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guides for municipal officials

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1. Planning and Overview (SW-157.1)
2. Technologies (SW-157.2)
3. Markets (SW-157.3)
4. Financing (SW-157.4)
5. Procurement (SW-157.5)
6. Accounting Format (SW-157.6)
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8. Further Assistance (SW-157.8)

Resource Recovery Plant Implementation:

Guides for Municipal Officials

MARKETS

This guide (SW-157.3) was compiled
by Yvonne M. Garbe and Steven J. Levy

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CONTENTS

MARKETS FOR MATERIALS AND ENERGY RECOVERED FROM MUNICIPAL SOLID WASTE

By Yvonne M. Garbe and Steven J. Levy*

Several materials and a variety of different energy products can potentially be recovered from municipal solid waste and sold to produce revenue. The recoverable forms of energy include solid, liquid, and gaseous fuels as well as steam and electricity. The materials that are considered to be the primary recovery candidates are paper, ferrous metals, glass, and aluminum.

This report discusses the markets for these energy and material products, focusing on those characteristics that affect marketability. Discussed are descriptions and locations of potential markets, the product quality required by those markets, and approximate market prices. The report then addresses marketing techniques, including how to conduct a market research and obtain a purchase agreement.

Perhaps the paramount message which should flow from this document is this: Markets First: specifications determine technology. Market availability and specifications determine not only the basic components of a recovery system, but also the specific manner in which those components are designed and operated.

ENERGY PRODUCTS AND MARKETS

Resource recovery technologies under development in the United States today can generate a variety of different energy products from solid waste. Solid, liquid, and gaseous fuels are possible products, as well as steam and electricity. Not all of these options have been developed to the point where a municipality can consider them for immediate implementation. (For a further discussion as to which options are presently available, see the Technology Guide section of this series.) The energy recovery system that should be employed in any particular community depends upon the market outlets available for their products.

This section discusses the characteristics of various energy products, especially those characteristics that affect product marketability. It also discusses potential markets for energy products, and the factors that influence their willingness to buy. Solid, liquid, and gaseous fuels are considered first, then steam and electricity. Finally, the various energy products are compared.

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FUEL

Fuels can be produced from solid waste using a number of technologies currently under development. Either heavy duty shredders, or pulpers, operating in conjunction with material classifiers, can produce solid fuels, while pyrolysis reactors can produce liquid and gaseous fuels. These fuels may be burned in furnaces either by themselves or in conjuntion with their fossil fuel counterparts: coal, petroleum, and natural gas. The usefulness of marketability of these waste-derived fuels depend on their characteristics.

Fuel Characteristics

Fuels derived from municipal solid waste will have physical and chemical properties different from those of conventional fuels and, therefore, will have different handling and combustion characteristics.

There are a number of general characteristics that determine the marketability of fuels derived from solid waste whether they are solid, liquid, or gaseous. These include the following.

Quantity of fuel produced. Enough of the product must be available to justify any expenses that the user may incur in modifying his facility to accept this new fuel source. Naturally, the higher the cost of plant modification, the greater the minimum quantity of fuel will be required. This reduces the alternatives available to communities of 50,000 people or less. These communities may want to investigate using small incinerators with heat recovery systems.

Heat value. The heat value of each fuel must be high enough to maintain boiler or furnace efficiency. For example, tests using gaseous fuels with heat values of 300 British Thermal Units (Btu)/cu.ft. and above have been successful. Below this level, they may require speical consideration, although some types of industrial operations have used gaseous fuels with heat values as low as 90 to 100 Btu/cu.ft. Also, the lower the heat value, the higher the per unit cost to transport, store, and handle the greater quantity of fuels required.

Supply reliability. An adequate and continuing supply of the fuel increases its value because the user does not need to maintain standby equipment or fuel.

Quality. The better the product, in terms of handling, stability, uniformity, good burnout, greater Btu value, etc., the more it is worth because the customer's cost to use the product is reduced.

Price. The price of the fuel will probably be approximately equivalent (on the basis of heat value produced) to the price of the fossil fuel it replaces. In determining equivalence, adjustments must be made for additional costs incurred in its use.

Solid Fuel

Solid waste fuels are produced by separating the light combustible fraction of shredded or pulped solid waste from the heavier noncombustible portion. The light fraction will probably represent 70 to 80 percent of the incoming solid waste, and may be the primary contributor of product revenue.

Refuse derived solid fuels can be used as a supplement to coal in suspension-fired utility boilers. They are also being considered for use in conjunction with oil-fired units as a fuel supplement in cement kilns. These fuels can be prepared as a fine powder, light fluff, dewatered wet pulp, or as a densified pellet or cubbette. Heat values are typically 4500 to 6500 Btu per lb (as received) and the fuel may have value of $.30 to $2.00 per million Btu depending on the quality of the product, the user's expected handling costs, and the availability of alternative fuels. Some factors that influence the marketability of these solid fuels are:

Particle size. Ideally, particles must be small enough to permit complete combustion when burned in suspension. However, practical size ranges vary with the type of unit used to burn the fuel. A general rule of thumb has been a one-inch nominal (90 percent less than one inch) particle size. Small particle size is particularly important if there are no burnout grates at the base of the combustion chamber.

Residue content. Residue should be kept to a minimum in order to prevent erosion of the furnace walls and the fuel firing system. Excessive residue may restrict the re-sale value of the coal ash. Air classifiers and magnetic separators can be used to remove noncombustible materials to reduce the ash content of the combustible fraction of the fuel. Typically, ash content amounts to about 20 percent by weight. This can cause a five fold increase in ash per unit of heat delivered, since better grades of coal average about 10 percent ash and have heating values two and one-half times that of the refuse derived fuel.

Moisture content. Moisture content will affect the heat value of the fuel. The combustion efficiency of the unit is reduced as the moisture content is increased. This is particularly important in preparing fuel by the wet pulping method because the fuel product must be dewatered to an acceptable moisture content. Dry separation processes generally produce a fuel containing 25 to 30 percent moisture content and having a 4500 to 6500 Btu/lb. heat value. The wet pulping method produces a fuel containing 50 percent moisture and has a 3500 Btu/lb. heat value.

Solid fuels may also be formed into pellets in order to improve the fuel's handling characteristics. Also, by forming pellets this fuel may be made suitable for use in older stoker-fired units which would not be able to use a finely divided fuel. The use of pellets, however, has not yet been demonstrated on a large scale.

Liquid Fuels

One energy recovery technology under development in San Diego, California, produces a heavy, oil-like liquid fuel that can be used as a supplement to No. 6 fuel oil in large industrial or utility boilers. Factors which will influence its marketability include the following.

Volumetric heating value. The volumetric heat value (Btu per gallon) influences the cost of transporting and storing the fuel. The fuel has about 75 percent of the heat value of No. 6 fuel oil, on a volumetric basis.

Chemical stability. If the fuel undergoes chemical change, storage time may be restricted.

Special handling problems. The need to maintain separate storage and firing systems for the solid waste fuel, and to purge the firing systems after the fuel has burned, places an extra burden on the user and may diminish the fuel's value.

Gaseous Fuel

Most gaseous fuels produced from solid waste have a low heating value (100-500 Btu per cu ft) as compared to natural gas (1000 Btu/cu ft) because they contain significant quantities of carbon dioxide and, in some systems, nitrogen. The distrance they can be transported is limited due to cost of compressing and pumping the gas during transit. As the fuel value goes down this cost becomes prohibitive. Distances beyond 2 to 3 miles may be uneconomical for transporting gases having heat values of 300 per cu ft or less. Such fuels would probably have to be converted to steam or electricity on site where they are produced.

Markets for Fuels

The best markets for solid waste fuels would be large utility or industrial users who could replace 20 to 30 percent or more of their conventional fuels with solid waste fuel.

Steam electric power plants, industrial operations, and central heating/cooling plants represent the most likely market outlets for solid waste fuels.

Steam Electric Power Plants

Electric utilities operating steam-electric plants fired by fossil fuels are the most promising market because they use very large quantities of fuel and are often located close to the urban area where the solid waste is generated. Also, the quasi-public structure of the electric utility tends to be more conscious of community problems and, in some cases, more receptive to accepting the present uncertainties associated with using these fuels. For instance, a utility may gain approval of a new power plant site more easily if it is part of a solid waste energy recovery program.

Economic gain is a minor factor influencing a utility to use solid waste fuels because savings, if any, would amount to only a small fraction of the utility's total fuel costs and because savings in the cost of a solid waste fuel are generally passed on to the utility's customers through an automatic fuel price adjustment clause. However, economic gain in the form of capital investment savings and generating capacity credits can be considerable and may result when the utility agrees to purchase steam and/or electric energy.

Solid fuel can be burned only in boilers equipped to handle the residue. To date burning has occurred only on a demonstration basis and only in plants that were initially designed to burn coal. Oil fired plants may not have suitable ash handling capability or air pollution control facilities suitable for handling burning of solid fuel. Waste burning in such plants has not been demonstrated. Recent orders from the Federal Energy Administration require many oil and gas fueled units that are capable of burning coal to convert to coal. This tends to expand market opportunities for waste firing.

In establishing a solid waste fuel market with an electric utility it is necessary to determine whether the market will be capable of using the fuel for the entire projected useful life of the waste processing plant. This is because as plants become older they are replaced by more efficient newer plants, and their load factors (the amount of use they receive) tend to decline.

The capacity of a power plant to handle solid waste fuel will be a function of its load factor as well as the percentage of solid waste fuel that can be handled safely without damaging the plant or otherwise affecting its operation. For example, a 200 megawatt boiler having a load factor of 60 percent and a heat rate of 11,200 Btu/kwhr retrofitted to burn 10 percent solid waste derived fuel could handle about 500 tons of solid waste per day. A nomograph to calculate capacities of various boilers to handle solid waste fuel is included in Appendix I.

Utilities project load factors for all of their units using a set of assumptions such as future price of fossil fuels, customer demand, planned nuclear construction, projected environmental constraints, etc. These projections are understandably subject to a great deal of uncertainty. If however, a utility company projects that the economic utilization of the facility which will burn solid waste is going to decline then it may mean that the price the utility will pay for the fuel will decline sharply, or that the market might disappear completely.

Industrial Operations

Many industrial operations are potential markets for fuel produced from solid waste. Cement plants, paper mills, steel mills, and lime plants, for instance use vast amounts of fuel. To date most of these industrial markets have not been investigated in detail and there is virtually no experience in their burning of municipal waste derived fuel.

Feasibility studies are currently examining the possibility of using solid waste as a fuel in cement manufacturing kilns and a demonstration project is planned in Palmer Township, Pennsylvania, in 1977. The solid waste would supplement the coal or other fuel being used, and any ash remaining would be incorporated into the final cement product. Research is needed on any adverse impacts on cement quality that may result from the use of a waste derived fuel.

Cement kilns require about 8 million Btu of fuel per ton of cement produced. Plants range in capacity from 1,000 to over 3,000 tons or more cement per day. Therefore, using solid waste as 20 percent of the fuel load, a small plant could consume the fuel produced from 400 tons of solid waste per day.

A typical paperboard mill using about 25,000 pounds of steam per ton of boxboard at the rate of 360 tons of boxboard per day would require 400,000 pounds of steam per hour. This is equivalent to an energy yield of 1,200 tons of solid waste per day based on 20 percent solid waste fuel input.

Most paper mills currently burn their own bark and wood waste in boilers to supplement conventional fuels. Although this reduces the capacity of this market for solid waste fuels, it should ease the marketing task because the industry is already accustomed to burning waste fuels.

Market Value

Current fossil fuel prices generally range from around $.30 per million Btu on older long term coal or natural gas contracts to $2.00 per million Btu for spot purchases of low sulfur coal or oil. The value of the solid waste fuel will be a function of the cost of the fuel it is replacing and the increased costs associated with the use of the fuel.

Because of the wide range in prices being paid for fossil fuel it is wise to examine all potential fuel markets before selecting a particular process or end user.

STEAM AND ELECTRICITY

Steam can be converted to other forms of energy: (1) its heat can be used directly, for example, to heat buildings in a district heating system; (2) it can be converted mechanically into electricity by the use of steam turbines, which is what happens in a steam-electric power plant; or (3) for steam to provide motive force for industrial operations, such as to drive machinery or to operate a compressing unit to produce chilled water in a district cooling system.

Steam Characteristics

Steam temperature requirements generally range from 250 F to 1,050 F with pressures ranging from 150 pounds per square inch (psi) to 3,500 psi. The strength of the materials used to construct the steam-generating system is dictated by the temperature and pressure. In electric power plants the greatest efficiency is achieved at the highest temperatures and pressures. In steam distribution systems, however temperatures are kept as low as possible to minimize heat loss in the delivery system and to minimize the possiblity of bursting pipes.

In systems that use solid waste as the sole or primary fuel, the steam is usually produced at 600 psi or less in order to minimize slagging and corrosion of the boiler tubes. The steam can be processed further in separate units to bring it to the temperature and pressure at which it is needed.

Market Considerations

Steam can be marketed in two ways: as a guaranteed supply, or as a limited supply that requires the user to have a backup system. In the first case, the producer (a municipality, private company, or public authority) provides a reliable supply and assumes the responsibility of providing steam from other sources (e.g., a fossil fuel package boiler) if there is an interruption in the production of steam using solid waste. In the second case, the customer buys all of the steam the producer can generate using solid waste, but the customer carries the burden of producing additional steam in the event that this supply is interrupted or is not adequate to meet its demand. In this case, the steam's value to the customer is lower, but the steam producer assumes less risk and responsibility.

To be marketable, steam must meet the specific needs of the user. Some factors that affect steam marketability are:

Proximity to Customer. The steam-generating facility must be close enough to serve the steam market economically. Steam can be transported economically only about 2 miles; and in congested areas expensive pipeline installation can be expensive and other problems may further restrict this distance.

Value. The price at which the steam is delivered must be competitive with the costs of the customers' alternate energy sources.

Availability of Solid Waste. The municipality must insure that it has enough waste to meet its steam output commitments.

Quantity. The amount of steam supplied must be compatible with the customer's needs. If peak loadings cannot be supplied entirely by burning solid waste, then standby, fossil-fuel-fired boilers will be needed.

Operating Schedule. The steam-producing facility must be set up on an operating basis that satisfies the operating schedule of the steam customer.

Reliability. The system must include sufficient backup facilities to meet the level of reliability of supply agreed upon. This may include contingency plans to burn fossil fuels when the solid waste unit is out of service or when strikes or weather prevents solid waste from reaching the plant. The cost of building and operating these facilities must be considered in the economic evaluation of the system.

Excess Steam. The facility must be designed to serve the community's disposal needs, even if there is an interruption to the steam market. Condensing units or a backup sanitary landfill may be necessary.

Timing. The steam must be available when it is needed. Unanticipated delays in construction of the facility could force a steam customer to find another source of steam.

Markets for Steam

Most metropolitan areas have one or more major outlets for steam. Yet, despite the fact that proven technology exists for generating steam from municipal solid waste, constraints on its use have made the marketing of steam difficult in some cases. Several of these are discussed below.

District Heating and Cooling Systems

There are about 450 commercial and campus district steam heating systems operating in this country, a number of which also distribute chilled water for cooling buildings during warm weather. A number of cities have large steam systems serving their central business or industrial areas.

In these systems, steam is distributed at a low pressure, generally about 250 psi, which can be provided easily by a solid waste disposal facility. Unlike the demand for electricity, which has certain peak periods, steam demand is generally more constant throughout the day and from day to day. Seasonal variations can be significant, but if the utility also distributes chilled water it can operate its chilling plant with a steam-driven turbine. In any event, the demand for steam can be sufficient to accomodate a constant amount of steam produced in an energy recovery plant during most, if not all, of the year.

Seasonal variations in energy demand can also be balanced by contracting separately for steam and chilled water. For example, in an area where peak demand occurs in the summer, a utility can serve a greater number of winter (steam) customers than summer (chilled water) customers. Also, customers with their own backup systems (such as existing buildings which were later tied into the pipeline) can be put on an interruptable contract to help balance loads.

Because steam usually cannot be transported economically for more than about 2 miles, the solid waste plant must be located close to the steam users; usually this will mean in or near the central part of the city. Although land costs may be higher, solid waste hauling costs will probably be reduced, because of the proximity of the plant to the waste generators.

In a city where no steam distribution network exists, the municipality can consider installing a complete solid waste steam-generating incinerator and a steam distribution network. To minimize the costs, this might be tied to a major urban renewal project or to the construction of a large industrial park. Although the municipality might then be able to sell the steam at a much higher price, it would also be responsible for a much higher capital investment because, being the only source of supply for its customers, it would also have to assume the responsibility for total reliability. A backup system (which might add 10 to 20 percent to the total system costs) would be needed to provide steam when the steam generator was out of service or if there were an interruption in the delivery of refuse to the facility.

Two new systems which are still undergoing modifications to improve their operations will soon produce steam for utility distribution. One is in Baltimore, Maryland and the other is in Nashville, Tennessee. Numerous European cities produce steam from refuse incineration for utility distribution.

Industrial Plants. Large industrial facilities such as paper mills, food processors, and major manufacturing plants, or industrial facilities who operate 24 hours a day, 7 days a week are preferred customers because a steam-generating (waterwall) incinerator is designed for round-the-clock operation. Some industrial users may specify the quantities of steam to be delivered at specific times, and all will most likely specify the temperature and pressure. These factors must be identified and incorporated in the design of the system.

Many cities have single industries large enough to utilize all the steam that a large solid waste facility can produce. In Saugus, Massachusetts, a waterwall incinerator is being built that will handle 1,200 tons of solid waste per day. All of the steam produced in this plant (about 350,000 pounds per hour) will be used in the adjacent General Electric Company plant for heating and cooling, electric power generation and a variety of manufacturing and testing operations.

Steam Electric Power Plants. Although steam electric power plants use tremendous quantities of steam, it may be difficult to develop satisfactory marketing arrangements in this sector.

One problem is that the cost of accomodating an outside steam source may exceed the value of the expected fuel savings. Modification of the pressurized components of the power plant could be prohibitively expensive and could require that the power plant be kept out of service for a long time. Also using supplementary steam may cause a boiler to operate at a lower efficiency so that additional fuel will be needed to obtain the same energy output.

Another marketing problem results from the fact that the amount of electricity that a utility must produce varies considerably throughout the day from day to day. The utility's most efficient plants are used continuously to supply the base load demand, while the less efficient or otherwise more costly plants are only used during peak demand periods. The utility would be able to buy steam only when the boiler that has been modified to accept outside steam is operating. Generally, base load units operate 75 percent or more of the year, while peak load units operate about 25 percent or less. The base load plants which would make the better market are the ones that the utility is least likely to subject to a disruption in service required by a retrofit.

An alternative to retrofitting an existing unit would be to build a new baseload turbine-and-generator unit especially to take steam produced in the solid waste facility. The Florida Power and Light Company suggested such an agreement to the Dade County Government as part of a plan to buy energy from a proposed solid waste processing facility. According to their proposal, the company building the solid waste facility would also build the generating facility. Florida Power and Light would then buy the steam and the generating facility, paying for the latter on the basis of the units of electricity produced. This arrangement requires that the municipality provide the capital investment; and the municipality, rather than the utility, assumes the financial risk because reimbursement is conditional on successful operation. The value of the steam in this situation is then adjusted to a price equivalent to the utility's "average" generating costs. In the case of the Dade County - Florida Power and Light arrangement, an equation will be used to calculate this value (see Appendix II).

Markets for Electricity

Electricity produced from solid waste is identical to electricity produced by any conventional method. The problem in marketing electricity though, is that it usually can be sold only to the electric utility serving the area, because within that service area the utility is generally exempt from competition. However, where the electric utility is municipally owned (10 percent of the nation's generating capacity), the city is already in the retail electric sales buisiness and thus, may sell this new supply of electricity to anyone.

The price that a utility will pay for electricity depends on whether it is used to satisfy baseload or peakload demand. Peakload marketing commands a much higher price (perhaps three to five times the price of baseload electricity), however, a municipality needs to sell electricity on a continuous basis (i.e., as baseload) in order to maintain a continuous solid waste disposal operation.

A municipality considering the sale of electricity to a utility should seek to establish a floating price for the electricity, whereby the price per kilowatt-hour rises as the demand on the utility increases. Thus, the price would be a function of the incremental direct costs the utility incurs in producing the electricity needed to meet increased demand. Another approach would be to sell the electricity to the utility at a price equal to its average cost of production.

ANALYSIS AND CONCLUSIONS

The key to successful implementation of a solid waste energy recovery program is to select a system that is compatible with the energy market as well as the community's solid waste disposal requirements. Once a suitable market has been identified, an appropriate system can be designed that will convert the solid waste energy potential into a marketable form. The system should not be selected until the market has been identified.

Comparison of Market Opportunities

It is important that the market is large in size since the customer may have to absorb the cost of process changes needed to accomodate the new energy source. This is particularly true with regard to producing an oil or a solid waste prepared fuel because special storage and firing facilities are needed and because it is anticipated that (at least for the present) that these fuels are fired only as a small percentage of the total fuel load.

The facility should be located near the point of solid waste generation to reduce transportation distance and costs.

Steam electric power plants are the most promising market for several reasons. They can accomodate large quantities of solid waste prepared fuel and geographic dispersion. The fact that most utility systems consist of several power plants increases the probability that an acceptable market can be found. The potential energy value of all solid waste generated amounts to between 5 and 10 percent of the total of fossil fuels used for electric power generation. However, limited experience with use of solid waste prepared fuels plus the limited economic incentive of the price regulated electric utilities makes it difficult to obtain commitments from utilities.

Steam distribution systems are also a good prospective market. The scarcity and rising cost of fuels (particularly natural gas) is creating a demand for new or expanded systems. These systems are centrally located in order to serve the greatest concentration of customers, so the solid waste haul distance is minimized. There may be less day-to-day and hour-to-hour fluctuation in load than in electric power with the constraints of a refuse-fired system.

Comparison of Energy Forms

In marketing energy from solid waste it is an advantage to produce an energy form that can be sold and used without regard to its derivation. It is also helpful if the type of fuel produced is storable and transportable so the solid waste facility can be located and operated independently of the fuel market.

Steam and electricity satisfy the first objective; but as pointed out earlier, neither can be stored and steam can be transported only very short distances.

The solid and liquid fuels can be transported and stored for brief periods of time (several days to several weeks). However both fuels require the user to install special storing and firing facilities. In addition, the user must follow special handling procedures to minimize problems of air pollution and corrosion.

Gaseous fuels currently being produced do not appear to require separate facilities for storage and firing, but they cannot be compressed economically for extended storage and shipment. The best of the gaseous fuels cannot be economically shipped more than 2 miles.

Selecting an Alternative

As the above discussion indicates, implementing a solid waste energy recovery program is more complex than just selecting a technology. The first and most important consideration is to secure a reliable and realistic market.

All aspects of the market must be carefully understood by both the user of the fuel or energy and the municipality that supplies it. The constraints of the market will indicate the technical alternatives available. Once the various major energy markets and the energy forms that can satisfy those markets are examined (Table 1), the possible alternatives can be narrowed to just one or a few technologies.

Table 1

LOCATION AND STATUS OF ENERGY RECOVERY SYSTEMS BY TECHNOLOGY TYPE AND ENERGY PRODUCT, 1975

Technology	Energy product				
	Electricity	Steam (other than for generating electricity)	Solid fuel (other than for producing steam or electricity)	Gaseous fuel	Liquid fuel
Waterwall incineration:					
Burning of unprocessed solid waste	—	Braintree, Mass.† Nashville, Tenn.† Saugus, Mass.§	Not applicable	Not applicable	Not applicable
Pulped or shredded solid waste	Hempstead, N.Y.**	Hamilton, Ontario†	Not applicable	Not applicable	Not applicable
Processing for use as supplemental fuel for boilers	St. Louis, Mo.† Ames, Iowa§ Bridgeport, Conn.§ Chicago, Ill.§ Milwaukee, Wis.** Monroe Co., N.Y.** New Britain, Conn.**	—	Palmer Township, Pa.**	Not applicable	Not applicable
Pyrolysis	—	Baltimore, Md.‡	—	South Charleston, W. Va.*†	San Diego, Calif.§
Methane recovery:					
From sanitary landfills	Los Angeles, Calif.*†	—	Not applicable	Los Angeles, Calif.*† Mountain View, Calif.*	—
Controlled digestion	—	—	Not applicable	Pompano Beach, Fla.*	—
Direct combustion/gas turbine	Menlo Park, Calif.*‡	Not applicable	Not applicable	Not applicable	Not applicable

*Research or experimental operations.
†System in operation.
‡In shakedown.
§Under construction.
**Construction not yet started, but system has been selected.

MATERIALS PRODUCTS AND MARKETS

Materials in municipal solid waste that can potentially be recovered and marketed include ferrous (magnetic) metals, glass, aluminum, and paper.

This section discusses the markets for each of these materials. Included in the discussion are characterization and location of the potential users, quality requirements for those markets, and approximate market prices. The following section includes a discussion of techniques for conducting a market search and obtaining a purchase agreement.

FERROUS METALS

Ferrous metals (excluding automobiles) comprise about 8 percent of municipal post-consumer discards now going to disposal. About 50 precent of these ferrous discards are in the form of cans.* The remainder consists of appliances (16 percent) and miscellaneous items such as hardware, metal castings, and non-descript pieces of metal (33 percent). In 1973 only about 160,000 tons, or 1.4 percent of the ferrous metal in these discards, were recycled.

The characteristics of steel cans bear heavily on the marketability for ferrous metals recovered from municipal solid waste. Scrap steel cans can be marketed to three discrete industries: steel, copper precipitation, and detinning. All recovered steel scrap potentially can be marketed to the steel industry, while only scrap steel cans are generally acceptable to copper precipitation and detinning markets.

Steel Industry

Present Scrap Consumption

The steel industry represents the largest potential market for ferrous metals recovered from municipal solid waste. There were 85 companies operating 145 plants in 1972. Ninety-five percent of these

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*"Steel" or "tin" cans are often a composit of several materials. Typical content is steel by weight (92 percent), tin (.4 percent), lead (1.5 percent), aluminum (3 percent or more) and organic coatings (1.8 percent). Food cans almost always contain tin and lead (but not aluminum), while some beverage cans contain no tin or lead but have aluminum tops.

plants are located in Standard Metropolitan Statistical Areas (SMSA's). and are therefore in close proximity to potential ferrous metal recovery sites.[2,p.7] (These mills are listed by State and City in the EPA publication "Locations of Markets for Recovered Materials").[3]

Closely allied to the steel industry is the foundry industry which melts pig iron scrap for molding into casting. There are 4,000 to 5,000 iron and steel foundries in the United States. They consume about 28 percent of the purchased scrap consumed in the United States.[2,p.6] To date there has been relatively little experimentation with high can content municipal ferrous scrap by this industry.

Despite the use of almost 70 million tons of purchased scrap by the steel industry in 1973, the amount of municipal ferrous scrap consumed was insignificant. Instead, the scrap used consisted primarily of borings, stampings and turnings from fabrication operations (e.g. automobile or can manufacturing), demolition steel abandoned automobiles and, post-consumer scrap from a variety of industrial sources.*

The quantities of steel recovered from municipal waste (excluding autos) constitutes only about 0.1 percent of the steel industry's present scrap consumption. Thus, it presently is basically an experimental input on an industry-wide basis.

Municipal scrap is significantly different from other sources of ferrous scrap. The lead and tin in the ferrous scrap are contaminants in steelmaking. The scrap may also contain organics or other materials that make the scrap undesirable.

The steel industry is immense and its potential assimilative capacity for the relatively small quantities of municipal ferrous scrap appears to be great. However, since the steel industry is in the early stages of experimenting with this type of scrap, the potential interest and demand is somewhat uncertain. Quality of municipal ferrous scrap will be a key to interest by the steel industry.

Steel Industry Scrap Specification

If steel scrap from municipal solid waste is to be sold to the steel industry, then it must meet certain quality and purity specifications. However, due to the industry's limited experience with this type of scrap, only a very general specification now exists. Listed below are the specifications for can bundles issued by U.S. Steel: [6, p. 28]

- Bundles must be hydraulically compressed to a charging box size not to exceed 24" x 24" x 60". Density must be greater than 70 lb./cu. ft.

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*A more complete discussion of the structure of the steel industry, its scrap consumption, and scrap recycling issues can be found in other EPA publications.

- Must be free of all liquids and solids prior to baling.
- Must be free of aluminum cans, loose tin plate and terne plate scrap in any form, dirt, garbage, nonferrous metals (except those used in can construction), plastics, vinyls in any form, and other non-metallics of any kind.

It is not certain to what degree this specification is accepted by the industry as a whole, because of the absolute terminology used (i.e. "free of all . . "). Indeed, if interpreted literally, it would be impossible to meet.

The American Society for Testing Materials (ASTM is presently endeavoring to establish specifications for steel scrap from municipal waste. The intent is to make the specifications as specific as possible with regard to both physical and chemical properties. The industry members represented on this committee acknowledge that no one specification can really suffice due to differences in the requirements of different products being produced. Therefore, negotiation of specifications with each user mill will still be necessary, but published specifications, such as from ASTM, can provide a common ground for negotiating and pricing and will provide basic guidance for recovery equipment design. However, the development of specifications may be a year or more away.

To be certain of being able to meet the specifications of a particular steel mill the official concerned with ferrous recovery must obtain clearly defined quality requirements from the potential buyer of steel scrap so that the ferrous recovery system in his plant can be designed to meet that specification. Alternatively, ferrous scrap could be sold to a secondary materials processor who would further process and refine the scrap and then sell it to a final consumer. These determinations should be made prior to final selection of a processing system.

Steel industry scrap prices

It is difficult to quote steel industry prices for ferrous metals recovered from municipal waste because little actual trading has occurred and because variances in quality result in significant price variations. It is likely that this material will have a market value equivalent to a No. 2 bundle less some discount related to contaminant levels. Table 1 shows the composite price of No. 2 bundles in the U.S. over the past 3 years.

Some insights into market value can be gained from the quotes for ferrous metals being recovered in EPA's resource recovery plant demonstrations. Examples are listed on the next page.

Location	Buyer	Price/ton (F.O.B. the resource recovery plant early 1975)
Franklin, Ohio	Gillerman Steel Corporation	$25
St. Louis, Missouri	Granite City Steel Company	$20
Baltimore, Maryland*	Metal Cleaning and Processing Company	$20

*Post incineration

Copper Precipitation Industry

Present Scrap Consumption

The copper precipitation industry utilizes ferrous scrap as precipitation iron. In the process, the scrap is placed in a solution of copper sulfate and in a chemical reaction, the copper is displaced by the iron, thus forming iron sulfate, while the copper is precipitated and extracted.

Eight copper products operate 23 copper precipitation facilities in Montana, Nevada, Arizona, Utah, and New Mexico. These plants are listed in a separate EPA publication.[3]

This industry presently consumes about 500,000 tons of ferrous scrap each year. An estimated 10 percent, or 50,000 tons, is scrap from municipal recovery operations. This represents almost a third of the total municipal ferrous scrap recovery.

The potential for additional use by this industry is somewhat uncertain. Though the growth of the industry is not rapid, the undetinned scrap from municipal recovery could displace more costly detinned scrap now purchased from the detinners, which can in turn be utilized by the steel industry. However, even if all 500,000 tons of precipitation iron came from municipal scrap, this amount would represent only a small portion of the over 9 million tons of scrap ferrous available in municipal solid waste. Nevertheless, in the near term this is a very viable and significant market.

The greatest difficulty posed by this market is its remoteness to sources of supply, particularly cities in the East. Nevertheless, the industry regularly receives scrap from as far away as Chicago and St. Louis.

Copper Precipitation Scrap Specifications

Specifications for ferrous metals used by this industry are very general at this time, just as those specifications available from the

TABLE 2

COMPOSITE PRICE OF NO. 2 BUNDLES
($/long ton)

	1972	1973	1974
Jan.	$23.2	$34.6	$48.9
Feb.	24.5	35.5	58.9
Mar.	24.5	34.4	68.1
Apr.	24.8	35.3	69.1
May	25.8	38.5	55.1
June	25.1	40.4	57.1
July	24.8	38.5	60.3
Aug.	25.1	37.8	56.8
Sep.	25.6	39.0	58.9
Oct.	26.3	41.8	60.5
Nov.	26.5	48.6	54.3
Dec.	29.4	47.6	47.6
AVG.	25.4	39.4	58.0

Source: Iron Age Magazine

steel industry. Like most current users of ferrous scrap, the current practice is to buy from scrap dealers whom they have depended on in the past rather than buying to a published specification.

The general requirements from precipitation iron are listed below.[6]

- Shredded and crumpled cans not folded on themselves (all magnetic material), loose packed density of 30#/cu.ft. maximum.

- Uniform guage and of maximum surface area to weight ratio.

- If not shredded to this specification, the cans may be prepared for shipment to a dealer and processor of scrap for the copper industry. In this case, the cans must be clean, free of heavy plate or wire, and shredded to a density of 40,000#/railroad car minimum shipment.

- Scrap cans sent to a dealer-processor may be incinerated first to remove lacquers, and organic contaminants, but not enough to cause oxidation, or metal and strength loss.

- Baled cans are unacceptable because surface exposure is too limited to permit reasonable reaction time.

It is particularly important to note that the material must be of fairly uniform thickness and have maximum surface area. This is in sharp contrast to steel industry requirements, where high density is important.

Copper Precipitation Scrap Prices

There are no published prices for scrap purchased by this industry. However, prices in 1974 ranged from $50 to $60 per ton or roughly equivalent to the No. 2 scrap bundle. Market prices for scrap metal are volatile, however, and there has been a declining price trend in 1975. Moreover, these prices are not attainable by the initial processor who simply shreds and magnetically separates ferrous metals. Controlled incineration of the scrap by a secondary processor is also necessary to prepare it for this market. Thus, price will vary depending on the degree of processing involved.

Because prices paid by copper precipitators are likely to be higher than those offered by the steel industry, and because the specifications of this market will generally be easier to meet, the municipal marketer should carefully investigate copper precipitators as a ferrous market.

The Detinning Industry

Present Scrap Consumption

Detinners chemically process "tin plate" such as that in cans to remove tin content. Tin which comprises roughly 0.4 percent of a "tin can", is a very valuable commodity, worth roughly $4.00 per pound

(1974 average). Although detinners process tin plate primarily for the tin content, the resulting "tin free" steel is also valuable as a raw material to the steel or copper precipitation industries. It is commonly sold to the steel industry as No. 1 bundles.

Fourteen detinning plants are located in Baltimore, Maryland; E. Chicago, Indiana; Elizabeth, New Jersey; Milwaukee, Wisconsin; Pittsburgh, Pennsylvania; San Francisco, California; El Paso, Texas; and Wilmington, Delaware. These plants are listed by location in a separate EPA publication.[3]

The major contaminant in post-consumer can scrap is aluminum tops from bi-metal beverage cans. When present, aluminum undergoes a chemical reaction during detinning causing foaming (boilovers) and the production of hazardous gases. Removal of the aluminum adds significant cost, approximately $10 per ton of cans processed to the detinning process.

Nevertheless, the detinning industry is a prime market for cans recovered from municipal solid waste, and the industry is showing increased interest in post-consumer cans despite contaminants. They have indicated possible interest in building new "mini" detinning plants wherever 30,000 tons of can scrap are guaranteed yearly. Facilities processing 2,000 tons per day or more of municipal solid waste would probably produce enough scrap to meet this quota.

Detinning Scrap Specifications

As with the steel and copper pricipitation industries, the specifications for scrap consumed by detinners are very general at present, but should be improved by the ASTM committees working on this issue. Two very basic considerations are that (1) the material destined for detinning should not be incinerated (indeed, post-incineration scrap is normally unacceptable to the detinning industry since incineration causes the tin to diffuse into and alloy with the base steel, making it unrecoverable), and (2) the scrap must have a large surface to weight ratio to allow for a maximum of surface exposure within a reasonable reaction time.

In general, the detinning industry will accept scrap cans that meet the following requirement.[6]

- The scrap should be all magnetic material, not incinerated.
- Loose flowing, whole cans, or shredded for maximum surface area.
- It should not be balled or convoluted so as to interfere with access of detinning solution.
- Less than 5 percent organic contamination. Content may be used to determine price.
- Less than 4 percent aluminum (only from a normal mix by bi-metallic cans). Content may be used to determine price.

Detinning Industry Prices. The 1974 market value for can scrap for detinning ranged from $30 to $100 per ton depending on the quality of the material and geographical location. Naturally the prices are influenced by the price for scrap steel, since detinned cans are sold to the steel industry.

The detinning industry, just like copper precipitators, appears able to offer prices for cans that are higher than the steel industry can offer. Therefore, this is a market which should be thoroughly explored as an outlet for recovered municipal cans.

Summary Comments on Ferrous Markets

The ability to market ferrous metals from municipal solid waste is heavily dependent on the form and purity of the recovered scrap. The three major potential markets have specification requirements that differ markedly. Therefore, it is important to arrange a market prior to the selection of recovery configuration and technology. If this is done it may be possible to successfully recover and sell municipal steel scrap because the recovery technology is available.

GLASS

Present Scrap Consumption

Glass comprises about 10 percent of the municipal post-consumer waste stream in the United States and in 1973 totaled 13.6 million tons. Glass containers represent the major portion of glass found in solid waste. Approximately two-thirds of these glass products are made of flint or clear glass. The remaining percent is split between amber glass used for beer bottles and green glass used for wine and soft drinks. In 1973 only 350,000 tons or 3 percent of the glass in post-consumer solid waste wa recovered.

There are two major potential markets for recovered waste glass: (a) as cullet for making new bottles, and (b) as a raw material for making secondary products (i.e., Glassphalt,[R] highway paving material, foamed insulation, construction materials).

Cullet in Glass Products

There are 119 glass plants in the United States with most located in the east and west cost regions. These plants are listed by location in a separate EPA publication.[3]

Glass manufacturers have long practiced adding waste glass to their glass furnaces to improve the operating efficiency through reduced fuel consumption and improved melting time. Normal cullet use is 10 to 20 percent of the glass batch, but a few plants use higher percentages of waste glass. Normally the cullet used is in-plant scrap, which is already color-sorted, of known quality, and is free of dirt organics and metal contaminants. A second source of generally acceptable cullet is from volunteer community recycling centers. The glass manufacturers require this glass be color-sorted, reasonably clean, and free of caps and neck rings.

Cullet Specifications

The most pressing issue with markets for municipal glass centers on the quality of the cullet. If the glass is properly sorted by color and if contaminants are kept to a minimum, it is likely that a buyer can be found. However, these are major barriers.

Color

There are three basic colors of glass containers produced: clear (flint), green, and amber. About two-thirds of the glass produced is clear.

To be acceptable to the container manufacturer for use in making flint glass, the cullet must be at least 95 percent clear. Similarly color-sorted cullet labeled "green" or "amber" can contain only limited amounts of other colors. These specifications provided by the Glass Container Manufacturers Institute in 1975 on cullet labeled "color-sorted" are listed below.[8]

Cullet Color	Amber (%)	Flint (%)	Green (%)
Amber	90-100	0-10	0-10
Flint	0-5	90-100	0-1
Green	0-35	0-15	50-100

Waste glass meeting these color specifications provides the industrial user with reasonable assurance that his final product will not be off-color, and therefore not meet specification requirements. Unfortunately, hand separation is the only color-sorting method currently being practiced that provides good color separation. Mechanical color-sorting is still in the developmental stages and has not been proven technically or economically feasible on a large scale (See the "Technology Options" section of Resource Recovery Plant Implementation--A Guide for Municipal Officials.) The only glass recovery subsystem which includes a color-sorting process is currently being evaluated at EPA's demonstration project in Franklin, Ohio. The evaluation should be complete in early 1976.

Use of color-mixed cullet products has a much more limited potential than use of color-sorted glass. One limitation is that color-mixed cullet is practically never used in making clear glass since roughly two-thirds of the industry's production is in clear glass, the potential buyers for mixed color cullet are not wide-spread. Thus, in several areas of the country, potential buyers do not exist.

Though mixed color cullet is generally thought to be acceptable for use in green or amber containers, many companies are uncertain of the amount of this material their furnaces will tolerate without causing their product to be off-spec. Experimentally, one glass company has successfully used as much as 50 percent color-mixed cullet in their amber furnaces and up to 80 percent mixed cullet in their green furnaces.

Contaminants

Whether sorted by color or not, glass cullet will not be accepted by container manufacturers unless rigid contaminant limitations are met. Contaminants include metals, organic materials, ceramics (refractories), and excessive liquids.

Refractories are by far the most serious concern at this time. Metals and organics can be removed in a resource recovery plant to an acceptable extent through a process called "froth floatation". This process is believed to be technically and economically feasible though it has not been demonstrated at full scale on glass from municipal solid waste. Refractories are also removed by this process, but it is questionable whether a very stringent specification could be met consistently. It is possible that the glass industry will relax this specification as they gain more experience with use of cullet from municipal waste.

The general glass cullet specification for container manufacturing is listed below.

- Cullet must be noncaking and free flowing.
- Cullet must show no drainage from the sample.
- Maximum 0.2 percent organic content (dry weight sample).
- Size 0 percent retained on 2" mesh screen; 15 percent maximum to pass 140 mesh.
- Less than .05 percent magnetic metal content; no particle to exceed 1/4".
- Nonmagnetics: +20 mesh — 1 particle per 40# sample. No particle shall exceed 1/4".
- Refractories:

  +20 mesh — 1 particle per 40# sample. No particle shall exceed 1/4".

  \- 20 + 40 mesh 2 particles per 1# sample.

  \- 40 + 60 mesh 20 particles per 1# sample.

- Color specifications (see p. 22 and discussion above).

Prices

Waste glass that can meet the color and contamination specifications discussed above will have a market value ranging from $15 to $25 per ton F.O.B. the plant (1974 prices) depending on the geographical locations. Color-sorted and clean color-mixed glass share an almost equal market value based on the substitution for raw materials.

Secondary Products for Waste Glass

There are several secondary products in which waste glass may be useable. The quality of the waste glass to be used in these products generally may be lower than that used in the glass furnaces; thus, color-sorting would not be needed and more contaminants could be tolerated.

Secondary products fall into three broad categories:

1. Road building material: Glassphalt^{R}paving, slurry seal, glass beads for reflection paints.

2. Building materials: bricks, foamed glass insulation, ceramic tiles, terrazzo tiles, building blocks, sewer pipe, aggregate.

3. Miscellaneous: costume jewelry, ground cover, trickling filters, glass-polymer composites.

Though some experimentation has been done with use of waste glass in these products, none of them are now manufactured on a large scale using waste glass. However, utilization of waste glass has been shown to be technologically feasible for many of these products. One of the most promising use is in brick manufacture. Although no large scale use in this manner is now taking place, it could be worthwhile for the city or company marketing recovered glass to contact a local brick yard and explore marketing arrangements.

Summary Comments on Glass Markets

Glass manufacturers have established stringent contamination specifications for waste glass. Although pilot plant work has been performed, there are currently no full scale glass recovery systems operating. Thus, it is uncertain whether these specifications can be met day to day on a production scale. The uncertainity regarding the ability to meet glass industry specifications should be investigated with potential buyers.

ALUMINUM

Present Scrap Consumption

Aluminum comprises about 0.7 percent of the municipal solid waste stream. About half of the aluminum discards in solid waste are cans, one-third are foils, and the remainder largely from major appliances. Aluminum composition varies significantly from one community to another due to differences in aluminum beverage can distribution.

Aluminum scrap constituted 27 percent of the aluminum produced in 1973. Sixty percent of the scrap utilized was consumed by secondary smelters, 17 percent by primary producers, and the remainder by aluminum fabricators and foundaries. There are 31 primary aluminum producers and 111 secondary aluminum smelters in the United States. The locations of these users are listed in a separate EPA publication.[3]

The only form of aluminum recovery from municipal solid waste currently being practiced is source separation of aluminum cans through volunteer community recycling centers. In 1973 about 34,000 tons of aluminum cans were recovered, which represents 3.5 percent of all the aluminum discarded. Source separated aluminum cans generally can be remelted by the primary producers and made directly into can stock.

Mechanical extraction of scrap aluminum from mixed municipal solid waste is being developed and as yet has not been demonstrated on a commercial scale. It is anticipated that aluminum scrap extracted by mechanical means will be lower in quality than that recovered through source separation. It is likely that a large portion of this may be sold to secondary smelters who will pretreat and upgrade the aluminum by removing contaminants and diluting the alloy contents to acceptable levels. As is common with any scrap metal, the value of this recovered aluminum scrap is likely to be negotiated based on the quality of the recovered product and the specifications required by the purchaser.

Scrap Specifications

The quality requirements of purchasers may vary from plant to plant depending on the alloy content in their products being produced. However, in general, scrap aluminum should meet the following specifications:[6]

- free of sand, grit, and particularly glass (at melt temperatures, aluminum reduces the silica in glass to silicon which will alloy and cause the melt to be off-spec).

- free of iron contamination (1 percent or less)

- contain a minimum of organic contamination. These materials will burn off in the furnace causing additional load on the air pollution equipment.

- have a low surface to volume ratio to avoid melt-loss during resmelting--hence it should be baled or briquetted. For the same reasons, fines are also limited.

Presently, a committee of the American Society for Testing Materials (ASTM) is attempting to develop more refined specifications. However, until significant quantities of this scrap are recovered and used successfully at full-scale operations, glass cullet useage will be confined to individual company experimentation and specification setting.

Prices

A price of $.15 per pound ($300 per ton) was paid in 1974 by certain aluminum companies and brewers for aluminum cans brought to their collection centers. Aluminum recovered mechanically will be less consistent in quality and priced accordingly. Prices in the range of $100 to $400 per ton are probable current for this scrap depending on the quality.

Summary Comments on Aluminum Markets

Like glass, aluminum is not presently being recovered in any great quantities from mixed municipal waste in any full-scale plants. However, pilot plant work is being performed and full-scale operations will begin in 1976 in Ames, Iowa. The quality specifications for aluminum seem to be a somewhat lesser problem than those for glass recovery. The high market value of aluminum permits further processing or price discounts if quality is not sufficiently high. Key issues for early resolution facing the city considering aluminum recovery are (1) the quantity of aluminum in the local waste stream, (2) the quality specifications of potential buyers, and (3) the level of confidence in developing technology to produce a product meeting those specifications.

WASTEPAPER

Present Wastepaper Consumption

Paper recovery depends primarily on source separation. However, some mechanical separation of paper is likely in the future, and in addition source separation of paper would affect the input tonnage and composition to a recovery plant. Source separation of paper should be considered explicitly by a city contemplating a resource recovery plant so that overall recovery strategy can be integrated.

Source separation technologies and paper market issues are discussed in greater detail in other EPA publications.[9, 10, 11, 12] The objective here is to provide a general understanding of wastepaper markets and quality requirements so that the roles of both mechanical and source separation can be better understood.

In 1973, 13.8 million tons of paper were recovered and recycled. About two-thirds of this quantity was recovered from post-consumer waste; the remainder originated in fabricating and converting operations.

Most of the paper now received is obtained through source separation and separate collection. Some is obtained through hand sorting from mixed waste, and almost none is recovered through mechanical separation from mixed waste. Obviously, the fraction of paper now recovered from post-consumer sources represents the highest value (clean, high grade paper), most readily recoverable fraction of paper discards. Nonetheless, a vast amount of paper is still available for recovery. (Table 3).

The major paper industry market for post-consumer recovered paper is combination boxboard. These are boxes used for packaging dry foods, shoes, and clothes, and similar items. Each ton of combination boxboard requires 0.25 tons of corrugated, 0.21 tons of old newspapers, and 0.48 tons of mixed wastepaper. The construction paper and board sector of the industry also uses substantial quantities of wastepaper, and the quality requirements of this market are not exacting. Properly segregated corrugated containers are used to manufacture new corrugated containers, and separated newspapers are used in manufacture of newsprint. High grade wastepaper, e.g. printing paper, is used to manufacture printing paper, tissue, and other products. More data on wastepaper use is available in other EPA publications.[7-11]

Paper mills are located throughout the nation; however most of the mills that now use wastepaper are located in the Northeast and North Central regions of the nation. Lists of mills organized by product category are contained in a separate EPA publication.[3] Exports offer a market that has grown in recent years and may provide an important outlet in selected areas of the nation.

Specifications

For a fiber fraction to be readily marketable, it must correspond to an existing fiber type. For example, the short groundwood fibers from newspapers cannot be used as a replacement for the long kraft fibers used in manufacturing corrugated boxes. Most paper mills rely heavily on specific fiber inputs and make substitutions among fibers only within narrow limits. (The greatest substitution occurs in construction paper grades. Boxboard mills can use some mixed grade fiber). Thus, a mixed fiber such as that obtained from a combination of all the different types of fiber found in municipal solid waste would be acceptable for only the lowest strength or quality products. Fortunately, there are many such paper products.

TABLE 3

PAPER IN THE WASTE STREAM 1973*
(million tons)

Category	Apparent Consumption	Estimated Post-Consumer Discard					
		Total		Household		Other	
		Gross	Net+	Gross	Net+	Gross	Net+
Newsprint	10.7	10.4	8.0	9.9	7.5	.5	.5
Writing/publishing papers	13.3	11.0	9.7	6.9	6.9	4.1	2.8
Corrugated packaging	17.2	15.1	11.8	1.2	1.2	13.9	10.6
Other	20.1	16.5	14.7	10.3	10.3	6.2	4.4
TOTAL	61.4	53.0	44.2	28.3	25.9	26.5	18.3

*This table was developed from statistics compiled by the American Paper Institute in their annual publications: The Statistics of Paper and Paperboard, Wood Pulp Capacity 1973 - 1976. The methodology employed is described in an EPA report (EPA/530/SW-147).A Solid Waste Estimating Procedure: Material Flows Approach. Fred Lee Smith, Jr. May 1975.

+Gross discards less quantity recovered.

Wastepaper is classified into a large number of grades that specify the source of the fiber and the amount of contaminants that the grade can tolerate. Wastepaper specifications are described in a publication of the National Association of Recycling Industries.[11] Only the news, corrugated, and mixed grades are relevant to those concerned with post-consumer wastepaper recovery.

Markets for Paper Recovered in Central Recovery Plants

The paper discarded from households and commercial establishments handled by the city and that is not separately collected will arrive at the centralized resource recovery facility in a more or less contaminated state. For some waste sources, the degree of contamination may be minimal and permit a favorable yield from sorting at a central facility. The traditional sorting methods is hand picking. In such situations, the practice has been to sort only those selected loads having very high paper content. A rule of thumb has been that the derived paper fraction must equal 50 percent or more of the total waste load in order for this practice to be feasible.

The technological possibilities for recovering paper fiber from a mixed refuse stream have only recently begun to be explored. The first major novel technology introduced into this area was the Hydrasposal/ Fiberclaim system developed by Black Clawson, Inc. in 1969 and demonstrated recently with EPA funding at Franklin, Ohio. This system is discussed in the "Technology" section of this Guide. In the Fiberclaim process, all incoming refuse is first wet pulped into a slurry, the fiber is drawn off, and then cleaned to produce a marketable fiber. The Franklin plant has operated successfully for over 3 years on a continuous basis. The quality of the fiber resulting from this process is low but is acceptable for use as a fiber input to a roofing felt mill. The demand for paper varies with construction activity, however, which may preclude the stable markets that a community will require.

All currently available mechanical fiber recovery processes yield relatively low value fiber fractions--somewhat equivalent to the mixed grade of wastepaper. The markets for such material are limited. Processes now under development have the potential of yielding more useful fiber fractions such as newsprint-rich stream or a high strength kraft fiber component, but neither the technology nor the economics of these alternative processes have been well developed.

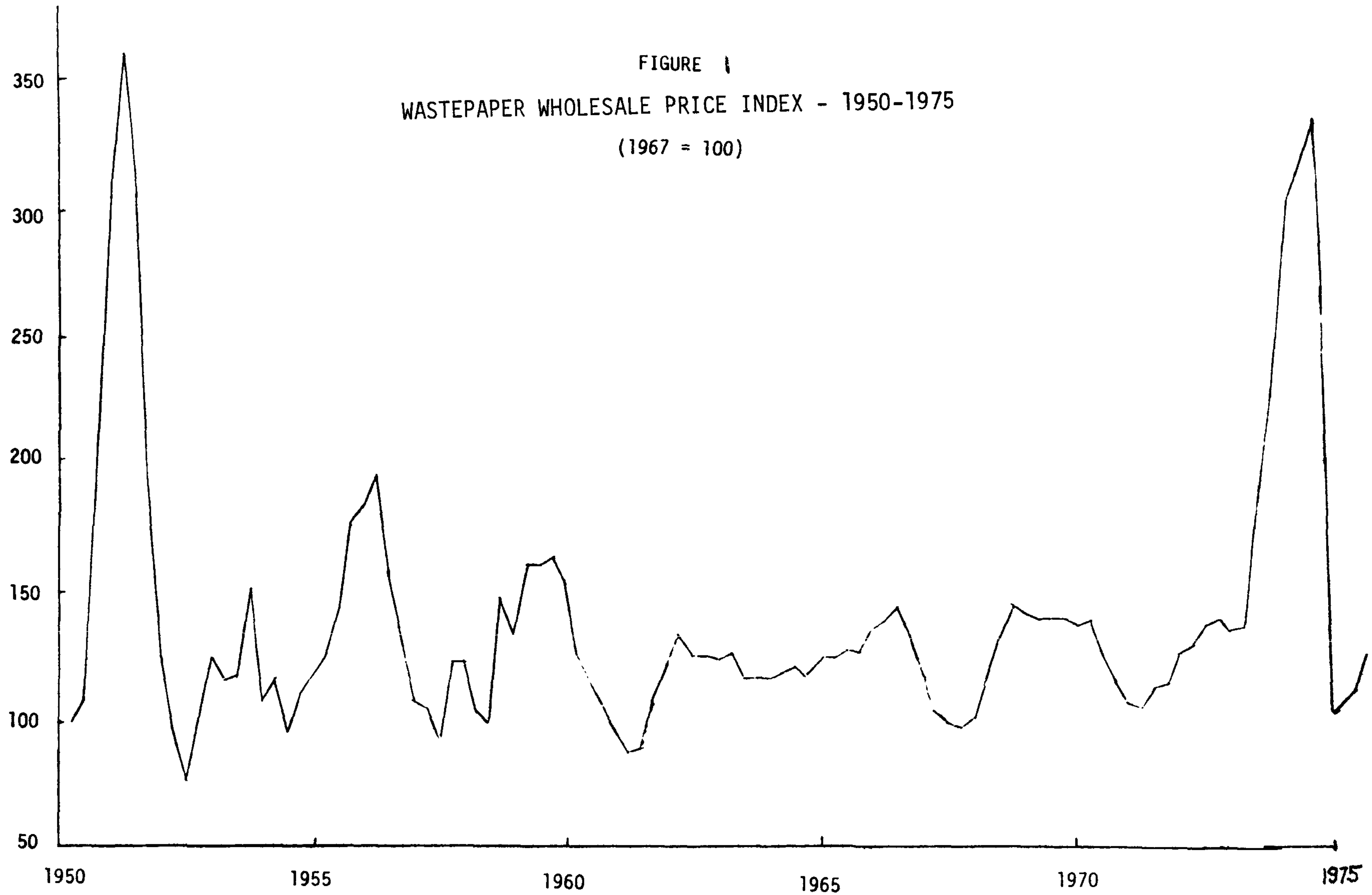
Price Considerations

Prices of wastepaper have historically been unstable. Figure 1 illustrates the wastepaper price index over the period 1950 to 1975. The two major anomalies correspond to very dramatic periods in recent economic history--the Korean War and the short-lived 1973-74

FIGURE 1

WASTEPAPER WHOLESALE PRICE INDEX - 1950-1975

(1967 = 100)



SOURCE: U.S. Bureau of Labor Statistics, Code 09-12.

economic boom. On such occasions, demand momentarily spurts ahead of installed capacity. Capacity utilization rates approach 100 percent and industries become willing to use secondary materials as the input of last resort. This, in turn, creates a sharp increase in the price of secondary material. The correction--increased supplies of wastepaper, increased virgin material availability, or downturn in the economy--results in an equally rapid drop in prices.

Wastepaper prices vary by grade and region. Prices rose in the 1973 boom period but then began to decline as markets collapsed in the 1974 recession. Although severe price fluctuations are rare, the decision-maker should ensure that his selling arrangements take account of their possibility. Specifically, contracts should be established which guarantee a minimum purchase prices.

Summary Comments on Paper Markets

Quality requirements of most markets for wastepaper can presently be satisfied only by recovery through separation at the source or hand sorting from mixed waste. In considering a resource recovery plant, the inclusion of source separation or hand sorting of paper in the overall recovery scheme will impact on overall recovery economics. It may increase the economic viability or decrease it depending on market prices for the recovered paper and for the energy or fuel outputs of the recovery plant. Also, source separation of paper would affect the input tonnage and composition to a recovery plant. Thus, source separation of paper should be considered at the same time that the city is contemplating a resource recovery plant so that overall recovery strategy can be integrated.

MARKETING RECOVERED MATERIALS*

The previous discussion addressed the characteristics of materials and energy products recoverable from solid waste and their potential markets. This information provides a foundation for the marketing of such products. However, the question of technique is also important. How should one go about finding a buyer for resource recovery products and obtaining a commitment to buy? The objective of this section is to provide general guidance that will lead hopefully to a sound marketing technique.

Marketing and Sales Strategies

Obtaining advance commitment for the purchase of recovered materials is the single most important step in resource recovery planning. The commitments provide the financial assurances that municipal managers seek and the specifications accompanying the commitments determine the type of plant to be built. Again, the statement made earlier needs to be emphasized: MARKETS FIRST; SPECIFICATIONS DETERMINE TECHNOLOGY. The recovery plant must be designed and operated to produce products to the specifications of the market commitments or else economic success of the plant will be unlikely.

An obvious first step in the marketing process is to determine which types of products can be sold in a reasonable proximity to the possible recovery plant sites. This means conducting a market survey. The elements of such a survey will be discussed below.

The second step is to attempt to obtain as strong a commitment as possible from these potential buyers. One feasible approach developed here is to obtain "letters of intent" from prospective buyers. Letters of intent will also be discussed below.

Who Does the Marketing?

There are two parties that could be designated to do the marketing. First, the city can rely on system bidders to obtain their own market agreements for the system they propose; then the city can evaluate the

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*The section is based on information obtained from the National Center for Resource Recovery, Inc.

strength of their market commitments as a facet of their bid to build, own, and operate a proposed facility. Secondly, the city can obtain these commitments in advance of a system procurement. In this case, the developmental marketing is done directly by the municipality or by its consultants. In this latter case, the availability of markets is the major determinent in the type of recovery system that a community should try to procure.

The issue of who conducts the marketing cannot be separated from the choice of type of procurement (e.g. A & E design of municipally owned plant v.s. turnkey or full service contract for either privately or publically owned plant). Even if turnkey or full service is selected and a request for proposal (RFP) is issued, the RFP will be more or less specific about markets, depending upon whom the city designates to do the marketing. Unless a very general RFP is to be issued, advance marketing is a requirement for specifying a system. (This does not preclude additional marketing by bidders.) These procurement issues are discussed in the "Overview" and "Procurement" sections of this Guide.

For purposes of discussion below, it will be assumed that the municipality or its consultant will conduct advanced marketing.

THE MARKETING SURVEY

The purpose of the market survey is to locate potential buyers for recovered products and to determine the conditions--price and quality--under which they would purchase these products. The market survey is the first major step toward selection of a recovery technology. If buyers for particular products do not exist within reasonable transportation distances, or if their specifications or probable prices appear unsatisfactory, then technologies producing these products should not be investigated seriously. If potential buyers exist, then serious consideration can be given to the equipment and processes to produce products to the buyer's specification.

Likely Markets

The likely markets for the products recoverable from municipal waste have been discussed earlier in this guide document. A detailed listing of users of various materials is provided in the EPA publication "Locations of Markets for Recycled Materials." The EPA publication "Where the Boilers Are" provides information on one potential market, electric utilities, for refuse derived fuel. Other potential fuel and steam markets can be identified by referring to data gathered by local chambers of commerce and by State and local air pollution control authorities.

In the case of recovered metals, glass, and paper, it may be desirable to contact the scrap processor whose role it has traditionally been to upgrade scrap materials and market them. Scrap processors typically already have working relationships with scrap users, are trusted for quality control, can market to numerous alternative buyers, and can inventory materials to help match supply to demand. Because of the upgrading that the scrap dealer provides, the specifications that the recovery plant products must meet need not be as stringent as required by final users.

In return for these services, the scrap processor receives a fee that results in a lower gross price paid for the scrap to the resource recovery plant compared to what may be paid by a paper mill, steel mill, or other ultimate user. However, the reduced purchase price must be discounted by the municipal planner against the value of the services and the consequent reduced investment in resource recovery facilities and operational costs.

Shipping Distances

In conducting a market survey, how far from the recovery plant location should one search? Simple answers are not possible. Indeed the shipping limits will be determined partly by the price offered, the cost of recovery, and the shipping rates that can be negotiated.

It is possible to estimate freight charges for particular commodities in many cases by contacting a local railroad or truck company. However, "rate table" quotes obtained by phone might be significantly different from rates obtained through serious negotiation. Also, one should expect the carrier to ask about quantities to be shipped, physical form, schedules, and loading and unloading facilities.

We believe that providing meaningful general rate information is useful only for rough estimates. More precise information can be obtained only through negotiation with local carriers.

The Specification

After locating the likely markets, the next step is to approach the potential buyer to determine quality requirements and potential price. The quality of the recovered product (its specification) must assure utility in current manufacturing processes. An existing industry, accustomed to operation on particular raw materials, will be unwilling to drastically alter its processes to accommodate perhaps a relatively small amount of material from a resource recovery process.

It would be helpful to have product samples from other recovery plants to show to prospective buyers. The seller should keep in mind, however, that essentially a specification, not a product, is being sold. The specification designates the form and composition of the product as the basis for a acceptance or rejection. Sale to a specification means that failure to meet it results in downgrading of price by the buyer, or rejection of shipments. It is critical that the seller understand this. A bid to a specification is of no value if a product cannot be produced to meet the specification.

It is likely that the prospective buyer is unfamiliar with recovered materials and may be somewhat uncertain of its performance. The prospective seller should familiarize the buyer with the specification developments underway by consensus standard writing organizations such as ASTM, industry associations, or other individual firms, and provide product samples when possible. These specifications are discussed earlier in this document.

Letter of Intent

The Letter of Intent (LOI) is the instrument negotiated between the seller and the potential purchaser of recovered materials. The LOI is the culmination of the market survey, the financial underpinning to the resource recovery plant, and the precursor to orders.

Terms and Conditions

The fundamental terms and conditions of an advance commitment to be included in the LOI are length of commitment, quantity of material, quality, delivery schedule, termination and price (which will be discussed separately). The LOI may be worded as an intent to issue a purchase order to the resource recovery plant subject to the terms and conditions in the LOI and is usually included in the buyer's purchase orders.

The length of commitment ought to be related to the financing term of the resource recovery plant. It is highly unlikely, and even unreasonable, to expect the advance commitment to be for the full financing term, which will be 10 or more years. However, both objectives may be fulfilled if the commitment were for the first five operating years of the facility. Because of the length of time needed to plan and construct a recovery plant, this may translate to eight or nine calendar years, a long commitment.

The quantity of material to be sold should be specified in the LOI. Because of the uncertainty in the composition of the waste, the quantity of recovered material to be delivered may be expressed as a range for the first year, subject to adjustment within this range after the first year.

The quality of the material to be delivered is delineated by a specification which becomes part of the LOI. Furthermore, the LOI should address who will be responsible for the accompanying quality control program as well as the basis for rejection of downgrading.

Guarantee delivery of a specified quantity and time schedule should be made by the facility operators if they are to service the customers (buyers). The operator may not divert deliveries to "spot" markets, even at higher prices except insofar as this may be provided for in the letter.

The delivery schedule should be expressed in quantity per day, week or month and method of delivery stating form of transportation and minimum shipments. This is essential information for planning the storage facilities, shipping dock and railroad siding at the resource recovery plant.

Pricing Arrangement

There are several ways the price paid for the recovered material can be established and expressed in the LOI. It can be based on a fixed price, commodity quote or the same price as being paid for a comparable material. Whichever of these pricing structures is used, every effort should be made to include a minimum (floor) price which is an essential feature for preparing a reliable financial forecast.

A fixed price states merely that the price paid per ton will be the stated figure, which may change at a later date (say after the first year) according to a specified formula, but is guaranteed not to fall beneath a floor price. This is a useful method of pricing materials that are not directly comparable to a standard scrap grade. It has been used for glass and aluminum and is easily combined with a floor price. For example, the LOI may state, "the price paid for the recovered aluminum the first year shall be 15¢ per lb., changing thereafter to be 80 percent of smelter's old sheet (as quoted in some standard periodical) but not to be less than 8¢ per lb." There are no comparable scrap quotes for glass; its price may be set at, say $17 per ton, renegotiable annually, upwards only.

Price for some recovered products, steel and paper in particular, may be tied to scrap quotes. For example, scrap cans may be purchased for some percentage of a No.1 or No. 2 bundle price as quoted in a standard periodical for the steel scrap industry for some city. (Scrap quotes are for particular markets around the country.) Some of the benefits (if the price increases) may be traded for some of the risks (if the price decreases). This is applicable in the case of the floor price. For example, the seller may have to choose between accepting a price of No. 2 bundles and a fraction of No. 2 bundles (say 65 percnet) with a $20 per ton floor price (or other figure). The choice is judgmental but highly influenced by the necessity to minimize downside risk as a requirement of the budget process. In the latter pricing arrangement, the argument is that the buyer is entitled to the 35 percent (or other) discount in exchange for offering a reasonably high guaranteed floor price. The floor price helps to control downside risk for the producer. Therefore, in such cases, during times of high prices the buyer benefits with a lower priced source of materials. During times of low prices, seller benefits by having a guaranteed buyer.

A third pricing arrangement pegs the price the buyer pays to what is paid for a similar grade to another supplier. This is a useful arrangement at times when the buyer has no historical pattern related to a commodity quote or the recovered product is a small amount of the total raw material purchased. This sort of arrangement has been used for old newsprint when the purchasing mill and their largest supplier were not in an area covered by one of the standard quoting services. Presumably, it can be the basis for determining market prices for glass cullet where the price paid for the cullet is determined by the cost of equivalent raw material (predominantly sand and soda ash).

Private vs. Public Ownership

The discussion of terms, conditions and pricing is generally applicable whether the resource recovery facility is to be privately or municipally owned--with the exception that if private, the potential owners have the right to negotiate their own arrangements and prices.

If the resource recovery plant is to be publicly owned, the dicta of open government and fairness generally requires that all responsible and responsive bidders have an opportunity to bid for the recovered material. The challenge, then, is how to secure the LOI as an advance commitment while still preserving public bidding rights. An innovative solution, used by the Metropolitan Washington Council of Government, Allegheny County, Pennsylvania, and the Tennessee Valley Authority was to negotiate a Letter of Intent to Bid (as distinguished from a Letter of Intent to Buy). The sample LOI appended here is structured in this way.

In signing an LOI to Bid, the potential purchaser essentially agrees to submit a response to an invitation to bid for the purchase of recovered material some time in the future. The LOI to Bid covers all of the necessary terms and conditions and the price structure. The potential bidder further agrees that the bid will not be less than a stated price. This minimum stated price can then be used for financial planning, the same as with an LOI to Buy. The bidder may increase this price at his option when responding to the final invitation to bid.

There are two cautions in dealing with an LOI to Bid. One is that prior to final bid opening, the exact prices in the LOI's should be kept confidential because knowledge of any one firm's price could be used to advantage by a competitor. This confidentiality may be arranged through a consultant or other trustworthy third party. The second caution is that the legality of this approach has not been tested. However, it seems reasonable and fair hence at least within the spirit of public bid laws.

Cancelling the LOI

Municipal planning for resource recovery is a lengthy process, having taken three years or longer in many communities. Even after this length of time, a resource recovery system may not be implemented. It is not fair to ask a potential buyer to maintain a commitment this long unless there is a reasonable chance of success that plans will be implemented. A potential buyer's commitment is his plan to use a certain amount of recovered material at the exclusion of making other commitments elsewhere.

A fair approach is to have a statement in the LOI (whether to Bid or Buy) terminating the commitment unless the municipality has demonstrated substantial progress toward implementation by a specified date, subject to renewal. Substantial progress may be completion of a planning document, issuance of a request for proposals, or similar event.

APPENDIX I

HOW TO CALCULATE WASTEBURNING CAPACITIES

As an aid for rapid calculations concerning boiler capacities and their potential for burning solid waste, a nomograph (Figure 2) was developed.

The nomograph shows the relationship among four variables: (1) the capacity of the boiler, in megawatts (MW); (2) the load factor of the boiler, as a percent of time; (3) the heat rate (or efficiency) of the boiler, in terms of Btu per kilowatt hour (KWH); (4) the tons of solid waste that can be burned in the boiler each working day, assuming that wastefuel replaces 10 percent of the fossil fuel input and assuming a 5-day work week for waste collection and handling. For any problem, three of the variables must be defined to calculate the fourth. When more than one of the variables are unknown, typical values for some of these can be used to make rough estimates of the remaining unknowns. For example, given only the boiler capacity and load factor to determine the waste burning capacity, one could use a typical plant heat rate of say, 11,000 or 12,000 Btu/KWH.

An example calcualtion is given on the nomograph itself:

Q. How much refuse could be burned each day of the week in a 200 MW boiler with a load factor of 60 percent and a heat rate of 11,300 Btu/KWH?

A. 500 tons/day.

The advantage of a nomograph is its complete flexibility to allow quick calcualtions to be made for any boiler or plant combinations. In addition, although the calculation would no doubt usually be done to determine the amount of refuse a boiler could burn, given its capacity, load factor, and heat rate, the "reverse" calculation may be useful to a municipality. For example, what is the size of a generating plant that could be expected to process all the refuse generated in the municipality, given the quantity as 300 tons of refuse per day, a typical plant heat rate of say 11,000 Btu/lb., and a typical load factor of say 50 percent? The answer is 146 MW.

DEVELOPMENT OF THE NOMOGRAPH

The nomograph is based on the following steps:

A. Define MW as unit (plant or boiler) capacity, in megawatts; define PC as the unit load factor, in percent; define H as the unit heat rate, in Btu/Kwh

B. The unit daily energy requirement is $(1{,}000 \times MW \times \frac{PC}{100} \times H \times 24)$ Btu/day

C. Assume the refuse-burning capability of the unit is 10 percent of the total fuel being fired. The energy to be supplied by refuse is thus $(4 \times MW \times PC \times H)$ Btu/day.

D. Assuming a heating value for refuse of 4,500 Btu/lb, the energy is equivalent to:

$$\frac{24 \times MW \times PC \times H}{4{,}500 \times 2{,}000} \quad \text{tons of refuse per day}$$

E. The above quantity is essentially a "year-round" daily figure, provided the average load factor for a long period time is used. The equivalent quantity of refuse (R) to be transported to a plant or boiler on a "5 working days per week" basis is therefore found:

$$R = \frac{24 \times MW \times PC \times H}{4{,}500 \times 2{,}000} \times \frac{7}{5} = (3.733 \times 10\text{-}6)\ MW \times PC \times H$$

Tons of refuse/working day

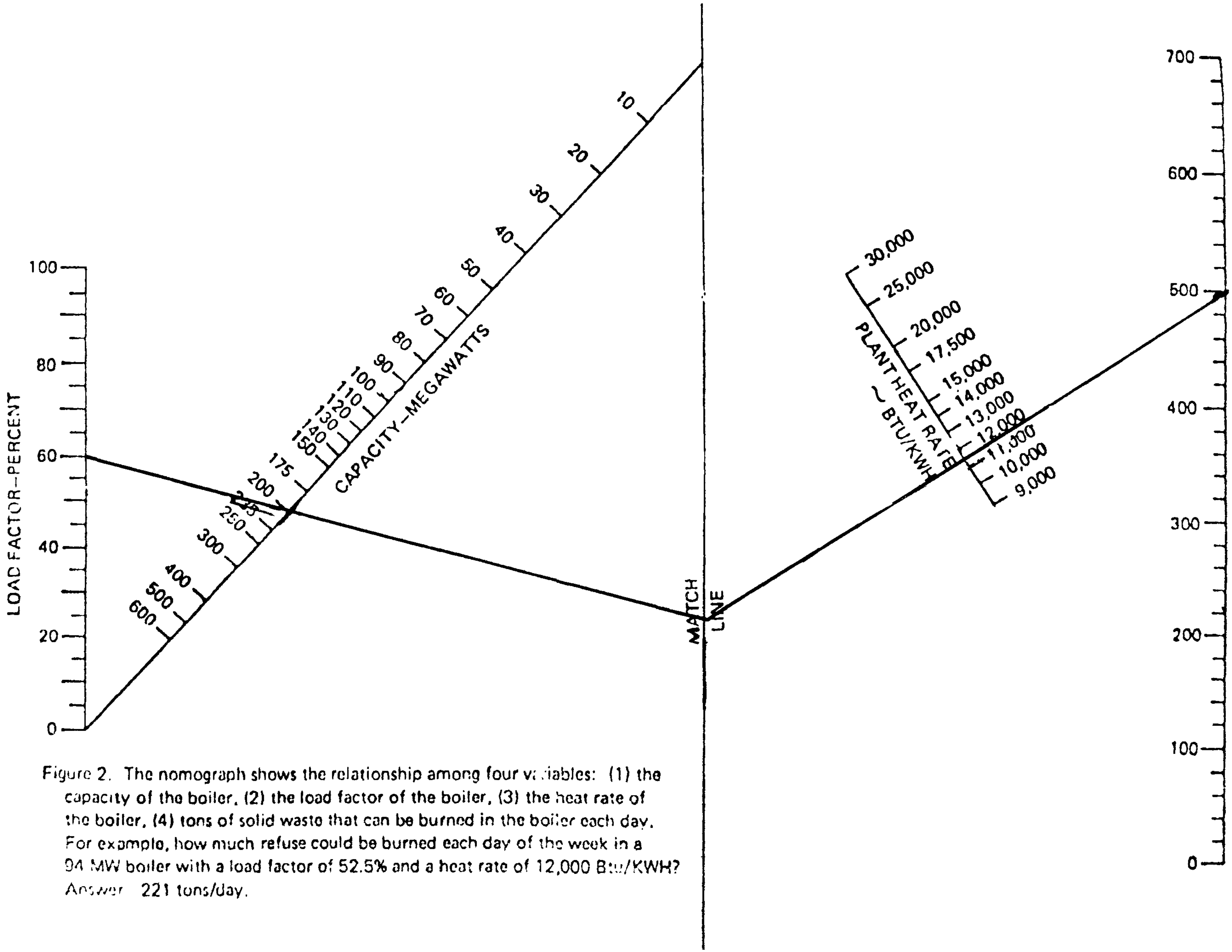

Figure 2. The nomograph shows the relationship among four variables: (1) the capacity of the boiler, (2) the load factor of the boiler, (3) the heat rate of the boiler, (4) tons of solid waste that can be burned in the boiler each day. For example, how much refuse could be burned each day of the week in a 94 MW boiler with a load factor of 52.5% and a heat rate of 12,000 Btu/KWH? Answer 221 tons/day.

APPENDIX 2

ADVANCE LETTER OF INTENT TO BID FOR THE PURCHASE OF RECOVERED PRODUCTS

Whereas, the ____________________ Corporation (hereinafter called the CORPORATION) endorses resource recovery from municipal solid waste as a means toward a cleaner environment and preservation of natural resources, and

Whereas, the CORPORATION recognizes the need to develop firm expressions of intent to purchase materials or energy products recovered from waste within known financial parameters as part of the planning process for a new endeavor such as this, and

Whereas, ____ (hereinafter called the DEVELOPMENT AGENCY, is evaluating the prospects of substituting resource recovery for its traditional means of solid waste disposal, and

Whereas, the DEVELOPMENT AGENCY recognizes the need to establish financial data for the determination of the economic feasibility of processing up to ________ tons per day of municipal solid waste to produce up to ________ tons per day of ________________ (hereinafter known as the PRODUCT) in a form usable and acceptable to the CORPORATION according to the Specifications attached to this Agreement and made part hereof.

(a) It will be a firm bid for five (5) years offering an Exchange Price either fixed or related to a commodity quote, and if the Exchange Price is not fixed, it will offer a Floor Price which will not fall during the term of the contract.

(b-1) If the Exchange Price to be paid by the CORPORATION is to be a fixed dollar amount per unit of product, f.o.b. the recovery facility (or the CORPORATION"S plant - choose one), the bid shall not be less than ___________________________ per ton.

OR

(b-2) If the Exchange Price is to be based on a commodity quote, the monthly Exchange Price shall relate to the quotation at the close of that month for ________________ (the same or the appropriate analogous commodity and location) as published in the last issue of that month of ________ (fill in source of quote) using the (mid-range or highside, or lowside choose one) of the quote, f.o.b. the recovery facility (or the CORPORATION's plant - choose one).

If the Exchange Price is to be bid in terms of a percentage of the quoted price, the Exchange Price shall not be bid at less than ________ percentage of appropriate quote as defined above. (Fill in percentage).

(c) If the Exchange Price is not fixed, a Floor Price will be bid which will not be below $______ per ton f.o.b. (fill in dollar amount) the recovery facility (or CORPORATION'S plant - choose one).

(d) The CORPORATION shall retain the right to reject any material delivered which does not meet Specifications. Such rejection will be at the expense of the resource recovery plant.

(e) The bid will be subject to <u>force</u> <u>majeur</u>.

(f) It will be noted the Additional Conditions of the CORPORATIONS covering general terms and conditions of purchase, acceptance delivery, arbitration, weights, and downgrading not explicitly covered in this Letter of Intent or by reference, will be negotiated according to good business practices and include such additional conditions as are attached to this Agreement and made a part hereof.

(g) This Advance Letter of Intent to bid is null and void if during the period between its execution and the actual bid or negotiated contract the CORPORATION'S plant ceases operation or no longer has a use for this or equivalent grade of recovered PRODUCT. The DEVELOPMENT AGENCY shall further recognize that a clause similar to this shall be incorporated in the actual bid when made or contract when signed.

(h) This Advance Letter of Intent may be assigned by the DEVELOPMENT AGENCY.

THEREFORE, in consideration of the fact that the legal authority to sell recovered products may rest upon a requirement to advertise for the purchase of such products, it is mutually agreed between the CORPORATION and the DEVELOPMENT AGENCY that:

I. The CORPORATION, as an expression of its support of the municipal solid waste recovery program, agrees to:

(1) offer herein a firm commitment to bid for the purchase of the recovered PRODUCT at prices not less than those entered

here should the DEVELOPMENT AGENCY be required or decide to effect a competitive procurement, and

(2) agree that if public bidding is not necessary and not the course chosed by the DEVELOPMENT AGENCY then the conditions of this Letter of Intent may be considered as a bona fide offer to purchase the recovered PRODUCT at prices not less than those recovered here.

(3) respond should a bid be required with a bona fide offer to purchase which will include the following:

II. The DEVELOPMENT AGENCY agrees:

(1) to see that the recovery plant establishes specification assurance procedures for the recovered PRODUCT, using good industrial quality control practices in recognition of the CORPORATION'S Use technology as practices in their _______ plant, so as to produce and offer the recovered PRODUCT for sale in a form and to the required Specification, useable in the plant with minimum alterations to present processing technology and buisiness practices, and

(2) to require, should a contract be effected as a result of the Advance Letter of Intent, that the PRODUCE be delivered to the CORPORATION according to conditions and prices determined herein and not diverted to a spot market which may on occasion be higher than the Exchange Price determined by the pricing relationship set forth here or as modified by the Contract.

(3) that should the CORPORATION's plant, as specified herein, become saturated in its ability to handle the recovered PRODUCT as a result of other Letters of Intent issued by the CORPORATION being converted into firm contracts for delivery and purchase prior to effecting such arrangements as a result of this commitment, the provisions of this Advance Letter of Intent become null and void.

The CORPORATION will communicate to the DEVELOPMENT AGENCY that information about its use technology and business practices which the CORPORATION at its sole discretion shall consider necessary so as to assure receipt of the recovered material in form and cleanliness necessary for use by the CORPORATION. Such communication shall be on a nonconfidential basis, unless otherwise subject to a confidentiality agreement.

This Advance Letter of Intent shall become null and void on __________ unless effected into a contractual relationship or mutually extended by both the CORPORATION and DEVELOPMENT AGENCY.

Witnessed by:

DEVELOPMENT AGENCY

____

By: ___________________________

____

CORPORATION

Witnessed by:

____

____

____

____

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