

AKRON RECYCLE ENERGY SYSTEM: AN RDF SUCCESS STORY

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ABSTRACT

The Akron Recycle Energy System which was beset with technical, financial and safety problems in the past, is now receiving over 1000 tons per day of MSW and tires. The City of Akron took control over operations in October 1985 as a "Public Enterprise," with financial and management support from wTe Corporation (wTe). Numerous capital improvements and changes in operating procedures made the plant safe and reliable, and also improved operating economics. The plant has operated at unprecedented production levels without a single day's interruption during the past 15 months.

The cooperative public/private partnership between the City of Akron and wTe has been a success, as compared to private operation alone. Public visibility and confidence in the project has improved substantially. The facility is a technical success. The Akron RES is becoming one of the nation's first RDF projects which is also an economic success.

placed on preserving the environment and aiding the conservation of natural resources through the generation of energy from municipal solid wastes. Part of the reason for building the Akron Recycle Energy System (RES) was to replace a coal-fired steam plant operated by Ohio Edison which provided steam to the downtown central business district. Ohio Edison had elected to abandon the plant and turn it over to the City because its cost to produce steam was no longer price competitive.

Refuse derived fuel (RDF) technology and Babcock & Wilcox semi-suspension boilers were selected for the Akron RES. A local engineer was hired to design the waste-fired power plant. A private operator was retained to assist the engineer in the design and to operate the facility. The project was publicly financed through revenue bonds which were to be repaid from project income, rather than as a general obligation of the community. The City of Akron and Summit County were to supply the necessary waste. Steam was to be sold to the downtown business community, Akron University, local hospitals, and B. F. Goodrich.

In 1979 construction of the Akron Recycle Energy System was completed and operations commenced for the nation's first dedicated boiler, RDF-type, waste-to-energy facility. Initial capital cost was \$54.5 million: \$42.2 million for construction and the remainder for contingencies and debt reserve funds.

Because the Akron project was a prototype, many

HISTORICAL OVERVIEW 1970-1984

In late 1970 the City of Akron, Ohio, initiated an innovative solid waste disposal program to control the future costs for waste disposal as well as to supply low cost energy for its downtown area. Emphasis was

aspects of it were untried. As a result, numerous problems were encountered — primarily with the RDF preparation and conveying systems. Project production was far below design, and operating costs increased considerably beyond those anticipated. There was not enough income to cover operating costs, let alone debt service payments.

In an attempt to correct the operating deficiencies of the project, the City terminated its contract with the first operator and entered into a new contract with a second operator. The new private operator was to correct the plant deficiencies at an additional cost of \$24.4 million, and conduct an acceptance test to demonstrate guaranteed levels of performance. \$11.4 million was for construction and the balance was to pay certain operating costs, past due debt service costs and bond costs. Upon successful completion of the acceptance test, the second operator commenced operations under a 10-year operating agreement with the City. Subsequent to these improvements, the RES successfully demonstrated that it could process solid waste at a rate in excess of 800 TPD to generate steam for sale.

However, during 1983 the RES experienced several explosions in the RDF processing area. Service, though better than under the first operator, continued to be unreliable and expensive. Finally, in December 1983 the plant experienced a very serious explosion which essentially shut down the RES for nearly 3 months. Following repairs from this first major explosion, waste in excess of 20,000 tons/month was processed during 5 of the 12 months of 1984.

In December 1984, a second severe explosion occurred in the refuse receiving area which resulted in the deaths of three workers and caused the Akron RES to shut down for nearly 10 months. It has been alleged that the explosion resulted from the unauthorized disposal of 80 tons of highly volatile hazardous wastes inadvertently delivered to the RES. Both the 1983 and the 1984 explosions were limited to the RDF processing/waste storage system. No damage was inflicted on the boilers.

The 1984 explosion caused an outage at the RES and forced the City of Akron to seriously reconsider its options for waste disposal and continued operation of the Akron RES.

With the support of a Blue Ribbon Commission of community leaders, the Mayor of Akron reaffirmed the City's prior conviction that the RDF plant could be made to work. Moreover, the Commission determined the RES offered the most environmentally sound, most cost effective, long-term means of dealing with the City's solid waste. In addition to waste dis-

posal benefits, the RES was necessary to the continued supply of steam to the City's district heating system.

The City managed to unburden itself of the project's original revenue bond debt. It did so through a cooperative federal, state, and local funding effort.

FALL 1985 TO PRESENT

In October 1985 the contract with the second operator was terminated and operation of the RES was resumed as a "public enterprise" under the direct control of the City with financial and management support from wTe Corporation (wTe) of Bedford, Massachusetts.

The balance of this paper presents a description of the overall system and process flow for the Akron RES as it currently exists under new management. Production and economics are presented for a 15-month operating period, October 1, 1985 through December 31, 1986. Safety and capital improvements have been implemented. Construction of a major RDF storage facility was completed in December 1986, increasing RDF production capacity while reducing the facility's dependence on natural gas. The effects of the improvements on recent operating results are presented.

Despite past problems with the operation of the Akron RES, the plant is currently enjoying the longest sustained period of uninterrupted service in its 7-year operating history. It has demonstrated unprecedented production output reliability and favorable "bottom line" results.

New records for production continue to be set every day. At long last, the RES is viewed by the Akron community as a reliable and cost effective waste-to-energy project. It is now a successful RDF operating project, one of the first in the United States.

SOLID WASTE DISPOSAL NEEDS AND RES GOALS

The City of Akron with a population of approximately 250,000 people has the overall responsibility for the annual collection and disposal of approximately 200,000 tons/year of all types of solid waste generated within its boundaries. The City also must provide energy to its downtown business community and local hospitals. The quantity of residential and acceptable commercial waste supplied by Akron to the RES varies from 250 to 500 TPD, on a 5 day/week basis. Figures presented in this paper are based on a 5 day/week basis.

The success of Akron's solid waste management plan is dependent on these factors:

(a) The ability of the RES to operate reliably at 800 TPD or more.

(b) The availability of acceptable solid waste for processing at a rate of 800 TPD.

(c) The ability to sell planned quantities of steam and hot water at competitive prices.

(d) Continued operating subsidies in addition to a tip fee of \$9.00 paid by Akron and capital investments from the City of Akron until such time as the project is self-sustaining.

(d) The ability to stockpile and store adequate supplies of shredded RDF for combustion on a 24 hr/day basis, including weekends and holidays and for periods when the waste processing portion of the facility is down for scheduled and unscheduled maintenance.

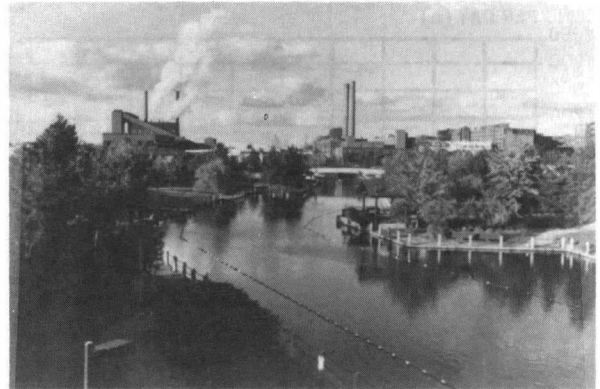


FIG. 1 LOCATION OF RES NEAR DOWNTOWN AKRON

WASTE COLLECTION AND DISPOSAL SYSTEM

The Akron Recycle Energy System receives, processes and burns municipal solid waste (MSW) and generates steam for distribution and sale. Located near the heart of downtown Akron (Fig. 1), the RES is owned by the City of Akron.

During 1987, the RES plans to receive and burn only residential and selected commercial solid waste. Part of this waste will come from City collection with the remainder coming from commercial haulers and nearby communities. "Acceptable Waste" is defined as waste which is collected from residences and a pre-approved list of commercial establishments. Every collection site must be approved by the Service Director at the recommendation of wTe management and the Akron Fire Department. For example, wastes collected from hardware stores, paint stores, or cleaning establishments are not acceptable. The rejection of unacceptable waste reduces the volume of waste that would otherwise be sent to the RES each year.

Individuals within the City contract with the City or private haulers for collection of residential waste. Collection and disposal of commercial and industrial solid waste remains the responsibility of the firms that generate the waste.

The City directs all residential and selected commercial solid waste to the RES for processing and subsequent combustion. The residues remaining after combustion, and any unprocessable waste which is bypassed, are delivered to the City's Hardy Road Landfill

for disposal. Industrial waste is also accepted at the landfill.

WASTE AVAILABILITY AND FUEL CONTRACTS

Waste is furnished to the RES under several different tipping fee schedules and service contracts. The waste supply contracts have been devised to "match" waste supply to energy demand.

Figure 2 shows the waste deliveries to the Akron RES during the reported 15-month operating period. It is evident that there has been a gradual build-up of waste supply with each passing month.

Although the plant initially served only the City of Akron, it is now operating as a truly regional facility serving the City, 62 private waste haulers in the greater Akron area, and three surrounding communities, as well as the cities of Cleveland Heights to the north and Canton to the south.

Waste is supplied under three different contract arrangements: uninterruptible, seasonal, and spot-market. Uninterruptible long-term, year-around disposal service was provided to the City itself, the 62 private waste haulers in the greater Akron area, and the three surrounding communities at a fixed cost of \$9.00/ton for 1986. Seasonal service is provided to Cleveland Heights (approximately 40 miles away) who must supply minimum quantities of waste in the winter at a cost of \$5.00/ton when the need for waste is highest because energy demand is highest. In the summer Cleveland Heights is limited in the weekly quantity of waste it can dispose at the RES, and is charged \$13.00/ton. To meet peak winter fuel needs on-demand, waste

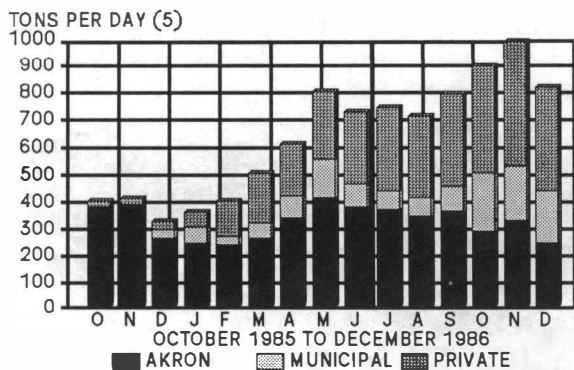


FIG. 2 WASTE DELIVERIES — AKRON RES

is furnished on a spot-market basis by the City of Canton, Ohio, 40 miles to the south. Canton delivers its waste on-call and is charged a tipping fee of only \$4.50/ton.

Although the tipping fees appear low, they are competitive with area landfill rates which tend to be on the order of \$1.50/cu yd.

Incrementally, it is much more cost effective to burn waste at the RES than natural gas. Since the City's winter steam load sometimes approaches 400,000 lb/hr, use of the least expensive fuel is an economic necessity. Rather than purchasing gas to meet this demand, it is much more cost effective to receive and process waste. The City receives revenue for waste delivered to the plant, whereas it experiences a cost of nearly \$4.30/1000 ft³ of gas. The avoided gas cost plus tipping fee equates to a cost avoidance of about \$50.00/ton of waste received.

Energy needs beyond those which can be met by the available waste supply sources come from tires and natural gas. Tires are tipped and processed in a tire shredder located at the City's Hardy Road landfill. Shredded tire chips are a high quality storable fuel which can be supplied on demand and burned at a rate of 1 ton of tires per 10 tons of MSW. The tires have a heating value which exceeds that of coal. Natural gas is available from the City's own gas wells, or is purchased through outside supply contracts and the local gas company.

RES OVERALL SYSTEM AND PROCESS DESCRIPTION

An overall system diagram of the Akron RES is provided in Fig. 3. Refuse is delivered by packer trucks,

dump trucks, and transfer trailers to a receiving area where it is weighed electronically and dumped into a storage pit. The scale system has recently been modified to integrate it into the plant's fully computerized accounting system. Up to 200 loads per day are received at the RES between 6:00 a.m. and 4:30 p.m. Turn-around time for a vehicle to weigh, tip, and exit the building is about 5 min. Operating personnel inspect each load of waste as it is dumped into the pit to be sure it does not contain unacceptable material.

Processing Buildings

The processing buildings house the scales, storage pit, shredders, magnetic separators, and material handling conveyors. The receiving pit is capable of storing a 2 to 3 day supply of waste. Hydraulic rams in the live-bottom waste storage pit move the waste to a pan conveyor which feeds the waste to two large horizontal hammermills powered by 1500 hp motors. Each shredder is capable of processing 60–75 tons of MSW per hour to a nominal particle size of 4–6 in. The shredders are equipped with Fenwall explosion suppression systems. Although normal operation is for one shredder to be in service and the other in standby, both shredders can be operated simultaneously if desired. The shredders discharge onto belt conveyors which feed a double drum-type magnetic separator which removes the ferrous materials. An air system assists in the removal of paper which would otherwise contaminate the ferrous metals. The ferrous metal is discharged into trucks owned by wTe and transported to market. wTe has a long term contract with the City for the purchase of ferrous metal.

RDF Storage Building

A recent improvement to the Akron RES is the reconstruction of an RDF storage facility. Due to the materials handling characteristics of the RDF, the original RDF storage building never operated reliably. The second operator removed the RDF storage bin. However, without storage of the RDF every item of equipment in the processing building was critical to firing the boilers on RDF. Furthermore, personnel had to perform maintenance in areas close to the operating shredders, a practice deemed by wTe to be unsafe. Whenever the shredders had to be maintained, a piece of equipment failed, or a chute plugged, the boilers were switched over from firing RDF to firing natural gas.

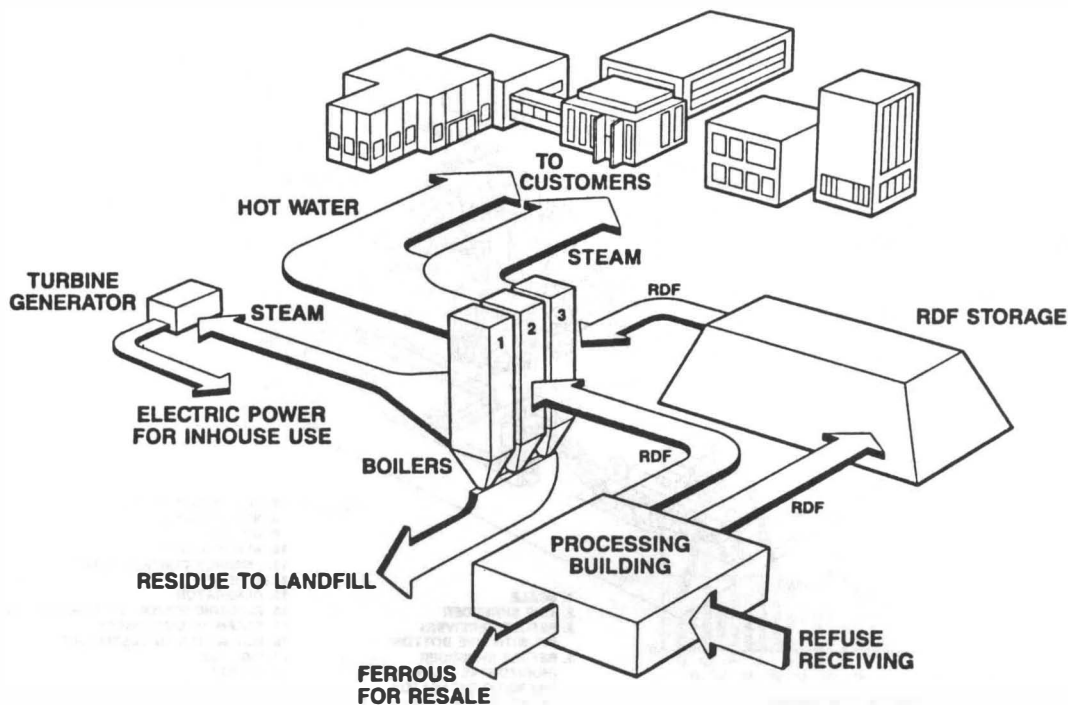


FIG. 3 OVERALL SYSTEM DIAGRAM—RECYCLE ENERGY SYSTEM
(Courtesy of Babcock & Wilcox)

wTe designed and installed a new storage facility capable of storing 600 tons of RDF. The storage building consists of a series of input and output conveyors fed back into the boiler feed system by a front end loader. Design, construction and startup was accomplished by wTe on a fast-track basis in only 6 months. This addition has increased the reliability of RDF firing and improved the ratio of energy produced from RDF to that of natural gas to over 94%.

Combustion Area

The plant contains three Babcock and Wilcox Stirling Power Boilers designed to produce 126,000 lb of steam per hour each when firing RDF in semi-suspension over a traveling grate. Full load may also be obtained by firing 100% natural gas. Combustion air preheating and four-stage electrostatic precipitators for emission control are ancillary to the boilers.

Boiler fuel feed is provided by a series of conveyors and fuel proportioners which distribute the fuel to the

boilers. Air swept spouts direct the waste fuel into each boiler. This unique system assures that required quantities of waste are introduced into each boiler. Excess prepared fuel can be recycled back to the receiving pit or go on to the RDF storage building.

Fly ash and bottom ash are mixed together in water quench tanks below the boilers. A chain type ash discharge system dewater the ash which is then mechanically conveyed to the ash storage building. Front end loaders place the combined fly ash and bottom ash into dump trucks which haul it to the Hardy Road landfill.

Steam produced by the RDF is transported throughout an 18-mile steam distribution loop to municipal and commercial customers in the downtown Akron area. Two 2-MW turbine generators produce electricity for in-plant use. A 2-mile district heating loop distributes 210°F hot water produced from turbine generator exhaust. Steam for feedwater deaeration is provided by the turbine exhaust.

A process flow diagram is provided in Fig. 4 which depicts the various unit operations in the facility.

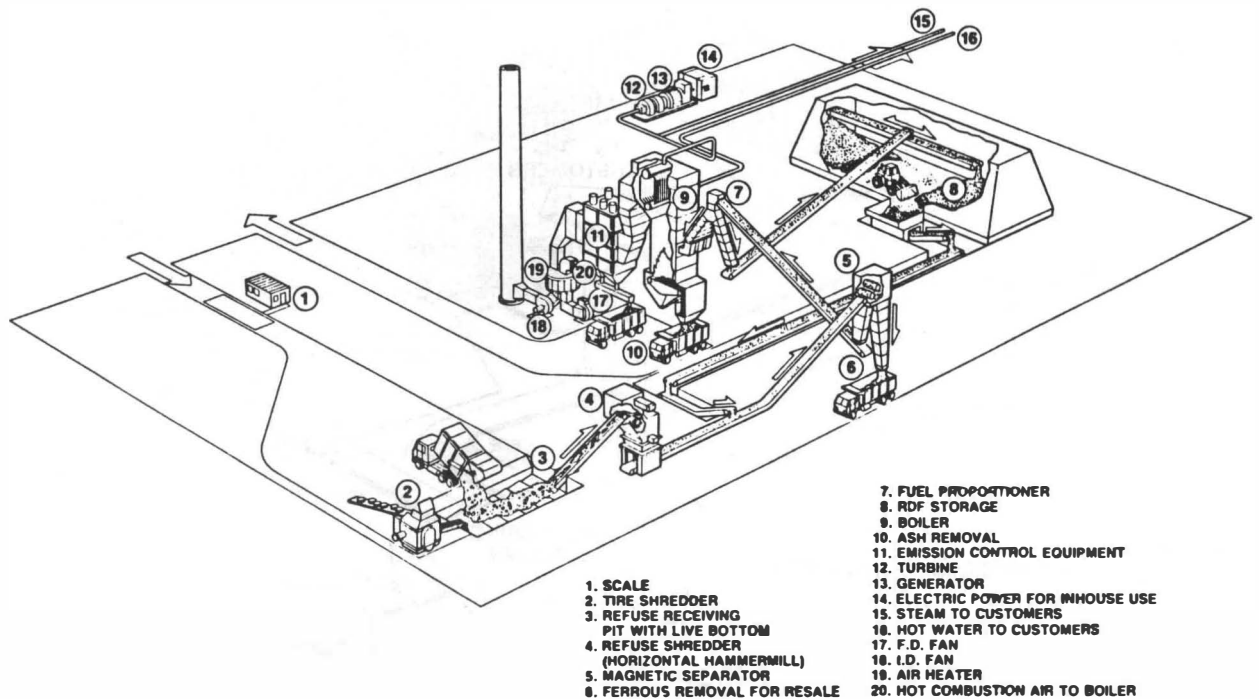


FIG. 4 PROCESS FLOW DIAGRAM
(Courtesy of Babcock & Wilcox)

Process Improvements

Many improvements have been made to the RES to improve safety and enhance operating economics.

The blast protection wall between shredders which was intended to allow maintenance on one shredder while the second was operating only a few feet away, was deemed inadequate. Shredding is now fully isolated from all other operating areas. Personnel are no longer allowed in the shredder building when waste processing is underway. A new blast wall, new control room windows, and covers over gratings in the tipping area have been added to isolate tipping operations from processing operations and to seal off the shredders from locations where personnel are working.

Contained areas which were previously "hardened" to withstand blast pressures were "softened" with canvas to relieve pressure and direct blast pressures through a path of least resistance. This reduces damage from explosions and provides a safer environment for personnel. Solid shredder vent deflectors installed to contain projectiles in the event of an explosion have been replaced by blast mats to relieve back-pressure. Vents within the shredder have been modified to give

better relief and yet prevent the vent from filling with RDF. A vapor detection system has been added at critical areas throughout the plant including: inside the shredder hoppers, at feed and discharge conveyors, in the receiving pit, and at specific low points in the building where vapors could build up. Ventilation systems have been added in the receiving pit and in the shredder building. Sprinkler systems have been added together with improved alarm systems. Ventilation has also been added to conveyor towers where dust can build up and where previous explosions have occurred.

Other improvements which have enhanced operating economics and plant reliability: RDF storage, building heating system, boiler temperature indicators, gas firing control and ignition systems, among others.

PRODUCTION

The City and wTe operate and manage both the processing and the energy production facilities. An average of 900-1000 TPD of MSW is processed 10-hr/day, 5 days/week. Energy production continues

	Period	
	Oct 85-Dec 86	1986
• Waste Processed at RES (tons):	211,675	186,243
- Residential and Commercial Trash and Garbage	208,193	183,456
- Shredded Tires	3,349	2,780
- Leaves	100	0
- Confidential Documents	32	7
• Tires Shredded at Tire Processing Facility (tons):	5,625	5,625
• Steam Generated (pounds):	2,095,098,000	1,754,695,000
• Steam Sold (pounds):	979,686,000	785,781,000
• Hot Water Sold (BTUs):	3,072,700,000	2,997,500,000
• Electricity Generated (KWH)	13,380,000	11,719,000
• Ferrous Shipped (tons):	8,300	7,511
• Non-Processible Waste Landfilled:	4,111	3,436
• Ash-Residue Landfilled (tons):	43,936	39,440

FIG. 5 PRODUCTION SUMMARY

around-the-clock, 24-hr/day, 7 days/week. A production summary is provided in Fig. 5.

During the period from October 1985 through December 1986, over 211,000 tons of waste were processed. Over 7.5 million pounds of tires were shredded and stockpiled as a storable fuel to meet the 1986/1987 winter heating demand.

Not once from October 1985 through December 1986 did the RES fail to meet its steam production quality or quantity requirements, nor was service interrupted to any RES customer on an unscheduled basis.

ENERGY AND METAL PRICES

Energy is produced and sold in the form of steam, hot water, and electricity. Steam produced from the boilers is distributed to a variety of outside customers and is used to generate in-plant electric power. Steam pressure leaves the boilers at 560 psi, and is reduced at several locations in the distribution system to meet customer pressure requirements. The entire steam distribution network is operated and maintained by wTe employees who also read meters, provide customer assistance, and advise customers on energy conservation and more efficient steam heating systems. Figure 6 illustrates steam sales.

Like the waste supply contracts, steam is sold on an uninterruptible, seasonal, and spot market basis. Here again, reliable service is the most expensive. Spot market energy is least expensive.

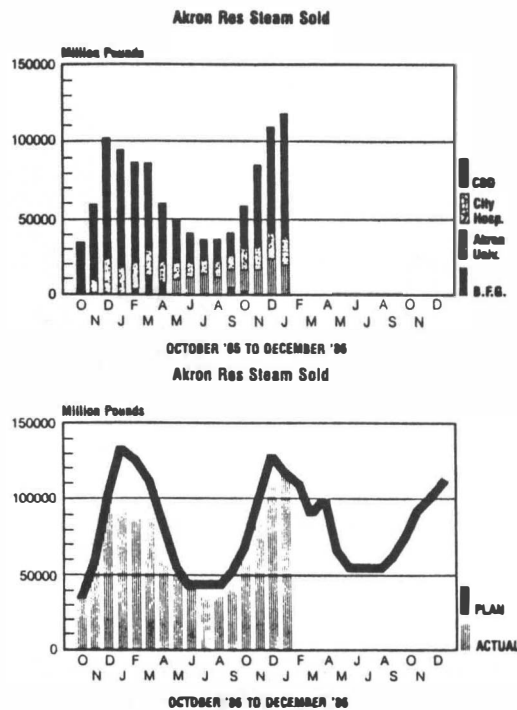


FIG. 6 STEAM SALES

Steam from the RES is sold on an uninterruptible basis to more than 100 businesses in the downtown Akron Central Business District (CBD). The cost of this steam per thousand pounds varies from \$9.00 to \$10.25 depending upon quantities purchased.

Steam is also sold on a semi-interruptible basis for heating and cooling to Akron City Hospital and Akron University who operate their own backup gas/oil fired boilers. Their range of steam pricing, based upon the avoided cost of their otherwise available fuel, has varied from about \$4.20/1000 lb up to \$6.00/1000 lb. A new contract is under negotiation to sell B.F. Goodrich steam at about \$6.00/1000 lb and chilled water at 12 cents per ton hour on a reliable basis. Previously B.F. Goodrich purchased spot market steam at approximately \$2.25/1000 lb.

In addition to steam sales, up to 4 MW of power is produced in two 2-MW backpressure turbines for internal plant use. Negotiations are ongoing to add generating capacity and sell excess power to the local utility, Ohio Edison Company.

Hot water, produced from the turbine generator exhaust, is used for internal heating and to supply hot water to the City's own district hot water heating sys-

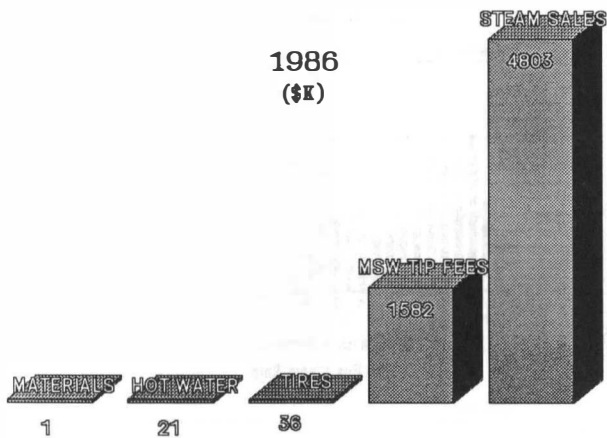


FIG. 7 SOURCES OF REVENUE

**TOTAL REVENUE = \$8,206,000
(OCT 85-DEC 86)**

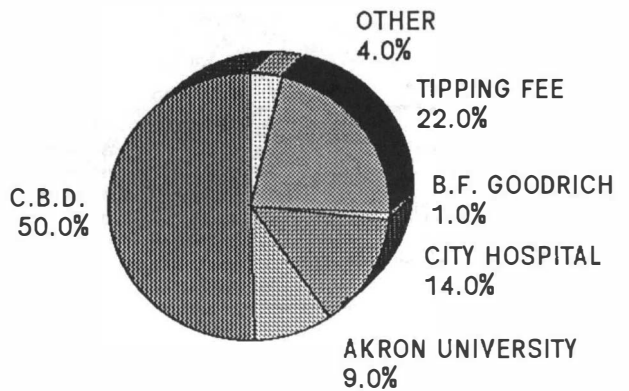


FIG. 8 DISTRIBUTION OF REVENUE

tem. Two 5.5 million Btu/hr heat exchangers, two hot water circulation pumps, a 650 gal expansion tank and associated valves and piping are used to provide hot water and heating to nine businesses and a 130-unit residential condominium. Hot water pricing is based on avoided natural gas heating costs.

Ferrous metals are removed from the MSW and sold to wTe for approximately \$2.00 to \$4.00/ton. wTe pays all transportation costs.

REVENUES

A bar chart which shows the sources of revenue for the project during 1985 and 1986 is provided in Fig. 7. Figure 8 shows the distribution of revenues among all revenue sources during the 15-month period. The Central Business District (CBD) contributed 50%; Akron University and Akron City Hospital added 23% to revenues. Tipping fees by comparison contributed an additional 22%. B.F. Goodrich revenues which were only 1% of the total during the 15-month period are expected to increase substantially under the new reliable steam sales agreement. "Other" includes interest on bank deposits and unanticipated revenue from a business interruption claim settlement.

COSTS

Figure 9 shows the relative annual distribution of costs.

The completion of the RDF storage building together with revised operating procedures are expected

to significantly reduce future expenditures for gas. More than \$1 million of the project's costs were for services purchased by the RES from other City departments for water, sewer and natural gas supplied from City wells and accrued to the project.

FINANCIAL PERFORMANCE

The net operating loss at the RES during the 15-month period from October 1985 through December 1986 has been steadily improved upon in subsequent accounting periods, as shown in the following table.

	Actual Oct 85-Dec 86	Actual 1986	1987 Budget	Actual 1st Qtr 87
REVENUES--	\$ 8,206,000	\$ 6,721,000	\$ 8,890,000	\$ 2,298,000
LESS COST--	\$12,562,000	\$10,573,000	\$ 9,769,000	\$ 2,263,000
NET INCOME (LOSS)	(\$ 4,356,000)	(\$ 3,851,000)	(\$ 879,000)	\$ 35,000
TONS PROCESSED	211,674	186,243	208,960	58,630
NET LOSS PER TON	-20.58	-20.68	-4.21	+0.60

Projected 1987 revenues are \$42.54/ton. Projected operating costs in 1987 are \$46.75/ton. Net cost per ton in 1987 is thus \$4.21 plus the \$9.00 tip fee included in revenue for a total \$13.21/ton. Debt service costs would have amounted to an additional \$30.57/ton in 1987, for a total of \$43.78/ton, had the project's rev-

**TOTAL COST = \$12,562,000
(OCT 85-DEC 86)**

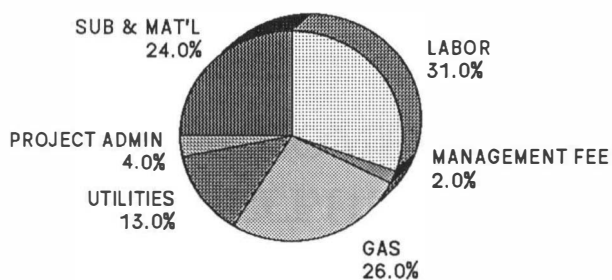


FIG. 9 ANNUAL DISTRIBUTION OF COSTS

enue bonds not been defeased by the City. Included in these costs are operation of a tire shredder and maintenance of the City's 18-mile steam distribution loop. Accounting for hauling and disposal of both ash-residue and by-passed waste (which on a wet weight basis amounted to only 23% of waste received in 1986) adds \$2.28 to the cost for a total net cost of \$46.06/ton.

By early 1987 the capital improvements to the RES were nearly complete. Their effect on operating eco-

nomics is already evident. For example, for the first time in the project's history, revenues exceeded costs during the first quarter of 1987.

FUTURE PLANS

The RES is operating safely and efficiently, meeting both steam delivery and waste disposal demands for the greater Akron area. Current emphasis is on increasing steam and electricity revenues, reducing the quantity of waste landfilled, and reducing costs at the RES — especially natural gas.

Investigations will be conducted to measure heavy metals in the ash residue and recover recyclable material, such as aluminum, from the bottom ash. Akron is currently using its ash as a landfill cover material and road base aggregate.

Processing of industrial and "by-passed" oversized bulky waste in a shear shredder is being investigated to redirect the acceptable part of Akron's industrial waste to the RES, thereby increasing the supply of acceptable waste supplies at the RES and extending the life of the City's Hardy Road Landfill.

Efforts to identify and implement cost savings through improved management information systems are continuing.