Recycling Economic Development

Through

Scrap-Based Manufacturing

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Institute for Local Self-Reliance

Environmentally Sound Economic Development

Recycling Economic Development
through
Scrap-Based Manufacturing

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Institute for Local Self-Reliance

ILSR is a nonprofit research and educational organization that provides technical assistance and information to government, citizen organizations, and industry. Since 1974, ILSR has researched the technical feasibility and commercial viability of environmentally sound, state-of-the-art technologies with a view to strengthening local economies. ILSR works to involve citizens, government, and private enterprise in the development of a comprehensive materials policy oriented towards efficiency, recycling, and maximum utilization of renewable energy sources.

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EXECUTIVE SUMMARY

Whether turning old rags into paper, melting scrap iron for tools, or mixing broken glass with sand to make jars, people have long recognized the economic and environmental advantages of squeezing every drop of potential from a resource. During the last 40 years, however, industry has decreased its use of scrap feedstock to rely more heavily on often-subsidized virgin resources. Today, with an ever-burgeoning supply of scrap collected through municipal recycling programs, waste is again becoming a common-sense feedstock.

This report provides close examination of scrap-based manufacturing in this country. It provides evidence of economic development brought by scrap-based manufacturers, clearly discusses attributes that allow a community to capture these benefits, and suggests policies for community implementation. This report will serve as a helpful guide to planners, public officials, entrepreneurs, activists, and those in the industry interested in the economic opportunities scrap-based facilities bring to a community. It was prepared for the Tri-City Working Group of the National Capital Area Project, sponsored by the U.S. Environmental Protection Agency, Office of Solid Waste.

As the common definition of recycling expands to include the complete system — from consumer to processor to manufacturer and back — the true economics of recycling become apparent. Not only is recycling feasible, but it brings economic benefits to a community. Value is added to a resource at every point along the recycling loop, and it is to the advantage of a community to add as much of that value as possible within its borders. In analyzing the impact of scrap-based plants on a local economy, the author examined the potential in the waste stream of a hypothetical city of one million residents. Results show that such a city's waste could feed 30 state-of-the-art factories, which would in turn generate nearly 2,000 manufacturing jobs (and another 2,550 jobs in related businesses), and add three-quarters of a billion dollars in annual gross revenue to the local tax base.

In addition to these economic benefits, scrap-based factories offer the host community a less-intrusive industrial sector, as these facilities often use less energy, water and other natural resources, and produce less solid waste, and air and water pollution than their natural-resources-based counterparts. Additionally, the community tames the twin problems of high disposal costs (saving approximately $10 million in the previous example of a city of one million residents) and over-reliance on environmentally questionable disposal options, such as landfilling and incineration. Over 635,000 tons of recyclable resources could be diverted from disposal operations in the hypothetical city every year, thereby reducing the environmental risks mentioned above.

These economic and environmental benefits are best realized through state-of-the-art facilities. These plants are successful in one or more of the following areas: producing high-value products, producing high recycled-content level products, operating appropriately scaled facilities, and/or utilizing technological innovations to address major recycling-related concerns.

Close examination of today's scrap-based manufacturing trends reveals a promising future for expanding these activities. Possibilities for growth are buoyed by several factors, including growth of many recycling-related industries, increase in demand for recycled goods, and increase in supply of scrap feedstocks. However, obstacles to growth also exist. They include the still-limited supply of quality feedstock, financing of new scrap-based manufacturing ventures, and demand for recycled products.

Reacting to their electorate, governments are rallying behind scrap-based manufacturers with creative public policies. Common measures include minimum recycled-content mandates for products, grant and loan programs for remanufacturers, and government-procurement mandates for recycled products. While all of these can be effective, a community must tailor the appropriate combination of policies to its local market conditions.

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Acronyms

abc rubble	asphalt, brick, and concrete rubble
C&D	construction and demolition
CDO	community development organization
CPO	computer printout
EPA	U. S. Environmental Protection Agency
FDA	Food and Drug Administration
HDPE	high density polyethylene
HGD	high grade deinking
ILSR	Institute for Local Self-Reliance
IPC	intermediate processing center, also known as materials recovery facility (MRF)
ISTEA	Intermodal Surface Transportation Efficiency Act
LDPE	low density polyethylene
MRF	materials recovery facility, also known as intermediate processing center (IPC)
MSW	municipal solid waste
NA	not available
OCC	old corrugated containers
ONP	old newspapers
PET	polyethylene terephthalate
PS	polystyrene
PVC	polyvinyl chloride
R&D	research and development
RMDZ	recycling market development zone
SBM	scrap-based manufacturer
SOTA	state of the art
TPY	tons per year
UBC	used beverage container
VA	value added

CHAPTER 1
SCRAP-BASED MANUFACTURING

After the many landfill closings and incinerator moratoriums of the 1980s and early 1990s, the three Rs of solid waste management — reduce, reuse, recycle — have become widely recognized by the American public. But after reducing waste and reusing what is possible, what exactly is recycling? Setting bottles, cans, and newspapers at the curb? Driving them to the local recycling center? Maybe buying recycled-content tissue products? Yes, but these are only parts of the whole, only links in the recycling chain.

THE CRITICAL LINK IN THE RECYCLING CHAIN

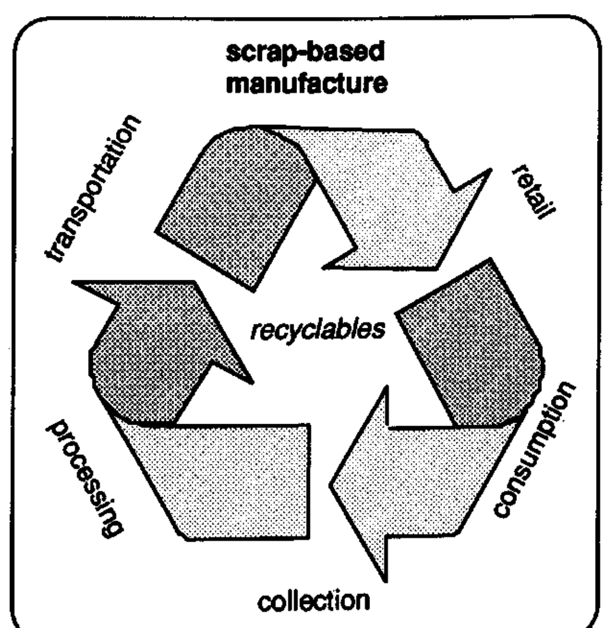
Communities first understood recycling as the collection of materials. Later, the intermediate processing center was recognized as an integral part of the whole, and, more recently, "buy recycled" campaigns have added to the growing definition of recycling. Now, as recycling assumes a prominent role in municipal infrastructures, it must be fully understood — as an entire system. Secondary material is not recycled until it completes passage through the entire recycling process (Figure 1.1). After being discarded by the consumer, material is collected, sorted, and compacted for transportation. Material is shipped via rail, barge, or truck to a manufacturer whoturns the resource into a new product. This product then follows the normal channels of commerce through a retailer and back to the consumer. While other stages, such as an additional processor or wholesaler, may exist, the critical issue is that each link in the chain must be strong for the system to thrive.

The unsung hero in this scenario is the scrap-based manufacturer (SBM). These operations make new products using part of the waste stream as feedstock. For example, a recycled paper mill uses old newspaper instead of trees to make new newsprint, and a steel minimill utilizes ferrous scrap in place of virgin iron ore. Because they provide markets for collected recyclables, SBMs are a major source of revenues for processors.

Waste-based production is not a new concept. In fact, most major industries have used secondary material as feedstock since their onsets. For example, paper in the United States originally was made from old rags. Steel, and metals of all types, always have been remelted and formed into new products. Glass containers, because of their inherent value, were commonly refilled.

In addition to reducing dependence on burn and bury facilities (i.e., incinerators and landfills), the remanufacturer offers a community local economic development potential. In fact, SBMs contribute a vast majority of the economic pay-off of the entire recycling process. Adding to the jobs and revenue that recycling collection and processing bring to an area, SBMs provide high-skill industrial jobs and sizable sales revenue to a community. These new factories hold the potential to revitalize a

Figure 1.1 Recycling Material Flow A Continuous System



Source: Institute for Local Self-Reliance, 1994.

community's industrial sector, while diminishing the local waste stream and buying locally-derived feedstock.

Why Scrap-Based Manufacturing

State-of-the-art scrap-based manufacturers provide communities with environmentally sound economic development opportunities by utilizing local secondary resources, lessening dependence on imported materials, and promoting local self-reliance. This statement is supported by the following seven points:

1) *Scrap-based manufacturers use part of the waste stream to produce marketable products.* Figure 1.2 illustrates the variety of resources available in the U.S. waste stream.

2) *Scrap-based manufacturers create industrial jobs and bring taxable revenue to a community.* Additionally, since they consume locally derived resources, SBMs stimulate the local economy. And, since they use material from the waste stream, scrap-based manufacturers avoid disposal cost — another economic benefit to the community.

3) *Scrap-based manufacturers impact the environment less than their virgin-material-based counterparts.* SBMs reduce the local solid waste disposal burden, produce less air, water and solid waste pollution, and use less energy, water and other natural resources, all while producing comparable products.

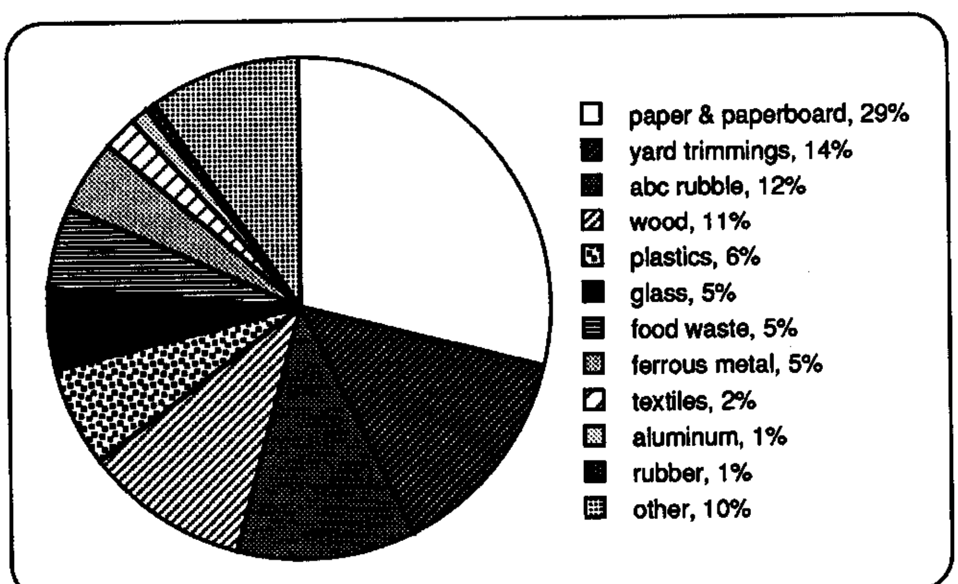
4) *State-of-the-art SBMs make high-value products, utilize high percentages of scrap (especially post-consumer scrap), are appropriately scaled, and use innovative technologies in the process.*

5) *Existing operations testify to the viability of scrap-based manufacturing* and illustrate the feasibility of using a wide variety of material from the waste stream, including asphalt, glass, metals, paper, plastics, rubber, textiles, and wood. Examples of products currently made from recycled material are listed in Table 1.1.

6) *Close examination of today's scrap-based manufacturing trends reveals a promising future for expanding scrap-based activities.* However, challenges to the growth of scrap-based manufacturing do exist. They include the supply of quality feedstock, financing of SBMs, and the level of demand for recycled products. For instance, too many manufacturing resources are either burned in solid-waste incinerators or buried in landfills. Figure 1.3 shows that two-thirds of the domestic secondary resources available in the municipal solid waste (MSW) stream were landfilled in 1990, while another one-sixth was burned.

Another opportunity is lost when secondary resources are exported out of the United States for remanufacture. These nations gain the majority of the economic benefits available through recycling by adding the most value to the

Figure 1.2 U.S. Waste Stream Composition (% by weight, 1990)



abc rubble: asphalt, brick, and concrete scrap material.
Note: Materials include those found in the municipal waste stream and C&D debris.
Sources: U.S. Environmental Protection Agency, Institute for Local Self-Reliance, William F. Cousulich Associates.

Table 1.1 Examples of Products Made by Scrap-Based Manufacturers

asphalt
- asphalt aggregate
- fill
- hot mix pavement
- hot-mix asphalt modifiers
- landfill cover
- low-cost pavement
- pothole patch
- road sub-base

glass
- aggregate
- art glass
- fiber glass insulation
- flat glass
- foam glass
- glass-bonded tile
- glass containers
- pressed glass
- road sub-base
- wastewater filter media

metals
- additives
- automobile parts
- cans
- I-beams
- sheet
- siding

paper
- animal bedding
- bag paper
- boxboard
- cellulose insulation
- corrugating medium
- ethanol
- fiberboard
- liner board
- molded pulp
- newsprint
- packaging fill
- paperboard
- particle board
- printing and writing paper
- roofing felt
- tissue
- tube stock
- writing pencils

rubber
- artificial reefs/breakwaters
- asphalt additive
- die cut machine parts
- dock bumpers
- erosion control
- floor mats
- gaskets
- highway crash barriers
- light weight gravel substitute
- playground equipment
- polymer oil
- rubber railroad crossing
- shoe soles

plastic
- battery cases
- building insulation
- carpeting
- detergent bottles
- egg cartons
- fiber stuffing
- floor tiles
- loose fill packaging
- lumber
- polyethylene modified asphalt
- traffic control signs and cones

wood
- animal bedding
- concrete aggregate
- furniture products
- mulch
- particle board
- refurbished pallets
- sweeping compound
- wood/plastic composite

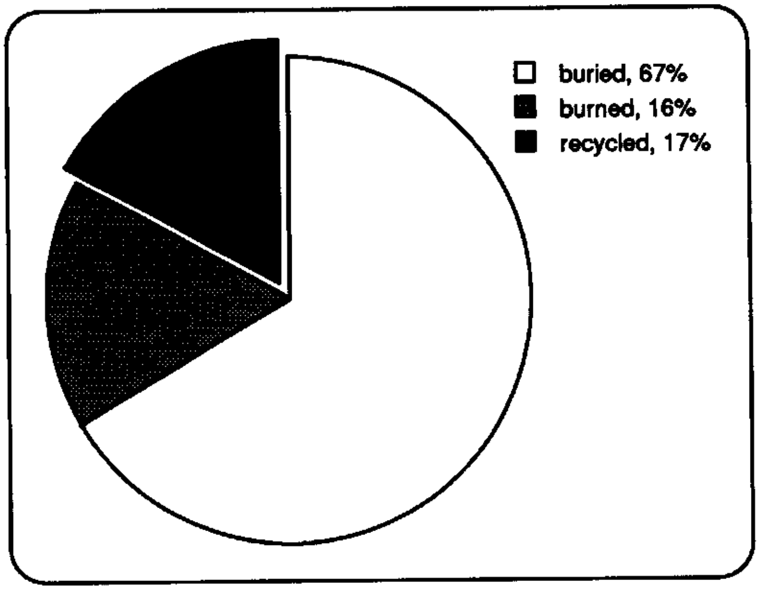
other materials
- compost
- cotton-rag paper
- ink
- lubricating oil
- paint

Source: Institute for Local Self-Reliance, 1994.

materials before selling their end products — often right back to the United States. Table 1.2 highlights this phenomenon.

7) *Communities are improving the climate for SBMs through progressive policies.* Examples of these policies include minimum recycled-content levels for products bought or sold in a jurisdiction, and special financing packages to attract SBMs. Growth of these policies will further benefit SBMs and their host communities through increased local self-reliance.

Figure 1.3 What Happens to MSW in the United States (% by weight, 1990)



Source: U.S. Environmental Protection Agency, 1992.

Table 1.2 Annual U.S. Export & Domestic Use of Selected Scrap Materials (1990)

scrap material	scrap exports (1,000 tons)	domestic scrap consumption (1,000 tons)	percent of scrap exported
plastic bottles [1]	210	180	54%
tires [2]	120	163	42%
zinc [1]	97	211	31%
nickel & stainless steel [1]	257	624	29%
iron and steel [1]	12,097	44,135	22%
paper [3]	6,505	22,712	22%
copper [1]	358	1,381	21%
aluminum [1]	466	2,834	14%
lead [1]	79	1,017	7%
total	**20,189**	**73,257**	**22%**

Note: Figures include industrial scrap.
Sources: [1] Institute of Scrap Recycling Industries, 1992; [2] U.S. Environmental Protection Agency, 1991; [3] American Paper Institute, 1991.

Chapter 2
Economic and Environmental Benefits of Scrap-Based Manufacturing

Recycling Economic Development

Scrap-based manufacturers create manufacturing jobs and bring taxable revenue to a community. Additionally, since they use locally derived resources, SBMs stimulate the *local* economy to a greater extent than virgin material-based enterprises that import their feedstocks. And, since SBMs use materials from the waste stream, the host community enjoys the savings from avoided disposal costs.

Table 2.1 lists several examples of existing scrap-based production facilities. The factories listed by secondary feedstock range in size from four to 1,300 tons per day of production capacity, and sustain from four to 300 manufacturing jobs in their host communities. They bring $500,000 to $56 million in annual revenue to their local tax bases. The capital investment for these industrial facilities ranges from $11,500 to $656,000 per manufacturing job created.

Jobs from Junk

Recycling creates jobs, and the manufacturing link of the recycling chain creates the greatest number and highest skill level jobs of the entire system. For example, a worker in a scrap-based manufacturing facility in the State of Maine earns an average hourly wage of $10. This compares favorably to the $9.50 per hour average wage for all workers.[1] Figure 2.1 compares the number of people

Table 2.1 Examples of Recycling Economic Development Opportunities

scrap used by factory	capacity (tons/day)	jobs	annual sales	capital investment/job
asphalt	350	21	$4,000,000	$95,200
	1,300	5	$3,000,000	$600,000
glass	6	16	$5,800,000	$26,400
	600	300	$50,000,000	NA
metal	130	18	$5,600,000	$200,000
paper	10	23	$1,800,000	$21,700
	50	30	$4,600,000	$500,000
	170	13	$500,000	$11,500
	250	210	$56,000,000	$238,000
	250	61	$25,000,000	$656,000
plastic	5	4	$1,000,000	$113,000
	6	13	$650,000	$30,800
	14	22	$1,500,000	$68,200
	25	10	$500,000	$30,300
rubber	4	25	$9,000,000	$300,000
wood	15	12	$1,200,000	$125,000

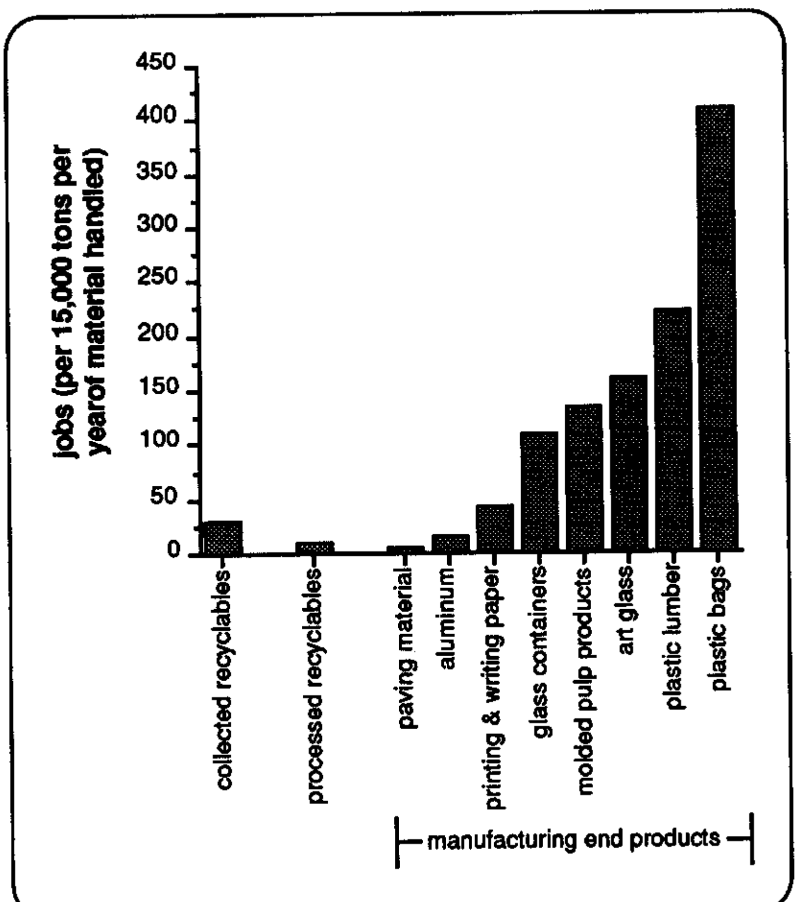
Note: Each of the 16 facilities represented in the table produces different products.
Source: Institute for Local Self-Reliance, 1994.

employed in the collection[2] and processing[3] of recyclables to those in the manufacture of various end products.

Adding Revenue to the Local Tax Base

Recycling brings revenue to a community, and scrap-based manufacturers bring the lion's share of it. Figure 2.2 shows the revenue realized by a host community through the manufacturing stage of the recycling system. Collection and processing bring little revenue, as most programs are break-even endeavors when viewed in the short-term. Plastics, due to their low weight-to-volume ratio and potential high value as end products, bring the most revenue per ton. One maker of curbside recycling bins reports revenues of $1,900 per ton (Figure 2.2). Paper products, like plastic, bring in revenues over a wide range, due to the variety of products that can be made from the various grades of scrap. At the low end, a cellulose building insulation maker grosses $170 per ton, while a maker of tissue products grosses $1,000 per ton.[4]

Figure 2.1 Jobs from Sample Collection, Processing, & Manufacturing Operations



Note: Manufacturing jobs reflect sample operations, not industry averages.

Sources: Collection jobs were estimated from ***In-Depth Studies of Recycling and Composting Programs: Designs, Costs, Results***, Institute for Local Self-Reliance, 1992. Processing jobs where estimated from ***The Economic Benefits of Recycling***, Institute for Local Self-Reliance, 1993.

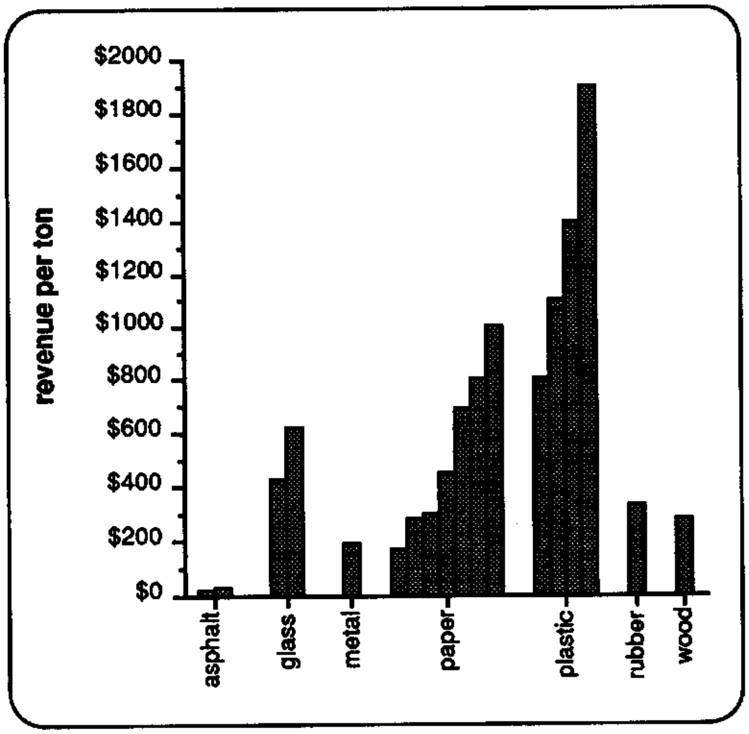
"Value Added" as an Indicator of Economic Development Potential

Manufacturers turn feedstock into products, and through this conversion they increase the economic worth of the material. This process results in "value added," a tool through which various production operations can be evaluated. (It is often expressed in dollars per ton of material.) In general terms, the greater the value added by a facility, the greater the economic benefits, either through greater revenue brought to the community, or through the creation of more and/or higher skill-level jobs.

Of special importance to recycling-related industries is the value added to a ton of scrap material. This figure is dependent upon the cost of the scrap feedstock, the selling price of the end product, and the reject rate of the scrap material.

Figure 2.3 illustrates two important trends, using ONP (old newspaper) as an example. The first is the different values of ONP at various stages throughout the recycling system. Collected ONP is worth little, in fact many communities pay mills a tipping fee just to rid themselves of the material. In Figure 2.3, an intermediate processing center (IPC, also known as a materials recovery facility or MRF) charges a $5 per ton tipping fee to the hauler, and sells the sorted and baled material to a mill for $15 per ton. At this point, the IPC has added $20 of value to

Figure 2.2 Revenue Generated by Sample Scrap-Based Manufacturers

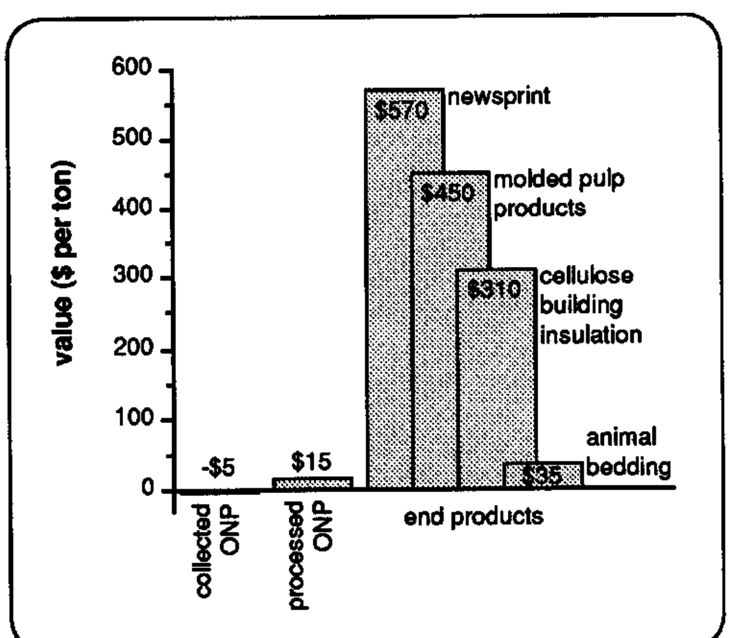


Source: Institute for Local Self-Reliance, 1994.

each ton of ONP. Once it is made into 100 percent recycled-content newsprint, the material sells for $570 per ton, resulting in a $555 per ton "value added."

The second issue is the varying levels of value that the end-product manufacturers can add to the scrap. Figure 2.3 shows the selling price of four products made from 100 percent post-consumer ONP. On the low end in this example is animal bedding. Selling at only $35 per ton, it has a value-added of $20 per ton. Similarly-sized newsprint and animal bedding plants have very different economic development potential, which is reflected in the difference in value added, with the newsprint mill bringing higher skill level jobs and greater revenues to the host community.[5] (See Appendix A for an explanation of how value-added is calculated.)

Figure 2.3 Value of ONP Products



ONP: Old newspaper.
Note: Values are based on sample facilities, not industry averages.
Source: Institute for Local Self-Reliance, 1994.

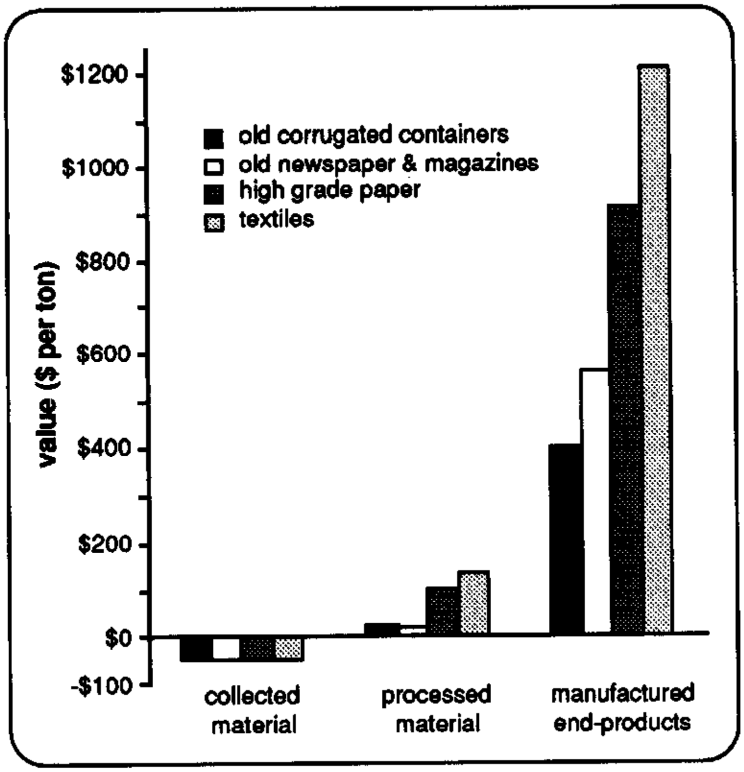
Figure 2.4 summarizes the value added to four materials in Maine. Scrap-based manufacturers add $375 to old corrugated containers, $545 to old newspapers and magazines, $805 to high-grade waste paper, and $1,070 to textiles.

Examples of Actual Recycling Economic Development

A growing number of state and regional associations are documenting recycling economic development and are designing policies to stimulate its growth. Massachusetts calculated that more than 200 facilities added nearly $600 million of value to scrap in the State in 1991 (Table 2.2). Recycling-related enterprises employed nearly 9,500 workers, with half working in the manufacturing sector (Table 2.3).[6]

In Washington State, between 1989 and 1992, 15,000 workers lost manufac-

Figure 2.4 Value of Various Products in the State of Maine (1992)



Source: Maine Waste Management Agency, April 1993.

turing jobs, while more than 2,000 found employment in scrap-based manufacturing companies. During that same period, private investment in these facilities totaled $380 million.[7]

Recycling added nearly $300 million and over 2,000 jobs to Maine's economy in 1992. Scrap-based manufacturers added $140 million in value and employed 600 workers. Another 770 workers found employment at companies that support the SBMs, adding an additional $100 million in value.[8]

In Pennsylvania, the more than 70 SBMs and 300 to 400 companies that sell and distribute recycled products contribute significantly to the State's economy. The total number of recycling-related jobs created or sustained is estimated to be 10,000.[9] New Jersey recognized 9,000 employees working for scrap-based manufacturers in 1991. As part of a larger plan to bring 110,000 new jobs to the City by the year 2000, New York plans to add 4,000 positions to the recycling field.[10]

Table 2.2 Value-Added by Recycling Industries in Massachusetts (1991)

type of recycling operation	value added ($/year)	plants (minimum)	scrap handled (tons/year)	value added ($/ton)
scrap paper processors	$42,909,000	45	657,000	$65
recycled paper manufacturers	$475,307,000	23	656,000	$725
scrap glass processors	$2,429,000	25	41,000	$59
recycled glass manufacturers	$20,010,000	1	87,000	$230
scrap plastic processors	$2,891,000	38	12,000	$241
recycled plastic manufacturers	$58,000	2	60	$967
scrap metal processors	$44,022,000	70	256,000	$172
recycled metal manufacturers	$3,000	NA	15	$200
compost	$400,000	NA	40,000	$10
total	**$588,029,000**	**204**		
processing	$92,251,000	178	966,000	$95
manufacturing	$495,378,000	26	743,075	$667
composting	$400,000	NA	40,000	$10

NA: Not available.
Source: Massachusetts Department of Environmental Protection, July 1992.

Potential Recycling Economic Development in a City of One Million

Scrap-based manufacturers bring enormous economic development potential to a typical U.S. city. In fact, a city of one million people could fully or partially sustain thirty facilities on secondary resources that would otherwise be burned, buried, or exported, assuming progressive recovery and source reduction programs, and a waste stream similar to national characteristics.[11,12] Table 2.4 presents a hypothetical mix of facilities (patterned after existing plants) that could be located in a city with one million residents. The choice of facilities is based on the existing supply of scrap feedstock, the maintenance of sustainable recycling practices (closed-loop recycling), and the production of high-value end products. A source reduction level of 4 percent and recovery rate of 66 percent by weight of MSW was assumed. (Assumptions for this example are detailed in Appendix B.)

All in all, the results are impressive. In addition to diverting more than 635,000 tons of solid waste from local landfills and incinerators, thereby saving nearly $10 million in disposal costs (assuming a moderate $15 per ton tipping fee), the 30 facilities add an average of $470 of value to each ton of previously discarded material. In the process, they would bring three-quarters of a billion dollars and almost 2,000 manufacturing jobs to the community. (An additional 2,550 jobs would be created in support of these manufacturing enterprises when a multiplier effect is included. See following section.)

Table 2.3 Jobs Sustained by Recycling Industries in Massachusetts (1991)

type of recycling job	estimated no. of jobs	portion of total
manufacturing	4,640	49%
scrap processing	2,327	25%
recycling retail	600	6%
construction & equipment	1,000	11%
transportation & service	200	2%
government & nonprofits	300	3%
custodial	400	4%
total	**9,467**	**100%**

Source: Massachusetts Department of Environmental Protection, July 1992.

The facilities produce a variety of products from the city's waste stream — glass tile to plastic trash bags, textile fibers and rags to high-quality printing paper. Some plants — such as the two aluminum facilities in Table 2.4 — are interdependent. The dross (an industrial byproduct) plant receives its feedstock from the aluminum minimill, then sells a portion of its product back to that same plant. The detinning operation produces steel from the waste stream then sells it to the steel minimill.

Many of the products listed in Table 2.4 have leading-edge post-consumer recycled-content levels. While 100 percent post-consumer content is not unusual for some products, such as paperboard, the use of high percentages in products such as plastic packaging and plastic sheeting has been accomplished only recently.

Constrained by the limited scrap recovered from a population of one million, some manufacturing plants will draw recyclables from a larger area. For example, the smallest feasible newsprint mill requires the ONP of 3 million people, and the automobile battery recycling plant gets just 15 percent of its feedstock from a city of one million. As noted in Table 2.4, five of the 30 manufacturers listed draw feedstock from an expanded area.

Of the nearly 2,000 manufacturing jobs provided by the 30 factories, almost 40 percent come from the large factories in the paper sector. The wood sector provides a more diverse employment base, employing 100 people at a moderate-size hardboard plant, 15 at a pallet-refurbishing operation, 10 at each of two mulch facilities, and five at a stable bedding operation. This diversification places less reliance on a single facility to fulfill an area's employment needs, and distributes jobs over a wider geographical area.

Of all the plants presented in Table 2.4, the battery facility adds the most to the local tax base — more than $200 million per year. Smaller plants, including the art glass, paving aggregate, PVC (polyvinyl chloride) plastic products, pallet repair, and stable bedding operations, exist on annual revenues of less than $1 million. The aluminum and steel minimills, producing relatively large volumes of high-value products (60,000 and 50,000 tons per year respectively), account for nearly 40 percent of the total scrap-based revenue. As with jobs, the diversification of facilities — large centralized sources of revenue commingled with many small localized sources — provides a healthy economic environment for the area.

The final column of Table 2.4 indicates the value that each operation adds to the average ton of scrap utilized. The glass sector demonstrates the wide range of value that can be added to a community's cullet (crushed scrap glass). Used as an aggregate, cullet in pavement (glasphalt) is worth only $30 more per ton. But the value climbs steadily as the glass is used to make new bottles ($330), art glass ($510), or glass-bonded tile ($2,500). Plastics tend to add the most value on a weight basis because of their low density and low value as scrap (e.g., a ton of expanded polystyrene produces a huge number of egg cartons, resulting in a high dollar value). (Appendix A).

Another important factor is the trade-off between volume and value for different facilities. Glass tile and polystyrene packaging, for example, use relatively little scrap, but command a high price per ton on the market. Alternatively, products such as aggregate, glasphalt, and animal bedding can absorb large volumes of scrap, but have a low per-ton sales price. Manufacturers of high-value products provide high per-ton revenue to host communities, while the producers of high-volume products ensure a stable market for collected recyclables.

The figures presented in Table 2.4 are based on existing state-of-the-art facilities and industry data. Even though economic factors, such as material prices, transportation costs, interest rates, and inflation change continually, the information is representative of the opportunities for today's manufacturers.

Invigorating the Local Industrial Sector

In addition to jobs and revenue, scrap-based manufacturers bring other benefits to their host communities, including demand for local products and services, and a steady supply of products for the immediate region.

A production plant must be supported by the region's business community. Its demand for products (such as feedstock materials, replacement parts, office supplies, etc.) and services (such as food services for its employees, administrative services, cleaning and maintenance, etc.) add to the local economy.

The number of indirect jobs related to scrap-based manufacturing enterprises can be estimated using a multiplier. Multipliers calculated for the Chicago area for numerous manufacturing industries range between 1.2 and 3.2,[13] while Maine found 2.3 total related jobs for each one in the scrap-based manufacturing sector.[14] Using 2.3, the total number of jobs brought to our example city of one million residents is 4,550. A similar increase in revenues is also realized.

A production facility may also provide other companies with feedstock for their operations, as in the case of a detinning plant and a steel minimill. The detinning operation retrieves high-grade steel from scrap tin-plate and sells that material to a steel mill. A local minimill then can buy the scrap directly from the detinner, thus avoiding long-distance shipping and brokerage fees. This availability of feedstock also can stimulate the local economy.

Environmental Advantages of Scrap-Based Manufacturing

Scrap-based manufacturers impact the environment less than most of their virgin-material-based counterparts. They use less energy, water and natural resources, reduce the local solid waste disposal burden, and produce less air, water and land pollution — all while making comparable products.

All of these ecological savings translate into economic savings as well (often called "externalities"), either directly in the short-term or indirectly over a longer period of time. In the case of energy, the reduced requirements realized by a factory that switches to a scrap emphasis are immediately reflected in a lower fuel bill. Likewise, pollution control costs decrease with an increase in scrap usage. Slowing the rate of depletion of a finite natural resource (such as bauxite ore used to make aluminum), however, requires a broad view to recognize the economic benefits involved. One study completed by the Massachusetts Institute of Technology found that states with stronger environmental policies consistently out-performed the less-protective states on all economic measures.[15]

Reductions in various negative environmental impacts are listed in Table 2.5. These figures are estimates taken from a number of sources. Aluminum manufacturers have the greatest amount of

Table 2.4 Recycling Economic Development Potential in a City of One Million

products	product post-consumer content	no. of plants	local post-consumer scrap used (TPY)	jobs	annual gross revenue	value added to one ton of local scrap
abc rubble						
paving material*	25%	1	40,000	20	$4,000,000	$370
aggregate	100%	1	20,000	5	$160,000	$10
subtotal		*2*	*60,000*	*25*	*$4,160,000*	*$250*
glass						
tile	30%	1	3,600	75	$40,000,000	$2,500
art glass	90%	1	500	5	$300,000	$510
containers	52%	1	38,000	250	$37,000,000	$330
glasphalt	10%	1	4,300	5	$1,500,000	$30
subtotal		*4*	*46,400*	*335*	*$78,800,000*	*$473*
metals						
aluminum products*	60%	1	6,000	50	$150,000,000	$3,000
aluminum dross	10%	1	18,000	20	$2,500,000	$240
detinned steel	100%	1	9,000	10	$1,900,000	$170
steel products	100%	1	10,000	50	$150,000,000	$1,200
subtotal		*4*	*43,000*	*130*	*$304,400,000*	*$1,024*
paper						
tissue	100%	2	41,000	250	$30,000,000	$640
newsprint*	100%	1	37,000	220	$57,000,000	$560
printing & writing	50%	1	24,000	120	$50,000,000	$550
cellulose bldg. insul.	82%	1	7,000	10	$2,000,000	$290
paperboard	100%	1	79,000	180	$21,000,000	$220
subtotal		*6*	*188,000*	*780*	*$160,000,000*	*$423*
plastics						
PS packaging	25%	1	500	150	$1,000,000	$1,700
dimensional lumber	100%	1	3,400	50	$3,000,000	$1,000
LDPE bags	30%	1	2,000	50	$4,000,000	$1,000
PVC products	10%	1	25	10	$250,000	$1,000
PET packaging	100%	1	960	25	$1,800,000	$950
HDPE sheeting	90%	1	960	20	$1,500,000	$900
subtotal		*6*	*7,845*	*305*	*$11,550,000*	*$1,026*
rubber						
flooring	85%	1	1,700	25	$1,200,000	$600
wood						
hardboard*	45%	1	20,000	100	$12,000,000	$230
pallets	100%	1	6,000	15	$600,000	$100
mulch	100%	2	14,000	20	$1,200,000	$75
stable bedding	100%	1	4,500	5	$200,000	$45
subtotal		*5*	*44,500*	*140*	*$14,000,000*	*$145*
other						
auto batteries*	99%	1	6,500	120	$210,000,000	$1,000
textile products	100%	1	10,000	120	$3,000,000	$200
total		**30**	**407,945**	**1,980**	**$787,110,000**	**$452**

Acronyms: abc, asphalt, brick, & concrete; PS, polystyrene; LDPE, low-density polyethylene; PVC, polyvinyl chloride; PET, polyethylene terephthalate; HDPE, high-density polyethylene.
*Additional scrap is required from the surrounding region to supply this medium-sized manufacturing plant.
Note: Subtotals and total for value-added column are weighted averages.
Source: Institute for Local Self-Reliance, 1994.

environmental incentives to recycle as seen in Table 2.5, while steel and plastic manufacturers also enjoy significant ecological advantages by utilizing scrap.

Conservation of Resources

All scrap-based manufacturers reduce the consumption of virgin materials. In 1990, recycled paper mills used 21,791,000 tons of scrap paper,[16] sparing more than 370 million trees. Steel recycling reduces use of ore, coal, and limestone by 90 percent. Los Angeles' use of 100 percent recycled asphalt has saved approximately 8,000,000 gallons of crude oil that would have been used to manufacture virgin asphalt.[17]

Besides the obvious reduction in use of natural resources, scrap-based manufacturing generally requires less energy and water. This is due to a reduction in the amount of processing required to bring recycled and virgin feedstocks to the same point in the production process. For example, debarking, chipping, and pulping trees is much more energy and water intensive than simply repulping waste paper. Likewise for steel — melting ferrous scrap requires much less energy and water than reducing iron ore and coal in a virgin-material-based mill.

Increasing the energy efficiency of the domestic industrial sector should be a desirable goal. Industry needs account for one-third of the nation's energy demand. Recycling is playing a significant role in reducing this over-dependence on fuels. Figures 2.5 through 2.8 show the approximate energy costs per ton of products manufactured in four different industries. Each graph compares the energy costs required for manufacturing a ton of product for varying recycled-content levels — zero percent (virgin), the industry average, and the state of the art. Although these economic savings are already significant, an adjustment of the cost of energy to more closely reflect the actual cost of that energy (e.g., through an energy tax) would provide further incentive for increased scrap utilization.[18]

Reduction of Solid Waste Disposal

Recycling diverts material from solid waste disposal facilities. This brings economic and environmental benefits to communities by extending the life of their landfills and by delaying the costly siting of burn and bury technologies that may ultimately harm the local environment. (In the past decade, over 14,000 landfills have closed and less than 1,000 have opened in the face of increased waste generation, largely due to public pressure.)

Table 2.5 Reduced Environmental Impacts by Industries when Scrap Replaces Virgin Feedstock

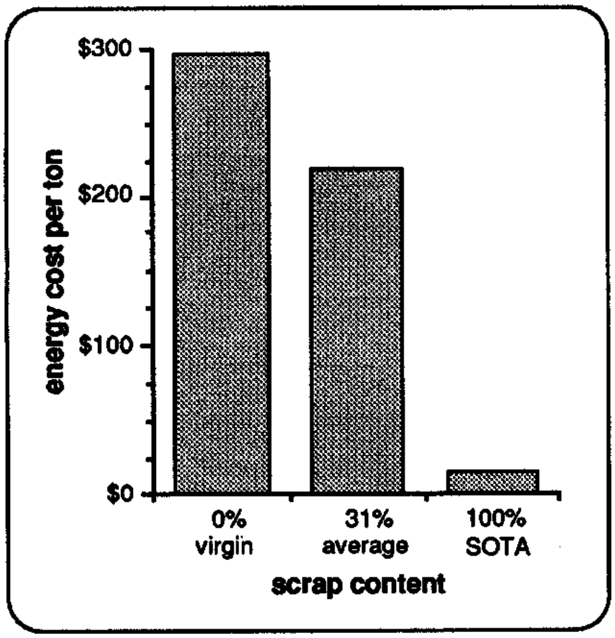
environmental impact	percentage reduction					
	aluminum	glass	paper	plastics	oil	steel
energy use	90-97	4-32	23-74	67	67	47-74
virgin materials use	98	97	98	98	98	90-98
mining waste	NA	80	NA	NA	NA	97
air pollution	95	20	74	50	NA	85
water pollution	97	NA	35	88	NA	76
water use	NA	50	58	NA	NA	40
environmental cost*	84	35	30-50	NA	NA	28

NA: Not available.
*Total environmental impact of production.
Sources: Robert Cowles Letcher and Mary T. Sheil, "Source Separation and Citizen Recycling," in William D. Robinson, ed., ***The Solid Waste Handbook***, John Wiley & Sons, New York, 1986; Aluminum Extruders Association, *The Shapemakers: Extrusion Showcase*, Wauconda, Illinois, 1992; ***Glass Container Markets in the New York Region***, prepared by Resource Management Associates, Napa, California, for New York State Department of Economic Development, Albany, New York, May 1992; Nottingham University Consultants, England, 1992; Mark A. Adams, Society of Tribologists and Lubrication Engineers "Used Oil Legislation and Pollution Prevention," ***Independent Lubricant Manufacturing Association 1990 Annual Meeting***, October 15, 1990; "Recycling Scrap Iron and Steel," Institute of Scrap Recycling Industries, Inc., Washington, DC, 1990; Tellus Institute, ***CSG/Tellus Packaging Study***, Boston, Massachusetts, 1991; Institute for Local Self-Reliance, 1994.

Pollution Prevention

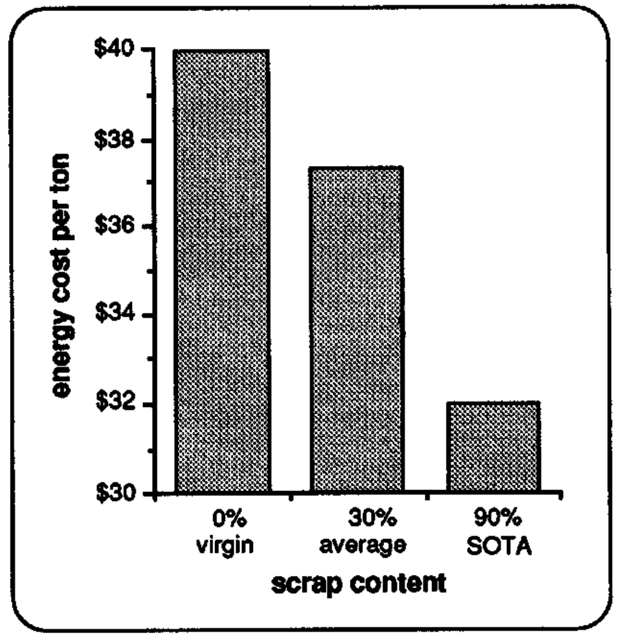
As previously noted because of the reduced level of materials processing, scrap-based manufacturers cause less air, water, and land pollution. As shown in Table 2.5, air emissions are reduced by 20 to 95 percent when scrap feedstocks replace virgin ones in various manufacturing processes. The range for water pollution reductions is 35 to 97 percent. One innovative process that produces 100 percent recycled asphalt from old streets produces

Figure 2.5 Estimated Aluminum Production Energy Costs for Varying Scrap-Content Levels



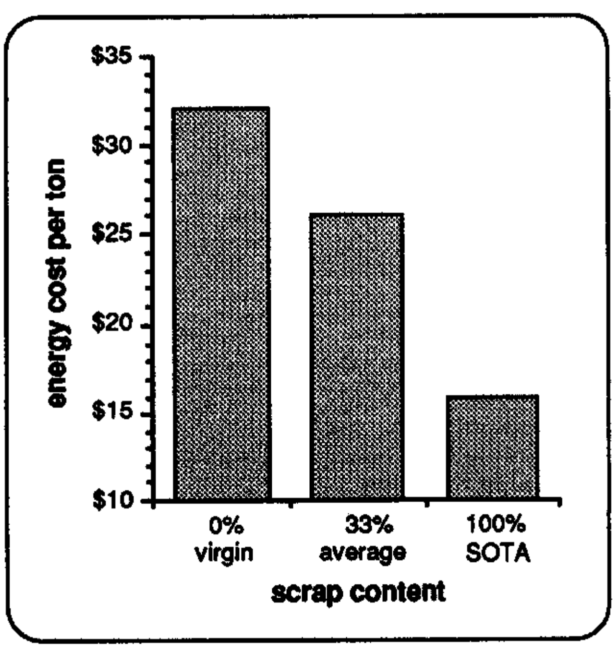
SOTA: State-of the-art recycled-content level.
Source: Institute for Local Self-Reliance, 1994.

Figure 2.6 Estimated Glass Container Production Energy Costs for Varying Scrap-Content Levels



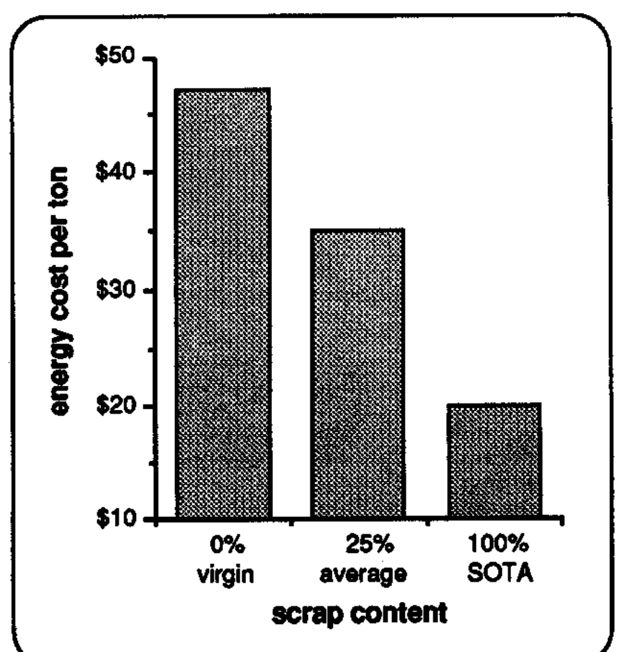
SOTA: State-of the-art recycled-content level.
Source: Institute for Local Self-Reliance, 1994.

Figure 2.7 Estimated Paper Production Energy Costs for Varying Scrap-Content Levels



SOTA: State-of the-art recycled-content level.
Source: Institute for Local Self-Reliance, 1994.

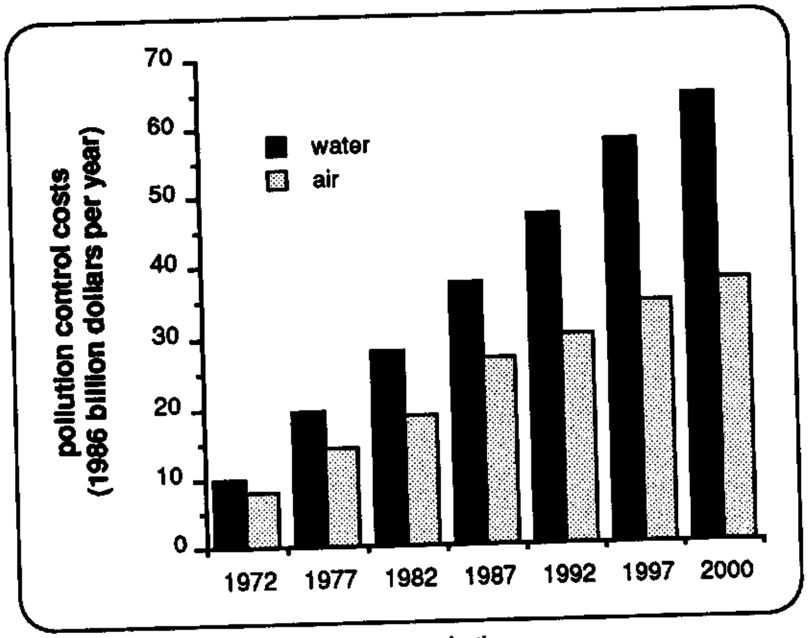
Figure 2.8 Estimated Steel Production Energy Costs for Varying Scrap-Content Levels



SOTA: State-of the-art recycled-content level.
Source: Institute for Local Self-Reliance, 1994.

zero emissions by utilizing a new technology. Additionally, use of local scrap reduces air pollution caused by transportation.

Figure 2.9 U.S. Pollution Control Costs (1972-2000)

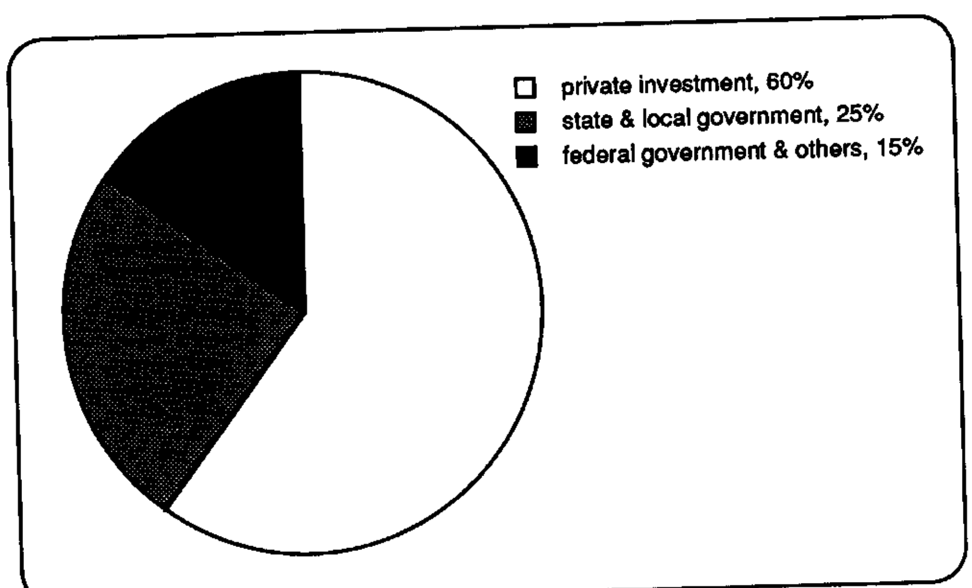


Note: Data for 1992, 1997, and 2000 are projections.
Source: U.S. EPA, 1991.

Reducing emissions is important not only for quality-of-life issues, but also for the bottom line. By the year 2000, local communities will spend more than $100 billion per year addressing air and water pollution.[19] Figure 2.9 shows the rising annual cost of pollution control in the United States. Transition to scrap-based manufacturing offers a solution to the problem of industrial pollution by preventing it, instead of attempting to control pollution after it has been generated. "End-of-pipe" technologies are costly and not as effective, since they simply displace toxins from one medium (air, water, land) to another.

The private sector bears the majority of pollution prevention costs, local and state governments pay 25 percent, and the federal government covers only 15 percent (Figure 2.10).[20] This indicates that pollution control is a local economic issue. Reducing this cost is one more impetus for manufacturers to increase use of recycled feedstock, and for states and localities to encourage the growth of scrap-based manufacturing through appropriate policies (see Chapter 5).

Figure 2.10 U.S. Expenditures on Pollution Prevention (1990)



Source: U.S. EPA, 1991.

Chapter 3
State-of-the-Art Scrap-Based Manufacturing

Today's economic and environmental challenges require a reexamination of what is understood as economic development. Too often, communities pour all available resources into attracting one huge factory to solve all of their economic woes. Even if such a deal works to the city's "advantage," the community's economic health is closely tied tothis one company. Today more communities are striving to attain the goals of *sustainable development*, including diversifying the local manufacturing sector through a variety of appropriately-scaled plants. Although the meaning of sustainable development may vary, it is always based on the fundamental premise of meeting the needs of a community without depleting the resource base essential to sustaining life. Appropriately-scaled scrap-based manufacturing is a step towards that goal.

Leading the way in this field are *state-of-the-art* scrap-based manufacturers. State-of-the-art SBMs use high percentages of scrap (especially post-consumer), make high-value products (often by "closing the loop"), are appropriately scaled, and apply innovative technology to accomplish these feats. Communities realize greater benefits when they develop policies to promote these facilities locally. What follows is a discussion of each of these four facets of state-of-the-art waste-based production.

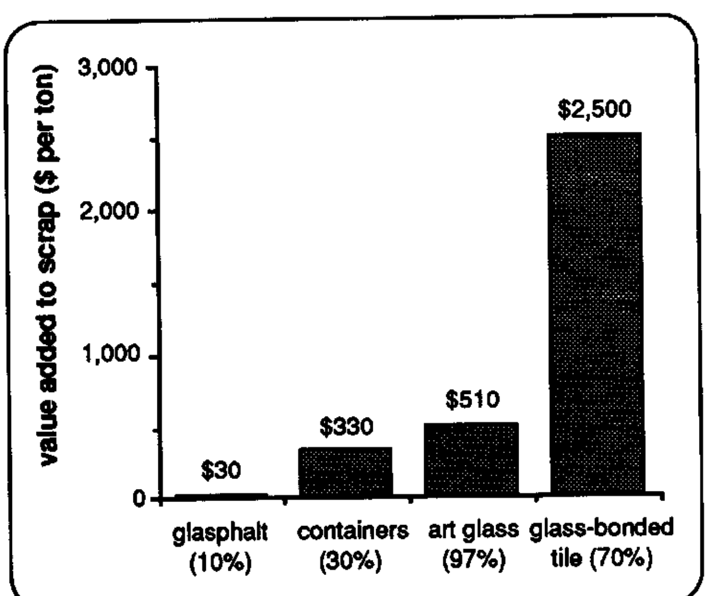
High-Value Products

Value Added

The scrap-based manufacturer, like all manufacturers, adds value to raw material through the production process. But what sets one SBM apart from another in this area is the *amount* of value that it adds. This difference is demonstrated in the case of production from scrap glass into four end products: glasphalt, containers, art glass, and glass-bonded tile. Figure 3.1 shows the increasing level of value added for these products. Similarly, Figure 2.3 displayed this relationship for products made from ONP, with animal bedding, cellulose building insulation, molded pulp products, and new newsprint selling for between $35 to $570 per ton. Figure 2.4 examined this issue for four other products. (See Appendix A for more information regarding value-added.)

Products with greater value-added are desirable because they tend to hold greater economic development potential. In the case of jobs, this translates to a greater number of positions and/or a greater degree of skill for the positions. In the case of

Figure 3.1 Value Added to Glass Cullet for Four Products



Note: Percent figures are the scrap-content levels of the products.
Source: Institute for Local Self-Reliance, 1994.

revenue, greater value-added tends to translate into more money added to the local tax base.

Value versus Volume

The level of income for a plant also depends on its production capacity. The relationship between value and volume is critical when evaluating SBMs. For example, cullet used in art glass is much more valuable than cullet used in glasphalt, yet glasphalt operations tend to use many times more cullet than art glass operations. This trade-off must be evaluated to the advantage of local needs.

Recycling Levels

The highest value product manufactured from a recycled material is often one returns a scrap material to its original use (i.e., close the loop). Examples of closed-loop recycling include ONP into new newsprint, container cullet into new glass containers, and aluminum UBCs (used beverage containers) into new cans. (This also is referred to as primary recycling in this document.) Secondary recycling occurs when scrap is recycled into a new product that is also recyclable. Examples include mixed paper into paperboard or molded pulp products, tires into rubber mats, and cullet into tile. And finally, tertiary recycling occurs when a material is remanufactured into something other than its original form, which itself is not recyclable. Examples include mixed paper into tissue and ONP into cellulose. Often, the higher the recycling level, the greater the economic development potential.

An additional benefit to primary recycling is that it allows materials to stay in the recycling loop instead of winding down and out of it. Many materials can be recycled a nearly infinite number of times through primary recycling. These include steel, aluminum and other metals, and glass. Petroleum products, including plastics, synthetic rubber, and lubricating oil, experience very little degradation, and therefore can be recycled many times. Organic materials travel through the recycling process fewer times. For example, the fibers in paper tend to shorten beyond usefulness for new papermaking after five to twelve times through the recycling process.[21] Quality is not sacrificed in paper products, though, as the too-short fibers pass out of the system through a screening process in the mill and are used in other applications. This is not a limitation to recycling, because, even with progressive recovery rates (above 60 percent) the virgin stock is sufficient to supplement the recovered fiber.

High Recycled-Content Levels

State-of-the-art facilities exist in all scrap-based manufacturing sectors. If a range of these facilities — using asphalt, glass, metals, paper, plastics, rubber, textiles, wood, and other materials — were to be established in a community, they could convert more than two-thirds of the generated waste into new products (see Chapter 2). This projection is based on the factories making products with high recycled-content levels.

High recycled-content levels have risen — both on the average and at the maximum — over recent years, as progressive manufacturers have done what others had called impossible. Table 3.1 summarizes for numerous products the national average, current maximum, and potential maximum recycled-content levels for both post-consumer and total recycled content. The current maximum levels imply that at least one plant in the United States is making the product at the recorded percentage. The potential maximum levels are based on interviews with industry experts.

Of special importance is post-consumer content. Post-consumer, loosely defined, means that the material already has served its intended purpose, all the way through to the end user. Pre-consumer material (including industrial, in-house, and inventory scrap) is typically of greater value than post-consumer, and therefore often already is recycled at near-maximum levels. The challenge in recycling is to increase post-consumer scrap use, because that material is underutilized dramatically in the United States. Products that attainnew levles of post-consumer content are deemed state of the art.

One such product is a 100 percent post-consumer recycled-content plastic curbside recycling bin. The HDPE bin is produced by Poly-Anna Plastics, Inc. (Milwaukee, Wisconsin), and is made with a special mold to accommodate the maximum level of post-consumer material. No other manufacturer has matched Poly-Anna's effort on this front. Another manufacturer, Evanite Fiber Corporation (Corvallis, Oregon), makes hardboard for building applications from 48 percent post-consumer wood chips from pallets, with most of the remaining content coming from pre-consumer scrap. This use of scrap is highly unusual in an industry that relies primarily on virgin wood chips.[22]

Table 3.1 Recycled Content of Various Products

industry	product	recycled content (%)					
		national average		current maximum		potential maximum	
		post-cons.	total	post-cons.	total	post-cons.	total
glass*	clear glass	25	30	48	50	90	90
	colored glass	25	30	74	78	90	90
metal*	aluminum	56	65	90	90	100	100
	bi-metal	<5	20	10	25	100	100
	steel	<5	20	10	25	100	100
paper	cellulose bldg. insul.	60	80	80	80	80	80
	molded pulp	50	100	100	100	100	100
	newsprint	9	17	100	100	100	100
	paperboard	23	25	100	100	100	100
	printing & writing	2	6	50	100	100	100
	tissue	30	42	100	100	100	100
plastic*	HDPE	<1	<1	100	100	100	100
	PET	<1	<1	100	100	100	100
	PS	<1	<1	40	40	100	100
	PVC	<1	<1	<5	50	100	100

post-cons.: Post-consumer recycled-content level.
*Figures presented are for container products only.
Sources: Institute for Local Self-Reliance, 1994; Scientific Certification Systems, 1993; *Scrap Processing and Recycling*, May/June 1992; *Resource Recycling*, February 1992; Glass Packaging Institute, 1991; Newspaper Association of America, 1991; American Paper Institute, 1991; Franklin Associates, 1991.

Consumers, however, are frustrated by false or misleading claims of recycled content. A lack of standard definitions for pre- and post-consumer content hampers efforts to promote high recycled content. Several organizations are addressing this issue, including the National Recycling Coalition (Washington, DC), the American Society for Testing and Materials (New York, New York), Scientific Certification Systems (Oakland, California), Green Seal (Washington, DC), and Conservatree Information Services (San Francisco, California).

Appropriate Scale

Contrary to the belief that giant corporations dominate U. S. industry, most domestic production is generated in shops of 100 employees or fewer. In the United States, small manufacturers account for one-third of the gross national product. Four-fifths of Chicago's industrial jobs are held by firms with less than 50 employees. A survey found that two-thirds of Cleveland-area firms employed less than 25 people, while 94 percent employed less than 100.[23] An appropriately-scaled SBM is one that is designed to be profitable by using local scrap to meet demand.

In addition to the availability of raw material and local demand, determining factors of plant size include capital costs and economies of scale. For example, the paper industry is characterized by large, vertically integrated corporations that dominate most paper markets with mills that produce as much as 1,000 tons per day. Competition is fierce in such markets for a small-scale mill (producing less than 100 tons per day). Such an enterprise can save transportation costs associated with receiving raw materials and delivering finished products. In fact, several states report that transportation costs are the biggest barrier to finding markets for their collected recyclables.[24]

Examples of small-scale remanufacturers include Optimum Art Glass, Inc. (Eaton, Colorado), which manufactures 3 tons of colored sheet glass per day (compared to typical flat glass plants that run at 1,000 tons per day), and Coon Manufacturing (Spickard, Missouri), which makes 5 tons of high-value recycled-plastic products per day.[25]

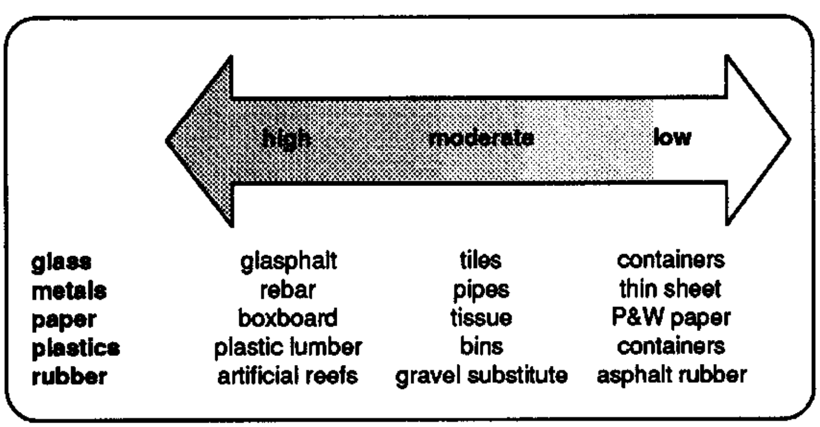
Innovative Uses of Technologies

Lack of appropriate technologies often is cited by industry as a barrier to increased use of recycled materials. But evidence is mounting that many of recycling's barriers are being hurdled by innovators using new methods with existing equipment or by inventing new mechanisms or systems. Areas of concern being addressed with technological innovation include contaminant removal, color and grade sorting, and utilizing rarely recycled materials.

Contamination

The increased use of post-consumer materials has introduced new challenges to recycling industries., but methods for sorting and removing contaminants are being developed to address these new problems. As a recycled material's quality is upgraded via sorting and processing, the value of the material is increased. This is illustrated in Figure 3.2. Low-quality waste paper is often used to make boxboard, but if some grading and contaminant removal occurs, then it is used in higher-value tissue products. If further sorted, the high-grade deinking waste paper can be sent to the highest-value end use — printing and writing paper.

Figure 3.2 Examples of Product Tolerance to Contaminants



Source: Institute for Local Self-Reliance, 1994.

Automated Sorting

Recycling's cost effectiveness can be improved through automation of some sorting tasks. Glass and plastic containers are the focus of most automation efforts. These materials are currently manually sorted, although some new systems show promise for increasing worker productivity and safety.

In glass recycling, several automated systems have been designed to separate glass containers by color, but none have met with commercial success. Some of these systems separate cullet, while others separate whole containers. Other efforts concentrate on removing ceramic contaminants from the glass stream.[26]

In plastic recycling, the sorting process concentrates on separating different resins, although color sorting may be required in some applications. The need to separate resins economically has spawned a variety of technologies that employ mechanical, physical, and chemical processes, some of which separate whole bottles, while others sort flakes.

Plastics Resin Separation Specialists, Inc. (Anderson, South Carolina) has the first commercial system to color sort plastic flakes. The system is proprietary and involves "a series of elimination made by a viewing process."[27] Magnetic Separation Systems, Inc. (Nashville, Tennessee) sells a system that sorts whole plastic containers by resin and color.

Rarely Recycled Materials

Industries that recycle a rarely recycled material reap all the benefits of scrap-based manufacturing, as well as those found in a niche market. Examples of these companies include Optimum Art Glass, which mixes flat and container cullet to make its product. Few enterprises utilize scrap flat glass, and no known plants mix it with container cullet. Ohio Pulp Mills, Inc. (Cincinnati, Ohio) recovers paper pulp from poly-coated milk and juice cartons.[28] Factories are opening in the United States to recover rarely recycled materials, ranging from household batteries to engineered plastic resins.

Chapter 4
The Potential of Scrap-Based Manufacturing

Close examination of today's scrap-based manufacturing trends reveals a promising future for expanding scrap-based activities. Possibilities for growth are buoyed by several factors, including the growth of a number of recycling-related industries, increase in demand for recycled goods, and increase in supply of scrap feedstocks. The State of Maine expects its scrap-based economic activity to double in two years, resulting in 4,300 jobs and $580 million in value-added by 1995.[29] However, obstacles to the growth of scrap-based manufacturing exist. They include the supply of quality feedstock, financing of new scrap-based manufacturing projects, and demand for recycled products.

Possibilities for Growth

Industry Growth Rates

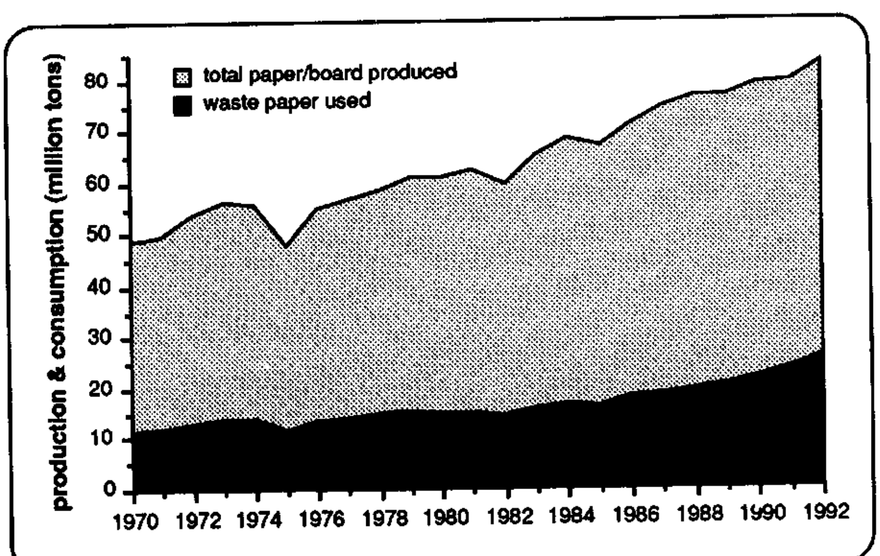
As primary industries, such as paper and plastic, experience growth, the opportunity for increased scrap-based production grows, too. Both an increase in demand for end products and an increase in the availability of discarded resources act as stimuli for increased waste-based production. This is shown in Figures 4.1 and 4.2 for paper and plastic, respectively.

The plastics industry has an especially large gap between domestic production and use of recovered scrap. This is primarily due to low recovery rates, but also to high export levels of plastic scrap (see Table 1.2).

Other industries, such as steel, have not shown a historically steady rate of growth. Instead, they fluctuate with the national economy and other factors. The steel industry has traditionally used ferrous scrap in production, therefore, the ratio of scrap consumed to total production is more than 50 percent (Figure 4.3). Nonetheless, significant amounts of ferrous scrap remain unrecovered or exported.

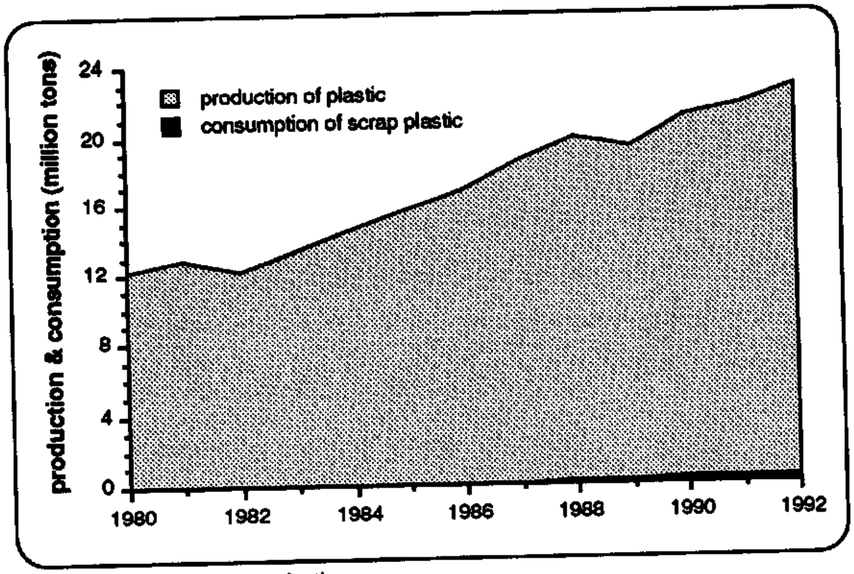
The glass container industry faces its own set of challenges. Glass is losing market share to other materials (such as aluminum and plastic), so that its overall level of production is declining. However, the current industry-average recycled-content level (about one-third) could be doubled with existing technology (Figure 4.4).

Figure 4.1 Annual U.S. Paper/Board Production & Waste Paper Use (1970-92)



Note: Data for 1992 is a projection.
Source: American Paper and Forest Association, 1992.

Figure 4.2 Annual U.S. Plastic Production & Scrap Use (1980-92)



Note: Data for 1992 is a projection.
Sources: *Chemical & Engineering News*, 1991-93; U.S. EPA, 1992; American Plastics Council, 1993.

Growth for Specific Products

Some recycled-content products have great potential for increased demand. These include rubberized asphalt, cellulose building insulation, detinned steel, recycled aluminum dross, printing and writing grades of paper, and plastic food and beverage containers.

Under Section 1038 of the Intermodal Surface Transportation Efficiency Act (ISTEA), rubberized asphalt stands to realize significant growth. The Act mandates recycled-content levels for pavements, favoring use of scrap tires (5 percent by 1994, 10 by 1995, 15 by 1996, and 20 by 1997, with certain caveats).[30] Rubberized asphalt will experience rapid growth from its current market share of less than 1 percent of U.S. roads, providing ample opportunity for rubber entrepreneurs.

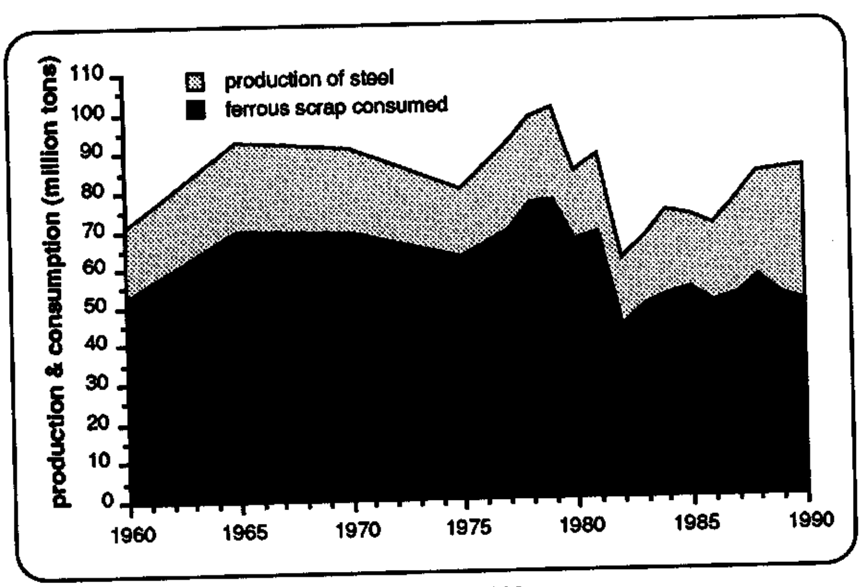
Cellulose building insulation, made from 100 percent waste paper, holds many technical advantages over other insulating materials (mainly fiberglass and expanded plastic), such as R-value, fire performance, and installer-safety. In 1989, cellulose had 3 percent of the building insulation market.

Feedstock Availability

Adding to the reasons for scrap-based manufacturing's promising future is the ever-increasing supply of feedstock. Recycling collection efforts are occurring at all levels — residential, industrial, commercial, institutional, and governmental — and these new programs are netting record amounts of secondary material for the manufacturing sector.

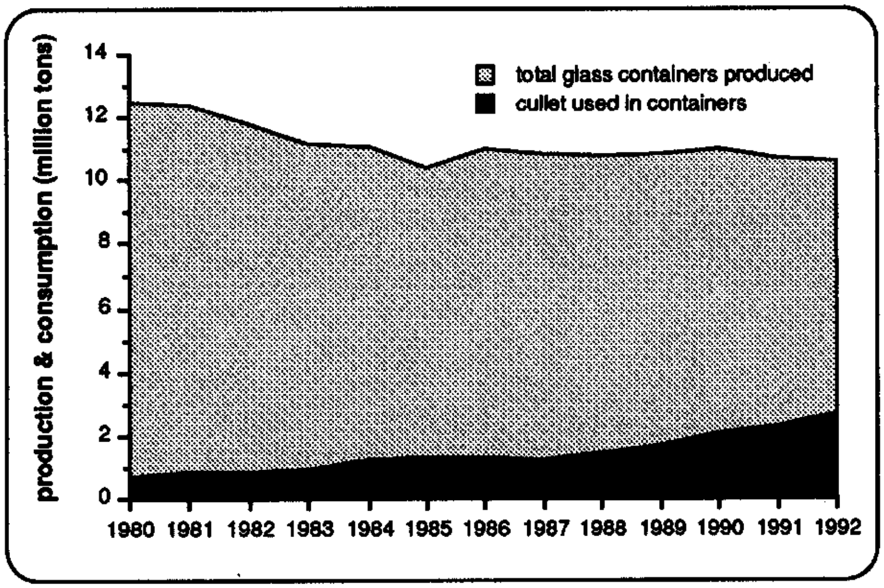
Figure 4.5 illustrates the growing amount of scrap recovered from the MSW stream. (MSW excludes industrial waste and C&D, or construction and demolition. debris.) From 1985 to 1990, the amount of materials recycled increased significantly. The U.S. EPA predicts that this trend will continue through the year 2000,[31] although these projections are based on conservative assumptions.

Figure 4.3 Annual U.S. Steel Production & Ferrous Scrap Use (1960-90)



Source: U.S. Department of Commerce, 1984, 1992.

Figure 4.4 Annual U.S. Glass Container Production & Cullet Use (1980-92)



Note: Data for 1992 is a projection.
Sources: U.S. Department of Commerce; Glass Packaging Institute; Resource Management Associates, Napa, California; 1992-93.

crease too. Others foresee recycling addressing nearly half of the MSW stream in the next few years, with incineration dropping off towards zero, and the overall amount of waste generated decreasing significantly, thus reducing landfill dependency.

Much of what is collected for recycling is shipped out of the country, resulting in lost economic opportunity, as the recipient foreign countries gain the benefits of scrap-based manufacturing — such as job creation, revenue generation, and an overall stimulation of their economies. Table 1.2 shows export levels for some scrap materials in 1990, and these levels tend to increase over time. While huge quantities of ferrous scrap and waste paper are exported annually (12.1 and

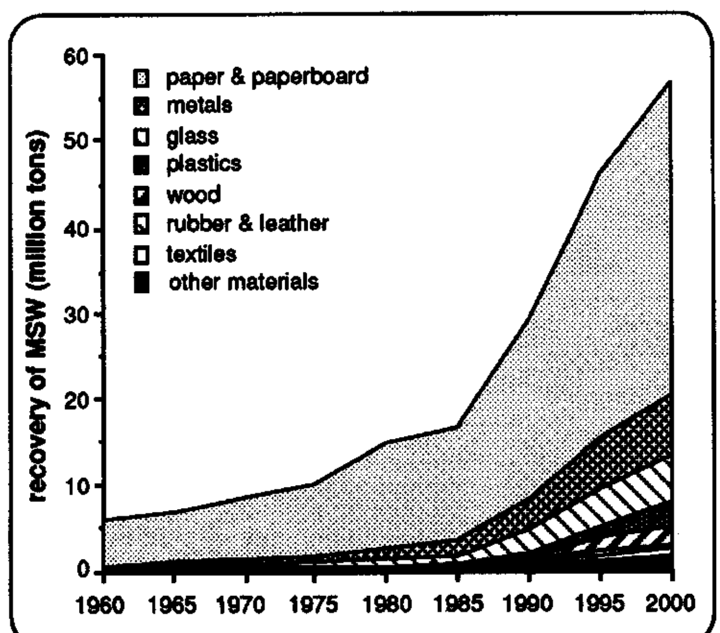
Obstacles to Growth

Despite many positive indicators, the future of recycling does face many difficult challenges. Obstacles to further success must be overcome, including guaranteeing a steady supply of quality feedstock, improving financing mechanisms for SBMs, and increasing demand for recycled-content products.

Supply of Quality Feedstock

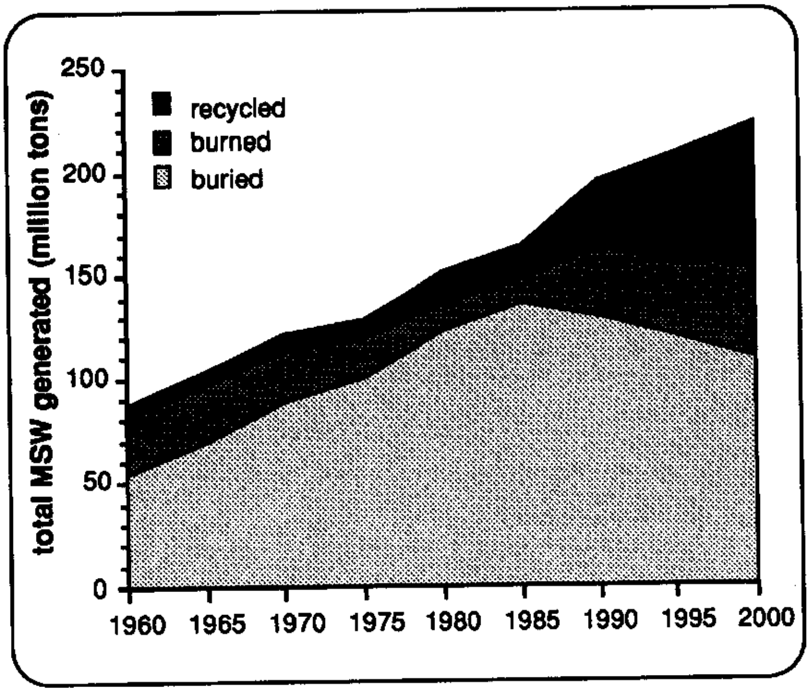
While the amount of scrap being recovered from the waste stream is increasing, issues of quality, quantity, and price are of paramount concern to scrap-based manufacturers. Despite increasing levels of waste generation and recovery, many more recyclables could be recovered. Figure 4.6 shows the expanding level of MSW and the amounts buried, burned, and recycled. While recycling levels more than doubled between 1985 and 1990, incineration grew at an even faster pace. The conservative projections of the U.S. EPA expect recycling to grow modestly, as incineration volumes in-

Figure 4.5 Feedstock Availability from MSW (1960-2000)



Note: Data beyond 1990 are projections.
Source: U.S. EPA, 1992.

Figure 4.6 Where Your Trash Goes (1960-2000)



Note: Data beyond 1990 are projections.
Source: U.S. EPA, 1992.

6.5 million tons in 1990, respectively), other lesser-volume materials represent additional lost economic opportunity. Such is the case with plastic bottles, of which only 210,000 tons were exported in 1990. However, this represented more than half of all plastic bottles collected for recycling in the United States that year.

Closely related to the issue of quantity of feedstock is its quality. As many recyclers discover in their start-up stage, below-spec materials are garbage, and manufacturers will not buy garbage. Therefore, there have been concerted efforts by many to improve the quality of collected feedstocks. Contamination typically comes in two forms: from other types of recyclables (e.g., broken glass mixed with ONP, or incompatible plastic resins mixed together), or from non-recyclables (e.g., dirt, gravel, or materials recycled elsewhere but not by the local program).

One of the most obvious solutions to reduce contamination of recyclables is to avoid mixing the various types of materials during collection and processing. Minimizing the mixing of materials will result in the need for fewer resources dedicated to sorting. If glass bottles and jars break in the collection process and mix with other materials and other colors of glass, then common sense dictates that special care be taken to avoid that mixing.

Other efforts — from better material handling systems on collection trucks, to automated sorting systems in processing facilities, to more forgiving manufacturing technologies, to education programs for all involved in the recycling process — are being made to improve the quality of materials. (See Chapter 3.)

Price incentives are another means of improving the quality of recyclables. Some mills inspect all incoming loads of potential feedstock, grade the material, and pay the supplier according to its quality. In some cases, the below-spec loads are just turned away. However, due to the relative youth of most recycling-related efforts and the dynamic nature of the field, these price incentives are difficult to implement.

Feedstock prices also can act as an impediment to increased remanufacturing. In spite of the other economic benefits of recycling (energy and natural resources savings, pollution prevention, solid waste reduction, job creation, etc.), prices for scrap feedstocks must be competitive with their virgin-material counterparts today if manufacturers with short-term financial concerns are to switch to recycled materials. Figure 4.7 shows the national average prices paid by manufacturers for various scrap materials, ranging from about \$15 per ton of green glass to \$635 per ton of aluminum UBCs. Most scrap feedstocks are purchased for a lower price than the virgin resources that they replace. Such is the case with glass containers, where average batch cost is about \$45 to \$50 per ton for virgin material while average cullet costs are between \$15 and \$50. Plastics, however, are a different matter, as the worldwide glut of virgin resin has depressed prices below the cost of collection and processing of most scrap plastics. In general, government subsidies for energy, transportation, and natural resource extraction all tilt the playing field to the advantage of virgin feedstocks.

Financing Scrap-Based Manufacturers

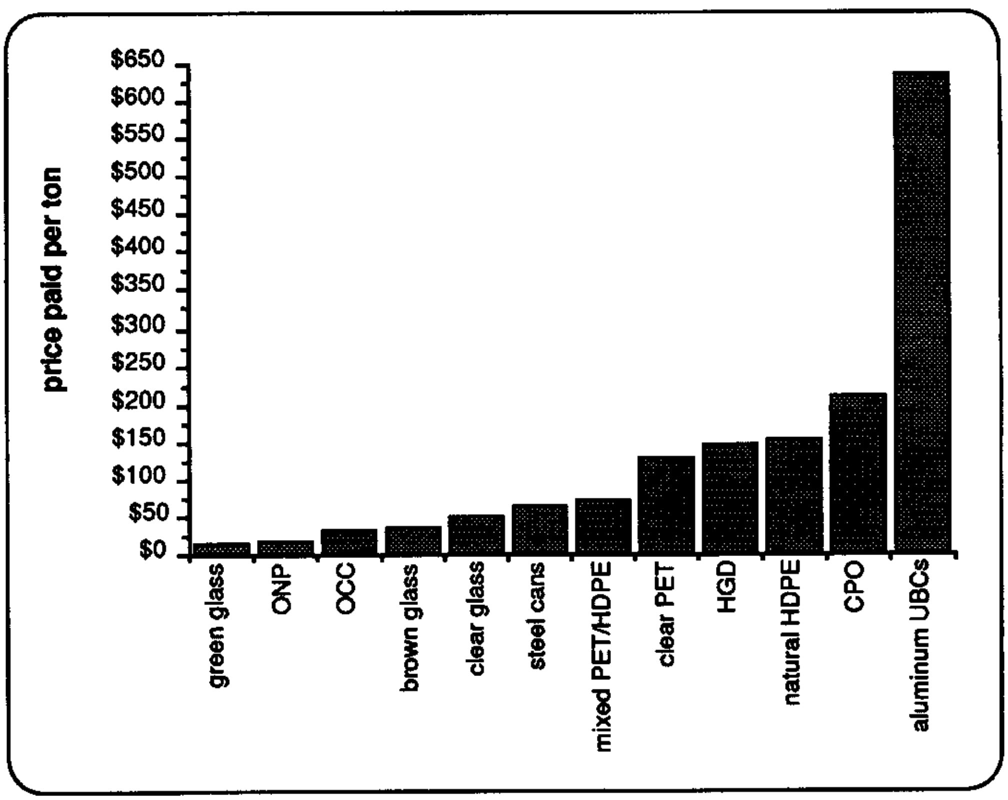
Many scrap-based manufacturing enterprises are recent start-ups undertaken by entrepreneurs. These business ventures often are seen as too risky by the traditional lending establishment, so SBMs turn to other sources for capital. Government policies have been especially helpful in providing low-interest loans for new ventures and conversions.

Another interesting development is the linking of community development organizations with new scrap-based manufacturing enterprises. In this relationship, the community development organization provides low-interest funds in exchange for a piece of the new company to be located in its neighborhood. The community benefits from new jobs, revenue and a local market for its recyclables, and the company gets both capital and the backing of its host community. (See Chapter 5.)

Level of Demand for Recycled Products

Finally, despite a general increase in demand for recycled products, consumption of recycled products must escalate exponentially if recycling is to achieve its potential. For example, despite increased amounts of recycled printing and writing paper purchased in the United States, three mills that specialized in that product closed their doors in 1992 due to shortage of demand. One policy designed to address this problem is the recent Executive Order from the White House mandating federal procurement of printing and writing paper with a high level of recycled content. (See Chapter 5.)

Figure 4.7 U.S. Average Prices Paid for Scrap Feedstocks (1992-93)

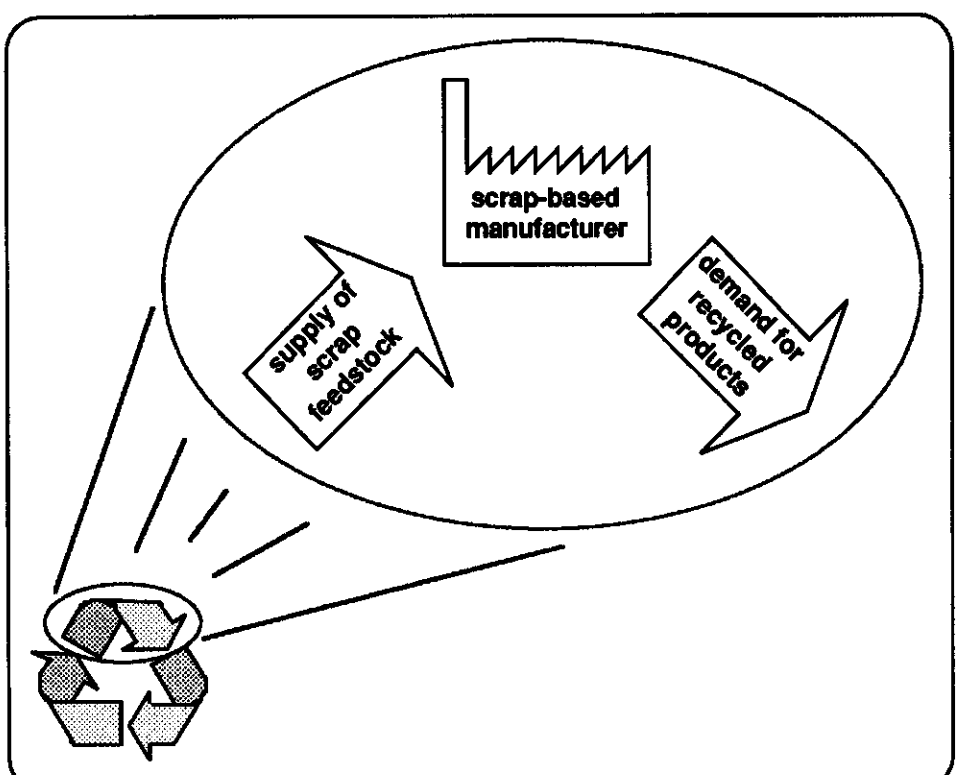


ONP, old newspaper; OCC, old corrugated containers; PET, polyethylene terephthalate plastic; HDPE, high-density polyethylene plastic; HGD, high-grade deinking paper; CPO, computer printout paper; UBC, used beverage containers.
Note: Averages calculated for period between December 3, 1992 and May 21, 1993.
Source: *Recycling Times,* ***Mid-Year Markets Update 1993.***

Chapter 5
Policies to Promote Scrap-Based Manufacturing

A manufacturer's success depends heavily on conditions in the collection, transportation, processing, and marketing sectors (as shown in Figure 1.1); therefore, government policies targeting these sectors significantly impact producers of recycled goods. This chapter examines many government policies that affect scrap-based manufacturing; not only those policies that target the manufacturer, but also those that affect supply of material or demand for recycled-content products. As shown in Figure 5.1, government policies tend to impact manufacturers of recycled products in one of three ways: by improving supply of feedstock, by assisting manufacturers' operations directly, or by influencing consumer demand for the resulting products. Table 5.1 lists several policies that assist SBMs.

Figure 5.1 Policies Focus on Supply, the Manufacturer, or Demand



Source: Institute for Local Self-Reliance, 1994.

Policies to Improve the Supply of Scrap Feedstock

Availability of Feedstock

The ability of a manufacturer to use secondary materials depends on the willingness of haulers and municipalities to separate and deliver the required feedstock. High tipping fees at landfills encourage the diversion of waste from disposal, which in turn creates a low-cost supply of material for the end user, the manufacturer. Surcharges on tipping fees, landfill bans on certain recyclable products, deposit legislation, and mandatory collection programs legislated by states, counties, and municipalities have contributed markedly to increasing the supply of secondary feedstock during the past decade.

These measures have caused some changes in the way SBMs conduct

Table 5.1 Policies Affecting Scrap-Based Manufacturers

policies to improve the supply of feedstock	mandatory recycling collection deposit systems high tipping fees at landfills and incinerators burn & bury bans for certain recyclables ban sale of contaminant materials loan/grant programs for improved equipment technical assistance remove subsidies for virgin feedstock
policies aimed at manufacturers	grant & loan programs for start-ups and R&D tax incentive programs loan guarantees fines for non-compliance with recycled-content levels ban sale of products that are not recycled locally high environmental control costs to encourage recycling high energy costs to encourage recycling community joint ventures recycling market development zones
policies to increase demand for recycled products	government procurement government price preferences for recycled products minimum recycled-content laws for the private sector ease limitations on recycled-content food packaging marketing assistance labeling laws

Source: Institute for Local Self-Reliance, 1994.

business. For example, waste paper shortages in the early 1970s forced one midwestern cellulose manufacturer to purchase ONP from collection programs in Texas. However, due to recently implemented Illinois collection programs, manufacturers now receive paper locally at a lower cost.

One policy that has proven successful in several states is deposit legislation. The ten states with some form of "bottle bill" contain one-third of the U.S. population, yet they recover two-thirds of all containers recycled in the country (Table 5.2). On average, a person living in a bottle bill state recycles four times more than a person living in a non-bottle-bill state. Without the current legislation, today's recycling rates for containers would be less than half of their current levels. New deposit legislation on a local, state, and/or federal level will likely stimulate recycling and its related economic development.

Quality of Feedstock

Material alone is not enough. Feedstock quality is vital to most scrap-based manufacturers as well. For example, an Owens-Brockway glass bottle facility (Portland, Oregon) has reached post-consumer recycled-content levels of 49 percent due in part to the plentiful supply of cullet provided by Oregon's redemption laws. However, while redemption legislation often ensures a large volume of material, it does not guarantee the quality of secondary feedstock. Spokespersons for Owens-Brockway and other

Table 5.2 Estimated Impact of Bottle Bills on Recycling (1990)

	bottle bill state	population (%)	redemption rate (%)				portion of national recovery (%)			
			overall	alum.	glass	plastic	overall	alum.	glass	plastic
1	California	12	**84**	88	76	50	**28**	16	30	29
2	Connecticut	1	**88**	88	94	80	**3**	2	4	5
3	Delaware	<1	**NA**	NA	NA	NA	**NA**	NA	NA	NA
4	Iowa	1	**88**	95	85	80	**3**	2	3	5
5	Maine	<1	**88**	92	85	50	**1**	1	1	1
6	Massachusetts	2	**85**	85	85	50	**6**	3	7	6
7	Michigan	4	**93**	93	93	50	**10**	6	12	9
8	New York	7	**70**	75	75	50	**14**	9	18	18
9	Oregon	1	**85**	85	85	50	**3**	2	3	3
10	Vermont	<1	**85**	85	85	50	**1**	0	1	1
	bottle bill states	**30**	**82**	**85**	**80**	**53**	**69**	**40**	**79**	**77**
	other 40 states	**70**	**15**	**54**	**9**	**6**	**31**	**60**	**21**	**23**
	total USA	**100**	**35**	**63**	**30**	**20**	**100**	**100**	**100**	**100**

overall: weighted average of aluminum, glass, and plastic rates.
NA: Not available.
Sources: Institute for Local Self-Reliance, 1993; Container Recycling Institute, Washington, DC, 1992.

recycled-product makers identify a lack of quality feedstock as the limiting factor constraining post-consumer content levels in their products.[32]

Government initatives aimed at improving the quality of feedstock supplies can benefit manufacturers. Such programs include loan or grant programs to processors for starting up businesses, upgrading machinery, or testing new technologies that could provide higher quality feedstock at lower prices. For example, a research grant from New York's Office of Recycling Market Development to Brandt Manufacturing Systems, Inc. (Windsor, New York) resulted in the development of a coating process for glass containers that could eventually phase out the need for brown or green glass. Brandt sold the first license agreement for this technology to Anchor Glass Container Corporation (Tampa, Florida) in December 1991,[33] and Anchor is moving the technology towards commercialization.

Also, such policies as California's ban on ceramic closures in beverage containers,[34] or Wisconsin's prohibition on the "sale of beverage containers which have a plastic body and aluminum ends"[35] help alleviate some of the contamination problems that manufacturers face.

Technical Assistance

Many government agencies have established technical assistance offices to facilitate recycling economic development and have resources available that can help secure better and cheaper supplies for manufacturers of recycled products. Offices such as the New York Office of Recycling Market Development, the Clean Washington Center, and the California Integrated Solid Waste Management Board compile databases and publish directories that list sources of recycled material for manufacturers. These offices also provide other forms of liaison, linking collection programs, processors, and manufacturers in joint ventures or other business agreements. Resource Recycling, Inc. (Portland, Oregon) publishes a directory of these agencies.

Policies Aimed at Manufacturers

Financial Incentives

In a number of states, grant and loan programs are implemented to start or expand manufacturing operations, or for research and development of recycling technologies. New Jersey, for example, gave Marcal Paper Mills (Elmwood Park, New Jersey) $3 million in loans and authorized the issuance of tax-free bonds worth $13 million to upgrade its deinking facility and broaden its range of acceptable waste papers. Spokesman Peter Marcalus said, "without the help, it would have taken us many more years to make the changes necessary to use post-consumer waste."[36]

In addition to providing grants and loans for start-up capital, governments can assist manufacturers of recycled products in obtaining other types of financing by administrating loan guarantees. In 1992, for example, Wisconsin had $10 million in loan guarantees available to businesses selling recycled products. Loan recipients included Envigro (Germantown, Wisconsin), a remanufacturer of wood pallets.[37]

Tax incentive programs also encourage the use of recyclables in manufacturing. These include tax credits, deductions, or exemptions for the costs of purchasing land, recycling equipment, or the expansion of facilities to enable increased use of recycled feedstock. Oregon pioneered tax credits for recycling operations with its Pollution Control Tax Credit Program. Launched in 1967, this program provides a 50 percent investment tax credit for any facility intended to prevent, control, or reduce pollution. Since 1968, $47 million dollars in tax credits have been awarded to recycling projects. Included in this figure are $14 million for newsprint deinking operations, $6 million for companies using recovered corrugated cardboard, and $2 million for a window glass recycling facility.[38,39]

Fines and Penalties

In addition to providing incentives to businesses that use recycled materials, governments also have developed policies that penalize businesses that resist such use. For example, laws exist that require manufacturers to use certain percentages of recycled material in their products, or face pecuniary repercussions. Recycled-content laws have been passed in Oregon, California, and Wisconsin for products such as glass and plastic containers, plastic trash bags, and fiberglass building insulation, and in eight other states for newspapers. The severity of the penalties and the ability of governments to enforce these laws are significant factors in determining their influence on manufacturers' decisions to use recycled material.

Product Sales Ban

In some areas, products that are not recycled locally at reasonable levels are banned from sale. These bans are often associated with expanded polystyrene food containers, however, the State of New Jersey considered such a law for green glass containers in 1994. The State eventually backed away from the ban, though, when the glass container industry produced several alternitive approaches to address the perceived oversupply of green cullet in New Jersey.[40]

A partially related policy is the current U.S. Food and Drug Administration's (FDA) restriction on the use of recycled materials in food packaging. However, progress has been made recently as a number of packaging products have received a letter of "non-objection" from FDA, allowing their use.[41] One such judgment was awarded to Dolco Packaging Company (Decatur, Indiana), allowing it to sell its expanded polystyrene egg cartons (made from 25 percent post-consumer plastic).[42]

Environmental Protection Laws

Other regulatory measures may indirectly benefit manufacturers of recycled products. For instance, businesses struggling to comply with strict environmental regulations may find it easier to introduce recycled feedstocks, which generally pollute less, than to invest in pollution-control technology.

This was the case with Seminole Kraft Corporation (Jacksonville, Florida), which makes linerboard for corrugated containers. Rather than invest $135 million in a new recovery boiler needed to meet Florida's odor emissions standards, the company chose to switch feedstock, from wood chips to old corrugated containers. This conversion required only a $110 million investment, saving the company $25 million and ensuring its ability to meet Florida's environmental requirements.[43]

Policies to Increase Demand for Recycled Products

The Power of Government Procurement

The government is a powerful consumer and provides an enormous potential market for recycled products. Purchases made by state and local government agencies account for approximately 13 percent of the United States' gross national product, and federal agencies account for another 8 percent.[44] Additionally, government purchases often act as role models for other major buyers. However, a report from the U.S. General Accounting Office found that the federal government has been slow to implement previous programs to purchase products made of recycled materials.[45]

At the federal level, the Clinton Administration issued an executive order in 1993 stipulating procurement of recycled paper by all federal agencies.[46] The order establishes a 20 percent post-consumer recovered materials content standard for uncoated printing and writing paper purchased by federal executive agencies. For some of these papers, the standard is 50 percent total recovered materials, including 20 percent post-consumer.[47] The paper industry already has the capacity to service that 2 percent of the market purchased by the federal government. However, the executive order is expected to stimulate increased purchases of recycled paper in other sectors, too. This will prompt the paper industry to convert existing virgin capacity or build new recycled mills to meet this demand.

Section 1038 of ISTEA is another example of a national policy to use more scrap material — in this case, rubber in new roads (see Chapter 4).[48] Hawaii, Idaho, and Virginia all have passed bills that target highway construction projects as users of recycled materials too.[49]

"Buy recycled" programs within state and local governments may include any of the following features: rewriting procurement specifications to allow (or require) recycled products in the bidding process; price preferences that allow purchasing agents to pay a premium for recycled products; funds set aside for the procurement of recycled goods; and interstate or intrastate cooperative-purchasing programs, which generate larger orders and lower prices for goods made from recycled materials.

Kentucky has taken the lead in adopting regulations that mandate the purchase of recycled products. While other states may allow a price preference or earmark a portion of their funds for recycled procurement, Kentucky requires that 46 categories of product purchases contain specified minimum levels of recycled content.[50] Such measures, if adopted by other states, could open up vast markets to recycling industries.

New York State's procurement program is noteworthy for the range of recycled products it has thus far been able to procure. Recycled-product purchases include lubricating oil, recapped tires, aluminum sheet, polyethylene film, copying machine parts, cellulose building insulation, automotive replacement parts, and various types of paper.[51] According to a recent study, New York spent more than any other state on recycled paper — over $13 million in 1991.[52] Besides granting a 10 percent price preference, the state has incorporated other strategies to expand its recycled purchasing. In order to maintain contact with supply sources, the Department of General Services keeps records of companies from which it has bought recycled materials. Also, New York encourages any political subdivisions within the state to join state contracts or to develop their own cooperative purchasing agreements. This enables smaller government entities to get better buys on recycled products. The New York State Supreme Court, Appellate Division, First Judicial Department, ruled that every brief and appendix filed with the court after January 1994 must be printed on paper with a minimum 50 percent recycled content.[53]

Recycled-Content Laws Targeting Private Sector

Certain procurement regulations are written to target businesses — the newspaper publishing industry in particular. Ten states and the District of Columbia have passed 19 mandatory recycled-content laws.[54] In Florida, Wisconsin, and Connecticut, laws have been passed that tax newspaper publishers for their use of virgin newsprint.[55] Arizona, California, Maryland, Connecticut, District of Columbia, Illinois, Missouri, North Carolina, Oregon, Rhode Island, and Wisconsin similarly require publishers — not manufacturers — to ensure that the products they sell to the general public contain a minimum recycled content.

As a result of these mandatory steps (and the voluntary goals they provoked among industry associations), demand for recycled newsprint substantially increased. Between 1990 and 1993, newspaper deinking capacity in the United States increased by 174 percent.[56] This gain is less than anticipated,

CONCLUSIONS

In addition to reducing dependence on incinerators and landfills, scrap-based manufacturers stimulate local economic development. These production facilities contribute the largest economic pay-off of the recycling process. Adding to the collection and processing jobs and revenue that recycling brings to a local economy, scrap-based manufacturers provide high-skill industrial jobs and sizable sales revenue. These factories invigorate a community's industrial sector, while they diminish the local waste stream, provide savings via avoided disposal fees, and create sustainable markets for locally-derived goods and services.

Policies that promote scrap-based manufaturers benefit all of recycling. These policies should address the manufacturers major concerns, which include a steady supply of quality scrap feedstock, a minimum level of demand for end-products, and sources of capital for retention, expansion, and creation of recycling-related enterprises.

APPENDIX A
VALUE ADDED

Value added to a ton of scrap feedstock by the manufacturer (va_S) is the value added referred to in the text. This calculation is explained below. In addition to the product prices and feedstock cost, the scrap reject rate must be figured into the calculation of value-added.

va_S	=	(1 - reject $rate_S$) $price_P$ - $cost_S$

$price_P$	=	product price ($/ton)
	=	average price at which the manufacturer sells product
reject $rate_S$	=	scrap reject rate (%)
	=	percentage of scrap input that ends up in the waste output of the manufacturing process
	=	$(output_{W,S})/(input_S)$
$output_{W,S}$	=	amount of output waste from scrap input (matched to $input_S$ units)
	=	$(output_{W,t})(content_W)$
$output_{W,t}$	=	amount of total output waste (matched to $input_S$ units)
$content_W$	=	scrap content of waste output (%)
	=	average percentage, by weight, of waste that is scrap
$cost_S$	=	average price manufacturer pays for feedstock ($/ton)

Appendix B
Assumptions for "City of One Million" Example

Table 2.4 (Recycling Economic Development Potential in a City of One Million) shows state-of-the-art scrap-based manufacturers in each material group and their economic development potential, based on the waste stream from a city of one million residents.

Each one of the 30 plants listed in Table 2.4 are modeled after an existing facility. The post-consumer content, scale, revenue, jobs, and value-added figures presented in the table are based on these existing facilities, as well as industry-wide data.

The amount of waste generated annually by this population is listed in the second column of Table B.1, and is categorized by discarded products. The third and fourth columns state the estimated source reduction and recovery rates for the products based on existing efforts in the United States.[70,71] The final column lists the amount of material available to scrap-based manufacturers based on the other information.

Table B.1 Estimated Secondary Resources Available from a City of One Million

scrap material	waste generated (tons per year)	source reduction	recovery rate	waste available (tons per year)
abc rubble	120,000	0%	50%	60,000
auto batteries	6,800	0%	95%	6,460
glass				
beer and soft drink containers	*22,800*	*0%*	*90%*	*20,520*
wine & liquor bottles	*8,400*	*0%*	*90%*	*7,560*
other bottles	*16,400*	*0%*	*90%*	*14,760*
flat glass	*4,300*	*0%*	*80%*	*3,440*
sub-total glass	51,900	0%	89%	46,280
metals				
aluminum cans	*6,000*	*0%*	*90%*	*5,400*
aluminum foil & closures	*1,000*	*0%*	*20%*	*200*
other aluminum scrap	*22,000*	*0%*	*30%*	*6,600*
steel cans	*11,000*	*0%*	*85%*	*9,350*
steel packaging	*1,000*	*0%*	*60%*	*600*
other ferrous scrap	*356,000*	*0%*	*70%*	*249,200*
sub-total metals	397,000	0%	67%	271,350
paper				
ONP	*52,000*	*0%*	*85%*	*44,200*
OCC	*96,000*	*10%*	*85%*	*73,440*
high grade paper	*48,000*	*10%*	*88%*	*38,016*
mixed paper	*59,000*	*20%*	*70%*	*33,040*
sub-total paper	255,000	10%	82%	188,696
plastics				
soft drink bottles	*1,600*	*0%*	*60%*	*960*
milk bottle	*1,600*	*0%*	*60%*	*960*
other containers	*7,200*	*0%*	*25%*	*1,800*
bags and film wraps	*12,800*	*20%*	*25%*	*2,560*
other packaging	*8,000*	*20%*	*25%*	*1,600*
plastic plates and cups	*1,200*	*50%*	*0%*	*0*
sub-total plastics	32,400	15%	28%	7,880
rubber tires	7,200	20%	30%	1,728
textiles	20,000	0%	50%	10,000
wood				
wood packaging	*31,600*	*20%*	*75%*	*18,960*
C&D debris	*76,000*	*0%*	*35%*	*26,600*
sub-total wood	107,600	6%	47%	45,560
total	**997,900**	**4%**	**66%**	**637,954**

Sources: William F. Cousulich Associates, 1991; U.S. Environmental Protection Agency, 1992; Institute for Local Self-Reliance, 1994.

Resources on Recycling Economic Development

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