Chapter

Introduction and Framework for Analysis

Contents

Tables

Figures

Introduction and Framework for Analysis

Objectives and Scope

Society's primary interest in resource recovery, * recycling, and reuse arises from the need to dispose of municipal solid waste (MSW) from residences, institutions, commercial establishments, and light industry. Resource recovery, recycling, and reuse can be constructive supplements to less desirable traditional disposal methods such as open dumping, landfill, uncontrolled incineration, and ocean burial. In addition, it can contribute to the wise and efficient use of materials, to conservation of energy, to preservation of the environment, and to improvement in the balance of trade through reduction of the Nation's dependence on imported natural resources. By using materials more than once, virgin resources can be conserved for ourselves and for future generations.

The objectives of this study are:

1. To identify the technological, economic, and institutional factors that influence the generation, recovery, recycling, and reuse of MSW.
2. To identify Federal policy options that could be adopted to reduce the rate of generation of MSW or to stimulate the recovery, recycling, and reuse of the resources it contains.
3, To analyze the effectiveness of the policy options, and to assess their impacts and the issues that accompany each of them.

The scope of this study is limited to the generation and disposal of ordinary MSW in the United States. Specifically excluded from consideration are the management of hazardous wastes, sewage sludges, or other special wastes; the remanufacture, reworking, or refurbishing of products for reuse; the recycling of industrial scrap; and the recovery of materials or energy from agricultural, forestry, mining, or industrial residues.

The following specific issue areas are addressed:

1. Potential markets for recovered materials and energy, including the effects of railroad freight rates and product quality specifications. (Chapter 3)
2 The status of technologies and approaches for resource recovery and recycling, including small- and large-scale centralized processing and separate collection. (Chapters 4 and 5)
3. Economics of the construction and operation of large-scale centralized resource recovery facilities. (Chapter 6)
4. Institutional considerations in implementing resource recovery and waste reduction programs. (Chapter 7)
5. Education, training, technical assistance, and research and development for resource recovery, recycling, and reuse. (Chapters 4,5, and 7)
6. Financial options and incentives for influencing the relative costs of virgin and secondary materials. [Chapter 8)
7. The effectiveness and impacts of beverage container deposit legislation. (Chapter 9)
8. The nature of the interactions between programs for centralized resource recovery, source separation, and beverage container deposit legislation. (Chapters 4,6, and 9)

*See the Glossary at the end of this report for definitions of the terms used.

Approach

The study was carried out during the period from January 1976 to June 1978 by OTA staff, contractors, and consultants. Contractors and consultants collected and analyzed data, prepared models, and wrote papers, which have been published in the Working Papers volume. Several workshops were held to get the views of interested parties. OTA staff made a number of site visits to existing facilities and programs, participated in congressional hearings and briefings, and benefited greatly from individual contacts with persons in the field.

The overall framework for the analysis, discussed further below, consisted of an examination of the technological, economic, and institutional factors that influence resource recovery, recycling, and reuse. An attempt was made to analyze or assess all these factors and all the relevant policy options for addressing them. The emphasis was on the effectiveness of each option or strategy in accomplishing the goals of’ product reuse, reducing waste generation, and recovering and recycling materials and energy from MSW.

The Municipal Solid Waste Problem

Background

Solid waste disposal is a growing problem in many parts of the country for three reasons: (i) unsanitary disposal in open dumps or uncontrolled landfills poses health and safety hazards and esthetic problems that are no longer deemed acceptable; (ii) landfill sites are becoming increasingly difficult to obtain as citizens resist their development, as land values increase, and as higher water quality standards render many areas geologically unsuitable or too expensive for controlled landfill; and (iii) stricter air and water pollution standards make uncontrolled incineration, open burning, and ocean dumping unacceptable disposal alternatives.

In 1976, the national average cost to collect and dispose of 1 ton of MSW was reported to be $30.(1) It was as high as $50 per ton in some areas. In recent years, modern management methods and new technology have helped to control the cost of collection, which has typically been 70 to 80 percent of the total. Disposal costs, however, have increased rapidly as the problems mentioned above have emerged. The. Nation, concerned about the growing disposal burden and motivated by the prospect of materials and energy conservation, has begun to look toward resource recovery, recycling, and reuse as alternatives to disposal of a significant portion of MSW.

In 1975, an estimated 136 million tons of MSW was generated nationwide, an average of nearly 3.5 pounds per capita per day.(2) At $30 per ton, the cost to manage these wastes totaled over $4 billion in 197’5. The Environmental Protection Agency (EPA) has projected that waste generation rates will continue to grow, based on current trends and policies.(3)

One way to consider the potential for resource recovery, recycling, and reuse is to examine the composition of MSW on a nationwide, annual average basis, as shown in table 3.* The content, on a weight basis, of metals and “garbage” (food wastes) is relatively small. The content of combustible materials that can be burned to provide energy is nearly 80 percent of the total wet weight of MSW.

Another way to consider the composition of MSW is in terms of the product origins of the materials it contains as shown in table 4. Over 50 percent of the weight of MSW consists of paper and packaging, which are largely transitory goods. Over 51 percent of the aluminum, 46 percent of the glass, and 12 percent of the iron and steel come from beverage containers (beer and soft drinks).

*Accurate data on the amount and composition of MSW are not available. EPA’s estimates are based on a materials flow approach that considers production rates and lifetimes for each product, rather than on actual measurement of wastes.(3)

Table 3.— Material Composition* of MSW in 1975

Material	Waste content as discarded: Million tons	Waste content as discarded: % of total	Net waste disposed of after recycling: Million tons	Net waste disposed of after recycling: % of total
Paper	44.1	32.4	37.2	29.0
Glass	13.7	10.1	13.3	10.4
Ferrous	11.3	8.3	10.8	8.4
Aluminum	1.0	0.7	0.9	0.7
Other nonferrous	0.4	0.3	0.4	0.3
Plastics	4.4	3.2	4.4	3.4
Rubber	2.8	2.1	2.6	2.0
Leather	0.7	0.5	0.7	0.5
Textiles	2.1	1.5	2.1	1.6
Wood	4.8	3.5	4.8	3.7
Other	0.1	0.1	0.1	0.1
Total nonfood product waste	*85.4*	*62.7*	*77.5*	*60.4*
Food waste	*22.8*	*16.8*	*22.8*	*17.8*
Yard waste	*26.0*	*19.1*	*26.0*	*20.3*
Miscellaneous inorganic wastes	*1.9*	1.4	1.9	1.5
TOTAL	136.1	100.0	128.2	*100.0*

* The compositton reflects considerable geographic and seasonal variation, especially for the content of metals and yard wastes Furthermore, accurate composition data are difficult to obtain due to problems in obtaining representative samples of waste streams 1975 is the most recent year for which detailed composition estimates have been published by EPA

SOURCE U S Environmental Protect (on Agency Off Ice of Solid Waste Management Programs, *Resource Recovery* and Waste Reduction, Fourth Report to Congress, EPA Publicaton SW-600, Washington, D C U S GPO 1977, p 18

Another perspective on the potential of resource recovery from MSW can be gained by its contents as generated to total domestic consumption of its various components as shown in table 5. These data show that resources recovered from MSW could provide a substantial source of supply for some materials and could contribute to the Nation's supply of energy.

Federal Involvement in Solid Waste Problems

Rationale

Municipal solid waste collection and disposal have traditionally been the responsibility of State and local governments, with the latter bearing the primary burden. In the last two decades, however, the Federal role has expanded considerably, for several reasons.

First, the Federal Government has helped to create some of the problems faced by localities. For example, certain tax policies have encouraged the development and use of virgin materials. At the same time, increasingly stringent Federal environmental legislation has outlawed some disposal options and made others more expensive.

Second, the environmental problems created by improper disposal of wastes do not respect State boundaries. Water pollution from landfills and dumps, and air pollution from incineration and open burning often cross State lines, indicating a clear need for Federal coordination or action.

Third, the Federal Government has available a wider variety of policy tools for avoiding or managing waste disposal than do State and local governments. For example, most scrap materials are traded in volatile national markets over which State and local governments can exert little influence, whereas the Federal Government might undertake stockpile or subsidy programs to stabilize or strengthen markets. Only the Federal Government oversees railroad freight rates for materials. While State or local governments may have the power to levy product disposal charges, most are unlikely to do so because of the competitive disadvantage created by such unilateral local actions.

Fourth, the Federal Government can assume responsibility for funding research, development, and demonstration programs for which the expense or risk would be unreasonably high for a local government or an individual firm, but well worth it for the Nation as a whole. Likewise, Federal resources can be efficiently brought to bear on education, training, and information dissemination.

Fifth, the Federal Government can best represent the long-term national interest in recovering, reusing, and recycling materials for improving our balance of trade with other nations and for conserving materials for use by future generations.

48-786 0 - 79 - 3

Table 4.—Product Composition of MSW in 1975 (1,000 tons)

Product category	As discarded	Net waste disposed of after recycling: Quantity	% of total waste	% of nonfood product waste
Durable goods:	14,740	14,350	11	19
Major appliances	2,430	2,280	2	3
Furniture, furnishings	3,370	3,370	3	4
Rubber tires	1,790	1,600	1	2
Miscellaneous durables	7,150	7,100	5	9
Nondurable goods, exe. food:	24,140	21,365	17	27
Newspapers	8,850	7,020	5	9
Books, magazines	3,075	2,820	2	3
Office paper	5,210	4,510	4	6
Tissue paper, inc. towels	2,235	2,235	2	3
Paper plates, cups	485	485	—	—
Other non packaging paper	1,045	1,045	1	1
Clothing, footwear	1,250	1,250	1	2
Other miscellaneous durables	1,990	1,990	2	3
Containers and packaging:	46,550	41,740	33	54
Glass containers	12,520	12,150	10	16
Beer, soft drink	6,345	6,095	5	8
Wine, liquor	1,790	1,760	1	2
Food and other	4,385	4,295	3	6
Steel cans:	5,525	5,225	4	7
Beer, soft drink	1,340	1,275	1	2
Food	3,195	3,035	2	4
Other nonfood cans	760	720	1	1
Barrels,drums, pails, misc.	230	220	—	—
Aluminum:	770	685	1	1
Beer soft drink*	510	430	—	1
Other cans	25	25	—	—
Aluminum foil	235	230	—	—
Paper, paperboard:	23,135	19,080	15	25
Corrugated	12,520	9,745	7	13
Other paperboard	5,470	4,750	4	6
Paper packaging	5,145	4,585	4	6
Plastics:	2,635	2,635	2	3
Plastic containers	420	420	—	—
Other packaging	2,215	2,215	2	3
Wood packaging:	1,800	1,800	1	2
Other miscellaneous packaging	165	165	—	—
Total nonfood product waste	85,430	77,455	61	100
Food waste	22,785	22,785	18	29
Yard waste	26,010	26,010	20	33
Miscellaneous inorganic wastes	1,900	1,900	1	2
GRAND TOTAL	136,125	128,150	100	164

*Includes all-aluminum and aluminum ends from bimetallic cans

SOURCE US Environmental Protection Agency, Office of Solid Waste Management Programs, *Resource Recovery and Waste Reduction,* Fourth Report to Congress, EPA Publication SW-600, Washington, DC, U.S GPO,1977, p 17

Table 5.—Comparison of Materials and Energy Content of MSW to Total U.S. Consumption in 1975

MSW component	MSW content[a] as a percentage of consumption
Ferrous metal	12
Aluminum	22
Other nonferrous metal	5
Glass	69
Paper	67
Energy[b]	1.9

[a]MSW as discarded Some portions of each material are recovered for recycling before disposal See table 3
[b]Includes fuel value of paper
SOURCE Off Ice of Technology Assessment

Finally, local solid waste management problems are highly visible and, unlike many other local problems, may be resolvable by the application of sufficient money and technical know-how.

History

Three major laws have prescribed the Federal role in solid waste management: the Solid Waste Disposal Act of 1965, the Resource Recovery Act of 1970, and the Resource Conservation and Recovery Act of 1976. Several other acts have had a lesser influence. *

Federal involvement in the problems of MSW management was first established under the Solid Waste Disposal Act of 1965, which is part of the Clean Air Act Amendments (Public Law 89-272, 79 Stat. 992 (1965)). The Act recognized the association of solid waste disposal, air pollution, and waste generation rates, and provided for designing and testing new methods for solid waste disposal and resource recovery. It also provided technical and financial assistance to States and to interstate agencies for planning resource recovery and solid waste disposal programs. It was originally administered by the Department of Health, Education, and Welfare, but in 1970 the responsibility was transferred to the newly formed EPA.

*See appendix A for a more detailed discussion of existing laws on solid waste management.

The 1965 Act was amended by the Resource Recovery Act of 1970 (Public Law 91-512, 84 Stat. 1227 (1970)). The amendment recognized the special disposal problems of hazardous wastes. It established the need to examine a national materials policy to conserve resources and protect the environment through Title II, the Materials Policy Act of 1970, which established the National Commission on Materials Policy.(6) The Act, as amended, required annual reports to the Congress on studies of various waste-generation, materials recovery, and waste disposal options, practices, and policies. Under the Act, the EPA Administrator could fund resource recovery demonstration projects; award grants for State, interstate, and local planning; and recommend guidelines for solid waste recovery, collection, separation, and disposal systems.

The Resource Conservation and Recovery Act of 1976 (Public Law 94-580, 90 Stat. 2795) was enacted and signed during the last days of the 94th Congress. This Act is designed to establish broad new programs, including comprehensive regulations for the management of hazardous wastes; to provide incentives for regionalized solid waste planning; and to accelerate research, development, and demonstration. The Act provides that, in order to receive Federal planning funds, State plans must ban open dumps and require all sanitary landfills to meet environmental criteria to be set by EPA. Section 8002(j) of the Act established the interagency, Cabinet-level Resource Conservation Committee charged with investigating a variety of resource conservation measures for possible future actions.

A number of other recent laws have had important implications for solid waste management and resource recovery. The Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500, 86 Stat. 816), as amended by the Clean Water Act of 1977 (Public Law 95-217, 91 Stat. 1566) treat solid waste disposal sites as nonpoint sources of water pollution. The Federal Ocean Dumping Act of 1972 (Public Law 92-532, 86 Stat.

1051) as amended in 1974 (Public Law 93-254, 88 Stat. 50) prohibits ocean dumping of hazardous wastes, and requires a carefully defined permit for ocean disposal of MSW. This law has nearly eliminated such ocean disposal.

The Secretary of the Treasury, with the cooperation of EPA, is required by Public Law 94-568 (90 Stat. 2697), which amends the Internal Revenue Code of 1954, to investigate all provisions of the Internal Revenue Code that impede or discourage recycling of solid wastes, and was to report his findings by April 20, 1977, to the President and Congress with specific legislative proposals and detailed estimates of their costs. Activities under this Act, however, have been subsumed under the ongoing interagency Nonfuel Minerals Policy Study* ordered by the President on December 12, 1977.(7)

The Railroad Revitalization and Regulatory Reform Act of 1976 (Public Law 94-210, 90 Stat. 30) required the Interstate Commerce Commission to investigate the structure of freight rates for recyclable materials. The Commission's actions, and subsequent court actions, are discussed in chapter 3 of this report.

The Emergency Interim Consumer Product Safety Standard Act of 1978 (Public Law 95-319, 92 Stat. 386) established an interim consumer product safety rule relating to the standards for flame resistance and corrosiveness of cellulose for home insulation. Cellulose insulation is made from recycled newspaper treated with fire retardant. The intent of the Act was to guard against fire hazards from insulation treated with inadequate amounts of fire retardant.

The Energy Tax Act (Public Law 95-618, 92 Stat. 3174) contains two provisions that should influence recycling. One provides an additional lo-percent investment tax credit (for a total of 20 percent) for the purchase of equipment used to recycle ferrous (with certain exceptions) and nonferrous metals, textiles, paper, rubber, and other materials for energy conservation. The additional credit is available for a wide range of equipment placed in service after October 1, 1978. The other provides for setting recycling targets for major energy-consuming industries. These include the metals, paper, textile, and rubber industries. Specific targets will be set for the increased use of recycled commodities over the next 10 years.

*On Feb. 1, 1979, the Department of the Treasury published the report, Federal Tax Policies: Recycling of Solid Waste Materials, in response to Public Law 94-568 and the ongoing interagency Nonfuel Minerals Policy study. The report was also given to the Resource Conservation Committee which was established under the Resource Conservation and Recovery Act of 1976.

For legislation affecting solid waste management, resource recovery, recycling, and reuse considered by the 95th Congress, see appendix B.

Framework for the Analysis of Resource Recovery, Recycling, and Reuse

This section sets forth a general framework for the analysis of issues and options. The materials system concept is used to illustrate the various ways in which recovered materials can reenter the materials cycle. The roles of technology, economics, and institutions are explored for the insights they provide. Finally, guidelines for the analysis of the available options are discussed.

The Materials System and Policy Options

The traditional view of the materials system as seen by local MSW managers is modeled in figure 1. Those responsible for the management of MSW have exercised little or no control over the other parts of the materials system. They have only been involved with the last two steps, collection and disposal.

The comprehensive materials system model shown in figure 2 displays a wide variety of opportunities for Government and for the private sector to affect the flow of materials toward ultimate disposal through reuse and recycling. Some of the major public policy op-

Figure 1 .—A Simple Model of the Materials System With No Reuse or Recycling

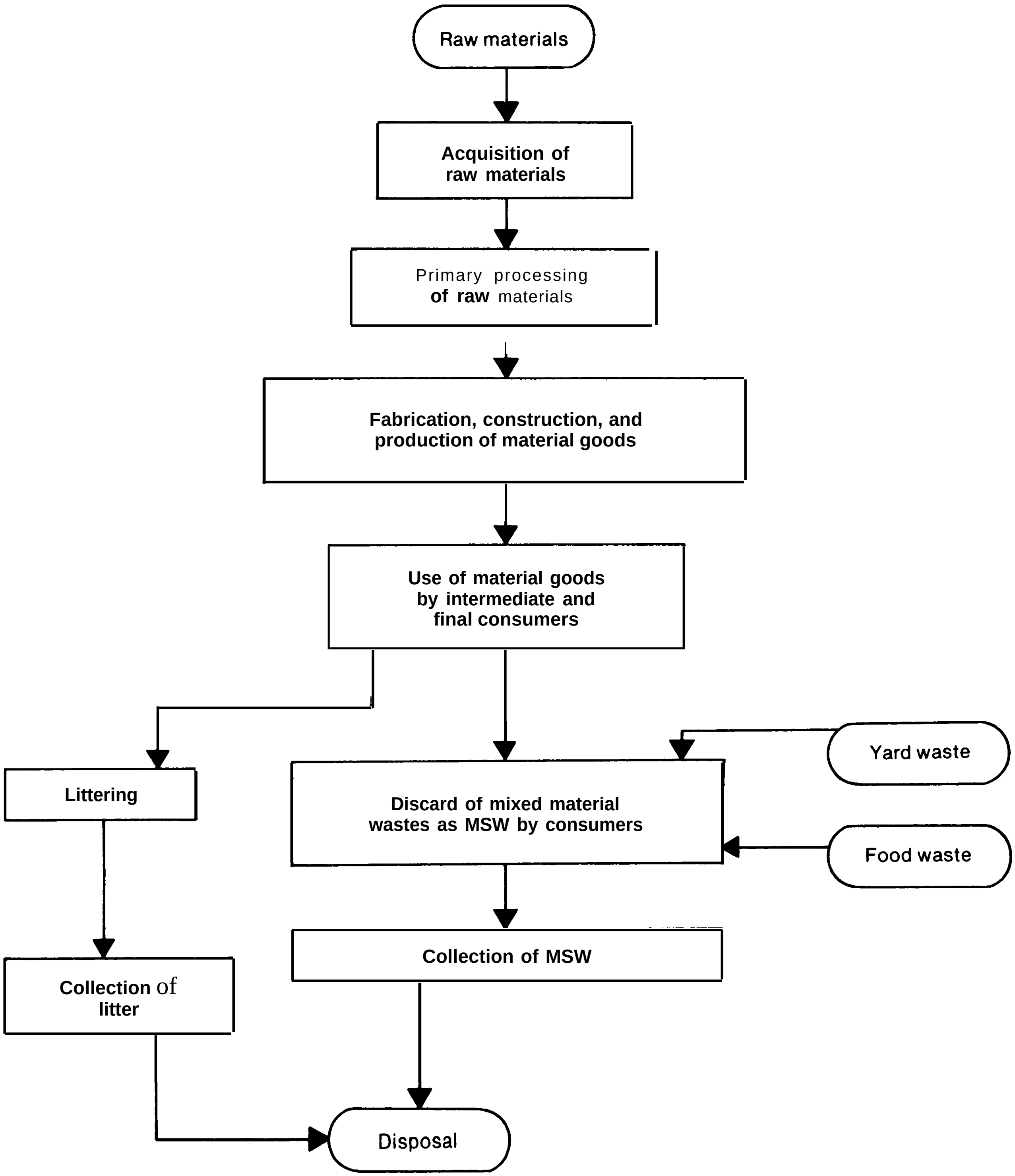
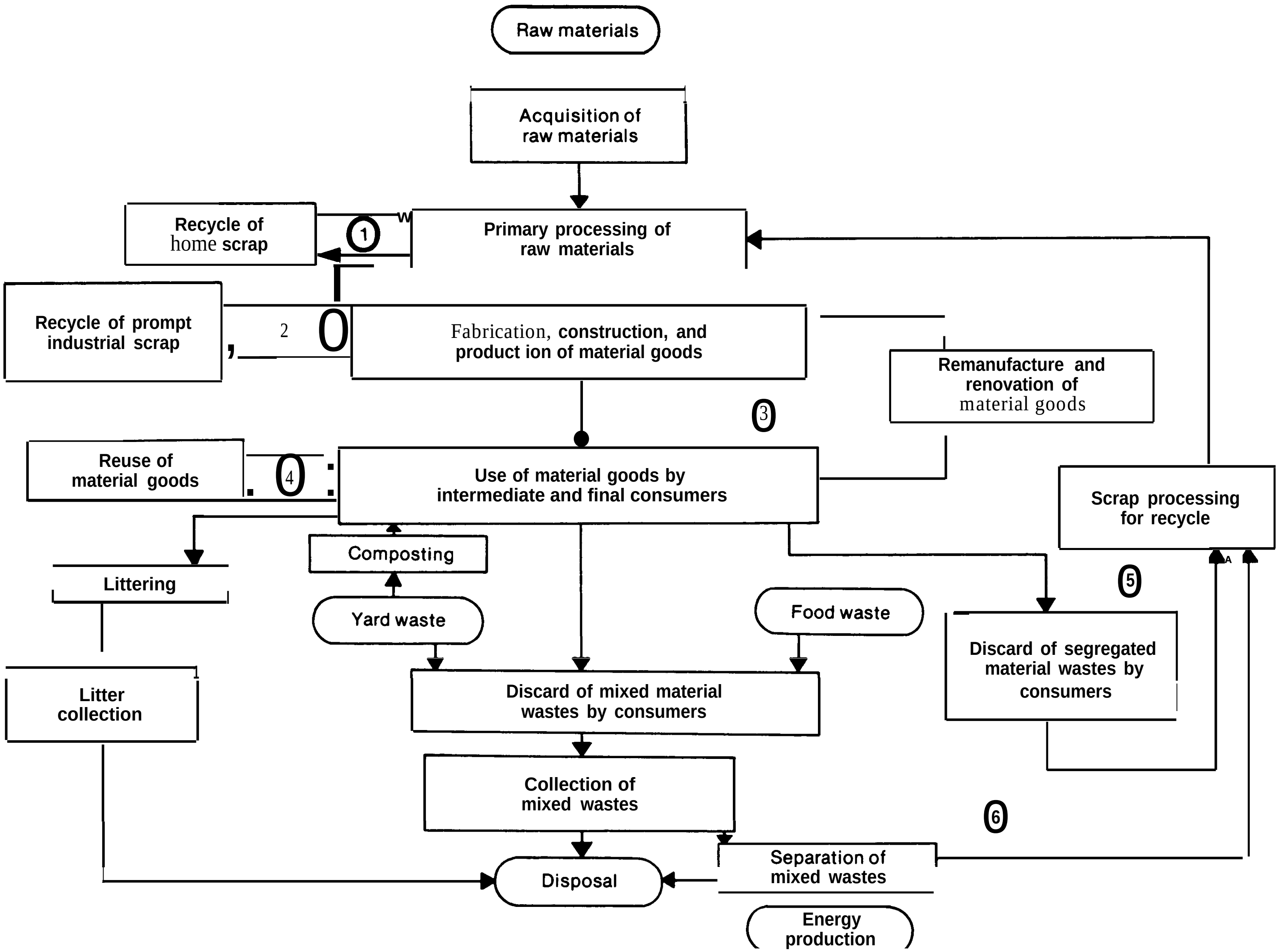


Figure 2.—A Complex Model of the Materials System Showing a Variety of Recycle Loops and Disposal Options



ions available for modifying the structure and functioning of the materials system are the subject of this report. The nature of many of these options is revealed by examination of the technical, economic, and institutional influences on the materials system.

The materials system model in figure 2 contains six pathways or loops by which materials are recycled or reused prior to ultimate disposal. Loops 4, 5, and 6 are within the scope of this study; loops 1, 2, and 3 are not. The six loops are:

1. Home scrap recycle.
2. Prompt industrial scrap recycle.
3. Product remanufacture or renovation.
4. Reuse of material goods.
5. Recycle of segregated wastes.
6. Recovery of energy and materials from mixed wastes.

Loops and 2 represent the long-established industrial practices of immediately recycling either home scrap within the primary materials processing facility or rompt nciustrial scrap from fabricators directly back to such processors. Loop 3 represents a variety of rework practices. These include the remanufacture of auto parts, the refurbishing of telephones, the renovation of standing buildings, and the repair and sale of used clothing and appliances by handicapped workers. The characteristics of materials flows in home and prompt scrap and in product rework are currently under study in another TA project.(8)

Loop number 4 represents direct reuse of material goods with little or no change in form. Typical examples of reuse include return of beverage containers for refilling, reuse of "used cars" by second or third owners, and reuse of shipping pallets.

Loop number 5 represents recycling discarded material wastes, which are segregated by material type at each stage in the loop. One example of this approach is separate collection of one or more components of municipal waste. This is practiced in a number of areas, often by curbside collection of newspapers, glass, and cans; by collection of corrugated cardboard at commercial establishments; or by "paper drives" sponsored by nonprofit organizations. A second example is "community recycling" in which nonprofit organizations or local governments provide facilities at which citizens can drop off on-mixed wastes such as paper, cans, bottles, and waste oil. A third example is aluminum can recycling centers operated by aluminum manufacturers or beverage companies. In each of these examples the segregated wastes can be easily processed because they are kept relatively free of contamination.

Loop number 6 represents recycling mixed wastes, which are separated to recover materials and fuel or burned in mixed form to produce energy. In either case a residue remains for ultimate disposal. One example of this kind of recycling is the shredding of automobile hulks to remove nonmetals and to produce one or more recyclable metallic components. Another example, which is of primary interest in this study, is the separation and/or combustion of mixed SW in centralized resource recovery plants. This method may be able to produce various recyclable materials such as ferrous metals, aluminum, glass, and mixed nonferrous metals; as well as such energy products as refuse-derived fuel, steam, electricity, pyrolytic gas or oil, or biologically produced methane gas.

Finally, figure 2 shows yard waste being returned to users as compost or mulch. This can be done by individuals at home, or by collection, comporting, and redistribution of such waste as compost and mulch, as is practiced in some communities.

Technical Characteristics of the Materials System

The flow of materials through the materials system obeys certain physical laws. Matter is neither created nor destroyed. Its physical and chemical form, however, can undergo change, and some matter is lost to the environment as it moves through the system. In addition, energy is needed to drive the flow of materials through the system.

These physical laws imply that (i) some new materials must be acquired to make up for any losses; (ii) there will always be some residuals left as a result of the materials flow; and (iii) in principle, all materials can be accounted for as they flow through the system. This means that in either a static or a growing economy in which there is no technological change, recycled materials can satisfy only part of the need for materials. Furthermore, regardless of the effectiveness of the materials and energy recovery system used, some residual SW will always require disposal.

As materials move through the system from acquisition to disposal, it becomes increasingly difficult to recover, recycle, or reuse them. They may become part of manufactured goods in which they are firmly combined with other materials and thus not recoverable unless products are designed to facilitate reuse and recycling. Materials may also become so widely dispersed that they are essentially irretrievable. Paint pigments, chrome plating, and copper wire in automobiles, for example, cannot be recovered economically, if at all.

The technologies needed to move materials along each of the six recycle pathways shown in figure 2 are currently at different stages of development. This reflects the level of historic interest in each recycling method, the different states of the scientific knowledge base necessary to develop such technology, and the differing levels of technical difficulty presented by each recycling approach. For example, the technologies needed to reuse beverage bottles reached their current stage of development years ago. Modern engineering and management methods could probably improve them significantly. Yet economic interest in improving such systems over the last 20 years has not been sufficient to stimulate the necessary applied research. As another example, currently large sums of money and considerable technical talent are being devoted to developing, demonstrating, and improving methods for the challenging task of separating SW into useful components.

The connections between materials flows and energy consumption are neither simple nor obvious. On the one hand, combustion of SW is often cited as a potential energy source. On the other hand, recycling or reuse of some of the combustible components of SW such as paper or plastic may conserve more energy than would have been produced by burning them. Also, while the production of materials consumes energy, carefully designed energy-conserving structures or machines may use more materials than would be used in alternative designs that consume more energy. In these as well as in other cases, the relationship between materials and energy must be carefully examined—no general principle of co-conservation exists.

Some resource recovery, recycling, and reuse options may employ technologies that are more sophisticated than others. This is an insufficient reason to justify orientation of public policy toward the adoption of either "high" or "low" technology approaches. The various technical approaches to resource recovery, recycling, and reuse may be mutually supportive and compatible. Thus, the wisest policy may be to allow for the choice of a mix of approaches based on technical capabilities, economic costs, and political realities.

Economic Characteristics of the Materials System

The flow of materials in the materials system is influenced by economic forces, as well as by other factors such as technological possibilities. An overview of the economic nature of the materials system, including forces created by existing Government policies, can highlight opportunities for public policy initiatives in the resource recovery, recycling, and reuse area. An understanding of the economics of the materials system is also useful in identifying and analyzing the implications for the various parts of the system of changes in one or another of its parts.

A fundamental principle of market economics applicable to the materials system is that there is a tendency in the short run and a much stronger tendency in the long run for the buyers and sellers of materials to respond to prices, costs, and profitability considerations. For example, all other things being equal, consumers will purchase the cheapest of two or more products, and producers will incorporate the lowest priced materials in their products. The significance of this economic principle is that economic incentives such as taxes, charges, deposits, subsidies, depletion allowances, and the like can influence the flow of materials through the system.

A number of specific observations about the behavior of the materials system follow from economic principles:

1. The rates of flow of each material between various stages in the materials system depend on the material's price; the prices of all other materials, goods, and services in the economy; the level of technical knowledge; prior capital investments; and consumer demands.

2. Consumer demands for materials ultimately depend on consumer tastes. These can change to reflect changing economic, political, moral, and spiritual values.

3. The demand for materials is largely derived from the demand for the goods that are made from them. Since material costs are usually a small fraction of the costs of final goods, the demand for a material is often relatively insensitive to a change in its price in the short run. Over longer periods of time, material demand will change as producers adjust to changing prices by investing in new capital equipment designed to use less expensive or more available material inputs.

4. A host of existing Government programs affect the costs and relative prices of materials and thus influence their rates of flow in the materials system. Such programs as income and property taxes, environmental regulations, and various subsidies may be intended to accomplish other social goals and may shift the patterns of materials flow only as side effects.

5, A variety of direct and indirect subsidies that tend to reduce material costs are listed in table 6. Such subsidies, whose benefits accrue both to the materials industries and to users of materials, are designed to accomplish various public purposes. Their consequence, however, is that not all the costs of the production and use of materials are reflected in their market prices.

64 The primary materials acquisition and processing industries are capital-intensive with large fixed costs of operation. At the same time, the demand for basic materials varies strongly with the general state of the economy. To avoid the burden of paying high fixed costs in periods of low demand, the basic materials industries try to meet peak demands by using more scrap raw materials. As a result, the demand for secondary materials fluctuates and is highest when overall materials demand is high. Fur-

Table 6.—Selected Subsidies in the Materials System

Direct subsidies
- —percentage depletion allowance for virgin minerals
- —capital gains treatment of timber income
- — accelerated depreciation for capital investments
- —tax credits for investment in new capital equipment
- —tax deductions for interest payments

Indirect subsidies
- — royalty-free access to virgin materials on public lands
- —Government funding for highway construction and support for railroad operations
- —differential freight rates for various materials
- —free use of domestic waterways
- —educational benefits for training of professional and skilled labor
- —Government R&D on materials production and use
- — forest product R&D and technical assistance
- — low-cost use of clean air and water
- —low-cost use of worker health and safety
- –Government production of geological and mapping data

SOURCE Office of Technology Assessment

thermore, in periods of high economic activity and consequent high secondary materials demand, prices for secondary materials rise. Thus, scrap demand appears to increase with its price, when, in fact, its price increases with demand. One implication of these observations is that policies designed to stimulate the demand for scrap are likely to be more effective in assisting resource recovery, recycling, and reuse than are policies designed to increase the supply of scrap.

7. In most communities, consumers pay uniform charges for solid waste collection and disposal, or such costs are met by local property taxes. In either case, there is less incentive to avoid waste disposal or to seek recycling or reuse alternatives than there would be if full collection and disposal costs were paid for each discarded item.
8. The social costs of litter (collection, esthetic loss, personal and wildlife injury, machine damage, law enforcement) are higher than the cost to the litterer of proper disposal. Therefore, policies that provide incentives to avoid littering are likely to be more cost effective than those that provide for increased collection activity.
9. The economic system, which discounts the future costs and benefits of current actions, does not take into consideration the long-run exhaustion of high-grade natural resources as it would if the interests of future generations were taken into account.

Institutional Characteristics of the Materials System

In our society, the forces of economics and the capabilities of technology are often constrained or enhanced by institutional influences arising from geography, historical development, tradition, political action, or other exercise of power.

Some institutional factors are specific to the materials system and may be readily susceptible to alteration in pursuit of the goals of resource recovery, recycling, and reuse. An example of this kind of institution is a design specification that requires the use of virgin materials when recycled materials might perform equally well.

Other institutional factors are parts of the total cultural framework and are much less susceptible to manipulation in the interest of resource recovery, recycling, and reuse. An example is the fragmented, overlapping system of local, regional, State, and Federal responsibilities for government. This system tends to inhibit the adoption of efficient methods for control of waste generation and for management of wastes. It cannot, however, be significantly altered solely to accomplish these particular social purposes.

Table 7 lists selected institutional characteristics of the materials system. These have been chosen to illustrate institutional barriers to resource recovery. Some serve important social purposes and should not be changed to accommodate recycling. In such cases, it may be better to add new institutions or to adopt compensatory economic incentives. In other cases, institutional barriers can be overcome by new legislation or regulation.

Some institutional characteristics of the materials system could be equally classified as economic. For example, historic investments in primary processing facilities designed to use virgin ore contribute to the large size and vertical integration of virgin materials producers. This economic activity has created an institutional barrier to recycling postconsumer scrap. Some analysts have argued that many institutional forms, including Government policies, have economic roots. While the distinction may be somewhat arbitrary, it provides a useful part of the analytic framework in later chapters.

Guidelines for the Analysis of Policy Options

Several guidelines have been used to focus the analysis of policy options. These guidelines, which reflect the diverse goals of our

Table 7.— Selected Institutional Characteristics of the Materials System That Are Barriers to Resource Recovery

Industry structure and practice
- —entrenched local interests in collection and outmoded disposal methods for MSW
- —local or national economic concentration in the materials industries
- —vertical integration in the virgin materials industries
- — small size of secondary materials firms
- —joint ownership of transportation and virgin materials firms
- —declining quality of some rail freight service
- —fluctuations in secondary material demand and prices
- —use of advertising and packaging as a means of product differential ion

Regulatory practices
- — regulation of freight rates
- — material design or purchase specifications that require use of virgin materials
- —electric utility rate regulation that discourages risk-taking with nontraditional fuels
- —limitations on interjurisdictional transfer and disposal of wastes
- —delay in promulgating environmental and occupational standards for new resource recovery technologies

Government limitations
- —limited enforceability of anti litter laws
- —limited ability of the political process to respond to tradeoffs between the loss of existing jobs and the creation of new ones
- —fragmented and overlapping nature of Government responsibility for waste problems
- —difficulty of local government cooperation
- —absence of technical and marketing skills in local governments
- —limitations on local government participation in long-term contracts

SOURCE Office of Technology Assessment

society, provide a basis for illuminating the tradeoffs among society's goals that are required when a policy for resource recovery, recycling, and reuse is adopted. The guidelines are:

1. Technical, administrative, and political feasibility;
2. Economic efficiency;
3. Equity and participation;
4. Ecological, national, and personal security; and
5. Diversity and complementarily.

In certain parts of this study these guidelines are used explicitly as criteria for the assessment of options. In other parts, they are implicit in the discussion. In the following paragraphs, the application of these guidelines to materials policy is outlined.

The technical, administrative, and political feasibility guideline concerns the implementation and workability of a proposed policy. Is the necessary technology available, or can it be developed within a meaningful time frame? Are the political interests alined in such a way as to allow a reasonable chance of adoption and implementation of the policy? If adopted, can ways be found to administer a policy at reasonable costs and without unduly infringing on constitutional or traditional freedoms of individuals or institutions? If all these answers are "yes," will the proposed policy be effective in accomplishing its goals?

According to the economic efficiency guideline, society as a whole is most benefited when each resource is used in its highest and best use. In an ideal market economy this is approached when each activity bears its full social costs and benefits, including externalities; when all producers and consumers are completely informed; and when competition exists. We do not live in such an ideal world, however, and economic efficiency means that the costs of a policy should not outweigh its benefits and that the policy with the highest benefit-to-cost ratio is most likely to be efficient. In the area of waste management, the concept of efficiency is exemplified by the "polluter pays" principle. (9)

The equity guideline requires that the costs and benefits of using natural resources be fairly distributed. Equity also extends to the preservation of natural resources for future generations. The best way to achieve equity among generations, however, has yet to be decided. Participation refers to the right of citizens and their representatives to influence decisions that affect them and their heritage of nature's resources. Participation by affected citizens can help to achieve an equitable and acceptable resolution of conflicts.

To achieve ecological security for the human species the cycles that underlie life on this planet must be preserved. While not yet fully understood, this appears to require minimal disturbance of the air and water, control of persistent hazardous materials, preservation of plant and animal species, and preservation of unique or genetically rich ecosystems.

National security means maintenance of the integrity of the United States as an independent nation-state. There is disagreement over what constitutes independence and about how this goal is to be accomplished. In a world that features economic, political, ecological, and spiritual interdependence, the proper design of a materials policy to preserve national security is by no means clear.

Personal security, in the context of materials policy, pertains to the preservation of private property and the protection of individuals against undue risk of personal harm from the functioning of the materials system. It includes the right to just compensation for the sale of one's labor or property as well as the right to reasonable assurance against health hazards from improper production, use, or disposal of materials.

Options that allow for a variety of approaches to be used at the same time or at the same place are often more desirable than those that require using a single or uniform approach. In solid waste management, differing local circumstances may make certain solutions feasible in some places and unworkable in others. In some circumstances, a combination of approaches may work best. As issues in resource recovery, recycling, and reuse are brought to the national level, a diversity of approaches will allow for adaptation to local situations. This will also increase the chances that local experimentation may discover better approaches.

References

1. U.S. Environmental Protection Agency, Office of Solid Waste Management Programs, Resource Recovery and Waste Reduction, Fourth Report to Congress, EPA Publication SW-600, Washington, D. C., U.S. GPO, 1977, p.4.
z. Ibid., p. xii.
3. U.S. Environmental Protection Agency, EPA Activities Under the Resource Conservation and Recovery Act of 1976, Report SW-663, February 1978, p,2.
4. Ibid., footnote 1, p. 18.
5. Ibid., footnote I, p. 17.
6. National Commission on Materials Policy, Material Needs and the Environment Today and Tomorrow: Final Report, June 1973,
7. Presidential Proclamation: Administration of Jimmy Carter, 1977. Nonfuel Minerals Policy; Announcement of a Cabinet-Level Interagency Study, Dec. 12, 1977.
8. Office of Technology Assessment, U.S. Congress, forthcoming report on Technical Options for Metals Conservation: Case Studies of Eight Selected Metals and Seven Selected Products, to be published in mid-1979.
9. Organization for Economic Cooperation and Development, The Polluter Pays Principle, OECD Publication 97-75-02-1, May 1975.