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Waste-To-Energy and District Heating

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Waste-to-Energy and District Heating

A Handbook for Municipal Officials

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energy market; and selling electricity does not produce any additional benefits for the community. The message is, "be innovative." There may be other uses for the energy that are more beneficial to the community. You may even have the best of both worlds: cogenerating electricity and thermal energy will produce two revenue streams to help offset disposal costs.

Some of the papers make reference to "current tax law." Please be aware that the papers were written prior to enactment of 1986 federal tax reform legislation; therefore, unless otherwise noted, the tax law referred to is that in effect before the 1986 legislation.

The papers in this handbook are not technical; they are institutional in nature, addressing such issues as economics and financing, environmental concerns, legal issues, and energy markets. Their purpose is to assist the local elected official or executive staff by providing information needed to make critical decisions in project development.

No handbook can provide all the information required during project development. Local governments must call on their own resources, and must depend on their consultants and advisors for assistance. Further information is available on both resource recovery and district heating from several sources, including HUD and the Conference of Mayors/National Resource Recovery Association. The annual HUD-DOE National District Heating and Cooling Conference addresses a range of issues in DHC development, including the link between resource recovery and DHC. A national resource recovery conference conducted each March by the Conference of Mayors/NRRA focuses on timely topics in resource recovery development. Also, the Conference of Mayors conducts a series of workshops on resource recovery development, the Resource Recovery Leadership Institute, designed especially for local government officials.

For further information on these meetings, contact:

Wyndham Clarke
Office of Environment and Energy
U.S. Department of Housing and Urban Development
Room 7156
451 Seventh Street, S.W.
Washington, D.C. 20410
Telephone (202)755-5504

Ronald W. Musselwhite
Office of Development Programs
U.S. Conference of Mayors
1620 Eye Street, N.W.
Washington, D.C. 20006
Telephone (202)293-7330

District Heating Systems Fueled by Municipal Waste: A Winning Combination

Caroline Brooks

Argonne National Laboratory

September 1986

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FOREWORD

Resource recovery--or waste-to-energy--systems and district heating/cooling projects are ideal partners. As discussed at some length in this handbook, each complements the other, to the benefit of the community. It is realized that not all resource recovery projects are fortunate enough to have such a reliable long-term energy market as a district heating system; but, when feasible, serious consideration should be given to this type of thermal energy market for a resource recovery project.

This handbook for municipal officials has a dual purpose; to point out the desirability of matching a resource recovery facility with a district heating/cooling (DHC) system or other multi-user thermal energy market; and to offer information that the municipality can use as a guide in developing a waste-to-energy project.

The papers in this handbook were developed for a series of workshops conducted during 1986 and 1987 by the U.S. Department of Housing and Urban Development, Argonne National Laboratory and the U.S. Conference of Mayors. The authors are largely representatives of the private sector, and are acknowledged experts in their areas of resource recovery development.

The primary purpose of a resource recovery facility is, of course, to dispose of a community's municipal solid waste. But the astute public official will realize that, given the right set of circumstances, a resource recovery project can be much more -- especially if linked with a DHC system. For example, a waste-fired DHC system can become part of the foundation of a downtown revitalization plan; or the availability of reliable, relatively inexpensive thermal energy from a resource recovery facility can be a factor in attracting industry.

Such a system can also fit in well with other HUD programs in the community and economic development area, such as the Community Development Block Grant (CDBG) and Urban Development Action Grant (UDAG) programs. In some cases, CDBG funds can be applied to certain portions of the project; if the project is privately owned, a UDAG might be utilized.

Waste-to-energy projects are extremely complicated undertakings, and there is a tendency among both public officials and the industry to take the easiest route: choose a proven technology and sell electricity to the utility. The editors agree with the first part of this: be sure a technology has a track record before you select it. But the utility may not be the best

DISTRICT HEATING SYSTEMS FUELED BY MUNICIPAL WASTE: A WINNING COMBINATION

by
Caroline Brooks
Energy and Environmental Systems Division
Argonne National Laboratory
Argonne, Illinois

INTRODUCTION

Since district heating first proved economically feasible in the late 1800s, it has continued to be an efficient method of providing thermal energy to customers for space heating, for industrial process use, and, more recently, for cooling. Urban district heating systems experienced a decline over the years but began a resurgence in the 1980s.

Traditionally, district heating systems have used fossil fuels as an energy source. Recently, however, alternative fuels are being considered for an increasing number of systems; possibly the most promising of these alternative fuels is municipal solid waste.

Resource recovery is a relative newcomer, experiencing the first real interest in this country in the late 1960s and early 1970s. (Resource recovery, in its broad sense, refers to the recovery and reuse of a variety of materials and energy from municipal solid waste; here, the term is used interchangeably with waste-to-energy, or the burning of municipal solid waste to produce energy.) Interest in waste-to-energy systems surged with the jump in oil prices, but now the dominant force driving resource recovery is the scarcity of landfills and the need for an economically and environmentally acceptable alternative to landfill.

Given the right circumstances, these two technologies--both a boon to American cities--can be ideal partners. Each complements the other, offering something needed by the other. A resource recovery facility needs energy customers, and a district heating system provides a large multicustomer base; the district heating system needs a reliable,

relatively low-cost source of thermal energy, which the resource recovery facility can provide. With the proper strategy, each can be used to advance the development of the other.

This paper will discuss each technology and how, in combination, a synergistic relationship can be developed. Resource recovery and district heating together can be a winning combination, providing great benefits to the host municipality.

TECHNOLOGY HISTORY AND DEVELOPMENT

District heating systems use a mature and well-understood technology. Hot water transmission and distribution systems are commonly used in Europe, whereas both hot water and steam systems are used in the United States. In some cases both steam and hot water networks are operated separately within one district heating system.

The first system in the United States was developed in Philadelphia more than 200 years ago. Commercial steam district heating systems have served numerous U.S. cities over the years, and while many of these systems have aged and been abandoned, new systems continue to be developed. For instance, the cities of St. Paul, Minnesota; Willmar, Minnesota; Piqua, Ohio; and Trenton, New Jersey, have recently built new hot water district heating systems that serve high-density areas.

Heat recovery from incinerators was first practiced before the turn of the century. The first known municipal incinerator was built in Nottingham, England, in 1874. Generating steam and electricity began in Hamburg in 1896 and New York City in 1903.

Benjamin Franklin is recognized both for organizing a system of waste disposal for Philadelphia in 1782 and for developing what is considered to be one of the earliest systems of district heating, also in Philadelphia. Although Franklin is credited with the earliest district heating system, the world's first financially successful system was developed in Lockport, New York. Designed in 1877 by Birdsill Holly, the Lockport system provided steam from a central boiler plant to a few nearby residences and other users.

By 1890, district heating systems were being rapidly installed in numerous small cities and towns in upstate New York. They soon spread to other small cities in the United States, especially in northern industrial states, and to large cities such as Chicago, Pittsburgh, and Baltimore.

Meanwhile, a new wave of resource recovery was growing slowly until the energy crisis of the 1970s. Most solid waste is combustible; thus many cities in the United States used incinerators to "destruct" refuse. Some older installations used waste to generate steam and electricity, although few such plants were operating in 1973. At the same time, steam and/or electricity generation from solid waste was commonplace in Europe.

By the mid 1970s, energy recovery from municipal solid waste began to make more sense to many U.S. cities. The price of energy increased tenfold, the price of land increased dramatically, and the price of labor and materials increased. Moreover, the waste contained energy, and every pound of waste landfilled or incinerated without energy recovery meant a loss of energy and potential revenues generated from energy sales.

The district heating and cooling system in Nashville, Tennessee, was the first in the world to use refuse as a source of energy to provide both district heating and cooling. Operating since 1974, the resource recovery facility has a design capacity of 720 tons per day (TPD); it provides steam to 29 buildings in downtown Nashville and chilled water to 24. Both the refuse-burning facility and the distribution system are currently being expanded.

In Baltimore, a privately owned system provides district heating to about 500 customers, including commercial and government buildings, hospitals, and schools. Beginning in 1986, the Baltimore Southwest Resource Recovery Facility, a 2250-TPD mass-burning facility, will sell steam to the district heating system, making it the largest resource recovery facility in the United States to cogenerate steam and electricity.

District heating systems are used extensively in European cities where national policies promote its use. District heating and cooling systems are used for more than 40 percent of domestic space conditioning requirements in Denmark and for 70 percent in the Soviet Union.

A list of waste-to-energy systems in the United States with thermal markets is presented as Table 1.

In the United States, the problem of refuse disposal in urban landfills is widespread and the use of refuse incineration with heat recovery is increasingly seen as an attractive option to provide hot water or steam for existing district heating systems and/or steam for industry.

The use of heat recovered from municipal waste combustion for district heating is still small, but nevertheless significant. However, with the high cost of conventional waste disposal methods and widespread concern about environmental pollution arising from current methods of waste disposal, it is expected that waste heat recovery from refuse combustion linked to existing or proposed district heating systems will become more widespread.

Three types of district heating systems have developed in the United States. First, steam heating systems were developed beginning in the late nineteenth century to serve a variety of users and buildings located in urban areas, typically in the central business district. Many of these systems were owned and operated by local electric utilities. When operated by investor-owned utilities, the older urban systems have been regulated by state utility commissions in ways that often have made them uncompetitive relative to alternative fuels and heating systems.

Changes in power plant technology, size, and siting caused many urban systems to decline, beginning in the late 1920s, as they lost their sources of nearby relatively cheap fuel. Other systems continued to provide steam but at a higher price. Urban systems continued to decline after World War II as low-priced oil and natural gas began to be used for heating and as larger and more efficient power plants were located farther from the center of cities. Many of the remaining systems are older, deteriorating, and inefficient.

Table 1. Waste-to-Energy Systems with Thermal Markets
September 1985

Year of Startup	Location	Technology	Design Capacity (TPD)	Energy Market Type
1965	New York, NY	Refractory	500	District steam loop
1970	Chicago, IL	Waterwall	1,600	Brach Candy Co.
1972	Harrisburg, PA	Waterwall	720	District heating loop
1974	Nashville, TN	Waterwall	800	District heating/cooling loop
1979	Akron, OH	RDF, Dedicated	1,000	District heating loop
1979	Salem, VA	Controlled-Air	100	Mohawk Rubber Co.
1979*	Waukesha, WI	Refractory	175	Amron Corp.
1980	Auburn, ME	Controlled-Air	200	Pioneer Plastics Co.
1980	Crossville, TN	Controlled-Air	60	Crossville Rubber Products
1980	Dyersburg, TN	Controlled-Air	100	Colonial Rubber Works
1980	Durham, NH	Controlled-Air	108	University district heating loop
1980	Hampton, VA	Waterwall	200	NASA steam loop
1980	Lewisburg, TN	Controlled-Air	60	Heil-Quaker Co.
1980	Osceola, AR	Controlled-Air	50	Crompton Osceola, Inc.
1981	Aroostook Co., ME	Refractory	50	Frenchville Airport
1981	Burley, ID	Controlled-Air	50	Simplot Co.
1981	Albany, NY	RDF, Dedicated	750	District steam loop
1981	Johnsonville, SC	Controlled-Air	50	Wekman Industries
1981	Batesvile, AR	Controlled-Air	50	General Tire and Rubber Co.
1981	Pittsfield, MA	Refractory	240	Crane & Co. industrial loop
1981*	Collegeville, MN	Controlled-Air	65	University district heating loop
1981*	Niagara Falls, NY	RDF, Dedicated	2,200	Hooker Chemicals & Plastics Corp.
1982*	Gallatin, TN	Waterwall	200	Industrial district heating loop
1982	Waxahachie, TX	Controlled-Air	50	International Aluminum Extruders
1982	Harrisonburg, VA	Refractory	100	University district heating loop
1982	Portsmouth, NH	Controlled-Air	200	U. S. Air Force district heating loop
1982	Rolla, ND	Controlled-Air	100	District heating
1982	Miami, OK	Controlled-Air	108	B. F. Goodrich
1982	Red Wing, MN	Controlled-Air	72	S. B. Foot Tanning Co.
1982	Park Co., MT	Controlled-Air	72	Burlington Northern Railroad
1983	Cattaragus Co., NY	Controlled-Air	115	Cube Cheese Co.
1983	Huntsville, Al	Controlled-Air	50	U. S. Army district heating loop
1984	Pascagoula, MS	Refractory	150	Morton-Thiokal Co.
1984	Tuscaloosa, AL	Controlled-Air	300	B. F. Goodrich
1984*	New Hanover Co., NC	Waterwall	200	W. R. Grace
1984	Susanville, CA	Refractory	100	Lassen Community College
1984*	Baltimore, MD	Waterwall	2,250	Baltimore Thermal
1984*	Haverhill/Lawrence, MA	RDF, dedicated	1,300	Industrial district steam loop
1985	Atlantic County, NJ	Controlled-Air	15	Atlantic County Justice Facility
1985*	Oneida County, NY	Controlled-Air	200	Air Force district heating loop
1985*	Oswego Co., NY	Controlled-Air	200	Armstrong World Industries
1985	Sitka, AK	Refractory	50	College district heating loop
1985*	Franklin, KY	Refractory	75	Glover Garden Products
1985	Delaware Co., PA	Refractory	50	Far Acres Geriatric Center
1985	Hampton, SC	Controlled-Air	225	Westinghouse Electric (steam)
1985	Carthage, TX	Controlled-Air	40	Tasty Bird Foods (steam)
1985	Cleburne, TX	Refractory	100	Donnelly Printing, Inc. (steam)
1986	Ft. Dix, NJ	Controlled-Air	80	U. S. Army
1986*	Tulsa, OK	Waterwall	750	Sun Oil Co.
1986*	Portsmouth, VA	RDF, Co-fired	1,900	U. S. Navy district heating loop
1986	Olmsted Co., MN	Refractory	200	Federal Prison district heating loop
1987*	Detroit, MI	RDF, Dedicated	3,000	Detroit Edison district steam loop
1987*	Wilmington, DE	Refractory	750	ICI Chemicals
1987	Davis Co., UT	Refractory	400	Air Force district heating loop
1987*	Rochester, MA	RDF, Dedicated	1,500	Commonwealth Edison, future industrial
1987*	Dutchess Co., NY	Waterwall	400	IBM (steam)

SOURCE: Gershman, Brickner 7 Bratton, Inc.
*Electric generation or cogeneration

The second type of system serves institutional users. These include college and university campuses; military bases; industrial parks, multifamily residences; and office, medical, and commercial complexes. Institutional systems serve a single user, a single or few related buildings, or a complex of buildings.

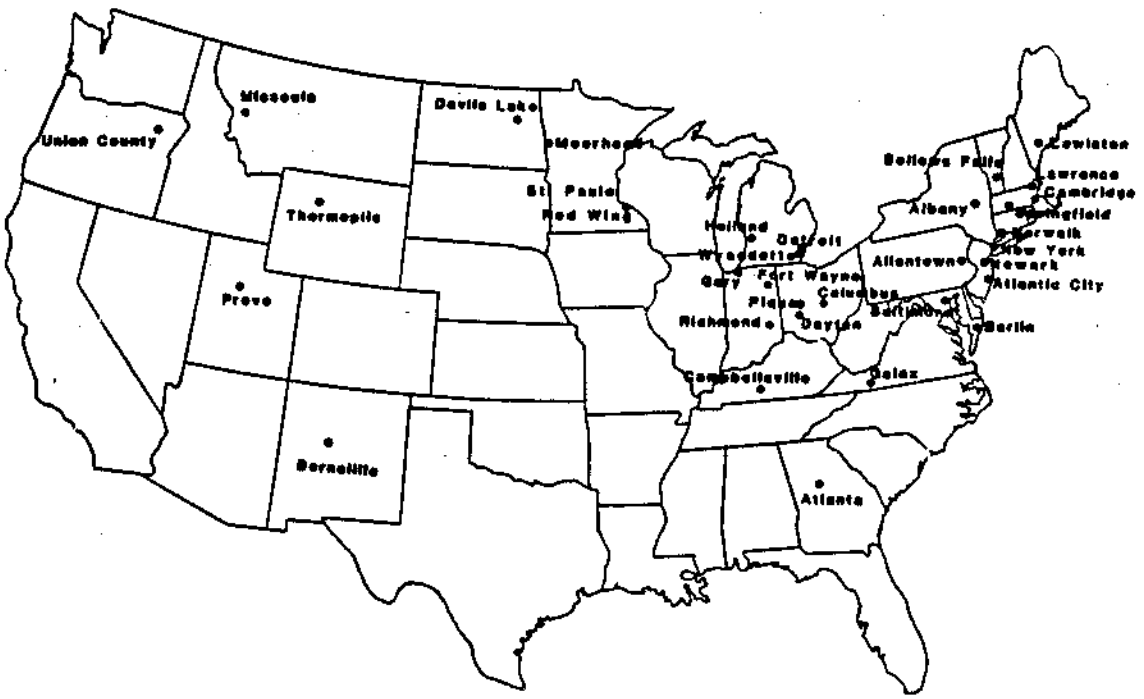
In sharp contrast to the urban systems, institutional systems have grown significantly in the last two or three decades. Until recently, however, there were few or no data on which to judge their extent. One recent informal survey identified 4,900 miles of thermal piping on U.S. Army installations in the United States; another identified 160 institutional systems in the Washington, D.C., and Baltimore metropolitan areas, principally in public housing projects. Among the places served are the White House, the U.S. Capitol, the National Zoo, and Washington's subway system.

A third type of district heating and cooling system has emerged. These are nonprofit systems, usually municipally incorporated or owned, that serve many and varied urban users. Many have replaced older urban systems operated by investor-owned utilities, as in St. Paul, Minnesota. In other cities, groups of users have combined to form nonprofit cooperatives that run systems formerly operated by investor-owned utilities, as has happened in Pittsburgh and has been proposed for Rochester, New York.

A number of these new urban systems (Figure 1) have been assisted by demonstration projects sponsored by the U.S. Department of Housing and Urban Development (HUD) and the U.S. Departmeant of Energy (DOE). HUD, in particular, has used district heating and cooling as a tool to help cities with their economic and community development. DOE began sponsoring cogeneration and district heating projects in 1977 that retrofitted power plants in central cities.

In addition, there are systems owned by profit-making developers. These include the purchase of older district systems and the development of new district heating/cogeneration systems. Examples are Thermal Resources of America, with systems in Youngstown, St. Louis, and Baltimore; and Cogeneration Development Corporation in Trenton, New Jersey.

Figure 1. District heating and cooling project cities (courtesy U.S. Department of Housing and Urban Development and U.S. Department of Energy).



Significant growth in demand for district heating systems has occurred in recent years from institutional installations such as military bases and college and university campuses. More recently, there has been renewed interest in urban systems, either renovating and rejuvenating existing systems or constructing new ones. This is due to changes in oil supplies and increases in fuel prices over the past 10 years.

District heating in Europe did not take hold until after World War II. Since that time, however, it has developed rapidly and has received excellent public acceptance. The contemporary success of district heating in Europe has helped renew interest in this country and has led to a movement toward adoption of European methods in several American cities.

The United States generates more than 450,000 tons per day of municipal solid waste. Disposal of this waste is a rapidly growing problem for many areas of the country where traditional methods (e.g., landfilling and uncontrolled incineration) are becoming too expensive or environmentally unacceptable. In a survey of mayors and councilmen taken in 1974, refuse and solid waste ranked as the most important of 28 major urban problems. Although other local problems -- primarily fiscal ones -- have moved to the top of the list, solid waste remains one of the most important urban problems and is reaching crisis status in many cities.

Historically, the disposal of municipal waste was simply to dump it in open dumps and/or burn it. When governmental regulations prohibited this practice, sanitary landfills and incineration became the two primary sources of disposal. In a survey taken of incinerator plants, it was reported that in 1965 there were 299 operational incinerators, including at least one in each state. Between 1965 and 1969, more than 200 of these plants closed, primarily due to the enactment of federal and state air pollution control standards. In that era of cheap energy, little consideration was given to energy recovery from the incineration of municipal solid waste.

The period from 1968 to 1973 was a turning point in solid waste management. Development efforts focused on systems that would prepare fuels from waste to be fired in existing combustion units, reducing the capital costs of waste-to-energy facilities. Other U.S. efforts were directed at developing systems that would provide more useful fuels such as gases, liquids, or char that could be used in a wider variety of applications. Continuing advances in European technology and the proliferation of feasibility studies and actual projects in the United States have brought credibility to the waste-to-energy concept. Technological barriers are becoming less of a problem with each new generation of technological refinements.

An annual national survey conducted by Governmental Advisory Associates, Inc., divides waste-to-energy projects into two broad categories -- those in the conceptual phase of development (124) and those in advanced planning stages or already completed (128). Other significant findings in the survey include:

- 54 percent of the systems in conceptual phases of development will be mass burn, 32 percent will be modular mass burn, and 14 percent will be refuse-derived fuel;

- of those plants in advanced or completed stages, 37 percent are mass burn, 34 percent are modular mass burn, and 25 percent are refuse-derived fuel.

STATUS OF TECHNOLOGIES

Thermal Systems

A solid-waste-fired combustion plant supplying energy to a district heating system is made up of three major components. The first is the thermal production plant, which provides the hot water or steam. Additionally, absorption refrigeration equipment or steam-turbine-driven mechanical chillers can be used to generate chilled water. The boilers burn solid waste along with conventional fossil fuels or, depending on the design of the unit, can be dedicated boilers that burn only solid waste.

The second component of the thermal energy system is the transmission/distribution network. This network conveys energy in the form of steam, hot water, or chilled water through pipes from the thermal production plant to the ultimate customer or customers.

The third component of the thermal energy system is the customer's in-plant or in-building equipment. Steam or hot water supplied by the thermal system can be used directly for heating or cooling; in this case, it is directed into the building and circulated through the customer's equipment. For example, in several older systems, steam is directed through a pressure-reducing station for use in the low-pressure (0-15 psig) steam space heating system, service water heating system, and absorption chilling equipment. In the case of hot water systems and newer steam systems, heat exchangers are used most frequently, and many building space heating and domestic water heating systems are hot water design. When chilled water is also distributed by the system, water-to-water heat exchangers are usually employed within the building. Heat exchangers isolate the user from the thermal system and preserve the integrity of both system and customers. Energy loss in this approach is very low.

District heating and cooling systems are typically classified by the thermal energy media used, as follows:

- Steam Systems:

  - Heat-only systems, where boiler capacity is committed to supply steam at the design pressure to the distribution network (example: Akron, Ohio).

  - Cogeneration or combined thermal and power systems, where the steam used in the district heating system is a by-product of the electric generation process (example: Baltimore, Maryland).

  - Supply/purchase systems, where steam above a base capacity generated by a waste-to-energy plant is supplemented from other boiler plants, depending on demand and availability (example: Albany, New York).

- Hot Water Systems:

  - Conventional hot water systems, where hot water is supplied from dedicated boilers or other heat sources at central locations in the system (example: St. Paul, Minnesota).

  - Hybrid systems, where a steam system produces steam that is converted in a heat exchanger to hot water for a localized hot water network (example: Pease Air Force Base, New Hampshire).

- Cogeneration or combined thermal and power systems, where hot water is developed as part of the electric generation process (example: Trenton, New Jersey).

- Chilled Water Systems:

  - Chilled water is produced at a central plant by steam-driven equipment (examples: Nashville, Tennesssee; San Antonio, Texas; and Hartford, Connecticut).

  - Chilled water is produced at a central plant by electrically driven equipment.

  - Chilled water is produced in the user's building from the steam or hot water supplied by the district heating system.

Of the 56 waste-to-energy plants in the United States that burn municipal solid waste and market thermal energy (Table 1), the form of the eventual product or products sold (versus generated by the boilers) is as follows:

Marketed Energy Form	No. of Plants*
Steam 54	
Hot Water	3
Chilled Water	2

*Not all of the plants supply district heating, but all produce steam that could supply district heating with either resiting or connection.

The technologies and fuels used to produce thermal energy vary. Simple boilers can be used to distribute hot water in a single loop to a variety of buildings. Boilers and chillers can provide hot and chilled water to users, with supplemental systems for specialized large users. The system may consist of a large number of independent production sites using direct combustion, recovered heat, cooling, and domestic hot water.

A heat exchanger is used to convert the thermal energy that the system provides into heating or cooling for the end user, usually a single building or a group of buildings. Demand for energy, measured in British thermal units (Btu) per hour or its equivalent, is influenced by climate, building size and characteristics, and end user needs.

The transmission and distribution system transports thermal energy through a network of insulated pipes. The pipe loop carries energy in the form of steam or hot or chilled water to the end users. A separate pipe returns water with most of the energy removed (or added in the case of cooling) to the production plant for reprocessing. Insulated pipes can be buried directly in the ground, placed in tunnels or concrete culverts, or located above ground. A typical steam piping system normally services customers within 2 to 3 miles of the generating source. Hot water, on the other hand, can be piped over distances of up to 15-20 miles with limited heat loss.

The use of hot water systems by district heating and cooling utilities in the United States is limited because most of the utilities' customers are in old areas and often in older buildings designed for steam. However, hot water distribution is more frequently used in institutional installations such as college and university campuses, large prisons, airports, merchandise centers, and military bases.

Where steam is provided and is already an essential part of an industrial/commercial zone, it may be impractical to convert to hot water distribution. However, when new areas are developed, a hot water system may be appropriate. One way to develop hot water district heating is through the hybrid concept, where steam is

transmitted for the distance necessary to meet existing customer commitments and is then fed into a heat exchanger and pumping system for a hot water loop. High-temperature hot water can be utilized to produce steam for these customers by installation of appropriate equipment.

Hot water can also be produced in a generating plant by placing a heat exchanger in the turbine exhaust to heat the system's water supply. In this system, the boiler water flowing through the turbine in the form of steam is kept separate from the water distributed for the thermal market loads and the cost for water treatment and energy loss is markedly reduced from the level experienced by steam systems where the condensate is not returned.

Table 2 provides a comparison of steam district heating and hot water district heating, showing advantages and disadvantages.

For chilled water systems, water is chilled to 35-40°F and distributed to customers who use heat exchangers for space conditioning.. Chilled water distribution is limited because large pipe systems are required and effective distances are less than for hot water distribution. Waste-to-energy systems produce steam year-round, and there is little demand for heating in warm weather. Use of the steam to drive chillers for air conditioning, where practical, can contribute to the energy revenue stream and make the project more economically viable.

Resource Recovery Systems

Resource recovery systems include any process that can recover materials or energy from municipal solid waste. The nature and developmental status of each of the recovery systems that is applicable to district heating is discussed. Other systems are in the laboratory or pilot stage.

Table 2. Comparison of Steam and Hot Water District Heating

Advantages	Disadvantages
Steam District Heating	
Pumps are not required. Can be a one-pipe system with no return.	Piping can range to 1 to 2 miles (1.6 to 3.2 km), 3 miles (4.8 km) maximum, for older systems; newer ones can achieve longer ranges with improved insulation.
Retrofit of old urban steam buildings may be easier.	If steam is extracted from a cogenerator, a great deal (±10%) of electricity is sacrificed.
Cogeneration employed uses steam for electricity before distribution.	Steel pipes are required--they are expensive and they corrode.
Good energy end-use match.	Water must be conditioned to prevent mineralization.
	If condensate is not returned (it usually is not), water, water conditioning, and low-grade energy are wasted.
	Use of high-temperature steam for space-heat/service-water heating is a poor energy end-use match.
	Heat loss during distribution is high (15-45 percent).
	Piping, boiler, and personnel codes are stringent; steam is not as safe as hot water.
	Installation is difficult--requires pitched piping, steam traps, pipe expansion, manholes.
	Maintenance costs are higher.
	Metering energy use is difficult.
	Difficult to operate under conditions of varying loads.

Table 2. Comparison of Steam and Hot Water District Heating (contd.)

Advantages	Disadvantages
Hot Water District Heating	
Piping can range to 15 miles (25 km), possibly up to 70 miles (110 km).	Pumps are required; system balancing is important.
Less cogenerator electricity is sacrificed.	System needs two pipes.
Plastic pipes can be used in limited cases--less expensive, no corrosion.	Cannot provide high-pressure steam if a customer on the circuit requires it--can act only as preheat.
Water may not need to be conditioned; if so, it is closed loop.	
Closed loop, so water is not wasted.	
Good energy end-use match.	
Heat loss during transmission and distribution is low (5-15 percent).	
Construction and operation codes easier to meet; relatively safe.	
Installation, retrofit to buildings is generally easier.	
Maintenance costs are lower.	
Metering energy use is relatively easy.	
Not as susceptible to mis-sizing.	
Easy to operate under conditions of varying thermal load.	
Hot water can be stored.	

SOURCE: Office of Technology Assessment (1982).

Mass combustion is the process that burns waste as received at the facility in either waterwall or refractory-wall units. Both types of units have boiler tubes in the combustion-gas exit path. The waterwall units are more efficient and generally more expensive. Figures 2 and 3 show the generalized process flow for these two basic types of systems. Mixing and some removal of bulky noncombustible items take place in the receiving and/or storage area. The product from most of these units is steam, which is used directly or converted to electricity, hot water, chilled water, or some combination thereof. The installed facilities range in size from 25 to 2,250 TPD of combusted waste, and they are site-built and custom-designed.

Modular units, shown in Figure 4, range in size from 10 to 200 TPD. When higher capacities are required, the individual modules are usually grouped in multiple-unit systems to form a single facility. The modules are standardized and factory-manufactured. The major components are assembled at the factory. Only final assembly is done on-site.

Most of the modular units use two-stage combustion in two connected chambers. Municipal solid waste is charged into the first chamber and, in some manufacturer's units, burned in an oxygen-deficient, or starved-air, atmosphere. In this type of unit, the gases produced in the primary chamber are burned in the secondary chamber. In other units, the secondary chamber provides needed extra time for combustion of refuse vapors and particulates and also allows for tempering of the gases before they enter the heat exchanger.

Figure 2. Schematic of a Typical Mass Combustion Waste-to-Energy Facility

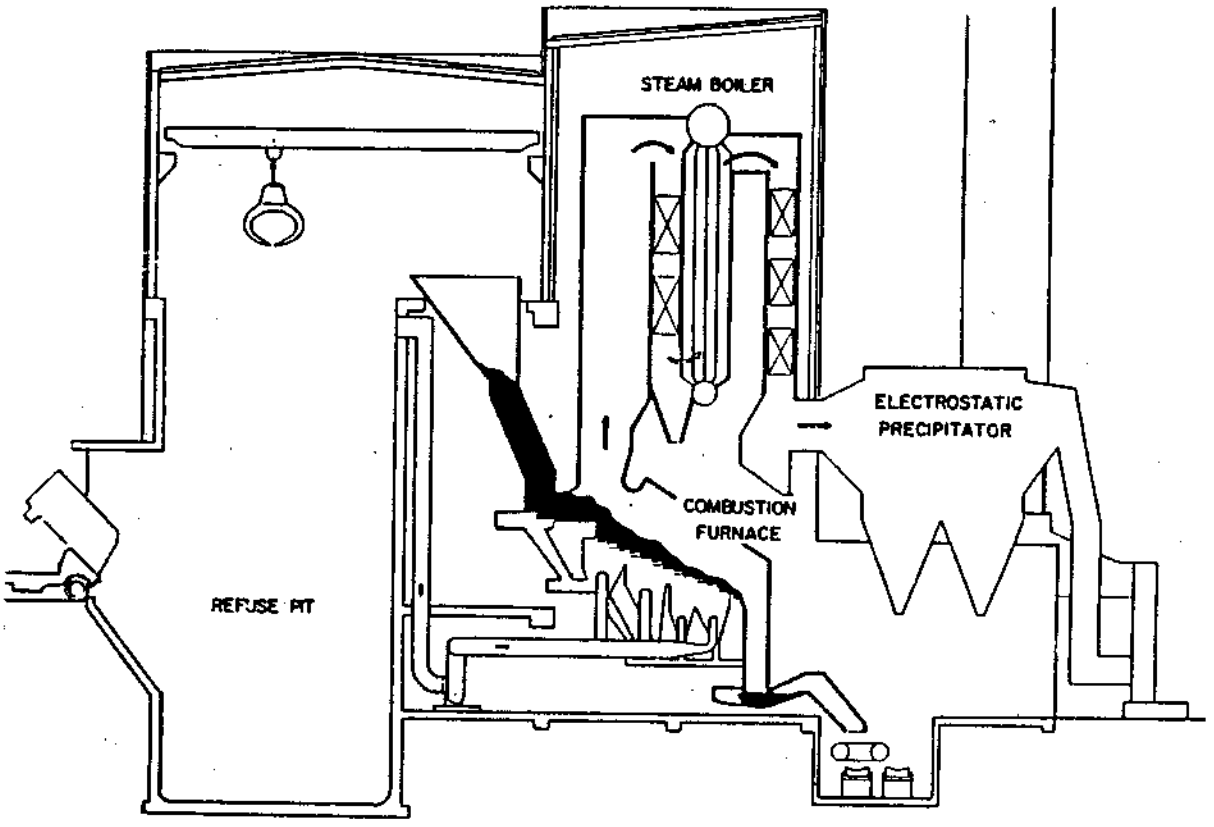


Figure 3. Schematic of a Typical Refractory

Waste to Energy Facility

LEGEND

1 REFUSE PIT
2 BRIDGE CRANES (2)
3 CHARGING HOPPER & CHUTE
4 PRIMARY COMBUSTION CHAMBER
5 SECONDARY COMBUSTION CHAMBER
6 NATURAL GAS BURNERS
7 UNDERFIRE AIR SUPPLY
8 OVERFIRE AIR SUPPLY
9 RECIPROCATING GRATE STOKER
10 RESIDUE CONVEYOR
11 SPRAY CHAMBER
12 FURNACE PRESSURE CONTROL DAMPER
13 SUBSIDENCE CHAMBER
14 BREECHING
15 DUST COLLECTOR
16 INDUCED DRAFT FAN
17 STACK

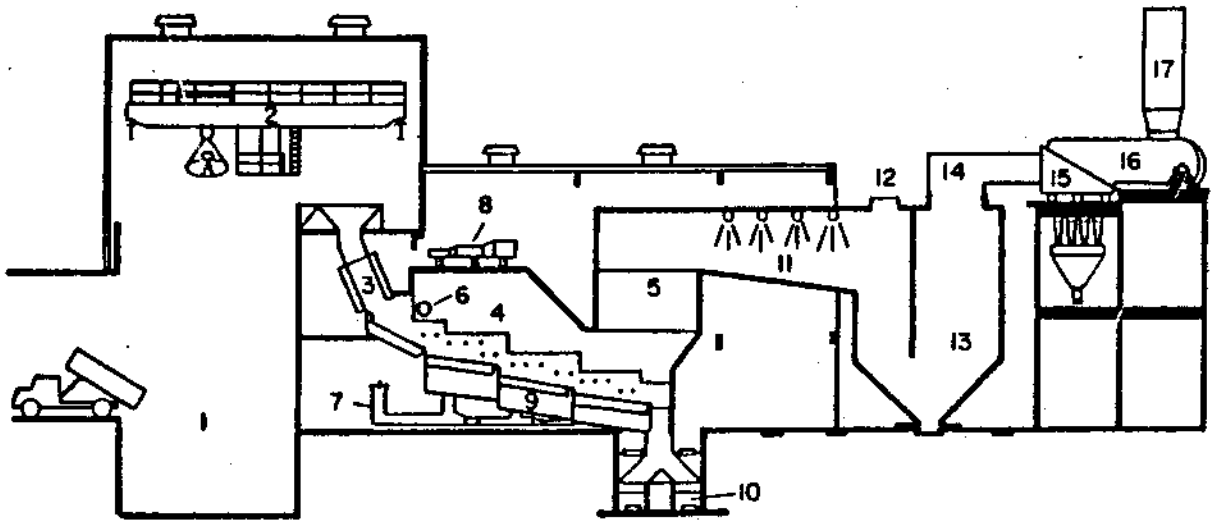
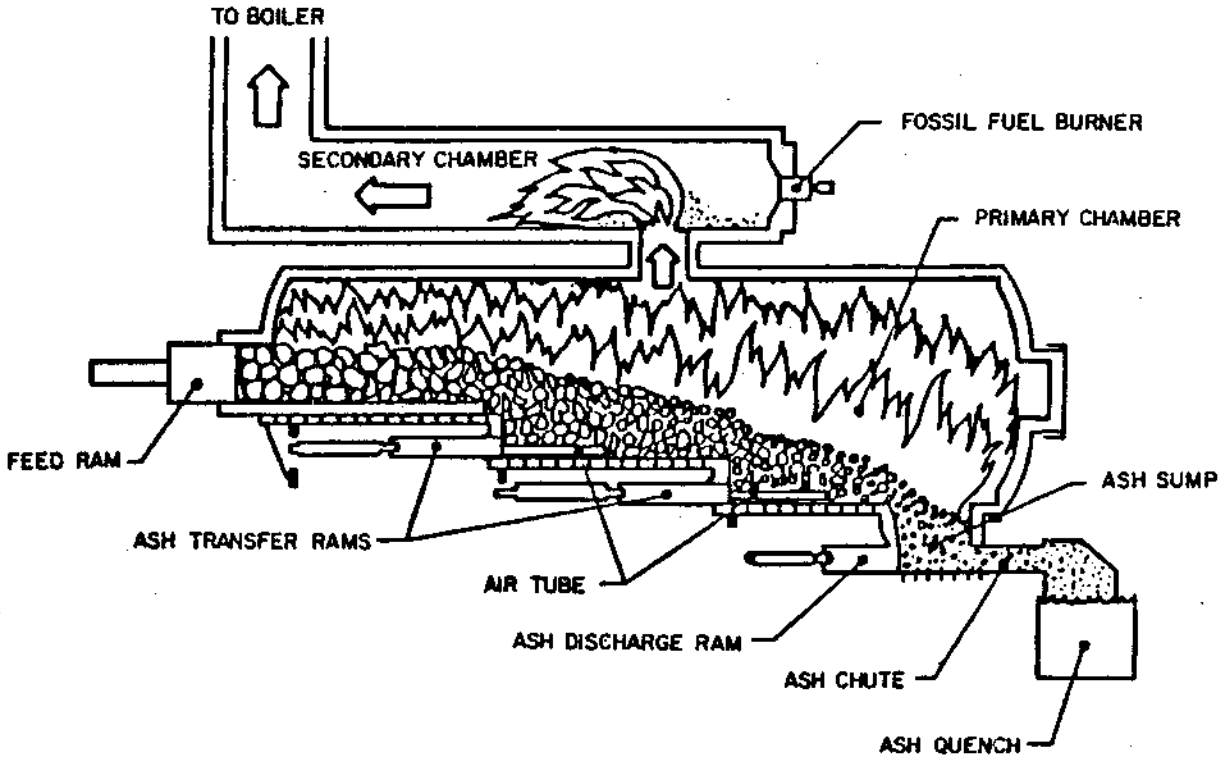


Figure 4. Cross Section of a Typical Modular Combustion Unit



Selected Mass Burn Plants
with District Heating Applications

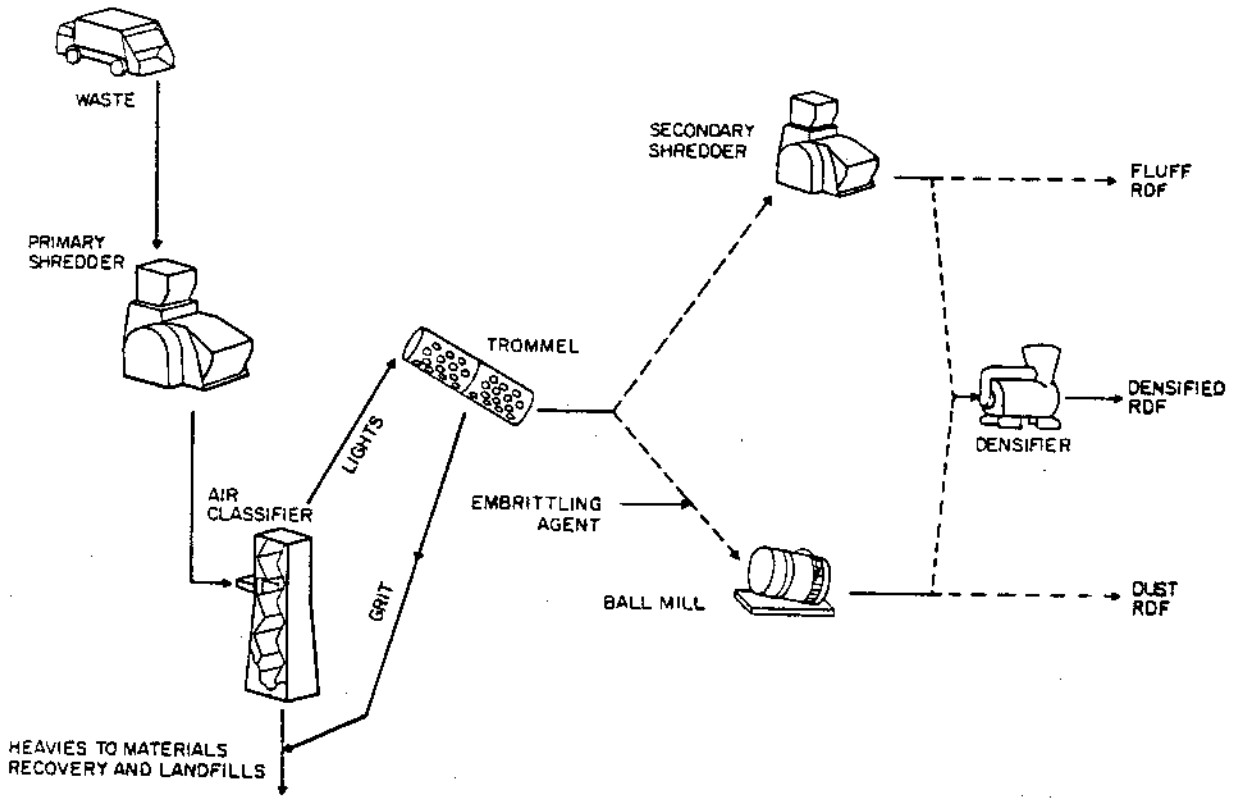
Location	Technology	Energy Customer	Plant Size (TPD)
Baltimore, MD	Waterwall	Baltimore Thermal Steam Loop	2,250
Nashville, TN	Waterwall	City Steam Loop	800
Norfolk, VA	Waterwall	U.S. Navy	180
Durham, NH	Modular	University of New Hampshire	108
Collegeville, MN	Modular	St. John's University	64
Portsmouth, NH	Modular	Pease Air Force Base	200
Mays Landing, NJ	Modular	Atlantic County Justice Facility	15

Refuse-derived fuel (RDF) is municipal solid waste that has been processed to remove most of the noncombustible material (metals, glass, and other inert material) and to reduce the combustible residue to a nominally uniform size. This processing makes the product easier to burn, with a higher heat content per pound than raw municipal solid waste. It requires specialized and relatively expensive production equipment. The resulting product has the advantages of being a better fuel than municipal solid waste and a fuel that can be fired in either a dedicated boiler or in a utility or industrial boiler cofired with coal.

Figure 5 depicts a simplified dry-processing technique to produce fluff, densified, or dust RDF in a mechanical processing plant. Iron is separated and sold commercially. Aluminum and glass, although more difficult to isolate, can also be separated.

Operating examples of RDF facilities serving municipal utility boilers can be found in Ames, Iowa; Madison, Wisconsin; and Lakeland, Florida. The combustion of RDF in dedicated boilers generally produces a medium-temperature and -pressure steam, which is appropriate for industrial process application and district heating. Dedicated boiler systems with thermal energy customers are located in Akron, Ohio; Lawrence/Haverhill, Massachusetts; and Albany, New York.

Figure 5. Municipal Solid Waste Dry-Processing Diagram



THERMAL MARKETS

Securing a long-term market for energy has been -- and will continue to be -- the most important element in determining the success of district heating and/or resource recovery systems. Economic success for both technologies is based on developing energy customers. When the two are combined, the district heating system becomes the consumer for the resource recovery facility, and in turn, the district heating plant must establish a high energy demand density within the service area. When approaching prospective energy consumers, a district heating system management team has an advantage if the system uses municipal solid waste as fuel.

In addition, resource recovery facilities have revenues from user tipping fees and, in some instances, from the sale of recovered materials. This income can create a subsidy to hold down the price of the recovered energy.

Generally, conditions that favor district heating in the United States are as follows: (1) our cities are densely populated -- some more so than their European counterparts -- and many have long, cold winters; (2) the U.S. technology for cogeneration exists -- and has been encouraged by federal legislation such as the Public Utilities Regulatory Policy Act; and (3) by utilizing available municipal solid waste as fuel, the criterion for a cheap energy source is met.

All these factors vary in their significance from country to country and, within the United States, from city to city. Some may be crucial whereas others count for little in deciding whether to build a district heating and cooling system and in determining how successful it will be. A cold climate, for instance, reduces the relative cost of distributing thermal energy by extending high heating demands over a longer time. It also provides more favorable load factors (ratios of average to peak demand), which reduce the cost of heat per million Btu produced.

In some cities, district heating and cooling can be used successfully because many modern office and other commercial buildings require heating in one part and cooling in another at the same time. In addition, modern office buildings require cooling even on days when most residences do not, because windows are often sealed for heating and cooling system control.

District heating and cooling likewise benefits from the recent surge in the number of multifamily residences built in or near downtowns in U.S. cities. Apartment complexes, in particular, create a favorable potential market, although older construction also offers possibilities. In New York City, where an industrial park has been proposed for the site of the old Brooklyn Navy Yard, a district heating and cooling system is planned for the park that would also supply thermal energy to nearby public housing units.

Cities like St. Paul, Minnesota; Piqua, Ohio; and Jamestown, New York, have used their new or revitalized district heating systems to attract business and commercial developments to their downtowns. A new, privately owned for-profit system provides district heating and cooling to the downtown area in Trenton, New Jersey. In Brooklyn, New York, a privately owned, 46-building apartment complex, Starrett City, gets its heating, cooling, and electricity from an on-site cogenerating power plant. Project owners estimate the cost of Starrett City's thermal energy as about one-third that of retail rates.

Another opportunity for urban systems may come from combining several existing institutional systems. The current district heating system in Copenhagen, for example, began as separate systems that were later combined; later still, the new system was expanded to serve new customers. Now, half of the residential dwellings in Copenhagen itself and 40 percent of those in the greater metropolitan area are served by district heating.

ENVIRONMENTAL ISSUES

A significant advantage of a district heating system fueled by municipal solid waste is the potential for reduced environmental pollution. The environmental benefits are gained primarily through system efficiency resulting from the larger power generation plants producing a more optimum ratio of units of useful energy to emissions.

Another benefit of district heating is the potential for reduction of thermal discharges to lakes, rivers, and the atmosphere. The rejection of waste heat through once-thru cooling systems (from retrofitted power plants) or from cooling towers will on the average decrease, with a significant decrease during the winter months when heating requirements are greatest.

As waste-to-energy technology has developed, the environmental issues have become an increasingly important part of system acceptance, and system designs have accordingly been modified to incorporate features that minimize environmental impacts. Systems controlling air and water pollution have been added, existing designs of equipment and operation have been modified, and new equipment and process designs have been tailored to comply with federal, state, and local environmental regulations.

In addition, with a waste-to-energy combustion system, less land area is needed for landfill. Although there is still a need for landfilling noncombustibles that remain (metals, ash, glass), this material is largely inert and presents less of an environmental threat than that associated with placing solid waste directly into a sanitary landfill. Combustion of waste removes many of the environmental issues associated with landfilling, e.g., blowing of trash and rodent infestations. Perhaps the most important environmental advantage of resource recovery is that it eliminates the very real danger of contaminating groundwater by leachate from landfills.

COSTS AND FINANCING

Both resource recovery facilities and district heating and cooling systems are highly capital-intensive. On the average, district heating operates with 80 percent fixed costs and 20 percent variable costs; this is exactly the opposite of the cost ratios for its gas competitors, indicating the sensitivity of the systems to interest rates and financing methods. For district heating systems, half or more of the capital costs are represented by the distribution and transmission network. Costs can be minimized by keeping the number and length of pipes to a minimum. Thus, most systems are designed to serve high-use customers within specified areas. None of the existing U.S. steam systems serve more than 3,500 customers and most serve less than 1,000.

Resource recovery facilities are one of the largest investments a community will make. For example, the 2,250 TPD mass burn facility completed in Baltimore in 1985 was a $254 million project, financed with $191 million in industrial development bonds and $63 million in equity capital from the private developer. Financing for either resource recovery facilities or district heating systems can be similar to that for any other large-scale, long-term municipal utility project. In this sense, the project should be able to generate sufficient revenue to pay back its costs over its useful life.

An important aspect of facility success is the need for systems to get customers to sign long-term (20-year) take or pay commitments. This is difficult because the commitments may be considered a lien against property. Although the legal validity of these commitments has not been tested, the requirement unnecessarily complicates already difficult institutional arrangements and further extends the long development time.

Table 3 summarizes and compares several methods of financing facilities.

Table 3. Comparison of Financing Methods

Type of Financing	Investor Risk	Interest Rates	Tax on Interest	Tax Benefits	Security	Ownership	Operation
1. General Obligation	Lowest	Lowest	No	No publically owned	Tax power	Public	Public
2. Municipal/ Special Revenue	Higher than for Type 1	Higher than for Type 1	No	No publically owned	Revenue stream	Usually public	Public or private
3. Industrial Develop- ment	Higher than for Type 2	Higher than for Type 2	No	Yes	Lease, mortgage, contracts, corporate, credit		Private
4. Lease	Same as for Type 3	Same as for Type 3	No	Yes	Lease, mortgage, contracts, corporate, credit, municipal credit	Public or private	
5. Private	Dependent on corporate involve- ment	High	Yes	Yes	Corporate, credit	Private	Private

SOURCE: Adapted from Gershman, Brickner & Bratton, Inc.

THE HUD/DOE 28-CITIES PROGRAM

Beginning in the 1970s, a series of government- and corporate-sponsored demonstration projects have contributed to the revitalization of interest in district heating and cooling. New systems have been built or old ones rehabilitated in cities such as Provo, Utah; Lawrence, Massachusetts; and Baltimore, Maryland. These and other new or revitalized systems have been funded in part by a variety of HUD and DOE programs, including HUD's Urban Development Action Grant Program and a joint HUD-DOE District Heating and Cooling Assessment Program.

DOE began sponsoring cogeneration projects in 1977 that were typically tied to district heating and cooling systems. Participating cities include Trenton, New Jersey, and Piqua, Ohio.

In 1980, HUD began a district heating program in collaboration with DOE. One goal of HUD was to increase the community's interest in obtaining more widespread distribution of the benefits produced by a new or expanded district heating and cooling system. To accomplish this, a competition was conducted among cities for financial assistance to do preliminary feasibility assessments of potential district heating and cooling systems (called Phase I of the development process). The request for proposal required applicants to demonstrate that they had given more than casual consideration to the potential impact of a district heating and cooling system in their community and economic development program. It required cities to indicate where the major concentrations of demand were believed to be located and to relate them to candidate heat sources. They also were required to make preliminary estimates of the impact on business retention and job creation.

This original competition in 1980 drew proposals from 112 cities to conduct Phase I assessments of one or more district heating and cooling projects. Twenty-eight

cities were selected from this group and granted a total of $1.5 million. Cooperative agreements with those cities selected were signed in July 1981, and their year-long assessments began over the following months. More than half of the cities finished Phase I with a project that appeared to be feasible based on preliminary technical, financial, and institutional analyses.

A second phase of the program carried out by HUD was designed to assist communities in the further development of projects that had shown apparent feasibility in the Phase I assessments. Three cities were competitively selected in the fall of 1982 for financial assistance with Phase II. That number has since increased to 10. These cities were drawn principally from the ranks of those that had received financial assistance for Phase I from HUD.

Significantly, five of the original 28 developed plans far enough to determine that they could complete their design, marketing, and financial packages (Phase II) without further federal assistance. Most of the HUD-assisted Phase II projects indicate a strong potential for reaching construction.

CONCLUSION

District heating and cooling technology is well understood. When used in conjunction with resource recovery, district heating and cooling systems provide neighborhoods and business districts with heating and cooling that is advantageous from the standpoint of economics, dependability, and energy conservation, and is also environmentally acceptable. With the unstable cost and long-range declines in the availability of oil and gas, energy consumers such as individual local industries and institutions and agglomerates of energy users such as district heating and cooling loops are becoming more and more conscious of the need for alternative sources of energy to help control long-term costs.

Meanwhile, regulations affecting solid waste disposal programs, as well as the unpopular political overtones associated with siting new landfills in newly populated areas, have caused an awareness of the importance of controlling waste disposal programs. Disposing of solid waste through resource recovery has become increasingly popular since the 1970s, and municipalities are planning and building waste-to-energy systems that have dual purposes -- to provide for waste disposal in an environmentally acceptable manner and to supply an alternative source of energy. Generally, these waste-to-energy systems process solid waste into one or more readily utilized, and therefore valuable, energy forms. These include electricity, thermal energy, and solid fuels. Refuse-derived energy can provide a cost-effective means of generating hot water, chilled water, and low- and high-pressure steam.

In establishing a resource recovery project, one point is always clear: the project's economics are dependent on a strong market for the recovered energy product. Industries, institutions, and district heating and cooling systems have been and continue to be promising customers for energy generated by waste-to-energy systems. Controlling

fuel costs is a priority. Currently, fuel costs represent a large share of a typical energy system's overall costs. Energy derived from burning low-cost trash offers a lower-cost energy over the long run, even when high facility costs are taken into account, and thus merits serious consideration.

Relative to conventional fossil fuels, solid waste as an energy source can become progressively cheaper over time. Income at a resource recovery facility is also derived from providing a waste disposal service and charging tipping fees, thereby creating another revenue stream that can be used to hold down the price of the recovered energy. In addition to the potential pricing benefits of solid-waste-derived energy, the specific generation of thermal energy typically offers purchasers insulation from future fossil fuel shortages and other interruptions.

A district heating and cooling system can be a key facet of downtown redevelopment plans. It can help clean up a city's air by replacing many small, uncontrolled sources of emissions with one large, properly controlled source. It conserves energy, which can be a key component — to the energy customer — of a waste-to-energy system. As a reliable and competitively priced source of energy, district heating in combination with a waste-to-energy system can help attract businesses and industry to a city.

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The Planning and Development Process for Resource Recovery Projects

Harvey W. Gershman

President

Gershman, Brickner & Bratton, Inc.
Washington, D.C.

THE PLANNING AND DEVELOPMENT PROCESS FOR RESOURCE RECOVERY PROJECTS

Harvey W. Gershman

Introduction

The planning and development process utilized by resource recovery project sponsors are critical to timely, cost-effective facility implementation and operation. An overview is presented to assist development agencies in these activities. Examples of previous project schedules, costs, and approaches are discussed to help exemplify the numerous options available to project sponsors. It is important to recognize that many methods are available to reach project implementation and that the individual circumstances and philosophies of the project sponsor(s) should indicate the preferred development and implementation approach.

Past Examples

Let us first review how energy recovery projects have been implemented in the past. Exhibit 1 is a compilation of selected U.S. projects. Generally, the earlier and smaller projects were procured using the traditional architectural/engineering (A/E) method that is most often used for public works oriented capital acquisitions. Full service contracts are usually the preferred procurement approach in more recent projects. The Southwest Facility in Baltimore, Maryland utilized an innovative "fast track" approach to project implementation which simultaneously completed procurement and contract development activities. The objective of the schedule was to have all activities completed at approximately the same time in order to input all the results into the final financing package. In Hampton, Virginia a turnkey approach was the preferred alternative chosen by the City and NASA, the two project sponsors.

Each procurement and financing approach dictates varying degrees of project risk by the sponsor, contractor and/or system vendor. It is important that risk allocation be considered when procurement and financing decisions are being determined. This will better define the project, the responsibilities of participants, and prevent any uncertainty with the project structure later in negotiations.

EXHIBIT 1

REVIEW OF IMPLEMENTED ENERGY RECOVERY PROJECTS

Plant	Size	Procurement Approach	Financing Method	Allocation of Major Risks: Construction	Operation	Markets[1]	Waste Stream[2]	Change in Laws and Regulations
Lamprey Coop Univ. of N.H. Durham, New Hampshire	108 TPD	Turnkey	$3.5 M (1979)	Cooperative	Cooperative	Coop/ Univ. Agreement	Cooperative	Cooperative
N. Little Rock Arkansas	100 TPD	A/E	$2.3 M (1980) • G.O. Bonds • Municipal Revenue Bonds • City General Fund	Consumat	City then Consumat Facility closed November 1983	City/Koppers 20-year contract	Municipal control and economics	City
Windham, Connecticut	108 TPD	Turnkey	$3.7 M (1980) • DEP Grant • FHA Loan	Consumat	Town	Town	Agreements between Town/ participating communities	City
St. John's University Collegeville, Minnesota	65 TPD	Turnkey	$2.3 M (1977) • U.S. HUD loan (60%) • U.S. DOE Grant (2%) • In-house debt (38%)	Basic	University	University	Contracts among University, a municipality, and private haulers	University
Auburn, Maine	200 TPD	Modified Turnkey	$4.7 M (1981) • G.O. Bonds (74%) • State Grants (10%) • U.S. DOE Grant (6%) • Interest on (10%) G.O. Bonds	Consumat/ Global via construction agreement with City	Consumat (3 years)	City	City through put-or-pay contracts	City
Baltimore, Maryland S.W. Facility	2,250 TPD	Full Service	$260 M (1983) ID Bonds 72.5% Owner Equity 27.5%	BRESCO	BRESCO	BRESCO	City County BRESCO	City County BRESCO
Akron, Ohio	800 TPD	A/E	$51.0 M (1976) • $46 M in Revenue Bonds • $5 M in G.O. Bonds	Teledyne initially now Tricil	Tricil	City	City	City
Pinellas Co., Florida	2,000 TPD	Full Service	$160 M (1980) Revenue Bonds	UOP	Signal Resco	County	County	County
Tampa, Florida	1,000 TPD	Full Service	$115 M (1980) Revenue Bonds	Waste Management Inc.	Waste Management Inc.	City	City	City
Hampton, Virginia	200 TPD	Turnkey	$10.4 M (1979) • Municipal Revenue Bonds (67%) • NASA (33%)	NASA	City	20-year contract between City/NASA	Economics	City
Portsmouth, New Hampshire	200 TPD	Modified Full-service Approach	$5.8 M (1980)	Consumat	Consumat	City/Pease Air Force Base 10-year contract	City/ Towns	City

EXHIBIT 1
(Continued)

Plant	Size	Procurement Approach	Financing Method	Allocation of Major Risks: Construction	Operation	Markets[1]	Waste Stream[2]	Change in Laws and Regulations
Gallatin/ Sumner County, Tennessee	200 TPD	A/E	$9.8 M • Grants, TVA Low Interest Loans (38%) • 3-year Construction Loan (62%) • Municipal Revenue Bonds (1983)	Contractor	Authority	Contracts between Authority and 4 Energy Markets	Authority contracts with Sumner County Waste Suppliers	Authority
Salem, Virginia	100 TPD	A/E	$1.9 M (1977) G.O. Bonds	Consumat	City	City/ Mohawk Rubber Contract	City	City
North Andover, MA	1,500 TPD	Full Service	$160 M (1983) ID Bonds	UOP, Inc.	UOP, Inc. (20 years)	UOP, Inc.	Contract Communities UOP, Inc.	-
Dutchess Co., New York	400 TPD	Full Service	$53.5 M (1984) • $40 M ID Bonds • $13.5 M EQBA Funds	Pennsylvania Engineering Corporation	Pennsylvania Engineering Corporation	Pennsylvania Engineering Corporation (20 years)	County	County
Marion Co., Oregon	550 TPD	Full Service	$69.9 M (1984) • $57.3 M ID Bonds • $12.6 M Vendor Equity	Ogden Martin	Ogden Martin (20 Years)	Ogden Martin	County	Ogden Martin
Pittsfield, Massachusetts	240 TPD	Full Service	$6.2 M (1979) • Tax-free revenue bonds • Private equity	Vicon	Vicon pay"	15 year "take or supply for 15 contract between Crane and Vicon	City guarantees years	City
Tulsa, Oklahoma	750 TPD	Full Service	$74.4 M (1984) • $58.5 M ID Bonds • $15.9 M Vendor Equity	Ogden Martin	Ogden Martin (20 years)	Ogden Martin	City	-
Biddeford/ Saco, Maine	500 TPD	Full Service	$103 M (1985) • $81 M ID Bonds • $ 22 M Third-party equity	General Electiric (construction and start-up)	Maine Energy Recovery Company (General Electric has 5 year operating contract with MERC)	Maine Energy Recovery Company	Municipalities	Maine Energy Recovery Company

1. Energy market contracts typically 15 to 20 years, "take or pay."
2. Waste stream contracts typically 15 to 20 years, "put or pay."

Stages of a Project

Let me next discuss the stages of developing a project: Feasibility, Procurement Planning, Procurement, Design-Construction, and Operations. These stages may span three to ten years for projects to reach operations stage. The typical time frame should be four to five years from the time the concept is brought forward as an alternative. A typical implementation process is shown in Exhibit 2.

To start a project, there must be two important elements in place. First, a garbage crisis has to be present or imminent. A crisis can manifest itself as diminishing landfill capacity; new landfill regulations that will cost too much to put into place; costs for the new landfill will only escalate higher and now it's time to do something; or a new landfill siting has been turned down and politicians are scared to try again. As despondent as we all are about the local media, they can be a project's biggest ally in communicating a garbage crisis. They must be utilized fully and carefully to make local constituents aware of the choices. Nothing can focus attention on energy recovery like strong landfill regulatory actions. In the 1970's, energy recovery promoters were all screaming, "Regulate those landfills properly, and energy recovery will take care of itself." In the 1980s, states have developed stronger enforcement capabilities, but often still lack the "stick" to close a landfill. Regardless, their continued regulatory efforts will help focus on the need for an option. There is also nothing like a landfill siting evaluation to get neighbors stirred up. This is not to imply that siting an energy recovery facility is easy, but landfills are even tougher.

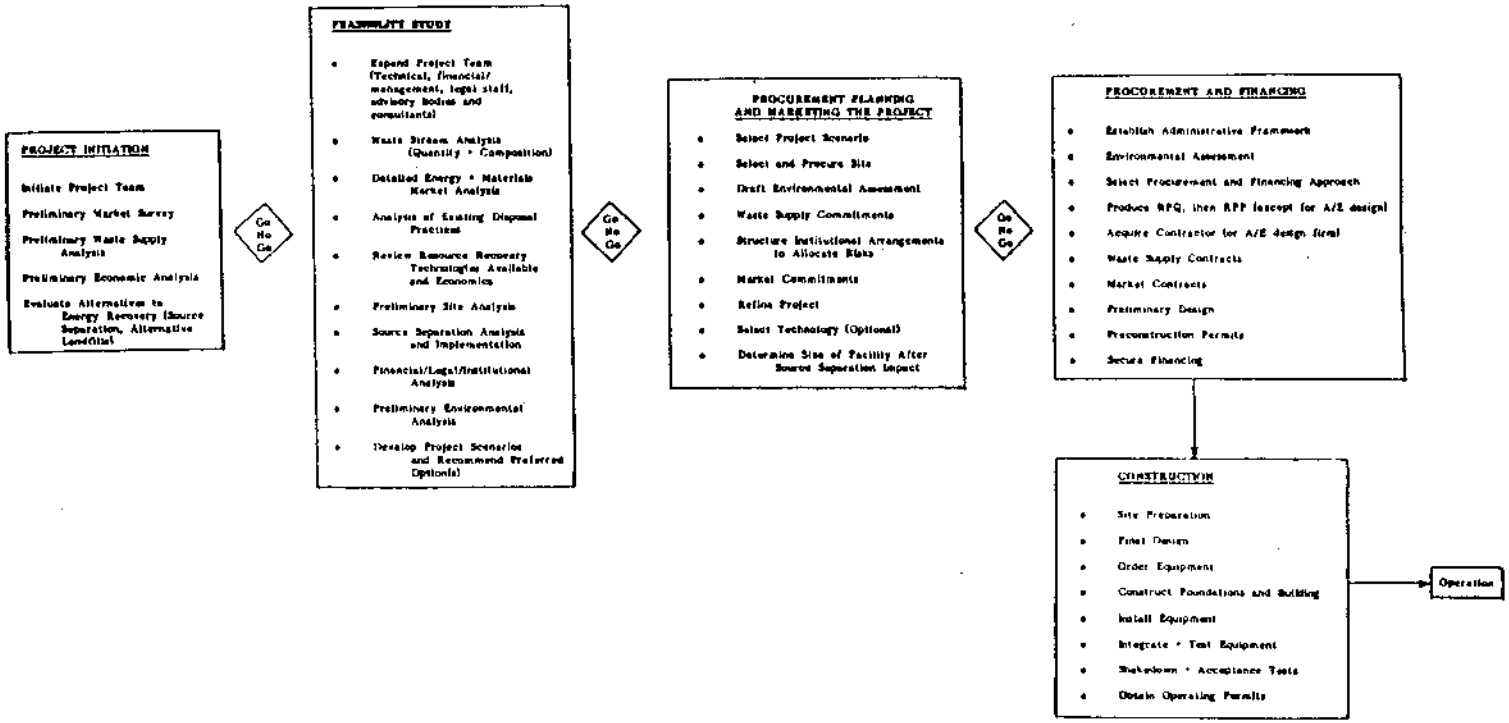
Second, political leadership has to be present to move forward. Without it, the best laid plans collect dust on a bookshelf. Political leadership is either present or it's not. If it is not, you may as well wait until it is, or until the crisis that exists comes to the point where a leader steps forward. History shows that a good idea is only good if the timing is right.

The planning and development process most often is conducted with the assistance of a consultant or group of advisors. With the selection of advisor(s), comes a pre-determined set of biases, based upon experience as well as interests. Project managers will do well to understand any preconceived technology, energy market, procurement, or financing preferences advisors may have. Their particular biases will affect the advice given, and as a result, the direction a project may take. Project managers are well served by contacting others who have been through the process and ask "How would you do it if you had to do it all over again?"

Typically, these efforts start with a feasibility study. Project development agencies have spent from zero to several hundred thousand dollars on such studies. The study's objective should be to focus on an energy recovery approach that can be implemented and will be competitive with anticipated landfill costs. The study can provide the focus for a

EXHIBIT 2

WASTE-TO-ENERGY IMPLEMENTATION PROCESS



better approach, but by no means should it be viewed as the final word on almost any aspect of the project that may evolve. The real definition to the project, and where resources are best applied, is in the project's procurement and contracting.

Projects Building Blocks

There are several factors that are essential in the development of a resource recovery project. These can be viewed as key elements or "building blocks." If any one of them is missing, it is unlikely that a project can be procured, much less implemented (See Exhibit 3). These building blocks include:

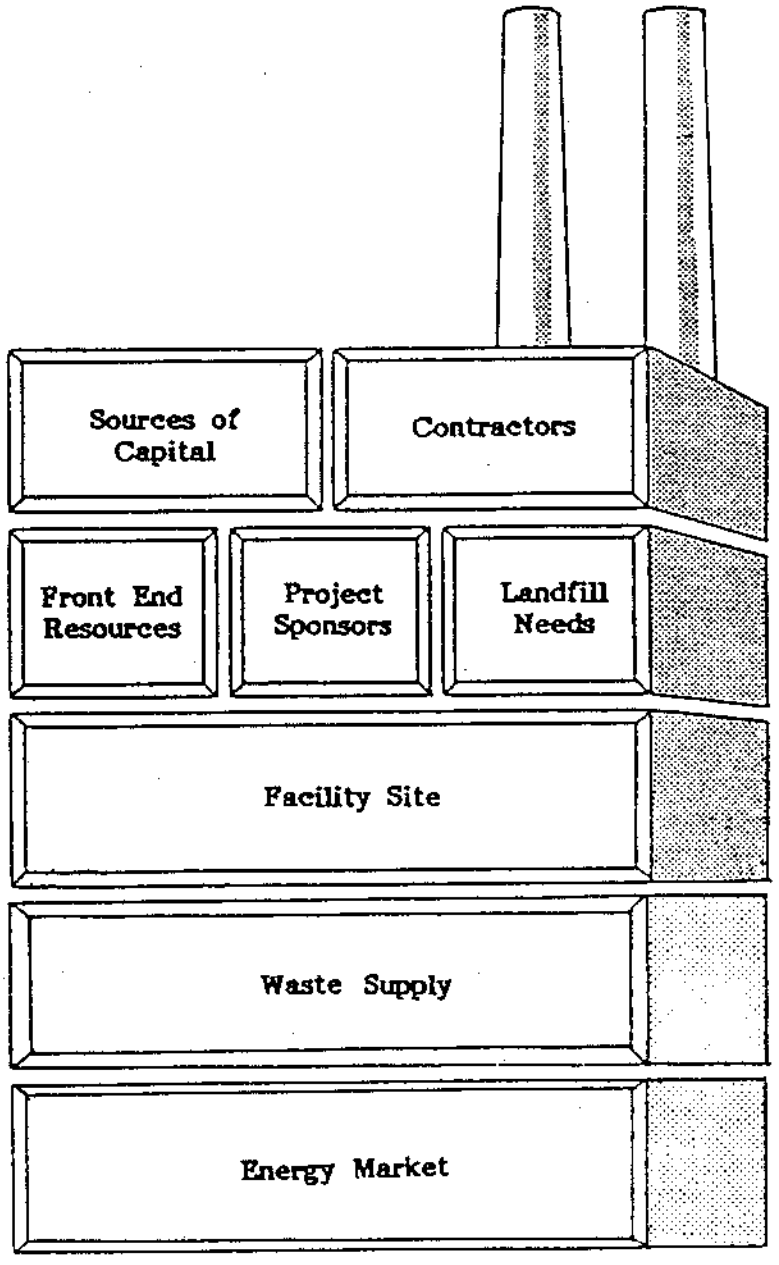
- Energy Market(s)
- Waste Supply
- Facility Site
- Project Sponsor
- Landfill for Residue or Use in Emergency
- Front-End Resources (staff and funds)
- Source of Long-Term Financing
- Contractors

The most critical elements are the energy markets and waste supply. They relate to the project's economics, which, in itself, will usually be the most important factor in deciding whether to proceed with implementation. The other factors, however, are more qualitative in nature and are sometimes overlooked by communities who believe that a project can be developed if the economic feasibility is evident. A brief review of these other factors will give the project planner an appreciation of their importance and the need to consider them as the procurement and negotiation process proceeds.

Securing one or more energy markets should be top priority in development efforts. Purchasing alternative energy, whatever the form, is usually a new activity for the market. The currently marketable forms of energy derived from solid waste via resource recovery plants are: thermal energy, electricity, and solid prepared fuels. Thermal energy takes several forms: steam, high temperature hot water, and chilled water. Much handholding and education will need to take place at the operating level as well as different management levels of the energy market. Visiting operating plants provides assurance that the concept works. Negotiating letters of intent which define the responsibilities of various parties and clarify the contract posture in relationship to terms, pricing formula, providing land for facility site, interest in ownership and operations, etc., is important to the market commitment process. If properly done, the energy market's interest will be committed and be well defined input into the project's technical concept and facility performance requirements before a contractor is solicited. In many cases, multiple markets such as cogeneration for an electrical and a thermal market (or assembly of many thermal markets as in district heating and cooling systems) improve the

EXHIBIT 3

PROJECT BUILDING BLOCKS



economics. However, this does increase the marketing effort required of the project.

Without a raw material to process, an energy recovery facility has no means of surviving. Waste supply has to be both logistically and contractually made available to a project. It may be prudent to establish a transfer station system to enhance efficient deliveries. Communities will need to know what any extra transportation costs will be to the new project and they should be compared to their other available options (if any). Usually, long-term waste supply contracts must be established for project financing, but are worth having regardless of financing method. Obtaining such agreements, especially for regional projects, can be a difficult process and one that may require special counsel and even state-authorized legislation. Oftentimes, waste districts or authorities are formed that have special powers which ease the process of waste supply control and contracting. Private solid waste hauling contractors are wary of such controls and oftentimes organize to fight state legislative initiatives. The local project manager will need to be an active spokesperson with the ability to communicate, develop confidence and gain support. With the assistance of experienced advisors, that person must establish preliminary commitments such as resolutions and contract forms that can be turned into long-term waste supply agreements.

Obtaining a site on which to build the facility is a critical project component. The difficulties in securing a site, and/or the time required to do so, often are not fully appreciated. This aspect of the project must be addressed early and unequivocally resolved well before implementation begins. Obtaining options to purchase the site and developing a strategy for site acquisition and permitting should be accomplished before procurement commences so that they can take place as procurement proceeds. The "Not in My Backyard" reaction has caused many a project to stop dead in its tracks. Fictitious concerns over environmental and health impacts (particularly dioxin-related) can cause nearby residents to be very alarmed to the point of getting organized, hiring a health/environmental "expert," and generally declaring war on the project. Such reactions should be rebutted with open and honest information and forums. Project managers will do well by communicating their plans and the real impacts of these plants early. Internal and/or special public relations advisors can also help deal with the public and the impacted neighborhood. A combination of newsletters, brochures, information, and speakers should be an ongoing function of project managers. Initiating permitting, for at least the air pollution permit, is also worth consideration, prior to contractor procurement. The air permit usually requires the longest lead time and greatest expense. Having the process started provides an early indication of what pollution control measures will be required in the facility's design; an indication of the ability to obtain a permit for the selected site, and an incentive to contractors that this part of the permit process has started. A constraint in starting the process is technology selection. Applications need to be technology specific. This can result in

a technology decision too soon, thereby limiting the vendors from which facility proposals would be received.

Implementing a waste-to-energy project does not eliminate the need for a landfill. Between 30 and 50 percent by weight and 5 to 15 percent by volume of the input to the system will leave in the form of fly ash and residue which will require landfilling. Fly ash and/or residue may be classified as hazardous wastes, primarily because of heavy metal contamination, and therefore require special handling and disposal arrangements at a higher cost. Existing or new landfill capacity is also required for periods when the system is down for scheduled or unscheduled maintenance. Perhaps a participating community can provide landfill capacity or a separate private landfill service may need to be procured.

A project sponsor must step forward. This refers to the need for an individual or agency to accept responsibility for developing and implementing the project. There must be a single, committed coordinator to keep the development process moving. Depending on the ownership and financing approach of a particular project, the coordinating role may be played by a municipality, special authority, industry, utility, or system vendor. In all cases, without such a sponsor, the inevitable technical pitfalls and institutional barriers will unnecessarily delay or terminate the project.

Front-end resources for planning and development efforts, before the contractual commitments have been obtained and financing secured, are often difficult to obtain. Nevertheless, front-end money for in-house staff and advisors are both critical to a project's ultimate success. In planning and developing a resource recovery project, the funds needed up-front (before the project is financed and construction begins) could amount to several hundred thousand to over a million dollars, depending upon the size of the project and the length of the implementation process.

The last building block is a source of capital for the project provided through a sound financing method. In most recent projects, this involved some type of revenue bond financing, often combined with private equity. The type of bonds which can be used for future projects will depend on the outcome of pending tax reforms. It can take considerable time to get projects to the point where bonds of any type can be issued. Moreover, the ability to finance a project is dependent on the other building blocks. They form the security structure for the project.

Institutional Setting

The institutional environment a project develops within is sometimes difficult to gauge. In any project there are a number of parties-at-interest who will have an impact on decision making. If there is a solid waste crisis, i.e., little or no landfill capacity remaining or lack of disposal outlets with which a contractual relationship can be arranged, then the sentiment to plan and develop a resource recovery project may be widespread quickly

among municipal officials, solid waste collectors, the general public, interest groups and other local parties. On the other hand, if local landfill capacity is not critically limited, disposal costs are not exorbitant, and the site location is not too far away, then local interest and momentum for resource recovery may not be strong, even if a resource recovery project appears economically attractive. Oftentimes, resource recovery projects that were otherwise economically feasible have been abandoned in the planning stages simply because sufficient action could not be generated among the local leaders.

The planner must carefully review the sentiment in the community for resource recovery and assess the posture and philosophy of the municipal officials, the local haulers, local markets, the general public and others. Local haulers who would have to haul to a more distant location could not be expected to initially, if at all, offer strong support. A private landfill operator whose operation could be affected adversely would also not be expected to provide support. Other institutional barriers in the form of competing demands for planning monies or staff time on other local projects may sidetrack efforts toward resource recovery. The existence of a potential implementation agency such as a solid waste authority or perhaps ongoing efforts toward some other solid waste project could affect the political climate and interest for a resource recovery project. Essentially, it must be a "politically feasible" undertaking as well as being economically justified. The planner will have to sound this out over the course of the feasibility assessment.

A resource recovery facility is a capital intensive project. For example, bonded debt on a 200 tons per day plant could exceed $15 million dollars. Most communities in the United States have limited capital to apply to such projects and their borrowing capacity may be at or near its legal limit.

Recently, there is a trend toward revenue bond financing and full service contracting with a private system vendor in view of the substantial costs and risks involved. Fewer projects are being financed through general obligation debt secured by the backing of the taxpayers. Typically, projects are financed through a special authority such as a solid waste authority or industrial development authority empowered to issue revenue bonds secured by the project revenues and assets. Such financing may or may not include private equity. In these forms of financing, and with private participation through the vehicle of a special financing entity, many of the capital limitations and risks are removed from the municipality although it would be obligated to supply solid waste to the project.[1]

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1. At this time uncertainty has been introduced in the financing equation by the Administrations tax proposal, Treasury II. Until this proposed legislation is dealt with, passed, modified or rejected, this uncertainty will make financing decisions difficult.

In analyzing the potential for developing a successful project, it is appropriate to determine the positive and negative conditions existing which critically affect ultimate feasibility. This review can be completed through the use of a checklist. Exhibit 4 presents a checklist which can be applied by the user to help evaluate the project potential. If substantially more negative than positive entries are made to the checklist, it is doubtful that a resource recovery project is feasible, at least not in the near term.

Roles That Can Be Taken

The implementation of an energy recovery project will need to include the following physical elements:

- A waste delivery system, including transfer stations, to get refuse to the energy recovery facility;
- An energy recovery facility to process the refuse, generate steam for delivery and use by the steam customer(s) and/or electricity for sale to the utility and residue for haul to a disposal site; and
- A landfill to accept the residue and, if necessary, serve as an emergency disposal site for refuse in the event that the energy recovery facility is inoperable for an extended period (greater than two to three days).

The different entities that could be involved in a project and the role(s) each party could play are as follows:

ENTITY	POTENTIAL ROLES
The Municipality	Owner and/or operator of transfer station(s), waste supply contract for publicly controlled waste to the project, source for general obligation debt, project sponsor, operator of the energy recovery facility, procurer and/or provider of landfill for residue disposal and backup, procurer and provider of transfer station(s), public relations, host community.
Other Incorporated Municipalities	Waste suppliers to the project, host community.

(cont.)

EXHIBIT 4

CHECKLIST OF CRITICAL FACTORS AFFECTING THE FEASIBILITY OF A RESOURCE RECOVERY PROJECT

Factor	Exists (yes/no)	Uncertain (x)
Competitive Project Economics		
Sufficient Waste Supply		
Sound Market(s)		
Facility Site		
Residue/Backup Landfill		
Project Sponsor/Implementation Agency		
Front-end resources to continue		
Potential Source of Project Financing		
Solid Waste Crisis (Few or no disposal alternatives)		
Support of Political Leaders		
Limited Environmental Restrictions		
Support of Solid Waste Haulers		
Support of Landfill Operator(s)		
Support of General Public		
Ability of Community to enter into long term contracts		
No long term commitments to other solid waste facilities		
Ability to direct delivery of privately collected waste		

Federal and State Regulatory Agencies	Permitting and perhaps technical assistance.
Thermal and/or Electricity Customer[2]	Thermal and/or electricity purchaser, energy recovery facility site, operator of energy recovery facility, owner of energy recovery facility.
Private Waste Haulers and Operator	Waste supply contracts, transfer station(s) operator. Private landfill owner. Landfill for residue disposal and backup.
Contractor(s)	Design, construction, operation, owner of transfer station(s) and/or energy recovery facility.
Outside Party(ies)	Owner, bondholders.
Federal and State Governments	Capital for facilities if available, technical assistance, permitting.

Before a project can be implemented, the sponsor will need to determine the roles it would prefer taking in such a project. In so doing, the objectives of each party have to be analyzed with respect to the risks that are assumed in taking the respective role(s). Common objectives for this type of project include:

- Having control over the project's development and implementation;
- Having control over the facility's operations and associated costs;
- Having a degree of confidence in the cost for participating in the project;
- Passing off major design, construction and operation risks to other parties better equipped to deal with these;
- Being able to take advantage of significant funds that may be available from the Federal or state governments;

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2. Thermal customers can purchase energy in the form of steam, high temperature hot water, or chilled water, or any combination of the three.

- Being assured of a long-term, reliable, environmentally sound and economical source of solid waste disposal;
- Minimizing facility siting impacts and citizens' concerns; and
- Being assured of a long-term source for waste to provide the project.

As discussed above, developers of recently implemented projects have sorted out their roles and objectives in different ways. This allocation has been a key to determining the position the public sector takes in such projects. Several issues will need particular attention. The ability to secure privately collected waste for the project is one vital issue. If a project is implemented with this waste stream secured under long-term contracts and/or legislatively controlled to assure waste delivery to the implemented energy recovery system, the cost for such a project should lower than if a project were developed with the waste stream "at risk."

Another critical consideration is whether the project should seek to take advantage of equity funds to lower the debt that the project will have to repay for the capital facilities required. Several recent projects have been implemented as privately owned projects which offset part of the capital requirements through equity contributions in exchange for tax benefits (leveraged lease or vendor financing structures). Even with public ownership, it is still possible for the project's design, construction and operation risks to be put on the shoulders of a full service contractor, as has been done in Auburn, Maine. Additionally, the transfer stations and landfill that are to be part of the system do not have to be owned and operated by the same party/contractor. In fact, some projects have sought to involve local private industry by segmenting out these portions of the project from the energy recovery facility itself.

Procurement Method

The procurement process which is selected by the project sponsor will delegate many of the risks and responsibilities of the project implementation and operation. The level of risk which is to be assumed by the sponsor can be expressed in the procurement process. This section will briefly discuss the Request For Qualifications (RFQ)/Request For Proposals (RFP) procurement method and other approaches such as sole source, RFQ to negotiations, and RFQ to a Basis Of Negotiations (BON).

Whether an A/E, Turnkey, or Full-Service procurement method is chosen by the project sponsor, the process usually issues a RFQ and RFP. Exhibit 5 shows an example of a RFQ outline used for the Harford County, Maryland project. The RFQ requests various background information from respondents including general corporate qualifications, management approach, technical and operating experience, and financial status.

EXHIBIT 5

SAMPLE RFQ OUTLINE

REQUEST FOR QUALIFICATIONS

FOR

HARFORD COUNTY, MARYLAND

RESOURCE RECOVERY PROJECT

June 30, 1982

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SAMPLE RFP OUTLINE
(City of Springfield, MA - Issued 10/7/83)

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I. Term Sheet: Steam Sales to City

J. Executive Summary - Technical and Economic Feasibility Study for District Heating in Springfield

K. City of Springfield Sewer Information

L. Environmental Regulations and Permit Information

M. Draft Solid Waste Disposal Service Agreement

The general corporate information in the RFQ should include the type of company (e.g., corporation, partnership, etc.), history, listing of officers, organizational chart, and project team, if applicable. Management information and approach should demonstrate the respondents' commitment to resource recovery, especially as it relates to the project size requested. The respondents should provide a listing and description of all previous and current resource recovery projects, demonstrating their proven application in similar situations. This should include a list of financial participants, personnel involved, implementation schedules, markets for energy and/or materials, and procurement approaches. The technical and operating experience of the respondent should be fully supported, including a reference facility of similar size and technology. This should describe in detail the equipment, design, technology, and successes/failures of the facility. Finally, the financial status of the respondent is important, especially if a private financing option is to be used. A statement of their net worth, profitability, major financial commitments, performance bonds guarantees, equity contributions, and indebtness, particularly relating to the reference plant, should be included.

After issuance of a RFQ, the sponsor frequently issues an RFP to no more than four to six selected qualified firms. The RFP outlines the contract structure and details the facility requirements as requested by the sponsor(s). The RFP should also set the basis for the negotiations of final contracts by providing drafts of key project agreements. The proposers should be required to comment on the drafts as their "points of negotiation." This procedure can save significant time (and expense) during negotiations. An example of a RFP outline is shown in Exhibit 6. The sponsor will then evaluate the proposals to check for their responsiveness to the information requested in the RFP. Further information may be solicited in an addendum if needed. The sponsor(s) then may choose to negotiate with one or more respondents if they evaluate their proposals as satisfactory.

Other procurement processes are available besides a RFQ/RFP approach. The project sponsor may choose to negotiate with a qualified respondent(s) directly after the RFQ process, or develop a Basis Of Negotiation (BON) document for discussions with one or more respondents. The sponsor may feel reasonably certain following the RFQ process, that one or two qualified respondents can provide the desired waste-to-energy system. If a turnkey or full-service approach is being used, the BON document is written to outline the design criteria and contract structure desired by the sponsor as in an RFP. The project sponsor may then negotiate with one or more system vendors to provide these services. The RFQ/BON approach was used for the Baltimore, Maryland Southwest Facility and Harford County, Maryland project. Both of these processes are successful if the sponsor is sure of the technology and system desired, and is reasonably certain these can be provided by the particular firm(s). The BON approach provides for more open discussion of contract terms before proposals are submitted thus allowing proposals to be submitted upon pre-negotiated contracts.

In an A/E procurement, competition to select a design engineer is frequently conducted following standard consulting engineer selection procedures. If an A/E consultant has been advising a project during pre-procurement phases, that same firm often continues as the design engineer. A separate procurement for a general contractor, major equipment components, and/or trades may also be required depending upon local municipal purchasing laws. Unfortunately, operating contractors may not be selected until construction is well underway. If a private operator is to be hired, they need to be hired early and be required to sign-off and accept the A/E's design. This will not be easy to accomplish, but will help avoid "finger-pointing" when start-up problems occur.

Finally, a project sponsor may choose, for whatever reason, to immediately negotiate with one firm and not issue any formal request documents. This process is called "Sole Source Procurement" and necessitates that the sponsor know the technology and vendor which they want for a project and be legally allowed to take such a step. The sole source approach expedites the procurement process since there are no RFQ or RFP activities, but it limits the negotiating potential, price competitiveness, and system alternatives available since there is only one vendor.

It is very important that the sponsor(s) of the project be very familiar with procurement laws in their state, and jurisdiction. These may determine the ability of a sponsor to choose the procurement process desired. The sponsor should seek to allow for negotiated procurements with whatever process is chosen.

Risk Allocation

Exhibit 7 identifies risks that are incurred during various stages of the system implementation for each procurement method. Many of these risks can be totally or partially covered by insurance. There are certain key risk areas that must be addressed prior to procurement. These include the waste supply to the system, the commitment of one or more energy markets, facility ownership and operation, and residue and by-passed waste disposal. The philosophy and posture of the sponsor relative to these management decisions determines the procurement and project ownership/operation structure. They will also help to organize the negotiating strategy with potential vendor(s).

Project Scheduling

The procurement approach chosen and the clear definition of participants' roles and responsibilities will dictate the duration of project implementation. Generally, a full-service procurement approach can be accelerated faster than the A/E or turnkey. A full-service contract allows the project sponsor to simultaneously perform procurement activities instead of requiring lengthy delays with project implementation phases.

EXHIBIT 7

RISK ASSIGNMENT UNDER ALTERNATIVE PROCUREMENT APPROACHES

Risk Elements	Risk Assumed By: A/E Procurement	Turnkey Procurement	Full Service Procurement
Capital Costs Risks			
Capital costs overruns	O	C	C
Additional capital investment to achieve required operating performance	O	C	C
Additional facility requirements due to new State or Federal legislation	O	O	O
Delays in project completion which leads to delays in revenue flow and adverse effect of inflation	O	C	C
Operating and Maintenance Costs Risks			
Facility technical failure	O	C	C
Excessive facility downtime	O	O*	C
Underestimation of facility O&M requirements (labor, materials, etc.)	O	O*	C
Insufficient solid waste stream	O	O/M	M
Significant changes in the solid waste composition	O	O	O/C
Changes in State and Federal legislation which affect facility operations	O	O	O
Inadequate facility management	O	O*	C
Underestimation of residue disposal costs	O	O*	C
Tipping Fee Income Risks			
Diversion of waste to other competing facilities	M	M	M
Overestimation of the solid waste stream	O/M	O/M	O/M
Adverse changes in participating community's fiscal condition	O	O	O
Recovered Energy Income Risks			
Overestimation of technology energy recovery efficiency	O	C	C
Significant change in the solid waste composition	O	O	O/C
Changes in legislation which affect energy production and/or use	O	O	O
Overestimation of solid waste quantities	O	O	M
Significant adverse changes in the energy market financial condition or local commitment	O	O	O/EM
Downward fluctuation in the price of energy	O	O	O
Inability to meet energy market specifications	O	O*	C

Legend

Participants

O - Owner (assumes owner's ability to assume risk)
C - Contractor
EM - Energy Market
M - participating Municipalities
* - Modified turnkey procurements may provide for intermediate or long term private contractor facility operations which could lead to further risk assumption by the private contractor.

The Baltimore, Maryland Southwest Facility is an excellent example of a "fast track" project which was implemented in a comparatively short period of time. Exhibit 8 shows the timelines for project procurement for selected resource recovery projects now in operation. As projects continue to be implemented and procurement approaches become more refined, the length of the implementation process of projects can be reduced. This can significantly reduce the cost of the project to the project sponsor and the system vendor. It has been observed that a project implementation process which does not clearly define all the responsibilities of project participants can create conflicts and disruptions during negotiations, financing, and/or construction and thereby delay the project completion.

Implementation Budgets

Resource recovery projects require significant amounts of money for procurement activities. Activities required to be executed by the sponsor's staff or consultant include solid waste quantification and composition studies, markets commitments for energy and materials, economic modeling and analysis, issuance of procurement documents, and facility site acquisition. The implementation process from planning phases to facility construction generally take three to ten years. Exhibit 9 shows some of the implementation costs of operating facilities. Many of the costs (i.e., financing, legal fees, engineering, insurances, etc.) incurred in the procurement process are included in the project financing to defer the direct cost of the project sponsor.

Negotiations

Following the selection of a preferred system vendor, the project sponsor must assemble a negotiating team and prepare for detailed contract discussions. The negotiating team should, at a minimum, consist of the following project participants: project manager, legal counsel, financial advisor, technical advisor, management advisor, and investment banker. The coordination and a consistent philosophy and approach by the negotiating team are very important to negotiating project agreements. Local elected officials should be briefed regularly throughout the negotiation process, but need not participate directly.

The negotiating team and preferred vendor must both have a clear and well defined understanding of the contract and risks structure expected to be assumed. The contract structure should be remembered throughout the negotiations so that the roles of all participants are clear. Critical "deal" points should be dealt with last, the easily agreed-upon issues should be considered first. This will familiarize the negotiating participants with each other and allow for a basis from which to continue discussions. It is important to be fair in approach, but always remembering the project's objectives and overall structure. The negotiations will also set the tone for the long-term business relationships.

EXHIBIT 8

REPRESENTATIVE PROJECT SCHEDULES

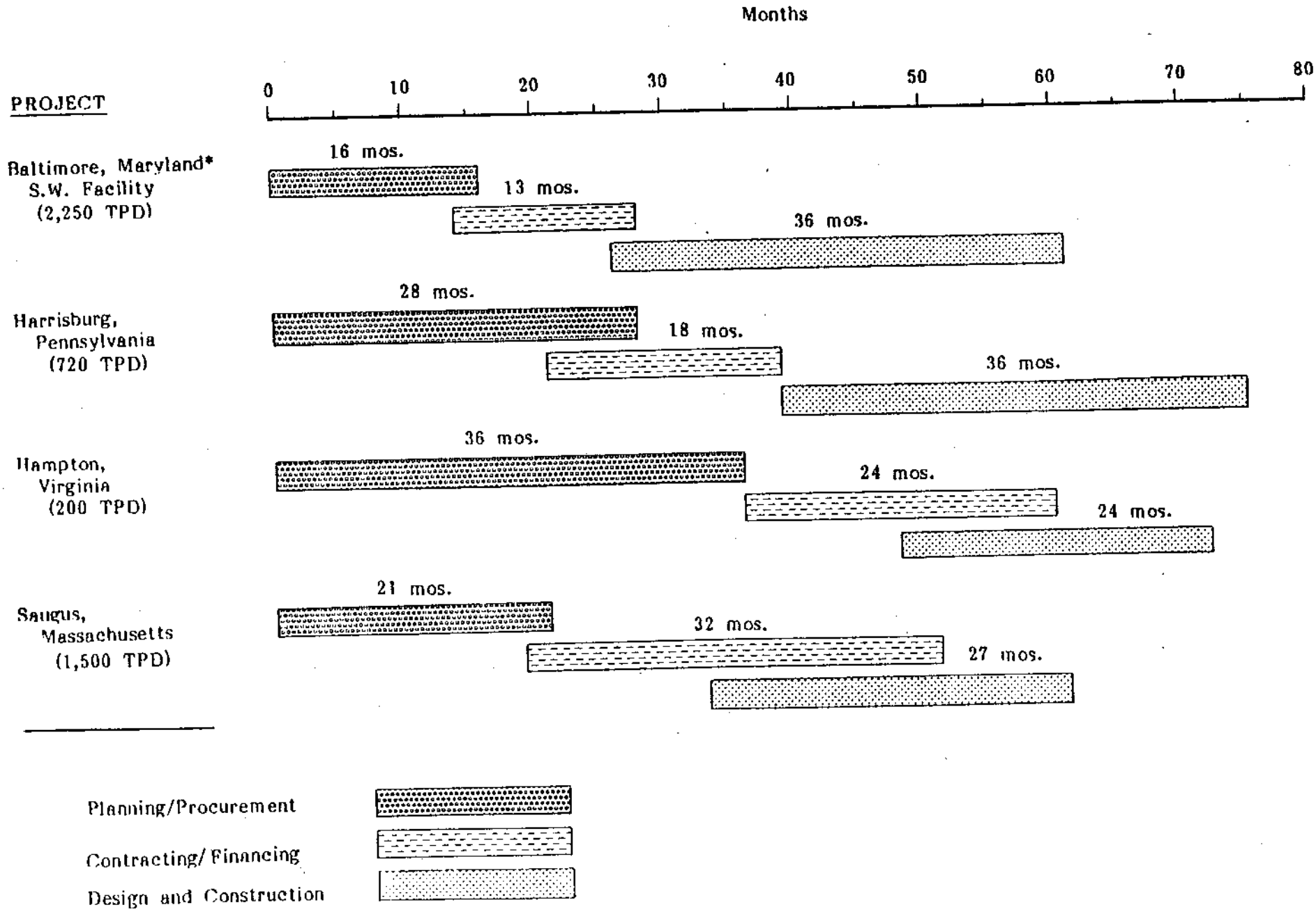

EXHIBIT 9

SELECTED PROJECT PROCUREMENT BUDGETS

Baltimore, Maryland Southwest Facility	1983 $
• Legal, Consulting Engineers, Authority, Printing, and Other Bond Insurance Costs	$ 3,800,000
• Total Bond Issue	190,765,000

Akron, Ohio 1976 $	
• City and Design Engineering Costs	$ 1,100,000
• OWDA Fees, Legal Fees, Underwriting, and Other Issuance Costs	2,000,000
• Principal Amount of the Bonds	46,000,000

Westchester County, New York	1982 $
• Project Management, Insurance, and Other Estimated Costs[1]	11,950,000
• Legal and Printing Expenses	1,574,000
• Total Cost	236,970,000

Pittsfield, Massachusetts	1979 $
• Project Design - Engineering Cost	$ 175,000
• Bond Issuance Costs	416,050
• Total Bonds	6,185,000

North Andover, Massachusetts	1983 $
• Consulting Engineer and Independent Engineer Fees	$ 1,100,000
• Insurance, Performance, and Payment Bonds	1,250,000
• Allowance For Issuance Expenses	2,200,000
• Actual Bond Issue Size	160,000,000

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1. Wheelabrator (now Signal RESCO) estimates of costs for spare parts, start-up working capital, permits, and insurance.

During the negotiating period, it is important that attention be given to coordinating meetings and agendas, communicating results of meetings and summarizing follow-up items, and documenting points of agreement and open issues in contract drafts and documentation. Providing adequate time for preparation of project agreements/documentation, their internal review/finalization, and their negotiation is very important. Such schedules should be forecast remembering the political/decision making calendars.

It also is important for the local jurisdiction to remember that when negotiating a project it has the power to make the project happen and thus carries bargaining strength. A system vendor has to rely upon the local jurisdiction in order to be able to implement the project. If a project team bargains too hard, this will increase the project cost, thus it is important to be consistent and fair. This approach will achieve the best negotiated contracts for all participants.

Financing

The financing of a waste-to-energy facility is typically a long and difficult process. The actual financing, i.e., the sale of bonds, is done over a short period; however, the activities and planning leading up to this step take many months and many turns. Structuring financing which is acceptable to all parties-at-interest in the project and, most important, one that will be attractive to the sources of project capital (typically the bondholders and sources of equity) requires careful planning and substantial input from experienced financial advisors and investment bankers who have arranged successful waste-to-energy plant financings.

Waste-to-energy projects generally have been unfavorably received by the investment community. They are perceived as capital intensive, new, and risky even though certain waste-to-energy technologies have been widely applied for years in Europe, Japan and elsewhere and now systems are operating in the United States. Waste-to-energy projects financed with revenue bonds have been characterized by high yields and high debt service coverage requirements. Lenders are not equity risk takers. They desire security and liquidity in their investments. In view of the perceived risks, many investors see better investment opportunities in other sectors of the tax-exempt bond market. They demand protection against all risks except for changing bond market conditions. They want assurance that they will be repaid either by the project sponsor, some other interested party, or the project itself. Moreover, an equity investor wants indemnification in the event tax benefits are not realized.

Most small-scale resource recovery projects (i.e., those in the 100 to 500 TPD range) operating today were financed with general obligation bonds at interest rates of 5 to 6.5 percent. Some projects even received government grants and/or loans which further enhanced the financing and have kept debt service costs down. Several medium-scale and large-scale projects financed between 1972 and 1980 included project financing with the use of tax-exempt revenue bonds. Interest rates ranged from 6 to 9.5

percent, and averaged approximately 100 basis points (1 percentage point) higher than the Bond Buyers Index (BBI) for other tax-exempt bonds at the time of issue. Most recent projects have included additional security such as the backup taxing power of a local or state government, municipal bond insurance, efficacy insurance for system performance, additional contributions agreements by a very credit worthy vendor, letter of credit arrangements and/or increased reserves requirements to enhance their financeability.

Most, if not all, of these security features were felt necessary by the bond underwriters to ensure a favorable bond rating and, thus, a financeable project. Waste-to-energy financing is now in a critical period. The next generation of projects, both the rapidly developing small-scale technologies and the refined large-scale systems, will place heavy demands on capital resources over the next several years. Many of these facilities, which could be less than $10 million for a small-scale facility, will be the largest single public works project ever undertaken in a number of communities. General obligation bond financing for such projects may no longer be viable in communities with limited remaining debt capacity and several competing demands for capital. An analysis of remaining debt capacity for a project of the size considered, and other likely uses in the foreseeable future should be done before the risks of public ownership are assumed.

Private ownership financing can significantly reduce the financing cost of an energy recovery facility, either by passing on a major portion of the tax benefits of the project through lower financing charges, or enhancing the profitablity of the builder/operator, allowing lower O&M fees. The financing cost is reduced by:

- In the case of leasing, replacing a portion of municipal debt or vendor equity with third-party capital. The equity is compensated largely by tax benefits associated with the project. The equity capital reduces the bonds otherwise outstanding, and therefore the debt service costs; and

- In the case of private ownership financing not involving leases, the vendor can either provide equity or pass back a rebate which offsets debt servicing costs.

The magnitude of private ownership financing benefits is such that, depending upon the precise structure chosen and the tax risks involved, an assumed revenue bond interest rate can be reduced roughly 300 to 500 basis points. The private ownership savings vary somewhat as interest rates and other tax assumptions change. The residual value of the facilities must rest with the private owner at the termination of the lease term or service agreement expiration in any private ownership financing. The residual value loss should be treated as a cost of private ownership financing which must be incorporated into any comparison with direct public ownership. Therefore, tax benefits related to solid waste facilities are an added benefit when

coupled with the tax-exempt financing advantages, versus merely representing an offset to the financing of most public facilities where private owners are restricted to taxable debt financing. Any private owner may obtain tax-exempt financing for solid waste facilities since they qualify as exempt activities under Section 103 of the Internal Revenue Code.

The availability of government grants and loans, which supported some earlier projects, has decreased substantially. At the Federal level, both the Environmental Protection Agency and the Department of Energy have essentially eliminated their municipal waste-to-energy funding programs. There are possibilities of grant or loan assistance through the Farmers Home Administration or the Department of Housing and Urban Development's Urban Development Action Grant Program.

There are some security features, developer incentives, and creative financing mechanisms that may serve to enhance private leveraged financing or full private financing. The application of more and broader insurance coverage is one mechanism. The insurance industry is pioneering new forms of coverage with higher limits. Stronger equipment performance guarantees are being made as technology matures and vendor experience broadens. Finally, the investment banking industry has sought to enhance project financing, much like the home mortgage banking industry has sought to create new forms of home financing, through innovative financing techniques which make project economics more attractive in the earlier years when revenues are expected to be lower. Financing programs, which include deferred equity, revenue stabilization and vendor loans, are now being integrated with the more conventional project financing structures. In any case, there is a growing trend toward project financing with some form of revenue bonds. However, there must be greater care given to assuring sufficient cash flows and reserves that cover bonded indebtedness and a contractual arrangement that ensures preservation of all tax benefits assumed by a private systems vendor or third-party participant where private constructive tax ownership is to be part of the "deal."

Summary

The need for effective coordination and management of waste-to-energy project planning, procurement and implementation should not be underestimated. It is essential that the project sponsor and/or management consultant be able to effectively organize the various project participants into a project team which has a consistent philosophy and understanding of the objectives. A project team that is well organized will develop a better project.

The political and local climates in the host community are very important to successful project implementation. The local elected officials must be appraised of the project at all times so that they can maintain public support for the project. It is critical that the garbage disposal crisis issue be kept in the foreground of the project at all times. This will accelerate the project by pointing out the necessity for project development.

Project development trends appear to be toward privately owned, full-service contracting. For smaller projects where financially weaker vendors are often involved than for large projects, public sector financial backing will come more into play, even with private ownership structures (like in Pittsfield, Massachusetts). As projects move away from public ownership and operation, the complexity of contracting increases to properly shift risks and responsibilities to the private sector.

Many approaches can work, and one approach is not best everywhere. A community will do well to think openly about its options and not predetermine the manner in which it proceeds.

Developing a Waste-to-Energy Project:

Overview of Key Project Ingredients and Development Activities

James W. Barker
President

and

Anne J. Sotan
Associate

CSI Resource Systems, Inc.
Boston, Massachusetts

DEVELOPING A WASTE-TO-ENERGY PROJECT: OVERVIEW OF KEY PROJECT INGREDIENTS AND DEVELOPMENT ACTIVITIES

INTRODUCTION

Since 1980, there has been a dramatic increase in the number of waste-to-energy projects that have been brought successfully through the complex maze of activities required to secure financing and get on with facility construction. This dramatic increase in serious project development activity can be attributed to four important factors that distinguish the waste-to-energy industry of the '80s from that of the '70s. First, many regions of the country are facing waste disposal crises -- either because of rapidly depleting landfill capacity (and difficulties in securing new capacity) or because of enormous increases in the cost of disposing of solid waste in landfills. Second, the chief executives of several municipalities have made commitments to waste-to-energy as the best approach for replacing dwindling landfill capacity and have provided the public leadership that is so necessary to successful project development. Third, the capabilities and expertise of the system vendors and professionals who are responsible for carrying out essential project development activities have advanced substantially. Finally, because several new facilities have been brought on-line without major mishaps, the fears of failure that dominated in the '70s have been replaced by cautious optimism regarding the credibility of waste-to-energy technologies and those who make claims regarding their performance and cost.

Over the last three years, some 60 waste-to-energy projects have been financed. These projects represent over 50,000 tons per day of disposal capacity and over $6 billion in new capital investment. Although many of these project financings remain in escrow until certain project development tasks are completed (in most cases, the only remaining task is securing final environmental permits that are necessary precursors to starting construction), these projects provide a strong indication of the current ability of the waste-to-energy industry to successfully develop projects that employ both large- and small-scale waste processing technologies.

New projects can, and should, take advantage of the experience in project development gained over the last several years. This paper presents a summary of certain aspects of this learning and experience -- namely, the ingredients of a good waste-to-energy project and the types of activities associated with developing a good project.

INGREDIENTS OF A GOOD WASTE-TO-ENERGY PROJECT

Waste-to-energy project development activities culminate in the successful financing of a project. If the project development process has been thorough, the project will be perceived by the public and the technical and financial communities as a well-conceived program that provides a long-term, environmentally and economically sound method of municipal solid waste disposal, as well as appropriate incentives for profitable operation of the waste-to-energy facility by the contractor. This positive perception will prevail if certain key project "ingredients" are present.

These ingredients, including the criteria related to each that will have been met as a result of thorough project development activities, are presented below. If these criteria have been achieved, thereby providing a project with all of the requisite ingredients, then objective professionals are able to make positive evaluations of the project, which lends reassurance to project participants and investors as to the quality of the project.

- AN ENVIRONMENTALLY SUITABLE SITE FOR THE FACILITY

  - A site is deemed suitable because, among other factors, it has good transportation access; it is compatible with the present land use and zoning of the area; its topography and subsurface conditions are appropriate for the proposed facility; and it is close to the point of interconnection with the energy market.

  - There should be no environmental, site, or facility design impediments which would prevent facility conformance with all of the approved major permits relating to environmental compliance and solid waste regulations. All such major permits must be approved by the responsible agencies. Any additional local and/or state permits or approvals that may be required for facility construction should be obtainable in a timely manner that will not affect the facility completion schedule.

- A NEARBY LANDFILL FOR RESIDUE AND BYPASSED WASTE

  - The capacity of the designated landfill, including its expansion potential, must be sufficient to fulfill the residue and unprocessed waste disposal needs of the facility throughout the term of the bonds.

- A LONG-TERM CONTRACT FOR THE SALE OF ENERGY

  - The energy purchase agreement must provide reasonable assurances that all of the energy produced by the facility and available for sale will be purchased throughout the term of the bonds.

  - The projections of the price received for the sale of energy produced by the facility must be reasonable.

- A PROVEN TECHNOLOGY AND AN EXPERIENCED VENDOR WHO WILL ASSUME RESPONSIBILITY FOR ITS PERFORMANCE

  - The facility technology must be a sound and proven method of municipal solid waste disposal.

  - The contractor must have the ability to design, construct, and operate the proposed facility, and must have demonstrated its ability to design, construct, and operate comparable facilities.

  - The design and construction of the facility in a manner that will result in a facility capable of satisfying the acceptance test must be within the demonstrated technical capabilities of the contractor. The acceptance test should be appropriate for the facility, based upon design expectations and demonstrated performance of existing facilities of similar design, and should be passable if the facility is designed and constructed in accordance with good engineering practice applicable to facilities of its type. Once the acceptance test is passed, it should be reasonable to expect that the performance of the facility, taking into account the effect of the air pollution control system, will be sustained at its annual effective design capacity if the facility is operated and maintained in accordance with good engineering practice applicable to facilities of its type.

  - The schedule for completion of design, construction, equipment installation, startup, and acceptance testing of the facility should be adequate for the facility's type and size, barring any unusual, uncontrollable, or unforeseen circumstances of a material nature.

- The facility construction cost estimates made by the contractor must be reasonable and achievable, and the funds made available from the bonds and the equity contribution should be sufficient to complete construction of the facility as designed.

- The contractor's projected operating costs for the facility, including those costs associated with the operation and maintenance of the air pollution control equipment, must be reasonable. In addition, the operation of the facility within these projected costs throughout the term of the bonds must be within the technical capabilities of the contractor, based on the demonstrated history of successful operation and maintenance of comparable facilities.

- The contractor's projections of facility performance, including processing capacity, electricity generation, and residue generation, must be reasonable and sustainable over the term of the bonds once the facility passes the acceptance test, and assuming that the facility is operated and maintained in accordance with good engineering practice applicable to facilities of its type. In addition, the design and operating procedures for the combustion system and air pollution control equipment must be adequate to ensure that the facility will operate in compliance with current emission criteria.

- The facility should have a useful life extending beyond the final maturity of the bonds if it is operated and maintained, with normal parts replacements, in accordance with good engineering practice applicable to facilities of its type.

- LONG-TERM FINANCING AT A REASONABLE COST

  - The contractual arrangements among the participants in the proposed project, and the credit-worthiness of each participant, should provide sufficient security to investors in the project to warrant an investment-grade rating of the bonds.

  - The projected receipts resulting from the operation of the facility under normal operating conditions must be sufficient to: (i) make debt service payments on the bonds, (ii) maintain

reserve funds at the required levels, (iii) operate and maintain the facility, (iv) make all other payments required of the contractor under the project agreements, and (v) provide a return to the contractor.

- LONG-TERM CONTRACTS FOR THE SUPPLY OF WASTE

  - Sufficient quantities of acceptable waste must be generated within a reasonable distance from the facility throughout the term of the bonds and must be committed or available to the facility so as to permit operation of the facility at its annual effective design capacity.

ACTIVITIES TYPICALLY REQUIRED TO DEVELOP A WASTE-TO-ENERGY PROJECT

The activities typically required to take a waste-to-energy project through development are demanding of the project sponsor, other project participants, and the professional resources that must be employed to support the development process. In conjunction with the required information-gathering and analytical tasks, there are several key decisions to be made regarding the roles of the various participants. These decisions are based on such considerations as risk posture, legal/institutional constraints, and objectives.

The required activities/decisions can be grouped topically as:

- Roles and Objectives of Project Participants
- Waste Acquisition
- Energy Market Development
- Site Acquisition
- System Definition
- Environmental Assessment and Permitting
- Economic/Financial Analysis
- Facility Procurement
- Project Financing
- Public Information
- Public Leadership

The most important information requirements and decisions are outlined below.

RESOLVING THE ROLES AND OBJECTIVES OF PROJECT PARTICIPANTS

Successful project development and implementation requires various levels of cooperation, commitment, and participation from the project sponsor, the waste supplier, and the energy market.

The substance of these relationships depends on how the eight essential roles in a waste-to-energy project are fulfilled:

1. Each project requires a SPONSOR who is capable of managing the preconstruction activities and overseeing the construction and operation phases. Preconstruction activities include facility procurement, project financing, site acquisition, development of final energy market and waste supply agreements, and satisfaction of relevant legal and regulatory requirements.

2. Each project requires a FINANCING ENTITY who takes responsibility for issuing bonds to cover the debt portion of the project financing.

3. It may be appropriate for a project to have one or more EQUITY PARTICIPANTS whose cash contributions reduce the amount of capital that must be raised through debt instruments.

4. The structure of the project financing may require that one of the project participants act as a GUARANTOR of the debt portion of the financing.

5. Each project requires a facility OWNER who is responsible for the project's financial performance.

6. Each project requires one or more WASTE SUPPLIER who is able to make long-term commitments to provide waste to the facility and to pay for its disposal.

7. Each project requires one or more ENERGY BUYER who is able to make a long-term commitment to purchase energy produced by the facility at a fair price.

8. Each project requires a DEVELOPER who is capable of ensuring that the design, construction, and operation of the facility is accomplished according to the expectations of the other project participants.

A single entity may play several of these roles. For example, the project sponsor may also be the financial guarantor, the owner, the waste supplier, and the financing entity. Whether or not a single party fulfills multiple roles and the particular way in which each role is filled depend on the objectives and capabilities of the project participants; the unique characteristics of the project; decisions by each project participant regarding its posture toward project risks; and decisions by the project sponsor regarding (a) the preferred method for financing the project, (b) whether the facility should be publicly or privately owned, and (c) how the facility should be procured.

Table 1 provides examples of key questions to be addressed in considering a financing and procurement approach. This table assumes that the project sponsor is also the primary waste supplier.

Decisions on facility procurement depend substantially on the ability and willingness of each participant in the project to manage the risks that are common to waste-to-energy projects. Table 2 categorizes some of these risks and suggests how several different procurement approaches [ranging from the architectural and engineering (A&E) approach to the "full-service" procurement approach in which a single entity is responsible for the design, construction, and operation of the facility] move risk from the public and the energy buyer to the private contractor.

The conventional A&E approach is the traditional procurement method for public works projects. The sponsor undertakes two procurements: one for engineering services, and one for construction. The engineering firm designs the facility and prepares the drawings and specifications needed for facility construction. After a competitive bidding process, the construction contract is awarded to the lowest bidder. With the assistance of an engineering consultant, the sponsor supervises plant construction and startup and is responsible for operation of the facility.

Using the turnkey approach, the sponsor selects through a single procurement a firm to be responsible for facility design and construction; this responsibility can extend through facility startup and acceptance. The design/construction contractor develops the facility design from process flow descriptions and performance specifications prepared by the sponsor and builds the facility according to the detailed design. The contractor can be required to demonstrate that the completed facility meets the sponsor's performance specifications, through a facility acceptance test; however, the contractor does not make long-term performance guarantees. Thus, while the sponsor may contract with the same or another entity to operate the facility, the sponsor usually maintains full responsibility for facility operation.

TABLE 1

EXAMPLES OF KEY QUESTIONS TO BE ADDRESSED IN CONSIDERING A FINANCING PLAN AND PROCUREMENT APPROACH

FINANCING AGREEMENT

Does the Sponsor want to own the facility?

Does the Sponsor intend to issue bonds to finance the facility? What type of bonds can it issue?

Does the Sponsor want vendors to provide equity for the facility?

Will the Sponsor back the bond with full faith and credit, service payment covenant, etc.?

What constraints does the Sponsor have in financing the facility?

What relationship does the Sponsor want among the construction, operation, energy/materials, and financial agreements?

What grants can the Sponsor obtain to help finance the facility?

CONSTRUCTION AGREEMENT

Does the Sonsor want review and/or approval authority?

What risks is the Sponsor able or willing to assume?

- Construction cost
- Delays in construction
- Inflation
- Changes in law
- Force majeure
- Failure of system to meet peformance specifications

OPERATION AGREEMENT

Will the Sponsor guarantee the supply and quality of the waste?

Will the Sponsor agree to a "put-or-pay" type of contract?

TABLE 1 (continued)

Does the Sponsor want to share in the facility revenues?

What types of guarantees does the Sponsor want?

- Waste disposal
- Revenue
- Product recovery

Will the Sponsor assume responsibility for unprocessed waste and residue disposal?

What risks is the Sponsor able or willing to assume?

- Operating costs
- Change in waste composition
- Market fluctuations
- Changes in law
- Force majeure
- Inflation

ENERGY AND MATERIALS AGREEMENTS

Does the Sponsor want to be a party to the agreements?

Does the Sponsor want approval or review authority?

Can the Sponsor sell energy and materials via a negotiated contract?

TABLE 2

DIFFERENCES AMONG PROCUREMENT APPROACHES

	A&E	TURNKEY	FULL SERVICE
CONSTRUCTION RELATED RISKS • Design Adequacy • Cost Overruns • Delays in Completion • Failure to Pass Acceptance Test • Uncontrollable Circumstance	Contractual performance responsibility is divided among the engineer, the general contractor, and the equipment suppliers. The liabilities of these parties are limited. Contracting parties are relieved of performance responsibility for broadly defined uncontrollable circumstances. The only contractual obligations that extend beyond completion are limited equipment warrantees from suppliers and errors and omissions liabilities of the contractors. The public owner has sole liability for any debt obligations of the project.	A single entity, the turnkey contractor, assumes performance responsibility for design and completion of construction. Method of establishing completion (e.g., acceptance test criteria) and turnkey contractor's financial liability for completion are negotiable. Contracting parties are relieved of performance responsibility for broadly defined uncontrollable circumstances. The only contractual obligations that extend beyond completion are limited equipment warrantees from suppliers and errors and omissions liabilities of the contractors.	A single entity, who will also operate and possibly own the facility, assumes performance responsibility for design, completion of construction, and and passing of an acceptance/performance test. Contractor's financial liability to provide an operating facility is negotiable. However, some companies have agreed to assume unlimited liability to provide an operating facility. At a minimum, the municipality will share in the responsibility for the consequences of events that are not within the contractor's control.
RELATIVE CONSTRUCTION COST ADVANTAGE	There is insufficient evidence to conclude that any one approach has an apparent cost advantage over the other.	There is insufficient evidence to conclude that any one approach has an apparent cost advantage over the other.	There is insufficient evidence to conclude that any one approach has an apparent cost advantage over the other.
EFFECT ON OWNERSHIP OPTIONS	Limited to public ownership.	The ability to effect private ownership is severely constrained.	Public or private ownership is possible.
MINIMUM SECURITY REQUIRED FROM MUNICIPALITY TO FINANCE	Pledge of municipal credit to cover cost and repay debt.	Pledge of municipal credit to cover cost and repay debt.	Put-or-pay guarantee for minimum tonnage and acceptance of adjustments in tip fee due to change in law. A deep pocket obligation may be required depending on deal structure and creditworthiness of contractor.
ALLOCATION OF OPERATING RISKS	Municipality assumes cost and performance risk for long-term operations.	Municipality assumes cost and performance risk for long-term operations.	Vendor responsibility for operations enables municipality to negotiate cost and performance guarantee.

With the full-service approach, a single contractor is assigned responsibility for facility design, construction, and operation. The construction phase (design through acceptance) and the operation phase may be covered by separate agreements. Relative to the procurement approaches described above, this is the only one that includes a meaningful facility acceptance test and long-term performance guarantees, so that costs and risks associated with both acceptance and facility operation can be passed on to the contractor. This approach has been preferred by many public sponsors of waste-to-energy projects, because it offers greater opportunity to minimize direct exposure to key technical risks, especially those associated with the long-term cost, availability, and performance of the waste-to-energy facility.

For those project sponsors seeking to further minimize their overall business and technical risks, it may be possible to expand on the full-service approach, such that the municipal waste supplier pays an annual service fee to a private entity (developer) who in turn contracts for the sale of energy; constructs, owns, and operates the facility; and assumes risks and responsibility for the sale of energy, the disposal of facility residues and unprocessed waste, the acquisition of non-municipal waste supplies and/or waste from other municipalities, and facility performance. Table 3 illustrates the difference between this approach and a full-service contract with the disposal fee calculated in accordance with a formula.

ACQUIRING ADEQUATE AMOUNTS OF SUITABLE WASTE

Determination of waste quantity and characteristics is critical for technical, economic, business, and financing reasons. From a technical point of view, waste quantity drives plant sizing decisions (including waste storage and transfer), and the characteristics of the waste (e.g., percent combustibles, moisture and ash content, heating value) drive process design decisions and affect the amount of energy products available for sale. From an economic/business point of view, a reliable supply of solid waste is required to achieve a constant flow of project revenues, and waste quantity and quality must be established before a vendor will make long-term system performance guarantees. From a financing point of view, where waste-to-energy projects have been financed through the issuance of revenue bonds, the underwriter has often required that there be a guaranteed delivery of a specified annual tonnage of solid waste.

Ultimately, it is desirable to develop waste generation estimates based on the actual weight of the waste disposed of, rather than deriving the estimates from such data as population and vehicle delivery rates. Thus, in the absence of existing weigh data, a waste weighing program is of value. A program that is conducted during different quarters of the year is preferable, because it provides information on seasonal variations in waste quantity.

TABLE 3

FORMULA VS. FIXED TIP FEE COMPARISON OF A TYPICAL GUARANTEE STRUCTURE/RISK ALLOCATION SCHEME BETWEEN VENDOR AND CITY

RISK	GUARANTEE/ALLOCATION SCHEME FORMULA TIP FEE	FIXED TIP FEE
CONSTRUCTION RELATED		
Inflation	Under a firm fixed-price contract, assumed by vendor; or, may be shared between vendor and City if fixed construction price is subject to escalation according to an index.	Assumed by vendor.
Cost Overrun	Vendor's responsibility.	Vendor's responsibility.
Delay Due to Vendor's Fault	Cost impact assumed by vendor who is liable for penalties equivalent to debt service during period of delay, but municipality may share in impact if contract permits vendor to defer service until plant completion.	Cost is vendor's responsibility; vendor may also assume consequence of delay in service if it has made unconditional guarantee to commence service by a date certain.
Design Errors	Cost impact of corrections absorbed by vendor. If plant performance is permanently affected (e.g., energy output below guarantee), vendor may be liable to make pro rata buy-down of construction price. However, in this case, City may lose anticipated benefit of performance above guarantee.	Vendor's responsibility.
Failure to Pass Acceptance	Same as above.	Cost impact is assumed by vendor; impact on City depends on whether vendor has made date certain guarantee.
Force Majeure/ change in law	Vendor is relieved of cost and completion guarantees to the extent of impact; City issues additional debt to complete and pays higher tip fee.	Vendor is relieved of cost and completion guarantees; however, vendor may have unconditional guarantee to finance increased cost of completion and subsequently obtain adjustment in City's tip fee.

TABLE 3 (CONTINUED)

FORMULA VS. FIXED TIP FEE COMPARISON OF A TYPICAL GUARANTEE STRUCTURE/RISK ALLOCATION SCHEME BETWEEN VENDOR AND CITY

	GUARANTEE/ALLOCATION SCHEME	
RISK	FORMULA TIP FEE	FIXED TIP FEE
OPERATIONS RELATED		
Inflation	Shared between vendor and City via annual adjustment in operating fee according to rate of change in inflation index.	Shared between vendor and City via adjustment in tip fee according to rate of change in inflation index.
Cost Overruns	Vendor is liable for actual cost increases above inflation index except for passthroughs.	Same as formula.
Facility Non-Performance	Vendor guarantees to accept a minimum tonnage, achieve a minimum net energy output, and generate a maximum residue and is liable for penalties equivalent to revenue loss or cost increase for performance below guarantees.	Vendor guarantees to accept minimum tonnage, generate maximum residue.
Force Majeure/Change in Law	Municipality assumes consequences of non-insurable events via adjustments in vendor's operating fee and performance guarantees for events defined under contract which affect facility operating costs and/or performance.	Municipality assumes consequences of non-insurable events via adjustments in service fee for events which affect facility operating costs and/or throughput.
NON-FACILITY RELATED:		
Energy Price Risk	Municipality assumes risks because tip fee is net of energy revenues.	Vendor assumes risk if tip fee is not subject to adjustment for change in energy price.
Waste Shortfall	Municipality assumes risk via make-up of vendor's revenue share and calculation of net tip fee.	Municipality guarantees tonnage and tip fee revenue make up. Municipality may also guarantee energy revenue make up depending on vendor's right to use available plant capacity for private waste.
Change in Waste Composition	Municipality specifies composition and higher heating value. Changes in waste outside of contract values are basis for adjusting vendor's performance guarantees.	A negotiable issue which depends in part on Vendor's right to use plant capacity for private waste.
Residue Landfill Availability and Cost	Municipality usually assumes responsibility for providing residue landfill and accepts landfill costs as passthrough for residue up to vendor's guarantee.	Same as under formula unless unique circumstances exist where vendor is able to offer landfill.

Quantification of waste characteristics (composition and quality) can be derived from existing data obtained from waste sampling programs conducted in various U.S. cities, or from a local waste sampling program. If there is reason to believe that a particular community's waste characteristics differ significantly from those of sampled communities, then a waste sampling program should be performed. Such a program entails obtaining samples of the waste at the landfill and sending them to a laboratory for testing. This program can be performed in conjunction with a waste weighing program, and, again, should be conducted during different quarters of the year to provide information on seasonal variations in waste characteristics.

In addition to waste stream quantification, the principles of the waste supply agreement (e.g., duration, put-or-pay commitment, tip fee escalation, revenue sharing) must also be established as a basis for negotiating a final contract. Depending on the selected procurement approach, a letter of intent from the waste supplier(s) is preferred prior to initiating procurement in order to demonstrate the soundness of the project to prospective bidders. The waste supply contract, however, is typically not finalized until after vendor selection.

DEVELOPING THE ENERGY MARKET(S)

Because the energy market plays such an important role in the success of a waste-to-energy project, it is critical to ensure the viability of the market in terms of technical suitability, energy revenue potential, and level of commitment. The various market criteria that must be addressed include:

Availability of a Nearby Site

Site availability is critical for a waste-to-energy facility that generates steam for sale. For economic reasons, the steam-generating facility should be located no more than a few miles from the energy buyer. Locating an adequately sized parcel of land suitable for a steam-generating facility within a small radius can be difficult. For refuse-derived fuel (RDF) production, the site's proximity to the market is important in terms of transportation costs but is not critical. If electricity is the final energy product, site location is a lesser issue because electricity can be transmitted into the utility power system at virtually any point (preferably, however, at an existing substation).

Energy Demand and Operation Profile

An ideal energy customer uses significantly more energy than the waste-to-energy facility produces. Such an energy buyer can use all

of the energy produced by the facility and usually can supplement this amount with energy from other sources. Thus, when the facility is not operational due to scheduled maintenance or other reasons, the buyer can compensate for this temporary energy loss by using more energy from its other sources or by relying on in-house standby energy production units.

On the other hand, an energy buyer relying on the waste-to-energy facility for all or almost all of its energy may not be able to provide its own standby capability on short notice. Consequently, the waste-to-energy facility may have to include its own standby fossil-fuel-fired boilers (for a steam-generating system). The addition of such boilers would increase the cost of the facility. Moreover, a buyer that relies on the facility for most of its energy needs may not be able to purchase all of the facility's energy output at all times -- a situation that can result in reduced project energy revenues.

The ideal energy customer also operates 24 hours a day, 365 days a year, and has an energy demand that remains nearly constant. Less desirable is the customer that experiences excessive variations in its energy demand over a period of hours; does not operate on weekends; has large seasonal variations in energy demand; and/or has regular seasonal shutdowns that exceed, or differ from, scheduled shutdowns of the waste-to-energy facility for maintenance.

Financial Stability

To finance a waste-to-energy project with revenue bonds, the investment community requires an energy buyer that is financially strong and willing and able to undertake a long-term commitment to a project.

Current Energy Costs

The objective of selling energy derived from solid waste is to displace the fuels otherwise used by potential customers. To effect such displacement, the waste-to-energy project must offer this alternative energy at a price lower than the potential customer's current energy cost. Therefore, the most attractive potential customers are those that now use the most expensive fuels, such as oil and gas, for the production of steam and/or electricity.

Product Quality Requirements and Specifications

The energy customer's requirements for the quality of the energy product are particularly important for waste-to-energy facilities that produce steam or fuel. For example, a steam customer may impose

restrictions on steam temperature and pressure, the level of organic and/or inorganic contaminants, and the type of feedwater chemicals. In addition, a steam customer's product specifications may restrict the use of waste-of-energy technologies. If, for example, a customer needs steam at very high temperatures and pressures, resulting increases in boiler corrosion may make solid waste combustion undesirable. If, on the other hand, the customer needs low-temperature, low-pressure steam, cogeneration (the production of both steam and electricity for sale) may be technically and economically feasible.

Willingness to Participate

The energy market's interest in a waste-to-energy project, the minimum and maximum quantities of the energy product that it is willing to buy, the basis for pricing the energy product, its willingness to make a long-term purchase commitment, and its preferred role in the project are all critical considerations.

The above information is needed not only to refine waste-to-energy facility design, but also to establish contract principles as a basis for negotiating a purchase agreement, including provisions for contract duration, take-or-pay conditions, base price, price escalations, and product quantity and quality. Prior to initiating procurement, a letter of intent should be secured from the energy buyer to demonstrate the soundness of the project to prospective bidders.

ACQUIRING SITES

Facility site suitability depends on the type of technology being considered and the particular energy market being considered. A detailed site assessment is required to determine suitability and to develop site information necessary for facility design purposes. This detailed assessment should address: (a) proximity to the energy buyer; (b) shape and size; (c) road access to the site; (d) proximity to the centroid of the waste generation area; (e) compatibility of waste-to-energy facility with adjacent land uses; (f) zoning change requirements; (g) ownership, willingness to sell (if privately owned), and price; (h) existing air quality; (i) proximity to sensitive areas (e.g., conservation land, historical sites); (j) flood potential; (k) adequacy of available utilities; (l) terrain; (m) subsurface conditions; (n) proximity to a landfill for residue and unprocessed waste disposal; (o) need for special permits (e.g., from the Army Corps of Engineers, the Federal Aviation Administration); (p) traffic impacts; and (q) noise and odor impacts.

In addition, a plan for acquiring the most appropriate facility site (e.g., purchase, lease) must be developed.

In the absence of an available landfill for the disposal of residue and unprocessed waste from the facility, arrangements must also be made for a landfill site. This is an integral part of a waste-to-energy system, and environmental permitting requires identifying the landfill site. Moreover, depending on the selected procurement approach, a vendor may require that the landfill site be secured before it will bid on the project, or, absent a landfill site, the vendor will want the cost of disposing of residue and unprocessed waste to be a passthrough item.

DEFINING THE SYSTEM

On the basis of information on waste, energy market, and site, a selection of appropriate commercially available technology(ies) can be made. Mass and energy balances must be performed to develop estimates of system performance in terms of energy output. It is also necessary to develop facility layouts to ensure that a facility employing the selected technology can be accommodated on the site.

In addition, the trade-offs among available design options (e.g., storage capacity, facility capacity, reliance on landfill to receive waste that cannot be processed because of facility outages or variations in the rate of waste arriving at the facility) must be evaluated. This evaluation enables decisions to be made regarding requirements for reliability, availability, redundancy, and other design options.

Finally, the technical design and operation requirements must be specified for purposes of facility procurement, and engineering cost estimates must be developed as input to the analysis of project economics.

PERFORMING ENVIRONMENTAL ASSESSMENTS/PERMITTING

It is first necessary to identify the environmental permits (e.g., air, water, solid waste) required for the facility, including the associated review times, and the need for environmental impact statements or other major environmental studies. Depending on the site location, there may be requirements for special permits and/or reviews (e.g., floodway/floodplain management).

Critical to the successful implementation of the project is the development of a permitting plan, including a schedule. It is important that the permitting schedule be consistent with the overall project schedule, so that obtaining permits will not delay project implementation.

Once environmental requirements have been identified, it is necessary to assess site-specific environmental and social impacts and benefits. A site-specific assessment includes the impacts of

emissions on air quality at ground level and on any nearby elevated receptors; the impact of major facility outflows on surface waters; the implications of discharging facility cleanup and process waters to the sanitary sewer system; the implications of and requirements for disposing of ash at landfills; and the impact on the population in the area of the facility in terms of aesthetics, employment, noise, odor, traffic, etc. This assessment identifies any major anticipated problem areas and the appropriate mitigating actions that can be taken.

PERFORMING ECONOMIC/PROJECT FINANCIAL ANALYSES

As the project becomes more defined in terms of waste, market, site characteristics, environmental requirements, and performance expectations, project economic estimates (i.e., capital costs, operating and maintenance costs, financing costs, and energy revenues) must be developed and refined using various assumptions regarding construction schedules, inflation rates, and interest rates. To be useful, the economic analysis should be performed for each year of operations, as well as on a life-cycle (present value) basis. In addition, in support of developing a financing approach, economics should be estimated assuming various financing scenarios (e.g., 100-percent tax-exempt debt, combined debt and equity). Finally, the sensitivity of the net tip fee calculations to the various assumptions used should be determined.

Sources of funding for a waste-to-energy facility include: general obligation and/or revenue bonds; tax-exempt vehicles, such as industrial development bonds; any available federal, state, and local grants; and/or public or private equity contributions. Federal tax laws have provided economic incentives for private investment in resource recovery, such as investment tax credits and accelerated depreciation write-offs. These incentives have led to the transfer of ownership of a waste-to-energy facility from the public sponsor to a private concern. The public sponsor has been able to use these incentives to obtain equity contributions to reduce the price of a facility or to stabilize the net disposal cost. Moreover, even when a private ownership route via an equity contribution was sought, a waste-to-energy facility still qualified for tax-exempt financing of the debt portion, as well as other benefits afforded under federal tax law. However, proposed changes in federal tax law threaten the viability of this form of project financing.

After a preferred procurement and financing approach has been selected, detailed analyses are required to evaluate the possible economic impacts of revenue-sharing options for vendors and the local community, pricing scenarios (including discount factors) for the energy product, and various levels of equity.

It is critical that the economic soundness of the project and its ability to be financed be determined prior to entering into system procurement and contract negotiations.

FACILITY PROCUREMENT

Regardless of the selected procurement approach, certain information must be compiled regarding what the sponsor wants to purchase, what the sponsor expects from the contractor, and what the sponsor is willing to commit to the contractor and the project. As such, the technical requirements for the facility must be specified, as well as the business approach for the sponsor's relationship with the contractor, and, if applicable, the energy market. Whether this information is communicated in the form of a Request for Proposals (RFP), or less formally during an ongoing negotiation process, depends on the selected procurement approach.

Below, some of the types of information that need to be communicated to a prospective contractor are summarized.

Business Structure

The structure for business arrangements between the project participants (e.g., waste supplier, project sponsor, energy buyer, system vendor) needs to be defined. The business structure addresses the risk and reward postures of the various project participants and indicates how the project sponsor intends to protect itself against risks that should appropriately be the responsibility of other project participants.

Scope of Work

The scope of work defines the responsibilities of the vendor as they relate to the waste supplier, the project sponsor, and the energy market during the design, construction, startup, acceptance testing, operation, maintenance, and financing of the facility.

The scope must clearly define these responsibilities to avoid ambiguities or conflicts. A clear definition of responsibilities also aids vendors in preparing their bids. Finally, a clearly defined scope helps in the evaluation process by standardizing responses from vendors.

Performance Requirements

On the basis of the energy market requirements, a set of performance requirements for the resource recovery facility is prepared. These requirements must also reflect waste disposal and environmental requirements. Care must be taken to ensure that the performance requirements are consistent with proven waste-to-energy technologies. Specific design practices that have been proven to be necessary or desirable for waste-to-energy facilities should be specified. These requirements provide the basis for establishing long-term guarantees by the vendor with respect to availability, throughput, and energy output from waste.

Waste-to-energy facilities are typically procured through some form of formal competition involving the preparation of technical, business, and price proposals by system vendors. Once proposals are evaluated, the sponsor and its project team focus on finalizing contracts with the preferred vendor and other project participants. In order to maintain the competitive nature of the procurement process, the project sponsor usually retains the right to terminate negotiations with the first-ranked proposer and initiate negotiations with the next best proposer. Alternatively, the project sponsor may negotiate simultaneously with two or more proposers until the best possible deal is struck. Although simultaneous negotiations can be beneficial, they demand considerable discipline among the sponsor's project team members in order to prevent the negotiation process from becoming an "auction."

PROJECT FINANCING

Because most waste-to-energy projects are financed primarily with some form of revenue bond, the most demanding activity leading to a successful bond sale is to prove to the financial community that the project's revenues are secure and that the project participants are willing and able to fulfill their respective obligations. It is during the process of finalizing financing documents and preparing to appear before the bond rating agency that the project sponsor has to demonstrate that the ingredients for a good project are in place and that the criteria for a successful project have been met.

In addition to the considerable legal work that is required during the preparation of financing documents, it is usually necessary for a consulting engineering firm with a national reputation in the waste-to-energy field to conduct a complete evaluation of the project and report its findings to the project sponsor, facility owner, and the bond underwriting team. This engineer's feasibility report is relied upon by the rating agencies and financial community for making judgments regarding the quality of the project from the point of view of potential investors.

PUBLIC INFORMATION

A waste-to-energy project can be expected to have a high profile and to be controversial. It is, therefore, essential to communicate clearly the substance of the complex issues surrounding the implementation of a project. The project sponsor, with the help of its advisors, must communicate with and respond to the concerns of constituent interest groups whose support is critical to successful project implementation. Such groups typically include: local government officials; interest groups representing the local waste collection, disposal, and recycling industry; local business interests; affected neighborhood groups; and concerned environmental groups. Accordingly, meetings must be held between the sponsor and such groups within a reciprocal forum that allows the presentation of facts pertinent to the concerns raised before misperceptions have a chance to develop. Such presentations must be made and information must continue to be disseminated at critical junctures of project implementation so as to maintain a factual dialogue that will both address concerns and minimize misunderstanding.

PUBLIC LEADERSHIP

It is essential to successful project implementation that political leaders support the project and are involved in the decision-making process during project development. Without such approval and advocacy, broad public support will be difficult to muster. Without the active, consistent involvement of political leaders in the decision-making process, the project development team will be severely constrained in its ability to reach closure on project agreements.

Thermal Markets for Waste-to-Energy Plants

Robert H. Brickner
Senior Vice President

and

J. Frank Bernheisel
Vice President

Gershman, Brickner & Bratton, Inc.
Washington, D.C.

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Robert H. Brickner, Senior Vice President

and

J. Frank Bernheisel, Senior Consultant

Gershman, Brickner & Bratton, Inc.
1025 Vermont Ave., Suite 608
Washington, D.C. 20005

INTRODUCTION

The increase in regulations affecting solid waste disposal programs, as well as the unpopular political overtones associated with siting new landfills near populated areas, has caused a profound awareness of the importance of controlling waste disposal programs in many communities around the country.

In order to properly portray the economic implications of the many different disposal scenarios available from the waste management industry, an accurate determination of the cost components of each waste management system option becomes an essential task for solid waste program managers. With a workable methodology, industry and local government officials can systematically investigate the attractiveness of high technology options, such as a waste-to-energy facility, compared to their existing methods of disposal - most commonly sanitary landfill systems.

Similarly, the increasing cost and declining availability of traditional fuels are forcing energy consumers such as individual local industries and institutions, agglomerates of energy users such as district heating and cooling loops, and a few public utilities to examine alternative sources of energy to help control long-term costs. One specific alternative available and compatible with these interests is resource recovery. Generally, these waste-to-energy systems process solid waste into one or more readily utilized, and therefore valuable, energy forms. These include electricity, thermal energy, and solid fuels. With regard to thermal forms (i.e., hot water, chilled water low and high pressure steam), refuse derived energy can provide a cost effective means of generation.

THERMAL LOAD APPLICATIONS

In establishing a resource recovery project, one point is always clear: the project's economics are dependent on a strong market (or markets) for the recovered energy product. Over the past ten years, industries, institutions and district heating and cooling systems have been and continue to be promising customers for energy generated by waste-to-energy plants. Currently, fuel costs represent a large amount of a typical energy system's overall costs. Controlling fuel costs, therefore, must be a priority. Since the cost of traditional fossil fuels of the past 10 years has been

significantly escalating, waste-derived energy may well represent a lower cost energy source over the long run, and thus merits serious consideration. Over the past two years energy costs have stabilized or even dropped slightly. However, energy managers cannot be lulled into thinking this trend will endure.

Despite the recent growing interest in all-electric waste-to-energy plants because of the perceived security of having a public utility as the long-term energy market, the historical picture continues to favor resource recovery development predicated upon a majority of single thermal customers or a multiple energy buyer base via a district heating loop system. Relatively few waste-to-energy plants have been constructed to service only the needs of utility plants (i.e., all electric plants).

Several approaches are possible to achieve a marriage of resource recovery and thermal systems. First, refuse-derived fuel (RDF) can be used as a supplemental fuel in existing utility type boilers. These conventional utility boilers produce a high-temperature and pressure steam which can be applied in a cogenerating capacity for both electrical generation and steam heating. Operating examples of RDF facilities serving municipal utility boilers can be found in Ames, Iowa; Madison, Wisconsin and Lakeland, Florida. Second, the combustion of RDF in dedicated boilers (boilers designed to use RDF as the primary fuel) generally produces a medium-temperature and pressure steam, which is more appropriate for industrial process applications and heating purposes rather than for electrical generation. Such dedicated boiler systems with thermal energy customers can be found in Akron, Ohio; Lawrence/Haverhill, Massachusetts, and Albany, New York. Finally, unprocessed solid waste can be burned in specially designed combustors ("Mass Burn" Facilities). This is the most widely utilized waste-to-energy technology. A few examples of this approach reflecting the full range of applications are shown as follows:

SELECTED MASS BURN PLANTS WITH DISTRICT HEATING APPLICATIONS

Location	Technology	Energy Customer	Plant Size (tons/day)
Baltimore, MD	Waterwall	Baltimore Thermal Steam Loop	2,250 TPD
Nashville, TN	Mass burn	City Steam Loop (Cogeneration)	800 TPD
Norfolk, VA	Mass burn	U.S. Navy	180 TPD
Durham, NH	Modular	University of New Hampshire	108 TPD
Portsmouth, NH	Modular	Pease Air Force Base	200 TPD
Collegeville, MN	Modular	St. John's University	64 TPD
Mays Landing, NJ	Modular	Atlantic County Justice Facility	15 TPD

A potential market opportunity may exist if a local utility desires to phase out an old and inefficient (and potentially unprofitable), downtown heating operation. This can provide the opportunity for a resource recovery plant to augment the existing energy source or take over that market completely. Further, the need or desire to construct a new modern and efficient downtown thermal energy loop may arise as a result of urban revitalization or downtown redevelopment as occurred in Nashville, Tennessee. This situation can create another natural market opportunity for resource

recovery. However, despite the potential compatibility of resource recovery with existing downtown district heating systems, such a coalition has not developed to the extent that may seem warranted. Exhibit 1 presents a detailed listing of the waste-to-energy plants which have thermal energy customers, currently in operation or under construction. Of the 56 plants presented, 29 serve a single industrial or institutional customer (typically via steam sales); three serve multiple industrial markets (via steam); 8 serve municipal district heating systems; and 14 serve military base or institutional thermal loops. Of the 56 plants three generate hot water; two provide chilled water; and 16 are cogenerating with electricity and thermal sales.

As previously mentioned, any resource recovery facility is highly dependent upon the revenues from its energy sales, and therefore requires a dependable, long-term energy market or markets or the municipality assumes the risk of short-term contracts. Exhibit 2 shows some typical resource recovery facility revenues from energy sales, recovered materials sales, and user "tipping" fees. The energy revenues range from 28 percent to 47 percent of the overall revenue stream, thus making the facility financially dependent upon the sale of energy. Typically, higher tipping fees to make up the revenue shortfall from loss of energy markets would be an unacceptable risk to the local community. Since solid waste management is a matter of seeking the least cost disposal option, resource recovery becomes attractive compared to other options (e.g., landfills) as its relative cost to the users (i.e., its tipping fee) goes down. Since recovered energy prices are usually set by formula at a level the market will bear — often at a slight discount to the more traditional energy forms or sources — the tipping fees for the facility must generate funds at a level sufficient to make up the difference to cover the annual debt service payments and all associated system operating and maintenance costs.

Relative to conventional fossil fuels, solid waste as an energy source can become progressively cheaper over time. In the decade prior to 1984, the cost of fossil fuel-based energy was escalating in the range of 12 to 15 percent per year. Over the past two years, the U.S. oil price has softened and a relatively stable market price has resulted. The comparable escalation rate for solid waste-derived energy need not be aligned to worldwide energy prices, but will align at or below to the nation's general inflation rate (CPI). This is mainly due to the fact that resource recovery is highly capital plant intensived—construction costs escalate about CPI rate during planning and implementation but costs stabilize once the plants is in operation because the debt service is then fixed.

As has been pointed out previously, income is also derived from providing a waste disposal service (tipping fees), thereby creating a "subsidy" which can be used to artifically hold down the price of the recovered energy. This potential for a differential between the theoretical cost to produce conventional fossil fuels and energy derived from solid waste may allow resource recovery systems to offer discounted energy prices. This can be accomplished within the framework of an economical waste disposal system.

In addition to the potential pricing benefits of solid waste-derived energy, the specific generation of thermal energy typically offers purchasers insulation from future fossil fuel shortages and other interruptions. This benefit has already been demonstrated in Nashville, Tennessee, where plant manager Milton Kirkpatrick reported that "when some people were closing down because they could not get natural gas, we kept going. We never ran out of fuel."

EXHIBIT 1

WASTE-TO-ENERGY SYSTEMS WITH THERMAL MARKETS, SEPTEMBER 1985[1]

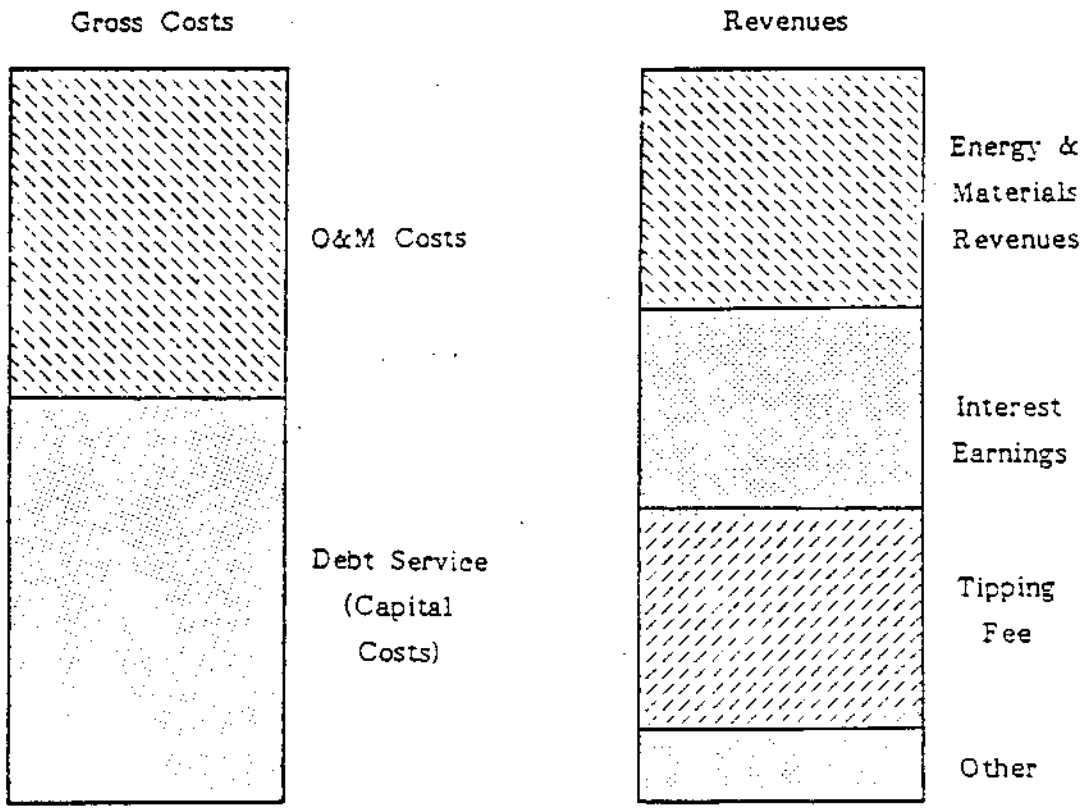
Year of Start-Up	Location	Technology	Design Capacity (tons per day)	Energy Market Type
1965	New York, NY	Refractory	500	District steam loop
1970	Chicago, IL	Waterwall	1,600	Beach Candy Co.
1972	Harrisburg, PA	Waterwall	720	District heating loop
1974	Nashville, TN	Waterwall	800	District heating/cooling loop
1979	Akron, OH	RDF, Dedicated	1,000	District heating loop
1979	Salem, VA	Controlled-Air	100	Mohawk Rubber Co.
*1979	Waukesha, WI	Refractory	175	Amron Corp.
1980	Auburn, ME	Controlled-Air	200	Pioneer Plastics Co.
1980	Crossville, TN	Controlled-Air	60	Crossville Rubber Products
1980	Dyersburg, TN	Controlled-Air	100	Colonial Rubber Works
1980	Durham, NH	Controlled-Air	108	University district heating loop
1980	Hampton, VA	Waterwall	200	NASA steamloop
1980	Lewisburg, TN	Controlled-Air	60	Heil-Quaker Co.
1980	Osceola, AR	Controlled-Air	50	Crompton Osceola, Inc.
1981	Aroostook Co., ME	Refractory	50	Frenchville Airport
1981	Burley, ID	Controlled-Air	50	Simplot Co.
1981	Albany, NY	RDF, Dedicated	750	District steam loop
1981	Johnsonville, SC	Controlled-Air	50	Wellman Industries
1981	Batesville, AR	Controlled-Air	50	General Tire and Rubber Co.
1981	Pittsfield, MA	Refractory	240	Crane & Co. (Industrial loop)
*1981	Collegeville, MN	Controlled-Air	65	University district heating loop
*1981	Niagara Falls, NY	RDF, Dedicated	2,200	Hooker Chemicals & Plastics Corporation
*1982	Gallatin, TN	Waterwall	200	Industrial district heating loop
1982	Waxahachie, TX	Controlled-Air	50	International Aluminimum Extruders
1982	Harrisonburg, VA	Refractory	100	University district heating loop
1982	Portsmouth, NH	Controlled-Air	200	U.S. Air Force district heating loop
1982	Rolla, ND	Controlled-Air	100	District Heating
1982	Miami, OK	Controlled-Air	108	B.F. Goodrich
1982	Red Wing, MN	Controlled-Air	72	S.B. Foot Tanning Co.
1982	Park Co., MT	Controlled-Air	72	Burlington Northern Railroad
1983	Cattaragus Co., NY	Controlled-Air	115	Cuba Cheese Co.
1983	Huntsville, AL	Controlled-Air	50	U.S. Army district heating loop
1984	Pascagoula, MS	Refractory	150	Morton-Thiokal Co.
1984	Tuscaloosa, AL	Controlled-Air	300	B.F. Goodrich
*1984	New Hanover Co., NC	Waterwall	200	W.R. Grace
1984	Susanville, CA	Refractory	100	Lassen Community College
*1984	Baltimore, MD	Waterwall	2,250	Baltimore Thermal
*1984	Haverhill/Lawrence, MA	RDF, Dedicated	1,300	Industrial district Steam Loop
1985	Atlantic County, NJ	Controlled-Air	15	Atlantic County Justice Facility
*1985	Oneida County, NY	Controlled-Air	200	Air Force district heating loop
*1985	Oswego Co., NY	Controlled-Air	200	Armstrong World Industries
1985	Sitka, AK	Refractory	50	College district heating loop
*1985	Franklin, KY	Refractory	75	Glover Garden Products
1985	Delaware Co., PA	Refractory	50	Fair Acres Geriatric Center
1985	Hampton, SC	Controlled Air	225	Westinghouse Electric (steam)
1985	Carthage, TX	Controlled Air	40	Tasty Bird Foods (steam)
1985	Cleburne, TX	Refractory	100	Donnelly Printing, Inc. (steam)
1986	Ft. Dix, NJ	Controlled-Air	80	U.S. Army
*1986	Tulsa, OK	Waterwall	750	Sun Oil Co.
*1986	Portsmouth, VA	RDF, Co-Fire	1,900	U.S. Navy district heating loop
1986	Olmsted Co., MN	Refractory	200	Federal Prison district heating loop
*1987	Detroit, MI	RDF, Dedicated	3,000	Detroit Edison district steam loop
*1987	Wilmington, DE	Refractory	750	ICI Chemicals
1987	Davis Co., UT	Refractory	400	Air Force district heating loop
*1987	Rochester, MA	RDF, Dedicated	1,500	Commonwealth Edison, future Industrial Park
*1987	Dutchess Co., NY	Waterwall	400	IBM (steam)

* Electric generation or cogeneration

1. Source: Gershman, Brickner & Bratton, Inc.

EXHIBIT 2

ANNUAL COST AND REVENUE ELEMENTS
OF WASTE-TO-ENERGY FACILITIES



However, one of these problems of selling a refuse-derived thermal load to commercial (including residential) users is that the generation of hot water or steam in a solid waste fired boiler cannot always be "reasonably" varied to meet load conditions. In cases where the energy available from the solid waste exceeds the customer, or system demand, the plant must be equipped with a boiler bypass flue or steam-condensing equipment. This is the case in Chicago where Brach Candy only purchases a portion of the steam generated. Conversely, when thermal demand exceeds the supply, the resource recovery plant must be equipped with an auxiliary fossil fuel-firing system if customer demand is to be met. Experience has shown that the additional cost of this equipment is usually only justified where firm long-term contracts with a premium price for an uninterrupted energy supply can be secured for all of the thermal load produced.

POTENTIAL THERMAL ENERGY SYSTEMS

A wide range of products can be recovered from solid waste. Thermal energy from a waste-to-enegy plant source can be distributed to residential, commercial, and industrial customers for space heating and cooling, domestic hot water, and process heating. The waste-to-energy source may be one of any number of types of waste-to-energy incinerator systems that would otherwise utilize the heat developed for electrical generation. Additionally, cogeneration allows for a high level of total energy utilization and efficiency. District heating and cooling systems are presently served by a central source of energy generated by a wide variety of fuels.

First commercial applications of multiple thermal customers (known as district heating) in the United States dates back as far as 1876. In 1877, Birdsill Holly pioneered the first commercially successful district heating system. Using a boiler in his cellar as a central heat source, he developed a loop of steam distribution, radiation, and condensation return for his own home. This was followed by increasingly distant extentions of the system to heat neighbors' homes up to 1,000 feet away. In 1879, the same year Thomas Edison was installing electric lines in New York City, the Steam Heating and Power Company of New York was founded. District heating is best suited for those areas with high building/population density in a relatively cold climatic zone. In such areas, district heating can maintain stable and competitive pricing. District cooling is also applicable in high population concentrations and can help provide balanced seasonal loads.

Initially, district heating in the United States was based primarily on the use of steam. Currently, district heating and cooling systems accounts for 1 percent of the total energy demand for space and hot water heating in this country. This reflects a drop in the number of urban systems from their peak in the 1930's. This drop resulted from the cheap fossil fuel available after World War II. Significant growth in demand for district heating systems has occurred in recent years from institutions such as military bases and on college campuses. More recently, there has been renewed interest in urban systems, renovating and rejuvenating existing systems or constructing new ones. This is due to the changes in oil supplies and increases in fuel prices over the past ten years.

District heating in Europe did not take hold until after World War II. Since that time, however, it has developed rapidly and has excellent public acceptance. Contemporary success of district heating in Europe has helped rearouse interest in this country and has lead a movement toward adoption of European methods in several of this nation's cities. The European method uses hot water from back pressure turbines distributed to meet customer loads. Expansion of the system is created incrementally as new communities are developed. However, in this country, new building construction

as a percent of the total existing building volume is lower. In the U.S., steam has been the preferred thermal medium for heating. Also, cooling is used in the U.S. to a larger degree than in Europe. Electricity powers most cooling machinery (e.g., the summer air conditioning load); this results in poor load factors for both electric or DHC systems. As a result, electric utilities in the past have overly promoted electric heating. Existing buildings equipped with steam and electric heating cannot be adapted readily to hot water systems and hot water cooling devices are less efficient when compared to electrically driven units.

Over the past 25 years, most European countries have centralized heat production and combined the generation of heat and electricity. West Germany has 472 district heating networks. In Finland, 14 percent of all homes are served by district heating systems. In the city of Helsinki, 65 percent of the homes are kept warm through district heating with a goal for 1990 of 85 percent. Feed and return pipe lines for the Helsinki system total 250 miles. Sweden has approximately 50 district heating systems providing space heating and domestic hot water which are owned by the communities they serve. Of these, 35 cities and towns have systems using hot water as a heat distribution medium supplied from plants having only hot water boilers. In Stockholm, about 50 percent of the inhabitants are served by district heating with a goal for the year 2000 set at 90 percent. District heating is strongly emphasized as part of the nation's fuels policy.

One of the earliest European nations to use district heating, Denmark has employed cogeneration technology for nearly 60 years. Fifty percent of all energy consumption in Denmark is for space heating, with district systems supplying 40 percent of all Danish households. Ninety percent of all towns with populations exceeding 2,000 people have some sort of centralized heat supply. Denmark, also a pioneer in the use of solid waste as an energy source, has approximately 60 percent of all waste used for generating district heating energy. This supplies 5 percent of the total heat consumed in the nation.

District heating systems can be classified according to the type of area they serve with different system technology and design necessary for optimum performance in each area type. Typical classifications by service area or market area are: (1) densly populated areas, (2) high density building urban areas, (3) industrial complexes, (4) low density residential areas. Three main factors determine whether or not district heating can be economically productive in a given area:

- heat load density
- annual load factor
- rate of consumer connections

For economical operation, a district heating system must connect the maximum number of system users in the service area as soon as practical. The rate of consumer connections sets the pace for revenues which, in turn, determines the economic success or failure of the system. Once the system is operational and the initial consumer connection rate satisfactory, the cost of connecting new buildings into the system is often less than the cost of new furnace and/or boiler installations. The cost of conversion of existing buildings depends on a number of factors: (1) type of DHC system, (2) fuel currently used, (3) age, type, and condition of existing equipment, and (4) the conversion to district heating becomes more attractive when existing systems are in need of replacement.

THERMAL ENERGY SYSTEM

A solid waste fired thermal energy system is made up of three major components as shown in Exhibit 3. The first component is the thermal production plant which provides the hot water or steam. Additionally, absorption refrigeration equipment or steam turbine driven mechanical chillers can be used to generate chilled water. The boilers can burn solid waste and/or other conventional fossil fuels depending upon reliability and/or demand needs. Typical electric generating plants normally discard 70 percent of the heat content of the input fuel and former municipal incinerator systems without energy recovery rejected all of the heat that they generated. Recovering this heat and using it in a thermal energy system, whether to a single industrial steam customer or a more extensive district heating system, can reduce a community's consumption of primary fuels such as oil and/or natural gas.

The second component of the thermal energy system is the transmission/distribution network which conveys energy in the form of steam, hot water or chilled water through pipes from the thermal production plant to the ultimate customer or customers. Significant improvement in piping technology has been made through the use of new materials for carrier pipes, insulation, and exterior coverings. Piping can account for 50 percent of the capital investment.

The third component of the thermal energy system is the customer's in-plant or in building equipment. Steam or hot water supplied by the thermal system may be used directly for heating or cooling. In this case, it is directed into the building and circulated through the customer's equipment. This is the case for seven older systems where steam is directed through a pressure reducing station for use in the low pressure (0-15 psig) steam space heating system, service water heating and absorption chilling equipment. In the case of hot water systems and newer steam systems, heat exchangers are used most frequently, and many building space heating and domestic water heating systems are hot water design. When chilled water is also distributed by the system, water to water heat exchangers are usually employed within the building. This isolates the user from the thermal system and preserves the integrity of both system and customers. Energy loss in this approach is very low.

District heating and cooling systems are typically classified by the thermal energy media used, as follows:

- Steam System Types:

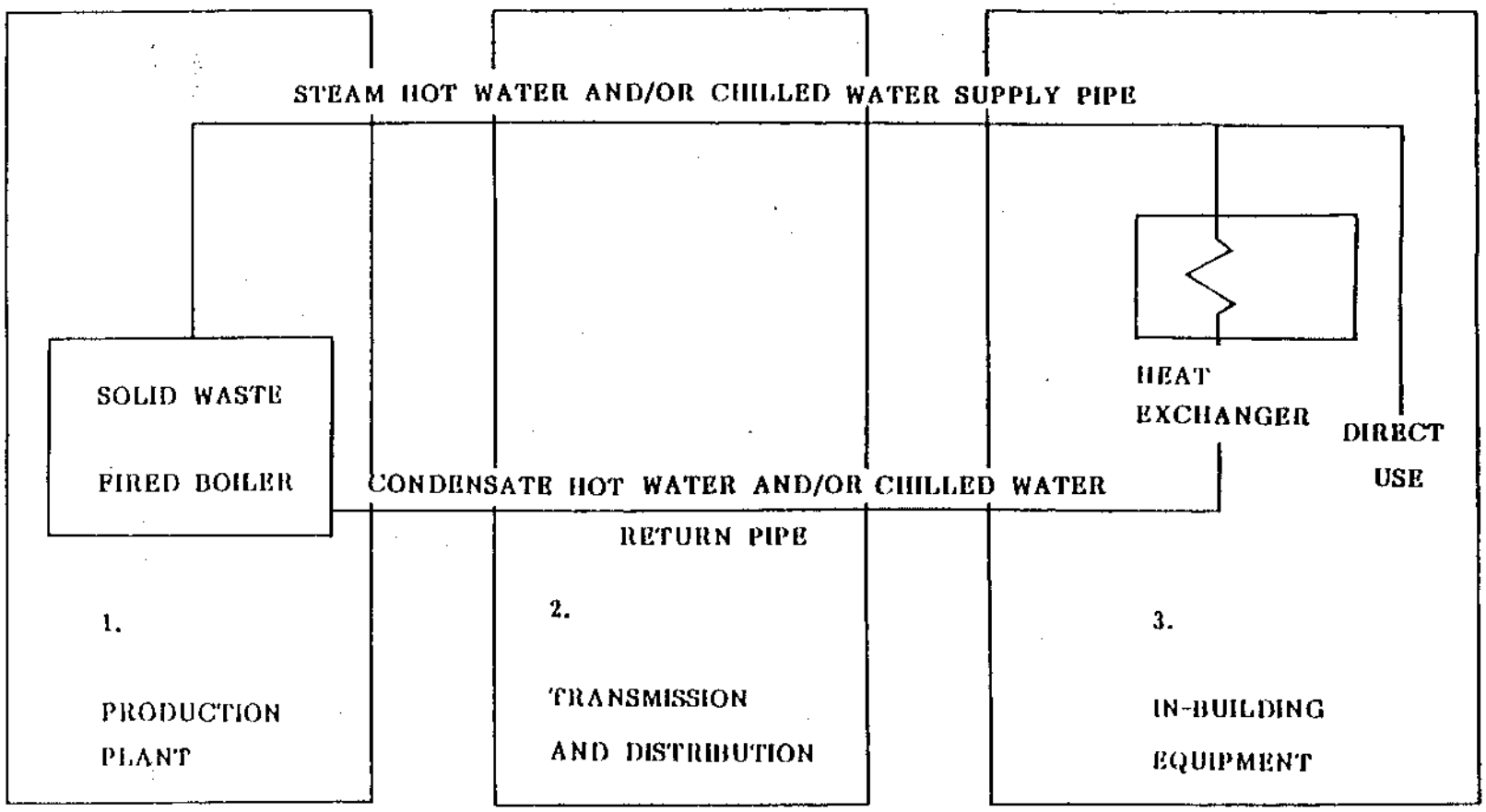
  1. Heat only systems where boiler capacity is committed to supply steam at the design pressure to the distribution network. (Example: Nashville, Tennessee.)

  2. Cogeneration or combined thermal and power systems; the steam used in the system is a by-product of the electric generation process. (Example: Baltimore, Maryland.)

  3. Supply/purchase systems, where steam above a base capacity generated by a waste-to-energy plant is supplemented from other boiler plants, depending on demand and availability. (Example: Albany, New York.)

EXHIBIT 3

DISTRICT THERMAL SYSTEM COMPONENTS



- Hot Water System Types

  1. Hot water is supplied from designated boilers or other heat sources, at central locations in the system. (Example: St. Paul, Minnesota)

  2. Hybrid systems where a basic steam system develops on-site hot water for a localized hot water network. (Example: Pease Air Force Base, New Hampshire.)

  3. Cogeneration or combined thermal and power systems where hot water is developed as part of the electric generation process. (Example: Trenton, New Jersey)

- Chilled water system types

  1. Chilled water is produced at the central plant by steam driven equipment. (Example Nashville, Tennessee.)

  2. Electrically driven equipment produces chilled water at a central plant.

Of the fifty-six waste-to-energy plants in the U.S. that burn municipal solid waste and market thermal energy, the form of the eventual product(s) solid (versus generated by the boilers) is as follows:

Marketed Energy Form	No. of Plants
Steam	54
Hot Water	3
Chilled Water	2

Steam Systems

The first thermal resource recovery plants in the United States consisted of low pressure fire-tube boilers supplying low pressure steam into the piping network. The principal change and upgrade in the original concept in more recent times has been to increase the pressure to meet the needs of customers and to handle the ever-increasing distances of energy markets from the waste-to-energy boiler plant. A trend toward locating waste-to-electric generating facilities away from the urban core cities has brought about an increase in all-electric operations rather than using cogeneration systems in many areas. Pressures in steam supplied from heat only boilers range from a low of 8 psig to 650 psig with an average of approximately 150 psig.

Cogeneration, or combined heat and power (CHP) systems are based on the sequential generation of electricity and the use of the thermal energy from the same primary energy source. The concept is not new in the United States, with the first such system installed about 1905. It should be noted that steam from conventional fossil fuel fired plants was a by-product from the generation of electric power and a source for district heating in many cities until the power production stations were moved to such distant locations that steam could no longer be effectively transported.

A typical steam piping system normally services customers within 2 to 3 miles of the generating source. Historically, U.S. systems have been of single pipe design. After heating or cooling the downtown buildings, the steam is condensed and conveyed to the municipal sewage system. The disadvantages of this single pipe system include:

1. Increased requirements for boiler feed water demineralization since the condensate is discarded,

2. Energy loss with the condensate,

3. Reduced flexibility in the amount of steam provided, and

4. Increased load in the city's sewage or storm drain system.

The most widely used piping system designed in the United States is the grid system, with the main trunk line placed on the street and branches provided to each building. Steam distribution systems generally can be classified according to set pressure ranges: (a) low pressure systems range up to 30 psig; (b) intermediate from 30 to 125 psig; and (c) high pressure systems are above 125 psig. Selection of the distribution steam pressures are based on the minimum design pressure requirements of the equipment and/or industry to be served by the system.

Hot Water Systems

The wide use of hot water systems by utilities in the United States is limited for a variety of reasons. However, hot water distribution is frequently used in more institutional installations, such as in systems on university campuses, large prisons, institutions, at airports, merchandise centers and on military bases.

In most hot water systems the heated fluid is pumped through transmission piping to a distribution piping network. After the heat is extracted at the customer's use point, the cold fluid is returned through companion lines. Such systems require two pipes of similar size, unlike the single pipe steam system. Since the water is returned to the boiler plant, the amount of fresh water and associated treatment which must be newly introduced into the system is greatly reduced. Generally, hot water is not utilized in the same manner as steam. At the customer's point of use a heat exchanger, water to water or water to air, isolates the heat supply. Service hot water is produced in a similar manner, usually through use of a separate heat exchanger.

Where steam is provided and is already an essential part of an industrial/commercial zone, it may be impractical to convert to hot water distribution. However, when new areas are developed, it may be appropriate for a hot water system. One way to develop hot water district heating is through the hybrid concept, where steam is transmitted for the distance necessary to meet existing customer commitments, then is fed into a heat exchanger and pumping system for a hot water loop. Also, high temperature hot water can be utilized to produce steam for these customers by installation of appropriate equipment.

Hot water may also be produced from a solid waste-to-electric generating plant by placing a heat exchanger on the path of a turbine exhaust to heat the system's water supply. This keeps the boiler water separate from the water distributed for the thermal market load(s) as well materially reducing the cost for water treatment and energy loss from the level experienced by steam systems where the condensate is not returned.

The temperature of hot water utilized in various systems is presented below:

TEMPERATURES OF HOT WATER SYSTEMS

TEMPERATURE		SYSTEM
(204°C)	400°F	High temp DH line Trenton, N.J.
(180°C)	356°F	Transmission temp. Ruhr area, West Germany. (Many temps used throughout W. Germany.)
(165°C)	330°F	EPCOT, Disneyworld, Florida
(149/121°C)	300/250°F	Range of temps. used in USSR
(121°C)	250°F	Temp. above which use of geothermal water is regulated under Oregon law.
(120°C)	248°F	"General Standards" - Sweden and Finland (Stockholm higher)
(110°C)	230°F	Temp. of Kalmath Falls Geothermal DH System
(87°C)	190°F	"General Standard" - Denmark
(77°C)	170°F	Temp. of original 1890 DH system in Boise, Idaho - still growing at this temp.
(46°C)	116°F	Supply temp. St. Paul Energy Park DHC System (from ground water heat pump).

Hot water systems are gaining in popularity in the United States, but factors affecting the design, installation and cost are very site specific. Basic design considerations apply as follows:

- Temperature and pressure: Most hot water systems in West European countries are designed for maximum supply temperatures between 230°F and 266°F and return temperatures of 122°F to 158°F. Typical maximum design temperatures in the supply and return lines in Eastern European Block countries including the U.S.S.R. are 300°F and 160°F respectively. The reasons for using the lower temperatures are the smaller system sizes and the possible use of polyurethane insulation (with a temperature limitation of about 250°F). Piping network pressure depends on the system size and operating temperature and varies from 130 to 250 psig during the winter, and between 60 and 150 psig during the summer. The water velocity of the network is usually determined by detailed engineering study. Basic data indicates that water velocities may typically range from 1.6 to 13 feet per second. District heating pipes are usually installed under ground and a variety of different designs are used to protect the insulation

and pipe from groundwater damage which could deteriorate the insulating material. Piping installation requirements can be summarized as follows:

- Prevention of water penetration to the piping surface;
- Retention of efficient heat insulation, and
- designed for a reasonable installation cost.

A comparison of the advantages and disadvantages of steam vs. hot water systems are presented is Exhibit 4.

Chilled Water System Types

Water is chilled (reduced in temperature to 35° or 40°F) and distributed to customers who utilize heat exchangers for space conditioning. Chilled water distribution is limited because large pipe systems are required and effective distances are less than hot water distribution. When steam is produced year-round from a process such as a waste-to-energy system, although there may be little demand for the steam in warm weather, it may be practical to use steam turbines to drive conventional compression chilling devices. If this can be achieved, a better waste-to-energy plant energy load factor results, assuming generally that both heating and cooling will utilize the same thermal source(s).

Absorption chillers are another method of developing chilled water at production plants. Such machines are capable of operating at much lower pressures than steam turbines and the efficiency of steam-driven chilling equipment and controls are rapidly improving. Absorption chillers are available which can be efficiently driven by high temperature (350°F) hot water.

Statistics on total U.S. chilled water sales reflected the total distributed chilled water sales in 1981 as 3,718 x 10^6 daily tons, an increase over 1980 of approximately 10 percent. The total installed chiller capacity was estimated to be 170,000 tons per hour of which 106,000 was by steam turbine drive, 48,000 by electric motor drive, and the majority of the rest by absorption chillers.

Steam turbines can be used to drive centrifical refrigeration machines and condenser water circulating pumps. Steam turbines are usually selected to improve the heat balance where exhaust or high pressure steam is available. Non-condensing turbines are most often used to drive centrifical compressor chillers which share the cooling load with one or more adsorption units. The turbine's 15 psig exhaust steam can serve as the heat-energy source for the absorption unit's generator.

Experience has shown that distribution piping can be up to 50 percent of the total installed cost of a chilled water district heating system, so careful planning of the installation is very important. The water flow in the distribution loop between the central plant equipment and the individual buildings must always be greater than the total flow in all the building loops. This is necessary to assure constant supply temperature to each building. By the same token, the total flow in the building loop must be less than in the distribution loop to insure a constant supply temperature. In other words, the change in temperature in the distribution loop must be intermediate between the building loop and the equipment loop. This change in temperature will then usually fall into the range of 12 - 14°F.

EXHIBIT 4

COMPARISON OF STEAM DISTRICT HEATING AND HOT WATER DISTRICT HEATING

System	Advantages	Disadvantages
Steam district heating	Pumps not required Can be a one pipe system with no return	Piping range limited 2 2 miles to 3 miles
	Retrofit of old urban steam buildings may be easier	If steam is extracted from a congenertor, a great deal of electricity is sacrificed.
		Steel pipes are required—they are expensive and they corrode.
		Water must be conditioned to prevent mineralization.
		Condensate is not returned wasting water, water conditioning, and low-grade energy
		High-temperature steam for spce heat/service water heating is a poor energy use.
		High heat loss during distribution (15-45 percent).
		Piping, boiler, personnel codes are stringent.
		Installation is difficult—pitched piping, steam traps, pipe expansion, manholes.
		Maintenance costs are higher.

EXHIBIT 4

COMPARISON OF STEAM DISTRICT HEATING AND HOT WATER DISTRICT HEATING (Continued)

System	Advantages	Disadvantages
		Metering is difficult. Difficult to operate under conditions of varying loads.
Hot water district heating	Piping range of 15 miles Less cogenerator electricity sacrifice than for steam. Plastic pipes can be used--less expensive, no corrosion. Water need not be conditioned. Closed loop, so water is not washed. Good energy end use match. Low transmission loss during (5-15 percent). Construction and operation codes easier to meet. Installation, retrofit to buildings generally easier than for steam. Lower maintenance costs. Metering is easy and accurate. To easy to operate under varying thermal loads. High system inertia.	Pumps are required—system balancing is important. System needs two pipes. Cannot provide high pressure steam is a customer on the circuit requires it—can act only as preheat.

SOURCE: Office of Technology Assessment (1982).

System Planning

The development of integrated thermal energy systems serving industrial as well as municipal and/or commercial customers depends on several site related factors, such as the developer's ability and the price of alternative energy sources, market potential, peak hour loads, annual energy use patterns, and the potential for cogeneration. Evaluation of all these factors is necessary to determine the feasibility of a new thermal energy system or the retrofit or expansion of an existing system.

When used primarily to meet space heating loads, a district heating system is typically economical in locations with a reasonably cold winter season. The U.S. Department of Energy studies seem to indicate that district heating systems are usually cost effective in areas with more than 4,000 degree days. However, this rule of thumb does not apply to district heating system applications when used primarily for meeting year round industrial process loads or for balanced heating and cooling loads. For comparative purposes Exhibit 5 presents a review of the climatic data for selected U.S. cities.

Identification of District Thermal Energy Market Areas

The selection of market areas is not an exact science, but some basic principles can be used as guidelines in assessing area potential:

1. Area should have a high thermal load density.
2. Connected loads should have a high load factor.
3. Market areas should be as close as possible to thermal sources.
4. New development or redevelopment areas often are useful in forming the core of the initial service area.
5. Major physical obstacles between heat sources and load areas should be avoided wherever possible, whenever possible.
6. Groups of buildings under single ownership should be included whenever possible.
7. Other relevant planning objectives of the community should be considered in selecting district heating service areas.

Cogeneration

Cogeneration is the term used to designate systems which produce electrical (or mechanical) and thermal energy (usually in the form of hot liquid or gases) from a thermal source at the same time. Cogeneration is used by electric utilities to provide district heating, both for space heating and industrial process heating applications, and also is employed by industries who sell their excess electricity and or thermal energy to neighboring facilities. From an electric utility's perspective, the advantage of cogeneration is its greatly improved fuel utilization efficiency. The overall conversion efficiency of a conventional electric only plant is about 30 percent. The remaining two thirds of the energy is rejected in the environment through stack gas losses and the cooling system. By contrast, a cogeneration power plant can operate in overall efficiency as high as 80 percent, with some sacrifice in electrical output. For each

EXHIBIT 5

CLIMATIC DATA FOR SELECTED U.S. CITIES

Location	Heating Degree-Days (HDD)	Winter Design Temperature[a] (WDT) (°F Dry-Bulb)
Boston, Massachusetts	5,634	9
Chicago, Illinois	6,155	0
Cincinnati, Ohio	4,410	6
Denver, Colorado	5,524	1
Des Moines, Iowa	6,588	-5
Detroit, Michigan	6,232	6
Duluth, Minnesota	10,000	-16
Indianapolis, Indiana	5,699	2
Kansas City, Missouri	4,711	6
Milwaukee, Wisconsin	7,635	-4
New York, New York	4,871	15
Omaha, Nebraska	6,612	-3
Philadelphia, Pennsylvania	4,486	14
Portland, Oregon	4,109	24
Salt Lake City, Utah	6,052	8
Seattle, Washington	4,424	27
Washington, D.C.	4,224	17

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* Temperature equalled or exceeding during 97½% of the total hours from December through February.

unit of electricity sacrificed, it is estimated that five to seven units of thermal energy available for district heating. This conservation advantage, coupled with the use of solid waste as the primary energy source, may allow a dual purpose plant to supply very competitive thermal energy to a customer.

Distribution Systems

The thermal transmission and distribution system must be capable of conveying thermal energy to consumers economically and efficiently. The final choice of a piping system to carry the transport media depends on the space heating and cooling requirements, the service hot water requirements, the transport media (chilled water, hot water or steam), and on total cost consideration. A number of major considerations are involved in the decision on the piping system to be used to transport the the thermal energy.

MARKETING THERMAL ENERGY

Steam and hot water are versatile heat transfer fluids usable in a wide variety of application such as:

- Industrial process steam;
- Space heating, including district heating;
- Domestic or service hot water;
- Cooling through mechanical or absorbtion chillers;
- Generating electricity using steam turbines;

The specifications for steam and hot water recovered from solid waste will depend entirely on the needs of the market. The following items are important in assessing steam markets:

- Proximity to customers - A generating facility must have a nearby market because thermal fluids cannot be economically transported long distances. In congested areas, expensive pipeline installation may further restrict this distance.
- Value - The cost at which the steam or hot water is delivered must be competitive with the cost of the customer's alternative energy sources.
- Quantity - Price is affected by the ability of the steam or hot water plant to supply amounts of energy which are compatible with the customer's needs. If supply is guaranteed to the customer and peak loadings cannot be met entirely by burning refuse alone, then standby, fossil fuel-fired boilers will be needed and the price correspondingly increased.
- Operating schedule - The producing facility must set up an operating schedule that conforms to that of the customer. This

affects the price of the steam or hot water as well as the existence of the market itself.

- Quality - The temperature, pressure, and saturation at which the steam or hot water is produced must be within the limits acceptable to the customer according to the contract. Variations from this norm could seriously affect the price of the steam or hot water.

- Reliability - If service is to be non-interruptible, contingency plans should be made when the resource recovery unit is out of service.

- Timing - This aspect can seriously affect the thermal plant and the expected revenues. Unanticipated delays in construction of the facility could force the steam or hot water customer to secure another source.

- Diurnal and seasonal fluctuations in demand - Refuse-fired generators are best suited to generating a constant level of output; if variations in demand do exist, they should be relatively predictable.

Industrial Markets

For municipalities, there are many reasons for seeking to involve local industries in waste-to-energy projects. From a solid waste disposal perspective, industries may be able to purchase steam or hot water from a facility at very attractive prices, depending on the nature of their existing boilers and energy production system. This could result in a waste-to-energy project with less expensive tipping fees than otherwise would be possible. In addition, from an economic development perspective, cities are also interested in aiding industries to reduce their reliance on costly foreign energy sources, to become more efficient and to encourage their expansion in that community. Industrial participation in a waste-to-energy project not only solves a specific waste disposal problem, but also provides a greater opportunity for the region's waste, energy and capital resources to be reinvested into the local economy.

Industries are finding more and more reasons for participating in a waste-to-energy project. These reasons include:

- Rising energy costs;
- Energy supply shortages (fuel and electricity);
- Tax benefits;
- Capital cost savings;
- Reduction in operations problems of energy production; and
- Disposal of their own industrial wastes.

The sum total of these factors has resulted in attractive paybacks for industries pursuing such projects. The ROI (return-on-investment) hurdle rates for industries considering such participation are decreasing and some firms are seeing these projects as a way of gaining an important competitive edge in energy-intensive industries. Industries primarily view these projects as an alternative energy source to meet their large energy

demands. The principal types of industry that offers the best compatibility with waste-to-energy projects are as follows:

SIC Code	Industry
20	Food and kindred products
21	Tobacco products
22	Textile mill products
23	Apparel and other textile products
24	Lumber and wood products
25	Furniture and fixtures
26	Paper and allied products
27	Printing and publishing
28	Chemicals and allied products
29	Petroleum and coal products
30	Rubber and misc. plastic products
31	Leather and leather products
32	Stone, clay, and glass products
33	Primary metals
34	Fabricated metal products
35	Machinery, except electric
36	Electric and electronic equipment
37	Transportation equipment
38	Instruments and related products
39	Miscellaneous manufacturing

Thermal energy can be marketed in two ways: as a guaranteed supply (uninterruptible service) or as a limited supply that requires a back-up system (interruptible service). The pricing structure will vary in accordance with the type of service offered.

In the first case, the resource recovery system provides a complete and reliable supply of steam or hot water and assumes the responsibility of producing thermal energy and back-up sources if there should be an interruption in the production from solid waste. If the resource recovery system is supplying steam or hot water that the customer does not have the capabilties of producing, then it must guarantee the reliability of supply. When the resource recovery system's costs go up, so does the value of the energy it is selling. This steam or hot water has a value equivalent to what the customer would have to spend to produce it himself. In the second case, the customer buys all the steam or hot water produced from solid waste, and assumes the burden of producing additional steam or hot water in the event that this supply is interrupted or is not adequate to meet its demand. In this case, the value of the steam or hot water is necessarily lower in that it is limited to the value of the fuel saved by the customer. At the same time, the development agency assumes less risk and responsibility.

CONSTRAINTS AND CONSIDERATIONS

A major constraint in selling thermal energy based on municipal solid waste as feedstock is that the generation of steam or hot water in a municipal refuse incinerator is not easily varied to meet load conditions. In cases where the generating value of the solid waste exceeds the demand, the plant must be equipped with a boiler by-pass flue or steam-condensing equipment. Conversely, when the demand for steam or hot water exceeds the supply, the plant must be equipped with an auxiliary fuel-firing

system if its customer service contract(s) demands an uninterrupted supply of steam. Experience has shown that the additional cost of this equipment is only justified where firm markets can be secured for all the steam or hot water produced. To date such markets have not materialized to any extent.

Despite the apparent incentives for utilizing waste-to-energy processes with a large customer pool (e.g., district heating systems), actual implementations have only been moderate. The Nashville facility, mentioned earlier, is the oldest and most notable fully operational example. The largest steam loop in the procurement phase is a 3,000 TPD system to be located at the Brooklyn Navy Yard. This $250 million facility will generate steam for the lower Manhattan steam loop. A 3,300 TPD RDF plant in Detroit may be financed in late 1985. Also, smaller systems, employing steam from modular incinerator units to heat and cool universities and other institutions, are in place or proposed in various locations throughout the country. A specific example can be found in New Hampshire, where the Lamprey Regional Solid Waste Cooperative is operating a $2.5 million facility that supplies steam to the University of New Hampshire.

There are a number of factors which account for this relative scarcity of resource recovery-district heating systems. One of the most apparent is the extremely high cost of installing new steam distribution pipelines in addition to the highly capital intensive resource recovery plant. The former factor effectively limits the growth of such systems to places where steam lines are already in place or where urban renewal or new construction facilitates their placement.

This limitation is significant because existing steam lines are found primarily in densely populated, downtown areas which are incompatible with the concept of heavy refuse truck traffic or disposal facility siting. Furthermore, downtown areas usually face stringent air pollution standards which may place further constraints on the siting of new or additional point sources of pollution. It is unclear whether combustion of solid waste-RDF is worse for the atmosphere than conventional fuels. However, federal guidelines allow the exemption of resource recovery facilities from meeting the offset requirement in critical nonattainment areas. Final approval of this exemption rests with each state, but the potential clearly exists for encouraging urban resource recovery sites.

In cities where steam lines are in place and operated by investor-owned utilities, there are certain problems. Many of these problems stem from the fact that utilities' heating systems are usually under the control of state regulatory commissions. Consequently, state law often requires that the previously described potential fuel savings from the use of refuse-derived steam have to be automatically passed through to consumers. This destroys much of the utility's incentive for incorporating waste-to-energy processes.

Now, the high cost of fossil fuels has forced energy consumers to take another look at district heating and cooling and cogeneration and a variety of Federal and state programs are actively encouraging this trend. The trend is significant for resource recovery facilities interested in district heating systems because they are in many respects ideally positioned to cogenerate; solid waste is combusted to produce high pressure/temperature steam for the generation of electricity for in-house use and/or sale to the grid and then the turbine's back-end steam can be sold for distribution to district heating systems. In situations where the same utility controls both markets, overall ease of system implementation is generally further increased. Consequently, the status of the various Federal and state programs affecting cogeneration are of prime importance to the marriage of resource recovery and district heating.

The design of a resource recovery program as a cogeneration/district heating venture also offers other significant benefits. From the utility owned district heating system's perspective, there are side benefits from participating in a resource recovery/cogeneration project. If a utility does not have to raise capital to expand capacity, its cash flow position is improved, and ratepayers receive an indirect relief from costs of capital formation. Ratepayers also do not have to bear the full burden of the costs of any unscheduled outages of the facility, as it is not included in the utility's rate base.

Compared with single-market projects, cogeneration project implementation should result in expediting several phases of project development. Early project development is often hindered because industries are reluctant to assume all of the risks associated with being the sole market for the full term (20 years) of a project. Cogeneration offers industries flexibility to adjust future energy purchases to changes in demand. This flexibility could be a key inducement for many industries to participate in a project.

Economic development planning could be phased with solid waste disposal goals if resource recovery planning is structured properly. Cities initially develop resource recovery to solve solid waste problems; few municipalities have related waste issues directly to economic growth. However, marketing of resource recovery's products could be targeted to stimulate economic development. For example, a city could sell energy to an industry which would like to expand but is unwilling to make capital investments on boilers to meet its growth in energy demand. In such a case, the city's supply of energy through a district heating system could be a major push toward the decision to expand one industry or relocated another. Careful selection of markets is, therefore, key to both securing a project's financial viability and to maximizing economic development impact.

The above factors can be used to identify thermal markets which may have economic development potential. As energy markets expand to include several industries, a city should use these factors to identify which markets would have the maximum economic development impact.

Economic development planning can be phased with regionalized solid waste disposal goals if resource recovery planning is structured properly. Cities or groups of towns initially develop resource recovery to solve solid waste problems; few municipalities have related waste issues directly to spurts of economic growth. However, the marketing of a resource recovery plant's products could be targeted to stimulate economic development. The supply of energy through a small thermal systems can be a major push toward the decision to expand an industry or institution.

Thermal customers with an expensive inefficient system, or anticipated critical energy need are most likely to receive economic benefits from the purchase of resource recovery energy. Supply of energy to meet a critical need may help existing markets stay in business (or expand) or help institutions remain cost competitive.

IDENTIFYING A MARKET

Waste-to-energy projects in small- and medium-size communities generally have a limited number of potential product markets. Because thermal energy is typically a highly valuable and saleable product, it is advisable to identify and establish contact early with industries with, ideally, two characteristics: (1) a user of substantial quantities of process steam and/or hot water, (2) internal generator of combustible wastes. For

the latter, rising disposal costs may represent a substantial incentive to join a municipally-sponsored waste-to-energy venture.

Although projects to date are perceived to be dominanted by single-customer industry markets, no technological barrier prevents steam and hot water sales to multiple customers involving industrial, commercial and institutional users. Such options may be particularly attractive in cases where a waste-to-energy facility forms an early and integral part of an industrial park development. In this instance, the location of the facility and its energy products can be planned in coordination with the park's occupants, an approach which is likely to enhance the marketability of the sites under a banner of energy self-sufficiency.

Before initial gestures are made to potential customers, the anticipated waste stream must be characterized as accurately as possible. Although existing studies of various areas of the country are useful guide points, a systematic weighing of the local waste stream should be evaluated to identify any major deviations from the norm. When a satisfactory estimate of waste quality and quantity is achieved and translated into expected energy value, market contacts should be initiated.

For potential energy product users, substantial information is needed in order to determine if that potential can be realized. The required data includes: description of energy production facilities; future energy requirements; types and amounts of fuels consumed; availability of on-site space; energy demand curves; value of alternative fuel/energy sources; economics of present energy production; adaptability to integrating the use of either solid fuels or steam and electricity; overall interest in using new energy sources; and financial stability to insure product purchase under long-term contractual arrangements. An efficient means of obtaining this information is through a survey questionnaire. This form can be mailed to all potential markets and followed up with a phone call or personal visit to the most promising respondents. Once this information is gathered, an evaluation will be required to determine whether one or several installations can provide the required consumption levels for the different energy outputs.

The following criteria should be used to select entities for further consideration as markets for recovered energy:

- Technical Feasibility. The use of recovered energy by the market is not precluded by technical constraints.

- Energy Demand. The energy demand of the market is sufficient to consume all or a significant amount of the solid waste generated in the landfill service area where it is located.

- Load Uniformity. The seasonal variation in the energy demand of the market is insufficient to cause a significant loss of revenues for energy sales from a resource recovery facility.

- Location. The market is located sufficiently near the waste generation centers to prevent high transportation costs but away from residential areas.

COMMITMENT STAGE

With potential markets identified, a closer look at the processing technologies available to meet market specifications should come next. Technological risks, system capital and operating costs, alternative facility sites, overall system logistics and costs, financial and management alternatives, required legislation/authority forming, and budget requests should be evaluated. As this other information is developed, a further refinement of market development should take place prior to any decision on project "go/no-go." The development of more detailed documents such as "Memoranda of Understanding," "Letters of Intent to Bid for the Purchase of Recovered Products," or actual "Invitation to Bid for Recovered Products" should then be undertaken.

"Letters of Interest" or preferably "Letters of Intent" are essentially advance contractual purchase commitments. The objective of the advance commitments is to go beyond a general statement of willingness to consider the future purchase of recovered products if and when they become available. Financial planning for resource recovery, either on a public or private basis, must be based on a well-defined revenue stream. In this way, some of the economic uncertainty is removed as a tradeoff against technical uncertainty.

Letters of Intent (LOI) obtained for products to be recovered from a public-owned facility must be structured differently than for a privately-owned facility in order to be within the general legal framework of public bidding laws. As such, the LOI for a public-owned facility becomes "a letter of intent to bid for the purchase of the recovered product." Later, the competitive bidding process can take place for the actual sale of the recovered product, or the LOIs obtained as part of the initial feasibility analysis can be assigned to a private organization if the recovery is to be done by this mode.

An LOI should include the following elements:

- Delineation of Product. The LOI should contain specifications for the energy product to be sold.

- Quantities. The quantity of the energy product to be delivered should be specified. This could involve a "put or pay" clause in the LOI.

- Delivery Schedule. A delivery schedule for the specified quantity of the energy product should be agreed upon in the LOI. This is particularly critical for steam and electricity.

- Duration. The duration of a LOI agreement should cover the planning and procurement stages of a resource recovery facility. The LOI agreement for energy products should last the planned life of the facility (usually 20 years) since the revenues for energy are critical for the economic viability of the project.

- Specification. The LOI should agree on specifications for the recovered energy product which are reasonable for both the user and seller.

- Pricing Structure. The pricing should allow for escalation in relation to alternative fuels or sources of energy.

- Assignability. The LOI should be assignable in case the actual operation of the resource recovery facility is performed by an entity other than the one involved in negotiating the LOI.

- "Out" Clauses. In the event the implementation of a resource recovery project is delayed, the LOI should not bind the purchaser of energy. A clause should be included allowing termination of the LOI if substantial progress toward implementation is not made.

In negotiating prices for energy products (steam, hot water, chilled water, and electricity), the goal is to establish a fair and equitable price for both the producer and the user. This price should provide an incentive to produce the energy as well as use it. Hence, the price should lie somewhere between the net cost of production and the net value of the energy to the user, both of which are subject to the uncertainties of any long-term forecast. Also present is the problem of apportionment in applying the operating and maintenance costs of the various items when there is more than one product.

As the project development process proceeds, "Letters of Interest" or "Letters of Intent" which sufficed for purposes of financial planning must be transformed into formal, legally-binding contracts.

CONCLUSION

The central importance of market guarantees in implementing a resource recovery system cannot be overstated. Early identification of potential energy customers and involvement of the same throughout the project development process are cornerstones to a successful project. To date, industrial steam has proven to be the most marketable energy product produced by waste-to-energy facilities. Industries which both consume large quantities of process steam and internally generate large volumes of combustible wastes will typically be the most promising candidates under current conditions.

However, as the cost of energy continues to rise, thermal energy from refuse-burning resource recovery projects will be gaining more attention and this will greatly depend on the amount of existing district heating and cooling systems. The more retrofitting required to interface with a waste-to-energy plant, the greater the amount of capital involved and hence higher tipping fees. It should be noted that when new district heating and cooling systems are being planned, retrofits may be required of existing individual energy systems regardless of the initial energy source (i.e., coal, oil, or refuse). Therefore, the costs of a DHC system will be incurred regardless of whether a refuse-burning resource recovery project is involved. The costs of the retrofits may then be part of an economic development program, and/or eligible for grants from Federal or state governments. The project economics are greatly affected by the cost of fuel displaced. If fuel oil increases in cost, the economics of a refuse-burning resource recovery project with DHC become much more attractive. Also, as waste disposal landfills are closed and the approved sites become located further from the waste generators, project economics will improve and more thermal based projects implemented. There is natural alignment between waste-to-energy and thermal markets, particularly district heating and cooling projects, reflected in the implementation of the 56 projects listed at the beginning of this paper. This alignment stems in part from the concern and responsibility of city administrations for both solid waste and

energy problems. This awareness presents the opportunity for bold action to solve both problems in the larger context of economic development.

Resource Recovery Systems Vendors and Technology

Kenneth C. O'Brien

E. Larry Beaumont

R.W. Beck and Associates
Denver, Colorado

RESOURCE RECOVERY SYSTEMS

VENDORS AND TECHNOLOGY

Kenneth C. O'Brien
E. Larry Beaumont

R.W. Beck and Associates
Denver, Colorado

Introduction

Today there are more than 60 solid waste resource recovery plants operating in the United States, processing municipal solid waste (MSW) to generate some form of energy. These plants process about five percent of the 400,000 tons of MSW produced daily in the United States.

The concept of waste-to-energy is not particularly new, with a few early attempts being made around the turn of the century. Europeans began building solid waste resource recovery plants in earnest in the 1950's.

There are more than 300 operating solid waste resource recovery facilities in Western Europe. Many of them have been in operation for a considerable period of time, thus giving Europeans an edge in experience.

It has been proposed that the scarcity of land and high cost of energy in Europe has encouraged the development of solid waste resource recovery projects. However, it is reported that there are some other factors which might differentiate development in Europe as compared to the situation here. First, the city or agency implementing the project is likely to have large in-house engineering and project development staff capabilities. Second, the plants are staffed with a large number of highly qualified personnel as compared to the minimum staff orientation of most United States projects. This is an accepted European practice. Third, the public is more inclined to accept higher disposal costs and close-in plant locations than in the United States, provided the plant will serve as a long-term solution.

Most of the successful European technologies are available in the United States. In addition, there are several American technologies which work well when properly designed, constructed, operated and maintained.

The solid waste resource recovery program got off the ground in the United States in the early 1970's. Early projects, such as Chicago Northwest, Nashville Thermal and Saugus, Massachusetts, have about ten years' experience. While some projects experienced problems, most problems could be attributed to misapplication or misoperation of specific types of equipment. Most of these

problems have been eliminated in recent years. As long as facilities are designed, constructed, operated and maintained by qualified professionals, it can be said that resource recovery technology works well indeed.

It is important at this point to distinguish between the terms "vendors" and "technology." To do this, let's look at Figure 1, which shows the elements of a typical solid waste management system. Note that a solid waste resource recovery plant is only one part of a comprehensive, integrated management system. Such a plant is compatible with local recycling efforts, because recycling enhances the quality of the solid waste fuel entering the plant. Also, a landfill will always be required to dispose of residue from the the plant and to accommodate bypass waste when the plant is out of service. As implied by Figure 1, this presentation will consider only resource recovery plants which produce energy. The vendors and technology we will talk about are those manufacturing and marketing equipment for service within the dotted box on Figure 1.

Figure 2 shows a blowup of the box from Figure 1. This box contains the various "technologies" involved in a resource recovery plant. Yet, when most people refer to "resource recovery technology," they often mean only the incinerator/boiler <u>part</u> of the overall plant technology. This is because all of the other technologies tend to revolve around the incinerator/boiler. You might say that the competition for a resource recovery project is usually based on the incinerator/boiler technology. For that reason, this discussion focuses on types of incinerator/boilers.

By now, you've probably noticed that I have avoided the term "vendor." The reason for this will become apparent a little later. First, we'll stay with "technology" and look at major categories of resource recovery incinerator/boiler technology.

Technology - Major Approaches

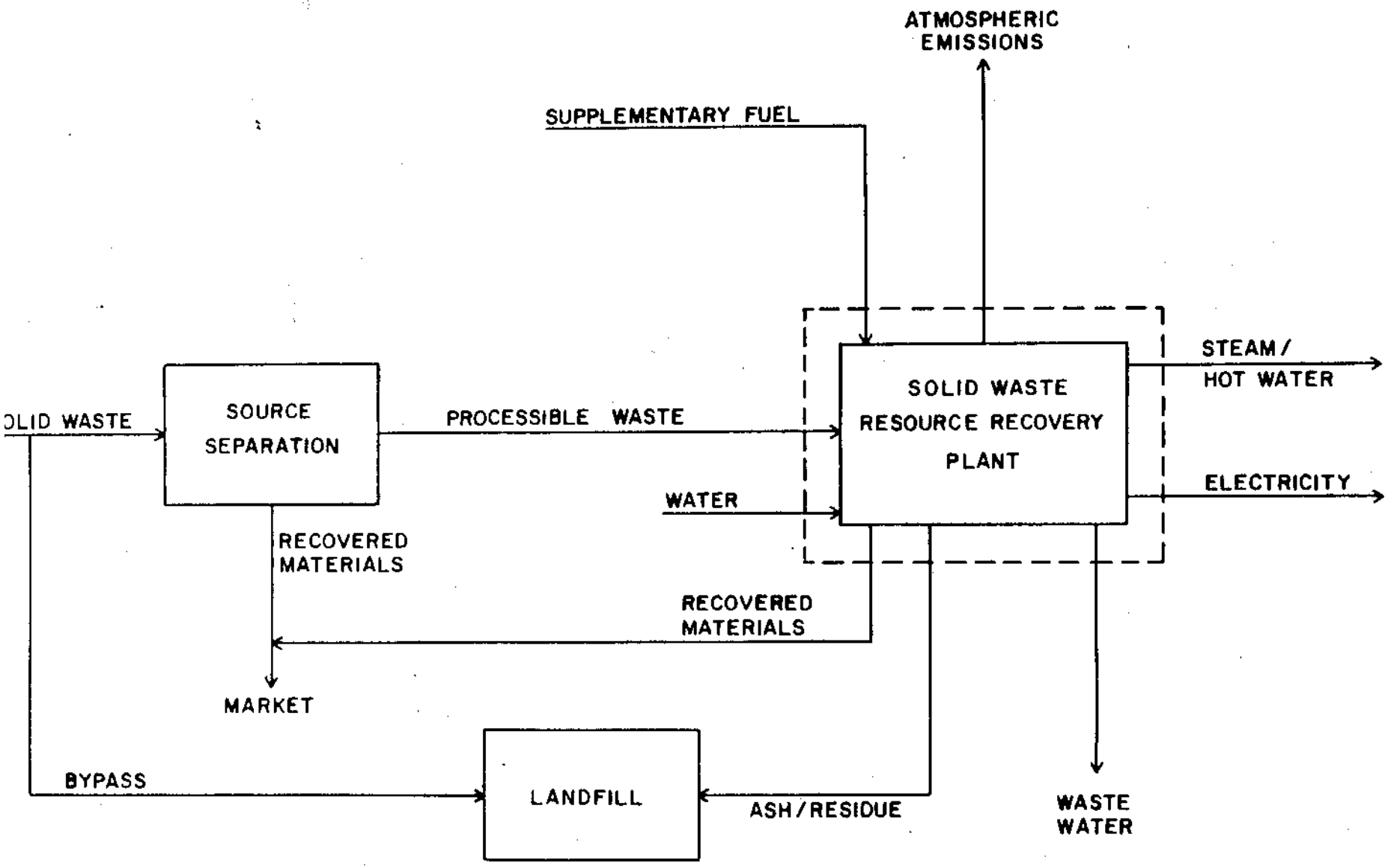
There are five major approaches to thermal conversion of solid waste:

1. Large-scale mass burn
2. Small-scale mass burn
3. Prepared fuel or refuse-derived fuel
4. Pyrolytic conversion
5. Fluidized bed combustion

This presentation will focus on the first three because, if you were to build a plant today, the chances are you would use one

TYPICAL SOLID WASTE MANAGEMENT SYSTEM

FIGURE I



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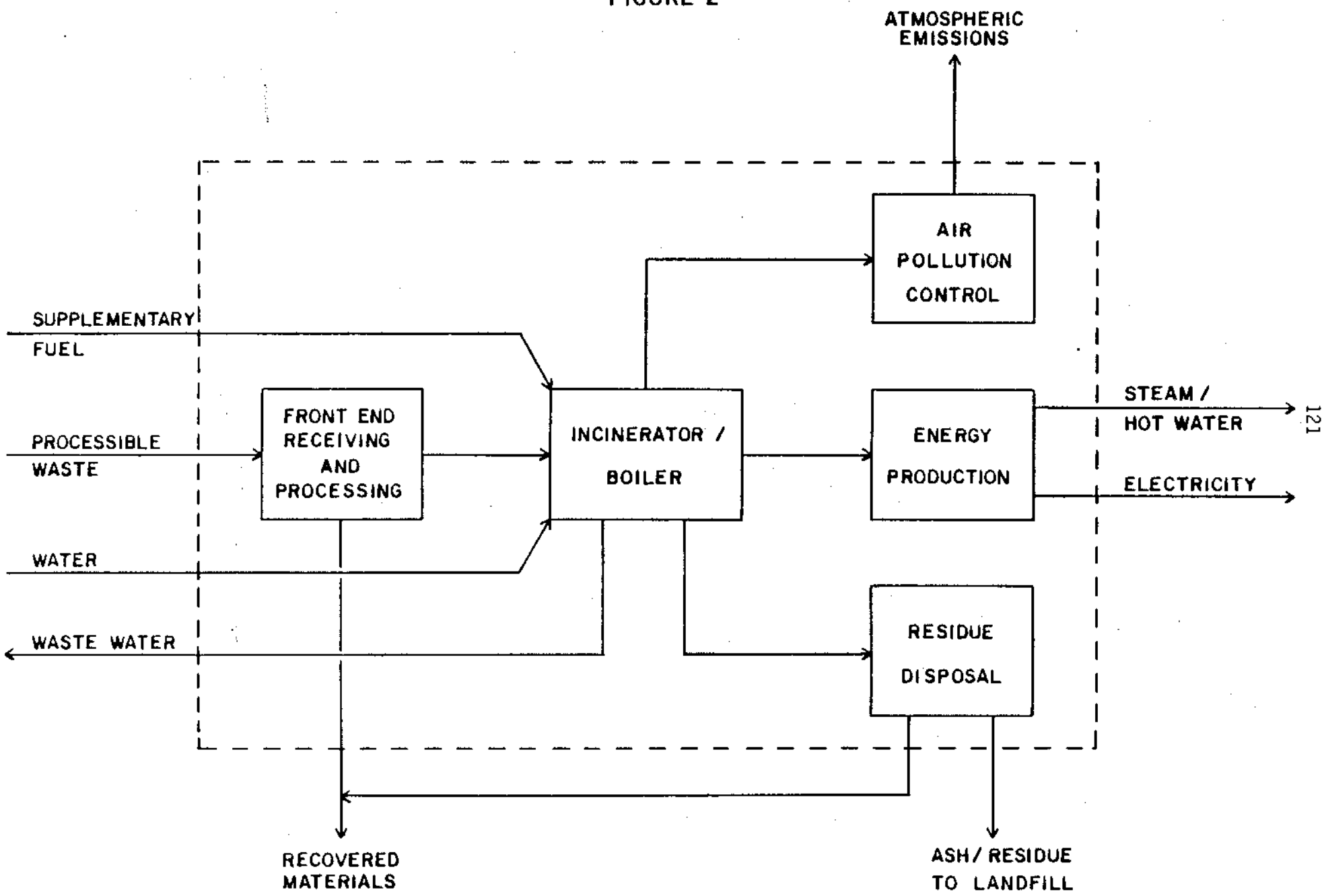
TYPICAL SOLID WASTE RESOURCE RECOVERY PLANT

FIGURE 2



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of these three. The remaining two, pyrolysis and fluidized bed technology, are not considered "commercially available" at this time, although they may be more developed some time in the future.

A typical large scale mass-burn system is shown in Figure 2. These systems are normally designed for systems handling more than 500 tons per day (TPD), although similar characteristics may be found in a group of medium-sized units in the 200 to 500 TPD range. For simplicity we have included systems above 200 TPD capacity in this category. These units are usually field-erected, which distinguishes them from smaller systems.

Figure 4 shows a typical small mass-burn system. This type of unit is often called "modular," because it is built in the shop and shipped to the site in only a few large, easily mated pieces. Please note that these classifications are somewhat arbitrary, and there are hybirds which possess features of both categories.

The third major approach is the prepared fuel system shown in Figure 5. By pre-processing the waste, a conventional coal-fired boiler with stoker feed, like the one shown in Figure 6, can be utilized.

There are many permutations available on the market, such as combinations of refractory versus water wall, integral unit versus waste heat boiler, starved air versus excess air combustion, and so on. In fact, there have been volumes written documenting all of the various details of incinerator/boiler technology. But for now, this gives you an overview of what is involved with technology.

Figure 7 shows some of the technology names you are likely to hear. This list is not all-inclusive, but it represents a large majority of leading technologies.

Vendors and Procurement

Armed with a classification of technologies, the question becomes, "Who sells the technology and who will be calling on you?" The answer to this question depends on how you will purchase the plant and who will own it.

Under the traditional Architect/Engineer (A&E) approach, where you would take bids on equipment and construction contracts while retaining ownership of the facility, you could expect to deal directly with the technology manufacturers shown in Figure 7.

However, there are two other scenarios where you might deal with someone other than the manufacturer:

1. Turnkey design and construction package, while you own and operate.

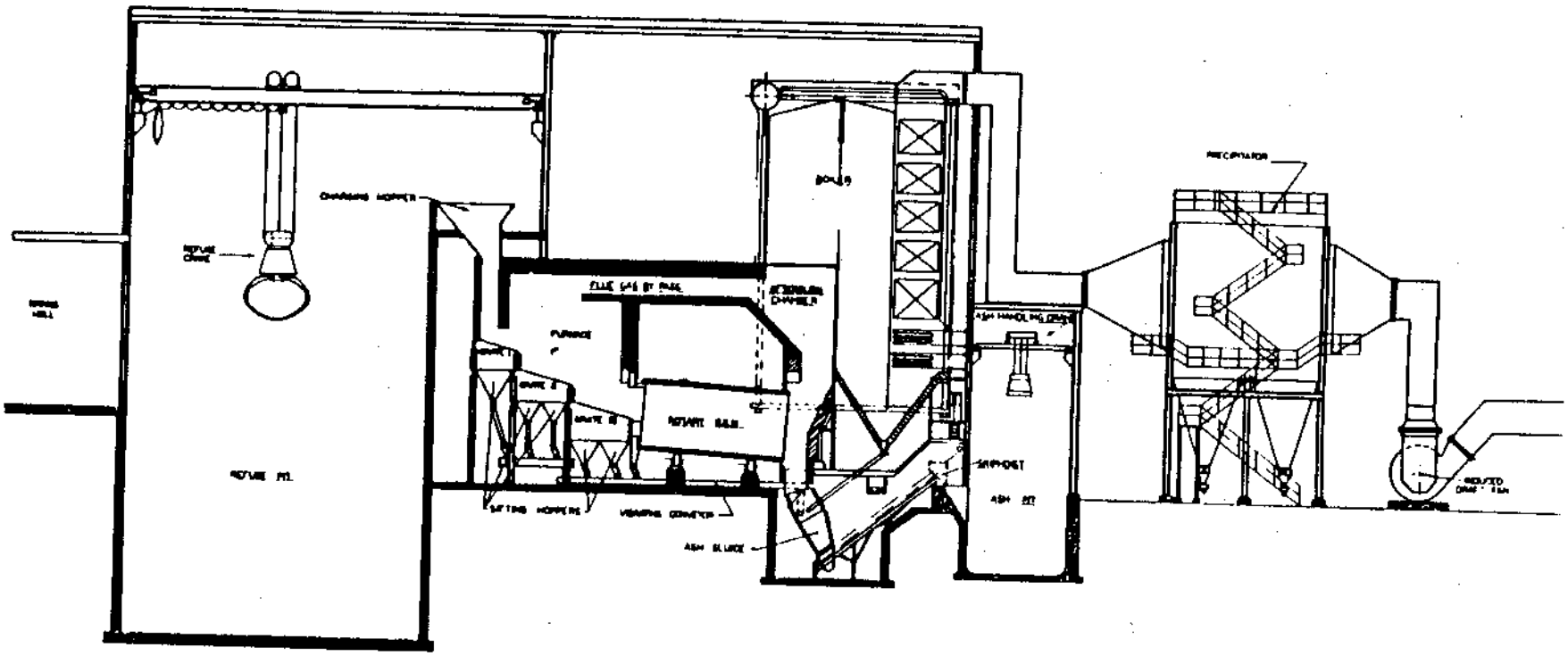

CHARGING HOPPER
REFUSE CRANE
REFUSE PIT
FLUE GAS BY PASS
FURNACE
ROTARY BASIN
SITTING HOPPERS
VIBRATING CONVEYOR
ASH SLUICE
BOILER
ASH HANDLING CRANE
SKIPHOIST
ASH PIT
PRECIPITATOR
REDUCED DRAFT FAN

FIGURE 3

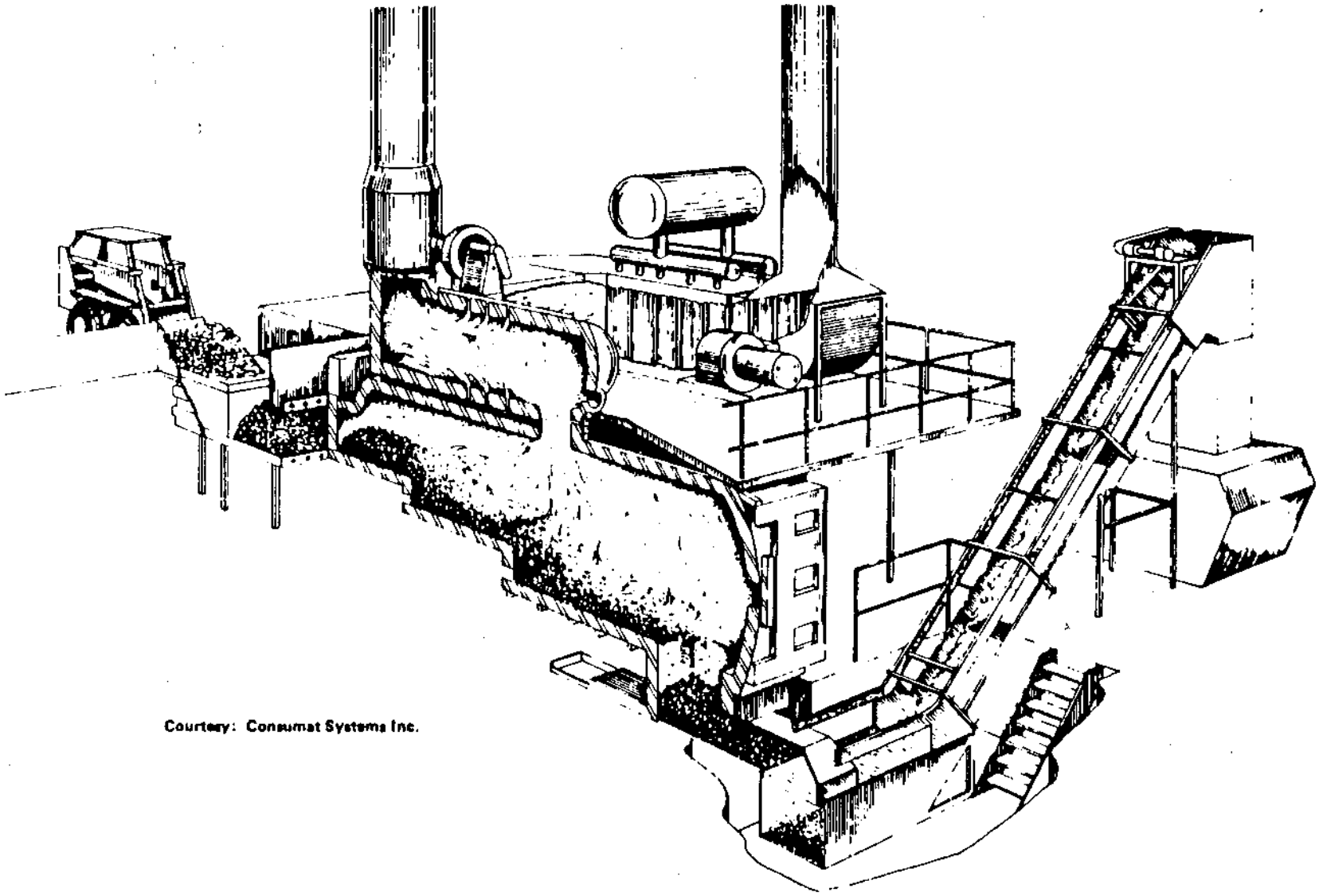


FIGURE 4

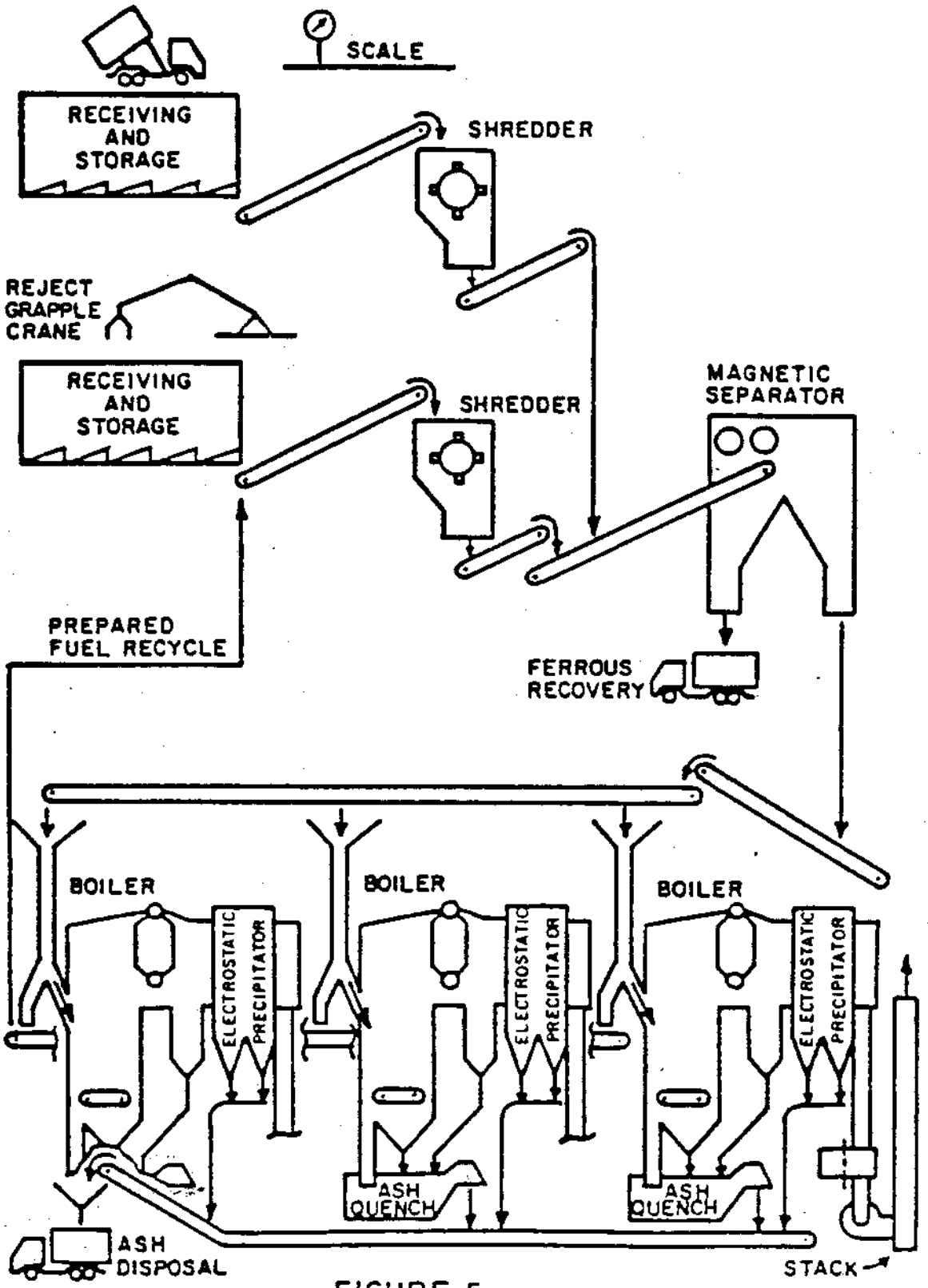
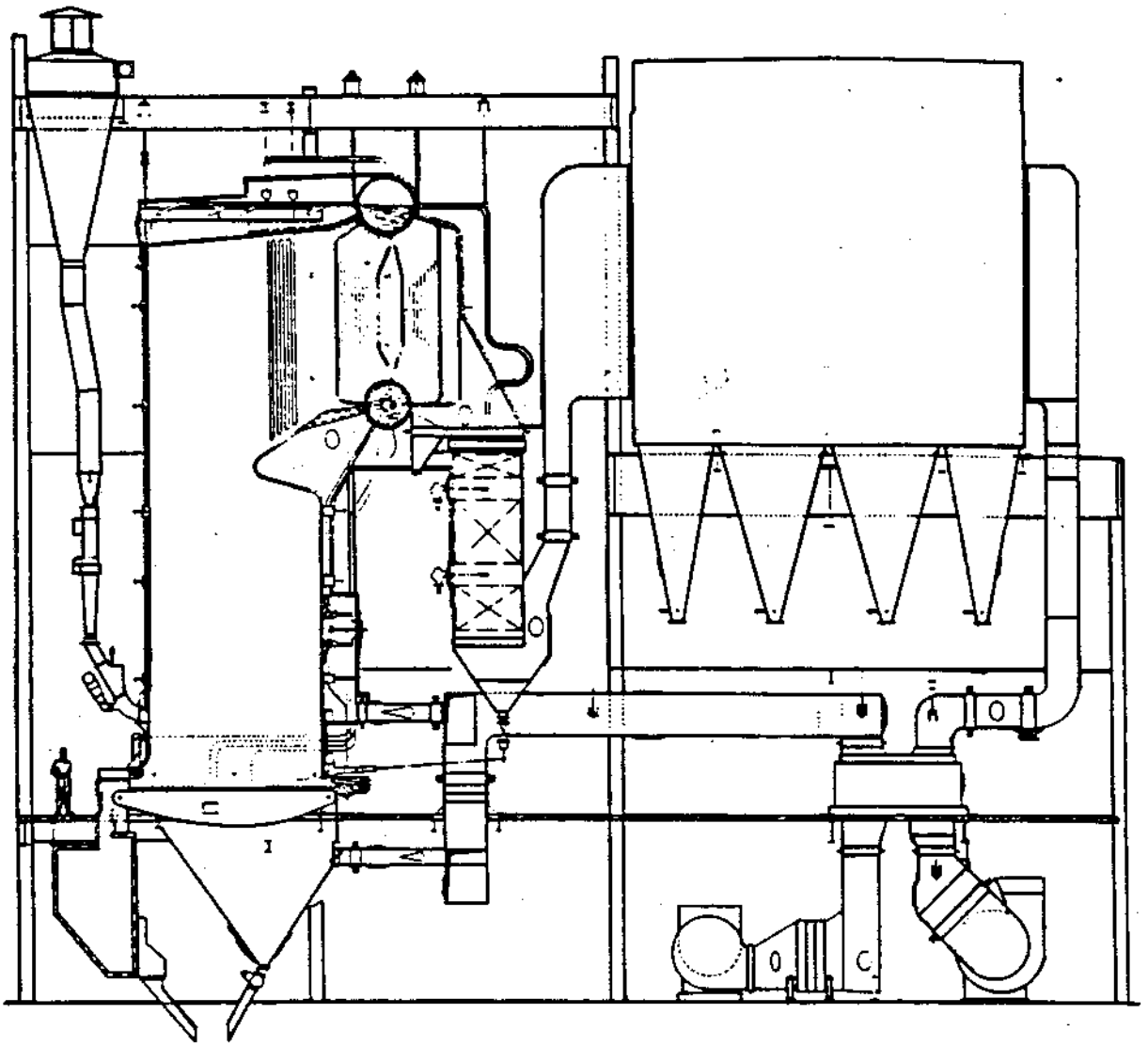


FIGURE 5
SIMPLIFIED FLOW DIAGRAM

RDF INCINERATOR BOILER



Side view of refuse fired boiler

Figure 6

FIGURE 7

REPRESENTATIVE TECHNOLOGIES

LARGE MASS BURN	SMALL MASS BURN	PREPARED FUEL
Martin	Consumat	Babcock & Wilcox
Seghers	Cadoux	Combustion Engineering
VKW	Clear Air	Foster Wheeler
Von Roll	Vicon	Riley Stoker
Volund	Basic	
Detroit Stoker	O'Connor	
Widmer & Ernst		
Stein		

FIGURE 8

REPRESENTATIVE VENDORS

LARGE MASS BURN	SMALL MASS BURN	PREPARED FUEL
Ogden Martin (Martin)	Thermo Reduction (Consumat)	
Katy-Seghers (Seghers)	Payne & Keller (Cadoux)	
REF-FUEL (VKW)	Westinghouse (O'Connor)	
Signal Environmental Systems (Von Roll)		
Waste Management (Volund)		
Clark Kenith (Detroit Stoker)		
Blount (Widmer & Ernst)		
Trans-Energy (Stein)		

2. Full service package for design, construction, operation and ownership.

The vendors for these packages include a certain type of technology, but also may include other team members, such as a design engineer, investment banker and legal counsel. Figure 8 shows the "vendors" which use certain "technologies" for their teams. (Vendors who provide full design/own/operate packages might more accurately be called "systems contractors.")

So how you deal with "vendors and technology" will depend on your ultimate means of procurement and ownership.

Remember that there is more technology involved with a resource recovery plant than just the incinerator/boiler companies. Here's a brief look at some of the other technologies:

1. Front-end processing: Combustion Engineering, Raytheon, Tricil, Teledyne
2. Air pollution control: Belco, Western, Teller
3. Residue disposal: Detroit Stoker, United Conveyor, Beaumont Birch
4. Energy Production
   a. Waste Heater Boilers: Deltak, IBW
   b. Turbine-Generators: General Electric, Westinghouse, Turbodyne, Terry, Elliott

What Constitutes "Proven Technology?"

In more conventional industries, such as coal-fired steam-electric power plants, one would expect to verify proven technology by visiting existing plants which have the following characteristics:

1. In continuous operation at least 20 years
2. Located in the United States
3. Similar fuel
4. Excellent performance
5. Verifiable operating statistics

Unfortunately, in the real world of solid waste resource recovery, all of the above criteria are seldom available, although the American operating experience improves with each day. Until we have plants in operation for 20 years in this country, we must rely on the experience which is available, both American and

European, and on our best professional engineering judgement. As plants are built, empirical rules are developed, based on actual experience, to judge a particular technology.

Engineering review of a technology may involve the following steps:

1. Compliance with design criteria:
   - redundance
   - completeness
   - safety

2. Review of basic design concepts and applied theories:
   - mass balances
   - flow diagrams
   - material selection
   - general arrangement

3. Compliance with empirical rules:
   - grate mass loading
   - heat release rates
   - tube temperatures

4. Review of operating installations. How similar are they with respect to:
   - solid waste fuel
   - environmental requirements
   - operating and maintenance staff requirements
   - size

   How long have they been operating? What do operators say? How will the licensor be involved? What do the operating records show?

For most projects, a general category of acceptable technology will be selected before procurement. A detailed review of the specific technology and vendor will be made before a contract award is made. A third review may be made in connection with the financing.

Basically, the more that is known about a technology, the less risky the project will be. Remember that technology is changing very quickly. It is important to confirm that what you checked out and deemed proven is what you actually get when the plant is built. Seemingly minor design changes increase the possibility of problems sometime in the future. This is why you will want to rely heavily on at least one, and possibly two, professional technical staff persons or consultants. You will be given the best in technical opinions, but ultimately you will decide what constitutes proven technology.

The Mayor's Role

Does the mayor need to get so involved with vendors and technology? It's rather difficult not to get involved; if you have not already been contacted by technology manufacturers and system vendors, you will be.

Before it all starts, the Mayor should develop a game plan for dealing with vendors and technology, involving council members, staff, consultants, citizens' advisory committees, etc. The goal should be a well-planned, united posture to handle the numerous contacts you can expect. If this if done, your community will gain a reputation for consistency, fair treatment, honest and open competition, and a defensible selection methodology.

In fact, the entire solid waste industry will gain status and acceptance in the public's eye as cities prepare consistent, open strategies for dealing with selection of vendors and technology.

Environmental Issues in Resource Recovery: An Overview

Andrew E. Mishkin

Beveridge & Diamond, P.C.
Washington, D.C.

ENVIRONMENTAL ISSUES IN RESOURCE RECOVERY--AN OVERVIEW

Andrew E. Mishkin
Beveridge & Diamond, P.C.,
Washington, D.C.

I. INTRODUCTION

Resource recovery facilities are subject to numerous and extensive environmental regulatory requirements. For the most part, those requirements are not specifically directed at resource recovery as such. Rather, resource recovery facilities are regulated under various more general environmental programs, including those relating to industrial and municipal incinerators, waste handling facilities, and many others.

Thus, resource recovery facilities generally are required to obtain state or federal permits relating to air emissions, water discharges, and operation of solid waste management facilities. In addition, it may be necessary to obtain separate permits or show that arrangements have been made for a landfill for disposal of ash residue, nonburnable waste, and bypassed waste. The site for the facility also may bring into play a number of other permitting requirements. Finally, where significant federal action is involved or where state statutes require, an environmental impact statement ("EIS") must be prepared and subjected to public review and comment.

This lack of a specific regulatory framework for resource recovery probably results in less stringent requirements in a number of areas than would be imposed under a comprehensive program geared specifically toward resource recovery facilities. On the other hand, as is obvious from the above listing of regulatory requirements, it also results in overlapping and perhaps more complex regulatory requirements for resource recovery.

This paper presents an overview of the major environmental regulatory programs that may affect a resource recovery facility, including air permits, water permits, issues relating to landfills and hazardous waste, and other concerns. Although both federal and state regulatory programs have an impact on resource recovery, the federal programs are in many cases dominant, and therefore this paper primarily addresses them. However, the environmental compliance program for a resource recovery facility must take into account applicable state requirements as well.

II. AIR PERMITS

Air pollution issues are generally regarded as the most important concerns in implementing resource recovery. The federal requirements in this area are contained principally in the Clean Air Act (42 U.S.C. §§ 7401 *et seq.*). A summary of the overall statutory scheme is necessary for an understanding of specific requirements that are likely to apply to a resource recovery facility.

A. National Ambient Air Quality Standards

The federal Environmental Protection Agency establishes specific limitations on the amount of certain pollutants allowed to be present in the ambient air, known as National Ambient Air Quality Standards ("NAAQS"). (42 U.S.C. § 7408.) These standards are not restrictions on emissions from any particular source; rather, they are goals to be achieved through a variety of means, including emissions restrictions. There are two types of NAAQS: "primary" standards for the protection of health, and "secondary" standards for the protection of welfare. (42 U.S.C. § 7409(b).)

EPA has issued NAAQS for sulfur oxides, nitrogen oxides, particulates, carbon monoxide, hydrocarbons, photochemical oxidants (ozone), and lead, and these pollutants are as a result referred to as "criteria pollutants". All other pollutants (for which NAAQS have not been established) are called "non-criteria pollutants".

EPA has divided the country into "air quality control regions," with each state consisting of at least one region and some regions covering interstate areas. The statute makes each state primarily responsible for assuring its own air quality. The principal vehicle for achieving this is the development by each state of a State Implementation Plan ("SIP") consisting of laws and regulations specifically directed to the achievement and maintenance of the NAAQS within each air quality control region within the state.

B. Hazardous Air Pollutants

In addition to the air quality standards established by EPA as described above, there is an emissions limitation program for certain hazardous air pollutants--pollutants that cause or contribute to air pollution that may reasonably be anticipated to result in an increase in mortality or serious irreversible, or incapacitating reversible, illness, and that are not the subject of NAAQS. (42 U.S.C. § 7412.) The hazardous pollutants are identified in a list published and updated by EPA.[1/] The emissions limitations, which must be at a level that provides an "ample margin of safety to protect the public health," are referred to as National Emission Standards for Hazardous Air Pollutants ("NESHAPS"). (42 U.S.C. § 7412(b)(1)(B).)

C. New Source Performance Standards

In addition to the programs described above, EPA promulgates standards for certain newly constructed stationary sources of air pollution known as New Source Performance Standards ("NSPS"). (42 U.S.C. § 7411.)

EPA has issued NSPS for refuse incinerators. (40 C.F.R. § 60.51(a).) The NSPS for such incinerators only addresses particulates. Thus, even if particulates emissions from a resource recovery facility were not subject to an

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1/ Currently, hazardous air pollutants listed by EPA with respect to certain sources are asbestos, benzene, radon 222, beryllium, mercury, radionuclides, and vinyl chloride. 40 C.F.R. Part 61.

emissions limitation under a state's SIP, they would be regulated under the federal NSPS.

Under certain circumstances, the more extensive NSPS for other types of facilities, such as electric utility generators, industrial steam generators, or sewage treatment plants, might be applicable to a resource recovery facility.

D. Prevention of Significant Deterioration

The Prevention of Significant Deterioration ("PSD") program requires maintenance of air quality in each region even if NAAQS are being met. (42 U.S.C. § 7471; 40 C.F.R. § 52.21.) The PSD program requires the classification of areas in each region as either class I (those in certain national and international parks and wilderness areas) and class II (all other areas). The achievement of PSD is to be effected through emissions limitations and other measures contained in each state's SIP. The PSD program attempts to maintain air quality by limiting the amount of additional pollution which may be introduced into any region. A project that will emit a significant amount of air pollution must obtain a PSD permit.

The permitting procedure begins with a New Source Review procedure, under which the amount of each regulated pollutant expected to be emitted is determined. One of two types of analysis then takes place, depending on whether the project is in an area where NAAQS are being achieved (an "attainment area") or not being achieved (a "nonattainment area"). Nonattainment area analysis is discussed in Subsection E, below.

In attainment areas, if the emission from a new source of any pollutant regulated under the Clean Air Act will exceed either 100 tons per year for 28 industrial categories (including municipal incinerators capable of charging more than 250 tons of refuse per day) or 250 tons per year for any other type of project, a PSD permit is required. In addition, any physical or process changes at an existing facility may constitute a "major modification" requiring PSD review. If a permit is required for any one air pollutant, the expected emissions of all air pollutants covered in the Clean Air Act must be determined. If the quantities of any of these other emissions will be in excess of the minimum rates set out in the PSD regulations, then these pollutants are also subject to PSD review.[2/] Resource recovery

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2/ The pollutants and minimum emissions rates currently included in the PSD regulations are:

Carbon monoxide	100 tons per year (tpy)
Nitrogen oxides	40 tpy
Sulfur dioxide	40 tpy
Particulate matter	25 tpy
Ozone	40 tpy of volatile organic compounds
Lead	0.6 tpy
Asbestos	0.007 tpy
Beryllium	0.0004 tpy
Mercury	0.1 tpy
Vinyl chloride	1 tpy
Fluorides	3 tpy
Sulfuric acid mist	7 tpy
Hydrogen sulfide (H_2S)	10 tpy
Total reduced sulfur (including H_2S)	10 tpy
Reduced sulfur compounds (including H_2S)	10 tpy

40 C.F.R. §51.24(a)(23(i)

facilities can be expected to generate most of the listed pollutants to at least some extent.

The PSD review results in three findings:

(1) whether NESHAPS, NAAQS, or NSPS will be violated (42 U.S.C. § 7475(a)(3));

(2) for pollutants for which a region is an attainment area, whether the projected emissions will consume more than the amount of additional pollution (for each pollutant) allowed in the region from new sources (42 U.S.C. § 7475(a)(3)); and

(3) whether the Best Available Control Technology ("BACT") for each pollutant will be implemented (42 U.S.C. § 7475(a)(4)).

The first finding involves a comparison of the projected emissions with the limitations or constraints posed by the NESHAPS, NAAQS, and NSPS programs. For the second finding, EPA is required to set a limit on the amount of additional air pollution for each criteria pollutant for each region where concentrations of the pollutant are lower than the maximum allowed under the NAAQS. This allowable additional amount is called the "PSD increment." Currently, PSD increments have been established for sulfur dioxide and particulate matter. (40 C.F.R. § 52.21(c).) Once the PSD increment for a pollutant is exhausted, no additional amount of that pollutant may be introduced into the region.

The BACT finding requires the applicant to reduce each regulated pollutant to the maximum degree achievable taking into

account energy, environmental, and economic impacts and other costs. Alternative control technologies must be evaluated and compared to the ones proposed by the applicant. The BACT for each pollutant is then expressed as an emission limitation, generally with reference to a particular method of achieving the limitation.

The applicant for the PSD permit must provide a description of the nature, location, design capacity, and typical operating schedule of the source, including specifications and drawings showing its design and plant layout; a detailed schedule for construction; and a detailed description as to what system of continuous emission reduction is planned for the source emission estimates; and any other information necessary to determine that BACT will be applied. (40 C.F.R. § 52.21(n).) In addition, an analysis of the air quality impact projected for the area as a result of general commerical, residential, industrial, and other growth associated with the source or modification should be included. (Id. at § 52.21(o).)

The BACT determination requires the utilization of air diffusion computer models to predict the impact of the project on ambient air quality. In addition (and perhaps most important from a timing point of view), continuous air quality monitoring data for each pollutant of which the project may emit significant amounts generally must be provided for a period of at least one year, representing at least the year preceding receipt of the application. (40 C.F.R. § 52.21(m)(1)(iv).) An exemption from

this requirement may be granted if EPA determines that a complete and adequate analysis can be accomplished with monitoring data gathered over a period shorter than one year, but not less than four months in any case. (Id.) Also, if state and local network monitors for the area are available and the applicable data can be gathered from them and is acceptable to EPA, a source may be exempted from the monitoring requirements. The computer model also requires meteorological data for the area of the project site.

E. Nonattainment Areas

Nonattainment area New Source Review analysis is performed if the project is located in a nonattainment area for any criteria pollutant for each such pollutant. If the project will emit more than 100 tons per year of any nonattainment pollutant, the BACT determination is replaced by a more stringent determination of the Lowest Achievable Emission Rate ("LAER"). This requires the project to achieve the most stringent emission level possible. Unlike the BACT determination, the LAER decision is made without regard to the cost of the control technology.

In addition, the nonattainment pollutant generally must be offset by a reduction in emissions of that pollutant by a different source or sources in that area, and a net air quality benefit must result. Emissions offsets can be obtained from existing sources by paying for new pollution controls, for the use of cleaner fuels, for reduced operating hours, or through other means.

F. Permit Procedure

If the PSD program has not been delegated to the state in which the project is located, the federal EPA procedures, described below, are applicable. State procedures are generally similar.

The appropriate EPA regional administrator reviews each permit application for completeness and should notify the applicant in writing within 30 days whether the application is complete. (40 C.F.R. § 124.3.) The regional administrator may notify the applicant and schedule a site visit if necessary. (Id.) Once an application is complete, the regional administrator tentatively decides whether to prepare a draft permit or to deny the application. (Id. at § 124.6.) If he chooses to prepare a draft permit, certain procedures must be followed and an administrative record gathered. (See id. at §§ 124.6 - 124.10.)

Public notice must be given by EPA and 30 days must be allowed for public comment. A hearing may be scheduled and held and all comments must be considered and answered by EPA in making its final decision. The entire PSD permitting process can easily take 8 to 10 months to complete and may take substantially longer if problems arise.

G. Specific Implications for Resource Recovery

For resource recovery facilities, most BACT determinations to date have required the use of an electrostatic precipitator ("ESP") to achieve a reduction in particulate

emissions, usually down to a range of approximately 0.02 to 0.03 grains per standard dry cubic foot. Often, other pollutants such as lead, asbestos, beryllium, and mercury are also reduced through use of an ESP, so this technology may also serve as BACT for those types of pollutants as well.

As discussed below, concern about acid rain has resulted in increasing interest in regulating certain emissions from resource recovery facilities, and acid gas controls are being required for a growing number of new facilities.

One other area not directly addressed in the above discussion but important to the air pollution impact of a resource recovery facility is stack height. This can be a sensitive issue because although a tall stack may be helpful in reducing the impact of air emissions, it increases the visual impact of a facility, and may pose a hazard to air traffic (see Section VI below).

As noted below in the discussion of acid rain and dioxin, pollution control requirements for resource recovery are in a state of change, and are likely to become more stringent in the future.

H. Acid Rain and Dioxin

The most serious current concerns regarding air pollution for resource recovery relate to acid rain and dioxin. Because understanding of the nature and scope of these problems is not yet complete, and because control technologies are either developing or not yet developed, the likely future regulatory

constraints for resource recovery resulting from these issues are uncertain.

1. Acid Rain

Among the pollutants implicated in acid rain formation are sulfur dioxide and oxides of nitrogen. Resource recovery facilities emit these pollutants, and it is therefore likely that they will be subject to programs controlling acid rain, whether or not those programs are specifically directed at resource recovery.

Although the federal government has yet to take specific regulatory action to deal with acid rain, New York State, for example, has enacted the State Acid Disposal Control Act (the "Acid Rain Act"). The Acid Rain Act requires New York's Department of Environmental Conservation to identify the state's sensitive affected areas, establish thresholds for acid deposition in these areas, and promulgate interim and then final control targets which all covered sources must meet, in the absence of a controlling federal statute or program which the Department finds to be consistent with the purpose of the statute.

2. Dioxin

Concerns about dioxin have played a major role in recent resource recovery environmental regulatory activity. Although most of the scientific and regulatory community has concluded that dioxin emissions from a modern and properly operated resource recovery facility pose no significant health risks, controversy surrounding the issue continues, and it has

been the focus of much of the public concern about implementing resource recovery.

There currently are no EPA air quality standards or regulations affecting dioxin emissions. The recent amendments to the Resource Conservation and Recovery Act directed EPA to make a study of dioxin emissions from resource recovery facilities, including: (i) the current data available on emissions of dioxins from resource recovery facilities burning municipal solid waste; (ii) any significant risks to human health posed by these emissions; and (iii) operating practices appropriate for controlling these emissions. Based upon its report and upon any future information on dioxin emissions, EPA is authorized in the statute to publish advisories or guidelines regarding the control of dioxin emissions from resource recovery facilities. (Hazardous and Solid Waste Amendments of 1984 § 102.) The EPA study is projected to be completed in February, 1987. Thus, the dioxin issue will continue to develop, and it may well continue to have a significant impact on resource recovery.

I. Other Developments

A number of groups within and outside government have proposed special restrictions on operations of resource recovery facilities or requirements for particular pollution controls. For example, in California, the state's Air Resources Board has prepared a report establishing guidelines for various emissions that would require a number of additional pollution controls.

(Air Pollution Control at Resource Recovery Facilities, California Air Resources Board (December, 1985).) New Jersey has also proposed recommended guidelines for resource recovery facilities. (Air Pollution Control Guidelines For Resource Recovery Facilities and Incinerators, New Jersey Department of Environmental Protection, Air Pollution Control Program, March, 1983.) These recent initiatives are directed at particulates, acid gas control, minimum temperature and residence time, combustion efficiency, and stack testing.

Other areas of potential concern for resource recovery include inhalable particulates, which are those particulates that are smaller than 10 microns in size, and respirable particulates, a subcategory of inhalable particulates, which are smaller than 2.5 microns. The inhalable and respirable particulates are ingested into the lungs rather than blocked in the nasal passages. Federal standards regulating emissions of inhalable or respirable particulates have recently been proposed, but there are now no binding standards and it is not clear when there will be.

III. WATER PERMITS

A. Discharge Permits

Water discharges by resource recovery facilities generally are subject to regulation under the federal Clean Water Act. (13 U.S.C. §§ 1251 *et seq.*) That program, like the Clean Air Act, provides for delegation of authority to implement the

program from the federal EPA to states under certain circumstances.

The Clean Water Act requires a project to obtain a permit if it will discharge any pollutant into surface waters or groundwater. The term pollutant is broadly defined, and includes heat from otherwise uncontaminated cooling water. The permit is referred to as a National Pollutant Discharge Elimination System permit ("NPDES permit"). Similar state permits are known as State Pollutant Discharge Elimination System permits ("SPDES permits"). The permit lists, on a pollutant by pollutant basis, the pollutants the project is allowed to discharge and the amount of each it is allowed to discharge. Recordkeeping and reporting requirements are also included.

The most likely source of water pollution from resource recovery facilities is cooling water, and the most likely type of pollutant is therefore heat. In addition, leachate from residue disposal sites and minor in-plant chemical usage may generate pollutants.

B. Dredge and Fill and Construction Permits

If the project involves dredging and filling-in of navigable waters, the project is required to obtain a separate permit from the U.S. Army Corps of Engineers (a "Section 404 Permit"). (33 U.S.C. § 1344.) To obtain the permit, an applicant must demonstrate that the proposed dredging and filling

will not hinder navigation, significantly affect water quality, or disturb areas of special ecological significance.

Also requiring a permit from the Corps is the placement of structures in navigable waters, including pilings and outfall pipes. (33 U.S.C. § 403.)

Perhaps as important as the permits themselves, the involvement of the Corps of Engineers may trigger the need for a federal environmental impact statement, discussed below in Section V.

C. Other Local Permits

Many states and localities require permits for withdrawal of water from wells or water systems, and water use by resource recovery facilities is often substantial. In addition, localities generally impose permit and possibly pretreatment requirements for sewer connections. Although resource recovery incinerators do not necessarily generate significant amounts of heavily polluted water, if a landfill is part of the project, it may be necessary to pretreat leachate generated from landfilled residue and bypassed and nonburnable waste.

IV. LANDFILL AND HAZARDOUS WASTE ISSUES

A. Landfill for Residue, and Bypassed and Nonprocessible Waste

Resource recovery reduces but does not eliminate the need for landfilling. Combustion results in ash residue which may or may not be saleable; certain types of waste, particularly bulky items, cannot be processed at most resource recovery

facilities; and even the most reliable facility may be temporarily shut down for a variety of reasons, resulting in bypass of solid waste that must be disposed of.

Because of these residue, bypass, and nonprocessible (but nonhazardous) waste streams, a landfill is an essential element of any resource recovery project. Usually, a preexisting landfill is available for this purpose at least for the first few years of project operation. This is not always the case, however, and in most situations a new landfill will be necessary at some point in the life of the project. Thus, the permitting process will often involve not only the refuse incinerator, but also a landfill.

Because the back-up landfill is usually not directly within the scope of the project (and is not often provided by the vendor of the incinerator), and because the permit for a landfill for resurce recovery residue, bypass, and nonprocessibles is not necessarily different from a permit for any sanitary landfill, the requirements will not be addressed in detail in this paper. It will suffice to note that landfills are subject to regulation under the federal Resource Conservation and Recovery Act of 1976 ("RCRA") (42 U.S.C. § 6901 et seq.) and state programs implemented pursuant to RCRA, and that state permitting agencies often require that sponsors of a resource recovery project demonstrate the availability of a landfill for the project. Thus, although lack of availability of landfill is often an

important spur to the development of resource recovery it can also be a hindrance.[3/]

As more resource recovery facilities are built and sufficient capacity exists for waste to be disposed of at neighboring resource recovery facilities, and as more acceptable uses for residue are found, the landfill issue may become less difficult.

B. Hazardous Waste Issues

1. Residue

The above discussion of the need for a landfill is based on the assumption that the residue generated by the resource recovery facility will not be deemed hazardous as that term is defined in RCRA and EPA's regulations under that law, and that its treatment, transportation, and disposal therefore will not be subject to the extensive substantive and procedural requirements of the statute and regulations. However, this issue has not yet been fully developed, and residue may pose special

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3/ A recently enacted New York State landfill bill purports to encourage resource recovery as a preferred method of waste disposal, but also prohibits the expansion of landfills in certain parts of the state except as an interim measure in connection with the implementation of a resource recovery system (N.Y. Environmental Conservation Law § 27-0704). The actual impact of the statute has been to impede the development of resource recovery in the area by eliminating economically viable sites for landfills at which resource recovery facilities can dispose of residue, bypass, and nonburnable waste. This situation may be partially alleviated as a result of a subsequent statute setting up procedures for the establishment of a residue disposal site for resource recovery facilities in the area. (Laws of 1985, Chapter 359.)

problems in the permitting or operation of a resource recovery facility.

Under RCRA, a substance generally is deemed hazardous if it has the characteristic of ignitability, corrosivity, reactivity, or toxicity. Although residue from resource recovery facilities rarely exhibits the first three characteristics, it may exhibit toxicity. Toxicity of residue currently is determined in a test known as the Extraction Procedure ("EP") Toxicity Test, in which the residue is ground, an acid is filtered through it, and the leachate is tested.[4/]

Currently, it is clear that if the residue (which is mixed with fly ash automatically at many resource recovery facilities) generally passes the EP Toxicity Test, the requirements of RCRA will not be applicable to the residue. (50 Fed. Reg. 28702, 28725-26, and 28743, (July 15, 1985), promulgating 40 C.F.R. § 261.4(b)(1).)

If the residue routinely fails the EP Toxicity Test, the situation is less clear, although a recent amendment to RCRA can be read as exempting such residue from RCRA requirements, if certain precautionary measures are implemented. The federal EPA has recognized this as a thorny issue, the resolution of which may have to await further developments. (See Hazardous and Solid

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4/ The EPA recently proposed significant changes to the EP Toxicity Test, which would be redesignated the Toxicity Characteristic Leaching Procedure. See 51 Fed. Reg. 1602, 1750 (January 14, 1986).

Waste Amendments of 1984 § 223 (Pub. L. 98-616, November 8, 1984); 50 Fed Reg. 28702, 28725-26, and 28743 (July 15, 1985), promulgating 40 C.F.R. § 261.4(b)(1).)

Whether or not the residue passes the EP Toxicity Test or is subject to RCRA requirements, a separate and potentially important issue regarding residue is posed by the federal Superfund law (42 U.S.C. §§ 9601 et seq.). Even if not subject to RCRA requirements, residue may contain materials, e.g., heavy metals, that are defined in the Superfund statute as hazardous.[5/] If a landfill containing such residue, alone or in combination with other wastes, develops a problem governed by Superfund, the owner or operator of the resource recovery facility generating the residue may be financially responsible in whole or in part for cleaning up the site. Thus, this issue must be considered in making arrangements for disposal of residue.

The issues of whether residue constitutes hazardous waste and what requirements must be met if it does are also the subject of evolving state regulatory programs that in some cases may be more stringent than the federal requirements.

2. Deliveries of Hazardous Waste to Facility

Yet another potentially serious problem is posed by the possibility that hazardous waste (as that term is defined in

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5/ It should be noted that the concentrations of hazardous substances in residue is immaterial for the purposes of the Superfund law. A list of hazardous substances under Superfund is set forth at 50 Fed. Reg. 13456, 13475-13513 (April 4, 1985).

RCRA) may be delivered to a facility. Potential deliveries of hazardous waste create the possibility that a resource recovery facility may be deemed a hazardous waste treatment, storage, generation, or management facility as defined in RCRA and therefore be subject to the requirements of that statute. However, relief from these provisions is available if the facility burns only household and nonhazardous commercial and industrial waste, and if the facility establishes procedures to assure that hazardous wastes are not burned at the facility. (Hazardous and Solid Waste Amendments of 1984 § 223 (Pub. L. 98-616, November 8, 1984).)

Although the above provisions exempt certain resource recovery facilities from the RCRA provisions, a practical problem remains: even a resource recovery facility with extensive procedures to prevent the delivery of hazardous waste may occasionally accept deliveries that are later discovered to contain substantial amounts of hazardous waste. Most contracts regarding operation of facilities require that in such cases arrangements be made for the removal of the hazardous waste in accordance with the provisions of RCRA, usually at the expense of the municipality.

V. ENVIRONMENTAL IMPACT STATEMENT

The preparation of an Environmental Impact Statement ("EIS") for a major waste-to-energy project is a complex technical and

legal undertaking. Skillful use of the EIS process can accelerate administrative action and minimize the possibility of a successful challenge in court. Conversely, if poorly coordinated, the environmental review process can delay and, in some cases, derail an otherwise well-conceived project. This section addresses major legal requirements governing the preparation of an EIS under both state and federal law and will briefly discuss the roles of the governmental and technical participants in that process.

A. Background

Environmental Impact Statements often are required for waste-to-energy projects under the National Environmental Policy Act ("NEPA"), which directs agencies of the federal government to subject all proposed major federal actions which would significantly affect the quality of the human environment to a detailed inter-disciplinary study, the results of which must be published in the form of an EIS. An EIS must identify the environmental effects of the proposed action, describe alternatives to that action, discuss any appropriate measures to mitigate adverse environmental impacts, and, after a comparison of the environmental impacts of all of the alternatives (including that of no action), identify the agency's preferred course of action. Informed by the EIS, the responsible federal official can then determine whether the agency will carry out the proposed action, adopt one of the alternative courses of action, or elect to take no action.

In addition, many states have enacted similar laws requiring an EIS for state and local governmental actions even where there is no federal involvement.[6/]

At base, NEPA and most related state statutes are disclosure statutes rather than laws imposing substantive restraints on the governmental decisionmaker. Once the required analyses and procedures are concluded, the agency may either adopt or reject the findings of the EIS so long as its decision is reasonable and well supported.

Nonetheless, environmental review under NEPA remains critically important for a number of reasons. First, agencies frequently adopt the preferred alternative that has been shaped and described by the EIS. Second, a properly conducted environmental review serves to involve the public in the decisionmaking process and permits serious local concerns to be addressed and resolved early in the planning phase of a project. Finally, scrupulous adherence to the procedural requirements of the EIS process may help to strengthen the legal adequacy of the agency decision if it is challenged in the courts.

B. Actions Requiring Preparation of an EIS

Under NEPA, all "major federal actions significantly affecting the quality of the human environment" must be made the

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6/ See, e.g., California Environmental Quality Act, Cal. Pub. Res. Code, Division 13, Chapter 4, §§ 21150-21155; Connecticut Environmental Policy and Protection Acts, Conn. Gen. Stat. Ann., Title 22a-1; Massachusetts Environmental Policy Act, Mass. General Laws, Chapter 30, §§ 62-62-h; and New York Environmental Conservation Law, Article 8, Laws of 1972, Chapters 643, 664.

subject of an EIS; most state "NEPA" statutes have a similar threshold for the preparation of impact statements. The proponent of a waste-to-energy project should consult with its legal advisors to determine whether and when an EIS must be prepared for its particular project.[7/]

The courts have required the preparation of a federal EIS in connection with many projects involving apparently minimal federal participation and little foreseeable impact on the environment. Federal actions for which an EIS may be required include, but are not limited to, the issuance of or entry into a license, permit, lease, loan, grant, insurance, contract (including extensions and modifications), conveyance, assistance authorization, or approval of right-of-way. Waste-to-energy projects could be subject to an EIS process as the result, for example, of federal grant funding, loan guaranties, the need for a dredge-and-fill permit under Section 404 of the Clean Water Act, use of federal property (by sale or lease), or entry into a contract with a federal waste supplier or energy user for the facility.

Thus, as a practical matter, any major waste-to-energy project with any form of federal participation will likely be

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7/ Under NEPA, the determination whether an EIS is necessary may be made after the preparation of an Environmental Assessment ("EA"). If it is determined that an EIS is not required, the agency must prepare and file a Finding of No Significant Impact ("FNSI"). If an EIS is found to be necessary, the agency must publicize the preparation of that document in a Notice of Intent ("NOI").

deemed to have a significant effect on the environment and therefore a full EIS will be required.

C. Procedural Requirements for the Preparation of an EIS

The general regulations governing the preparation of a federal EIS impose complex procedural requirements on the environmental review process. These requirements are amplified and particularized by even more detailed implementing procedures promulgated by each federal agency. Regulations implementing state environmental review statutes follow the general federal pattern. The brief description set forth below is merely a synopsis of the more significant federal regulatory requirements.

After publication of the NOI announcing the commencement of the review process, the federal agency begins what is known as the "scoping" process. First, all affected federal, state and local agencies are contacted and their assistance solicited. The agency with the primary responsibility for preparing the EIS (the "lead agency") then proceeds to determine the scope and significance of issues to be analyzed in depth in the EIS. The purpose of this analysis is to narrow the discussion of the issues in the statement and to eliminate from detailed study issues which are insubstantial.

Once the scope of the statement has been established, a draft EIS is prepared. In some cases, the draft is actually prepared by the lead agency. In many instances, however, both the draft and final EIS may consist largely of materials prepared by a private consulting firm selected by the lead agency and paid

by the project's proponent. Such "third party contracts" often result in a more expeditious environmental review than would be obtained if the impact statement were prepared by the federal agency itself. Under the federal NEPA, such delegation is permissible, but the federal agency whose action (e.g., granting a permit or funding a project) triggers the need for a federal EIS is the party responsible for preparation of a legally adequate EIS. Accordingly, the federal agency must actively supervise and participate in the EIS preparation and make its own independent, critical evaluation of the EIS before adopting it as the agency's statement.

The draft EIS must describe all reasonable alternative courses of action, including both the proposed action and a no-action alternative. After a comparison of the various alternatives, the draft should identify the agency's preferred alternative, if one exists.

In comparing the alternatives, the environmental effects of each alternative must be identified and the draft must assess any feasible mechanisms by which adverse environmental impacts may be mitigated. Until recently, where there was a lack of sufficient information regarding a particular impact or where the cost of acquiring the information was prohibitive, the EIS had to include a "worst case" analysis along with an estimate of the probability of occurrence of the worst case situation. However, effective as of May 27, 1986, the worst case analysis requirement was rescinded by the federal Council on Environmental

Quality. (51 Fed. Reg. 15618 (April 25, 1986), promulgating new 40 C.F.R. § 1502.22.). The requirement was replaced by a new rule that requires the agency to disclose when there is incomplete or unavailable information in evaluating reasonably foreseeable significant adverse effects on the environment, and to obtain that information if the costs of doing so are not exorbitant. If the Agency is unable to obtain the information because of cost or the means to obtain it are unknown, the agency must disclose that information is missing and explain its relevance, summarize the credible scientific evidence relevant to the agency's evaluation of the adverse effects on the environment, and evaluate the impacts based on theoretical approaches or research methods accepted in the scientific community. In addition, impacts that have a low probability of occurrence but catastrophic consequences should be evaluated if the analysis is supported by credible scientific evidence and not pure conjecture, and is within a judicially developed rule of reason regarding the degree to which an EIS must discuss remote and highly speculative or unforeseeable events.

When completed, the draft must be circulated to all interested federal, state, and local agencies, the applicant (if any), and other interested parties, including members of the general public who request a copy. Notice of its availability must be published in the Federal Register. The lead agency is responsible for collecting and compiling all comments on the draft.

At the close of the comment period a final EIS is prepared. This document must attach a copy of all substantive comments received in connection with the draft EIS and the agency's response to them. In addition, the final EIS must identify the lead agency's preferred alternative and the reasons for that choice.

D. Timing and Structure of EIS Process

Although the types of actions requiring an EIS and the procedural requirements for EISs are generally well defined, two issues that are slightly less clear are when the EIS should be prepared, and whether additional EISs are required for the different phases of a project. The easiest answers--an EIS should be prepared as early in the decisionmaking process as possible, and additional EISs should be prepared as the project develops--are not necessarily the best answers for a resource recovery project.

As noted above, the fundamental purpose of NEPA and similar state statutes is to force government agencies to take environmental consequences into account in making decisions regarding governmental actions. Thus, to be meaningful, the EIS process should commence before major decisions regarding a project are made.

For most resource recovery projects, the EIS process does not begin until after a vendor is selected, and often not until a contract is signed. However, at that stage, many major decisions, such as site and technology, have already been made.

As a result, some municipalities have begun the EIS process much earlier, for example, at the initial fesibility study phase.[8/] This approach poses difficulties, however, because at such an early stage a number of important issues that must be addressed in a resource recovery project EIS are not yet ripe for decision (e.g., site-specific mitigation measures, technology-specific pollution controls). Thus, a series of EISs might appear necessary as a result of this approach, and in fact some of the projects that have begun the EIS process at the preliminary feasibility stage have utilized a generic EIS that only addresses the issues being decided at that time; as the project develops, an additional EIS regarding site-specific and technology-specific issues will also be prepared. If the first EIS has addressed the general siting and technology issues adequately, and circumstances and the agency's plans have not changed, the subsequent EIS need only summarize those issues and incorporate discussions from the generic EIS by reference. This process of multiple EIS preparation, sometimes referred to as tiering, has been used by the federal government to address programmatic decisions followed by implementation programs, and decisions of national scope with region-specific impacts. (See 40 C.F.R. §§ 1502.20, 1502.28.)

8/ In fact, regulations under NEPA require that the EIS for a project directly undertaken by the government be prepared "at the feasibility analysis (go-no go) stage and . . . supplemented at a later stage if necessary." (40 C.F.R. § 1502.5(a).)

E. Issues in a Resource Recovery EIS

For waste-to-energy projects, the EIS requirements will necessitate a discussion of a number of potentially difficult issues. It may be necessary to explore the possibility of transporting solid waste to a remote landfill, and to discuss effects of current waste disposal practices on the environment. Disposal of residue and bypassed and nonburnable material must be addressed. The economics of the proposed project must be described. Noise, odor, disease vector, and traffic generation by the facility, as well as measures to control them, must be described. Visual impacts of the project also must be addressed. Finally, the air pollution impacts of a waste-to-energy project, which are likely to remain a controversial issue for some time, and the possible health effects of potential air emissions, will need to be addressed.

F. Roles of Governmental and Technical Participants in the EIS Process

In practice, for most waste-to-energy projects, much of the material contained in the EIS is prepared by consulting firms selected by the agency and compensated by the project's proponent. Although, as noted above, the agency retains the ultimate responsibility for preparing an adequate EIS and the consulting firm is answerable to the agency, the consultant and the applicant frequently develop a close working relationship. This relationship can help to assure that all pertinent technical information concerning the project is included in the EIS and

that legitimate environmental concerns are identified at an early stage when they can be accommodated most economically.

At the outset of the environmental review, the applicant's key officials should become conversant with the requirements of NEPA and its implementing regulations. This permits the applicant to provide the maximum input in the preparation of the EIS, consistent with the goals of NEPA. Moreover, it provides the applicant's staff with a benchmark against which to measure the adequacy of both the consultant's work and the agency's participation in the drafting process.

Once the draft EIS has been prepared, it should be reviewed carefully by both the applicant and its counsel before submission to the governmental authority. This review provides an early opportunity to assure that the draft is legally sufficient and fulfills all of the requirements of the regulations.

Upon submission of the draft to the agency, the applicant should make every effort to assure that the document receives a full and independent review by the responsible officials. Such review is an absolute requirement of NEPA. Government officials should be encouraged to document each stage of their review in order to minimize the possibility of a successful procedural challenge in court.

Similarly, the applicant should monitor the agency's procedures for giving notice of the availability of the draft EIS and for the circulation of the document. Any deviation from the procedures required by the regulations should be brought to the

agency's attention immediately and remedied as expeditiously as possible.

Finally, the applicant should review all comments on the draft EIS and should be a full participant in the preparation of adequate responses. While the final responsibility for the adequacy of the final EIS rests with the agency, the technical expertise of both the applicant's staff and the consultant are frequently invaluable in crafting cogent and persuasive responses.

G. Joint Review Process

Several states have adopted a joint review process which works to coordinate all environmental review and planning activities for a project simultaneously. This coordination typically improves the quality of the reviews and may avoid unnecessary duplication of effort and delay in the environmental permitting and review process.[9/] Also, related projects may be reviewed in a single generic EIS, with site-specific reviews conducted in individual impact statements. This procedure is another application of the "tiering" technique described above, and in appropriate cases may be useful, for example, where a municipality is planning to implement more than one resource recovery project.

9/ See Don G. Scroggin, "Joint Review Process Expedites Project Completion," 5 Legal Times, (No. 3) 21 June 1982, pp. 18-25; U.S. Environmental Protection Agency Office of Policy and Resource Management, Streamlining the Environmental Permitting Process: A Survey of State Reforms, June 1982.

H. Basic Approach

A key to understanding the EIS requirements of NEPA is to recognize that NEPA seeks to achieve substantive environmental goals through a series of procedural steps, such as providing for adequate public participation. Courts readily seize upon procedural flaws in the NEPA process, but seldom question the substantive decisions of agencies.

However, a misunderstanding persists among some project proponents, who think that NEPA stands for the National Environmental Protection Act, rather than Policy Act. Thus, they assume that an EIS should not emphasize a project's expected harmful environmental impacts, because it may cause undue alarm or give ammunition to opponents of the project. An unfortunate consequence of this fear is that there is sometimes a tendency to gloss over harmful environmental impacts in an EIS and to fail to take a hard look at feasible alternatives that are undesirable to the project proponents. Probably no path could be more hazardous for the legal sufficiency of an EIS. The most legally defensible EIS will present an open and frank assessment of feasible alternatives and of both the beneficial and harmful environmental impacts of a proposed project, along with appropriate mitigation measures.

Truly controversial projects simply cannot escape close environmental scrutiny. The only question is when that scrutiny will occur--early in the process when the problems are manage-

able, or late in the process, when the costs can be so great as to kill a project.

VI. OTHER PERMITS AND APPROVALS

Depending upon the location and nature of the facility, a number of additional regulatory programs may be applicable. For example, there are restrictions on development of certain coastal areas pursuant to both federal and state regulatory programs (e.g., the federal Coastal Zone Management Act, 16 U.S.C. §§ 1451 et seq.). If located near an airport, the facility stack may pose a hazard to air navigation under Federal Aviation Agency regulations and require clearance from that agency prior to construction. If the facility will affect archaeological or historical resources, the federal National Historic Preservation Act and related state programs may come into play.

VII. CONCLUSION

As the above summary description makes clear, the environmental regulatory programs affecting resource recovery are broad, complex, and detailed. In addition, this is an area of the law which is in an almost constant state of change, and the changes are not always subject to grandfathering provisions.

As a result, those involved in a resource recovery project must at the outset become familiar with the full range of applicable regulatory requirements; must take those requirements into account in developing the project at its earliest stages,

including site selection; must establish and maintain good working relationships with regulatory agencies; must pay strict attention to procedural as well as substantive requirements; must anticipate public sentiment and skillfully conduct required public participation programs; must keep informed about changes in the regulatory climate; and must maintain as much flexibility as possible to deal with those changes.

Siting a Waste-to-Energy Facility: The First Acceptance Test

Fran Buhler

CSI Resource Systems, Inc.
Tallahassee, Florida

SITING A WASTE-TO-ENERGY FACILITY: THE FIRST ACCEPTANCE TEST

Fran Buhler
CSI Resource Systems

Once constructed, a waste-to-energy facility typically must "pass" an acceptance test which validates actual facility performance in relation to expected design capacity and performance levels. But for project sponsors, this is really the facility's last acceptance test -- a routine procedure following accepted engineering protocol and usually too uneventful to attract the media and TV cameras.

In contrast, the facility's "first acceptance test" occurs when local officials and project planners consider where to locate the proposed facility. For, despite increasing restrictions on tax-exempt financing, site selection remains one of the most critical aspects of developing a waste-to-energy project today.

In order to locate a waste-to-energy facility, a site must be technically, environmentally, and politically acceptable.

Technically, the facility site decision springs from two fundamental project elements: the location of the wasteshed (primary sources of waste) and the location of the energy buyer. A detailed site assessment is required to determine other areas of technical suitability and to develop the site information necessary for facility design purposes. In addition, environmental suitability is paramount: Will the site lend itself to obtaining the necessary environmental approvals?

The purpose of this paper is to review briefly the technical and environmental requirements for site selection (which are summarized in Figure 1) and address the facility siting process itself, including strategies that can move the site selection task along in a manner that avoids the expensive delays and defeats that kill projects.

In addition to the technical/environmental criteria summarized in Figure 1, Figure 2 presents various energy market siting considerations which should be addresssed in the preliminary facility site assessment.

Figure 3 presents several issues of importance for facility siting in relation to a thermal energy market such as a downtown district steam loop serving a number of customers, an industrial network, or an institutional system serving a cluster of buildings on common property.

Figure 4 presents the acreage requirements typically assumed for small and large-scale facilities.

The waste-to-energy industry has reached the stage, say some, that the issues surrounding site selection can be smoothed over with a public relations campaign. Bring out the fact sheets, show some fancy graphics, wow them with a scale model of the plant. Such well-intended advice is frequently misleading and misdirected.

All too often in the waste-to-energy field, public relations activities have been tacked on, almost as an afterthought, either when opposition to a site has already snowballed, or just prior to project financing when the local government's reputation is on the line.

Experience suggests that public information activities should be established and considered at a project's inception, and the the public relations effort must be a genuine, integral part of the overall project development sequence. In recent years, three public relations pitfalls have surfaced again and again:

- The best public relations campaign will not change public opposition to an unsuitable site.
- A technically and environmentally suitable site is no guarantee of public and political acceptance.
- Some segments of the public will oppose any site, regardless of its merits or the thoroughness of the selection process.

Which brings us as projects planners to the politics of resource recovery. Indeed, the most difficult problem in developing a waste-to-energy project is obtaining a technically suitable site that is also politically acceptable. Remember the adage: All brandy is not cognac and all cognac is not Courvoisier. Likewise, all technically suitable sites are not politically acceptable. Many projects have experienced great delays and have been stopped due to political and public opposition, even after environmental approvals have been obtained.

So, what can be done? Clearly, careful thought and preparation should be given to the site assessment and selection process to ensure technical/environmental suitability and to achieve public understanding and support.

To minimize siting problems it is essential that political leaders support the project and the selected site. Public relations and public participation programs to inform the public and develop support for the project are necessary and can by very successful if their purpose is understood. There must be a reciprocal dialogue in these forums. That is, project sponsors

and proponents must give information, receive concerns and questions, and respond to those in a way that presents the project as a benefit rather than a threat. Objective information must be disseminated to counteract the emotionalism that often surrounds public opposition, which often is a result of misinformation or false preconceptions.

Consistent with this approach, the following suggestions are offered for consideration as possible strategies for facilitating the siting process.

- Avoid site selection via a public referendum. Opponents to a site can too easily employ untrue statements, incorrect or deliberately misleading information, and scare tactics which become impossible to answer or refute within the constraints imposed by the media.

- Initiate the site assessment process early in the project feasibility phase. Do not assume it is better to wait until other aspects of the project can be defined and developed to influence public opinion.

- Integrate the site assessment with the energy market evaluation, the environmental review and the plant size decision. "No site, no project" should be every project manager's guide. It is a blunt maxim, but adherence to it will avoid wasted expenditure of funds on project activities which are at best premature and at worst irrelevant.

- Avoid, where possible, sites adjacent to residential and commercial areas; nonattainment areas; sites suitable for prime development; and sites near wetlands, sensitive ecosystems, or flood plains. (See Figure 1)

- Begin early in the site assessment phase to solicit opinion from public and private groups in the "host" community, especially elected officials in whose district the site is located.

- Establish and utilize a citizens advisory group as a conduit for communicating project and site information to the public, and public viewpoints to project personnel.

- Prepare comparative site assessments, listing the pros and cons of each site, including a cover piece which describes in non-technical language the criteria used to establish site suitablilty. Use individual contacts to inform key community leaders and organizations about the selection process, the assessment criteria, and the evaluation results.

The key is establishing an open, technically correct, defensible process which leads to an orderly conclusion and selection, rather than choosing a site and then trying to devise ways to promote its acceptance.

Another facility siting strategy is to use incentives or "sweeteners" to make site acceptance more attractive to the host community. This is a strategy seen with increasing frequency in projects serving county-wide, multijurisdictional or regional areas. The premise is simply that a host community should receive some tangible, economic benefit for providing a project site. Some of the incentives emerging across the country include:

- Taxes for additional revenue to the host community
- Payment in lieu of taxes
- Royalty or a per-ton rebate to reduce tipping fees
- Public works expansion and public service improvements, such as new roads and utilities, industrial park, development or expansion of fire and police protection, etc.

A good example, illustrating the use of a combination of incentives, is found in the Westchester project in an agreement between Westchester County, New York, and the City of Peekskill. Peekskill became the host community for the Westchester facility after the County had wrestled with the siting controversy for more than a year. Major terms of the agreement are as follows:

- County pays annual rent for the facility portion of the site (25 acres) sufficient to amortize the purchase of the entire 65-acre site by Peekskill's industrial Development Agency.
- County makes payment in lieu of taxes to the City.
- An Environmental Impact Statement was prepared for joint concerns.
- County provided a new access road to the site.
- City assisted County in creating a special district for solid waste management.
- Agreement also included development of transfer stations to help control traffic flow to the site.

A final siting strategy is the facility complex approach, that is, locating more than one facility in a common area or complex. Obviously, this example has its precedents in the public works planning of previous eras, but it is re-emerging in a compelling way.

In the parlance of local officials, facilities such as landfills and treatment plants are regarded as "orphans" having no constituency, and they are often referred to as "LULUs"--locally undesirable land use. Yet in spite of its "unwanted" image, each facility provides an essential service and demands its home. This approach takes the liabilities associated with the siting of individual facilities and combines them in a "package" that becomes an asset to the locality.

In a rapidly growing county in the southeast, the concept of a facilities complex consisting of five treatment or disposal facilities is under consideration. Included are two types of landfill, a waste-to-energy facility, a septage and grease trap treatment facility, and a wastewater sludge composting facility.

A county administrator in Florida coined the phrase "utility campus" to describe the area in the northeast quadrant of the county which includes a wastewater treatment facility, a landfill, a proposed correctional facility, a power plant, and a proposed waste-to-energy facililty. Officials in other communities have used the terms "energy park" and "environmental park."

In the early 1970's, the primary concerns in developing a resource recovery project (other than the availability of federal funds) were: "Will the technology work?" and "Who will buy the energy?" The field was just getting underway and everyone's approach was tentative. "Siting" was not the buzz word it is today. In the late 70's and early 80's, siting became a major controversy confronting the development of numerous waste-to-energy facilities. In my opinion, we in the waste-to-energy field made siting controversial by ignoring some basic lessons that should have been learned from earlier projects.

For example, it is instructive to review some of those early projects as well as later projects that are well-known for reasons other than siting and to examine them solely for their siting features and characteristics. Figure 5 presents several siting features typical of these projects which we in the waste-to-energy industry may ignore at our peril. From this admittedly incomplete listing, two observations merit attention.

First, locating a waste-to-energy facility on former disposal sites and co-locating with either existing or new landfills offers advantages:

- Landfill availability at the plant site provides for backup during planned and emergency outages and for disposal of bypassed waste.

- Landfill proximity offers economies for residue (ash) disposal due to haul cost avoidance.

- The landfill and the proposed facility have equivalent requirements for access and transportation.
- It is likely that with establishment of the landfill, compatible land uses have already been encouraged, if not achieved.
- Co-location offers the opportunity to centralize operations management, if desired.

Conditions in some localities prohibit the co-location option because steam users, typically, are not found next to the landfill. However, where the flexibility does exist -- either with steam markets or with the sale of electricity -- and where the requirements of the energy market can be met by siting the facility at the landfill without compromising environmental approvals, the option should be evaluated. Co-locating offers another means for achieving economic benefit.

Secondly, major changes in existing land use and zoning status often impede the site approval process. This observation is illustrated by numerous small-scale projects in which the waste processing plant is located "next-door" to energy buyer, usually and industrial steam user, and by large-scale facilities which have been sited successfully in industrial zones. In both examples, approvals have been simplified and accelerated.

An attractive parcel of pasture land located outside the city may appear to represent the path of least resistance. But numerous local elected official have learned the hard way that zoning change from "agricultural" to "industrial" is about as easy as changing the zoning adjacent to a residential neighborhood.

In the waste-to-energy field, a number of project development essentials have been problematic at one time or another, ranging from waste supply and institutional impediments to environmental standards and debt financing. Capital financing, all agree, remains a challenge.

But in today's development climate, the critical early tasks are deciding where to site the plant and how to achieve acceptance and support for locating the facility at a site to which, inevitably, someone will object.

As local officials and project planners, we in the waste-to-energy industry cannot always win the support of every voice crying, "DON'T PUT IT HERE!" But with the aggressive use of the positive strategies suggested here, perhaps we can answer some of the dissenting cries with strong-voiced supporters and advocates saying, "Let's locate the facility here because it will benefit the community and help solve our waste disposal problem."

FIGURE 1

TECHNICAL/ENVIRONMENTAL CRITERIA
FOR FACILITY SITE ASSESSMENTS

- Site configuration and acreage available
- Proximity to energy user, backup landfill and to centroid of the wasteshed
- Road and/or other access to site
- Compatibility of facility with adjacent land uses
- Zoning change requirements
- Ownership/acquisition status of the site, including price
- Existing air quality and potential air and water impacts
- Proximity to sensitive areas, such as residences, hospitals, wetlands, conservation lands, and historical sites
- Proximity to flood plain or coastal zone
- Availability of potable water, wastewater collectors, and electric utilities
- Terrain features, subsurface conditions, and area geology
- Noise, traffic impacts
- Ability to obtain standard environmental approvals, need for special permits

FIGURE 2

PRELIMINARY FACILITY SITE ASSESSMENT

ENERGY MARKET CONSIDERATIONS

Universal Preference: Site as close as possible to point of delivery

ELECTRICITY CUSTOMER

- Offers flexibility for interconnection
- Relative proximity still important

STEAM CUSTOMER

- Distance is limited due to heat losses (1 to 2 miles)
- Distance is also an economic consideration
- Typical site is on user's property or "across the fence"

FIGURE 3

PRELIMINARY FACILITY SITE ASSESSMENT

DISTRICT STEAM LOOPS AND THERMAL ENERGY MARKETS

- Siting in a central business district or in institutional building clusters is difficult
- Existing steam plant replacement is a siting constraint
- Thermal energy may be supplied from another site along a major distribution line
- Siting should consider load density
- Siting can affect energy market development
- Market development keys are price advantage, price stability and system reliability
- Refuse haul costs -- to the facility and to the backup landfill -- can be significant and should be evaluated

FIGURE 4

PRELIMINARY FACILITY SITE ASSESSMENT

ACREAGE REQUIREMENTS

Small-scale facility (100-300+ TPD)	5 acres
Large-scale facility	10-15 acres

Represents the range required for facility layout and access exclusive of landfill.

Site plan may require additional acreage for landscaping, natural buffering, berming, and other site design and exthetic considerations. For example, if additional buffering and landscaping are desired, the large-scale facility acreage requirement would be 20 to 25 acres.

FIGURE 5

SITING FEATURES OF EXISTING FACILITIES*

LOCATION	FEATURES
Saugus, MA	Former private landfill
Nashville, TN	City-owned site, edge of central business district
Bridgeport, CT	Waterfront site; industrial zone; Authority acquired; access by turnpike, rail and barge
Akron, OH	7.8 acres adjacent to B.F. Goodrich, near central business district, City acquired and urban renewed
Baltimore, MD	Industrial zone, one mile from Baltimore Gas & Electric
Dade County, FL	Former County landfill
Pinellas County, FL	20 of 225 acres total, no adjacent development, landfill at same site
Tampa, FL	15.2 acre site, previous disposal site in industrial zone, near downtown
Westchester County, NY	Site offered by City of Peekskill in return for considerations
Little Rock, AR	Industrial zone, adjacent to Koppers Co. (steam user)
Salem, VA	Next to Mohawk Rubber Co. (steam user)
Pittsfield, MA	Next to Crane Paper Co. (steam user)

* An impartial listing for illustration only

Legal Issues in Resource Recovery

Eric S. Petersen

Partner

Hawkins, Delafield &Wood
New York, New York

LEGAL ISSUES IN RESOURCE RECOVERY

Eric S. Petersen
Hawkins, Delafield & Wood
New York City

1. Introduction

Historical Legacy of Public Works Laws. The framework of current law shapes the development resource recovery facilities in several fundamental ways. In its procurement and financing efforts, the municipality ordinarily finds itself confined by state statutes governing debt issuance, service contracting authority, construction of public works, imposition of taxes and the treatment and disposition of municipal property. Statutes such as these reflect a state's accumulated experience in delegating and regulating the power of municipalities to erect public works or obtain essential services. They represent well settled methods of handling traditional public undertakings which are municipally owned and operated or traditional services supplied by the private sector which are sufficiently simple and generic to warrant price comparisons only.

Impact on Resource Recovery. Resource recovery, because it involves a complex mix of public and private endeavors, often does not fit easily into the mold of existing law. Waste disposal services sought by municipalities are available only through proprietary technology held by private companies. Risks and rewards associated with the construction and operation of a facility are shared. Project ownership may lie with the community, the company or with the community for state law purposes and with the company for tax purposes. Laws based on concepts of purely municipal projects or conventional services may fail to provide adequate authorization or be unduly restrictive of necessary municipal activities. Early evaluation of the controlling legal framework, and pursuit of any required statutory changes, are essential to a well-planned procurement.

Legal issues based on federal law, particular tax and energy law, of course are common to all projects. State law requirements, however, vary considerably. Issues which are inconsequential in one jurisdiction may be intractable in another. This paper notes some of the legal concerns which often arise in project implementation efforts.

Need for Express Authorization. It is perhaps important to reiterate that, under basic principles of municipal

law, municipalities have only that power which is expressly delegated by state law or which is available under home rule. The express delegations of power which are needed to effectuate resource recovery projects are often absent due to the relatively recent advent of this industry.

2. Procurement Process Authority

Broad Applicability of Competitive Bidding Statutes. Municipal contracts for public works or service typically must be let pursuant to public bidding statutes. These statutes generally require award of a contract to the lowest responsible bidder after advertisement for sealed bids. Implicit in this procedure is a drafting of plans and specifications by the municipality with the essential element of the bid being cost.

Whether resource recovery facilities constitute public works or services within the contemplation of a public bidding statute is often a difficult question. If the facility is to be municipally owned, public works statutes may apply; if it is to be privately owned and operated, public service contract statutes may apply. Such statutes usually did not contemplate and do not specifically mention resource recovery facilities. But they are ordinarily written broadly enough arguably to encompass resource recovery procurements.

Need for Flexibility and Multiple Criteria. Public bidding procedures have not proved viable for most resource recovery projects for a variety of reasons. First, in many projects the municipality cannot, nor does it want to, draft the technical specifications. There are a limited number of proven proprietary technologies available in the resource recovery market, most of which are licensed to a vendor. Each technology will have unique specifications which are capable of development only by the vendor. Furthermore, if the municipality expects performance guarantees by the vendor, city determination of design specifications will generally make such guarantees unlikely to be negotiated. In fact, city design of a facility may lead a court to determine that, if a facility is constructed in accordance with the design, a vendor will not be held liable for failure of the facility to perform. Second, the feasibility of a resource recovery project depends on many factors in addition to cost, each of which it is advantageous for the municipality to have vendors bid on. These items include solid waste throughput and energy production guarantees, parent company supports, allocation of risks, length of construction, vendor experience, damage provisions, and use of local personnel. The lowest cost project in terms of construction price may not be the most economical project for the municipality. Furthermore, the lowest cost bid may not provide a project with security features sufficient to make the project financeable.

Utility of the RFP Process. Many states have enacted special statutes which permit a broader contract-letting authority than public bidding for solid waste disposal and resource recovery projects. An example of such a statute is Chapter 552, Laws of 1980, in New York State. The statute permits procurement of resource recovery projects either through a public bidding process or through what is generally known as a request for proposals (RFP) process. The law permits a municipality to issue an RFP and to evaluate proposals submitted in response to the RFP. Each proposal must include information concerning the experience of the proposer, the ability of the proposer to secure financing, proposed project staffing, identification of all cost elements which would be charges to the municipality, identification of revenues from material or energy sales, and such other information as the municipality may require. While a municipality is required to consider cost as a major factor in selecting a contractor, the municipality is also permitted to consider such factors as facility design, system reliability, energy efficiency and environmental protection.

Sole Source Procurements. Some states do not require either public bidding or an RFP process, and permit "sole source" procurements. Under this method, a municipality may solicit a proposal and negotiate a service contract with one vendor without regard to the competition. This procedure is undoubtedly attractive to the selected vendor, and may save the municipality considerable time in the RFP planning, drafting and evaluation process. The discipline on price and performance guarantees afforded by a competitive proposal process, however, may be lost in a sole source procurement, as well as the opportunity properly to plan the project and ascertain bargaining objectives.

3. Long-Term Contracting Authority

Many municipalities are restricted in their authority to enter into long term contracts. For example, in Puerto Rico, leases or service contracts for terms in excess of five years require the approval of the Governor of the Commonwealth. In New York, contracts for the collection or disposal of waste (not resource recovery) entered into by cities having a population of under one million may not exceed five years. A resource recovery project expected to be financed other than with general obligation bonds will most likely not be financeable unless contracts for service and waste disposal for the term of the bonds are executed. This will generally equal or exceed twenty years. Thus, in locales where long-term contracting authority is limited, special legislation may be required to provide such contracting authority. In New York, legislation explicitly provides municipalites with authority to enter into contracts for up to twenty five years for services relating to resource recovery projects if the RFP process is followed.

4. Is a Service Contract Payment Obligation

Actually Municipal Debt?

General Obligation Bonds. Financing a resource recovery project is generally accomplished either with general obligation bonds or through project financing. The issuance of general obligation bonds may result in a lower interest rate, but is usually subject to specific legal constraints. These may include a public referendum, notice, hearings, debt ceilings and maturity limitations. General obigation bonding capacity as a practical matter often must be devoted to traditional public works where revenue bond financing is not a possibility. Further, in a general obligation bond financing the municipality would bear the risk of vendor default and bankruptcy. For these reasons, a service arrangement with project revenue bond financing is usually the preferred alternative.

The Service Contract Doctrine. As a general rule, a continuing contract for furnishing a service to a municipality, in which the municipality agrees to make payments as the service is furnished, does not give rise to present indebtedness in the aggregate contract amount when the contract is entered into. This result is based on the municipality's obligation to make payments being conditioned on the receipt of service. In certain instances, however, where the municipality's obligation to make payments is not conditioned upon receipt of service, the obligation may be construed as debt. Thus, if appropriate debt issuance procedures have not been followed, or if municipal debt limits have been exceeded, the obligation is void.

Transit Service Contract Example. For example, where a transit authority encompassing several municipal jurisdictions issued bonds to finance a mass transit system and participant municipalities entered into long-term "service" contracts whereby they agreed to pay as part of their service fee a proportionate share of any "operating expense" deficit in any year in which the mass transit service operated at a loss, the contracts were construed to be debt of the municipalities (an agreement to pay the transit authority's bonds) and as such were entered into pursuant to an unauthorized procedure. When the service contracts were restructured so that the municipalities were required to make specified payments for each trip made by a resident, plus a fixed payment for each mile of train service actually rendered in the municipality, it was found that the obligation of the municipality to make payments was strictly tied to receipt of service, and thus the service contract payment obligation did not amount to debt.

Put or Pay Contracts. "Put or pay" contracts for solid waste disposal, usually used in resource recovery transactions to obligate the municipality to pay even for waste it fails to deliver, are generally construed to be a valid part of the service arrangement not creating municipal debt. This is so

because the service (an available facility) is seen as being rendered despite the non-delivery.

Risk Allocations Raising the Debt Question. But very often in the context of resource recovery project financings, the law is silent or unclear as to the applicability of the service contract doctrine. The issue often arises in risk allocation negotiations. Following are some of the risks which, if assumed by a municipality, may raise the issue of whether a municipal payment obligation is debt or is for service:

(1) Municipality agrees to make service fee payments commencing on a specified date whether or not it receives an operational facility.

(2) Municipality agrees to make service payments upon facility shutdown for operator fault.

(3) Municipality agrees to make service payments upon long-term shutdown for uncontrollable circumstances.

Definition of Service. Much of the contract negotiations thus will revolve around the question, "what is service?". How long and to what extent during the construction and operation periods can the municipality make service payments where partial service or no service is being provided? What is the importance of the cause of service interruption?

In each of the above situations, the municipality's payment obligations may be viewed as not being contingent on receipt of service. Non-contingent payment obligations are ordinarily regarded as debt. The possibility of such an outcome may be minimized by requiring the facility operator to dispose of by-passed municipal waste during facility outages, with no significant increase in the service charge. In addition, if the service to the municipality is viewed as the making available of the capacity of a facility, it may be argued that such service is being provided by a facility operator even in situations where the facility is shut down due to uncontrollable circumstances. Determination of the proper result depends on the interpretation of constitutional, statutory and case law in each state.

Public Power Take or Pay Contract Examples. Some examples of the problems raised by the service contract doctrine may be found in the public power field, where the law is perhaps somewhat more developed. The recent Washington Public Power Supply System (WPPSS) litigation, for example, determined definitively that in the State of Washington municipal contracts to pay for electricity regardless of whether the electricity is produced and where the municipality has no ownership interest in the facility are void. South Carolina, by contrast, statutorily authorizes any municipality to contract, under certain

conditions, to be obligated to make payments for power regardless of whether the project expected to supply such power is completed or operating, and notwithstanding suspension, interruption or reduction of output.

Effect on Bond Marketability. Because of the absence of clear law in many jurisdictions regarding resource recovery contracts, difficulties arise in determining whether a specific risk-sharing arrangement will amount to debt. This is especially so where a municipality may wish to agree, for reasons such as weak vendor credit, to make service payments even where service is not being rendered due to the vendor's fault in order to assure bond marketability. In such circumstances it may prove difficult to get an unequivocal opinion of counsel as to the validity of the disposal contract, which may in turn affect the marketability of project bonds. The municipality may thus be required to limit its service contract exposure, or to incur debt directly by issuing general obligation bonds.

5. Security for the Municipality's Service Payment Obligation

Pledge and Segregation of Taxes or Revenues. Generally, tax revenues of a municipality are available to pay operating expenses of that municipality. In order to secure payments for solid waste disposal and resource recovery services in a project financing, investors may require that a municipality segregate certain revenues and pledge such revenues to secure the municipality's payment obligation. Such segregation and pledging of revenues may not be authorized under existing law, and therefore new legislation establishing a segregation authority and mechanism may be required if constitutionally permissable. Non-ad valorem tax revenues were pledged to support the project revenue bonds issued for the Pinellas County project. In Tampa, revenues from an existing waste disposal system were pledged in support of project revenue bonds. In both cases, the special tax and revenue pledge were expressly authorized by statute.

Third Party Custody. A municipality with weaker credit may require more than a simple segregation of revenues. In order to avoid the risk of bankruptcy, investors may require that certain revenues be isolated in an entity other than the municipality. Establishing such an entity and providing it with a revenue source may also require legislation.

Faith and Credit Obligations. Other credit strengthening devices are also possible. In Connecticut, for example, municipalities are authorized to make service payments which are faith and credit obligations. Once service is rendered, the municipality's obligation to pay for the service can be a faith and credit obligation of the municipality. Such obligations are the equivalent of general obligation debt of the

municipality, and in the event of municipal bankruptcy would be treated as such rather than as obligations for general services.

6. Bond Issuance Authority

Identification of Bond Issuer. Identification of a potential issuer of revenue bonds for a resource recovery facility, and a review of the issuer's legal powers, is also an early requisite in project planning. The bond issuer is usually a public corporation, authority or agency specifically empowered to issue resource recovery revenue bonds. Occasionally a municipality or a state itself may issue project revenue bonds if properly empowered.

Conduit Financing. Some issuers are involved merely as a financing conduit. Sufficient power generally exists for their participation if they are authorized to issue resource recovery revenue bonds, lend the proceeds for project purposes, and contract for its construction and operation. Industrial development financing agencies are typical of such conduit issuers.

Operational and Credit Support Issuers. Other issuers are chartered to play a more active role. Most often these are public authorities with regional or statewide responsibilities specifically for resource recovery, such as the Connecticut Development Authority or the Northeast Maryland Waste Disposal Authority. Authorities such as these are more than financing conduits in their power to provide credit support or assume actual operational and administrative authority over waste disposal. Planning and development functions are also often found in such entities, as well as the power to contract directly with municipalities to provide waste disposal service.

The existence of public corporations with such expanded powers often reflects a considered effort within the state to effectuate resource recovery on a comprehensive basis. In working with regional authorities, municipalities should assure themselves that power exists in the regional entity to enter into all of the contract arrangements which may be required.

7. Private Tax Ownership

Available Tax Benefits. A determination by a municipality to implement a project that is privately owned for federal tax purposes may result in significant project savings, since the private owner can take advantage of tax benefits that are unavailable to a municipality. These benefits include accelerated depreciation, the investment tax credit and interest deductions on borrowed money. The projected economic value of federal cost recovery and interest deductions and investment credits associated with an investment involving the private sector is usually shared between the private owner and the

governmental unit. Most often this sharing takes the form of a reduced service fee. Where high service fees are expected in the early years, the impact of shared federal tax benefits can often improve the feasibility of the project.

The entitlement of a private owner to current tax benefits, including factors bearing upon the determination of ownership, and whether the project is tax-exempt use property and qualifies as a solid waste disposal facility, together with proposed changes in current tax law, are discussed in a concurrent paper entitled "Gold in Garbage, Gold in Tax Benefits" dated March, 1985 by Eric Petersen and Jeannette Bond of Hawkins, Delafield & Wood.

Risk of Loss of Tax Benefits. The vagueness and multiplicity of the tests of ownership and use, and the absence of decisions or rulings directly applicable to resource recovery transactions, has caused considerable dispute over their correct application to any particular case. For this reason the private entity owning the plant and the municipality receiving its services must devote considerable effort to structuring the transaction in a way which maximizes the chances for a successful claim of the investment tax credit by the owner, and to providing for the financial contingencies of an unsuccessful claim.

Factors other than an adverse Internal Revenue Service determination as to tax ownership can also affect the owner's economic expectations. The owner may lose its need for the tax benefits through lessened taxable income; future changes in federal tax law could affect either the tax benefits or the tax owner; and the investment tax credit could be recaptured by the IRS due to a presumed disposition of the project where a permanent shutdown occurs for any reason.

Indemnification by the Municipality. Vendors sometimes seek indemnification from a municipality should a loss of expected tax benefits occur. Indemnification indeed may be requested for all of the federal tax benefits which the vendor expected, not merely that portion (say, 25%) of the benefits which were to be shared with the municipality through service fee reductions.

Providing such indemnification raises significant potential legal and policy problems. In many jurisdictions the authority to agree to tax indemnification does not exist with sufficient clarity, even if indemnification is framed in terms of an adjustment to the service charge. As a policy matter, the difficulties of identifying and measuring such a risk and the dramatic impact on the service charge should the contingency occur may argue against a municipality's assumption of this risk.

Some vendors, in light of these considerations, do not seek municipal tax indemnification. Their assumption of this

risk, which is generally outside anyone's control, is naturally reflected in a lessened share of the tax benefits which they offer to the municipality. The sensitivity and importance of this issue make its early resolution desirable.

Disadvantages of Private Tax Ownership. Beyond possible tax indemnification, private ownership entails some clear disadvantages to the municipality. The service contract cannot run for the full useful life of the plant, even though the municipality is, in a sense, paying for the plant through the service charge. Disposition of the plant's residual value must remain in the discretion of the vendor. The vendor must be free to offer service to other users from excess capacity or when the plant is otherwise not needed to provide service to the municipality. Design, construction, operation, possession and general control of the facility must rest with the owner. As long as service is provided, the municipality's rights are generally limited to inspection and receiving limited classes of information. These disadvantages must be weighed against the value of the equity to be contributed by the owner. Among the major projects, examples of private tax ownership and public ownership may both be found.

8. Waste Flow Control

Need For Flow Control. A resource recovery project may become uneconomical if insufficient waste is delivered to the facility to permit it to operate at or near capacity. Especially where facility financing is secured primarily by project revenues, it is important that an adequate supply of waste be committed to be delivered to the facility for the entire term of the financing, which may be in excess of twenty years. Where such quantities of waste cannot contractually be committed to the facility, municipally enacted flow control ordinances may be required to insure an adequate supply of waste at a facility. Such ordinances generally regulate (a) the sites at which waste generated or brought within a jurisdiction may be disposed of and (b) the tipping fee charged for disposal at the designated site.

Antitrust Considerations. It may be argued that regulation of disposal fees and direction of all waste to a particular resource recovery facility constitutes monopolization and an unfair restraint of trade and thus violates the federal, and possibly state, antitrust laws. The United States Supreme Court in Community Communications Company, Inc. v. City of Boulder, Colorado, limited the situations in which actions taken by municipalities are exempt from challenge under the fedreal antitrust laws. In order for a "state action" antitrust exemption to apply to municipal actions, the challenged activity must be in accordance with and pursuant to a "clear articulation and affirmative expression" of a state policy. Furthermore, the Court articulated but did not pass on the applicability of a second requirement that may be necessary for a state action exemption, that of "active state supervision" of the challenged activity. Subsequent to the Court decision in Community Communications, several circuit courts have ruled that the "active state supervision" requirements is inapplicable to a Municipality engaged in regulating a traditional municipal function such as waste disposal, and other, while not expressly stating that such state supervision is required, have concluded that, in any event, the standard was met by minimal involvement by a state or state agency. Each state's laws, will have to be reviewed individually for antitrust considerations.

Principal Contractual Arrangements for Resource Recovery Facilities

Irwin M. Heller

Mintz, Levin, Cohn, Ferris, Glovsky and Popeo, P.C.
Boston, Massachusetts

PRINCIPAL CONTRACTUAL ARRANGEMENTS FOR RESOURCE RECOVERY FACILITIES

Irwin M. Heller, Esq.
Mintz, Levin, Cohn, Ferris, Glovsky and Popeo, P.C.
One Financial Center
Boston, Massachusetts 02111

I. Thematic Considerations
II. Construction Contracts
III. Waste Supply Contracts
IV. Operations and Maintenance Agreements
V. Electric Contracts
VI. Thermal Energy Contracts

I. THEMATIC CONSIDERATIONS

A. Project Financing. Many resource recovery facilities are "project financed": Revenues generated by a facility must be sufficient to support operating costs and the financial commitments that have been made to construct the facility.

B. Framework of Financing. The major contractual arrangements entered into in connection with development of a facility provide the framework of the project financing structure.

1) The construction contract represents the largest single cost of developing the project.

2) The solid waste and energy sales contracts are the "engine" that drives the project during operation. Collectively they provide the project's fuel and its saleable products.

C. Is it Financeable? A project will never be built unless it is financed. The major objective of the developer in negotiating contractual arrangements for a resource recovery facility is to obtain contracts that contribute to the creditworthiness of the project in the estimation of the financial community. Achieving certainty of price - of payment - of timing - of duration - is a goal that may sometimes exceed in importance potential profit maximization.

D. Fairness. Resource recovery facility contracts for solid waste and energy sales are typically long term contracts having terms of 20-25 years. Contracts that are perceived to be unfair by one or both parties for such a long period can be expected to adversely affect the smooth and uninterrupted operation of a project.

II. CONSTRUCTION CONTRACTS

A. Three Major Risks. Most of the negotiation of a resource recovery facility construction contract involves the allocation as between the developer and contractor of three forms of risk:

1) Price risk

2) Delay risk

3) Technology risk

B. Price Risk. The concept of a project financing involves the raising of a finite sum of money for development and construction of a project. Typically the largest expenditure component is for construction. There is usually a limited construction contingency reserve to provide for change orders and unanticipated additional costs. The fact that this reserve is limited cannot be overemphasized. Every effort must be made to eliminate price uncertainty in the construction contract since there is likely to be no money available to provide for cost overruns in a project financing context.

1) Firm Fixed Price. The developer should be prepared to accept a higher firm fixed price instead of a lower "estimated" or "anticipated" cost-plus price. The former is project financeable; the latter are not.

2) Inclusive Scope of Work. The contractor's scope of work should be stated in inclusive language (i.e. "everything needed to . . .") rather than by specific task enumeration. There is always a danger of forgetting something critical - and expensive. Inclusive language puts the onus on the contractor to think of everything needed and gives the developer a degree of negotiating

advantage if the contractor forgets something and requests a price increase.

3) General Contractor. Designate a general contractor. Construction without a general contractor will inevitably lead to requests for change orders and price increases "necessitated" by another contractor's work product. A general contractor's participation will reduce the likelihood of "finger pointing".

4) Acceptance of Site. Insist that the contractor accept the construction site "as is". Unanticipated rock ledges or unstable soil conditions can dramatically increase a contractor's costs. Encourage contractors to perform borings and soil tests <u>before</u> the contract is signed, even if the cost of borings increases the contract price.

5) Change in Law. Narrow the list of situations in which regulatory changes (environmental, land use, public utility, etc.) can affect price. The contractor's price should certainly reflect adherence to any laws and regulations in effect as of the date of the contract. The developer should attempt to enlarge the contractor's risk to include some or all of the following: laws and regulations proposed as of the date of the contract; laws and regulations in effect or proposed as of the date of commencement of construction; or all laws in force or proposed as of the completion of construction.

6) Force Majeure. Narrow the definition of force majeure. Acts of God, strikes, acts of government, inclement weather, etc. may delay construction and thereby increase a contractor's costs. The developer should try to limit the circumstances in which delay will entitle a contractor to a price adjustment.

   a) Make the contractor take some or all of the risks

   b) Permit price increases on account of force majeure delays only to the extent

that aggregate delays exceed a specified duration (e.g. 30 days, 60 days, 120 days).

c) Limit price increases to the contractor's documented additional costs (i.e. no extra profit).

d) Obtain insurance covering additional costs on account of some or all circumstances constituting force majeure, or have the contractor obtain such insurance.

7) Sales Tax. Make sure that sales taxes are included in the firm fixed price or are otherwise provided for in the project's financing budget.

C. Delay Risk. A project financing includes an amount budgeted for construction period interest based on the anticipated construction completion date. Once this budgeted amount and any reserves set aside for this purpose are expended, there is no ready source of funds available to meet the financial obligations of the project pending the commencement of commercial operation. It is critical, therefore, that a completion date be identified and that suitable financing arrangements be made to cover the possibility that the construction is not completed on time. Both of these issues can be addressed in the construction contract.

1) Guaranteed Completion Date. The contractor must promise to complete construction of the project on or before a specified date. It is to the advantage of the project to ascertain that the time frame to which the contractor agrees is reasonable in the context of the industry experience. Pushing the contractor to promise unrealistically early completion will only result in a lower-than-necessary budget for construction period interest and the likelihood of financial difficulty.

2) Force Majeure. As is true with respect to price (see above), the circumstances justifying delay beyond the promised completion date should be limited or eliminated from the contract so that the risk

associated with them is borne, as much as possible, by the contractor. Such circumstances might include regulatory changes, strikes, or other events falling within a definition of force majeure. To the extent that the contractor refuses to shoulder the entire risk, negotiate to reduce the contingent liability.

a) Permit completion date extensions on account of force majeure delay only to the extent that aggregate justified delays exceed a specified period of time (e.g. 30 days, 60 days, 120 days, etc.)

b) Limit the completion date extension to a maximum period of time (i.e. one year) and provide a reserve in the financing budget to cover the financing cost for that period of time.

c) Obtain insurance in the name of the project developer (or the contractor if the contractor will be liable for liquidated damages) that will pay the financing costs associated with some or all periods of force majeure delay.

3) Liquidated Damages. If completion is delayed due to circumstances within the contractor's control, or due to circumstances beyond the contractor's control as to which the contractor has nevertheless agreed, contractually, to bear the risk, the contractor should bear financial responsibility for the delay. The developer should negotiate for a liquidated damages clause providing that for each day that completion is inexcusably delayed beyond the scheduled completion date, the contractor will pay liquidated damages at least equal to the financing cost of the project for that day.

a) In the context of a $100 million project, liquidated damages relating to financing costs are likely to total $25,000 to $30,000 per day. It is essential for the creditworthiness of

the project that the contractor have the financial wherewithall to shoulder such obligations. In some cases, and for certain categories of delay risk, the contractor may be able to obtain insurance.

b) It should be recognized that actual damages resulting from unjustified late completion are not necessarily limited to financing costs. The developer, particularly if it is a public entity, may have firm obligations to dispose of waste as of the date of anticipated completion and may incur substantial costs in making alternative disposal arrangements. In addition, anticipated energy sales revenues are reduced or eliminated by late completion. It may be appropriate to consider these damages elements in fashioning liquidated remedies.

c) The developer should strive to make the obligation to pay liquidated damages absolute and unconditional in the event of inexcusable delay.

d) The contractor may be able to share the burden of liquidated damages with and among its subcontractors. The developer should look solely to the general contractor, however, so as not to be caught in the middle of a finger-pointing exercise among sub-contractors.

e) The burden on the contractor may be reduced in some circumstances by netting any revenues generated by the project against the financing cost. For instance, if the project is in the acceptance testing stage, it may be generating significant revenues notwithstanding that it is not "completed". These revenues might be applied to financing cost before liquidated damages.

f) All or a portion of the liquidated damages payments made by the contractor might be repaid to the contractor out of project profits, if, as, and when received.

g) The contractor who assumes the risk of delay by agreeing to pay liquidated damages is making an extraordinary financial commitment. The commitment will inevitably be reflected in the price.

4) Early Completion Incentives. Desire to avoid liquidated damages liability will provide strong incentives to contractors to complete work on or ahead of schedule. Many construction contracts also provide for early completion incentive payments. Such payments may be justified by (and perhaps measured by) the lower-than-anticipated construction period interest payments resulting from early completion and/or by earlier-than-anticipated project revenues. In formulating an early completion incentive provision, however, the developer should be careful to ensure that amounts sufficient for payment are budgeted and available when payment is due, whether from financing proceeds or from project revenues.

D. Technology Risk. Construction of a resource recovery facility involves a category of risk not associated with real estate development or even many industrial projects - the risk that the plant and equipment will not perform as planned or with the efficiency anticipated. The risk derives from a number of factors, including the relative youth of the industry in this country, the developmental nature of some of the technology in use and the heterogeneity of the solid waste feedstock, both as to Btu content and as to material handling characteristics. Financial participants in resource recovery projects are (or should be) acutely aware of technology risks. Together with the developer, they have a strong interest in ensuring that the contractor is contractually obligated to deliver a facility that performs in accordance with its specifications and economically justifies the investment made.

1) Acceptance. A facility should not be "accepted" until it has passed a stringent acceptance test that involves the entire facility. Acceptance of facility components one at a time may be of limited value because the components of a resource recovery facility are interdependent to a significant degree. In general terms, "acceptance" should turn on whether, in compliance with applicable environmental standards and given a particular input of waste, there is a minimum production of electricity and/or thermal energy.

2) Acceptance Tests. Acceptance tests are generally developed and administered by an independent engineering firm retained by the developer and/or the financial participants. Typically the nature of the acceptance test is the subject of detailed negotiations with the contractor.

   a) Acceptance tests should be of the longest possible duration, both in number of days and in number of hours of operation per day to provide assurance of the dependability of the equipment. Testing that measures boiler efficiency is complex and expensive; it is sometimes confined to shorter periods than testing designed to measure the ability of a facility to simply accept, process and combust waste at a specified rate or volume.

   b) Acceptance tests should include demonstrated compliance with all applicable environmental permits and regulations.

   c) The results of any acceptance test will depend on the Btu content of the waste employed to conduct the acceptance test. Therefore, one component of the acceptance test must be a Btu analysis of the waste that is employed in the test.

3) Continuing Completion Obligation. Notwithstanding its payment of liquidated

damages (as described above in "Delay Risk") the contractor should be obligated, as its expense, to continue work on the facility until it passes its acceptance tests, or until the developer elects to terminate the contract or make the contractor "buydown" the facility (see below).

4) Performance Guarantees. Contractors make every effort to minimize their ongoing contractual obligations from and after the date of acceptance. From the contractor's viewpoint, once it has turned a facility over to the owner, it loses control of the facility; subpar performance may be attributable to the acts or omissions of the owner or operator. The developer may, however, be successful in obtaining guarantees with respect to individual systems or components of a facility. For instance, the contractor (or one of its subcontractors) may guarantee maximum electrical usage of shredders or material handling components, average or maximum particle size output of shredders, or maximum maintenance requirements of a boiler. If the contractor will operate the facility under an operations and maintenance agreement, of course, it will be easier to achieve continuity of construction contract obligations.

5) Warranties. A contractor's warranties with regard to materials and workmanship should be stated as running from the date of acceptance, not from the date of delivery or the date of first use, since warranties stated in these terms may expire before the date of acceptance, and commencement of commericial operations.

6) Efficacy Insurance. Efficacy insurance, if available (for a sizeable premium), may support, or take the place of performance guarantees. Such policies may provide payment of the shortfall between a project's operating revenues and its financing obligations in the event that the facility does not perform in accordance with particular specifications. While not an entirely satisfactory solution to a

technology problem since lost profit is not recovered, efficacy insurance can maintain solvency of a project while technology is being modified or refined.

7) Buydown. Notwithstanding a facility's inability to pass its acceptance tests, and notwithstanding the contractor's continuing efforts to make the facility pass the acceptance tests, the developer should reserve the right to accept the facility, in its then current condition, at a fraction of the contract price. This may be advantageous if the facility, even at less at a than 100% performance level, can be an economically viable venture. Typically such a right to accept is excercisable after the contractor has been given an opportunity, after the scheduled completion date, to bring the facility to a 100% performance level (while paying liquidated damages). The reduced price at which a facility is accepted in such circumstances is likely to reflect less-than-anticipated waste processing capability and/or less-than-anticipated future energy revenues resulting from either reduced waste processing capability or less-than-anticipated energy conversion effeciency.

III. WASTE SUPPLY CONTRACTS

A. General. No resource recovery facility can be successful - or financed - without a dependable supply of solid waste. The receipt of solid waste generates tipping fees that contribute directly to a project's income economics. More importantly, however, solid waste is the fuel that produces electricity and thermal energy, the prime revenue products of any project.

B. Municipal and Private Sources. Most resource recovery facilities utilize waste obtained through contractual arrangements with municipalities or other governmental units. The "municipal" solid waste is often supplemented by "private" waste obtained directly from commercial waste management companies.

1) "Municipal" waste typically consists of materials discarded by residences. In some municipalities it may also include waste generated by commercial establishments such as restaurants, offices and retail stores. It is typically collected by vehicles owned and operated by the municipality or by private companies working under contract with a municipality and over whom the municipality exercises control with respect to disposal.

2) "Private" waste may consist of household waste, waste generated by commercial establishments and to some degree, by industry. Many suppliers of private waste are small companies whose waste supply resources may be limited, both as to amount and duration, since they may serve their customers on a year to year basis. Their creditworthiness may also be suspect in the context of a long-term contract. The several very large waste management companies that operate in most areas of the country and control large volumes of waste provide more substantial credit support to a resource recovery project, from both waste supply and financial capability perspectives.

C. Term. The developer of a resource recovery facility should strive to obtain waste supply contracts ensuring a supply of waste sufficient to operate the facility for the duration of the financing. In most instances this means 20 or 25 years. With respect to contracts with municipalities, applicable state law must be carefully reviewed to determine the nature and duration of contracts that may be entered into by municipalities and to determine what procedural steps are required in order to make such contracts valid and binding upon the municipality.

D. Volume. As stated above, it is the objective of the resource recovery facility developer to obtain contracts for a supply of waste sufficient to operate a particular facility in accordance with its scheduled plan of operation. It may not be sufficient to contract for a certain number of tons of waste on an annual basis since seasonal fluctuations in waste generation may result in a pattern of shortages and oversupplies. Based on a

study of seasonal waste generation patterns and demographic projections, reasonable and realistic monthly, weekly, or even daily commitments should be established.

E. Pricing. Two methods of pricing are predominant in waste supply contracts. "Fixed rate" pricing is generally accomplished by establishing a per-ton tipping fee that is subject to increase or decrease periodically in accordance with changes in one or another published economic indicator index. In a "net" pricing arrangement, the tipping fee in effect from time to time reflects the amount needed, if any, to bridge gaps between the project's revenues and the project's operational and financing costs, including financing costs.

1) Based on current expectations as to inflation, fixed-rate pricing will result in tipping fees that increase over time. If periodic increases are stated to reflect only a percentage of the increase in an economic indicator, however, tipping fees will not increase as fast as inflation and the true tipping fee cost will decline.

2) If a project is successful, the gap between project revenues and project costs may narrow and tipping fees calculated on a net basis may decrease over time, both in absolute and real terms. If the project is unsuccessful, however, and project costs exceed project revenues to an extent not anticipated, net pricing may result in tipping fees that far exceed expectations. In a sense, net pricing makes the supplier of waste a partner in the project, both able to take advantage of, and vulnerable to, such factors as technology risk, energy price uncertainty, and circumstances constituting force majeure. Net pricing enhances the credit characteristics of a project by introducing additional sources of revenue to cover unexpected costs or circumstances.

3) Fixed-rate pricing provides a degree of certainty to municipal officials; the cost of solid waste disposal in a given year can be accurately predicted for budgetary and planning purposes.

4) Net pricing permits a municipality to share in the success of a resource recovery facility. Assuming a favorable operations experience, a traditional cost of municipal government may even be eliminated. Some net pricing schemes go so far as to share with waste suppliers the excess of project revenues over project costs, thus putting the waste supplier into a position of exploiting a local resource - waste - for profit that can be substituted for tax dollars. The corollary principle is that net pricing can result in unexpected increases in tipping fees in the event of a facility shutdown or malfunction. The potential for increases may result in budgetary uncertainty. There could be potential for adverse political ramifications if a malfunctioning facility doubled or trebled the tipping fee in a particular year, necessitating a dramatic increase in the tax rate of a municipality.

F. Put or Pay. Many waste supply contracts contain "put-or-pay" clauses -- even if the waste supplier fails to deliver its minimum waste commitment, it must pay the applicable tipping fee for its minimum commitment.

1) Put-or-pay clauses are intended to ensure stable and uninterrupted cash flow to the project, and are desirable to financial participants. The obligation to put-or-pay is not a panacea, however; notwithstanding payment or tipping fees, a resource recovery project cannot be successful unless waste is actually delivered, processed and burned for the production of energy.

2) Combined with "net" pricing, a put-or-pay clause essentially pledges the credit of waste suppliers, including municipalities, to the financial viability of a project. To the extent that funds are needed in order to make the project break even, tipping fees are adjustable and payable even if no waste is actually delivered to or combusted by the facility.

3) State law should be carefully examined as to the enforceability of put-or-pay obligations

entered into by municipalities. Cf. Chemical Bank v. Washington Public Power Supply System, 666 P.26 329, 99 Wn.2d 772 (1983).

4) State law should be carefully examined in states in which tax limitation laws are in effect to determine the priority of contractual commitments in the event that insufficient funds are available to meet municipal obligations.

G. Responsibility for Content. Most waste delivered to a resource recovery facility is burned, releasing combustion gases into the atmosphere. Combustion ash is typically landfilled. Some waste is never processed or combusted, but is disposed of directly by landfilling. In each case there is potential for environmental damage or impairment of public health and safety. If the composition of waste delivered to a facility is known, appropriate technological measures can be taken. To the extent that the composition of waste is unknown, however, there is liability risk.

1) For purposes of limiting environmental and public safety risks, waste generated by households is generally thought to be preferable to commercial waste and commercial waste is generally thought to be preferable to industrial waste.

2) Liability that might be associated with the combustion of waste components is particularly undefinable because of the large number of substances involved and relative ignorance as to their effects.

3) Much waste delivered to resource recovery facilities is delivered in closed containers and bags. Unless each is opened individually, the operator of a facility has little control over the nature of the contents. Individual inspection is in most instances not economic.

4) Individuals involved in the waste collection process have some knowledge of the nature of waste that they collect, although such knowledge may be limited to knowing what sort of facility is disposing of the waste (e.g. household, retail store or chemical plant).

5) The developer should try to charge its waste suppliers with responsibility for the content of waste they deliver. It must be recognized, however, that significant problems of causation proof will be encountered in the event that there are several suppliers of waste.

H. Municipal Antitrust Liability. In Community Communications Co. v. City of Boulder, 455 U.S. 40 (1982) the United States Supreme Court dispelled the long-held belief that municipalities were immune from the reach of federal antitrust laws in connection with the performance of traditional governmental functions. City of Boulder narrowed immunity to situations in which a municipality, though engaging in arguably anticompetitive activities, does so in furtherance of a "clearly articulated and affirmatively expressed state policy". Since most resource recovery facilities derive all or part of their waste supply from contracts with municipalities, it is important to assess the potential exposure of the municipality and/or parties contracting with the municipality, to federal antitrust liability.

1) It may be desireable to require a municipality to enact an ordinance or regulation directing that all waste generated in the municipality must be made available to the resource recovery facility or that all waste haulers licensed to do business in the community must deliver waste to the resource recovery facility. Monopolization and restraint of trade claims under the Sherman Act have resulted from such ordinances or regulations. See, e.g. Hybud Equipment Corp., et al v. City of Akron, 742 F.2d 949 (6th Circuit, 1984) Central Iowa Refuse Systems, Inc. v. Des Moines Metropolitan Solid Waste Agency, 715 F.2d 419 (8th Circuit, 1983) and Ideal Waste Systems, Inc., v. Provo City Corporation, 605 F. Supp. 100 (C.D. Utah 1985).

2) Under cases subsequent to City of Boulder, "clearly articulated and affirmatively expressed state policies" sufficient to confer municipal antitrust immunity in cases involving solid waste have been found in

legislation encouraging development of resource recovery facilities and in legislation requiring that appropriate steps be taken to ensure repayment of bonds issued to finance a facility. See Hybud Equipment and Central Iowa, supra. See also Town of Hallie, et al. v. City of Eau Claire, 471 U.S. __, 85 L. Ed.2d 24 (1985).

3) In Town of Hallie, supra, the United States Supreme Court held that "a clearly articulated and affirmatively expressed" state policy need not expressly contemplate specific anticompetitive effects. The Court further held that anticompetitive municipal conduct need not be compelled by state legislation, so long as it is "authorized" by a statutory scheme. Finally, with a view to clarifying prior case law, the Court held that municipal antitrust immunity did not require "active state supervision" of anticompetitive municipal conduct in order to pass muster in cases where the anticompetitive actor is a municipality, as opposed to a private party. Town of Hallie resolves many uncertainties that had arisen in the wake of City of Boulder and is likely to result in a decreased number of municipal antitrust actions in the solid waste area. The Local Government Antitrust Act of 1984, Pub L. No. 98-544, 98 Stat. 2750 (1984) further alleviates concern by providing that no damages, costs or attorneys fees may be recovered from a local government entity or its employees under the Clayton Act. See Jefferson Disposal Company, Inc., v. Parrish of Jefferson, 603 F. Supp. 1125 (E.D. La. 1985).

4) Whether a private party involved in activities as to which a municipality is immune from federal antitrust liability is similarly immune will depend on the facts of a particular case. See Cantor v. Detroit Edison Co., 428 U.S. 579 (1976); Deak-Perera Hawaii v. Department of Transp., Etc., 534 F.Supp. 976 (1983); Areeda & Turner, Antitrust Law §212b (1978).

5) In addition to federal antitrust law, applicable state antitrust should be examined in the context of a particular contractual arrangement.

IV. OPERATIONS AND MAINTENANCE CONTRACTS

A. General. A developer, whether public or private, may not wish to actually operate its resource recovery facility. This may be motivated by lack of interest or expertise, or by financial participants' requiring an experienced operating entity. The natural choice for an operating entity is the construction contractor or an affiliate since that organization will be familiar with the technology and performance standards of the facility. Often construction and O & M obligations are combined in a single agreement between a developer and a contractor.

B. Transitional Problems. If the O & M contractor is not the construction contractor or an affiliated entity, the problems of moving the project from the construction stage in to the operations stage will be exacerbated. If the O & M contractor is expected to guarantee performance of the facility, it will be intensely interested in, and likely to complicate, the performance testing of the facility and will attempt to retain rights against the construction contractor in the event of facility failure. The developer should attempt to limit severly the right of the O & M contractor to claim excuse from its obligations to the developer as a result of what the O & M contractor alleges to be the fault of the construction contractor. In a situation in which the construction contractor and the O & M contractor are the same or affiliated entities, of course, the opportunity and justification for "finger pointing" is reduced.

C. Pricing and Pass-Throughs. O & M contracts may be "cost-plus" arrangements, but they are more commonly based on a fixed price concept. Typically the fixed price covers all labor, supplies and parts needed to operate and maintain the facility at a guaranteed level of performance. The fixed-price may be an annual lump sum, payable in monthly increments, or may be paid on a per-ton-processed basis. The parties may negotiate the "pass-through" to the developer of the cost of

specified materials, supplies (such as chemical reagents for pollution control equipment) and utilities. Utilization of pass-throughs in certain circumstances may lower the annual O & M fee substantially because the O & M contractor is thereby able to shift a risk element, which is difficult to price precisely, to the developer. It may be prudent, however, to limit pass-through costs to budgeted amounts in order to prevent the O & M contractor from engaging in excessive use of supplies to compensate for failure to maintain the facility as contemplated.

D. Performance Guarantees. The revenues of a resource recovery project are dependent, in large part, on the ability of the facility to operate at certain minimum levels of performance. Failure to so operate will jeopardize the success of a project. It is important, therefore, to require an O & M contractor to cause the facility to perform to minimal standards or to pay damages to compensate the developer for lost revenue and/or additional costs.

1) Energy Efficiency. The O & M contractor should agree to produce a specific average amount of steam and/or electricity per ton of waste processed by the facility. Presumably the specified average amount will bear some relation to the production performance of the facility during acceptance testing. The impact of varying Btu characteristics of waste is likely to be discussed during any negotiation of energy efficiency performance guarantees, since Btu content will directly affect energy production. One way to resolve Btu content issues is to assume an average Btu content; another is to periodically conduct tests (which are likely to be burdensome and expensive) to determine typical Btu content and to periodically adjust energy efficiency guarantees based on the results of such tests. If energy efficiency performance guarantees are not met, the O & M contractor might be required to pay damages, measured, perhaps by the difference in value between the energy that should have been produced at the minimal standard and what was actually produced.

2) Throughput. The O & M contractor should agree to process at the facility a minimum tonnage of waste. Since the developer is likely to have ongoing commitments to accept waste from third parties, the obligations of the O & M contractor to accept waste should be coordinated with the developer's obligations to third parties (i.e. minimum monthly or even weekly quantities). If the O & M contractor fails to accept and process specified mimimun quantities, it should pay damages, which could be measured by the costs to the developer of arranging for alternate methods of disposal and/or lost energy revenues resulting from the fact that waste was not processed.

3) Other. Additional performance guarantees may be devised by the parties, such guarantees relating to glass or ferrous metals recovery or guarantees relating to volume reduction.

E. Incentives. Consistent with maintaining the facility in accordance with acceptable standards, the O & M contractor may be offered incentives to operate the facility to maximum potential. This can be achieved by various sharing mechanisms.

1) Sharing Energy Revenues. The O & M contractor is commonly entitled to a share of energy revenues. To the extent that energy revenues increase, either on account of price increase or volume increase, the O & M contractor derives a benefit. A sliding scale sharing arrangement may further enhance incentives by giving the O & M contractor increasing percentages of energy revenues as total energy revenues, or production efficiency, increase.

2) Throughput Incentives. Incentive payments may be made on the basis of the number of tons processed in excess of specified minimum quantities. Such payments might reflect an agreed-upon amount per ton. Alternatively, they might be calculated to reflect the value of the energy produced from the tons of waste accepted in excess of the specified minimum quantity.

F. Force Majeure. As discussed above with respect to construction contracts, the developer and the O & M contractor must allocate (or impose upon a third party such as an insurance company) the risks associated with events of force majeure. The O & M contractor, of course, will seek excuse from its obligations to the extent that it is impaired by force majeure. The developer and its financing participants should attempt to impose such risks, to the maximum extent possible onto the O & M contractor, with the realization, however, that any risks borne by the O & M contractor will be reflected in its basic O & M price and/or its incentive expectations.

V. ELECTRIC CONTRACTS

A. General. The most important revenue source of most resource recovery projects is the sale of electricity. Most projects sell 100% of the electricity they produce to public utilities pursuant to long term contracts. Some projects sell a portion of their output to retail customers. Since many public utilities have high credit ratings, a contract with a public utility pursuant to which the public utility agrees to buy the electrical output of a facility will provide significant credit support for the project's financing. The terms of a particular contract can enhance the degree of support.

B. PURPA. All resource recovery facility electricity contracts are negotiated and drafted in the context of PURPA.

1) PURPA, the Public Utility Regulatory Power Act of 1978, guarantees a market for most electricity that is cogenerated or generated with renewable resources such as solid waste. The guarantee is effectuated by compelling utilities to buy the output of a qualifying facility.

2) PURPA provides that the price to be paid by a utility is to be determined by the individual utility's full avoided costs, (i.e. the cost the utility would have otherwise incurred in generating or buying the same electricity). The pricing policies of PURPA were upheld in American Paper Institute, Inc. v. American

Electric Power Service Corp., 461 U.S. 402, 76 L. Ed.2d 22 (1983).

3) PURPA exempts equalifying facilities from most regulation under the Federal Power Act, the Public Utility Holding Company Act and state laws affecting public utilities. The extent to which PURPA exempts a particular facility from state regulations (which is important inasmuch as the degree of state regulation may affect characterization if the facility for depreciation and investment tax credit purposes) must be determined by reference to state law. In any event, PURPA does not cover intrastate or retail sales or their regulation by state law.

4) PURPA by express language does not prohibit qualifying facilities from entering into contracts with public utilities that vary from PURPA regulations.

C. Contract as PURPA Alternative. PURPA does not make a resource recovery facility financeable because provisions of PURPA that compel utilities to purchase the output of a qualifying facility can be altered or eliminated by legislation and interpreted by the courts at any time. From a credit point of view, it is preferable to enter into a long-term contract with a public utility on terms and conditions similar to those that would be applicable to a compelled sale and purchase under PURPA. In addition to providing a measure of certainty, resource recovery project is more likely to enjoy a good working relationship with its energy purchaser under an agreement that is mutually satisfactory. Several state regulatory bodies have, by regulation, developed "standard offer" contracts that utilities are required to offer alternative energy projects.

D. Avoided Cost Considerations. Many contracts for the electrical output of a resource recovery facility calculate price by reference to "avoided costs" of the public utility. In exchange for its long-term commitment to purchase, the public utility will agree to pay a percentage (typically 90%-100%) of the avoided cost that it would otherwise pay under PURPA.

1) Different utilities have different avoided costs depending on the type and age of their generating equipment and their fuel mix. Avoided costs can fluctuate seasonally. A survey of all local utilities should be conducted to determine which one may be in a position to offer the best price.

2) Distinguish "full" avoided cost (which includes capital costs) from "avoided fuel cost", which takes into account only the fuel cost that would have been incurred if the public utility had generated the electricity itself.

3) Avoided costs will usually be calculated on time of use "off-peak" (lower) "semi-peak" and "on-peak" (higher) bases.

4) From a financing perspective, reference to avoided cost as a pricing mechanism is increasingly undesirable due to fluctuating fuel prices and uncertainty as to future trends. A possible alternative approach, in addition to those described below, is to project (based on current information) an avoided cost per kilowatt as of the anticipated in-service date of the facility and to adjust this base price in accordance with an index on which fuel prices have a relatively minor impact.

E. Special Pricing Considerations. In some situations, public utilities have agreed to purchase electricity generated by a resource recovery project on terms that provide more credit support than "avoided cost" pricing.

1) Willingness of Public Utilities. Some public utilities actively encourage the resource recovery industry and will agree to special credit support mechanisms if they are necessary to accomplishment of the project. In some instances the utilities' position derives from regulatory pressure.

2) Floors. A public utility may agree that the price it will pay for electricity produced by a resource recovery facility, although generally calculated by reference to avoided

costs, will never fall below a specified minimum. This ensures a minimum level of project revenue if the facility produces a given output of electricity.

3) Levelized Pricing. A public utility may agree to pricing terms that contemplate a uniform price during the entire term of the contract, or two or three pricing periods during which the price is stable. This pricing structure is likely to result in a price that is substantially higher than "avoided cost" in the early years and a price below "avoided cost" in later years. A public utility entering into such an arrangement takes a risk that the facility will be viable in the later years; otherwise it may not be able to recoup its "overpayment" in the early years. As a condition of taking this risk in public utility may demand collateral security such as a utility bond, a letter of credit or a mortgage on project assets.

4) Financing Support. A public utility may agree to temporarily increase the price it pays to permit a project to meet a financing obligation installment payment. The aggregate amount of the increase may be repayable out of future profits or reflected in a price decrease during a subsequent period.

F. Capacity Charges. If a resource recovery project contracts to supply a minimum quantity of electricity over a stated period it is likely to obtain a significantly higher price per kilowatt by virtue of a capacity charge. The increased price may be stated in terms of a higher percentage of peak, semi-peak and off-peak avoided costs or as an additional lump-sum payment.

1) In calculating its minimum output requirement, the seller must give itself (or the pricing assumptions must contain) generous allowance for planned and unplanned outages since there may be a significant penalty (price step-down) if output is less than that committed.

2) Responsibility for minimum output may necessitate acquisition of backup equipment and/or the maintenance of standby fuel supplies.

3) Responsibility for delivering a minimum output should commence only at such time as the facility has achieved full-scale commercial operation. During start-up, when electricity generation may be sporadic and fluctuating, the utility should agree to purchase electricity on an as-available basis without in any way compromising the capacity charge pricing applicable to full scale operation.

G. Wheeling. For a negotiated fee, a public utility may agree to transmit, or "wheel", electricity produced by a resource recovery facility to another public utility. Conceptually this permits a resource recovery facility to take advantage of the best available price. For example, a resource recovery facility might sell power to its local public utility during the winter months and wheel power to other public utilities during the rest of the year. As a practical matter, however, the magnitude of wheeling fees and the loss of capacity charges that is likely to result from a wheeling arrangement diminish the attractiveness of wheeling.

H. Interconnection. PURPA contemplates that the cost of interconnecting a qualifying facility to a public utility will be borne by the qualifying facility. Most long-term contracts with resource recovery facilities adopt this model, but there is no requirement that they do so. Depending on geographic and other circumstances the cost of interconnection can be significant. The right of the utility to modify or substitute for interconnection equipment should be clearly defined and limited, particularly if the resource recovery project is responsible for all or a portion of the cost.

I. Term. The term of a contract with a public utility should be at least as long as the project's financing arrangements. The resource recovery project may, however, wish to reserve an option to terminate the contract so that it can take advantage of a more attractive pricing structure offered by another utility.

J. Obligation of Utility to Purchase. Circumstances in which a utility is not obligated to purchase electricity generated by a resource recovery facility should be carefully circumscribed. Only if acceptance of electricity would damage the utility's transmission assets should the utility be excused from accepting and paying for electricity.

K. Regulatory Controls Over Contracts. Notwithstanding PURPA, state regulatory authorities may assert, or purport to assert, jurisdiction over certain aspects of long-term contracts with public utilities. Accordingly, utilities frequently attempt to include in contracts a provision to the effect that the terms and conditions of the contract are subject to applicable regulatory approvals and actions. This may raise questions about the enforceability of a particular contract and limit its value as a credit support document. Counsel to a resource recovery project should attempt to limit the impact of such clauses by specifying particular aspects of the contract that may be subject to regulation and by requiring the public utility to perform its obligations under the contract unless compelled to do otherwise by a regulatory body having jurisdiction.

L. Ratepayer Protection. A consistent theme in utility negotiations is that a public utility is duty bound to protect its ratepayers. Arguments that may be employed to countervail this assertion (especially in cases where the price to be paid by the utility is avoided fuel cost) are 1) that the public utility is avoiding significant capital expenditures by contacting with the recourse recovery project, and 2) that it is good public policy to encourage the development of alternative fuel use.

VI. THERMAL ENERGY CONTRACTS

A. General. In many resource recovery projects, the sale of thermal energy (steam and hot water) is secondary in importance to the sale of electricity. This is due, in large part, to the fact that thermal energy users generally have lower credit ratings than public utilities. There is also less certainty of continuing sales to thermal energy users due to facility relocation or technology change. Nevertheless, thermal energy

sales can produce substantial revenues, which, if combined with electric sales revenues, can give a cogenerating resource recovery facility the potential for enhanced profitability.

B. Potential Customers. Selection of potential customers should focus on customer needs and location since the distance that thermal energy can be transported efficiently is limited.

1) Institutional Customers. Institutions such as federal, state and local governments, military bases, educational facilities and hospitals are potential users of thermal energy for heating purposes. Institutional customers are less likely to move or close down than customers in other categories, so that their credit support contribution can be significant. Sales to customers in this group can be expected to be seasonal unless thermal energy use can be utilized in connection with cooling capability.

2) Industrial Customers. Industries have the potential to use enormous quantities of thermal energy, both for industrial process and heating purposes. Industrial customers are, however, more prone than institutional customers to shutdown or relocate as a result of general economic conditions or changes in technology. They may be reluctant, therefore, to enter into long term contracts, especially long-term contracts with minimum purchase guarantees.

3) Steam Loops. Many older cities have unused or underutilized steam loops serving a variety of industrial, commercial and residential users. While no individual customer can provide an economic steam market for a resource recovery facility, a combination of readily accessible customers may justify the providing of service, particularly if the steam line is already in place and the capital costs of interconnection can be minimized. The risk of customer shutdown or relocation is ameliorated by large numbers of customers.

C. Seasonality. To a much greater extent than for electricity, thermal energy sales are seasonal to the extent that they provide energy for heating purposes. To maximize thermal energy revenues, consideration should be given to scheduling planned facility downtime (for maintenance or capital replacement) during periods when thermal energy demand is historically low.

D. Continuity of Supply. Unlike electric utilities, which typically obtain power from a number of generating sources, thermal energy customers are likely to rely on a single source of supply. To meet this need, a resource recovery must have redundant, or backup operating systems, so that thermal energy supply can be maintained at all times. Without such capability the process of marketing thermal energy becomes significantly more difficult.

1) A seller should negotiate for contractual language that recognizes that service will be interrupted on occasion.

2) A seller should resist contractual language that facilitates termination by a customer in case of service interruption and should limit the grounds for termination to repeated interruptions of long duration.

E. Term. Long term thermal energy contracts are less frequently encountered than long term electric contracts. They are very desirable, however, from a financing viewpoint.

F. Pricing. The most effective way to market thermal energy produced by a resource recovery facility appears to be to offer a potential customer a price that reflects a discount of the customer's avoided cost of thermal energy utilizing traditional fuel sources and its own equipment.

1) A customer's true avoided cost reflects its fuel cost and mix, its current and projected capital costs and its potential maintenance savings.

2) Frequently the customer is not aware of the magnitude of its thermal energy costs; representatives of the resource recovery

project must take the initiative and generate an analysis that can serve as basis for negotiation.

3) Escalation clauses ensure continuing profitability to the resource recovery project and maintain the price to the customer at or lower than the cost it would pay if it generated its own thermal energy. Price escalation can be effected by reference to increases or decreases in fuel prices, or by reference to published economic indicator indexes.

4) Most thermal energy contracts provide significant volume discounts.

G. Take or Pay. Take or pay contracts, providing for payment for a minimum quantity of thermal energy even if delivery is not accepted, are viewed favorably by financial participants, particularly if the customer is a large institution or industrial plant. The financial certainty resulting from a take or pay contract may justify a significantly lower price structure. If a take or pay arrangement is unacceptable to a particular customer, the next approach should be a "requirments" contract whereby the customer agrees to purchase all steam that it uses from the resource recovery facility.

H. Interconnection. Interconnection with customers entails significant capital expenditures for the planning and construction of distribution facilities. Although customers may be asked to share in this cost, it is unlikely that they will agree to do so.

1) Steam customers are likely to have differing interconnection requirements since heating and industrial uses require that steam be supplied at a variety of pressures.

2) The responsibility of the resource recovery project should end at the customer's premises. The customer should be responsible for distribution of steam on its premises.

I. Regulation. Steam distribution may be subject to the jurisdiction of state or local regulatory authorities. State law should be reviewed to determine the nature of any applicable laws or regulations.

3607T

Resource Recovery: Options and Economics

Lee F. Jackson

Kidder, Peabody & Co.
New York, New York

The implementation of a resource recovery project requires public officials to make many choices that will affect project revenues and expenses. The relationship between revenues and expenses, or "project economics," is important because, like a business, there is a direct relationship between project "profitability" and the ability of the project to return "dividends" to its owners. The dividends to the community take the form of lower tipping fees and reliable service.

We begin our discussion of project economics with a description of the various revenue sources and the risk and contractual options associated with each revenue source. A brief description of project expenses follows. Next, we compare the project economics of a publicly owned facility with a privately owned facility. Finally, we discuss the impact of the President's Tax Proposal on resource recovery project economics.

I. REVENUE SOURCES

Resource recovery projects receive revenue from several sources including tipping fees, energy sales and recovered material sales. Some projects also receive fees for processing the waste of other communities. Energy and recovered material revenues can fluctuate significantly over the life of the project, depending on the amount of waste processed and energy and recovered material prices. The allocation of the risk associated with these revenue sources is important since swings in project revenue can be passed through to the tipping fee.

A. Tipping Fees

The amount and potential variability of tipping fee payments are extremely important since tipping fees represent the cost to the community of implementing resource recovery.

Public officials can select one of two means of calculating tipping fees for a privately owned project. This choice will affect both the amount of the initial tipping fee and the tipping fee over the life of the project.

Bid vs. Formula Tipping Fee

Tipping fees may be calculated on the basis of a formula ("formula tipping fee") or on the basis of a fixed tipping fee bid by the vendor ("bid tipping fee"). With a formula tipping fee, the tipping fee is equal to the sum of debt service on the bonds issued to finance the project (net of any investment income) plus operation and maintenance costs, less the community's share of energy revenues. In this instance, the tipping fee is directly affected by energy price fluctuations. If energy prices rise, the community pays a lower tipping fee. If energy prices fall, the community pays a higher tipping fee. The bid tipping fee is a relatively new concept under which the vendor bids a fixed initial fee which is escalated only by an inflation factor and the cost of certain narrowly defined uncontrollable circumstances. The community does not bear the risk nor the reward of energy price fluctuation.

The choice of a bid or formula tipping fee will affect vendor selection. Since the vendor bears the energy price risk with a bid tipping fee, it is important that the vendor have the financial capabilities to meet its commitments if energy prices decline sharply. Indeed, some smaller vendors may be unwilling to submit bids on this basis.

The choice of a bid or formula tipping fee will also affect the risk sharing arrangement described in the service agreement. For example, with a bid tipping fee structure, vendors typically require that a community compensate the vendor for lost energy revenues in addition to paying the tipping fee if the community fails to deliver its guaranteed tonnage.

It is impossible to say which business structure will result in the lowest tipping fee over the life of the project. Bid tipping fee structures typically have lower initial tipping fees, but the tipping fees will rise slightly over time. Formula tipping fees tend to decline over time. A public official may request potential vendors to submit proposals on both a formula and bid tipping fee basis.

B. Energy Revenues

Selecting an Energy Purchaser

Most resource recovery facilities are capable of generating electricity and steam. The energy can be sold to a variety of customers, including privately owned utilities, private companies, publicly owned utilities and other public entities.

Energy sales are an important source of project revenues, typically comprising between 30 and 60 percent of total revenues. Thus, selecting the energy purchaser(s) is an extremely important decision. To date, most projects have entered into energy purchase agreements with privately owned utilities. However, there are several significant exceptions. For example, the Dutchess County, New York facility sells steam to the IBM Corporation. The Chicago, Illinois facility sells steam to the Brach Candy Company. Finally, the Saugus, Massachusetts facility sells steam to the General Electric Corporation. Moreover, the project need not sell a single type of energy to a single purchaser. For example, the Dutchess County facility also sells electricity to the local utility.

Energy Purchase Agreements

There are several types of energy purchase agreements. The most common form of energy purchase agreement is an agreement to sell electricity to a privately owned utility under the Public Utilities Regulatory Policies Act of 1978 ("PURPA"). Under PURPA, private utilities are required to purchase power from certain alternative energy producers (including resource recovery projects) at the utility's "avoided cost" (i.e. the cost "avoided" by the utility by purchasing power from the alternative energy producer). A utility's avoided cost is generally higher than its average cost since a utility will typically use lower cost means of energy production first. Under a PURPA contract, the price received by the community will vary with the utility's marginal cost of producing energy.

Much of the uncertainty surrounding energy prices can be removed by entering an energy purchase contract with a fixed price schedule over the life of the contract. Typically, this type of contract will include a price escalator to reflect anticipated energy cost increases. If the public official is concerned about high early year tipping fees, an energy purchase agreement may be negotiated that pays prices higher than projected avoided cost in the early years and prices lower than projected in in later years. The energy purchase agreement for the Commerce, California resource recovery facility includes this type of provision.

C. Other Revenue Sources

Other sources of revenue for resource recovery projects are recovered materials and host fee payments.

Recovered materials are typically metals that are removed from the waste stream and sold to scrap purchasers. Generally, recovered material revenues do not account for a significant portion of project revenues. Moreover, material recovery revenues are very sensitive to world metal prices.

Host fee revenues are a possibility if the resource recovery facility has been built to process solid waste in excess of the amount guaranteed to be delivered by the community. The excess capacity can be filled with waste delivered from sources outside the host community. Naturally, outside users will pay a fee to have their waste processed. In addition to providing another revenue source, constructing excess capacity allows the community room for growth in meeting its solid waste disposal needs. The danger of constructing excess capacity is that the community and/or the vendor may not be able to fill the excess capacity. In this instance, the community and/or the vendor must pay the additional capital cost associated with a larger facility without concomitant increased revenues.

II. EXPENSES

The two major expense categories are operation and maintenance costs and debt service payments.

The operation and maintenance charge should be fixed and subject to escalation only by reason of inflation, community fault or uncontrollable circumstances.

The amount of debt service payments will depend on the size of the project, the rating on the debt and the financing structure chosen. There is a wide variety of financing options available to resource recovery issuers. Recently, many resource recovery financings have involved variable interest rate structures, which provide lower initial interest costs but subject the project to the possibility of increased rates in the future. Resource recovery financing options are examined in much greater detail in the papers prepared for the Financing Alternatives panel.

III. PUBLIC VS. PRIVATE OWNERSHIP

A key consideration in implementing resource recovery is whether the project should be publicly or privately owned. In a privately owned project, the vendor pays a portion of the project cost with an equity contribution (thus reducing the size of the bond issue) and constructs, owns and operates the facility. The vendor realizes certain tax benefits as a result of ownership and shares these benefits with municipalities through reduced tipping fees. In a publicly owned project, the community owns the project and contracts the construction and operation of the project to private firms.

Tipping fees are typically lower throughout the life of the project under private ownership. Another benefit associated with private ownership is that vendors are typically willing to accept greater risk if they own the facility. One disadvantage of a privately owned project is that the community does not own the project at the end of the term of the service agreement.

We performed an economic analysis of a hypothetical 1,600 ton per day project under public and private ownership assumptions.* The initial tipping fee for the privately owned project was $26, as compared to $39 for the public owned facility -- a 50 percent difference. However, in our model the public ownership tipping fee declined over time while the private ownership tipping fee rose slightly. The present value of tipping fee payments at a 10% discount rate under the private ownership scenario was less: $159 million for private ownership versus $185 million under public ownership.**

IV. POTENTIAL IMPACT OF THE PRESIDENT'S TAX PROPOSAL

The potential impact of the President's Tax Proposal on the economics of resource recovery projects is negative and severe. It is important to note, however, that if passed, the President's Tax Proposal is not expected to affect projects financed prior to January 1, 1986.

The elimination of tax-exempt financing (for "private purpose" projects), the investment tax credit, accelerated depreciation, and loss of other tax benefits would radically reduce the attractiveness of private ownership. In our hypothetical model, the initial tipping fee for a privately owned facility under the President's Tax Proposal would be $43 as compared to $26 for a privately owned project under current tax law. The present value of total tipping fee payments at a 10% discount rate over the life of a privately owned project under the President's Tax Proposal would be $290 million, as compared to $159 million for private ownership under current tax law and $185 million for public ownership under current tax law.

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* Note that the private ownership case assumes a bid tipping fee while the public case assumes a formula tipping fee.

** Our model incorporates many assumptions that may not be applicable to your project. Thus, the results do not necessarily predict tipping fees for any particular project, but, rather, illustrate relative tipping fees under the two ownership scenarios.

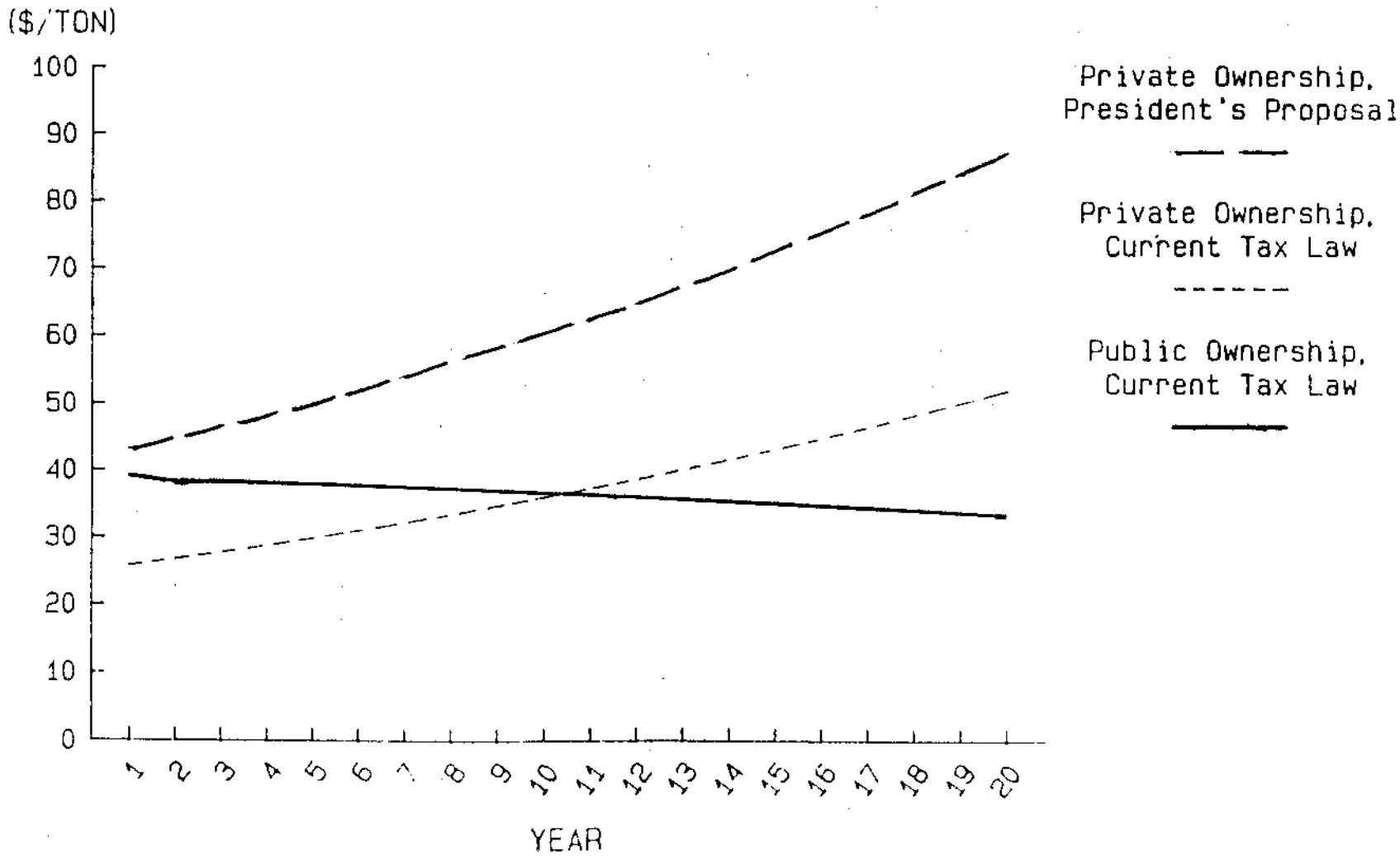
The President's Tax Proposal also poses problems for publicly owned projects. Under the President's Tax Proposal, tax-exempt financing would be denied to publicly owned projects that hire private operators under long-term management contracts (more than one year). The inability to secure a professional operator for the life of a project would increase the risk of operating mishaps and make the project more difficult to finance. Tax-exempt financing would also be denied to publicly owned projects that sell energy under long term contracts to privately owned utilities or companies, thus severely restricting energy sale options.

The graphs on the following pages compare tipping fees under public and private ownership and illustrate the effect of the President's Tax Proposal on our hypothetical project.

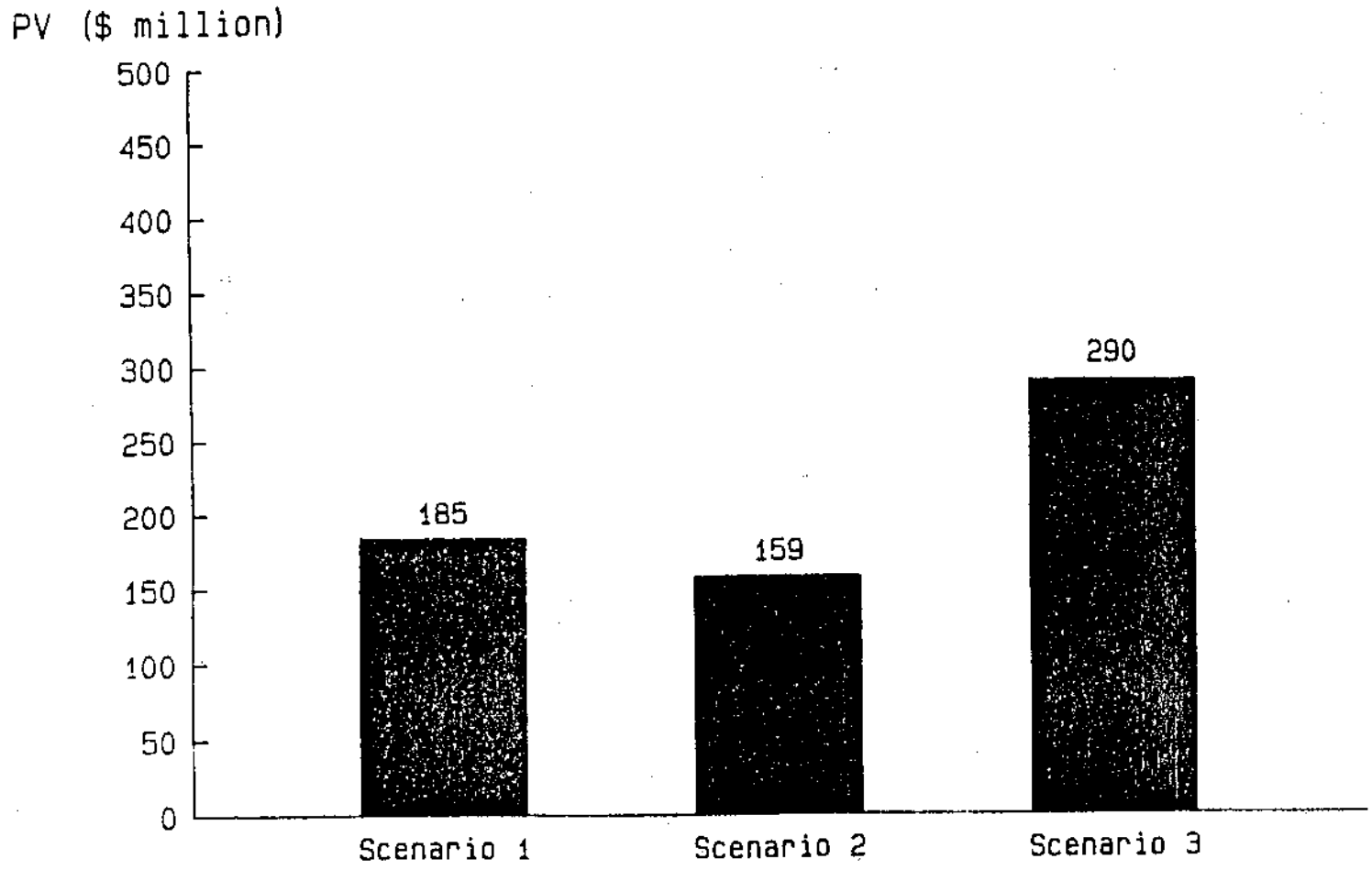
V. CONCLUSION

Despite the uncertainty resulting from the current tax reform debate, many of the factors that dictate project economics are under the control of the public official. Thus, extreme care should be taken in deciding between public or private ownership, bid or formula tipping fees, and electric and/or steam energy sales. It is important to remember that each resource recovery project is unique and the choices made by a neighboring project may not be in the best interests of your community.

HYPOTHETICAL PROJECT
TIPPING FEE COMPARISON



HYPOTHETICAL PROJECT PRESENT VALUE OF TIPPING FEES



Scenario 1 : Public Ownership, Current Tax Law
Scenario 2 : Private Ownership, Current Tax Law
Scenario 3 : Private Ownership, Pres. Proposal

Resource Recovery Project Economics: Thermal Markets

Nancy Winkler

Public Financial Management, Inc.
Philadelphia, Pennsylvania

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RESOURCE RECOVERY PROJECT ECONOMICS

THERMAL MARKETS

As you develop your resource recovery project, you should investigate the feasibility of thermal energy sales. Thermal markets can provide economic benefits to a resource recovery project for two main reasons: (1) thermal markets create an opportunity for cogeneration, and (2) thermal heat is often priced higher than electrical energy. Thermal energy can be sold either in the form of hot water or steam. There are several possible thermal energy markets:

- Sales of steam or hot water to institutions such as hospitals, schools, prisons and universities for heating and cooling;
- Sale of process steam for industrial uses - either to a single user or multiple users such as an industrial park; and
- Sale of steam or hot water to district heating and cooling systems.

Feasibility of thermal energy sales will be based upon a number of project specific components which I have classified into three main project criteria:

1. Availability of a stable customer demand within a feasible distance from the resource recovery plant;
2. Ability to negotiate meaningful take or pay energy sales contracts with thermal customers; and
3. Ability of the resource recovery project to provide thermal energy at an attractive price to both the customer and the project.

Criteria 1: Availability of a stable customer demand within a feasible distance to the resource recovery plant.

a. Potential steam customers' energy demand should be analyzed to determine fluctuations due to time of day, day of week and season of the year. During periods when the thermal customer's demand is low, electricity can be generated. However, the more volatile the thermal customer's demand, the more likely the economic benefits of cogeneration will be reduced.

If you plan to cogenerate, a good balance must be struck between thermal and electrical sales. This allows for efficient design of the turbine and can allow you to maximize energy revenues. The economic benefits of cogeneration can be reduced if:

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i. the need to provide peaking thermal energy to a customer reduces the project's ability to base load electricity and receive capacity credits and

ii. a majority of the electric energy is sold during times of the day, week and year when electric rates are low (e.g. nights, weekends, spring and fall)

b. The greater the distance of the thermal customer from the resource recovery plant, the higher will be the capital costs of transmission. Increased captial costs can substantially reduce economic benefits of thermal sales.

c. The classes of thermal customers' demand are very roughly characterized as follows:

Customer Type	Demand
District heating	High in Winter
District heating and cooling	Less seasonal fluctuations than heating only; highest demand in summer and winter
Industrial Process Steam	Fluctuates by time of day and season
Large heating and cooling customers (schools, hospitals, prisons)	Depends upon use and type of building

Criteria 2: Ability to negotiate meaningful take-or-pay energy sales contracts with thermal customers.

a. Energy sales provide a key revenue source for a project. Energy revenues should be secured by take-or-pay contracts whereby the energy customer agrees to take the amount of energy it has contracted for and to pay for the energy even if it can not use the contract amount. Loss of energy revenues can severely disrupt project economics.

Take or pay contracts are a key element of the security for the financing of the facility. In order for thermal sales to be feasible the customer should be willing to enter into a long term take or pay contract.

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b. Energy sale negotiations are never easy and negotiation of thermal energy sales tends to be more difficult than for electric energy. Thermal customers can be attracted if the price and contract terms are right.

c. The thermal customer should be creditworthy and able to stand up to its financial commitments.

d. If the resource recovery project will only sell thermal energy, it is advantageous to have several customers. Diversification of the customer base can help mitigate economic problems due to the loss of a customer. Multiple customers may also help smooth out the demand load.

Criteria 3: Ability of the resource recovery plant to provide thermal energy to both the customer and the project at an attractive price.

a. In order to attract thermal customers, the resource recovery project must offer economic advantages to the customer over alternative thermal sources such as in house steam or hot water generation. The customer may also require a discount in order to commit to a long term take or pay contract.

b. The thermal rate should be high enough to generate revenues greater than or equal to electric sales. This is likely if the electric rates are low and capacity credits are not available.

c. The economics must be evaluated considering increased capital and operating costs and projected revenues.

CASE STUDY: KENT COUNTY, MICHIGAN

Kent County is planning a 530 tons per day mass burn resource recovery facility. The facility will cogenerate, selling steam to the Grand Rapids District Heating System and electricity to Consumers Power Company. One of the key forces behind the project's development is its particularly strong energy economics.

Initial discussions with Consumers began several years ago for both the sale of electricity and steam (Consumers owns the district heating system). The pace of negotiations picked up this summer when the County began to plan for an escrow financing this fall. The electric negotiations are going well. In 1990, the first full year of facility operations, we epxect a 5.1¢ per kwh capacity credit and a 3.3¢ per kwh rate for production. The projected 8.4¢ per kwh is an excellent rate compared to the electric rates many projects are able to negotiate.

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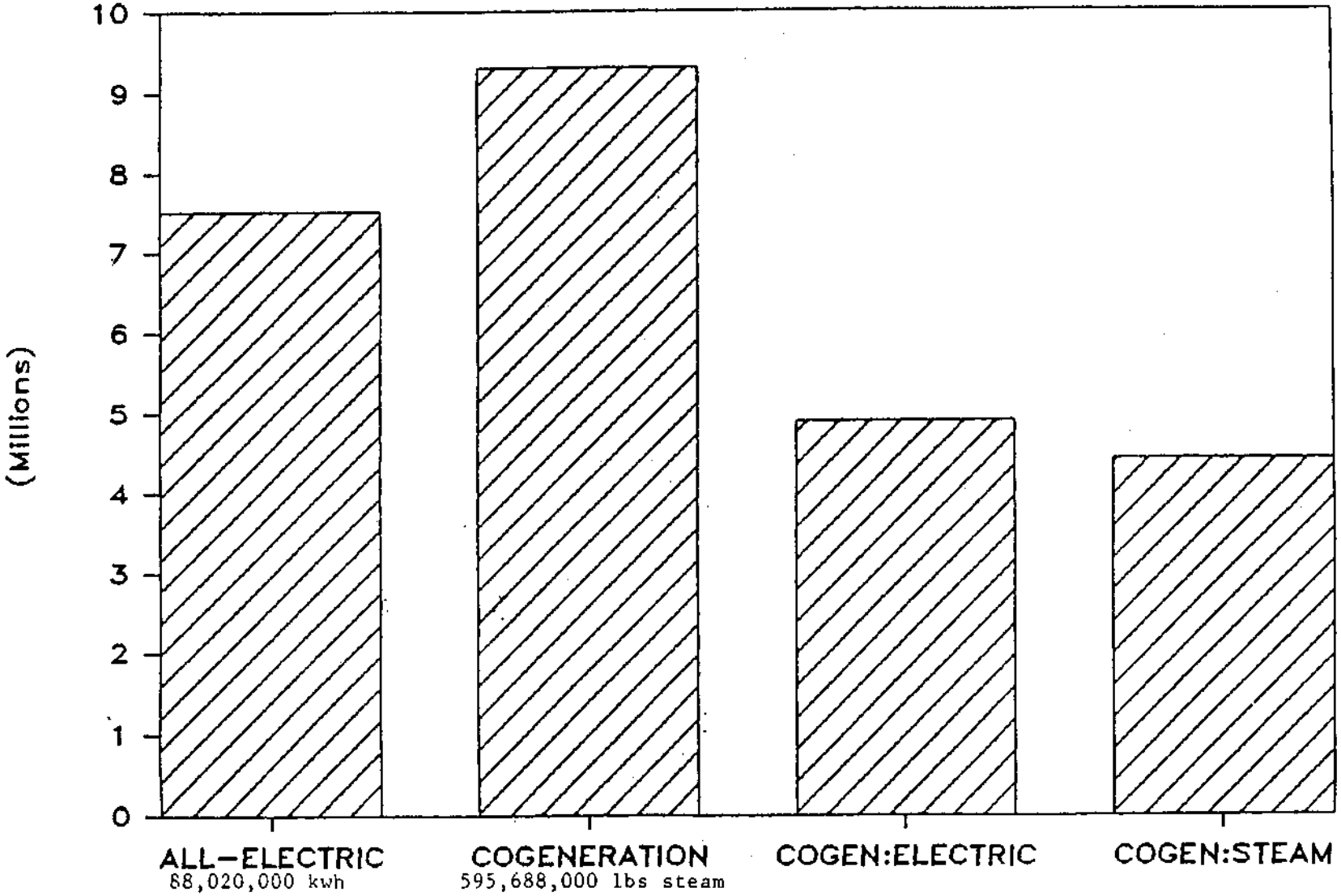
The steam sales negotiations have taken an interesting turn. Consumers, a financially distressed utility, is trying to sell the district heating system. The system is in good physical condition and has turned a modest profit in recent years. The customer base is stable and a market study indicates the strong potential for adding substantial load. For all of these reasons, two private companies have made offers to Consumers to purchase the system. Both of the private companies preference is to install electric turbines, become a cogenerator, and sell electricity to Consumers. These private companies would have little dmeand for the steam from the Kent County resource recovery facility.

In order to preserve the thermal market and the strong project economics, the County determined that its best strategy was to buy the system itself. Last week, the County submitted an offer to Consumers and commemced negotiations. We expect to successfully negotiate the purchase of the system by December. Once the County has purchased the system, it will begin contract negotiations with the 100 current customers in order to insure that there will be a stable base of demand.

The following tables and graphs set forth the positive impact that the sale of steam energy will have on the Kent County resource recovery project economics.

KENT COUNTY FACILITY

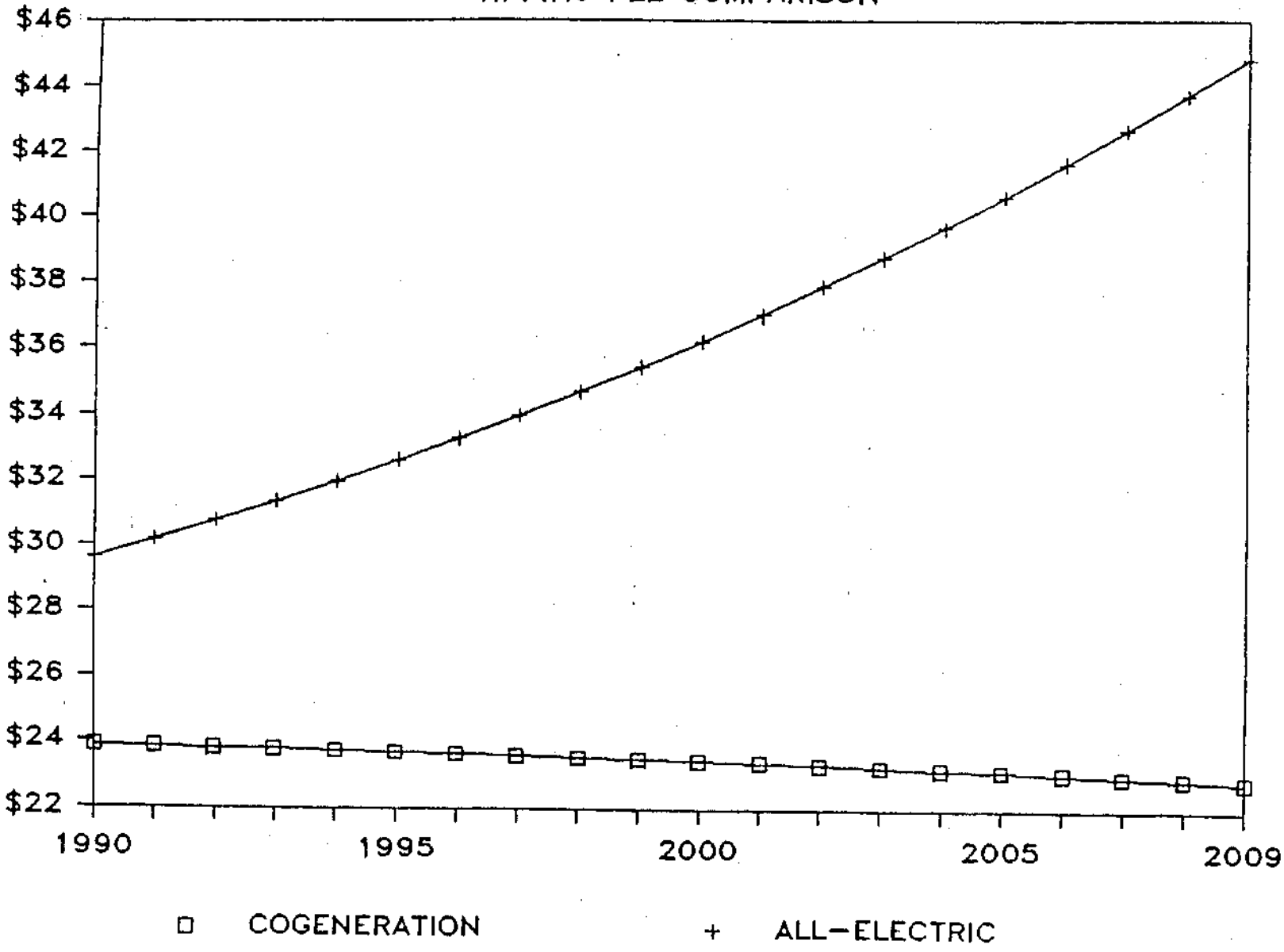
ENERGY REVENUES IN 1990



	ALL-ELECTRIC	COGENERATION	COGEN:ELECTRIC	COGEN:STEAM
	88,020,000 kwh	595,688,000 lbs steam		
Capacity Credit	$4,489	57,244,000 kwh	Capacity Credit 2,191	
Avoided Fuel	3,021		Avoided Fuel 1,965	
	$7,510	$9,285	$4,884	$4,401

KENT COUNTY FACILITY

TIPPING FEE COMPARISON



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KENT COUNTY
COGENERATION VS. ALL ELECTRIC ECONOMICS

	All Electric	Cogeneration
Construction Cost	$65,987,000	$61,887,000
Bond Size	$87,640,000	$83,200,000
1990 Energy Revenues	$ 7,510,000	$ 9,250,000
1990 Tip Fee	$30 per ton	$24 per ton
Tip Fee Trajectory	Inceasing over time	Stable over time

GRAND RAPIDS DISTRICT HEATING SYSTEM

DESCRIPTION OF SYSTEM

Consumers Power Company acquired the operation in 1915. In 1923, the Plant was rebuilt in two sections: boiler room and turbine room. Four 60,000 pound per hour boilers and one 1,500 kw noncondensing steam turbine generator were installed.

In 1964 and 1965, the four coal-fired 60,000 pound per hour boilers were retired and replaced with three 100,000 pound per hour gas/oil-fired boilers. Construction of new 125 pound steam mains were necessary to serve new buildings in the lower Monroe Street area and Butterworth Hospital.

In 1969, the fourth boiler was installed. This was a 150,000 pound per hour gas/oil-fired boiler. Also installed at this time was a 125 pound steam main to serve the St. Mary's Hospital Complex.

The Plant presently has 450,000 pounds per hour capacity of saturated steam at 250 psig and 405 F and delivered to the customer at 8 psig and 125 psig.

The maximum steam load is 250,000 pounds per hour with an average annual steam load of 100,000 pounds per hour.

The approximate five miles of steam main installed between 1916 and 1983 serves an average 100 customers heating, cooling and process use. Customers consist of banks, hospitals, hotel, office buildings and miscellaneous small shops.

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The 250 psig produced is utilized in the plant to drive the turbines which are primary movers for the forced draft fans, boiler feed pumps, and the deaerator forwarding pump. Steam is exhausted from these turbines at approximately 10 psig into the low pressure system, which is delivered to the customer at approximately 8 psig, and this 8 psig steam is used in heating the feedwater in three tray-type deaerating feedwater heaters.

The Plant has very little condensate return to the boiler system. It is essentially a 100 percent make-up system. All of the steam distributed to the customers is then wasted via the customers' sewers. With this type of system there are no condensate main in the customer distribution network, eliminating considerable maintenance. If the condensate were returned by the approximately 100 customers, it would be very difficult to have control over the quality of condensate because of the potential contamination by the customers.

The Grand Rapids District Heating Plant utilizes a softener dealkalizer system of water treatment for boiler water make-up. The make-up water enters the Plant (see Flow Diagram below) through two separate services located at opposite ends of the Plant. The city water is then treated by a sodium zeolite water softening system which reduces the harness of the water to approximately zero. The make-up water is then treated with a dealkalizer which is used to control the alkalinity of the water. The treated water is stored in a large concrete clear well which is approximately 20' wide and runs the entire length of the plant. The treated water is then forwarded by the forwarding pumps to the three deaerating feedwater heaters where the water is heated and the dissolved oxygen in the water is removed. From the deaerators the water is pumped into the boilers by the boiler feed pumps.

SALES AND CUSTOMERS

In 1964 the annual sales were 220,000,000 pounds. The addition of new customers resulted in a steady increase in steam sales until 1975, at which time sales totaled 760,000,000 pounds. Due to conservation and competition from other heating sources, sales are now at a level less than in 1975. Sales for the past three years are noted below:

1982	632,000,000 lbs
1983	558,000,000 lbs
1984	579,000,000 lbs

The three largest customers are The Amway Grand Plaza Hotel and Butterworth and St. Mary's Hospitals. These three customers account for one-half of the total steam sales.

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FINANCIAL

Gross revenue and net operating income for the last ten years are noted below:

Year	Gross Revenue	Net Operating Income
1975	$2,064,000	$203,000
1976	2,548,000	154,000
1977	2,827,000	117,000
1978	3,202,000	127,000
1979	3,513,000	129,000
1980	4,133,000	39,000
1981	4,566,000	34,000
1982	5,399,000	183,000
1983	5,383,000	48,000
1984	5,296,000	228,000

MARKET POTENTIAL

Contacts are being made with established businesses and with developers and architects of the new buildings being placed along the system to advise them of the desirability of steam service. Some of these potential customers include a new sports arena, downtown condominiums, The City Public Museum, LaGrave Street Fire Station and the Riverfront #2 Office Complex.

These prospective customer, if connected to the steam distribution system, would result in additional annual sales of approximately 338,000,000 pounds.

Financing Resource Recovery Projects

Philip M. Chen

Senior Vice President

Shearson Lehman Brothers, Inc.
New York, New York.

I. INTRODUCTION

Solid Waste/resource recovery (hereinafter, "resource recovery project") projects can be financed in a variety of ways. The project can be totally owned by a municipality and financed through either general obligation debt or tax-exempt revenue debt. At the opposite end of the spectrum a project could be entirely owned by a private entity and financed solely from that sponsor's equity. Between the two extremes, the combination of equity and debt (taxable and tax-exempt) utilized is largely dependent upon ownership. Other factors, such as production of electricity or steam, sponsor's creditworthiness, project economics and sponsor's preference in financing, may also enter into the analysis.

Due to the size of the typical resource recovery project, many of these projects will be financed as non-recourse or limited-recourse project financings. In such financings, the cash flow and net worth of project sponsors are not pledged to the repayment of debt and, consequently, the economic success of the project is dependent solely upon repayment of debt using revenues generated by the project.

Recent and proposed federal tax law changes will reduce the availability and benefits of tax-exempt financing, making resource recovery projects more expensive. The following describes the progressively restrictive federal regulations on the use of tax-exempt industrial development bonds, and suggests using an escrow closing prior to year-end if the current effective date of January 1, 1986 is changed in the pending tax legislation, H.R. 3838, to capture existing financing and tax benefits.

Current Tax Law

Most resource recovery facilities are financed with a combination of equity and debt. Pursuant to Section 103(b)(4)(E) of the Internal Revenue Code (the solid waste exemption), tax-exempt Industrial Development Bond ("IDB") financing is presently available for the debt portion of resource recovery projects. The Internal Revenue Service ("IRS"), however, limits the use of tax-exempt IDBs for resource recovery facilities to the period when the solid waste being processed is "valueless." Consequently, tax-exempt financing is available for resource recovery facilities only to the point where a valuable or useful product is produced. Bond counsel generally defines this point as the production of steam in a solid waste disposal boiler. Equipment and facilities, and associated land, that use the steam (i.e., heat distribution systems or electric generating equipment) do not normally qualify for tax-exempt financing. (The exception to this rule is where the "back-half" of the project, i.e., the energy user, is a tax-exempt entity.)

The Deficit Reduction Act of 1984 (the "Act") further limited the availability of tax-exempt IDBs by subjecting the issuance of private activity IDBs (including those for resource recovery financings) to state volume caps. Each state's annual cap is $150 per capita or $200,000, whichever is greater. After 1986, the per capita amount decreases to $100. The Act also made tax-exempt financing more expensive by disallowing arbitrage. This meant that revenue from reinvestment of unspent bond proceeds in the construction and capitalized interest accounts cannot be used to lower the principal amount of the bonds, thereby resulting in higher debt service for the project. In addition, the Act eliminated the use of tax-exempt IDBs for publicly or privately owned facilities that have a longer than one year operation contract with a private company.

A third change was the loss of Accelerated Cost Recovery System depreciation ("ACRS") over appropriate ACRS periods. However, the effect of that loss was probably not significant since straight line depreciation over appropriate ACRS periods continued to be allowed, which still resulted in relatively fast depreciation of an asset.

Tax Legislation Under H.R. 3838

Financing options for resource recovery projects will be further constrained if the proposed tax changes contemplated in pending legislation ("H.R. 3838") become law. Although H.R. 3838 has passed the United States House of Representatives, the United States Senate has yet to act. No one can be certain that the Senate version of tax reform or, for that matter, the final version that will surely go through a joint House/Senate conference committee will alleviate or exacerbate the current provisions contained in H.R. 3838.

Because H.R. 3838 contains significant changes to the way the solid waste disposal portion of resource recovery projects will be financed, sponsors of such projects are well advised to monitor the debate and to encourage legislative efforts to minimize those impacts. Among other things, H.R. 3838:

- Preserves tax-exempt financing for only those solid waste projects in which private users do not benefit from more than 10 per cent or $10 million of the proceeds of the bond issue, whichever is less (the "10/10 test").

- Permits "nonessential function tax-exempt" debt for any solid waste disposal project exceeding the 10/10 test, whether municipally or privately owned, as a specific IDB exemption.

- Subjects interest earnings on all nonessential function tax-exempt bonds to the 25 per cent alternative minimum tax, including solid waste disposal bonds.

- Subjects tax-exempt IDBs,including those issued for solid waste disposal projects, to a $75 per capita volume cap in each state. The $175 per capita figure in H.R. 3838 allows only $75 per capita for general IDBs, including solid waste disposal. Certain states are allowed a minimum of $200 million per year because of their population.

- Eliminates the 10 percent "bad money" rule thereby requiring that all facilities or costs funded by tax-exempt debt be either qualifying cost or neutral cost.

- Eliminates the "functionally related and subordinate to" concept which may impact on the ability to finance such facilities as pollution control equipment. This may, however, be mollified somewhat by language that suggests facilities "essential to" the exempt facility may qualify.

- Eliminates the investment tax credit ("ITC").

- Extends the present ACRS periods for most solid waste disposal property from 5 years to 13 years.

- Changes the maximum personal and corporate tax rates.

- Eliminates the interest deductions by commercial banks for carrying tax-exempt securities.

- Requires use of 5 per cent of the bond proceeds within 30 days of issuance.

- Requires use of all proceeds within three years of issuance except where a delay results from events not under the control of the beneficiary of the bonds or the issuer (force majeure).

- Eliminates arbitrage for all tax-exempt securities, not just industrial development bonds.

Restrictions on tax-exempt bond financing: The effect of H.R. 3838 must be examined from two perspectives. The first perspective is that of a private sponsor. In this case, the private sponsor "leverages" his equity tax-exempt debt in financing the project. If nonessential function tax-exempt bond financing is subject to the alternative minimum tax, the cost of services may have to increase by as much as $4 to $7 per ton for each per cent increase in interest rate, depending upon such factors as project size, debt/equity ratios, and the spread between the rates for tax-exempt securities and comparable taxable securities. Since the private owner/operator would be expected to continue to look toward the sponsoring municipality to raise debt, investment banks are currently attempting to examine what a nonessential function industrial development bond market might look like compared to the present tax-exempt debt markets. Industry sources suggest that the interest rate premium for nonessential function IDBs may be 40 to 100 basis points or 0.4 to 1 per cent.

The second perspective is that of a municipality wishing to own its resource recovery project. Excluding for the moment the ramifications of the municipal leasing rules as they apply to operator contracts, the simple act of municipally-owning the facility will not insulate the project from the proposed changes in H.R. 3838. The reason for this conclusion is found in current Internal Revenue Service ("IRS") policies relating to "underlying arrangements" (the security interest test and the trade or business test). Under these policies, the IRS treats any financing in which more than 25 per cent of the revenues are derived from "private users" as a private activity IDB. A "private user" is defined as one whose payments of the project are greater than three per cent of that project's annual average debt service. The policies regarding underlying arrangements are applicable irrespective of the original nature of the financing. Therefore, even if a municipality used general obligation debt to finance the resource recovery project, but sold the energy from the project to private users in excess of the 25 per cent limit, the financing would be held to be private activity IDB and under the proposed law would be a non-governmental purpose IDB. A typical energy purchaser would be the local investor-owned electric utility buying power pursuant to the Public Utilities Regulatory Policies Act of 1978 ("PURPA"). H.R. 3838 would change the 25 per cent rule to a 10%/$10 million rule. The only situation wherein the underlying arrangement would not be a factor is one where the energy user is itself a tax-exempt entity.

Elimination of 10 per cent "bad money" and "functionally related to and subordinate to" costs from tax-exemption: Project sponsors will need to focus on these two factors in determining the economics of their resource recovery projects. Dependent upon the amount of equity required to be put into a project and the relative cost of non-qualifying costs or heretofore, functionally related to and subordinate to costs, the economics of a project could be significantly impacted. The change in language from "subordinate to" to "essential to" may prohibit certain ancillary costs such as general and administrative offices located in resource recovery facilities.

Loss of Investment Tax Credit and extension of ACRS depreciation periods, changes in maximum corporate tax rate and loss of interest rate deductions: These proposed changes can be discussed together as they affect the privately sponsored project only. Under the present law a private owner/operator can use both ITC and straight-line depreciation over appropriate ACRS periods as deductions for tax income purposes. In fact, the use of both ITC and ACRS depreciation periods results in substantial tax savings, thereby making project economics much more favorable. These savings are passed on to the municipality in the form of reduced tip fees. H.R. 3838 would eliminate the use of ACRS periods and replace it with the new depreciation rules, thereby stretching out the period over which depreciation must be taken.

Changes in the maximum corporate tax rate can also affect the value of ITC and depreciation deductions: Other changes are proposed such as losses in interest deductions by commercial banks purchasing tax-exempt issues. As a result of that loss of interest deductions, banks, who are major purchasers of tax-exempt securities may demand a higher coupon rate on securities purchased. Therefore, these proposed changes must also be examined from the standpoint of how they might affect resource recovery projects.

The need for resource recovery projects is driven by factors other than tax benefits. While it is clear that tax advantages encourage private industry to sponsor such projects, it is such factors as environmental regulations and groundwater problems that compel the need for such projects. The overwhelming impact of H.R. 3838 will be to make the project cost significantly more expensive. A typical resource recovery project today might cost about $25 to $35 per ton in tip fee. If all of H.R. 3838's changes were enacted, industry studies of earlier versions of the pending legislation suggest that the same project may cost $40 to $57 per ton or more in tip fee. Shearson Lehman Brothers Inc. is currently examining the costs associated with H.R. 3838 and will publish that information in a later version of this paper. Since most resource recovery projects are cost sensitive, the immediate effect of H.R. 3838 may be delays in project implementation as project sponsors re-educate the public as to the necessity of the project, despite the higher costs.

Transition rules on depreciation and ITC are proposed in H.R. 3838 for resource recovery projects. These rules are:

- The new depreciation rules do not apply to solid waste disposal facilities if before January 1, 1986 -

  (a) there is a binding written contract between the service recipient (the municipality) and the service provider with respect to the operation of such facility to pay for the services to be provided by such facility, or

  (b) a service recipient or governmental unit (or any entity related to such recipient or unit) made a financial commitment of at least $200,000 for the financing or construction of such facility.

- If a resource recovery project meets one of the above tests, it would be eligible for the ITC spread out over 5 years with full basis adjustment.

Certain proposed transition language applied to the volume cap limitations as well. However, certain actions had to have taken place prior to January 1, 1986, in order to benefit from those transaction rules.

II. PROJECT VIABILITY

In order for a resource recovery project to be financeable, it must be viable. The viability of a project extends not only to economic viability (discussed later) but to political, environmental, and public acceptability and technical viability, as well. Because of the Act, the possible lack of sufficient state and/or local government volume cap for financing a resource recovery project may adversely affect that project's viability.

Political -- The municipality or county sponsoring or encouraging the private development of a resource recovery project must be prepared to demonstrate political support of the project to the investment community. Appropriate governmental officials, at all levels, must understand and approve of the need for the project and the types of costs associated therewith. Some of the factors that must be examined include:

- Availability of alternative disposal (sanitary landfills, etc.);
- The level of tipping fees, commercial charges and household user charges that must enacted;
- Availability of flow control;
- Environmental and social economic decisions that must be made;
- Strength and organization of opposition;
- Contractual obligations of governmental unit; and
- Strength of all members of the project team (lawyers, bankers, engineers, staff and contractors)

The successful resource recovery project will be one that enjoys a solid political base; one that will survive changes in political structure as well as changes in political attitudes. The investment community will examine this aspect of a project thoroughly before committing their resources to the financing of such projects.

Environmental -- Is the project really needed? This question becomes increasingly important as the relatively higher initial tipping fee for a resource recovery project is compared to the relatively lower tipping fees associated with existing sanitary landfills. If, for example, an existing sanitary landfill in the vicinity of a proposed project is considered environmentally sound and has a relatively long remaining life, there may be no need to pursue a resource recovery project at this time. Recycling is another issue best explored during the early stages of a project's development. Can, for example, the combination of recycling and existing landfills adequately cover the solid waste needs of the community for some time to come? If so, the decision to construct a resource recovery project may be premature.

Where no adequate sanitary landfills exist and recycling is not practicable, the decision to proceed with the siting of a resource recovery project should be accomplished within the framework of a comprehensive environmental study. The resource recovery project can, of course, complement both existing landfills or recycling if all are elements of a broader solid waste management plan. Resource recovery projects tend to be relatively long-term from the financing standpoint. As a result, investment bankers are becoming increasingly aware of the environmental parameters that can affect the successful completion of such projects.

Public Acceptability -- Public acceptability also will be a critical issue affecting such projects. Basic to the economic success of the project is public awareness and acceptance of the need for and concomitant cost of resource recovery projects. Where the public is not behind a project, the political base of the project is threatened thereby bringing into concern its continued economic viability.

Technical Feasibility -- Potential equity participants and lenders are very concerned about the technology used in resource recovery projects. With simpler technology, their fears may be alleviated. Potential investors and, therefore, investment bankers, are sensitive to the issues arising from technical feasibility. For example, European mass burn technologies are currently considered most acceptable because of their history of successful operation. Due to a shorter operating history, other technologies, such as refuse derived fuel, may be subjected to greater scrutiny than European mass burn technologies by potential equity participants and lenders. When planning these projects, municipalities should retain an independent consulting engineer to carefully examine the technical feasibility of the project. In addition, the investment community will require that the suppliers of resource recovery systems, including even mass burn technologies, stand behind their projects and that such suppliers either be credit worthy on their own behalf or provide credit enhancement to ensure their performance guarantees are of investment grade.

Availability of Tax-exempt Financing -- Because of the state volume cap imposed by the Act, project sponsors should assess their tax-exempt financing needs as quickly as possible and seek appropriate carry forward of state volume caps. Resource recovery projects can benefit from up to three years of carry forward of unused volume cap if the project is so designated by appropriate authority. By combining state and local carry forward, along with current allocations, municipalities might still be able to fund these projects with tax-exempt bonds without having to worry about the drastic limitation of the state volume cap. This, however, requires planning and careful scheduling at early stages of the project. All of this, of course, is subject to change if H.R. 3838 is enacted.

III. PROJECT FINANCING MECHANISMS

As discussed in the Introduction, the methods for financing resource recovery projects are varied dependent upon many factors. For the purpose of this paper, we will examine three cases:

(1) totally municipally sponsored,

(2) leveraged lease financing, and

(3) project sponsor equity.

In each case, we will assume that the solid waste exemption is used to enable tax-exempt financing of all qualifying facilities. Financing structures are critical items for consideration by a municipality. By choosing an infeasible financing structure, a project can be unnecessarily delayed. This assumption is subject to drastic modification should tax-exempt financing opportunities become unavailable because of tax law changes.

Case I -- Totally Municipally Sponsored: In this case, the municipality is the owner of the facility and contracts with an outside company to design and construct the facility and operates the facility with its own personnel or contracts with an independent company to operate the facility. These types of facilities can be financed either through general obligation debt or through tax-exempt solid waste revenue debt.

Contractual structure -- Considering, for purpose of discussion, that the municipality engages an outside company to design, construct and operate the facilities, then the following contractual arrangements must be made:

- Construction contract,
- Operation and maintenance contract,
- Solid waste supply contract.

The construction contract, discussed in Section V, must be negotiated to provide for completion assurances and the mitigation of technological risk. The operation and maintenance contract will require the contractor to perform satisfactorily for a term of years. Most importantly, the solid waste supply contract will require the municipality to deliver a minimum quantity of solid waste per year at an agreed upon price per ton ("tipping fee") and to pay a specified amount in the event of non-delivery.

Rate convenant -- In this case, the municipality must generally convenant to fix, maintain and collect fees, rates or charges (at an appropriate debt service coverage ratio) for the use of the facilities sufficient to cover debt service and operation and maintenance expenses.

Energy & by-product material sales -- The municipality contracts with users of energy (electric or steam) and byproduct materials. Energy sales contracts are also described in Section V. However, to the extent that the energy user is tax-exempt, i.e., a municipal electric system, tax-exempt financing may be available for the entire project. Even where the resource recovery project is totally owned by the municipality,

tax-exempt financing is not available for "back half" facilities. i.e., steam distribution or electric generation, if the user of the energy is a private entity (the local investor owned utility, for example). A heretofore minor contract, by-product material sales contracts for reclaimed metal and other materials may become increasingly important to the municipality.

Case II -- Leveraged Lease: In this case, the facility is owned by a financial institution(s), possibly consisting of commercial banks and/or credit corporations (the "Lesssors"), which enters into a lease agreement with the project sponsor (the Lessee"). The Lessors make equity contributions, equal to a minimum of 20 percent of total capital, which comprise a portion of the costs of the project. Since the return on the Lessors' investment is dependent upon both tax benefits and lease rental payments, the use of the solid waste exemption for financing a portion of the debt is tempered somewhat by reductions in the availability of tax benefits flowing from the use of tax-exempt debt. The amount that the Lessors must have at risk is set by certain guidelines which also include other factors such as limitations relating to Lessee's investment; residual value; salvage value; profitability; and usefulness to others.

The Lessee in this form of financing is typically a private project sponsor, who wishes to provide waste disposal services to the municipality through a service contract. Since tax benefits only flow from taxable situations, leveraged lease transactions are not used in cases where the facilities are municipally owned.

The key contracts in this type of financing are the Participation Agreement (which sets out the rights of the Lessors, Lessee and trustees, which administer the trust); the Lease Agreement (which sets out the payment obligation of the Lessee or project sponsor) and the Service Contract (which sets out the obligations of the owner operator and the municipality, including solid waste supplies).

Case III -- Project Sponsor Equity: Equity contributions from project sponsors, including manufacturers, the general contractor and, possibly, energy purchasers, is another means of financing resource recovery projects. This form of financing is typically used in conjunction with tax-exempt debt financing. In these cases, the financing can be accomplished as a non-recourse or limited-recourse financing which places the participants at risk only to the extent of their equity contributions and any other contingent obligations that may be negotiated. By properly structuring the financing entity as a partnership or some other suitable form, tax benefits and cash flow can accrue to project participants. Obviously, project participants look to the revenues derived from the project to provide an adequate rate of return.

IV. RISK ALLOCATION

Allocation of risks should be weighed by two major factors: control and reward. When risks are considered, these two factors can often logically lead to a reasoned allocation of those risks. The maxim is that the party who can best control a risk or who stands to reap the greatest reward if the risk is not realized should bear the burden.

The typical resource recovery project generally must deal with the following areas of risk:

- Technological
- Completion
- Operational
- Legislative
- Supply of solid waste
- Energy revenues
- Force majeure

Technological: Resource recovery projects have suffered from some notable failures. Because of a heightened sensitivity to this issue on the part of the capital markets, assurances must be given that the equipment will perform as specified. Applying the test for allocation of risk described above, it becomes evident that the equipment supplier is the one that should bear this risk. One of the problems commonly encountered is the reluctance of equipment suppliers to agree to stipulated loss value greater than the value of the equipment supplied. The project sponsor, public or private, must often negotiate a reasonable value that will enable the retirement of debt at a minimum.

Completion: Completion risk is normally borne by the contractor or owner/operator since it is in the best position of any participant to control the schedule both from the standpoint of deciding the schedule and managing it. A fixed price contract with a date certain for completion should be the objective. As with technological risk, project sponsors may find a reluctance on the part of contractors to accept stipulated loss value in excess of the costs for performing the contract.

Operational: The operator of a resource recovery project is responsible for competent operation and maintenance pursuant to appropriate industry standards. Where the facility is rendered inoperable or its capacity is derated due to the poor performance of the operator, the operator should bear the cost of rectifying his mistakes. Where the operator is the private owner/operator of the facility, the operator is normally expected to take this risk, since it would expect to benefit from performance above contract requirements. Contract operators of municipally owned facilities, whose return is specified contractually, may be reluctant to accept measures for damage in excess of their contracted payments.

Legislative: The municipality is normally considered to be best suited among all project participants to control legislative risk. Examples of legislative risk are changes in environmental law, tax law and municipal ordinances. Although this risk, as with all other risks, can be the subject of negotiation, one would normally expect that private participants to such projects would look to the municipality to accept it.

Supply of solid waste: The municipality is normally expected to guarantee the contracted quantity of solid waste. The municipality may also be expected to bear the risk that the supply of solid waste may not meet contracted requirements. In certain cases this meant that the municipality was liable for lost energy revenues resulting from solid waste shortfall. This of course, is a matter for negotiation.

Flow control continues to be a major controversy in resource recovery projects. There are three methods of flow control: contractual, legislative and economic. In the first case, contractual, the host municipality and other participating cities (through intergovernmental agreements) contract with the private sponsor to deliver solid waste collected through their own municipal systems or via franchised contractors collecting on behalf of the municipalities. In the second case, legislative, the municipalities do not collect nor do they franchise the collection of solid waste. In this case, the guaranteed supply of solid waste can only be effectuated by legislation and ordinance. Pursuant to case law regarding municipal "monopolies" as articulated in the recent United States Supreme Court ruling in Hallie v. Eau Claire U.S. Sup. Ct. Case No. 82-1832, municipalities can enact and enforce waste control ordinances (flow control) where there exists a "clearly articulated" State purpose as embodied in appropriate state legislation. The third and final method of flow control is economic. In this case the project sponsor, public or private, relies on the laws of economic competition to assure an adequate supply of waste.

The first two methods of flow control, contractual and legislative, are normally acceptable means of guaranteeing solid waste supply. The third, economic flow control, is not acceptable unless a credit worthy project sponsor, municipal or private, is willing to guarantee the project and has sufficient capacity to ensure retirement of debt as a minimum.

Energy revenues: The risk that energy sales will not result in projected levels of revenues is subject to negotiation between the owner/operator of the facility and the municipality. The outcome is dependent upon such factors as the risk preferences of the negotiating parties, who reaps the greatest benefit of energy revenues, and the ability to negotiate fixed price contracts with the energy purchaser.

Force majeure: Force majeure risk is the most difficult to assign, since the very term suggest that performance under contractual arrangements is expected to be excused in such circumstances. Municipalities and private project sponsors typically will negotiate which entity will bear specific force majeure risks.

The key to allocation of risks is control and reward. In the case of owner/operators, allocation of risk is easier to make. Where the municipality expects to own the facility, allocation of those risks is more difficult. In the case of privately sponsored projects the owner/operator will likely accept completion, technological, and certain operational risks. The municipality would, in all likelihood, accept solid waste supply risk, including stipulated payments for waste shortfalls, and certain energy revenue risks. Legislative risk and certain force majeure risks are commonly accepted by the municipalities.

V. PROJECT CONTRACTUAL STRUCTURE

Four contracts will be critical for a project financing of this kind. These are the construction contract(s), the solid waste contract, the operating contract and the energy sales contract(s). Where a private sponsor will own, construct and operate the facilities some of these contracts can be combined into an overall "service contract". Each of these contracts will be examined in detail by equity participants and lenders.

Construction contracts -- The cost and timely completion of resource recovery projects are critical elements in providing economic viability. The contractor and major subcontractors should be responsible for timely completion of the project within anticipated costs. The construction contract should be of the fixed cost type with the contractor expected to pay full debt service if the project is not completed on schedule.

Operating contract -- Equity participants and lenders are typically concerned that experienced operators be retained for the project. A typical operating contract would contain guarantees by the operator that the facility will be operated efficiently and within projected costs for operation and maintenance. The operating contract may contain penalties to be paid by the operator in the event the operation of the project does not meet expectations.

Solid waste supply contract -- Equity participants and lenders would be concerned that an adequate source of fuel is committed to the project. As long as the project can accept the solid waste, the municipality must either deliver such solid waste or pay an agreed upon amount based upon a negotiated minimum solid waste supply to be delivered. Assurance must also be given that the available supply is sufficient for the life of the project.

Energy sales contracts -- While differences can exist, the economics of most project financings of this type depend upon both solid waste supply contracts and energy sales contracts. Energy sales contracts will probably be "take and pay" contracts, which require that all energy generated be taken and paid for by the company using the energy. These contracts should be negotiated for the full term of debt issued for the project in order to provide revenues that comprise the security for that debt.

A municipality can, in most cases, negotiate revenue sharing of energy sales with the private sponsor. This is particularly true where the municipality is willing to accept certain energy revenue short fall risks such as that occurring with inadequate solid waste supplies.

H.R. 3838, if enacted, would encourage municipal sponsors to seek tax-exempt purchasers of energy rather than private users. This results from the fact that municipally owned waste to energy facilities selling their energy to tax-exempt users would maintain their ability to finance using tax-exempt bonds.

All of the above discussed contracts may contain force majeure clauses. These clauses will be carefully scrutinized to assure that unnecessary "outs" are not provided. For example, where certain force majeure events such as destruction of the project can occur, equity participants and lenders may require that commercial insurance be obtained. The contracting parties also may be prevented from escaping the requirements of the contracts because of regulatory action and similar events. The thrust of the contractual structure of resource recovery projects is to provide the utmost security for equity participants and lenders.

VI. TAX-EXEMPT FINANCING ALTERNATIVES

Tax-exempt financing is generally available for a substantial portion of the cost of resource recovery projects. For municipally sponsored projects, financing can be accomplished using various tax-exempt options depending upon the character of the municipal sponsor. For example, if the municipal sponsor is an electric system, all of the costs of the facility may be financed as electric revenue bonds. For private project sponsors, Section 103(b)(4)(E) of the Internal Revenue Code provides, among other exemptions, that solid waste disposal facilities are eligible for tax-exempt financing as tax-exempt industrial development bonds ("IDBs"). However, recent legislation (the Deficit Reduction Act of 1984) has affected the availability of IDB financing for resource recovery facilities. H.R. 3838 may further impact on the availability of specific financing methods. The advantages of tax-exempt financing are the relatively lower interest rate and, in most cases, longer debt maturities. As a consequence, the financing costs of the project can be lowered, thereby improving project economics.

Different forms of tax-exempt financings may be structured, depending upon the credit and revenue history of the project sponsor. As discussed previously, in the case of facilities financed on a non-recourse project financing basis, third party credit support probably will be required.

Eligibility -- The availability of tax-exempt financing is limited to equipment used for the disposal of solid waste. The Internal Revenue Service has held that in order for the solid waste exemption to the industrial development bond law to apply, the solid waste must be "valueless." Once solid waste is changed into something of value, then further use of tax-exempt financing is prohibited. In the context of resource recovery facilities, this point is reached once the solid waste has been burned to produce steam. Therefore, while a significant portion of the incinerator/boiler is financeable by tax-exempt funds, the steam distribution and electric generating equipment are generally not.

Consequently, the typical resource recovery facility is financed with both tax-exempt and taxable funds. The exception to this rule is where the "back half" of the project, i.e., the energy user, is a tax-exempt entity. For example, if all the electricity is generated as part of a municipal electric system, then all of the financing may be raised by tax-exempt means, since debt for municipal electric systems is an allowable tax-exempt financing.

Different Types of Tax-Exempt Issues -- Resource recovery facilities may be built by private or municipal sponsors. For privately sponsored projects, the proceeds of IDBs will be used to finance the debt portion of the project costs. The municipal issuer may be merely a financing vehicle with no direct financing obligation with respect to the IDBs.

In regard to project financings of resource recovery facilities, the tax-exempt financing options may be limited, depending upon the revenue history of the sponsor, in the case of municipal sponsorship, or the commitment of the sponsor, in the case of private sponsorship.

Long-Term Bonds: Long-term bonds generally mature in 20 to 30 years, approximating the life of a project. A long-term municipal bond offers the project sponsor a fixed interest rate over the life of the project. These aspects of long-term bonds encourage project sponsors of resource recovery facilities to use such financing. In addition, for limited and non-recourse financings of privately sponsored projects, outside equity participants and lenders may require the issuance of long-term debt in order to lock in financing costs.

Generally, a public offering of long-term tax-exempt bonds is comprised of serial bonds and term bonds. Serial bonds are shorter-term obligations (3 to 10 years) which mature in specified amounts each year. Term bonds are longer-term obligations (10 years or more) which are generally retired by sinking fund payments prior to the final maturity of the bonds. Generally, tax-exempt bonds are repaid with level annual debt service (i.e., the principal of an interest on the bonds are repaid in equal annual installments in a similar fashion to home mortgage payments).

Other Types of Tax-Exempt Debt: Recent volatility and relatively high levels of interest rates on long-term tax-exempt obligations has led to the development of short-term tax-exempt alternatives. Short-term tax-exempt alternatives present opportunities for taking advantage of substantially lower interest rates, particularly during the construction period. Generally speaking, however, short-term tax-exempt alternatives are only available if long-term bonds are intended to be the ultimate debt.

If short-term alternatives are available, a project sponsor may be able effectively to lower its interest cost during construction and provide additional flexibility with respect to the issuance of long-term bonds, thereby providing the possible opportunity to finance long-term at a reduced interest rate. In the event that long-term interest rates do not decline in the future, the project sponsor will still have benefitted from reduced interest costs during construction which would, in fact, justify the issuance of long-term bonds in the future at a higher "breakeven" rate.

For the purpose of this paper, short-term debt is considered to be any debt having a maturity of less than one year. In addition to short-term debt programs such as tax-exempt commercial paper ("TECP"), project sponsors may want to examine slightly longer maturity financing structures such as bond anticipation notes ("BANs").

TECP: TECP is typically sold in maturities ranging from 1 day to 270 days. The average maturity is 30 days. TECP always requires liquidity support to protect against the possibility that maturing TECP could not be refinanced due to temporary market dislocations. In addition, third party credit support may be required. However, TECP is not long-term financing, and sponsors of projects financed on a project financing basis may not choose to avail themselves of this alternative due to the following risk: (a) the risk that interest rates may rise in the future to a level which jeopardizes economic feasibility and (b) the risk that future legislation would be enacted which would prohibit the use of tax-exempt financing for solid waste disposal facilities prior to issuance of long-term bonds. However, where the project sponsor believes these risks to be manageable, TECP offers a viable means of lowering project cost, particularly during the construction period. In addition, TECP affords an opportunity to keep interest costs low for the initial startup period of the project until a history of project revenues has evolved. Therefore, a project sponsor may wish to extend a TECP program beyond the construction period before committing to long-term financing.

A major disadvantage of TECP programs is the need to ultimately refund the program with long-term financing which may be subject to volume cap limitations at the time of the refunding.

BANs: Traditionally, BANs are notes issued by a tax-exempt issuer in anticipation of the issuance of long-term bonds. Because BANs are a short maturity obligation, the interest rate is typically lower than that for a long-term issue. The availability of this form of financing may be restricted by the considerations discussed immediately above.

When TECP and BAN's are available, project sponsors may substantially reduce interest costs during construction. In situations which do not involve project financings, such alternatives to long-term debt may be useful. An example of such situations may be found in ongoing solid waste/resource recovery enterprises constructing additional facilities or in those cases where appropriate sponsor commitments are available.

F/FRBs: In certain cases, financings combining both long and short-term characteristics may be applicable to project financings of resource recovery facilities. These alternatives include floating/fixed rate bonds ("F/FRBs"), an instrument which "floats" for a specified period and then at the initiation of the project sponsor "fixes" for the remaining life of the bonds. During the floating period, the project sponsor would benefit from short-term interest rates (about 1/4 percent to 1 percent above TECP rates). Generally, the mechanism for "fixing" the rate is pegged to an index chosen by the project sponsor, which reflects the "optimum" level of fixed rates expected by the sponsor. F/FRBs, like TECP, always require some form of third party liquidity support, i.e., commercial bank facilities, during the floating rate period. Certain projects may also require third party credit support. The advantage of F/FRBs over other instruments is that F/FRBs are long-term bonds, which reduce the risk that the obligations cannot be refinanced at maturity. However, the legislative risk that changes in Federal law prior to the point long-term rates are fixed may void such financings is still a possibility that must be addressed.

A/FRBs: Another combined long-term, short-term financing technique is the adjustable/fixed rate bond ("A/FRBs"). A/FRBs are long-term bonds which bear a fixed rate of interest for a defined period (usually 1, 3 or 5 years) with a new interest rate to be established at the conclusion of each period based upon the interest rates prevailing in the market for securities with comparable ratings and maturities. In effect, 30-year A/FRBs could be structured as a series of shorter term maturities, for example 10 periods of 3 years each. The project sponsor using this form of financing takes the risk that the short-term interest rate (for example, the interest rate on 3-year BANs) would not exceed the long-term rate prevailing at the time the A/FRBs are initially issued. A/FRBs,like F/FRBs, have mechanisms for "fixing" the rate if long-term rates become favorable. However, like F/FRB's, A/FRBs also suffer from legislative risk at the point the long-term rate fixed.

MMBs: The recent volatility in interest rates gives rise to concerns about committing to a long-term interest rate at today's levels or, conversely, taking the risk that short-term rates may rise dramatically thereby committing issuers to even higher fixed term rates in the future. Prudent financial managers often wish to mix their debt portfolio maturities as a means of avoiding both extremes of the yield curve. In the past it was difficult to issue securities for startup entities (i.e., resource recovery projects) in parts so that some could be in fixed rates and some could be in variable rates. This stemmed from a reluctance to tap capital markets more than once until an entity acquired an operating history. By issuing multiple maturity bonds ("MMB's") wherein several series within one bond issue can have varying maturities (and, hence, interest rates), the financial manager of a startup resource recovery enterprise can "mix" his maturities as a means for balancing his debt portfolio.

VII. ROLE OF INVESTMENT BANKER

In conjunction with the other members of a resource recovery team, including bond counsel, project sponsor's counsel, consulting engineers, accountants and financial advisor, investment bankers would expect to perform, among other things, the following services:

- Assist in the review of project economics along with the feasibility consultant particularly with respect to the evaluation of energy revenues to be received from energy sales contracts;

- Assist in the preparation of a request for proposals for and review of proposals to serve as the general contractor, including evaluation of the advisability of ownership and/or operation of the project by the contractor along with an equity investment by the contractor;

- Assist in the management team in designing and implementing the contractual arrangements, including construction, solid waste supply and energy purchase contracts, necessary to support the long-term financing and, as necessary, participate in negotiations with other participants in the project;

- Develop a detailed analysis of the financing alternatives, including interim financing, for the project and develop the most appropriate financing structure;

- Assist the management team in developing appropriate commercial insurance coverage to protect against construction completion and technical risks. This insurance coverage would be designed to provide protection against project risks not covered by the commitments of the various participants;

- Determine third party credit support mechanisms, if any, necessary to assure the availability of long-term financing for the project and, as required, prepare materials for bond rating agencies, municipal bond insurers and other potential sources of third party support, such as commercial bank letters of credits and commercial insurance underwriters; and

- If appropriate, provide analyses of the availability of third party equity investments, including leveraged lease and corporate partnerships.

Investment bankers prefer to be involved at the early stages of a project's development so that their input is considered at the formative stages of the process. Successful projects will depend upon the inputs of <u>all</u> participants.

VIII. CHECKLIST

Because of the complexity surrounding the financing of solid waste/resource projects, we felt that municipal officials confronted with an oft-confusing financing project could benefit from a checklist. However, the checklist cannot replace an experienced financing team. Its purpose is to provide a handy means for understanding the various documentation, studies, contracts and events that comprise a resource recovery financing. The checklist is attached as Appendix A to this paper.

IX. BIBLIOGRAPHY

The financial structures that can be implemented for resource recovery projects are limitless. Each project is unique, thereby requiring modifications to traditional financing structures. Because this paper cannot adequately cover the entire spectrum of financing techniques we suggest that the following bibliography may be helpful to those desiring more detailed information.

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APPENDIX A

CHECKLIST

I. Taxability

(a) Section 103(b)(4)(E) exemption

(b) Valueness concept

(c) Public ownership versus private ownership

(d) "Front half - back half."

(e) Bond Counsel opinion (tax-exempt status)

(f) State Volume Cap

(i) State and local volume cap
(ii) Project schedule
(iii) Carry forward

(g) State income taxation

(h) Pending Tax Legislation

II. Structuring the Financing

(a) Project economics

(i) Debt service
(ii) Tax benefits (if appropriate)
(iii) Project revenues

(A) Tipping fees
- User fees
- Solid waste contracts

(B) Energy sales
- Steam
- Electricity

(C) Byproduct materials

(v) Operation and maintenance costs
(vi) Return on investment

(b) Security

(i) Rate covenants
(ii) Credit enhancement (can only enhance; cannot make an unfinanceable credit financeable)

(A) Letter of Credit
(B) Bond insurance
(C) Other types of credit enhancement (revolving credit, etc.)

(iii) Mortgage

(c) Equity placement (private financing)

(i) Project sponsor equity
(ii) Leveraged lease
(iii) Equity placement fee

(d) Taxable debt placement

(i) Bank loans
(ii) Corporate debt
(iii) Debt placement fee

(e) Bond resolution

(i) Timing
(ii) Bond size
(iii) Authorization

(A) Contracts
(B) Bond Issue

(iv) TEFRA hearing requirements

(A) Scheduling of hearing
(B) Elected official

(v) Validation (only in certain states)

(A) Scope
(B) Timing

(f) Bond sizing

(i) Direct costs of issuance

(A) Bond counsel
(B) Issuer fees
(C) Printing
(D) Engraving
(E) Issuer attorney fees
(F) Issuer expenses

(G) Project sponsor counsel fees
(H) Blue sky
(I) Credit enhancement fees
(J) Rating agency fees
(K) Trustee fees
(L) Trustee counsel fees

(ii) Debt Service Reserve Fund
(iii) Capitalized interest
(iv) Construction drawdown

(A) Arbitrage potential
(B) Sizing of bonds to account for investment income

(v) Underwriter's spread

(A) Management fee
(B) Underwriter's expenses
- o Underwriter's counsel
- o Printing (AAU,BPA)
- o Out-of-pocket expenses

(C) Underwriting
(D) Takedown

(vi) Use of serial bonds and term bonds.

(g) Marketing of bond issue

(i) Negotiated versus Competitive Sale

(A) Complexity
(B) Need to include investment bankers in structuring project

(ii) Timing of pricing

(A) Volatility of market
(B) Market volume
(C) Inputs from Underwriters

(iii) Credit enhancement
(iv) Ratings
(v) Audited financials
(vi) Engineering reports

(h) Other factors

(i) Maturity of bonds

(A) Life of facility
(B) Lease considerations

(ii) Technological risk

(iii) Contracts

(A) Authorization
(B) Scope

(iv) Redemption

(A) Optional
(B) Extraordinary
- o Project existence
- o Economic viability

(C) Mandatory
- o Taxability

III. Basic Documents and Parties Thereto

(a) Owner Participation Agreement (where required)

(i) Owner Trustee
(ii) Lessor
(iii) Lessee
(iv) Municipal Issuer
(v) Debt lenders, if any

(b) Trust Agreement (where required)

(i) Lessor
(ii) Owner Trustee

(c) Lease Agreement (where required)

(i) Owner Trustee/Lessor
(ii) Lessee

(d) Ground Lease (where required)

(i) Project sponsor (lessor)
(ii) Owner Trustee

(e) Deed and Bill of Sale (where required)

(i) Project sponsor
(ii) Owner Trustee

(f) Assignments and Releases (various for such items as the solid waste supply contract)

(i) Project sponsor
(ii) Owner Trustee

(g) Trust Indenture (for placement of taxable debt)

(i) Owner Trustee
(ii) Indenture Trustee

(h) Service Contract

(i) Project sponsor
(ii) Municipality

(i) Solid Waste Contract

(i) Project sponsor
(ii) Municipality

(j) Energy Sales Contract

(i) Project sponsor
(ii) Energy user
(iii) Municipality

(k) Bond Indenture

(i) Issuer
(ii) Bond Trustee

(l) Financing Agreement

(i) Lessor
(ii) Issuer
(iii) Different forms (Sale, Loan)

(m) Bond Purchase Agreement ("BPA")

(i) Underwriters
(ii) Issuer

(n) Agreement Among Underwriters ("AAU")

(i) Managing underwriters
(ii) Syndicate members

(o) Credit Agreement

(i) Credit Supplier
(ii) Project sponsor
(iii) Bond Trustee

(p) Inducement and Bond Resolutions

(q) Issuer Arbitrage Certificate

(r) Bond Opinion

(s) Blue Sky (registration requirements)

(t) Legality Letter (investment by certain institutions)

(u) Preliminary Official Statement ("Red Herring")

(v) Official Statement

(w) Engineer's Feasibility Report

(x) Accountants' comfort letters

(y) Opinions of counsel

(z) Bonds

IV. <u>Types of Bonds</u>

(a) Long term bonds

(i) serial bonds
(ii) term bonds
(iii) original issue discount bonds

(A) Size of principal amount
(B) Treatment of interest

(iv) level debt service

(b) Bond anticipation notes

(c) Tax exempt commercial paper

(d) Hybrids

(i) Floating/Fixed Rate Bonds
(ii) Adjustable/Fixed Rate Bonds
(iii) Legislative risks

(e) Selecting the appropriate type of bond

(i) Interest rate
(ii) Interest rate risk
(iii) Remarketing risk
(iv) Legislative risk
(v) Project development phase
(vi) Limitations imposed by type of project equity (i.e., leasing)

V. Elements of a Bond Issue

(a) Project feasibility

(b) Selection of financing team

(i) Bond Counsel
(ii) Financial adviser
(iii) Underwriters
(iv) Bond trustee
(v) Special Counsel

(c) Bond resolution and/or inducement resolution

(d) Prepare financing schedule

(e) Prepare bond documents

(i) Bond Indenture
(ii) Financing Agreement
(iii) Bond Purchase Agreement
(iv) Integrate equity documents

(f) Conduct due diligence

(i) project sponsors
(ii) municipalities

(g) Bond sizing

(h) Prepare draft preliminary official statement

(i) Rating agencies

(j) TEFRA hearings

(k) Mailing of preliminary official statement and form initial syndicate

(l) Investor meetings

(m) Pricing

(n) Comfort letters

(o) Mail final official statement

(p) Closing

VI. Interface Between Equity and Bonds.

(a) Sizing of bond issue

(b) Interest rate on bonds

(c) Cost of credit enhancement

(d) Maturity of bonds

(e) Expected rate of return on equity

Alternative Energy Purchasers for Resource Recovery Projects

Philip M. Chen

Senior Vice President

Shearson Lehman Brothers, Inc.
New York, New York

INTRODUCTION

Due to the obvious presence of electric utility purchasers, proponents of resource recovery projects often overlook other equally viable energy users. The Public Utilities Regulatory Policy Act of 1978 ("PURPA") clearly establishes a requirement that electric utilities must accept energy from certain alternative energy generators, including resource recovery projects, at the utilities' avoided cost. Because of PURPA, sponsors may automatically assume that sale of electric energy to an electric company is a necessary component of a successful resource recovery project. This, of course, is not the case. Any economically viable energy sales contract with a creditworthy purchaser co-terminous with the debt issued for the project can suffice. However, finding such a buyer may be difficult at best. Several developments encourage this search: expected changes in tax law; surplus electric generating capacity and price differentials between steam and electric usage.

EFFECT OF THERMAL MARKETS

Thermal markets are defined for purposes of this paper as use of steam from the resource recovery project rather than electric energy. Examples of thermal markets are: industrial steam use, district heating/cooling, petroleum refineries, hospitals, schools and military bases. Thermal energy sale can be a cost-effective means of selling energy from resource recovery plants since they do not typically need the same degree of temperature and pressure that are needed for use in turbo-generating equipment and associated equipment. The cost savings gained through thermal energy output must, of course, be balanced against the cost of heat distribution systems needed to serve steam customers.

Ideally, the preferred energy export portfolio for a resource recovery plant may be to co-generate, i.e., produce both steam and electricity.

Investment bankers have, in the past, regarded thermal markets to be prudent avenues for energy revenues as long as:

- The energy market was able to accept a definitive amount of energy on a continuous basis;
- The energy user was relatively close to the resource recovery plant;
- A "take and pay" obligation was obtainable;
- The term of the energy sales contract was co-terminous with bond maturity; and
- The energy price and escalation were predetermined.

Consequently, capital market expectations for thermal markets do not appreciably differ from what would be expected from an investor-owned utility purchasing PURPA power at its avoided cost.

Since certain thermal sales contracts can be structured on a fairly attractive basis, the ability to tap these markets can be considered to be beneficial to a project's success. Consequently, thermal sales contracts meeting the above-mentioned four points would be considered as positive points by the rating agencies.

Rating agencies do not typically distinguish between electric and thermal energy purchasers. Their analysis focuses, instead, on the strength of the purchaser in meeting the long term contract obligation; pricing formulas contained in the sales contract; competing sources of energy; the effect of energy price fluctuations on project revenues; the strength of the sales contract and external factors such as inflation and regulation.

TAX LAW CHANGES

Proposed tax legislation (the "Tax Proposal") currently before Congress would have an impact on resource recovery projects. The specific effects are covered in other papers and are not detailed in this paper. For the purposes of our discussion, one major impact will be discussed: loss of tax-exemption for all non-governmental purpose or private activity industrial development bonds ("IDB"). Under this proposed tax law change, solid waste/resource recovery projects that "benefit" private parties would not qualify for tax-exempt debt. The benefit imparted to private parties is the subject of various existing Internal Revenue Service ("IRS") regulations pertaining to so-called "underlying arrangements." Under these policies, the IRS treats any financing in which more than 25 per cent of the revenues are derived from "private users" as a private activity IDB. A "private user" is defined as one whose payments of the project are greater than three per cent of that project's annual average debt service. The policies regarding underlying arrangements are applicable irrespective of the original nature of the financing. Therefore, even if a municipality used general obligation debt to finance the resource recovery project, but sold the energy from the project such that revenue from private energy users would be greater than 25 percent of total revenues, the issue would be taxable. A typical private party energy purchaser would be the local investor-owned electric ultility buying power pursuant to the Public Utilities Regulatory Policies Act of 1978 ("PURPA"). The Tax Proposal would change the 25 per cent rule to a one per cent rule. It remains silent as to what constitutes a "private user." The only situation wherein the underlying arrangement would not be a factor is one where the energy user is itself a tax-exempt entity, since in such cases the energy user also qualifies for tax-exempt debt.

The above, drastically abbreviated, discussion on the Tax Proposal serves notice to potential sponsors of resource recovery projects that they must evaluate the municipal ownership route with sale of energy generated delivered to only tax-exempt users. These users include:

- Municipal electric systems;
- Joint action power agencies;
- Specific municipal users of electric energy such as: waste water treatment plants, hospitals and universities;
- Specific municipal users of steam such as hospitals, schools and universities; and
- Municipal district heating and cooling systems.

Surprisingly, certain energy users that may on first blush appear to be tax-exempt users do not, in fact, qualify as such. These include federal military or naval installations and rural electric cooperatives. Military and naval installations do not qualify because they are federal, and not state or local entities and, hence, are not considered "municipal" by the IRS. In addition, care should be exercised to structure the energy sales contract with federal installations to avoid having the contract construed as being a federal guarantee. Under current tax laws, the presence of a federal guarantee would make tax-exempt debt (for qualifying solid waste disposal equipment) taxable. Under the Tax Proposal, the issue would be moot since the presence of a non tax-exempt energy purchaser would render the bonds taxable anyway.

Rural electric cooperatives, while not-for-profit are considered to be private corporations by the IRS (except in Nebraska) where they are deemed to be incorporated municipalities under state law and, hence, would not qualify for tax-exempt financing.

DISTRICT HEATING/COOLING SYSTEMS

District heating/cooling systems can be privately or municipally owned. Under the current tax code, district heating and cooling systems qualify for tax-exempt debt. From our discussion in the above section, the Tax Proposal may bias the choice between public and private ownership of district heating systems toward public ownership. However, we need to focus briefly between the two in this paper.

Private ownership - Under current tax law, private parties may own, build and operate local district heating and cooling systems for a municipality (subject, of course, to the underlying arrangement rules discussed above). As long as the contract to provide those services is characterized as a service contract rather than a lease to a tax-exempt entity, the private sponsor can obtain tax benefits such as the investment tax credit and accelerated depreciation. The contract between the private sponsor and the municipality must conform to the following rules to avoid being classified as a lease:

- The service recipient (the municipality, in this case) cannot operate the district heating/cooling system;
- The service recipient cannot bear the burden of operator nonperformance unless such performance is excused by unforeseen circumstances;
- The service recipient cannot benefit from the operator being able to run the district heating/cooling system more efficiently than originally contemplated; and
- Any purchase option of the facilities by the service recipient must be for fair market value.

If the Tax Proposal were to be enacted, the presence of a private operator may render this option economically unacceptable.

Municipal ownership - Municipally owned district heating/cooling systems appear to be a viable energy user under current tax law and the Tax Proposal as long as the 25 percent rule (current tax law) or the one percent rule (Tax Proposal) are not exceeded.

POSSIBLE CUSTOMER CONFIGURATION

The attractiveness of alternative energy users lies in the flexibility gained by resource recovery sponsors. As discussed in this paper, such events as change of tax law may increase the frequency of projects employing municipal ownership coupled with municipal energy users.

The flexibility of alternative energy use is illustrated in the following list of possible customer configurations, subject to the effect of the Tax Proposal:

- o Municipal electric user
- o Co-generation
  - Private electric user with private thermal user
  - Private electric user with municipal thermal user
  - Municipal electric user with private thermal user
  - Municipal electric user with municipal thermal user
- o Industrial thermal user:
  - single or multiple
- o Institutions, e.g., military or naval bases, schools, hospitals, etc.
- o District heating/cooling system
  - private ownership
  - municipal ownership

CONCLUSION

In conclusion, municipal sponsors should not feel constrained to sell the energy produced from resource recovery projects to only electric utilities. Consideration of alternative energy users increases project options and may, in fact, strengthen the credit of the project in the view of the capital markets.

Vendor Selection from a Financial Viewpoint

Gina France Brakebill

Vice President

Shearson Lehman Brothers, Inc.
New York, New York

INTRODUCTION

The single most critical decision a municipality sponsoring a waste-to-energy project can make may well be the selection of the vendor to design, engineer, construct, and possibly own and operate, its resource recovery project. Many factors will influence the final outcome, including price, experience, technical qualifications, local relationships and commitment to the project. This paper addresses the importance of including financial criteria in the vendor selection process, expecially if the project is to be financed with tax-exempt debt secured by project revenues rather than the municipality's pledge of its full faith and credit.(1)

There are several reasons why financial criteria are important to vendor selection. First, financing of a waste-to-energy project is one of the last steps prior to commencement of construction. A great deal of effort and lead time precedes the financing of a project. Often one to two years or more is spent selecting a vendor, procuring a site, obtaining appropriate permits and negotiating energy, construction and service agreements. Those efforts could be entirely wasted if the proposed technology is not acceptable to the financial community and/or the project vendor is found to not be creditworthy and the project cannot be financed as planned.

Second, the financeability of the vendor will directly impact the cost of the project — and hence tipping fees. In particular, the rating agencies approach a project financing on a "weak link" basis, generally assigning the rating of the lowest-rated participant which is critical for debt service payments to the entire project. Even if the municipality and the energy purchaser were both rated 'AAA', a 'BBB' rated vendor, would, in all likelihood, cause the project to be rated 'BBB' if the vendor is relied upon for debt service payments under any circumstances. A lower credit rating on the bonds will result in higher interest rates, and, as a consequence, higher costs over the life of the project. While credit enhancement may be used to improve the bond ratings, a less creditworthy vendor could make it more difficult and costly to obtain either a letter of credit or municipal bond insurance. In any event, providers of municipal bond insurance generally require that the project be "investment grade quality" ('BBB' or better) before they will insure the project.

In addition, the financeability of the vendor will affect project developmental and financing costs directly. A less creditworthy vendor will generally require more time and effort on the part of the project team (municipality, bond counsel, underwriters, underwriter's counsel, and consulting engineer, at a minimum) to structure a creditworthy project and procure financing. Such time and effort typically translates into higher project expenses. A less creditworthy vendor may also add to project expenses if vendor credit support is sought, as additional participants will be involved which would result in additional complexity and concomitant fees and expenses. The annual cost of such credit support may also add significantly to the cost of the project.

Finally, the financial status of the vendor may actually determine the future viability of the project. The municipality needs to feel comfortable that the vendor will be capable of honoring its contracts and guarantees. This is even more important if the vendor is expected to own and/or operate the waste-to-energy project. In this case, the vendor will have obligations and guarantees that may extend throughout the life of the project, or at a minimum, for the term of the outstanding debt. A municipality seeking a "full service" vendor certainly does not want to find itself suddenly responsible for staffing and operating the project. If the project has a successful operating history, it may be possible for the municipality to replace the vendor operating the project within a short period of time. However, if the project has had problems in the past or is operating at less than the full guaranteed levels, it may be very difficult to locate a replacement operator.

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(1) Special thanks to William Chew of Standard & Poor's Corporation for his review of and comments on this paper.

Vendor selection is a complex task, involving not only technical qualifications but also financial aspects and legal concerns to make sure the selection process meets local and state statutes. This reinforces an often-iterated theme by financial advisors, investment bankers, consulting engineers and bond counsel: retain your project team as early as possible to ensure your project runs smoothly and successfully.

THE VENDOR SELECTION PROCESS

Most municipalities will use some version of a Request for Qualifications ("RFQ")/Request for Proposals ("RFP") process. The purpose of the RFQ is to narrow the number of prospective vendors to a reasonable number of firms (generally 3–7 firms) for serious consideration. The response to the RFP is the vendor's formal proposal and should be sufficiently detailed for the municipality to make a knowledgeable decision. If the project timetable is short, a municipality may choose to eliminate the RFQ and focus solely upon the RFP. The focus of this paper is financial criteria for vendor selection. Depending upon the strategy of the municipality for the selection process, as discussed below, this criteria may be included in an RFQ, an RFP or both. The most typical process would be to establish the financial criteria in the RFQ and require that prospective vendors continue to meet such criteria throughout the RFP and selection process.

Although the objective of an RFQ is clear, to reduce prospective vendors to a reasonable number for closer scrutiny, the method of accomplishing this task is not. Opinions are mixed within the industry on the level of detail and information the RFQ should request. On the one hand is an argument for relative simplicity in the RFQ with much greater detail in the RFP. Preparing an RFQ or RFP response can be quite time consuming and costly for a vendor. A general or "generic" RFQ that requests standard information allows a vendor to utilize material already prepared ("boilerplate") and reduce preparation costs. This may be particularly helpful if the project is in something of a "sell" mode at this stage and needs to convince potential vendors that the project has merit and is worthy of the vendor's time and money.

Conversely, being as specific as possible within the RFQ allows the project to establish specific criteria, such as financial minimums or a risk allocation posture, that will eliminate vendors who either cannot or prefer not to comply. Exceptions to specific criteria can be allowed to permit the project team to evaluate an otherwise-acceptable vendor and weigh the consequences of the exception(s). Being specific in the RFQ may save the project a great deal of time and effort that might otherwise be wasted on an unacceptable vendor.

The major risk to this approach is keeping the field of vendors open to a reasonable number. The RFQ and RFP should be carefully structured to enable a reasonable number of firms to respond. An RFQ or RFP which sets such stringent qualifications that only one or two firms can meet those requirements defeats the purpose of the RFQ/RFP process. Projects which are small in size or have particularities which might cause concern among vendors will want to be careful to not overwhelm potential vendors with an unreasonable level of required information at the RFQ stage.

VENDOR SELECTION CRITERIA

There are two major areas of selection criteria, technical and financial, although other factors such as local presence, commitment to local concerns and perceptions of trustworthiness, flexibility and cooperation may enter into the decision-making process. Within the technical qualifications, factors such as previous experience, reference plant history and size, and design specifications should be considered. The consulting engineer for the project should be closely involved in designing the technical qualifications for the project.

Although technical qualifications are extremely important and will be considered by the financial community when the bond issue comes to market, this paper does not examine technical criteria but rather focuses on the financial criteria for vendor selection. The main objectives of financial criteria are to determine:

(1) the company has sufficient resources to predict with a high level of certainty that the company will be able to honor its contracts and guarantees on a long-term basis;

(2) the company's creditworthiness will not impair the project from being financed on a project revenue basis; and

(3) in the case of private ownership, the company will be able to meet its equity commitments or secure third-party equity financing.

This paper focuses on four areas necessary in determining whether a vendor meets these financial objectives: company background, specific requirements, guarantees, and private ownership considerations. In addition, a section is included discussing certain situations of which the municipality should be cautious, although there may not be a problem with a vendor. This paper is intended only to serve as a general guide to municipalities; each waste-to-energy project is unique and certain items in this paper may not be applicable. The municipality should rely on its financial team members to help establish project-specific requirements.

It should be noted that many vendors form separate special purpose subsidiaries for each resource recovery project, with the subsidiary having assets consisting of the project alone. In these situations, the parent corporation should guarantee the obligations of the subsidiary. This discussion of financial criteria uses the word "company" to mean that entity supporting the vendor's financial obligations. If a joint venture is proposed, both partners should meet the financial criteria unless there is 100% recourse to the partner which meets the financial criteria.

COMPANY BACKGROUND INFORMATION

Before a vendor is selected, the municipality should seek to obtain as much of the checklist provided below as possible. Financial data should be examined for possible trends or unusual items. Notes to the Financial Statements should also be examined. Non-financial information can be even more important than financial statistics. Corporate restructurings or litigation can dramatically affect the vendor's ability to meet its obligations and guarantees.

Off-balance sheet liabilities, including contingent liabilities and outstanding guarantees, are extremely important. A company's financial statements may appear sound but be inadequate when the impact of off-balance liabilities and outstanding guarantees are considered. Questions should be asked such as: Can the company's assets meet all its obligations when off-balance items are considered, including its outstanding guarantees? To how many waste-to-energy projects has the company committed? What is the likelihood of a technological failure that could affect all of the vendor's existing waste-to-energy projects? This last risk should be lessened if the vendor's technology is proven with a long, successful operating history.

Moreover, the municipality should be concerned with off-balance sheet items and guarantees for all areas of the company rather than just its resource recovery area. A major construction company, for example, may have significant guarantees on other types of construction projects which might significantly impact its ability to perform.

It should be noted that prospective vendors may be extremely reluctant to discuss off-balance sheet items. Vendors may respond that all material items have been disclosed in the financial statements or that such obligations are impossible to quantify. While it is true that the project team will not need to know the details of every off-balance sheet liability, this area has become a source of concern to the financial community and a municipality should attempt to obtain as much relevant information as possible.

A company's access to short-term liquidity is important as well: a company with $50 million in working capital, but with access to another $100 million through a revolving credit agreement may be stronger than a company with $55 million in working capital but no possible additional sources of funds. In addition, for a very large project, access to working capital may be as important, or more important, than the vendor's actual level of working capital.

Checklist of Company Background Information

A. Financial Information

1. Audited financials for last 3 years, if available (Income Statement, Balance Sheet and Statement of Changes in Financial Position)
2. Most recent 10-K and 10-Qs since last 10-K
3. Latest quarterly report and annual statement
4. Copy of the latest prospectus and Official Statement, if any, for company's latest securities offering and/or project financing utilizing tax-exempt debt
5. Rating of any outstanding corporate debt and rating agency report(s) on such debt

B. Non-financial information

1. Information on material changes or planned changes in method of conducting business
   a. bankruptcy proceedings
   b. corporate restructurings
   c. mergers or acquisitions
   d. actual or pending litigation

2. Off-balance sheet liabilities, including contingent liabilities
   a. description of all major financial commitments
      i) completion guarantees on construction projects
      ii) operating guarantees
      iii) other contractual relationships which may affect guarantees for project or financing for project, including corporate guarantees, affiliations, partnerships and/or joint ventures

3. Description of assets to be used to support company's guarantees. Recourse the project will have to company's balance sheet.

4. Information on company's access to bank lines of credit, revolving credit agreements or other sources of short-term liquidity.

SPECIFIC REQUIREMENTS

In addition to obtaining company information, the municipality will want to establish financial criteria particular to its project. Typical requirements are provided below. However, it should be noted that the guidelines discussed may (i) not be appropriate for some projects, and (ii) be failed by a creditworthy vendor due to particular circumstances. The municipality should allow a vendor the opportunity to explain such a situation. Moreover, it should be stressed that the municipality should examine the overall financial picture of the vendor: a $500 million company with a $10 million operating loss in one year may well be stronger than a $50 million company with a $10 million operating profit in one year. The riskiness of a vendor's mainline business(es) and its position within its industry should also be considered. A municipality may be willing to accept somewhat less stringent financial requirements if it intends to own and operate its waste-to-energy project. All requirements should be defined in accordance with generally accepted accounting principles.

Typical financial criteria will include:

1) The requirement that the company be capable of an investment grade rating. As discussed earlier, this is important since the rating of the company may determine the rating on the project bonds. Some companies do not have outstanding debt or an existing credit rating. The project team will need to decide what evidence will be deemed satisfactory to meet this criteria.

2) A net worth test. In a worst-case situation, the company may need to draw upon its net equity to honor its guarantees. At the very minimum, the company should have a net worth at least equal to the total project cost (bond financing, including financing costs, capitalized interest and reserve funds and other funding sources such as construction financing, third party equity or grant funding). Indeed, a company with a net worth equivalent or only slightly in excess of the project cost may not be acceptable to the rating agencies and financial community since the failure of that project would overwhelm the company. A general target might be a net worth equal to approximately two times the project cost. A company that is relatively strong according to the other criteria or is especially stable would not need as large a cushion as one that is relatively weak according to the other criteria.

3) A working capital test. This should measure the company's ability to obtain cash quickly for needed repairs or improvements to the project. It is important that the company have such funds available since more permanent financing, such as debt, may take several months or more to arrange, which might otherwise force the project to be closed for such time. Indeed, a municipality may prefer to focus on a vendor's "quick" assets such as cash, marketable securities and net receivables, and exclude items such as inventories and prepaid expenses, which may not be readily convertible into cash, from the calculation of working capital.

   However it is defined, working capital should be somewhat larger than the cost of the major "big ticket" equipment items, such as the turbine generators and possibly the boiler(s), to cover these costs plus other cash flow requirements that the company may have incurred since its last financial statement. For a very large project, access to sources of short-term liquidity, such as bank lines of credit, should be examined.

4) An acceptable long-term debt-to-total capital ratio. This will measure how leveraged the company is. The philosphy is that while some debt is perfectly acceptable, too much debt will place the company in a more precarious financial position as well as limit the company's ability to raise funds to honor its obligations or guarantees, if needed. A general guideline might be a debt-to-total capital ratio of less than 50%, although an otherwise acceptable company may fail this test if it had just financed a major acquisition or project.

5) Net income or cash flow tests. While it is very important to examine some measure of income or cash flow to determine how well the company is doing, we believe it is very difficult to establish an objective criterion for such a test. Instead, the municipality may want to examine the company's profitability in relation to the size of the company. As mentioned earlier, a small loss by a large corporation may be of less concern than a marginally profitable firm that is small in size. Moreover, net income may not be the appropriate measure since extraordinary gains or losses may dramatically affect net income. Operating profit or cash flow is a better measure of the company's success with continuing operations. The municipality should consider industry cycles as well: a company producing a small amount of cash flow and operating income during adverse industry conditions may be a stronger company than another firm showing more cash flow and operating profit during extremely favorable industry conditions. As the overall concern should be how the company's operations are affecting its long-term balance sheet, the municipality should look for trends in cash flow or operating income and may want to examine averages over a recent period of time.

   The municipality may also want to examine debt service coverage ratios. These will measure how well the company is covering its existing debt obligations and the company's ability to cover future debt, if necessary, from existing operations. However, debt service coverage ratios are probably of lesser importance than the other criteria discussed here.

There is some controversy as to whether the requirements discussed above should be measured as of the latest quarterly or annual financial statement or on the basis of an average over a period of time, such as three-year averages. Proponents of a period average argue that averaging smooths out unusual aberrations. Proponents of using the most recent financial data argue that the municipality should be concerned with the existing health of the company. A combination of the two approaches might be the best solution. Balance sheet items, such as net working capital, net equity and debt-to-equity ratios, might best be measured as of the most recent financial statement since the existing and future, rather than past, levels of those requirements will determine the company's ability to meet its obligations. Measures of the company's performance over a period of time, such as income statement items, may be better averaged over a period of time to avoid either a positive or negative aberration.

Because a company's financial picture can change dramatically, the municipality should state unequivocally that the vendor must meet the financial criteria at the time a proposal is submitted, at the time the vendor is selected, and at the time the project contracts are executed. This will provide the municipality at least some protection against a financially deteriorating vendor or a vendor who is planning major changes to its financial position.

GUARANTEES

Each waste-to-energy project is unique and the allocation of risks and vendor guarantees can vary greatly between projects. Moreover, vendor guarantees for a municipally-owned and operated project will be very different from vendor guarantees for a privately owned and operated project. This paper will not discuss risk allocation but rather will focus on major guidelines for vendor guarantees. However, the municipality should outline its risk allocation posture and examine prospective vendors responses prior to selecting a vendor. A municipality should consult its financial team members as to typical risk allocations and what will be acceptable to the financial community.

At a minimum, vendor guarantees for its obligations should provide sufficient funds to retire the outstanding bonds issued to finance the project. The municipality may want to consider requiring guarantees to cover total project costs, particularly if any grant monies used in financing the project are subject to repayment if the project fails. Some municipalities, contemplating the cost and problems of waste disposal if the project fails, have asked for damages from the vendor to subsidize the cost of such disposal or have requested vendors to guarantee alternative disposal methods at a fixed price for an interim period of time. Some vendors may believe such requirements are too onerous.

The financial community will require the vendor to guarantee or "front" all subcontractors' performance so the bond trustee has access to one creditworthy entity. Of course, the vendor should require appropriate guarantees from its subcontractors and will be free to pursue such remedies if a problem arises. Needless to say, the project should require the vendor to carry appropriate forms of commercial insurance. In addition, the project may wish to require a performance or surety bond from its vendor, although such a requirement should be imposed only after a careful cost-benefit analysis. Certain guarantees or risks may not be insurable or performance bondable.

As mentioned earlier in the section on Company Background Information, the vendor should be required to disclose all existing guarantees on resource recovery projects. The municipality should consider the vendor's ability to meet such guarantees as well as weighing the likelihood that a technological problem could cause a failure of all of the vendor's projects. This risk is less likely given a proven technology and successful vendor operating history.

EQUITY CONSIDERATIONS

If the facility is to be privately owned and operated, the municipality should examine additional considerations. The municipality may want to require a minimum amount of equity to be contributed to the project by the vendor. An equity requirement may be expressed as either an absolute dollar amount or as a percentage of project costs. Project cost should be defined since there may be confusion as to whether the term means the facility cost alone or includes financing and developmental costs. As pending tax legislation will have a major impact on the vendor's return on equity, the merit of specifying minimum equity requirements may change in the future.

The municipality will want to determine the timing of the company's equity contributions. This consideration was of greater concern when a municipality could invest bond proceeds and earn arbitrage on its investments. However, it is still important since the tax-exempt bond proceeds may only be spent on costs that are deemed "qualified" by the IRS and at least some equity funding will be required throughout the construction period.(2) The project will want to determine the timing of non-qualified cost expenditures and make sure vendor equity is available to fund those expenditures. Moreover, if the company wishes to contribute its equity after construction is completed, construction financing will need to be arranged. The municipality should feel comfortable that the vendor can arrange such financing. The municipality should also determine whether the cost of such construction financing has been included in the vendor's proposal and who bears the financial burden if construction financing costs are underestimated. In general, providers of municipal bond insurance and letter of credit banks will feel more comfortable if the vendor has committed its own equity during project construction.

The municipality should request the source of the vendor's equity funding. Corporate cash is the most straightforward source of funding, although a vendor should not be eliminated for proposing another funding arrangement. If an alternative source of funding is proposed, the municipality should determine the vendor's experience in arranging such funding, the vendor's relationship with potential funding sources, whether a commitment from a funding source is available, the terms and conditions of such a commitment, and the cost of arranging such funding.

Leveraged lease financing, where third-party equity is used in conjunction with project debt,(3) has not been used frequently in waste-to-energy projects although it is becoming more common and may be used much more in the future depending upon the continuing availability of tax benefits. Because of the low experience level in utilizing leveraged lease financing for waste-to-energy projects, and because leveraged lease financing adds additional participants to the project financing, leveraged lease financing is

(2) Tax-exempt industrial development bond financing for waste-to-energy projects is permitted under the solid waste exemption of the Internal Revenue Code. The Internal Revenue Service has held that tax-exempt financing may generally be used to finance equipment so long as the product being processed is "valueless". Bond counsel typically defines this as the point where steam is produced from the boiler. Hence, the steam distribution lines, turbine generators, etc. may not be financed with tax-exempt bonds unless the energy user is a municipal entity. Ancillary facilities, such as office space, may also not be qualified for tax-exempt bond financing. Pending tax legislation will affect the definition of qualifying costs.

(3) For a discussion of leveraged lease financing, see "Resource Recovery Financing: Lease Financing" by Roger McDaniel, Shearson Lehman Brothers Inc. Copies are available from the author of this paper upon request.

generally going to be more time-consuming and more expensive than a cash equity funding from a project vendor who has a use for tax credits. This is not to suggest leveraged lease financing is not an attractive alternative. Rather, the municipality should ask the vendor to include estimated financing costs in the vendor's proposal. A forward commitment for leveraged lease financing is very difficult to obtain so a municipality may want to require the vendor to provide equity funding for the project in the event that leveraged lease financing cannot be arranged during project construction. Finally, if leveraged lease financing is contemplated, it is highly preferable to incorporate such provisions into project documentation at the outset of the project rather than subsequently amending the project credit structure and documentation.

SPECIAL SITUATIONS

The following is a checklist of certain items which should encourage the municipality to proceed cautiously. This checklist is far from complete and is not intended to be used to eliminate potential vendors. It is meant to suggest the municipality exercise additional scrutiny when reviewing a prospective vendor. A perfectly acceptable vendor may appear on this list; however, these are areas of potential problems that municipalities have encountered in the past.

1. Major vendor exceptions to municipality's risk allocation posture. Some vendor exceptions to the municipality's risk allocation position are likely and should be expected. However, if a vendor takes major exceptions or exception to an item upon which the municipality is unwilling to negotiate, the municipality is likely to be better off eliminating an otherwise-qualified vendor. The municipality may otherwise spend countless hours in negotiation with a vendor without ever reaching an acceptable agreement. (This is not to imply that a municipality may not have risk allocation difficulties with a vendor that initially appears acceptable.)

2. New technology or less proven technology. In general, the financial community is very skeptical of new technologies or less proven technologies due to some notable technological failures in the past. The municipality should consult its financial team members as to the acceptability of the vendor's proposed technology to the rating agencies, municipal bond insurers, letter of credit banks, and the bond market. If the financial community refuses to accept a technology or demands a high interest rate premium for doing so, an otherwise acceptable project may be destroyed or uneconomic.

3. First time vendors. Every vendor operating in the U.S. had to have a first project, so this is not to suggest eliminating a firm on this basis. However, the municipality should ask for proof that the company will provide appropriate guarantees and, if applicable, an equity commitment. (A signed statement by a corporate officer authorized to make such commitments is desirable.) Numerous municipalities have selected vendors and proceeded to develop their project only to find out much later that the appropriate company entity was unwilling to issue guarantees or provide funding. Verbal promises are not acceptable proof.

Moreover, the municipality should determine whether the first time vendor is acceptable to the financial community since the project will need to convince rating agencies, providers of credit enhancement, and potential bondholders that the vendor knows what it's doing. A large company with substantial assets or a company with name recognition and high credit ratings will be a more acceptable first time vendor than a small or unknown company.

The municipality should further consider that a first time vendor may require more time to negotiate contracts, structure documents and design and engineer the facility. This will depend largely upon the corporate commitment to resource recovery and the individuals staffing the project.

4. Use of credit enhancement to provide an investment grade rating for the vendor. The municipality should be very cautious in this situation. The municipality should require proof that a vendor has a committed source of credit enhancement, such as a letter of credit, and what alternative sources of vendor credit enhancement are available if the first source withdraws. The term of the vendor credit enhancement may need to match the term of the project bonds or provide funding to redeem the project bonds if the vendor credit enhancement expires and an alternate source cannot be obtained. However, it may be possible to structure the vendor credit enhancement so that it may be eliminated if it is no longer required. Examples of such a situation would include the vendor achieving an investment grade rating or, in the case of a municipally-owned and operated project, successful passage of the vendor's construction and performance guarantees.

   The municipality should know the conditions to the vendor credit enhancement commitment and the project structuring terms that will be required. Moreover, the municipality should know the cost of the vendor credit enhancement and who is responsible for paying such costs. It is helpful if the vendor has an established relationship with the provider of credit enhancement and has used the provider in a previous resource recovery project financing. As a strong generality, the use of credit enhancement to support the vendor's credit rating will almost always add time and expense to the project.

5. Foreign joint ventures where a foreign corporation provides guarantees and financial backing. Foreign corporations are often not aware of the level and extent of corporate guarantees required for waste-to-energy projects in the United States. The municipality should confirm the foreign corporation's understanding and acceptance of the required guarantees and the project's risk allocation posture. In addition, the financial community will be concerned about ready access to corporate funds and foreign currency exchange rate fluctuations.

CONCLUSION

The various vendor financial criteria discussed in this paper should be considered not only individually but in relation to each other. As stated earlier, vendor selection is a critical decision for a municipality and the task is extremely complex. This paper discussed only financial considerations; technical qualifications are equally important and even greater in number. Having a qualified project team and including the investment banker, financial advisor, consulting engineer and bond counsel in the vendor selection process can greatly assist the municipality in weighing the various considerations and making an appropriate decision. An appropriate vendor will make the waste-to-energy project much easier to finance and complete.

Glossary

of terms used in solid waste management
and resource recovery

GLOSSARY OF TERMS USED IN SOLID WASTE MANAGEMENT AND RESOURCE RECOVERY

AEROBIC DIGESTION: The utilization of organic waste as a substrate for the growth of bacteria which function in the presence of oxygen to reduce the volume of the waste. The products of this decomposition are carbon dioxide, water and a remainder consisting of inorganic compounds and any undigested organic material.

AIR CLASSIFIER: A unit process in which mixed material is injected into a forced air stream and separated according to size, bulk density and aerodynamic drag of the pieces.

AIR EMISSIONS: Solid particulates (such as unburned carbon, etc.) and gaseous pollutants (such as oxides of nitrogen or sulfur, etc.) or odors. These can result from a braod variety of activities including exhaust from vehicles, combustion devices, compost piles, etc. State and local regulations establish limits.

AIR POLLUTION: The presence of unwanted material in the air. The term "unwanted material" here refers to material in sufficient concentrations, present for a sufficient time and under circumstances to interfere significantly with health, comfort or welfare of persons, or with the full use and enjoyment of property.

ANEROBIC DIGESTION: The utilization of organic waste as a substrate for the growth of bacteria which function in the absence of oxygen to reduce the volume of waste. The bacteria consume the carbon in the waste as their energy source and convert it to gaseous products. Properly controlled, anerobic digestion will produce a mixture of methane and carbon dioxide, with a sludge remainder consisting of inorganic compounds and any undigested organic material.

AQUIFER: A water-bearing formation that provides a ground water reservoir.

ASH: The incombustible material that remains after a fuel or solid waste has been burned.

ASH PIT: A pit or hopper located below a furnace where residue is accumulated and from which it is removed.

BAGASSE: The fibrous residue that remains after juice is extracted from sugar cane or sugar beets.

BAGHOUSE: An air pollution control technique which traps air emissions in a filter placed at the back-end of the incineration process.

BASE LOAD: The minimum continuous stream or electrical load over a given period of time.

ABBREVIATIONS & ACRONYMS

BACT - Best Available Control Technology

DEP - Department of Environmental Protection

EIS - Environmental Impact Statement

EPA- Environmental Protection Agency

KW - Kilowatt

MSW- Municipal Solid Waste

MW - Megawatt

NAAQS- National Ambient Air Quality Standards

NIOSH - National Institute for Occupational Safety and Health

NPDES- National Pollutant Discharge Elimination System

NSPS - New Source Performance Standards

OSHA - Occupational Safety and Health Act (or Administration)

PPB - Parts per Billion

PPM - Parts per Million

PSD - Prevention of Signifcant Deterioration

RDF - Refuse-Derived Fuel

RFQ - Request for Qualifications

RFP - Request for Proposals

SIP - State Implementation Plan

TPD - Tons per Day

DUMP: An open site where waste materials are buried, left to decompose, rot or simply remain. In most localities, dumps have been phased out because of water pollution, unsanitary conditions and general unsightliness.

EFFLUENT SEEPAGE: Diffused discharge onto the ground of liquids that percolated through solid waste or another medium; they contain dissolved or suspended materials.

ELECTROSTATIC PRECIPITATOR (ESP): A device that collects particulates by placing an electrical charge on them and attracting them onto a collecting electrode. When installed in resource recovery plants, they significantly reduce polluting air emissions.

EMISSION STANDARD: A rule or measurement established to regulate or control the amount of a given pollutant that may be discharged into the outdoor atmosphere from its source.

EMISSIONS: The total of substances exhausted to the atmosphere.

ENERGY RECOVERY: A form of resource recovery in which the organic fraction of waste is converted to some form of usable energy. Recovery may be achieved through the combustion of processed or raw refuse to produce steam (e.g., as a supplemental fuel in electric utility power plant boilers or as the primary fuel in incinerators), through the pyrolysis of refuse to produce oil or gas; and through the anaerobic digestion of organic wastes to produce methane gas.

ENVIRONMENTAL IMPACT STATEMENT (EIS): A document prepared by EPA or under EPA guidance (generally a consultant hired by the applicant and supervised by EPA) which identifies and analyzes in detail the environmental impacts of a proposed action. Individual states also may prepare and issue an EIS as regulated by state law. Such state reports may be called Environmental Impact Reports (EIR).

FACILITY: Any land and appurtenances thereto used for the treatment, storage and/or disposal of wastes.

FERROUS: Pertaining to, or derived from, iron. (In resource recovery, often used to refer to materials that can be removed from the waste stream by magnetic separation.)

FLUE GAS WASHER OR SCRUBBER: Equipment for removing fly ash and other objectionable materials from the products of combustion by means of sprays, wet baffles, etc. Also reduces excessive temperatures.

FLY ASH: All solids including ash, charred papers, cinders, dusty soot or other partially incinerated matter that rise with the hot gases from combustion rather than falling with the bottom ash.

FRONT-END RECOVERY: The salvage of usable materials, most often the inorganic fraction of solid waste, prior to the processing of the organic fraction. Some techniques for front-end recovery are grinding, shredding, magnetic separation and screening.

SHREDDED REFUSE: Solid waste which has been reduced in size through a hammermill or shredder.

SHREDDER: A mechanical device used to break up waste materials into smaller pieces by tearing and impact action.

SLUDGE: Waste mateials in the form of a concentrated suspension of waste solids in water. One type of sludge is produced from the treatment of sewage.

SOLID WASTE: Garbage, refuse, sludges, and other discarded solid materials, including those from industrial, commercial and agricultural operations, and from community activities; does not include solids or dissolved materials in domestic sewage or other significant pollutants in water resources, such as silt, dissolved or suspended solids in industrial waste water effluents, dissolved materials in irrigation return flow, or other common pollutants.

SOLID WASTE MANAGEMENT: The systematic administration of activities which provide for the collection, source separation, storage, transportation, transfer, processing, treatment, and disposal of solid waste.

SOLID WASTE MANAGEMENT FACILITY: Any resource recovery system or component thereof, any system, program or facility for resource conservation, and any facility for the treatment of solid wastes, including hazardous wastes, whether such facility is associated with facilities generating such wastes or otherwise.

SOURCE REDUCTION: Reducing the amount of materials entering the waste stream by voluntary or mandatory programs to eliminate the generation of waste. Synonymous with waste reduction. Using returnable beverage containers is a form of source reduction.

SOURCE SEPARATION: The segregation of various wastes at the point of generation. For example, householders separating paper, metal and glass from the rest of their wastes. Source separation makes recycling simpler and easier.

STACK (chimney, flue): A vertical passage for conducting products of combustion to the atmosphere.

STOICHIOMETRIC AIR: The amount of air required to provide the proper amount of oxygen for total combustion of a fuel. Municipal solid waste incineration technologies make use of both sub-stoichiometric and excess air processes.

SUPERHEATED STEAM: This is saturated steam heated to a temperature above the saturation temperature that is due to its pressure. This is done by removing the steam from the boiler steam drum (where it is in contact with water) and adding additional heat as the steam passes through the superheated tubes.

TRANSFER STATION: A place or facility where waste materials are taken from smaller collection vehicles (e.g., compactor trucks) and placed in larger transportation units (e.g., over-the-road tractor trailors or barges) for movement to disposal areas, usually landfills. In some transfer operations, compaction or separation may be done at the station.

LEACHING: The operation, natural or designed, of producing leachate.

LINER: A relatively thin structure of natural clay, Poz-O-Tec or manufactured material (various plastics) which serves as a barrier to prevent leachate from reaching or mixing with ground water in landfills, lagoons, etc.

LITTER: Solid waste discarded outside the established collection disposal system. (Solid waste properly placed in containers is often referred to as trash and garbage; uncontainerized, it is referred to as litter.) Litter accounts for about two percent of municipal solid waste.

MAGNETIC SEPARATOR: Equipment usually consisting of a belt, drum or pulley with a permanent or electro-magnet and used to attract and remove magnetic materials from other materials.

MASS COMBUSTION or MASS BURN: The burning of as-received refuse in furnaces designed exclusively for solid waste disposal/energy recovery.

MATERIALS MARKET: The combination of manufacturing interests which buy recyclable materials and process them for reuse. The demand for goods made of recycled materials determines the economic feasibility of recycling and resource recovery.

MATERIALS RECOVERY: The extraction of materials from waste for sale which can occur prior to or after combustion but, typically, occurs before combustion so as to enhance the material values.

METHANE: An odorless, colorless, flammable gas which can be formed by the anerobic decomposition of organic waste matter or by chemical synthesis. It is the principal constituent of natural gas.

MODULAR COMBUSTION UNIT: A self-contained incinerator designed to handle small quantities of solid waste. Several "modules" may be combined in a plant, as needed, depending on the quantity of waste to be processed. (See Incinerator).

MUNICIPAL SOLID WASTE (MSW): Includes waste generated in households, commercial and business establishments and institutions; and excludes industrial process wastes, demolition wastes, agricultural wastes, mining wastes, abandoned automobiles, ashes, street sweepings and sewage sludge.

NATIONAL AMBIENT AIR QUALITY STANDARDS: Federal standards which limit the concentration of particulates, sulfur dioxide, nitrogen dioxide, ozone, carbon monoxide and lead in the atmosphere.

NONFERROUS: Metals which contain no iron. In waste materials these are usually aluminum, copper wire, brass, bronze, etc.

ORGANIC REFUSE: Waste material from substances composed of chemical compounds of carbon and generally manufactured in the life processes of plants and animals. These materials include paper, wood, food wastes, plastics, and yard wastes.

FURNACE: An enclosed refractory or waterwall structure equipped with grates. The furnace is the area in an incinerator where the preheating, drying, igniting and most of the burning of refuse takes place.

GRATE: A device used to support the solid fuel or solid waste in a furnance during drying, ignition, or combustion. Openings are provided for passage of combustion air.

HAMMERMILL: A type of crusher used to break up waste materials into smaller pieces or particles, which operates by using rotating and flailing heavy hammers.

HAUL DISTANCE: The distance a collection vehicle travels from its last pickup stop to the solid waste transfer station, processing facility, or sanitary landfill.

HAZARDOUS WASTE: Waste which because of its quantity, concentration, or physical, chemical or infectious characteristics may pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of or otherwise managed.

INCINERATION: An engineered process using controlled flame combustion to thermally degrade waste materials. Incinerators must meet clean air standards. This process is used particularly for organic wastes with a high BTU value. The wastes are de-toxified by oxidation and will normally sustain combustion without the use of additional fuel.

INDUSTRIAL WASTE: Those waste materials generally discarded from industrial operations or derived from manufacturing processes.

INORGANIC REFUSE: Waste material made from substances composed of matter other than plant, animal, or certain chemical compounds of carbon. Examples are metals and glass.

IN-PLANT WASTE: Waste generated in manufacturing processes. Such might be recovered through internal recycling, energy recovery and/or through a salvage dealer.

INSTITUTIONAL WASTE: Waste materials originating in schools, hospitals, research institutions and public buildings. The materials include packaging materials, certain hazardous wastes, food wastes, disposable products, etc.

LANDFILL: A conventional sanitary landfill is "a land disposal site employing an engineered method of disposing of solid wastes on land in a manner that minimizes environmental hazards by spreading solid wastes in thin layers, compacting the wastes to the smallest practical volume, and applying cover material at the end of each operating day." A secure waste landfill should be designed to provide protection to the quality of surface and sub-surface waters, thereby making site selection very important.

LEACHATE: The fluid stream which issues from a pile or cell of solid materials and which contains water, dissolved solid and decomposition products of the solids. Leachate may enter the groundwater and contaminate drinking water supplies.

TROMMEL: A perforated, rotating horizontal cylinder which may be used in resource recovery facilities to break open trash bags, remove glass in large enough pieces for easy recovery and remove small abrasive items such as stones and dirt. Trommels have been used to remove steel cans from incinerator residue.

VOLUME REDUCTION: The processing of waste materials so as to decrease the amount of space the materials occupy. Reduction is presently accomplished by three major processes: (1) mechanical, which uses compaction techniques (sanitary landfills, etc.) and shredding; (2) thermal, which is achieved by heat (incineration and pyrolysis) and can reduce volume by 80-90 percent; and (3) biological, in which the organic waste fraction is degraded by bacterial action (composting, etc.).

WATERWALL FURNACE: Furnace constructed with walls of welded steel tubes through which water is circulated to absorb the heat of combustion. These furnaces can be used as incinerators. The steam or hot water thus generated may be put to a useful purpose or simply used to carry the heat away to the outside environment.

YARD WASTES: Grass clippings, prunings, and other discarded material from yards and gardens.

BASE LOAD STATION: A generating station which is normally operated to take all or part of the base load of a system and which, consequently, operates essentially at a constant output.

BIODEGRADABLE MATERIAL: Waste material which is capable of being broken down by bacteria into basic elements. Most organic wastes, such as food remains and paper, are biodegradable.

BOTTOM ASH: The non-airborne combustion residue from burning fuel in a boiler. The material falls to the bottom of the boiler and is removed mechanically.

BRITISH THERMAL UNIT (BTU): The quantity of heat required to increase the temperature of one pound of water one degree fahrenheit.

BULKY WASTE: Large items of refuse including, but not limited to, appliances, furniture, large auto parts, trees, branches and stumps which cannot be handled by normal solid waste processing, collection or disposal methods.

BYPASS WASTE: Solid waste which has been contractually committed to a facility, but which is diverted when the facility is unavailable.

COLLECTION: The act of picking up and moving solid waste from its location of generation to a disposal source, such as a transfer station, resource recovery facility or landfill.

COMBUSTIBLES: Various materials in the waste stream which are burnable, such as paper, plastic, lawn clippings, leaves and other organic materials.

COMBUSTION CHAMBER (PRIMARY): Chamber where ignition and burning of the waste occurs.

COMMERCIAL WASTE: Waste material which originates in wholesale, retail or service establishments such as office buildings, stores, markets, theaters, hotels and warehouses.

DENSIFIED REFUSE-DERIVED FUEL (d-RDF): A refuse derived fuel which has been compressed or compacted through such processes as pelletizing, briquetting or extruding, causing improvements in certain handling or burning characteristics. (See Refuse-Derived Fuel.)

DIOXIN: The generic name for a highly toxic group of organic chemical compounds, more formally known as polychlorinated dibenzo-p-dioxins.

DISPOSAL FACILITY: A collection of equipment and associated land area which serves to receive waste and dispose of it. The facility may incorporate one or more disposal methods.

DOMESTIC WASTE OR HOUSEHOLD WASTE: Solid waste, comprising garbage and rubbish, which normally originates in the residential private household or apartment house.