Chapter 7

# Resource Recovery From Municipal Solid Waste

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## CHAPTER 7

# Resource Recovery From Municipal Solid Waste

## Introduction

Public and private organizations throughout the United States are investigating and investing in technologies that will recover resources from municipal solid waste (MSW).[1] Two increasingly serious problems—those of waste disposal and resource supply—are compelling them to do so:

> The United States annually generates more than 135 million tons of MSW. Its disposal is a rapidly growing problem for many areas of the country, where such traditional methods as open dumping, landfill, uncontrolled incineration, and ocean burial are too expensive or environmentally unacceptable. At the same time, MSW contains over two-thirds of the national consumption of paper and glass, over one-fifth of the aluminum, and nearly one-eighth of the iron and steel. If burned, the combustible portion of this waste would be equivalent to about 1.9 percent of the Nation's annual energy use.
>
> Resource recovery . . . recycling, and reuse can contribute to the wise and efficient use of materials, to conserving energy, to preserving the environment, and to improving the balance of trade by reducing our dependence on imported natural resources. By using materials more than once, virgin resources can be conserved for ourselves and for future generations.[2]

Major environmental legislation enacted during the 1970's ruled out several previously acceptable methods of solid waste disposal, and this put pressure on State and local governments to find innovative ways of disposing of MSW. At the same time, supply disruptions and price increases, such as the 1973 oil embargo and the recent OPEC price hikes, have caused uncertainty about the future availability and cost of energy and other raw materials. This uncertainty has in turn led to greater efforts to conserve these resources and, where possible, to recycle them for further use. Consequently, to the extent that alternative technologies for solid waste disposal can also recover energy and materials from MSW, they can reduce the cost of community services and promote local development, as well as serving the interests of health, environmental protection, economic well-being, and national security.

[1] As defined by the Resource Conservation and Recovery Act of 1976 (Public Law 94-580), sec. 1004, these "resources" include both energy and materials.

[2] *Materials and Energy From Municipal Waste* (two vols., Washington, D. C.: Office of Technology Assessment, U.S. Congress, July 1979), vol. 1, OTA-M-93, p. 3.

## Alternative Resource Recovery Technologies

An earlier OTA assessment has identified two major methods for recovering energy and materials for recycling from MSW: source separation and centralized resource recovery. Source *separation* consists of programs to separate recyclable materials at the waste source and then collect them through such -methods as curbside collection, community recycling centers, industry-sponsored recycling programs, and commercial and industrial methods of source separation. These programs are the only available method by which wastepaper can be recovered for recycling into new paper products, and they also recover significant amounts of glass and ferrous and nonferrous metals. Industry-sponsored programs, for instance,

[3] Ibid., especially app. C; for a more extensive survey of research in this area, see U.S. Bureau of Mines, Bureau of Mines Research on Resource *Recovery, Reclamation, Utilization, Disposal,* and *Stabilization,* Bureau of Mines Information Circular 8750, (Washington, D. C.: Department of the Interior, 1977).

collected 25 percent of all the aluminum beverage cans produced in 1977. In addition, separated yard wastes and other organic matter can be composted to produce soil-enhancing materials.

*Centralized resource recovery,* in which mixed wastes are processed at a central facility, also can recover energy from MSW either by producing steam or by converting the organic components of the waste into some form of fuel. The upper limit on energy recovery from MS W would equal about 1.9 percent of current annual energy consumption in the United States, and the recovery of all of the recyclable materials would save an additional 0.4 percent—the energy it would require to produce these materials from virgin sources—for a total energy savings of 2.3 percent of current consumption. Technical and economic factors will keep energy recovery to a fraction of this potential for the foreseeable future; nevertheless, centralized resource recovery can play a small but significant role in conserving energy.

A number of alternative technologies for recovering materials and for burning the combustible portion of MSW or converting it into fuel are at various stages of development. *Commercially operational technologies* include the comporting of organic wastes and the magnetic recovery of ferrous metals, as well as two types of energy recovery systems: the mass incineration of raw MSW in waterwall furnaces or small-scale modular incinerators; and several processes that recover solid refuse-derived fuel (RDF) from separated and treated wastes.

*Developmental technologies,* which have been demonstrated in pilot operations but not in full-scale plants, include several processes for recovering aluminum and glass from the waste flow, as well as two methods of energy recovery: pyrolysis systems, in which the wastes are distilled at high temperatures to produce medium- and low-Btu gases and liquid RDFs; and landfill methane recovery, in which the gases produced by biological processes are removed through wells and treated to produce pipeline-quality methane. There is sufficient pilot experience with these systems to estimate full-scale performance, but technical and economic uncertainty is greater than with commercially operational systems.

*Experimental technologies,* which are still being tested in laboratories and pilot plants, include processes for the recovery of nonferrous metals and wastepaper from MSW, as well as two further energy recovery processes: anaerobic digestion, in which a mixture of methane and carbon dioxide is generated through bacterial action in a process similar to the activated sludge system of wastewater treatment (see ch. 8); and a waste-fired gas turbine. In addition, considerable research has been done on several hydrolysis processes, in which ethyl alcohol (ethanol) is produced from the organic portion of MSW through either acid treatment or enzyme action. There is as yet insufficient information to predict the technical or economic feasibility of any of these technologies.

This chapter consists of case studies of two projects that are applications of commercially operational technologies: the Recycle Energy System in Akron, Ohio, an example of centralized resource recovery through the waterwall combustion of raw MSW for steam generation as well as materials recovery; and the Bronx Frontier Development Corp. project in New York City, an example of source separation and the recovery of organic materials through comporting. Although these projects differ in scale and complexity as well as process and product, both are approaches to local development based on the assumption that solid waste is not a useless end-product to be disposed of, but rather is a resource that can be recovered and used in ways beneficial to the community.

In the case of Akron, the approach involves using solid waste as a fuel to generate energy needed for space heating and manufacturing in that city's business district. In the case of the Bronx, it involves transforming organic refuse from a produce market into compost, which is then used to reclaim otherwise infertile land for parks and urban farming. Both present alternatives to the conventional techniques and institutional arrangements for dealing with MSW.

# Centralized Resource Recovery-A Case Study of the Recycle Energy System, Akron, Ohio[4]

## The Community Setting

Akron, population 269,000, is located in northeastern Ohio. The city's economy centers on trucking and manufacturing industries, primarily those involved in rubber production. Manufacturing sector employment declined by 20 percent between 1960 and 1970, while service sector employment increased by almost 40 percent. Employment patterns in the rubber industry, the major employer, reflect these local trends: older plants have been phased out and hourly jobs eliminated, while Goodyear and B. F. Goodrich have invested millions of dollars in administrative and research facilities. Nevertheless, the manufacturing sector still employed 38 percent of the city's work force in 1970, compared to a national average of 26 percent.

Like many other northern industrial cities, Akron has experienced a decline in the economic activity of its central business district over the last 20 years. While most of the retail stores have moved to the suburbs, however, there has been some development of educational, office, and government facilities. The University of Akron has grown considerably and has made capital investments of $65 million in the city since 1965. The old Quaker Oats mill has been converted into a successful shopping mall, hotel, and office building, and Ohio Edison has built a new headquarters in the Cascade Plaza complex. City and county agencies also employ a significant number of people in the central business district.

Most of these offices, as well as the surrounding churches, hospitals, shops, and other businesses, use steam for space heating and hot water. The steam is supplied by the local utility company, Ohio Edison, but since 1948 the company has wanted to abandon its outmoded steam operations and concentrate on providing electrical energy. The cost of providing steam energy from antiquated central plants had become more expensive than onsite production, and Ohio Edison's downtown plant was in violation of Federal environmental standards. Two of the major energy users in Akron's central business district, B. F. Goodrich and the University of Akron, operated their own powerplants and did not purchase power from the utility. However, both institutions encountered problems with their plants; Goodrich, in particular, was also in violation of Federal emissions standards, and compliance would have required major capital expenditures. In addition, both institutions were faced with rising demand at a time when the cost of fossil fuels was rising rapidly.

At the same time that problems were developing in the energy supply for the central business district, Akron and surrounding Summit County also began encountering problems with the disposal of their solid waste. As early as 1969, the adverse environmental effects of landfill disposal were becoming increasingly apparent: raw garbage was an unstable fill, generated noxious odors, and spoiled the landscape. In addition, the Hardy Road landfill, the city's major facility, was projected to be filled within 15 years. New sites were difficult to locate because of the high population density and stricter environmental standards; in 1976, the Environmental Protection Agency (EPA) indicated that it would not approve further landfill sites in the Akron area. If the sites were located farther from the city, however, the cost of transporting garbage to them would increase significantly.

It was in this context that, in 1968, planners in Akron began searching for an alternative solid

[4]Material in this case study is based on the working paper, "Solid Waste Fired Steam Plant," prepared by Randall Constantine and Jonathan Feld for the Harvard Workshop on Appropriate Technology for Community Development, Department of City and Regional Planning, Harvard University, May 15, 1979; background information on Akron was made available by the city's Department of Planning and Urban Development,

waste management system. Any new system would have to meet five major objectives:

1. processing the widest range of solid waste without special handling or sorting;
2. reducing the volume of waste to a minimum residue for subsequent landfill;
3. reducing air pollution;
4. making any new disposal system compatible with an urban setting; and
5. keeping solid waste disposal costs at their current levels.

After considering pyrolysis, site compacting, railroad hauling, incineration, and continued landfill, the city turned its attention to the Recycle Energy System (RES), which would incinerate solid waste to generate steam energy.

## Development

When Akron began searching for a solution to its waste disposal problem in 1969, B. F. Goodrich donated $15,000 for a feasibility study of an energy recovery system. The study concluded that, although the system was technologically feasible, it would not be economical for the city to generate steam from garbage unless there was an increase in total demand for steam, particularly in the summer months when most users employed electric air conditioning. For this reason, and because of the large capital investment involved, the city did little to pursue the project at that time.

The 1973 oil embargo rekindled interest in energy recovery systems, and the project regained momentum. The greatest support for the project came from the City Council, particularly its President; the Mayor, on the other hand, was reluctant to commit the city to the large capital investment required for the development of a new technology. Unable to solicit Federal support, the city's Planning Department borrowed $1 million from Akron's revenue-sharing funds to finance a preliminary engineering study.

This time the study, conducted by the engineering firm of Glaus, Pyle, Schemer, Burns, and DeHaven, was more favorable, and the city retained an investment banking firm, Prescott, Ball, and Turbin, to float bonds to finance the project. The design work proceeded smoothly, but the underwriters had difficulty raising the necessary capital, in part because of problems encountered by similar plants elsewhere and in part because of the firm's lack of familiarity with this type of project.

In mid-1976 another banking firm, Dillon, Read & Co., agreed to help float the bonds for the project, and with their assistance additional steam users were found and contracts between them and the city were negotiated and signed. By December 1978 financing was completed and construction began. Once the details of the project took form, the Mayor and other members of the city government became more active in their support.

*Photo credit: Teledyne National*

**The Akron Recycle Energy System became operational in 1979**

By November 1979 the plant was operating at 60 percent of capacity and was due to reach 100 percent by the end of the year. The city owns the site and the plant, but Teledyne Industries is responsible for actually running the plant, and a user committee performs in an advisory and informational role.

## The Recycle Energy System Technology

The RES process is an example of a technology for centralized resource recovery—that is, it can recover energy and recyclable materials from collected, mixed MSW. It combines a waterwall combustion systems with an air classifier for density

[5]Waterwall combustion systems have been used commercially in Europe since World War II; other communities in North America using these systems include Saugus, Mass., and Hamilton, Ontario,

separation and a magnetic separator to recover ferrous materials. According to previous studies, these technologies are estimated to achieve a waste reduction efficiency of 70 to 80 percent by weight and 85 to 95 percent by volume; a ferrous materials recovery efficiency of 90 to 97 percent; and an energy recovery efficiency of 59 percent.[6]

Figure 26 is an operational flow chart of the Akron RES plant. The sequence of events at the facility is as follows.[7]

Solid waste is delivered to the RES by garbage trucks, tipped into a pit, and carried up to the shredders by means of inclined conveyor belts. Closed circuit cameras monitor the pits and conveyor belts to watch for unsuitable kinds of waste—although the RES is designed to accept a wide variety of refuse, it cannot process liquids, large objects, or tanks of compressed gas. Unsuitable refuse is removed from the conveyors by an overhead crane.

Two pulverizer shredders force the waste through a shredding grate, and the shredded material is fed through a stream of rising air—an air classifier—that separates refuse according to density. Heavy material is then passed through an electromagnetic device that separates ferrous metals (for recycling) from nonferrous metals (for landfill). Low-density material, which will be burned, is conveyed to a storage bin and then, when fuel is needed, fed into the boiler.

Fuel and air are fed into the boiler through jets in the boiler walls in order to ensure uniform combustion. About half of the fuel burns while falling through the boiler; the rest burns as it rests on the bottom grate. Flue gases pass through electrostatic precipitators, which remove particulate matter, and are then evacuated through the smokestacks. Both the bottom ash from the boiler and the fly ash from the electrostatic precipitators are loaded into trucks for removal. Should shredded waste be unavailable to fire in the boiler, because of either mechanical failure or inadequate waste supply, the plant can fire up three auxiliary oil burners fed by a 200,000-gal reserve tank.

Solid waste has an average heating value of 4,500 to 5,500 Btu/lb, compared to 10,000 Btu/lb for coal. The major problem in using raw waste as a fuel is the fluctuation in its consistency and, therefore, its heating value; it tends to create surges of energy when incinerated. The RES in Akron will minimize this effect by shredding the waste, putting it through a density separator, and then storing it to ensure a mixture with a more uniform heating value. The air jets and pneumatic feed system in the boiler are also designed to provide the burner with a uniform feed. With this system, the shredded waste ultimately has a relatively uniform value of 6,500 Btu/lb.

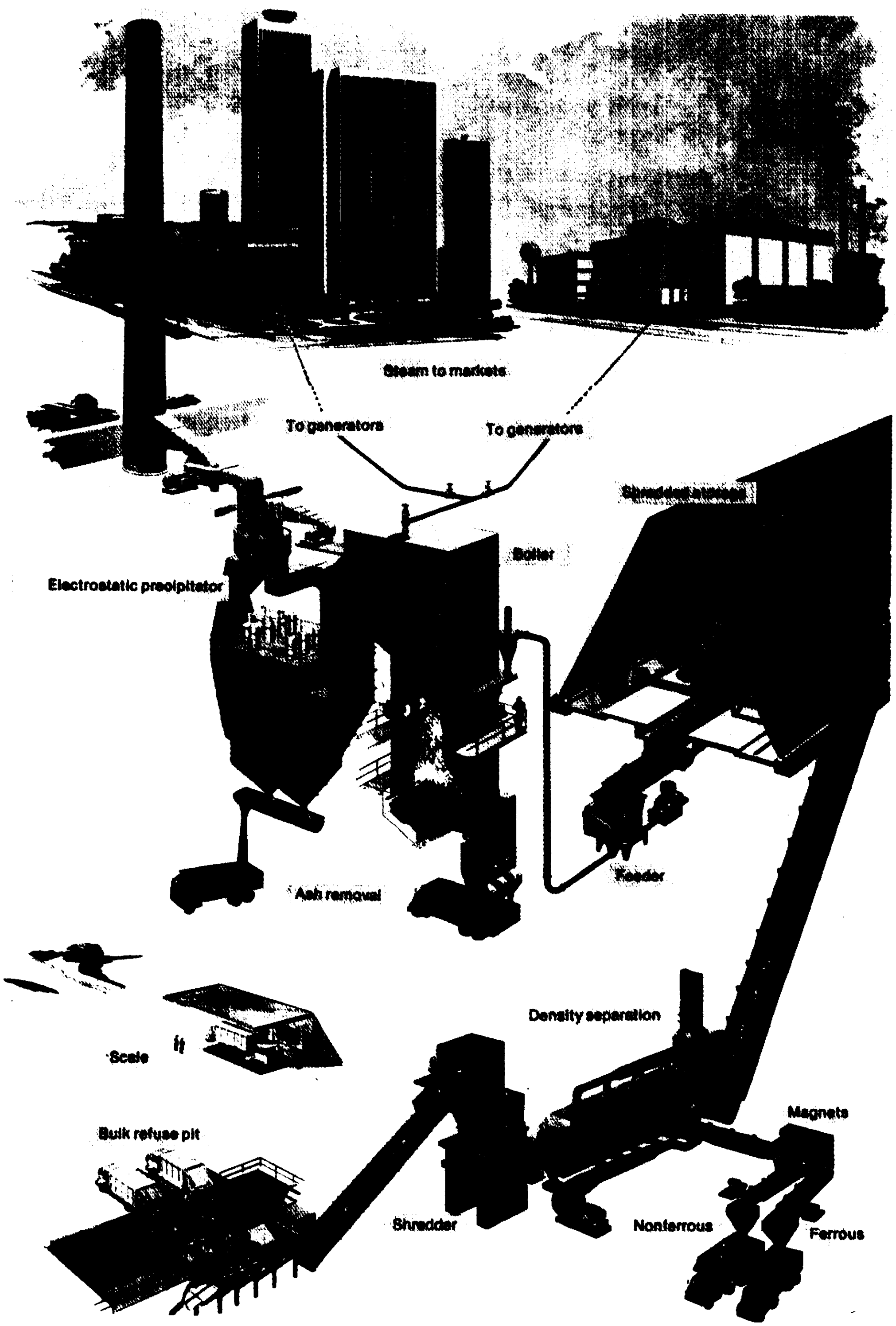
Critics of the technology employed in the RES have raised a number of doubts about its success. The waste may "bridge" or jam in the pits or in the storage bin; the dead weight of the waste may damage the rams or the conveyor belts; soot and bottom ash may collect in the boiler, causing frequent shutdowns for cleaning; and increased corrosion of the inside boiler walls caused by burning 100 percent garbage may decrease boiler life. The system's proponents feel that, despite these possible technical problems, the project's risks are acceptable.

The RES borrows selectively from technologies already in use by other industries, interjecting innovations and new designs where necessary, to produce a system that can deal effectively with the problems of burning solid waste. The boiler was designed especially for the RES: higher thermal efficiency allows the system to work at lower temperatures; suspension burning and the constant mixing of air and fuel inhibits corrosion caused by oxidation of the boiler walls; and steam jets have been installed to clean soot from inside the boiler before corrosion can recur. Where other problems may arise, backup and alternate systems have been built into the plant, and contingency funds have been set aside to finance necessary modifications.

[6] *Materials and Energy From Municipal Waste*, op. cit., pp. 99-100, tables 32, 33, and 34. "There is currently no standard accepted way to evaluate the energy recovery efficiency of resource recovery systems . . . . System energy efficiencies can be calculated in terms of the energy content of the fuel produced, and in terms of output energy available as steam." The 59-percent efficiency of the RES is in terms of the latter.

[7] Glaus, Pyle, Schemer, Burns, and DeHaven, "Feasibility Study of Solid Waste Reduction Energy Recovery," September 1977, and "Recycle Energy for Central Heating and Process Steam," June 1977. Information on the operational characteristics of the plant is as projected by the designers; since the plant has been fully operational for such a short time, it is difficult to evaluate how accurate these claims are. Other resource recovery plants have not operated with the reliability their designers expected.

**Figure 26.—Operational Flow Chart, Recycle Energy System**




SOURCE: Teledyne National.

## The Akron RES Facility

Akron's RES plant has been fully operational for less than a year, and the data have been insufficient to assess the system's impact on the environment. However, it typifies the current state of knowledge with regard to both pollution abatement and occupational safety and health. Air for the boilers will be pulled in from the plant, creating a negative air pressure that should prevent dust and litter from spreading to the surrounding area. The plant grounds will be pleasantly landscaped and well maintained, both as further protection against litter and to be esthetically pleasing. Little water will be discharged from the plant, and the combustion of shredded waste should produce fewer toxic gases than the combustion of coal. EPA is now monitoring pollution from resource recovery facilities as they come on line and is developing a data base which, if it proves necessary, should facilitate the development of further control technologies.

About 76 percent of RES revenue comes from the sale of steam, which is sold at prices competitive with Ohio Edison's rates. Steam users were required to sign 25-year contracts with the city in order to assure investors of the economic viability of the project; users who would not sign long-term contracts are required to pay a 20-percent surcharge.

Another important source of revenue is the tipping fee of $3.50/ton charged to haulers who dump their waste at the RES, which accounts for 16 percent of its revenues. The fee is lower than that charged at other dump sites in the area, and because the RES is centrally located haulers' transportation costs are also less than to more remote sites. However, in order to further assure itself of a steady and sufficient flow of wastes, the city has taken a controversial approach: it passed an ordinance requiring all haulers to deliver to the RES. Private haulers currently have a suit pending against the city challenging the legality of this ordinance.[8]

Another 8 percent of RES revenue comes from the sale of recovered ferrous materials. The city currently plans to landfill nonferrous byproducts of the RES, but potential uses also exist for these materials, and their sale could provide additional revenue. Fly ash and soot, for instance, can be used as construction fill or as a cement additive. An earlier OTA study projected potential markets for recovered aluminum, paper, and glass as well as iron and steel, that should exceed anticipated levels of recovery through 1995.[9] Akron has not depended on this source of revenue to make its RES project profitable, but it has provided incentives to Teledyne Industries, the plant operators, by giving them a portion of any revenues they can generate from the sale of reclaimed materials.

Total capital costs for development and construction are estimated at $56 million. Net operating revenues (total revenues less operating expenses) are projected to be $5.4 million in 1980, $5.7 million in 1981, and about $6 million per year from 1982 through 2004 (see table 19). Net profits after debt service, interest, and equipment replacement are expected to be over $1 million per year for the entire 25-year period.[10] While the RES is designed to generate income, however, the use of this income is restricted to the RES itself and cannot be mixed with general municipal funds. Any profits must be used to retire bonds early or to replace capital equipment.

Construction of the RES has assured downtown businesses of a reliable source of reasonably priced steam energy. As a result, some of them have begun long-needed renovation, and economic activity in the downtown area has been infused with a sense of optimism and confidence. The RES has also produced environmental benefits: the combustion of MSW produces fewer toxic gases than the coal-fired Ohio Edison plant; by reducing the volume of its wastes by 80 percent, the city has also reduced the pressure on its landfill and extended its useful lifetime; and RES residues provide inert fill that produces no odors, attracts no rats, and therefore does not need to be covered daily with dirt.

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[8] *Glenwillow Landfill*, Inc., *et al.* v. *City of Akron, et al.* Case C78-65A of the Northern District, Eastern Division of the Federal District Court of Ohio.

[9] *Materials and Energy From Municipal Waste*, op. cit. p. 63. However, the prices users would be willing to pay and the quality they might demand could present barriers to the profitable sale of large amounts of recovered materials if resource recovery were widely adopted.

[10] Ohio Water Development Authority, *Official Statement on the Recycle Energy Revenue* Bonds, 1976.

## Table 19.—Profit and Loss Statement (projected), Recycle Energy System Project, Akron, Ohio

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total revenues from sales of steam | $6,220 | $6,618 | $7,012 | $7,131 | $7,265 | $7,421 | $7,606 | $7,805 | $8,000 | $8,181 | $8,378 | $8,581 | $8,793 | $9,028 | $9,270 | $9,509 | $9,785 | 10,073 | 10,368 | 10,688 | 11,023 | 11,376 | 11,748 | 12,142 | 12,582 |
| Disposal fees at $3.50/ton | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 1,278 | 2,178 | 1,278 |
| Sales of recovered ferrous metal[a] | 681 | 700 | 719 | 739 | 759 | 780 | 801 | 823 | 846 | 869 | 893 | 917 | 942 | 968 | 995 | 1,002 | 1,050 | 1,079 | 1,109 | 1,139 | 1,170 | 1,202 | 1,235 | 1,269 | 1,304 |
| Total operating expenses | 2,741 | 2,863 | 2,978 | 3,134 | 3,301 | 3,476 | 3,659 | 3,854 | 4,059 | 4,273 | 4,499 | 4,735 | 4,987 | 5,253 | 5,533 | 5,821 | 6,139 | 6,465 | 6,811 | 7,174 | 7,559 | 7,966 | 8,394 | 8,844 | 9,328 |
| Net operating revenues | 5,438 | 5,733 | 6,031 | 6,0 1 | 6,001 | 6,003 | 6,026 | 6,052 | 6,065 | 6,055 | 6,050 | 6,041 | 6,026 | 6,021 | 6,010 | 5,988 | 5,974 | 5,965 | 5,944 | 5,931 | 5,912 | 5,890 | 5,867 | 5,845 | 5,836 |
| Total other income | 885 | 591 | 317 | 360 | 398 | 414 | 415 | 415 | 415 | 415 | 415 | 414 | 414 | 413 | 412 | 411 | 410 | 409 | 407 | 407 | 405 | 404 | 402 | 401 | 401 |
| Total funds available for debt service and cooperative agreement reserve funds | 6,323 | 6,324 | 6,348 | 6,374 | 6,399 | 6,417 | 6,441 | 6,467 | 6,480 | 6,470 | 6,465 | 6,455 | 6,440 | 6,434 | 6,422 | 6,399 | 6,384 | 6,374 | 6,351 | 6,338 | 6,317 | 6,294 | 6,269 | 6,246 | 6,237 |
| Debt service requirement | 4,200 | 4,216 | 4,232 | 4,249 | 4,266 | 4,278 | 4,294 | 4,311 | 4,320 | 4,313 | 4,310 | 4,303 | 4,293 | 4,289 | 4,281 | 4,266 | 4,256 | 4,249 | 4,234 | 4,225 | 4,211 | 4,196 | 4,179 | 4,164 | 4,158 |
| Funds available after debt service for payment to the following cooperative agreement reserve funds | 2,123 | 2,108 | 2,116 | 2,125 | 2,133 | 2,139 | 2,147 | 2,156 | 2,160 | 2,157 | 2,155 | 2,152 | 2,147 | 2,145 | 2,141 | 2,133 | 2,128 | 2,125 | 2,117 | 2,113 | 2,106 | 2,098 | 2,090 | 2,082 | 2,079 |
| Equipment replacement fund[b] | 48 | 410 | 773 | 777 | 420 | 644 | 683 | 724 | 767 | 810 | 860 | 910 | 964 | 1,025 | 1,084 | 1,147 | 1,218 | 1,292 | 1,366 | 1,452 | 1,537 | 1,628 | 1,726 | 1,831 | 1,946 |
| Interest on city and county notes[c] | 450 | 225 | — | — | — | — | — | — | | | | | | | | | — | — | — | — | — | — | — | — | — |
| Working capital reserve fund[d] | 641 | 127 | 28 | 19 | (10) | 39 | 25 | 26 | 27 | 27 | 29 | 30 | 32 | 35 | 36 | 38 | 41 | 44 | 45 | 49 | 51 | 54 | 58 | 61 | 66 |
| Payment into surplus fund[e] | 984 | 1,346 | 1,315 | 1,329 | 1,723 | 1,456 | 1,439 | 1,406 | ,366 | 1,320 | 1,266 | 1,212 | 1,151 | 1,085 | ,021 | 948 | 869 | 789 | 706 | 612 | 518 | 416 | 306 | 190 | 67 |

[a]Revenues are based on ferrous metal content of 6.7%, recovery rate of 90%, net price of $35/gross ton, and an escalation rate of 2.75% (50% of the average increase in the iron and steel wholesale price index 1968-73).

[b]The equipment replacement fund is comprised of: a) an annual payment of $40,000 during the first 5 years of operation and $380,000 per year thereafter adjusted to render increases in the wholesale price index for industrial commodities; and b) payment during the first 3 years of operation totaling 50% of the debt service fund.

[c]Interest payable at 4.5% on $10 million city and county notes for 18 months following commencement of operation of the project.

[d]Payment to the working capital reserve fund is made in accordance with the following: a) during the first year of operation, payments equal to 1 month's average fuel oil expense, 1 month's average operating and maintenance expense, and 1 month's loan payments and additional payments (these amounts are escalated at 6% per year over the term of the bonds); and b) at the end of the second year of operation of the project, payment to establish an unencumbered balance at $100,000.

[e]Amounts accumulated in the surplus fund in excess of $5 million shall be used to redeem bonds.

SOURCE: Official Statement of the Ohio Water Development Authority, Recycle Energy Revenue Bonds (1976).

# Source Separation and Resource Recovery-A Case Study of the Bronx Frontier Development Corp. Comporting Project, New York City[11]

## The Community Setting

The South Bronx is a large collection of poor neighborhoods whose unofficial boundaries have expanded tremendously in the last few years. Its acres of rubble-strewn lots and vacant buildings have made it a symbol of urban decay, and recent data illustrate the area's serious problems. During the first half of the 1970's, it experienced a severe population decline and a high rate of building abandonment, with some neighborhoods losing

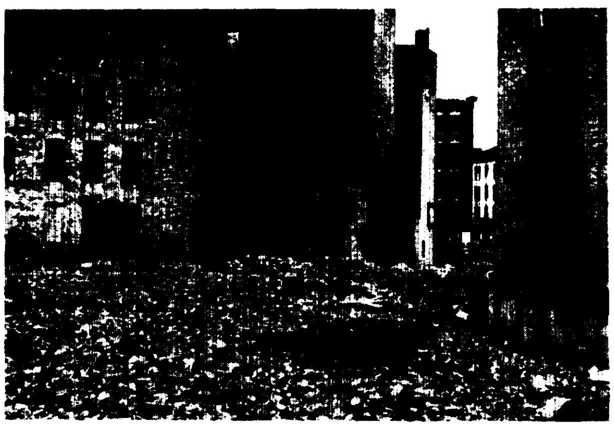


Photo credit: Bronx Frontier Development Corp.

**Abandoned buildings and rubble-strewn lots became a symbol of urban decay during the 1970's**

more than 50 percent of their population. *[2] Family income levels in the area are extremely low, with more than 25 percent listed below the poverty line in 1975. Unemployment rates are high, especially among the young, and less than 25 percent of the area students entering the city's academic high schools end up graduating.

As one city planner pointed out, however, these aggregate facts mask different trends within specific neighborhoods. [13] Although urban blight appears to be spreading to certain areas that had formerly remained stable, other neighborhoods–those that had been the most visibly devastated and had the highest crime and arson rates and the most school crowding—are now showing some improvement. There is a feeling in some of these areas that opportunities for progress really do exist.

There are obstacles, however, to realizing these opportunities. One of these is a long tradition of noncooperation among various elements within the South Bronx community and within its competing political organizations. Not only is there distrust among groups, but also among individual residents. As one community worker observed, "People in this neighborhood are scared; they won't even talk to people in the next-door apartment. It took us three months to form a tenants' association in one building. Nobody would talk to anybody else. "

Most residents see housing and jobs as the most important local concerns; they attach less importance to human services and open-space issues. However, some community organizations believe there is a great need to develop programs that help residents help themselves. One such way to organize people and give them a sense of self-worth, as well as skills and supplemental income, is urban gardening.

The Bronx Frontier Development Corp. (BFDC) is a nonprofit organization that was formed to aid in the redevelopment of the South Bronx. Through its principal activity, comporting, it hopes to contribute to efforts undertaken by several neighborhood groups to revitalize the community by reclaiming barren land with parks and urban gardens. Comporting is a process that reclaims organic solid waste by converting it into humus, an effective soil conditioner. Comporting

[11] Material in the following case study is based on the working paper, "Bronx Frontier Comporting Operation," prepared by Beth Siegel and Ann Verrilli for the Harvard Workshop on Appropriate Technology for Community Development, Department of City and Regional Planning, Harvard University, May 15, 1979.

[12] Data drawn from New York City's Housing and Vacancy Survey of 1975.

[13] Peter Cantillo, New York City Department of Planning, Bronx Borough Office,

Photo credit: Bronx Frontier Development Corp

**Urban gardens help revitalize communities**

also provides an opportunity to recycle the organic component of MSW productively, while simultaneously relieving the pressure on dwindling urban landfill sites.

## Development[14]

The initial idea of "greening the South Bronx" was inspired by a 1974 editorial in the New York *Times* written by the vice-chairman of the City Planning Commission, Martin Gallent. The editorial proposed that the city undertake a program of at least temporarily greening some of the vast tracts of rubble with parks and gardens until longer range plans could be developed. He suggested that opportunities for job-creating and income-producing ventures such as tree farms, nurseries, and cash crops be explored.

The editorial attracted attention throughout the city, and one local activist, Irma Fleck, decided to see how such a project could be brought about. Talking with local residents, urban gardening groups, city planners, and local officials, Fleck quickly established that community interest existed. She also found a major obstacle: the lack of good topsoil. The soil under the rubble was infertile, depleted of nutrients, and contaminated with lead and other toxic substances. Importing topsoil would be prohibitively expensive for community groups or even the city.

Photo credit. Bronx Frontier Development Corp.

**A big grin of pride**

Comporting seemed to be the best way to produce the necessary topsoil at lower costs. Humus,

14 Information on the history of Bronx Frontier Development Corp. is drawn from interviews with staff; from its publication, "BFDC's Long Term Goals, History and Background;" and from "Taming the South Bronx Frontiers," *Quest*, December 1978/January 1979.

produced by the natural decomposition of organic wastes, would provide nutrients and improve mineral and water retention; combined with clay and sand (which could be obtained by crushing rubble), it would produce good topsoil. The nearby produce terminal, Hunt's Point Market, could provide plenty of compostable vegetable wastes. The project also offered a way to provide employment and training for local residents, as well as a sense of purpose through community involvement, something Fleck considered essential to the long-term redevelopment of the South Bronx.

Discussions with New York City urban gardening groups and with the Institute for Local Self-Reliance indicated that a comporting program might work. The Institute, a Washington-based technical assistance group, studied its economic feasibility and reported in July 1976 that, with a capital investment of $250,000 for equipment and first-year operating costs, a comporting operation could be developed. Furthermore, if half of this compost were sold commercially, the operation could become self-supporting in another year. Armed with this information, Fleck and Jack Flanagan, a police community affairs officer in the South Bronx, were able to obtain seed money from the Community Services Administration (CSA) and additional funding from several private foundations.

The comporting operation was envisioned as a two-phase process. Phase I would involve setting up the comporting facility and distributing the compost free of charge to community gardens and parks. Phase 11 would consist of generating revenue by marketing the compost in bulk to the private sector (e.g., nurseries and farmers) and perhaps to city parks departments.

BFDC found that it had to file a long report with the New York State Department of Environmental Conservation, which had ruled that the comporting operation was a Solid Waste Management Facility and would have to comply with all the relevant regulations.[15] During 1977, BFDC signed contracts with the private waste haulers serving Hunt's Point Market for the delivery of vegetable refuse and with the suburban city of New Rochelle for leaves, and then leased a 3.7-acre city-owned site. Equipment was purchased, staff was hired, the site was prepared, and in June 1978, the first batch of compost was produced.

## The BFDC Comporting Technology

The two major comporting processes are anaerobic *comporting,* in which microbes (bacteria and fungi) that do not require oxygen break down wastes in a sealed container; and aerobic comporting, in which microbial action takes place in the presence of oxygen. Anaerobic comporting requires less frequent attention, but it is a much slower process and gives off highly objectionable odors. Aerobic comporting, on the other hand, is relatively odorless, faster, and, because it gives off more heat, more effective in killing disease-carrying organisms. Most comporting systems, including BFDC, are aerobic.[16]

Aerobic decomposition involves a succession of microbe populations, each species reaching a peak population under different nutrient and temperature conditions. The temperature range within which the microbes can survive and function most efficiently is limited, so temperature control is a major concern. They also require a supply of nutrients (oxygen, hydrogen, carbon, nitrogen, phosphorus, and potassium being the most important) to thrive and reproduce; when these elements are plentiful and properly balanced, decomposition is more rapid. The most important measure of nutrient balance is the carbon-to-nitrogen (C/N) ratio, which should remain between 20:1 and 30:1. An excessively high C/N ratio slows decomposition and inhibits plant growth when the humus is applied to the soil; and excessively low C/N ratio can be toxic to the microbes and later to plant roots. Since waste materials vary in their C/N ratios, the proper balance is often achieved by combining two kinds of wastes in the system—for example, MSW and sludge from wastewater treatment. Moisture and

[15] See "Technical Report on the Bronx Frontier Development Corporation Comporting Project," submitted by BFDC to the New York State Department of Environmental Conservation, 1976.

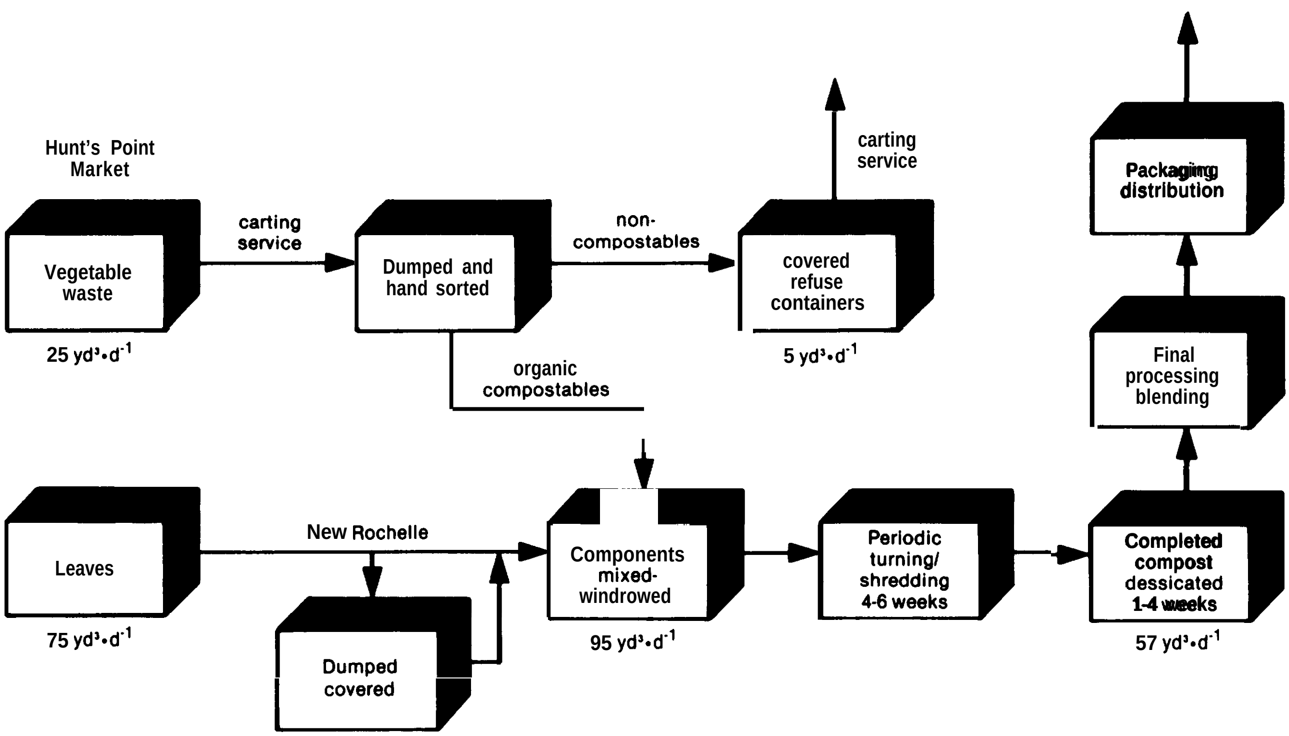
[16] Other communities Using composting processes include: Durham, N. H.; Burlington, Vt.; Tom River, N.J.; Bangor, Me.; Upper Occoquan, Va.; Windsor, Ontario; Camden, N.J.; Philadelphia, Pa.; Washington, D. C.; and Los Angeles, Calif. (Source: Jerome Goldstein, editor of *In* Business and *Compost* Science, The JG Press, Emmaus, Pa. )

oxygen content are also important, and can be controlled by a number of methods.

When BFDC first began operation, it used a version of the aerobic process known as "open windrow" comporting, which consists of six basic stages (see figure 27):

1. Compacted wastes, such as leaves and vegetable matter, arrive daily by truck. The leaves are stacked at the edge of the site, and the organic wastes are piled in a receiving area.
2. Laborers hand-sort the waste to separate out noncompostable materials, which are set aside for later pickup by the carting service.
3. The waste is laid out in windrows (long rectangular piles about 10 ft wide and 4 ft high) with a base of 3 ft of leaves topped by 1 ft of organic wastes, equaling three volumes of leaves to one volume of vegetable waste. Since the organic wastes can be very wet, the leaves serve as a bulking agent and help absorb some of the moisture.
4. The wastes are shredded and mixed by running a compost-turning machine through the windrow several times. Volume is reduced by about 60 percent during this step, and shredding also reduces the size of the particles so that a greater surface is exposed to microbial action, thereby accelerating decomposition.
5. Comporting begins. Over the next few weeks, decomposition is rapid as bacteria begin breaking down the material and heat is generated. During this period, workers monitor the windrows daily to check temperature, moisture level, oxygen content, and C/N ratio. The compost-turner is run through the windrow approximately three to five times per week to aerate the pile and redistribute heat and moisture. After about 2 weeks, the microbial activity begins to slow down and less frequent turning is required. The next 4 to 6 weeks allow the compost to mature and dry out. When temperature, C/N ratio, and

**Figure 27.—BFDC Open-Windrow Composting Process**




SOURCE: Bronx Frontier Development Corp.

other measures indicate that the humus is stable, it is ready for shipment.

6. After it is mechanically screened to remove pieces of plastic and glass, the compost is delivered to community gardens, where it is mixed with sand and clay and applied to the soil.

The principal drawback to the open-windrow technique, however, was that it could produce only a relatively small volume of compost on BFDC's 3.7-acre site. In order to transform the operation from the level of demonstration to that of a self-sustaining business enterprise, BFDC has turned to a second version of the aerobic process: "aerated pile" comporting. In this technique the compost piles are not turned; instead, electric blowers force air through them by means of perforated pipes placed through the piles. BFDC has installed a 40-kW wind turbine to run the blowers.

Since receiving a grant in 1979 from the National Center for Appropriate Technology (NCAT) to make this change, BFDC has expanded its capabilities in several ways. Its compost piles are now more than twice as large as those permitted by the open-windrow technique, comporting can be carried out in the winter. The increased temperatures generated inside the compost piles also allow for the safe inclusion of manure and/or sewage sludge. This combination of inputs, called "codisposal" because it combines wastes from two major waste streams (MSW and sewage), is a technology that one expert views as "the wave of the future."[17]

[17] Dr James F. Parr, laboratory chief, Biological Waste Management and Organic Resources Laboratory, Agriculture and Environmental Quality Research Institute, U.S. Department of Agriculture, personal communication, July 25, 1980.

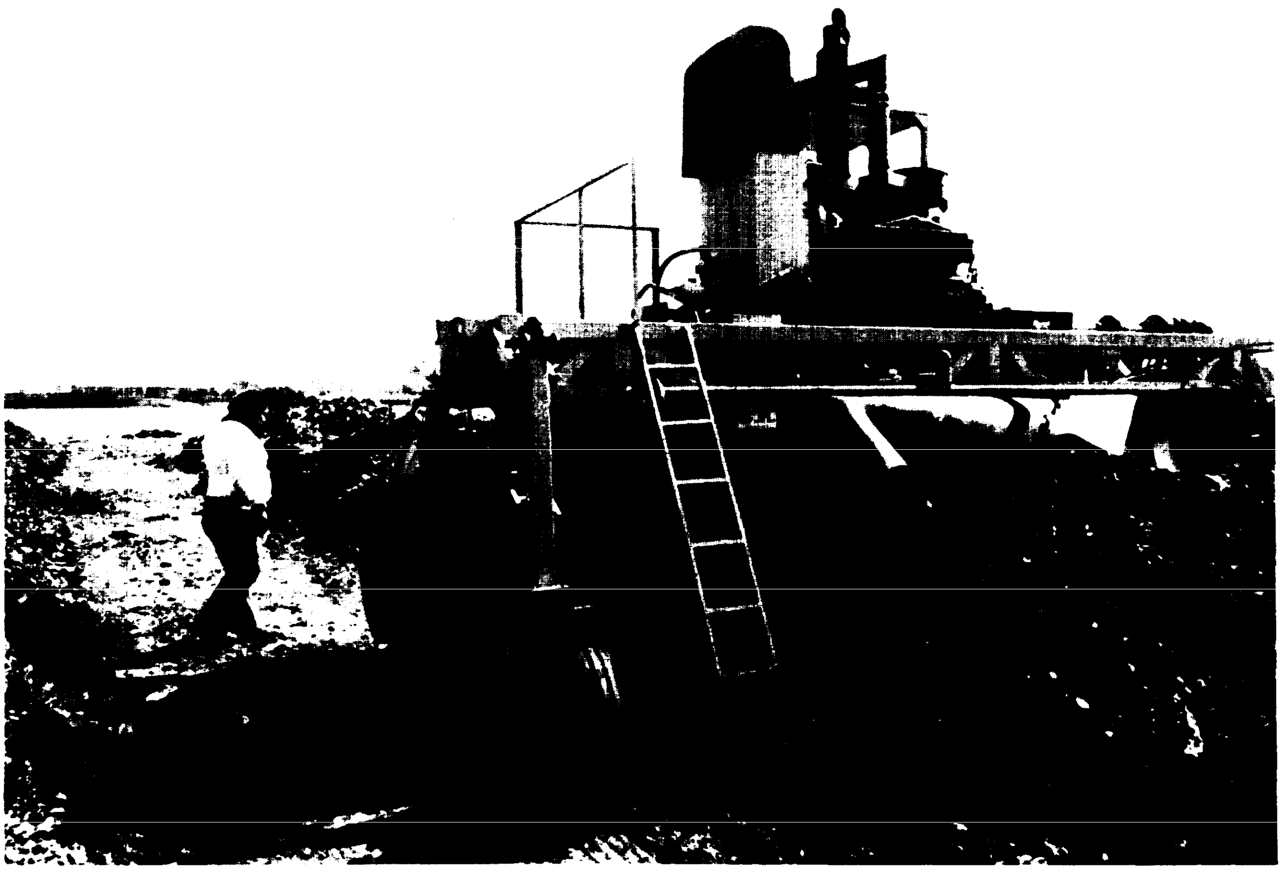


Photo credit: Bronx Frontier Development Corp.

**A compost turner aerating vegetable waste at BFDC**

## The BFDC Composting Facility

BFDC estimates that at full capacity their operation could be run by one skilled person, but because of their commitment to creating jobs they will have eight people on the staff. Except for the technical supervisor, the staff consists of local residents. Most of the skills involved are relatively simple and easily acquired: hand-sorting, operating the compost-turner and a front-end loader used to arrange the windrows, maintaining and repairing the equipment, and performing tests to monitor conditions in the piles.

The process appears safe, although a few precautions are required. BFDC provides gloves, earplugs, and safety goggles to the staff; it carries insurance against accidents; and it complies with a variety of Federal, State, and city health regulations. To ensure product safety, BFDC (with the assistance of EPA and the Cornell University Extension Service) tests the compost for heavy metals such as lead, cadmium, and zinc. The major source of these contaminants is automobile pollution, which enters the waste stream through the leaves of roadside trees. Tests are also performed at the garden sites on a regular basis. To date, all of these tests have indicated that the BFDC compost is safe.

Economics.–It is difficult to calculate what the total costs of the project are or how to separate them into development costs, capital costs, and operating expenses. In part this is because so much of the equipment, labor, and services have been donated or subsidized. [18] There are also indirect overhead and administrative costs that cannot be allocated specifically to the comporting operation. Finally, since the project is still in the first phase of its development, it is also difficult to forecast what operating expenses will be when it is fully operational. Nevertheless, based on past expenditures and fiscal estimates prepared by BFDC,[19] it is possible to approximate some of the costs for the project's open-windrow process. These costs are presented in table 20, as are the projected costs of the aerated-pile process. These projections suggest the economies of scale that might be achieved by full implementation of the aerated-pile process. Note that unit costs decline from over $30/yd^3$ for a process rate of 50 tons per day (tpd) to only $10/yd^3$ for a process rate of 200 tpd.

Revenue comes from tipping fees charged to waste haulers and from the sale of compost, either in bulk or in bags. BFDC intends to undertake a market study to evaluate the potential market for its compost, but while preliminary research points to a strong demand for the product, potential revenue from sale of the compost is limited because of prior commitments the group has made for its use. BFDC has promised 2,640 $yd^3/yr$ over the next 2 years as its matching contribution for a $1. 1-mil-

[18] It seems characteristic of man, of the projects OTA studied (particularly those where nonprofit organizations are involved) that traditional cost-accounting procedures are inadequate. This is especially true for cost items that are donated or subsidized. As a result, when unit costs are calculated (based on total costs excluding donations and subsidies) and compared to those for commercially available products, project proponents can often deceive themselves (and the community) into believing they are producing a less expensive product. The fact is, from a societal point of view, that these subsidized items have a real value and (if unit costs with the subsidy were the same whether commercially produced or produced by the nonprofit organization) this value is the price society pays to purchase the "unquantifiable" benefits of the project.

[19] "The Bronx Frontier Comporting Operation: Current Status, Spring 1979," prepared by BFDC for the New York State Department of Environmental Conservation, New York State Environmental Facilities Corp., and New York City Department of Sanitation, Apr. 20, 1979.

**Table 20.—Projected Costs of Two Aerobic Comporting Processes**

| | Open-windrow process | | Aerated-pile process | | |
|---|---|---|---|---|---|
| | 50 tpd | 100 tpd | 50 tpd | 100 tpd | 200 tpd |
| Capital investment[a] | $360,040 | $360,040 | $518,800 | $530,400 | $543,400 |
| Operating expenses/year | 170,079 | 170,079 | 122,500 | 146,200 | 186,800 |
| Total annual expenses[b] | 228,156 | 228,156 | 206,960 | 232,960 | 272,480 |
| Unit cost of compost/$yd^3$[c] | 33.81 | 16.90 | 30.67 | 17.26 | 10.09 |

aIncludes site preparation.
bIncludes Operating expenses, amortization of capital investment, and depreciation of capital equipment.
CBased on process output of 6,750 $yd^3/yr$ at 50 tpd, etc.

SOURCE: Bronx Frontier Development Corp.

lion grant from the Department of Interior, the New York State Department of Parks and Recreation, and the New York City Department of Parks. The grant was given to South Bronx Open Space Task Force, a coalition of two other community groups trying to build miniparks on 15 vacant lots in the borough. In addition, the Frontier has provided more than 2,000 $yd^3$ of free compost to urban gardening groups in the South Bronx.

The remainder of the compost will be available for sale. Table 21 illustrates the projected cost/revenue balance and shows the extent to which operating costs and total annualized costs can be met with various combinations of bulk and bag sales.

**Table 21 .—Projected Cost/Revenue Balance, Bronx Frontier Development Corp.**

| | 100 yd/day | 200 yd/day | 400 yd/day |
|---|---|---|---|
| Bulk sales . | Doesn't cover operations | Covers operations | Covers total annual costs |
| Bag sales. . | Covers operations | Covers total annual costs | Covers total annual costs |

SOURCE: Bronx Frontier Development Corp.

The project also offers distinct benefits to the private haulers who dispose of vegetable wastes from the Hunt's Point Market. Because the local landfill site in the Bronx is overloaded, these haulers have had to transport wastes to a landfill in Queens. The Frontier dumping site in the Bronx not only saves them fuel, but also charges them substantially less than the city landfill. Dumping fees at the BFDC site are only $l/$yd_3$ for uncontaminated vegetable wastes and $1.50/$yd^3$ for waste in nondegradable packages, compared to $3.50/$yd^3$ at the city landfill. This disparity in rates suggests that the dumping rates charged by BFDC are lower than they need be. Raising them, it has been suggested, would generate additional revenue and thereby improve the project's ability to sustain itself without further Government subsidies or grants.

Although BFDC's compost project cannot by itself alleviate the monumental waste disposal problems of New York City, it could, if adopted by other neighborhoods and boroughs, help extend the life of local landfills. A Government waste management expert has said that communities throughout the Nation should be able to replicate BFDC's comporting operation and its plans for co-disposal of sewage sludge, thereby multiplying its environmental benefits.[20] In addition, if the project becomes a commercial success and offers local residents the opportunity to learn marketable skills by participating in a business enterprise, it could also play a role, albeit very small, in addressing the social and economic problems of the South Bronx.

'"Parr, op. cit.

# Critical Factors

## Public Perception and Participation

The degree of public participation in the decisionmaking process varied considerably in these two resource recovery projects, primarily because of the different institutional settings. The RES was a municipal project, planned and executed in conventional ways by the Akron city government. The BFDC project, on the other hand, was setup as a community development corporation; as such, it tried to involve the community through a board of directors roughly representative of the South Bronx. Day-to-day management decisions are made by project staff, but the board of directors has final approval on all BFDC programs. However, it is not clear how active a role the board of directors played in formulating policy for the BFDC, nor whether all sectors of the community felt adequately represented by the board.

BFDC, through its active role in coalitions like the Open Space Task Force, is becoming an important organizing force in the South Bronx, but its experience demonstrates the difficulty of bringing community interests together. It has had difficulties in reaching the grassroots level of community organization. In addition, like other urban gardening groups, BFDC has reportedly encountered opposition from traditional political leaders of New York City's minority community. These leaders tend to identify themselves with multimillion-dollar housing projects and job training programs; they feel that low-cost, self-help approaches to redevelopment could be used as an excuse by Federal, State, and local officials to withdraw support from projects that involve more money. BFDC's answer to these criticisms has been that self-help projects create the necessary political and psychological foundation for redevelopment that previous efforts often lacked. BFDC's success in overcoming this opposition will depend on its ability to form coalitions with other self-help groups and to create a broad base of support from community residents.

BFDC also provides an interesting example of how local residents temper what might have been, in view of the limited expertise and resources available within the community, unrealistic objectives on the part of the project staff. The staff generally took a broad view of the problems of the South Bronx, but they were often overly ambitious in their attempts to address a wide range of issues with limited resources. The staff has spent much of their time fundraising, publicizing, and developing new programs; as a result, they have sometimes neglected the progress of the comporting operation, the core of the project. Day-to-day operations were often left to the onsite crew, who had too little expertise to deal with some of the problems that arose. Although many of the delays in the comporting project were beyond local control, part of its inefficiency was caused simply by the lack of management at the site. In many instances, the board of directors played an important role by "keeping the staff's nose to a specific grindstone." The board recognized the dangers of trying to accomplish too much and urged the staff to concentrate on the existing comporting operation rather than initiating new programs.

By contrast, the RES project in Akron was strictly a municipal undertaking, using traditional modes of urban planning and decisionmaking. When the city's Planning Department began investigating waste disposal strategies in 1968, the criteria used to evaluate the alternatives were largely technical, economic, and environmental. There is no evidence that any attempts were made to involve the public in the evaluation process through such devices as neighborhood study groups or public hearings. This approach typifies the way in which many municipalities go about making decisions on large, capital-intensive projects: they have been considered to be technical and economic decisions, rather than matters for public opinion or review (see chs. 7 and 8). In the case of Akron, not even the project's financing required public approval, because the revenue bonds which helped finance the project were issued by a special authority. Neither will the county's and city's general obligation bonds require public approval, since they will not increase the total municipal debt service above the existing spending limits.

The Akron steam users, a group with obvious interests in the project, played a very small role in the initial design and development of the RES. During contract negotiations over steam prices, users expressed resentment at not having been consulted; it was they who proposed forming an Users Advisory Committee. At first the city resisted, but it later agreed to the idea in order to allay user fears and accelerate contract bargaining. The committee will help spread information about RES to other users and will provide a forum at which to discuss common problems and difficulties. Although it has no official authority, the committee is perceived by the users as an effective way to exert their influence collectively.

## Essential Resources

One of the most important technical issues confronting any attempt at resource recovery is the volume and quality of the waste stream: what goes into the process greatly affects what comes out, whether the waste is composted or burned. Both projects offer low tipping fees and other incentives to haulers, but problems remain.

Although Hunt's Point Market in the Bronx is a good source of compostable organic waste, a great deal of nondegradable material such as plastic wrappings and containers was included in the matter dumped at the project site. To correct this, BFDC developed a formal system for sorting and separating the waste at Hunt's Point Market, but thus far the private carters have resisted any collection plan that would force them to pick up and dump organic wastes separately. In addition, the union opposes having drivers and helpers separate waste unless new contracts are negotiated with the carters. The Hunt's Point merchants, for their part, view any source separation plan as something that would benefit the carters; as an incentive, they want collection fees lowered. Because of the complexities involved, BFDC thinks the only general solution would be to have source separation mandated by a legislative act. In the meantime, it is attempting to establish a wider range of organic waste sources: BFDC accepts Christmas trees gathered by the City Parks Department and is also negotiating with local race tracks to obtain stable wastes.

The technical and economic viability of the RES in Akron is affected by the quantity as well as quality of its input waste. Its most critical need is for a large, constant supply of combustible refuse so that it can meet its steam contract obligations. Any shortfalls must be met by using auxiliary oil-fired boilers, at substantially increased cost, and frequent use of the auxiliary boilers could cause the project to be economically untenable. For this reason, the outcome of the lawsuit brought by private carters against Akron will materially affect this technology's ability to compete economically with alternatives. It should also give other cities an indication of whether the legislative method of controlling the waste stream will work.

## Financing

BFDC has relied primarily on foundation grants for the purchase of capital equipment and on CSA subsidies for operating and administrative funds. BFDC's goal is to achieve self-sufficiency through the retail sale of compost, but like many new small enterprises BFDC has had short-term cash flow problems. This has made it difficult to cover operating costs while the project is being expanded to an economically viable scale of production. Project revenues from the open-windrow process were inadequate to cover operating costs, but full implementation of the more efficient aerated-pile process could cover total annual cost (see table 21). The profits could then be used to fund the new programs BFDC would like to undertake in the future.

Optimally, BFDC might have spent several years at the 50-tpd process rate, operating at a deficit, in order to gain needed technical and managerial experience, but this schedule would have required either medium-term debt or subsidies to cover operating deficits. This option remained closed so long as BFDC's only source of operating capital was short-term grants limited to a specific use. This type of financing created two problems: first, staff time was diverted from project management to the search for new grants, leaving little time to correct problems or to prepare market surveys for its compost; second, new grants were often given only for new projects, and still more funding was required to cover the additional costs these projects entailed.[21] In this connection, BFDC came up with the concept of "consortium funding:" to avoid becoming restricted by dependence on money from a particular foundation, it instead sought small contributions from a number of foundations.

Financing for the RES in Akron has been supplied through both revenue bonds and general obligation bonds, which seems to be the most creative use of municipal debt instruments utilized in any of the cases examined in this study. The city retained the underwriting firm of Dillon, Read & Co., Inc., which had extensive experience with municipal bonds in general and with revenue bonds in particular. The firm also had extensive experience in financing other resource recovery and solid waste disposal facilities, including those in Toledo, Ohio, Hempstead, N. Y., and Dade County, Fla.

Dillon, Read's first decision in structuring the financing was to provide more money for the project: in addition to raising funds for construction costs and overruns, they established contingency funds for cost overruns and any necessary modifications after the plant became operational. They also recommended the local hauling legislation

[21] One example of these problems is the windmill that BFDC erected in the fall of 1979 to provide electricity for the planned aeration technology before the latter was even in place. The staff saw the potential for using wind power at the site; the group's fundraisers saw the opportunity to obtain a grant specifically for using wind power; and their proposal was accepted. However, this project diverted staff time and resources from the principal operation—comporting. While wind power represents an excitin8 addition to the project, at present it may be more important to develop a secure market for BFDC's compost.

and long-term steam contracts to ensure adequate sales revenues to cover the bonds. As a result, debt service coverage was reduced from 175 percent to 150 percent, which in turn provided an additional $16 million without increasing Akron's debt service payments.

The city and county participated in the permanent financing as well, each selling $5 million in general obligation notes. These notes were advertised and sold publicly without the assistance of an intermediary. Proceeds of the notes were used to build steam lines to B. F. Goodrich, the University of Akron, and City Hospital; a portion was also used as a construction contingency fund, to be spent if revenue bonds proceeds were insufficient. Any proceeds remaining after completion of construction were to be used to retire outstanding debts.

### Institutional Factors

Institutional problems in the development and implementation of source separation and centralized resource recovery programs include the following:

- uncertainty about cooperation by householders, businesses, and others who generate waste;
- uncertainty about cooperation by local waste collectors and haulers;
- opposition from competing landfills;
- arbitrary or inflexible application of health and environmental standards; and
- problems arising from fragmented and overlapping State and local jurisdictions.

Source separation programs like BFDC are particularly prone to problems of noncooperation by waste generators and haulers. Centralized resource recovery projects like the Akron RES are more likely to be hampered by problems of overlapping jurisdictions. Both types may experience problems arising from the application of health and environmental standards, plus those of competition from existing disposal systems. The suit against the Akron hauling legislation was brought by a landfill operator as well as local haulers, and if the suit succeeds it may reduce the project's supply of combustible wastes.

BFDC, on the other hand, has had problems not only with the waste sources at Hunt's Point Market and the local haulers, but also with overlapping jurisdictions and insensitive application of environmental regulations. The New York State Department of Environmental Conservation (DEC) ruled that the comporting operation was a "solid waste disposal facility, " which meant that it was subject to all of the rules and requirements for conventional landfills, incinerators, and dumps. BFDC had to submit permit applications not only to DEC but to the State Environmental Facilities Corp. and the New York City Department of Sanitation, and the time spent developing the supporting documentation caused significant delays and increased costs. BFDC also found that it could not include stable wastes in its comporting operation because of an city regulation that prohibits transporting manure except a sealed truck.

## Federal Policy

### Background

Several Acts have established national policies and programs for technologies which reclaim materials and energy from MSW. Taken together, they demonstrate Congress' growing commitment to resource recovery, primarily as a supplemental source of materials and secondarily as an alternative source of energy. However, these Acts also demonstrate a continuing commitment to large-scale rather than to small-scale projects. Because systems appropriate for smaller communities may have problems not shared by large-scale systems, an analysis of current and upcoming legislation can help to identify those areas which may need to be addressed if these alternatives are promoted in the future.

The Solid Waste Disposal Act of 1965, a part of the Clean Air Act Amendments (Public Law 89-272, as amended), was the first major law prescribing the Federal role in resource recovery and reclamation from MSW. The Act recognized the contribution of solid waste disposal to air pollution abatement, and it encouraged the design and testing of solid waste management and resource recovery systems that would protect public health and the quality of the environment. To this end, it provided technical and financial assistance to State governments and interstate agencies in planning and developing programs for solid waste disposal and resource recovery. The Act also emphasized the need to improve management techniques and organizational arrangements for collecting, separating, recovering, and recycling solid wastes and for disposing of unrecoverable residues.

The stated purpose of the Resource Recovery Act of 1970 (Public Law 91-512), the second of the three major laws, was to amend the Solid Waste Disposal Act of 1965 "in order to provide financial assistance for the construction of solid waste disposal facilities. " The Act not only stressed new methods of solid waste disposal, but also emphasized the importance of recycling and reuse of waste materials. In addition to monies allotted to conduct studies in several related areas, the Act made grants available for demonstration-scale resource recovery systems "of all types, and under representative geographical and environmental conditions." Further, its title II, the Materials Policy Act of 1970, established the National Commission on Materials Policy and required annual reports to the Congress on studies of various waste generation, materials recovery, and waste disposal options, practices, and policies. Under this Act the Administrator of EPA 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 overall intent of these two laws, as expressed in the legislative findings of the 1970 Act, was to enhance the quality of the environment and conserve materials through the development of a national materials policy. Both emphasized that the primary responsibility for MSW collection and disposal rests at the local level.

## The Resource Conservation and Recovery Act of 1976

Between 1970 and 1976, when the Resource Conservation and Recovery Act (RCRA) (Public Law 94-580) was passed, the issues of alternative energy sources, of materials recovery, and of technological size and complexity had become more important to Congress. RCRA reaffirmed that "the collection and disposal of solid waste should continue to be primarily a function of State, regional, and local agencies, " but it also found that "the problems of waste disposal have become national in scope . . . and necessitate Federal action." While protecting public health and enhancing the quality of the environment remained a major function of the Act, it also sought to encourage the recovery of energy and materials from MSW.

RCRA's stated purpose was to "provide technical and financial assistance for the development of management plans and facilities for the recovery of energy and other resources from discarded materials. " It established an Office of Solid Waste in EPA, through which all of the designated responsibilities except those pertaining to R&D were to be carried out (sec. 2007). Thus far, EPA has provided financial assistance to approximately 66 communities for feasibility analysis, development of a procurement strategy, and the solicitation and selection of contractors to design and construct facilities.

The Act also encouraged States and municipalities to take a more active role in the development of resource recovery projects. It called for the creation of "Resource Conservation and Recovery Panels," which were to "provide State and local governments upon request and without charge teams of technical, financial, marketing, and institutional specialists to render assistance on resource recovery and conservation" (sec. 2003). EPA, through its Technical Assistance Panels Program, provided staff and consultant expertise in these areas to over 160 communities during 1978 and 1979. EPA also provides States with funds to develop comprehensive plans for dealing with all areas of MSW management, and it has established planning requirements that require the removal of State laws that impede contracting for these projects. As a further aid, EPA has drafted a guide explaining how States can provide technical assistance, financial assistance, information dissemination, and other services to local communities.

Furthermore, in a notable expansion upon earlier legislation, RCRA required the Department of Commerce to promote the dissemination and commercialization of resource recovery technologies by providing: "l) accurate specifications for recovered materials; 2) stimulation of development of markets for recovered materials; 3) promotion of proven technologies; and 4) a forum for the exchange of technical and economic data relating to resource recovery facilities" (sec. 5001).

The Department of Energy (DOE), like EPA, also provides funds for feasibility studies by communities that are considering resource recovery projects. DOE also conducts and funds research into the basic science and technology underlying various processes for resource recovery.

Finally, beyond the provisions which promote recovery of energy and materials from solid wastes generally, RCRA contained several specific provisions which bear upon the technologies' appropriateness for local development. The first provided for information exchange among the several levels of government, and between government and private firms, regarding "technical and economic levels of performance that can be attained by various available resource recovery systems" (sec. 1008); this information on the range of available alternatives should aid local governments in choosing systems appropriate to their needs. Second, the Act required the EPA Administrator to "undertake a comprehensive study and analysis of systems of small-scale and low-technology waste management. " (sec. 8002) Although the subsequent report has not received wide distribution, EPA's Office of Solid Waste has launched a Small-Scale and Low Technology Program designed explicitly to respond to the waste disposal needs of small communities. This program is likely to encourage the diffusion of small-scale technologies that are appropriate for local development.

There is, however, one provision in the Act which may mitigate against small-scale technologies: section 8006 authorizes Federal grants for the demonstration of resource recovery systems; but subsection 8006(c)(B)(2) requires that the share paid by a Federal grant for the construction of a project which serves only one municipality cannot exceed 50 percent, while if a project serves more than one municipality the grant can pay for 75 percent of construction costs. This provision may allow several municipalities to build larger facilities and to realize economies of scale, but it may also cause individual communities to lose control over the design, financing, and operation of their own resource recovery systems.

## Other Laws Having an Impact on Resource Recovery

The Energy Security Act of 1980 (Public Law 96-29+).–Title II of this Act contains several provisions dealing with "municipal waste biomass energy." It reconfirms the Federal Government's commitment to research, development, and demonstration of energy-from-waste technologies, but it also strengthens the existing mechanisms for promoting the adoption of these technologies. The Act broadens DOE's power to encourage the construction of municipal recovery projects by increasing the Federal share of construction loans to 80 percent and by allowing risk guarantees of up to 90 percent of principal and interest (sec. 233). The Act also allows DOE to make price support loans for existing projects and price guarantees for new projects (sec. 234). Finally, the Act established within DOE an Office of Energy from Municipal Waste to administer these programs.

The Energy Tax Act of 1978 (Public Law 95-618).–This Act contains provisions that should influence resource recycling and recovery. The first provides an additional 10-percent investment tax credit (for a total of 20 percent) for the purchase of equipment used to recycle ferrous and nonferrous metals, textiles, paper, rubber, and other materials for energy conservation (sec. 301(c)(i)). The additional credit is available for a wide range of equipment placed in service after October 1, 1978. The second provision sets recycling targets for major energy-consuming industries, including the metals, paper, textile, and rubber industries. Specific targets will be set for the. increased use of recycled commodities over the next 10 years.

Amendments to internal Revenue Code of 1954--Exempt Organizations (Public Law 94-568).–Section 4 of this Act requires that "the Secretary of the Treasury, in cooperation with the Administrator of EPA, make a complete study and investigation of all provisions of the Internal Revenue Code of 1954 which discourage the recycling of solid waste material, and that he should report his findings to Congress, along with specific legislative proposals and detailed estimates of their costs." In compliance with this requirement, the Department of the Treasury published *Federal Tax Policies: Recycling of Solid Waste Materials* (February 1, 1979).

The Federal Ocean Dumping Act of 1974 (Public Law 92-532, as amended by Public Law 93-254).—While the general intent of the Act is the international protection of the oceans, one of its major effects has been virtually to eliminate the disposal of domestic solid wastes in the ocean. To the extent that it precludes the use of a former option for solid waste disposal, this Act increases the amount of solid wastes that communities must deal with.

## Issues and Options

The case studies presented in this chapter help to illuminate a number of issues which apply not only to incineration and comporting technologies but to alternative resource recovery technologies in general. In so doing, they point out some of the problems faced by the producers and consumers of these technologies, as well as suggesting a range of options available to the Federal Government for addressing those problems.

ISSUE 1:

Federal Financing.

The BFDC case study provides evidence that, even when Government funds are available, there may still be problems with the *type* of financing provided by the Federal sources, the use of this financing by the project staff, and the *approach* to financing appropriate technology projects. Government grants and subsidies are most desirable for those stages of a project that provide a social good but involve risks or potential returns on investment that are unacceptable to the private sector. In the case of the Bronx comporting project, the funds provided by CSA for feasibility studies, market surveys, organizational startup, and the purchase of capital equipment all served legitimate and appropriate purposes. However, BFDC also needs funds for long-range planning and administration. When money is made available for use only on a specific new program, it may encourage projects like BFDC to spread themselves too thin simply in order to obtain additional funding. Capital equipment and startup funds obtained in this manner may mistakenly be considered "free" by the staff, but these new programs carry with them present management duties and future capital obligations that can become a tremendous drain on limited manpower and resources.

Much of the problem may lie in the attitude of Federal programs and officials toward projects of this type. Local development projects like the comporting operation might be thought of exclusively as a human service—as "welfare' '-rather than as a potential new business enterprise. In such a situation the grantor may not fully take into account the financial aspects of the project or hold the grantee accountable for his financial decisions. By allowing the project to become over extended, or by encouraging new programs rather than the consolidation of existing ones, Federal support can become counterproductive from the point of view of local development. These projects are not intended primarily to be commercial operations, nor is it easy to separate social and economic objectives in a depressed area like the South Bronx. Nevertheless, those projects that prove to be successful economic enterprises are far more likely to provide a basis for community organization and local development—and therefore serve the purposes of the grant programs themselves—than those that are restricted exclusively to providing human services.

Congress may wish to address this issue by reviewing the procedures and standards by which existing Federal programs evaluate the financial performance of local development projects.

## ISSUE 2:
### Large-Scale Centralized Recovery Systems v. Modular Systems and Source Separation Programs.

Large-scale centralized energy recovery facilities, both mass incineration systems like Akron's RES and systems that produce RDF for sale to electric utilities, have experienced significant economic and technical problems.[22] The economic problems arise from the capital-intensive nature of these projects, recent high rates of inflation for all capital projects, additional capital requirements for plant modifications, unexpectedly high operating and maintenance costs, and the reluctance of both energy purchasers and financing sources to absorb the financial risks of the projects. Furthermore, the very size of projects like the RES can result in a built-in inflexibility making them dependent on a large and secure waste stream (see below).

The technical problems arise from uncertainties about the reliability of the technologies, unforeseen design problems that have caused excessive downtime and required extensive process and safety modifications, difficulties with boiler performance and corrosion, poor RDF quality, and reduced system energy efficiencies. In addition, there is uncertainty about the impact of future changes in emission-control regulations and monitoring techniques, and a widespread perception that (in view of these financial and cost/reliability problems) these technologies may become obsolete during their 25-year lifetimes as a result of future breakthroughs in resource recovery.

These problems and concerns are typical of new capital-intensive energy technologies, and they constitute a serious barrier to the implementation of mass incineration and RDF projects. The allocation of risk becomes harder to negotiate, and system vendors in particular have reacted to their negative experience with new installations by either withdrawing from the market or becoming far more cautious about the risk they will absorb. This trend, if continued, could make it even more difficult to implement similar projects in the future.

Option 2-A: Federal Intervention to Reduce or Absorb Risks.–Congress might wish to investigate methods of risk reduction, either by making centralized resource recovery projects eligible for tax-free bonding or by providing incentives or loan guarantees for manufacturers and/or municipalities.

Option 2-B: Investigate Other Alternative Technologies.–Congress may wish, in view of the continuing economic ad technical problems with capital-intensive, large-scale centralized systems, to investigate methods for encouraging the adoption of other proven technologies for resource recovery. Small-scale modular incinerators, for instance, have been used successfully to produce steam, hot water, and hot air in institutional and industrial applications. Individual furnace units are small but higher capacity can be achieved by adding several identical modules. This design should allow greater flexibility, and its two-stage combustion process may also reduce particulate emission problems.[23]

Another possibility would be to investigate methods of encouraging the establishment or expansion of source-separation programs. Familiar approaches include curbside collection, community dropoff centers, and commercial recycling operations. Such programs are labor intensive and produce relatively uncontaminated materials for recycling. They require greater cooperation by waste generators and may put a greater burden on collection, so such programs will require careful attention to design and implementation strategies.[24] Dissemination of information on program design, combined with some form of incentive to communities or local recycling entrepreneurs, might be effective in promoting such programs.

## ISSUE 3:
### Control Over the Waste Stream.

Because centralized energy recovery systems are subject to economies of scale, their viability depends on assured long-term access to a large supply

[22] The following discussion is drawn from a report prepared by Sandy Hale of Gordian Associates, Inc., for the Electrical Power Research Institute, 1979, pp. 39-47.

[23] *Materials and Energy* From Municipal Waste, op. cit., pp. 254-255.

[24] Ibid., p. 69.

of MSW.[25] Long-term waste flow control is difficult to achieve, however: other disposal options may have lower costs now or in the future; cooperation between several municipalities may be required, and flow control may be resisted by private haulers and competing landfills. The two basic methods to guarantee such a supply are: 1) offering lower tipping fees than competing disposal alternatives, which may endanger the economic viability of the project; and 2) legislating public control of the waste stream, which is now being challenged in the courts. The Akron waste control ordinance, which is now before the Federal District Court of Ohio, is therefore of national importance. The legal issues raised by the case, as summarized by a recent study, are as follows:

- *Interstate* Commerce.—The recycling of materials from MSW is considered to be a form of interstate commerce as is some hauling and disposal of MSW by private haulers. Such activities are thus regulated by a large body of Federal statutes which cannot be preempted by local or State legislation.
- Anti-Trust Violation.–The enactment of waste control legislation creates a monopoly which violates Federal law.

The U.S. Supreme Court has ruled that municipalities do not have the same exemption from Federal anti-trust provisions that States are allowed by terms of the Clayton Act. This sets legal precedent to the effect that cities cannot create monopolies, which indicates that any future waste control legislation may have to be enacted on a statewide basis. This, of course, is contingent upon a ruling in the Akron case that waste control legislation in general is not offensive on interstate commerce grounds.[26]

Option 3-A: Amend Federal Law to Allow Municipal Waste Control.–Congress may wish to investigate ways in which antitrust and interstate commerce statutes might be amended to exempt MSW and/or municipal waste control from their provisions.

Option 3-B: Encourage State Waste Control Legislation.–If municipal waste control legislation is found to be in violation of antitrust statutes but not in violation of interstate commerce, Congress may wish to encourage the adoption of State waste control laws. In some cases, for instance, municipalities and counties are constrained under their State charters from entering into the long-term contracts (20 to 30 years) that would be necessary to ensure adequate MSW supply for facilities like the RES; this problem is further complicated when MSW from several jurisdictions must be combined for a single facility. Two approaches have been taken: the State of Florida has enacted legislation requiring that MSW set out by community residents must be delivered to the resource recovery facility by private haulers; the State of Wisconsin has gone a step further, declaring that the municipality is the actual owner of the waste stream. Congress might investigate the advantages and disadvantages of these and other State approaches, and formulate a model waste control law to be recommended to the States.

[25] The following discussion is drawn from Hale, op. cit., pp. 47-49.

[26] Ibid., p. 49.

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