-industrial reclaim

Strong demand exists for quality extrusion scrap

Available rigid post-industrial reclaim from molding is limited

North American Supply of Rigid Post-Industrial Vinyl Reclaim, 1997 Million lb				
End Use	Total vinyl processed-a	Scrap generated-b	Closed-loop usage	PI reclaim available
EXTRUSION	9,570	435	260	175
CALENDERING	1,050	220	85	135
MOLDING	735	56	25	31
TOTAL	11,355	711	370	341

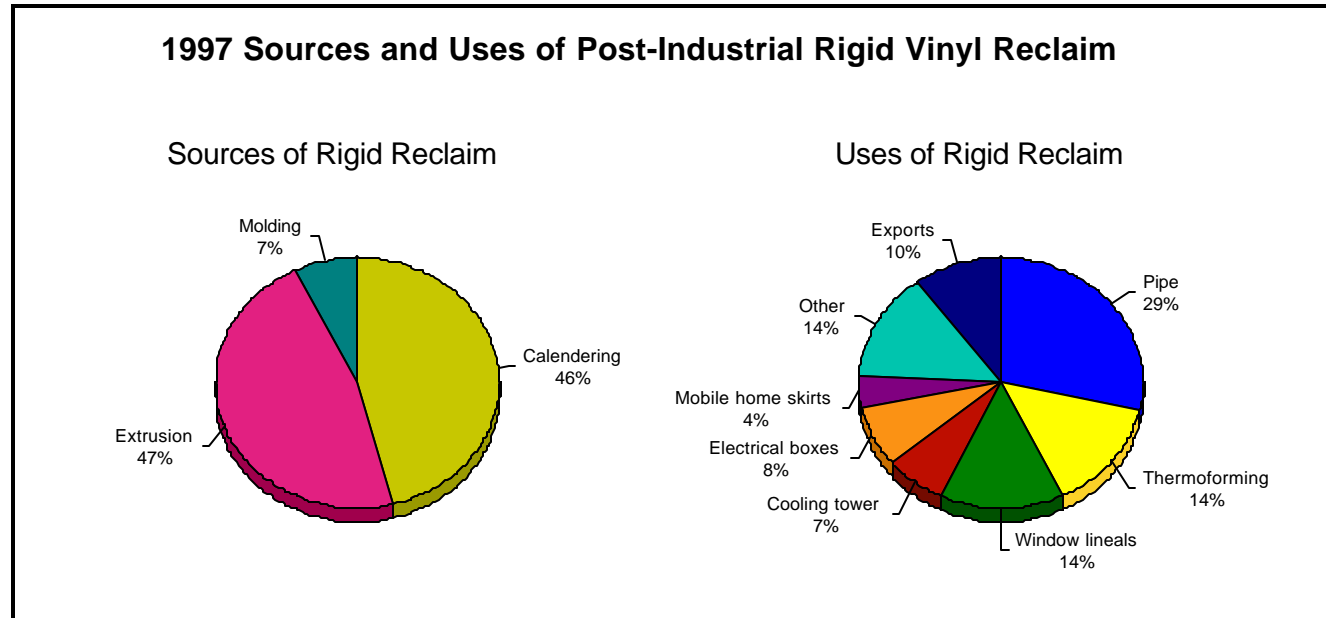
a - Compound basis; total virgin compound consumed in market in 1997.
b - Compound basis; cumulative scrap from all value-added stages of production.

Vinyl Reclaim Market—Rigid Post-Industrial

3 processes generate rigid reclaim

- % Extrusion
- % Calendering
- % Molding

...and a range of uses exist



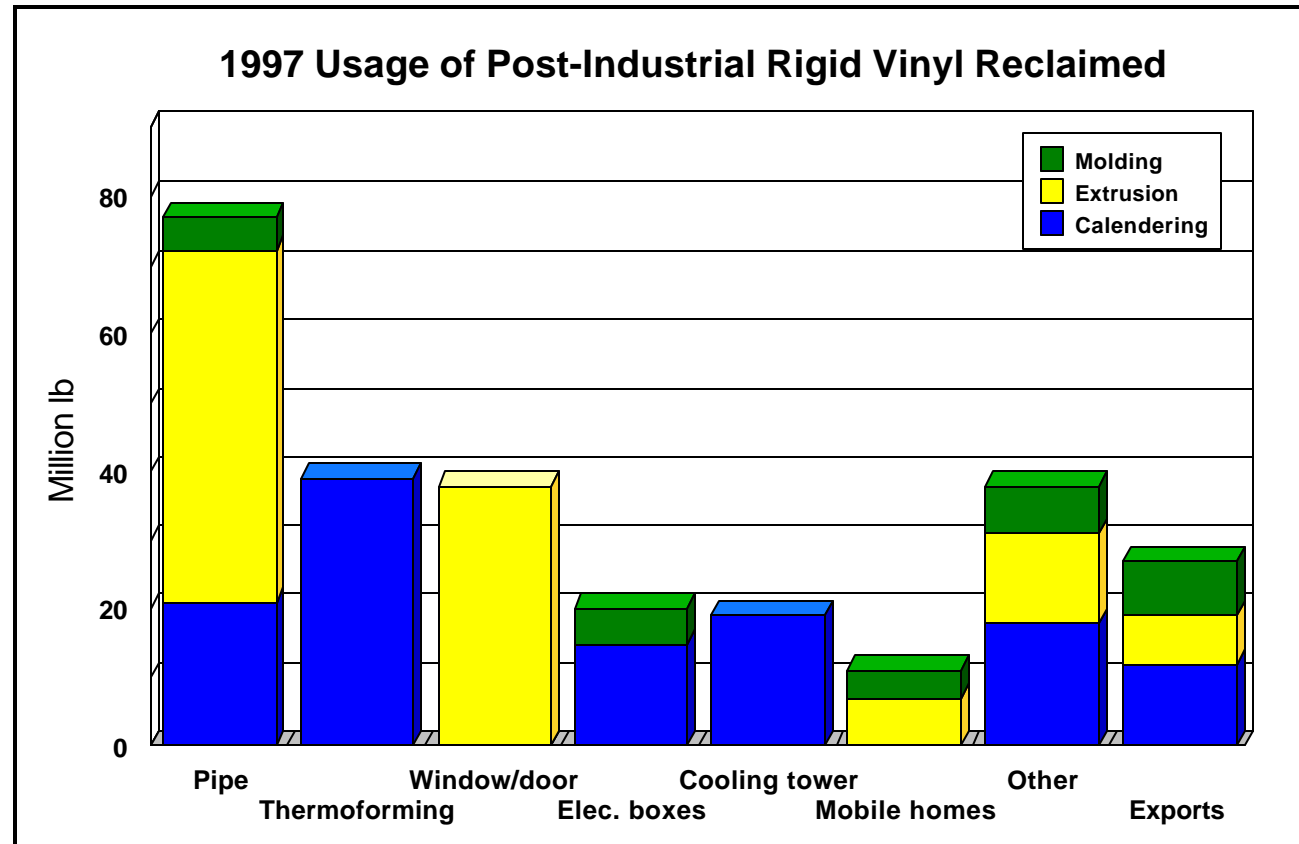
Each production step increases scrap rate

Certain rigid applications (e.g., calendered sheet, window lineals) are processed at two or more points in the value-added chain, generating scrap at each level by the individual processors involved in the overall production process. Scrap generation is closely linked to:

- 1] the number of value added steps,
- 2] the concentration/fragmentation of the supplier base,
- 3] the complexity of the parts made, and
- 4] the aesthetic requirements of the products.

Vinyl Reclaim Market—Rigid Post-Industrial

End uses for rigid reclaim use similar source materials; little IV cross-over takes place



Vinyl Reclaim Market—Rigid Post-Industrial

Of the 340 million lb available, 80% is re-used

Significant supply (7 million lb/yr) of rigid furniture edge trim exists with no market; scrap is thin (1/32") and difficult to process

Molding scrap generated is small volume and has limited suitability

North American Sources for Rigid Post-industrial Vinyl Reclaim, 1997 Million lb				
Source	PI reclaim available	PI reclaim sold-a	Available for reuse	% of Supply recycled
EXTRUSION	175	126	49	72.0%
CALENDERING	135	124	11	91.9%
MOLDING	31	20	11	64.5%
TOTAL	341	270	71	79.2%

a - Includes 27 million lb of exports.

Extrusion and calendaring each account for 45% of all rigid post-industrial reclaim sources

North American Sources and Uses for Rigid Post-industrial Vinyl Reclaim, 1997 Million lb										
Sources	Uses	Pipe	Therm o formin g	Window & Doors	Electr'l boxes	Cooling tower	Mobile homes	Other-a	Exports	TOTAL
	EXTRUSION		56	-	38	-	-	7	13	12
CALENDERING		21	39	-	15	19	-	18	12	124
MOLDING		-	-	-	6	-	4	7	3	20
TOTAL		77	39	38	21	19	11	38	27	270

a - Includes bottles, Christmas trees, custom profiles, decking, dunnage trays, fencing, gutters, lumber, and variety of custom molded parts.

Extrusion scrap sold into pipe

Extrusion scrap is sold primarily into non-pressure pipe applications which are forgiving in terms of color and cosmetic blemishes; some is consumed in window lineals and such other construction applications as fencing and gutters. Scrap generated also finds use in other window/door lineals through primary extrusion operations and end cuts generated from window and door manufacturers.

Vinyl Reclaim Market—Rigid Post-Industrial

Calendered sheet serves most major uses for rigid post-industrial reclaim

Calendering markets generate the most significant volume of post-industrial scrap, and serve most of the major end uses for rigid post-industrial reclaim. Approximately 40% is converted back into calendered sheet for thermoforming applications, including industrial packaging where aesthetic requirements are low; cassette trays; and P-O-P displays. Cooling tower fill (baffles/trays) is also a major outlet for rigid scrap from film and sheet; many of the calendering producers have 'take back' and 'buy back' post-industrial reclaim programs with customers to feed their internal need to make film/sheet for industrial packaging, cooling towers, and Christmas trees.

Molding scrap is used in electrical boxes, followed by export volume for a range of applications. Minor use in mobile home skirts and pipe fittings also exists for this post-industrial reclaim source.

Limited uses for rigid post-industrial reclaim from moldings

Rigid post-industrial reclaim generated from other moldings are used in a variety of miscellaneous applications. No major outlet exists for the limited amounts of scrap from these sources.

Building products-related applications account for most of miscellaneous uses

The applications grouped in 'Other' include blow molded opaque bottles, artificial Christmas trees, decking, dunnage trays, fencing, gutters, lumber, and variety of custom molded and extruded parts. Custom profiles sold into building products markets, is the single largest use among these miscellaneous applications; decking and lumber are also outlets for post-industrial vinyl reclaim to some extent.

South America is key export market for rigid post-industrial reclaim

Majority of exported rigid extrusion scrap (siding, lineals, custom profiles) is moved to South America for non-pressure pipe manufacturing.

Vinyl Reclaim Market—Flexible Post-Industrial

Flexible post-industrial reclaim similar in size to rigid post-industrial reclaim

380 million lb of flexible post-industrial reclaim is available

Extrusion represents the largest source stream

Calendering is small, as most scrap is reused within generators' facilities

Molding is minor; most scrap is available but difficult to collect

The flexible vinyl business generates nearly the same volume of post-industrial reclaim as the rigid vinyl business, although it consumes one-quarter the volume of resin. The 2.6 billion lb of resin (excluding exports) yields approximately 6.0 billion lb of flexible compound (including the highly loaded vinyl floor tile application) for a wide variety of applications.

North American Supply for Flexible Post-Industrial Vinyl Reclaim, 1997				
Million lb				
End Use	Total vinyl processed-a	Scrap generated-b	Closed-loop usage	PI reclaim available
EXTRUSION	2,470	335	85	250
CALENDERING	2,750	155	60	95
MOLDING	780	45	10	35
TOTAL	6,000	535	155	380

a - Compound basis; total virgin compound consumed in market in 1997.
b - Compound basis; cumulative scrap from all value-added stages of production.

Large base of producers, and multiple value-added steps

Most flexible applications have a large producer base and the products typically have two value-added steps at which scrap is generated. Both factors contribute to the higher average scrap rates compared to rigid vinyl.

Large base of producers, and multiple value-added steps

Most flexible applications have a large producer base and the products typically have two value-added steps at which scrap is generated. Both factors contribute to the higher average scrap rates compared to rigid vinyl.

Flexible compounds are extended with plasticizers

Formulations for rigid vinyl tends to be resin-rich, while flexible vinyl is plasticized and therefore the resin is further 'extended.' The 2.6 billion lb of vinyl resin used in flexible end uses yields approximately 6.0 billion lb of flexible vinyl compound (including the highly loaded vinyl floor tile application). These resin volumes represent the 1997 market in the United States and Canada (exports excluded) for suspension and dispersion resin.

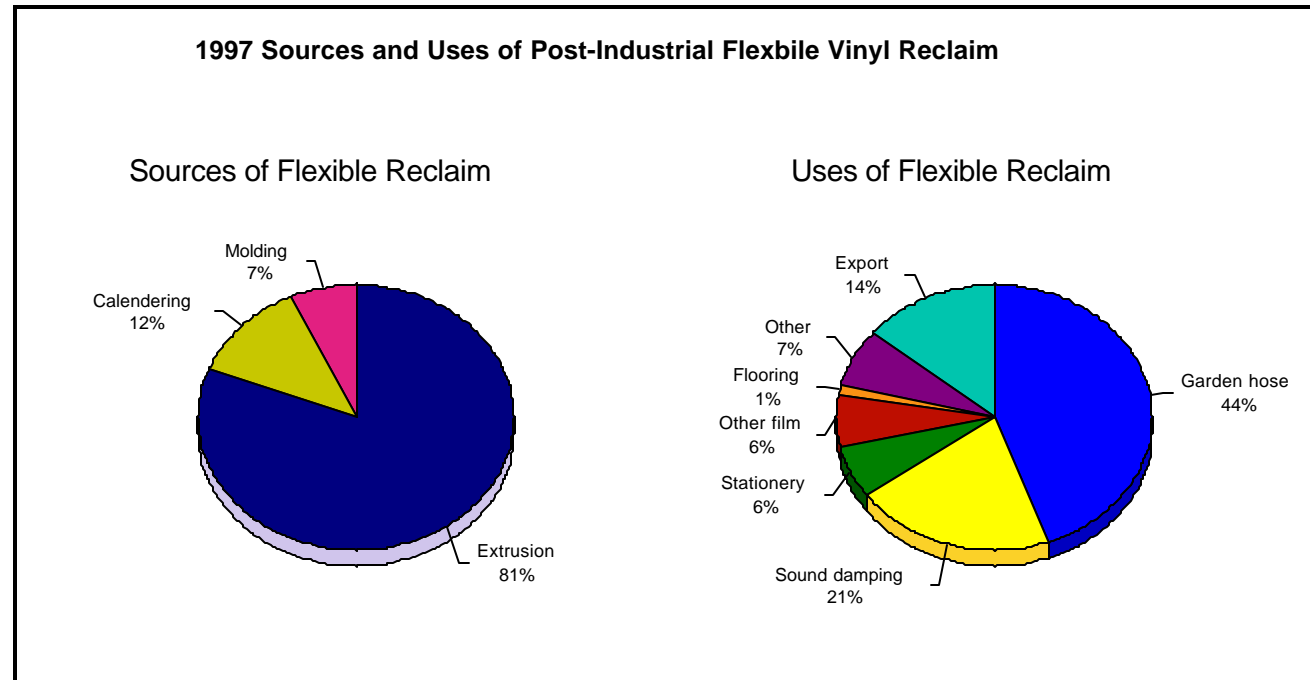
Vinyl Reclaim Market—Flexible Post-Industrial

Two value-added step for most flexible uses

Many flexible vinyl products are processed at two or more steps, generating scrap at each step in the chain. Scrap generation is closely linked to:

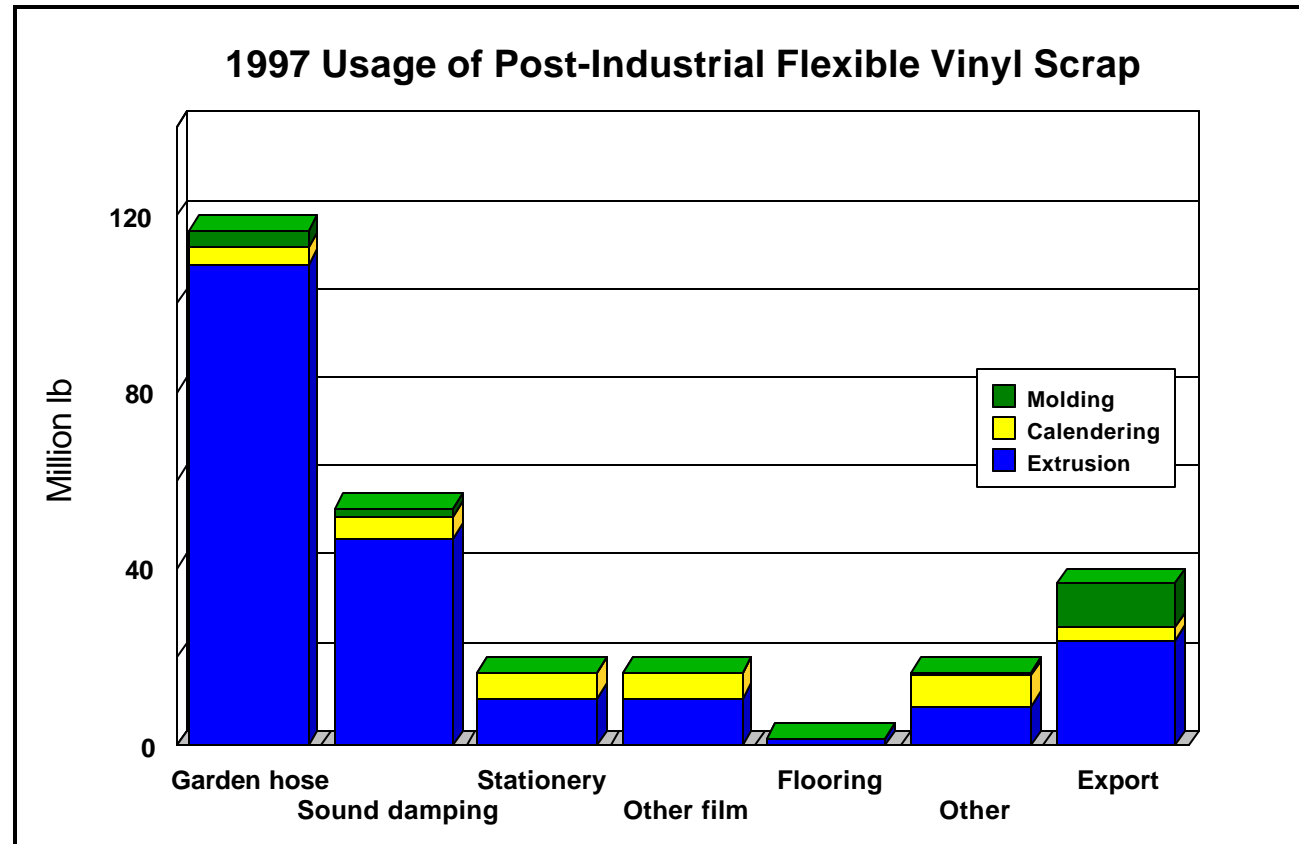
- 1] the number of value added steps,
- 2] the concentration/fragmentation of the supplier base,
- 3] the complexity of the parts made, and
- 4] the aesthetic requirements of the products.

Flexible post-industrial reclaim does not get used in like applications



Vinyl Reclaim Market—Flexible Post-Industrial

Few restrictions on type of flexible reclaim applicable to each end use, beyond types and level of contamination



Vinyl Reclaim Market—Flexible Post-Industrial

Utilization of supply is highest for extrusion sources

Overall rate is high at 71%

North American Supply for Flexible Post-industrial Vinyl Reclaim, 1997 Million lb				
Source	PI reclaim available	PI reclaim sold-a	Remains available for reuse	% of Supply recycled
EXTRUSION	250	215	35	86.0%
CALENDERING	95	34	61	35.8%
MOLDING	35	22	13	62.9%
TOTAL	380	271	109	71.3%
a - Includes 37 million lb of exports.				

Garden hose is versatile

Some vinyl garden hose is made with a 100% post-industrial reclaim inner core. Hose, which is the largest outlet for flexible scrap, can a broad range of flexible scrap.

Sound deadening panels made from extrusion scrap

Sound deadening panels used in automobiles are produced from a variety of post-industrial reclaim streams, as well as automotive exterior body trim scrap. These non-appearance parts are used along the firewall and as trunk liners to reduce road noise.

Post-industrial recycle content film competes against virgin film

A wide variety of film products are produced from flexible post-industrial reclaim. Much of this product competes directly with virgin film made for the same applications. Smaller, regional producers purchase post-industrial reclaim and compete with the large film calendering and extrusion houses. Applications within the stationery segment include bookbinding (3-ring binders, report covers, day timers), checkbook covers, business card holders, and similar products. Other film applications include swimming pool (i.e. above ground) liners, pond liners and geomembranes. These end uses consume primarily scrap film/sheet, which provides the appropriate filler loading, plasticizer content, and hardness for the calendering operation.

Vinyl Reclaim Market—Flexible Post-Industrial

All other applications are minor outlets for reclaim

Garden hose accounts for greater than 50% of all flexible post-industrial reclaim used

All other end uses for flexible post-industrial reclaim are fairly small, and supplied by a balanced group of sources

Export market for flexible post-industrial reclaim has sagged

Growing Mexican market for flexible post-industrial reclaim

The applications grouped in 'Other' include floor mats sold in the automotive aftermarket and in the industrial market for anti-fatigue uses; mud flaps; bicycle hand grips; automotive, appliance, and residential weatherstripping; shoe soles and industrial boots; and various other products. Each of these end uses consumes less than 2 million lb of flexible post-industrial reclaim a year.

North American Sources and Uses for Flexible Post-industrial Vinyl Reclaim, 1997 Million lb								
Sources \ Uses	Garden hose	Sound deadening	Stationery	Other film	Flooring	Other-a	Export	TOTAL
EXTRUSION	111	47	11	11	2	9	24	215
CALENDERING	5	5	6	6	1	8	3	34
MOLDING	4	2	-	-	-	6	10	22
TOTAL	120	54	17	17	3	23	37	271
a - Includes floor mats (auto & industrial), truck mud flaps, traffic cones/parking stops, weatherstripping, shoes/boots, and various consumer/sporting goods.								

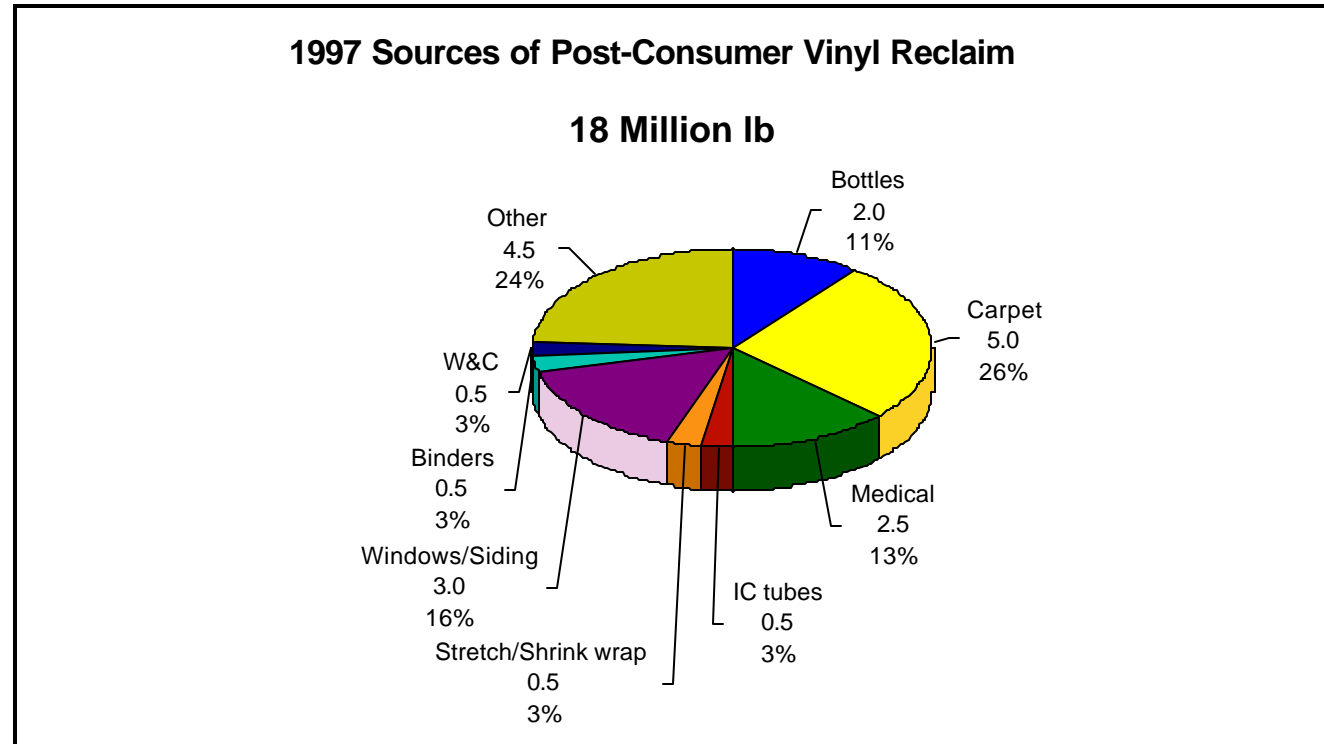
An established export market exists for flexible reclaim. The vast majority of this product is shipped to the Far East. Major importing countries include Taiwan, Hong Kong, and Indonesia. Demand in this region has dropped over the past two to three years, due to a self-imposed import restriction in China. Pricing in the domestic market softened due to the drop in export volume.

The market in Mexico for post-industrial reclaim for use in shoe production and automotive components (non-appearance parts) is growing, and several brokers and reprocessors are positioning to take advantage of the increased demand.

Vinyl Reclaim Market—Post-Consumer

18 million lb of post-consumer vinyl scrap recycled in 1997

A total of 18 million lb of post-consumer vinyl scrap was reclaimed in 1997. The volume is approximately equally split between rigid and flexible scrap. The flexible scrap is largely purchased by end users for the plasticizer content, while rigid vinyl scrap is used for its resin content. Due to the relatively low price for prime virgin rigid vinyl resin in 1997, the demand for



rigid post-consumer scrap is lower than the total supply. The plasticizer content in flexible post-consumer vinyl scrap has a higher value than the resin content, and therefore maintains its market value through fluctuations in prime virgin resin pricing.

Vinyl Reclaim Market—Post-Consumer

Sources of post-consumer reclaim similar to post-industrial

Except for the reclamation of commercial contract carpet backing, the sources of post-consumer vinyl are similar to the post-industrial sources. Included in the 'Other' category is a wide range of rigid and flexible products such as automotive trim, general-purpose molded products, thermoformed packaging, extruded sheet, cove base, gasketing, and custom profiles. These products are collected through various programs established either by a reprocessor seeking a source of raw material or an OEM with a custodial interest in reusing their original products. Reclamation of commercial carpet and binders are prime examples of OEMs with a custodial interest in their products. Both Collins & Aikman and Interface Carpet have programs to collect carpet and reuse the vinyl backing. O'Sullivan is active in collecting used 3-ring binders and recycling the vinyl skins, cardboard stiffeners, and the metal spines of these products.

Uses of post-consumer scrap are identical to post-industrial waste

The uses of post-consumer vinyl reclaim are identical to post-industrial scrap. The post-consumer channel simply represents another source of raw materials for reprocessors and reclaim users. In fact, post-consumer reclaim that is handled by the reprocessor channel is typically commingled with post-industrial scrap, and no differentiation between the materials is made beyond this step in the distribution chain.

As shown previously, flexible reclaim (e.g., medical, binders, films, wire & cable) are used in garden hoses, sound deadening panels, bookbinding, and other miscellaneous applications. The rigid post-consumer scrap (e.g., bottles, IC tubes, windows/siding, blister pack, custom profiles) is used in the production of non-pressure vinyl pipe, window profiles, mobile home skirts, and similar applications.

Market Pricing

Prices fluctuate based on supply/demand balance

The market for scrap vinyl is very efficient; pricing through the reprocessor and broker channels is set based on supply and demand. Pricing fluctuates daily and is driven by an ask and bid process, where suppliers set the asking price and end users bid for the material. Pricing is comparable across all regions of the country, although most product does not move more than 250 miles from source to end use.

Virgin resin pricing only influences reclaim prices in pipe market

Pricing for most types of reclaim is not impacted by movements in prime resin prices. Prices for rigid reclaim destined for the pipe market are affected by changes in pricing of virgin resin, and to a lesser extent window lineal reclaim prices are moved by resin price shifts. The flexible vinyl reclaim market is not greatly influenced by prime resin pricing. Supply and demand balance of flexible vinyl reclaim is the key factor for price changes in any given grade of flexible scrap.

In current market, rigid scrap is higher priced than flexible...

Under the current market conditions, rigid scrap is generally higher priced than flexible scrap. Strong demand exists for most forms of rigid scrap, and the total supply available does not outweigh the demand significantly. Several years ago when exports of flexible scrap to China represented a larger outlet for these materials, flexible scrap pricing was approximately double its current level. Strong demand in the export market had bid prices for flexible scrap in the domestic market to the high teens (circa \$0.17 to \$0.19 a lb). The abrupt drop in exports to China resulted in a sharp drop in domestic pricing for flexible scrap.

...but flexible regrind is higher priced than rigid

Pricing for regrind is higher than scrap prices because of the reprocessing cost. Reprocessing costs are largely driven by the cleanliness of the scrap material. The degree to which hand sorting of materials (to remove cigarette butts, wood chips, paper/cardboard, and various other 'contaminants') has a major impact on costs. Certain scrap sources require hand disassembly. For example, off-spec medical IV tubing sets have high durometer, white end fittings attached to the low durometer, clear tubing which must be removed before grinding. The cost of grinding is higher for flexible vinyl than rigid, due to the difficulty in processing the soft, plasticized material. A number of reproducers use cryogenic grinding methods for flexible scrap to increase throughput and improve consistency of the final product; this technique is higher cost than standard grinding.

Market Pricing

Post-consumer and post-industrial vinyl reclaim have traded in a fairly tight price range

Post-consumer prices have been typically a few cents a lb lower

Price differences were based on type and quality of reclaim

Clear grades commanded premium over highly filled or plasticized grades

High quality white grades of siding and window lineal scrap also generated higher resale prices

Market Pricing for Vinyl Reclaim, 4Q 1997				
Type	Scrap, Price, \$/lb (landed)		Regrind Price, \$/lb (landed)	
	Post-Industrial	Post-Consumer	Post-Industrial	Post-Consumer
RIGID	Post-Industrial	Post-Consumer	Post-Industrial	Post-Consumer
Rigid window lineals, white	\$0.10 - \$0.12	\$0.07 - \$0.10	\$0.16 - \$0.22	\$0.14 - \$0.18
Siding, mixed colors	\$0.06 - \$0.09	\$0.04 - \$0.08	\$0.13 - \$0.19	\$0.11 - \$0.15
Blister pack				
Clear	\$0.13 - \$0.15	N/A	\$0.17 - \$0.20	N/A
White	\$0.10 - \$0.12	N/A	\$0.15 - \$0.17	N/A
Bottles				
Clear	--	\$0.05 - \$0.09	\$0.17 - \$0.21	\$0.15 - \$0.19
Mixed colors	--	N/A	\$0.13 - \$0.16	N/A
Credit card, white	\$0.12 - \$0.15	N/A	--	N/A
FLEXIBLE	Post-Industrial	Post-Consumer	Post-Industrial	Post-Consumer
Commingled w/ PE, rubber	--	N/A	\$0.03 - \$0.05	N/A
Black, 100A duro, extrusion	--	N/A	\$0.04 - \$0.07	N/A
Mixed, 90A duro, molding	--	N/A	\$0.07 - \$0.10	N/A
Mixed, 70A duro, auto int	\$0.05 - \$0.08	N/A	\$0.16 - \$0.20	N/A
Tinted, 35A duro, fish lures	\$0.07 - \$0.10	N/A	\$0.19 - \$0.25	N/A
Pool liners/bookbinding	\$0.05 - \$0.10	\$0.01 - \$0.03	\$0.15 - \$0.18	\$0.09 - \$0.12
Wire & cable				
Extruder purgings	\$0.06 - \$0.08	N/A	\$0.13 - \$0.16	N/A
Scrap wire chop	\$0.01 - \$0.04	\$0.01 - \$0.03	\$0.09 - \$0.12	\$0.07 - \$0.10
Medical tubing, clear	\$0.09 - \$0.13	\$0.06 - \$0.10	\$0.27 - \$0.35	\$0.27 - \$0.35

Applications Review

Vinyl reclaim only replaces virgin vinyl

In virtually every application identified, vinyl reclaim is used in place of prime virgin vinyl. The use of vinyl reclaim does not open new applications for vinyl; however, the lower cost material allows vinyl to be more competitive in certain cost-sensitive applications. Post-industrial and post-consumer reclaim are used interchangeably in major scrap end uses. No distinct applications exist for the vinyl scrap depending on the source of the material.

Cost is primary reason for use

Vinyl reclaim is used primarily to reduce the cost of goods manufactured. The material represents a lower cost source of vinyl resin and/or plasticizer in each end use. Reclaim is only used where 1] commercial standards allow its use, 2] the aesthetic inconsistencies can be tolerated, and 3] the processing conditions are forgiving enough to withstand the somewhat degraded feedstock.

PIPE...

...is a major outlet for scrap from other markets

Non-pressure pipe, including low end drain/sewer, conduit/duct, and some irrigation products, is a major end market for vinyl resin. Post-industrial vinyl reclaim is also used extensively for these less critical pipe applications. Recycle content is typically sandwiched into the core of the pipe, between layers of prime or off-grade vinyl resin. Post-industrial vinyl reclaim replaces virgin (both prime and off-grade) vinyl resin. Cost is the key driver for using post-industrial vinyl scrap in these applications.

All contacted non-pressure pipe producers are major users of reclaim

All of the major pipe producers contacted, who manufacture non-pressure pipe, purchase vinyl reclaim. Quality vinyl reclaim has found historical use in non-pressure pipe for over 20 years. Cost reduction is the driver for this original market outlet for vinyl scrap.

THERMOFORMING...

...re-uses film & sheet scrap

Thermoforming is a major end market for rigid calendered film/sheet made from prime vinyl resin. All of the post-industrial reclaim manufactured into film/sheet is sourced from virgin rigid calendered film/sheet scrap. Blister packs for general purpose (e.g., hardware, cosmetics, many other consumer products) and high end (pharmaceutical, medical) uses; P-O-P displays; and transit/shipping trays are among the many uses. Rigid post-industrial vinyl reclaim also competes against virgin film/sheet in selected application areas, including general purpose/industrial blister packs (hardware, other industrial and low end consumer products) and cassette trays which is a growing market for recycle content film/sheet. Cost is the key driver for using vinyl scrap in these applications.

Applications Review

All calendering houses involved in post-industrial reclaim for thermoforming grades

Ratio is 70% closed loop/30% post-industrial reclaim for most thermoforming grades

All of the major calendering houses, including Klockner Pentaplast, NanYa Plastics, and VPI Mirrex, purchase or take back web trim (ground, baled) from customers to meet internal requirements and as a customer courtesy (through sales negotiation). These scrap buy back and take back programs supplement closed loop recycling to produce post-industrial recycle content film/sheet; these products do not contain 100% post-industrial reclaim. Calendering producers feed scrap generated from primary production (start up and shutdown) and secondary operations (slitting) into post-industrial content film/sheet; typical ratio of closed loop-to-post-industrial reclaim is 70:30 for most clear thermoforming grades. Conversely, the opposite ratio exists for cassette trays which are opaque (black or white opaque) and use 80% post-industrial and 20% closed-loop recycle content.

Ex-Tech is prolific extruder of post-industrial recycle sheet

Ex-Tech Plastics is a leading extruder of film/sheet containing post-industrial reclaim; the company produces some proprietary products from post-industrial scrap, although the majority of its sales consist of reprocessing post-industrial reclaim generated by a specific customer, and sold back on a tolling arrangement.

Identified thermoformers using post-industrial content film/sheet for industrial blister packs and POP displays include Alloyd, FormPac, Innovative Plastics, Plastofilm, R.F. Thermoform Products, Techform, Transparent Container, and Quality Thermoforming. Many other thermoformers using post-industrial reclaim also exist.

Several lead in cassette trays

Leading companies involved in thermoforming cassette trays from film/sheet with post-industrial reclaim include American Sealcut, Design Five, Fey Industries, Placon, and Printing Press.

Guaranteed and Nicos are major brokers

Major brokers serving this segment include Guaranteed Plastics and Nicos Polymers and Grinding.

Cost reduction is key consideration for use

Recycle content grades of rigid film/sheet are used to reduce cost where absolutely critical quality is not required. Most thermoforming applications using post-industrial reclaim are general purpose and industrial uses. Food contact and medical/pharmaceutical applications are not viable applications for film/sheet containing post-industrial reclaim.

Applications Review

WINDOW/DOOR LINEALS...

...uses regrind from window trimmings

Window/door lineals are extruded into profile shapes from prime vinyl resin and compounds. Aesthetic requirements demand the use of high quality raw materials and adherence to high quality of finished parts. However, lesser quality parts can be made from production scrap, including extrusion runs and end cuts generated during assembly. A fairly fluid market of post-industrial reclaim exists where scrap generated by one producer is sold to another producer; reprocessors may contribute a value-added step by reworking collected scrap into mixed flake or pellet form for use by the same or another lineal producer. Not included in the window market is the volume of vinyl resin and compound used for the manufacture of such window accessories as glazing beads, muntins, and edge seals. This is captured under custom profiles where most of these accessories are produced.

Cost is the key driver for using post-industrial vinyl scrap in these applications, and post-industrial reclaim competes directly against prime grades of vinyl resin and compound.

Leading generators are also leading users

Leading window/door lineal extruders include ACRO Extrusion, Chelsea, Easco, Insulate, Mikron, Milguard, Spectus, Royal, Thermal Industries, and vinyl Building Products. These same companies are primary generators and consumers of post-industrial vinyl reclaim.

COOLING TOWER FILL...

...are an ideal use of film scrap

Cooling tower fill (baffles, trays) has become an industry recognized use for rigid calendered film/sheet made from post-industrial vinyl reclaim. Good heat and flame resistance associated with vinyl makes it suitable for the application. All of the post-industrial reclaim manufactured into film/sheet for cooling tower fill is sourced from virgin rigid calendered film/sheet scrap.

All calendering houses involved in post-industrial reclaim for cooling tower fill

Post-industrial recycle-content film/sheet is made by both calendering and extrusion. All of the major calendering houses, including Klockner Pentaplast, NanYa Plastics, and VPI Mirrex, purchase or take back web trim from customers to meet internal requirements and as a customer courtesy. These scrap buy-back and take-back programs supplement closed-loop recycling to produce post-industrial recycle-content film/sheet; these products do not contain 100% post-industrial reclaim. Producers feed scrap generated from primary production and secondary operations into post-industrial content film/sheet; typical ratio of closed loop to post-industrial reclaim is 90:10.

Ratio is 90% closed loop/10% post-industrial reclaim for cooling tower fill

Applications Review

Three main users of cooling tower fill; Marley and BAC are also cooling tower mfrs

The three significant producers of cooling tower fill are Brentwood Industries, Marley, and Baltimore Air Coil. These three companies represent greater than 90% of demand for the roughly 100 million lb of finished sheet consumed in the cooling tower fill market. A number of OEMs (primarily involved in industrial refrigeration) account for the balance.

Low cost for cooling tower fill achieved through post-industrial reclaim

Cost is the key driver for using post-industrial vinyl scrap in cooling tower fill. This application has historically used closed loop recycle and post-industrial reclaim in order to remain cost competitive.

ELECTRICAL BOXES...

...use some regrind

The electrical junction box segment is a sizeable market for prime and off-grade vinyl resin and merchant vinyl compound. Post-industrial vinyl reclaim is used to a limited extent to offset prices for resin and compound. Post-industrial reclaim supplements closed loop recycling which is significant. Cost is the key driver for using post-industrial vinyl scrap in electrical junction boxes.

In addition, calendering producers also sell post-industrial reclaim (generated internally and taken/purchased back from customers) directly to electrical junction box manufacturers. Specifically, the largest electrical junction box producer has a direct supply relationship for rigid film/sheet scrap from a major calendered film manufacturer.

MOBILE HOME SKIRTS...

...use extrusion reclaim

Manufactured housing is a major vinyl market for both siding and skirting. Mobile home skirts represent a fairly small market for prime and off-grade vinyl resin and merchant vinyl compound. Post-industrial vinyl reclaim is used in the skirt substrate and masked with a vinyl capstock layer. The extrusion reclaim used is similar to virgin vinyl formulations used for skirting. Cost is the key driver for using post-industrial vinyl scrap in mobile home skirts.

3 major skirt manufacturers

Three major mobile home skirt producers exist in North America—Rustique Enterprises, StyleCrest, and Fabwell.

MR Plastic Recyclers is a prominent broker to this market

A key broker serving this market is MR Plastic Recyclers, who has a strong relationship with several siding producers and purchases regrind for sale to mobile home skirt manufacturers around the country.

Applications Review

CHRISTMAS TREES...

...is a declining market for post-industrial reclaim

At one time, artificial Christmas tree production was a sizeable market for utility grades (containing post-industrial reclaim) of rigid calendered vinyl film/sheet in North America. Domestic demand for film/sheet has largely eroded, as tree production has moved to Mexico and off-shore. Over half a dozen producers of artificial trees existed in North America as recently as 10 years ago. General Foam is the only remaining producer still purchasing film domestically for local production.

All calendering houses involved in post-industrial reclaim for Christmas trees

All of the post-industrial reclaim manufactured into film/sheet for Christmas trees is sourced from virgin rigid calendered film/sheet scrap. Post-industrial recycle content film/sheet is made through both calendering and extrusion. All of the major calendering houses, including Klockner Pentaplast, NanYa Plastics, and VPI Mirrex, purchase or take back web trim from customers to meet internal requirements and as a customer courtesy. These scrap buy back and take back programs supplement closed loop recycling to produce post-industrial recycle content film/sheet; these products do not contain 100% post-industrial reclaim. Calendering producers feed scrap generated from primary production and secondary operations into post-industrial content film/sheet; typical ratio of closed loop to post-industrial reclaim is 90:10.

Ratio is 90% closed loop/10% post-industrial reclaim for Christmas trees

OTHER END USES...

...use minor volumes of rigid reclaim

Most of the miscellaneous end uses for rigid vinyl reclaim are building products related. Individual applications consume less than 2 to 3 million lb of reclaim annually. In nearly all applications, prime vinyl resin has been substituted by reclaim to lower product cost. End uses tend to be non-appearance and have limited product liability issues that normally require stringent adherence to industry/government standards. An assorted listing of miscellaneous applications for rigid post-industrial reclaim is shown below:

- T Blow molded bottles
- T Decking
- T Dunnage trays
- T Fencing
- T Gutters
- T Lumber
- T Custom molded and extruded parts

Applications Review

GARDEN HOSE...

...is the single largest flexible reclaim end use

Most garden hose produced and sold in North America has a 100% inner tube of reclaim vinyl. Exceptions are 'Drinking Water Safe' hoses used for campers/RVs and some boating applications, which utilize only virgin FDA-approved materials. The inner tube (~0.040" wall thickness) accounts for 40% to 45% of materials in a 5/8" garden hose, with the fiber reinforcement and outer tube (virgin vinyl used) being the balance.

Garden hose can accept a wide range of reclaim

Only flexible scrap is used; however, any type of scrap is usable, except for mixed streams (i.e. no plastic other than vinyl can be tolerated). Garden hose manufacturers do not use post-consumer reclaim. In addition to the flexible reclaim, garden hose producers also purchase dispersion resin-based products, primarily from rotomolded toys.

SOUND DEADENING PANELS...

...are non-appearance automotive parts

Panels used in various locations in automobiles, including along the firewall, between the trunk and passenger compartment, and underbody areas, are made of reclaim vinyl and serve to isolate the passengers from engine and road noise. Use of sound deadening panels began in the mid-1970s and has grown dramatically due to the drive to reduce NVH (noise, vibration, harshness) ratings of vehicles. Growth is expected to continue as panels are introduced to new areas of cars, such as inside doors and around transmissions.

Sound deadening can accept a broad range of vinyl scrap, including some types of rigid

Due to the processing techniques employed and the lack of aesthetic requirements in the sound deadening panel business, virtually any form of vinyl reclaim can be used. In practice, only post-industrial and only flexible reclaim is used. Rigid film/bottle scrap could be used, but is seldom incorporated into sound deadening panels.

Scrap is acquired from all sources. Pool liner and bookbinding scrap is attractive due to the high plasticizer content; however, most of this type of scrap is purchased by garden hose manufacturers.

Two key end users in sound deadening

This application is served by two large panel producers, and several smaller competitors. The Hematite division of Pavaco and the Perstorp division of Collins & Aikman are the dominant suppliers of sound deadening panels, followed by Masland and a few minor producers.

Applications Review

BOOKBINDING FILM...

...reuses film scrap

Calendered vinyl film containing post-industrial reclaim is used for a range of stationery applications, all of which are commonly referred to as bookbinding. The film is used to produce 3-ring binders, folding notepad and report covers, checkbook covers, business card holders, pocket protectors/pen holders, and related office supplies. These applications also represent a significant market for virgin flexible vinyl compound. The reclaim-based film substitutes for virgin product in stationery sold at lower price points. Cost is the key driver for using reclaim material in these applications.

Four significant post-industrial reclaim film makers

There are several major calendering houses that recycle flexible vinyl for bookbinding applications. All are in the metropolitan New York area, and include Gibraltar, Nuhart, Plasco, and Flexon. These companies also produce film from virgin vinyl and will buy trim scrap directly from their customers, as well as through brokers. Major brokers serving this segment include E&G Plastics, American Trading, and ALA Plastics.

OTHER FILM...

...is quite similar

Although the ultimate end uses are quite different, the overall structure of the pool/pond liner and other film business and the drivers for use are identical to the bookbinding film segment. A comparable volume of flexible vinyl film and sheet scrap is recycled for use in residential above-ground pool liners, landscape pond liners, geomembranes, and as a feedstock for the production of certain vinyl-based wall coverings.

FLOORING...

...for specialty applications only

Select commercial vinyl floor tile products use post-industrial vinyl reclaim. The vast majority of residential and commercial vinyl floor tiles do not use reclaim, and no resilient vinyl sheet products have any recycle content currently. Two exceptions are VPI and Oscoda Plastics, both niche flooring producers. VPI adopted the use of post-industrial reclaim as an inexpensive source of binder in its laminated floor tile, while Oscoda Plastics was established by its parent, Dura-Last, as a captive user of vinyl scrap generated by its roofing operations. Oscoda produces a vinyl sheet flooring that acts as a protective floor mat. The product is used in ice skating/hockey rinks to protect the floors from skate blades. VPI's floor tiles are produced from a thick (~0.100") calendered sheet of vinyl with a decorative film laminated to the surface. A range of scrap is purchased—primarily through brokers—including medical tubing, film/sheet, automotive parts, automotive seating fabrics, and single ply roofing scrap.

Applications Review

OTHER END USES...

...use minor volumes of flexible scrap

Myriad other end uses for flexible vinyl reclaim exist. Each application identified consumes less than 2 million lb of post-industrial reclaim per year, and in total these uses account for 18 million lb of the scrap consumed in 1997. In each case, reclaim product has been adopted as a substitute for virgin vinyl in an effort to reduce the total manufacturing cost. The applications invariably are not required to comply to industry or government standards for product quality or content, and tend to be non-appearance parts. However, a number of consumer products, which have high aesthetic requirements, use a 100% post-industrial reclaim content. The following applications are among the key miscellaneous post-industrial vinyl reclaim outlets:

- T Shoe soles and industrial boots
- T Floor mats (automotive aftermarket and industrial anti-fatigue mats)
- T Heavy truck mud flaps
- T Parking stops
- T Bicycle hand grips
- T Weatherstripping (automotive, appliance, and residential)
- T Foot Log, a foot massager made from 100% reclaim

EXPORT MARKETS...

...are significant for flexible reclaim

The export of flexible post-industrial vinyl materials is a well established outlet. For years, considerable demand has existed in the Far East (e.g., Taiwan, Hong Kong, China, Indonesia) for reclaim. The key applications are not known. Over the past 5 years, the Mexican market has been developing as an outlet for flexible scrap. The two primary end uses in Mexico are shoes and non-appearance automotive parts (e.g., sound deadening, grommets).

Flexible scrap from most sources is exported, while wire & cable scrap represents the largest share of the volume. Medical tubing and sheet scrap is also in high demand in the export market due to the clear, clean nature of the product. The mixed colors and durometers that are typical of flexible molding scrap are consolidated for shipment to export customers as well.

Opportunities for Increased Reclaim Usage

Excess supply is the opportunity

The excess supply of vinyl reclaim represents the opportunity for increased recycling. A total of 109 million lb of post-industrial flexible scrap and 71 million lb of post-industrial rigid scrap was unused in 1997. Reduction of these volumes can be affected through better closed-loop recycling, improved collection and separation systems, and placement of the reclaim in current or new uses. An estimated 1.8 billion lb of post-consumer vinyl scrap is available for reclamation, but does not get recycled. This volume of vinyl scrap represents an essentially untapped supply of raw material. However, due to the difficulties with collection, identification, and separation of these materials, opportunities to increase post-consumer recycling are limited.

A supply of material exists that could be used

**109 million lb of flexible
71 million lb of rigid**

Excess Supply of Post-industrial Vinyl Reclaim in North America, 1997 Million lb			
Source	Flexible Vinyl Surplus	Rigid Vinyl Surplus	TOTAL
EXTRUSION	35	49	84
CALENDERING	61	11	72
MOLDING	13	11	24
TOTAL	109	71	180

Hurdles to using these supplies exist

Each source has limitations that must be overcome to enable use of the excess supply. The key reasons that material does not find a market are:

- T Scrap is contaminated with dirt, metal, or other plastics
- T Volumes of scrap are small, making collection uneconomical
- T Generation of scrap is geographically remote, making freight cost too high
- T Identification of vinyl in a mixed post-consumer waste stream is difficult
- T Separation of post-consumer vinyl from other materials is difficult due to nondescript nature of most vinyl packaging materials (i.e. rigid and flexible films)

Opportunities for Increased Reclaim Usage

Surplus W&C scrap is too contaminated

The wire & cable scrap that is not recycled is typically contaminated with copper or aluminum from stripped wire, or with paper, jute, or other cable fillings from cable jacketing. Certain applications (e.g., sound deadening) can tolerate relatively high levels of contamination due to the processing techniques used; however, the excess supply has contamination levels that are too high even for this application. Post-consumer reclamation of wire scrap from demolition projects is similarly contaminated with metals and other construction debris, limiting the market appeal of the resultant product.

Other flexible extrusion and molding are highly fragmented sources

The other flexible extrusion sources (i.e. film/sheet, hose/tubing, and extrusions) and all the flexible molding sources represent viable sources of reclaim. The primary hindrance for these materials is fragmented and small volumes of scrap generation. Much improved collection systems would be required to channel these materials to end users.

Floor tile scrap may fill a niche in sound deadening

Flooring scrap from tile production (residential and commercial) has very high filler content (80% filler) and is unusable by most vinyl end uses. However, sound deadening panel producers add a high content of filler, and could potentially use this feedstock.

Only end uses that tolerate fiber can use textile scrap

Textile scrap, with its fiber content, could be used in non-appearance, simple shapes. Due to the fiber content, only very simple shapes can be produced (complex shapes, deep draws, and other geometries are difficult to produce). Few existing applications can accommodate these materials. However, sound deadening panels and non-appearance flooring can handle limited volumes of this material.

Pipe scrap is unsuitable for current applications

Materials generated by pipe, pipe fitting, and electrical box makers that are unsuitable for closed-loop recycling are unsuitable for essentially all other applications. The high degree of contamination and heat histories associated with these sources yields the scrap unusable in current end uses.

Siding and window surplus could be used in pipe

Surplus scrap from the siding and window/door segments could be used in non-pressure pipe and pipe fittings or sold to the export market. However, the majority of this excess is generated at a second value-added step (e.g. window makers, manufactured housing), where the end user is small or geographically remote making collection difficult or uneconomical.

Opportunities for Increased Reclaim Usage

Other excess rigid scrap sources are fragmented

All other rigid post-industrial scrap sources are highly fragmented, primarily due to small end users at a second or third value added step. Collection of the post-industrial vinyl scrap is difficult to affect, and due to the small volumes of material, often commingled with other types of plastic which reduces the scrap value.

Potential uses for post-consumer reclaim are similar for virgin resin or post-industrial reclaim

Hurdles to greater use of post-consumer vinyl reclaim do not include potential applications. Post-consumer vinyl reclaim can readily substitute for post-industrial reclaim or virgin resin

Obstacles for further use are related to contamination and logistics

The major obstacles are related to contamination and logistics. Separation of mixed materials is not efficient, as contamination is difficult to avoid, and detrimental to most end uses. Collection of small volumes of scrap from many different sources is uneconomical. Further, storage by generators cannot be justified.

Post-consumer vinyl reclaim is a large virtually untapped feedstock source

Opportunities for greater use of post-consumer reclaim exist. Post-consumer reclaim represents the largest untapped source of vinyl scrap for processors/end users. Reuse rates for post-industrial vinyl are relatively high. Post-consumer reclaim is interchangeable with post-industrial vinyl, provided no contamination exists.

Today, most programs are driven by OEMs with a heightened sense of environmental responsibility...

Majority of post-consumer vinyl reclaim currently is the result of organized 'commercial' end users. Programs driven by desire to reduce landfill/disposal costs. Curbside collection (and MRFs) is not currently effective at identifying and consolidating post-consumer vinyl.

...AND also by entrepreneurs who recognize the potential to develop a profitable business

Concern over environmental impact is also major driver for OEMs to recover post-consumer reclaim; however, brokers and reproprocessors are driven by a desire to turn reclaim into a profitable business venture. While reproprocessors/brokers are active in facilitating programs, these firms do not bear the cost of collection, separation, and storage.

Appendix I: Reclaim Sources—Post-Industrial

Identified Companies Generating Post-Industrial Vinyl Reclaim		
Company & Address	Market served	Reclaim type
Alcan Cable Bracebridge, ON	Wire & cable	Flexible
Alcoa Building Products Sidney, OH	Siding	Rigid
American Building Components Inc. Pensacola, FL	Windows/doors	Rigid
Canadian General Tower Cambridge, ONT	Calendered film/sheet	Flexible
Cerro Cable Hartselle, AL; Ogden, UT	Wire & cable	Flexible
Cooley Pawtucket, RI	Calendered film/sheet	Flexible
Essex Group Lithonia, GA; Pauline, KS; Columbia City, IN	Wire & cable	Flexible
GenCorp Sylvania, OH	Calendered film/sheet	Flexible
HPG (former Hüls) Mountain Top, PA	Calendered film/sheet	Flexible
Intek Plastics Hastings, MN	Custom extrusions	Rigid
Jannock Inc. Pittsburgh, PA	Siding	Rigid

Appendix I: Reclaim Sources—Post-Industrial

Identified Companies Generating Post-Industrial Vinyl Reclaim		
Company & Address	Market served	Reclaim type
Klockner Pentaplast Gordonsville, VA	Calendered film/sheet	Rigid
Lamson & Sessions Clinton, IA	Electrical junction boxes	Rigid
Mikron Industries Kent, WA	Window/door lineals	Rigid
Nan Ya Plastics Wharton, TX	Calendered film/sheet	Rigid
Nan Ya Plastics Batchelor, LA	Calendered film/sheet	Flexible
Nicholas Plastics Allendale, MI	Automotive moldings	Flexible
Noma Cable Tech Stouffville, ON	Wire & cable	Flexible
Owens-Brockway Toledo, OH	Bottles	Rigid
O'Sullivan Winchester, VA	Calendered film/sheet	Flexible
Phillips Environmental Hamilton, ON	Wire & cable strippings	Flexible
Royal Group Woodbridge, ON	Siding, window/door lineals, custom extrusions	Rigid

Appendix I: Reclaim Sources—Post-Industrial

Identified Companies Generating Post-Industrial Vinyl Reclaim		
Company & Address	Market served	Reclaim type
Sandusky Vinyl Sandusky, OH	Calendered film/sheet	Flexible
Sarnafil Acton, MA	Calendered film/sheet	Flexible
Southwire Atlanta, GA; Salt Lake City, UT	Wire & cable	Flexible
Veka Holdings Fombell, PA	Window/door lineals	Rigid
Vinyl Building Products Oakland, NJ	Window/door lineals	Rigid
VPI Mirrex New Castle, DE	Calendered film/sheet	Rigid

Appendix II: Reclaim Users—Post-Industrial

Identified Companies Using Post-Industrial Vinyl Reclaim		
Company & Address	Market served	Reclaim type
Alloyd Company DeKalb, IL	Thermoforming	Rigid
American Sealcut South Hackensack, NJ	Thermoforming (cassette trays)	Rigid
Anchor Swan Bucyrus, OH	Garden hose	Flexible
Baltimore Air Coil Jessup, MD	Cooling tower fill	Rigid
Brentwood Industries Reading, PA	Cooling tower fill	Rigid
CanTex Mineral Wells, TX	Electrical junction boxes	Rigid
Carlton Clinton, IA	Electrical junction boxes	Rigid
Charlotte Pipe Charlotte, NC	Pipe	Rigid
Colorite Polymers Ridgefield, NJ	Garden hose	Flexible
Everlast Plastic Lumber Hamburg, PA	Lumber	Rigid
Ex-Tech Plastics Richmond, IL	Extruded film/sheet for resale (primarily for thermoforming)	Rigid

Appendix II: Reclaim Users—Post-Industrial

Identified Companies Using Post-Industrial Vinyl Reclaim		
Company & Address	Market served	Reclaim type
Fey Industries Edgerton, MN	Thermoforming (cassette trays)	Rigid
Flexon Industries Newark, NJ	Garden hose	Flexible
Foot Log Salt Lake City, UT	Consumer goods	Flexible
FormPac Corporation Sandusky, OH	Thermoforming	Rigid
Hematite (div of Pavaco) Guelph, ONT	Sound deadening panels	Flexible
Heritage Plastics Carrollton, OH	Custom profiles (including lumber)	Rigid
Innovative Plastics Orangeburg, NY	Thermoforming	Rigid
J-M Manufacturing Livingston, NJ	Pipe	Rigid
Klearfold, Inc. Warrington, PA	Box folding	Rigid
Marley Cooling Tower Kansas City, MO	Cooling tower fill	Rigid
Masland Industries Carlisle, PA	Sound deadening panels	Flexible

Appendix II: Reclaim Users—Post-Industrial

Identified Companies Using Post-Industrial Vinyl Reclaim		
Company & Address	Market served	Reclaim type
Missouri Industries Dexter, MO	Shoe soles	Flexible
General Foam Newport News, VA	Christmas trees	Rigid
Nuhart Long Island City, NY	Garden hose, calendered film	Flexible
O'Sullivan Winchester, VA	Calendered film/sheet	Flexible
Oscoda Plastics Oscoda, MI	Flooring, roofing	Flexible
Perstorp (div of Collins & Aikman) Kitchener, ONT; Springfield, TN	Sound deadening panels	Flexible
Plastic Profiles (div of Amesbury) Cannon Falls, MN	Custom profiles (primarily for windows/doors)	Rigid
Plastofilm Wheaton, IL	Thermoforming	Rigid
R.F. Thermoform Products Huntsville, AL	Thermoforming	Rigid
Recycled Plastics Products Milwaukee, WI	Lumber	Rigid
Regenex Corporation West Middlesex, PA	Custom profiles (primarily for windows/doors)	Rigid

Appendix II: Reclaim Users—Post-Industrial

Identified Companies Using Post-Industrial Vinyl Reclaim		
Company & Address	Market served	Reclaim type
Regina Sharon, PA	Custom profiles	Rigid
Rustique Enterprises St. Peters, MO	Mobile home skirts	Rigid
Schoeneck Containers New Berlin, WI	Blow molded bottles	Rigid
SFR Industries Cadott, WI	Custom profiles (primarily for windows/doors)	Rigid
StyleCrest Glen Rock, PA	Mobile home skirts	Rigid
Techform Mount Airy, NC	Thermoforming	Rigid
Teknor Apex Pawtucket, RI	Garden hose	Flexible
Transparent Container Berkeley, IL	Thermoforming	Rigid
VPI Sheboygan, MI	Flooring	Flexible

Appendix III: Brokers and Reprocessors—Post-Industrial

Identified Companies Brokering/Reprocessing Post-Industrial Vinyl Reclaim		
Company & Address	Phone/Fax	Role
ALA Plastics Brooklyn, NY		Broker/Reprocessor
American Plastics Inc. 1914 Akron-Peninsula Road P.O. Box 13541 Akron, OH 44313	330-945-4100 330-945-7222	Broker/Reprocessor Rigid (5 mm lb/yr) Flexible (1 mm lb/yr)
American Trading Company 123 Naylor Ave. Livingston, NJ 07039	973-740-9270 973-740-8790	Broker/Reprocessor Rigid (2 mm lb/yr) Flexible (50 mm lb/yr)
Astro Plastics, Inc. North Hollywood, CA	818-765-0767 818-982-7891	Generator/Reprocessor Flexible (Volume is confidential) Rigid (Volume is confidential)
B. Schoenberg & Company 345 Kear St. Yorktown, NY 10598	914-962-1200 914-962-0711	Broker/Reprocessor Rigid (1.5 million lb/yr) Flexible (3 million lb/yr)
Butler-MacDonald Inc. 5188 W. 74th St. Indianapolis, IN 46268	317-872-5115 317-872-5660	Broker/Reprocessor
Colors Compounds & Consultants Inc. P.O. Box 400 Seabrook, NH 03874	603-474-3667 603-474-5842	Reprocessor Flexible (12 mm lb/yr)
Conigliaro Industries Inc. 701 Waverly St. Framingham, MA 01701	508-872-9668 508-653-6672	Broker/Reprocessor (primarily post-consumer scrap) Rigid (150,000 lb of PI/yr) Flexible (100,000 lb of PI/yr)

Appendix III: Brokers and Reprocessors—Post-Industrial

Identified Companies Brokering/Reprocessing Post-Industrial Vinyl Reclaim		
Company & Address	Phone/Fax	Role
Domino Plastics Company 40 North Enterprise Ave. Trenton, NJ 08638	609-989-5800 609-989-8866	Broker Rigid (minor volume) Flexible (minor volume)
EG Plastics Corp. Brooklyn, NY	718-788-3733	Broker/Reprocessor Flexible (8 mm lb/yr)
East Coast Recycling Associates Inc. 1801 Eden Road Millville, NJ 08332	609-327-8888 609-327-8710	Reprocessor Rigid
Enviro-Tech Plastics Ltd. 130 Fort St. Amherstburg, Ontario N9V 1B8 Canada	519-736-4458 519-736-1081	Reprocessor
Ex-Tech Plastics Inc. 11413 Burlington Road P.O. Box 576 Richmond, IL 60071	815-678-2131 815-678-4248	Reprocessor Rigid (20 mm lb/yr)
Frankel Industries 10 Ryan Road Edison, NJ 08817	908-572-0036 908-819-8347	Broker Rigid (1 mm lb/yr)
Gibraltar Plastics Brooklyn, NY	973-473-0660	Reprocessor Flexible (15 mm lb/yr)
Guaranteed Plastics Inc. 549 S. Broadway Gloucester, NJ 08030	609-665-0909 609-665-3313	Broker Rigid (5 mm lb/yr)

Appendix III: Brokers and Reprocessors—Post-Industrial

Identified Companies Brokering/Reprocessing Post-Industrial Vinyl Reclaim		
Company & Address	Phone/Fax	Role
Gulf National Trading Co. P.O. Box 211 Vancouver, WA 98666-0211	360-571-8790 360-571-8809	Broker
JP Industrial Products 11988 State Route 45 Lisbon, OH 44432	330-424-1110	Reprocessor Rigid (18 mm lb/yr)
Lacerta Group Inc. 120 Southampton St. Boston, MA 02118	617-386-8952 617-386-8969	Generator Rigid (150,000 lb/yr)
Longwood Plastics 1210 Shotwell Houston, TX 77020	713-672-0218 713-672-6832	Broker Rigid (7 mm lb/yr) Flexible (5 mm lb/yr)
Masplas International Compose de Plastique Inc./Granuplas 8800 Crescent 1 Anjou, Quebec H1J 1C8 Canada	514-354-5757 514-354-3987	Broker/Reprocessor
Midwest Recycling Co. Inc. 6061 W. Dickens Chicago, IL 60639	773-804-1444 773-804-0287	Reprocessor Rigid (minor volume) Flexible (minor volume)
MR Plastic Recyclers Inc. 300 E. Main Ontario, CA 91762	909-391-2673 909-391-4961	Broker/Reprocessor Rigid (3 million lb/yr) Flexible (2 million lb/yr)
New Age Plastic Recyclers Inc. 1551 W. Copans Suite 100 Pompano Beach, FL 33064	954-968-0156 954-968-0194	Broker Rigid (250,000 lb/yr) Flexible (250,000 lb/yr)

Appendix III: Brokers and Reprocessors—Post-Industrial

Identified Companies Brokering/Reprocessing Post-Industrial Vinyl Reclaim		
Company & Address	Phone/Fax	Role
Nicos Polymers and Grinding 9 McFadden Road Easton, PA 18045	610-250-1230	Reprocessor Rigid (25 million lb/yr) Flexible (5 million lb/yr)
Norwich Plastics Group Kitchener, ON	519-893-0094 519-893-0123	Reprocessor Flexible (30 million lb/yr)
Nuhart Plastics Brooklyn, NY	516-586-9444	Reprocessor/End User Flexible (18 million lb/yr)
Parma Plastics Inc. 229 Speedvale Ave. W. Guelph, Ontario N1H 1C5 Canada	519-821-3044 519-821-4059	Reprocessor/End User Flexible (10 million lb/yr)
Phoenix Recycling Corp. Roseville, MN	612-635-0112	Reprocessor Rigid (Volume is confidential) Flexible (Volume is confidential)
Plastic Recyclers South East Inc. 1220 Church St. N.E. Decatur, AL 35601	205-351-2469 205-351-2473	Reprocessor Rigid (Volume is confidential)
Plastics Recovery Industries Inc. 1201 N.W. Grand Ave. P.O. Box 1468 Phoenix, AZ 85001	602-340-0400 602-252-1816	Reprocessor Rigid (650,000 lb/yr) Flexible (650,000 lb/yr)
Polymer Marketing Inc. 1147 Willow Ave. Marietta, GA 30067	770-952-1147 770-951-2474	Reprocessor Rigid (12 million lb/yr) Flexible (18 million lb/yr)
Polymer Recovery Corp. 1127 Tar Heel Road Charlotte, NC 28208	704-391-2470	Reprocessor Rigid (Volume is confidential) Flexible (Volume is confidential)

Appendix III: Brokers and Reprocessors—Post-Industrial

Identified Companies Brokering/Reprocessing Post-Industrial Vinyl Reclaim		
Company & Address	Phone/Fax	Role
Progressive Polymer Easton, PA		Reprocessor--subsidiary of American Trading
Rainier Plastics Inc. 1101 Ledwich Yakima, WA 98909	509-248-1473 509-453-7385	Reprocessor Rigid (Volume is confidential) Flexible (Volume is confidential)
Recycled Plastics Marketing, Inc. Redmond, WA	206-867-3200	Reprocessor/Broker Flexible (500,000 lb/yr) Rigid (500,000 lb/yr)
Recycled Polymer Associates 152 W. 26th St. New York, NY 10001	212-463-8622 212-675-5777	Reprocessor Rigid (Volume is confidential) Flexible (Volume is confidential)
Ricicla SA LLC (Bayshore Vinyl) P.O. Box 430 Route 522 Tennent, NJ 07763	732-577-7900 732-577-7901	Reprocessor Rigid (9 mm lb/yr)
Seletski Metals Worcester, MA	508-791-2444	Broker (Reprocessor of metals from W&C) Flexible (8 million lb/yr--all W&C strippings)
T.S. Investment Co. 9440 Clubhouse Road Eden Prairie, MN 55347	612-943-1966 612-944-6604	Broker Rigid (minor volume-spot buyer) Flexible (minor volume-spot buyer)
T5 Trading Group 1800 East State St. Trenton, NJ 08609	609-587-1958 609-587-1956	Broker Rigid (minor volume)

Appendix IV: Brokers, Reprocessors, End Users—Post-Consumer

Identified Companies Brokering/Reprocessing/Using Post-Consumer Vinyl Reclaim				
Company & Address	Role	1998 Volume Rigid Flexible	Sources	Uses
B&B Plastic Recyclers 14581 Manzanita Drive Fontana, CA 92335	Broker	10,000 10,000	Bottles Medical	Pipe Garden hose
Collins & Aikman 701 McCullough Dr. Charlotte, NC 28262	End user	3,500,000	Carpet backing	Traffic control
Conigliaro Industries 701 Waverly Street Framingham, MA 01702	Reprocessor	360,000 240,000	Siding, pipe Medical IV bags/tubing	Pipe Garden hose
Exchange Plastics 1914 Akron Peninsula Road Akron, OH 44313	Broker	360,000 350,000	Custom profiles Wire & cable, cove base	Pipe Garden hose
Footlog Salt Lake City, UT	End user	500,000	Gasketing for cast plastics	Foot massager
Interface, Inc. 2859 Paces Ferry Road Atlanta, GA 30339	End user	1,200,000	Carpet backing	Carpet backing
Longwood Plastics 1210 Shotwell Houston, TX 77020	Reprocessor	200,000 350,000	Siding, blister pack Medical, GP molding	Pipe, exports Garden hose, shoes

Appendix IV: Brokers, Reprocessors, End Users—Post-Consumer

Identified Companies Brokering/Reprocessing/Using Post-Consumer Vinyl Reclaim				
Company & Address	Role	1998 Volume Rigid Flexible	Sources	Uses
Materials Reclaim Ind. 409 Joyce Kilmer Avenue New Brunswick, NJ 08901	Reprocessor	60,000 6,000	Siding Medical IV bags/tubing	Pipe Garden hose, shoes
Micon International 2140 Old Hickory Boulevard Nashville, TN 37215	Reprocessor	480,000	Medical	Sound deadening
O'Sullivan Corp. 1944 Valley Ave Winchester, VA 22601	Source, End User	500,000	Bookbinders	Bookbinders
Ontario Recycling 12 Cairn Street Rochester, NY 14611	Reprocessor	300,000 60,000	Siding	Compounders
Polymark 1147 Willow Avenue Marietta, GA 30067	Broker	19,000 12,000	Window lineals Extruded sheet	Exports Molded parts/exports
Replastec Erie Industrial Park Bldg 460 Port Clinton, OH 43452	Reprocessor	72,000 48,000	Siding Automotive trim	Pipe Sound deadening
Ronald Mark Associates 1227 Central Avenue Hillside, NJ 07205	Broker, Reprocessor	1,800,000 1,200,000	Bottles Garden hose, medical, auto	N/A N/A

Appendix IV: Brokers, Reprocessors, End Users—Post-Consumer

Identified Companies Brokering/Reprocessing/Using Post-Consumer Vinyl Reclaim				
Company & Address	Role	1998 Volume Rigid Flexible	Sources	Uses
Selectech 15 Fourth Street Taunton, MA 02780	End user	165,000	Wire & cable	Flooring, traffic control
Total Recycling Road 1 Box 170 Boswell, PA 15531	Reprocessor	12,000	Siding	N/A