Chapter 18
Municipal Waste Combustion

Introduction

Some cities, primarily in the northeastern and mid-Atlantic U.S., burn part of their municipal solid wastes. Hemmed in by major population centers, landfill space there is at a premium, so burning wastes to reduce their volume and weight makes sense. Combustion reduces the volume of material by about 90 percent and its weight by 75 percent.[1] The heat generated by burning wastes has other uses, as well, as it can be used directly for heating, to produce steam or to generate electricity.

In Texas, municipal waste combustion facilities have had little to no economic impact on the state as a whole. Texas had two permitted waste incinerators in 2006, and one waste-to-energy facility in Carthage.[2] The Carthage plant is now owned by a private company that uses the facility to incinerate medical waste.

History

In 1885, the U.S. Army built the nation's first garbage incinerator on Governor's Island in New York City harbor. Also in 1885, Allegheny, Pennsylvania built the first municipal incinerator. As their populations increased, many cities turned to incinerators as a convenient way to dispose of wastes.

These incineration facilities usually were located within city limits because transporting garbage to distant locations was impractical. By the end of the 1930s, an estimated 700 incinerators were in use across the nation.[3] This number declined to about 265 by 1966, due to air emissions problems and other limitations of the technology. In addition, the popularity of landfills increased.[4]

In the early 20th century, some U.S. cities began generating electricity or steam from burning wastes. In the 1920s, Atlanta sold steam from its incinerators to the Atlanta Gas Light Company and Georgia Power Company.

Europe, however, developed waste-to-energy technologies more thoroughly, in part because these countries had less land available for landfills. After World War II, European cities further developed such facilities as they rebuilt areas ravaged by war. U.S. cities interested in converting waste to energy tended to acquire European technologies when they built or improved their incinerators.

In the 1970s, the Arab oil embargo and increasing energy prices encouraged the development of waste combustion. The U.S. Navy, for instance, built waste-to-energy plants at two Virginia naval stations, one of which is still in use.

Combustion reduces the volume of solid waste material by about 90 percent and its weight by 75 percent.

Federal laws and policies aided the development of the waste-to-energy industry. The 1970 Clean Air Act authorized the end of open burning at U.S. landfills. City incinerators also were required to install pollution controls or cease operation, and a number of the worst polluters were closed down. Losing incinerators forced cities to consider waste-to-energy plants and look again to Europe for technology. In 1975, the first privately built waste-to-energy plant opened in Massachusetts; it experienced a number of operational problems at first as engineers sought to adapt it to the contents of American waste and made other operational changes.

In the late 1970s, the federal government started to fund feasibility studies for local governments interested in setting up new waste-to-energy plants.

The 1978 Public Utility Regulatory Policies Act (PURPA), which required the Federal Energy Regulatory Commission to guarantee a market for electricity produced by small power plants, allowed new waste-to-energy projects to find financing. PURPA made waste-to-energy projects financially viable, since projects could find buyers for the electricity they generated.[5]

The 1980 Energy Security Act appropriated funds to support biomass energy projects and required federal agencies to prepare a plan for maximizing its production and use. The act provided insured loans, loan and price guarantees and purchase agreements for biomass projects, including waste-to-energy projects using municipal solid waste. It also directed the U.S. Department of Energy to prepare a municipal waste energy development plan and support it with construction loans, and loan guarantees, price support loans and price guarantees. The act also authorized research and development for promoting the commercial viability of energy recovery from municipal waste.[6]

While the majority of this funding was rescinded in the 1980's, some federal money flowed to businesses and local governments, and about 46 new waste-to-energy facilities were built.[7]

The 1986 federal Tax Reform Act simultaneously benefited and harmed the development of waste-to-energy facilities. The act extended federal tax credits available for waste-to-energy facilities for ten years, but also repealed the tax-free status of waste-to-energy plants financed with industrial development bonds.[8]

In the 1990s, after the tax credits extended in 1986 finally ended, fewer waste-to-energy plants were built.

The use of municipal waste combustion for energy is not common; the nation had only 87 such facilities in 2007.

Uses

The heat generated by burning waste can be used directly for heating; to produce steam; or to produce electricity.

Municipal Waste Combustion in Texas

Space for landfills has been plentiful in the past, but is becoming harder to find in large urban areas. Recycling programs have reduced the amount of matter going into landfills, but combustion may become more viable in some urban areas if landfill sites become scarce or if energy prices make combustion more economically viable.

Economic Impact

Municipal waste combustion facilities in Texas have had little economic impact on the state as a whole. Texas sole permitted waste-to-energy facility does not produce electricity. At this time, the Sharps Environmental Service Solid Waste Incineration Facility has the capability of producing steam for sale, but it is currently operating the facility only as an incinerator.[9] A 50 MW waste-to-energy plant in Polk County, Florida, has an estimated $6 million annual regional economic impact, according to its operator, Wheelabrator Ridge Energy, Inc.[10] A similarly-sized plant in Texas would have comparable economic impact.

Consumption

The use of municipal waste combustion for energy is not common; the nation had only 87 such facilities in 2007.[11] Even so, about 31.4 million tons of solid waste were channeled to these plants in 2006, representing 12.5 percent of all municipal solid waste disposal.[12]

Texas' sole permitted waste-to-energy facility processed 387 tons of waste in 2006.[13]

In addition, a 2006 agreement between two energy contractors will lead to the development of another waste-to-energy power plant supplying Dyess Air Force Base in Abilene.[14] About a third of Abilene's solid waste — some 35,000 tons a year — will be fired, along with garbage from the base and the nearby city of Tye. Dyess will buy discounted energy from the contractor operating the waste-to-energy plant, saving nearly half of its current energy costs.[15] The Air Force contract totals over $39 million and includes the waste-to-energy plant plus diesel back-up generators.[16]

Production

Waste-to-energy facilities tend to be built near the landfills of large urban centers. A few facilities are modular units, smaller plants built off-site and transported to wherever they are needed.

Waste-to-energy plants generate electricity by burning municipal wastes in large furnaces to produce steam, which in turn drives a steam turbine to generate electricity. On average, one ton of waste produces 525 kilowatt-hours (kWh) of electricity. This is equivalent to the energy produced by a quarter-ton of coal or one barrel of oil.[17]

One type of waste-to-energy plant is called a *mass burn facility* (**Exhibit18-1**). These facilities use solid waste directly off garbage trucks, without shredding or processing the materials. The solid waste is then fired in large furnaces to produce steam, which turns a steam turbine to generate electricity.[18]

Less than a fifth of the U.S. municipal solid waste incinerators recover glass, metals and other recyclable materials and then shred the combustible materials before firing. This type of plant is called a *refuse-derived fuel* (RDF) plant.[19] Sometimes, refuse-derived fuel is prepared at one facility and then transported to another for burning.[20] The shredded waste also may be added as a fuel to boilers that burn fossil fuels.

Mass burn and RDF plants are the most common facilities in use today. A new technology called *thermal gasification*, however, changes waste into synthesis gas, a mixture of hydrogen and carbon monoxide. Contaminants are removed from this gas, which can then be burned as fuel.[21] The Dyess Air Force Base project will be a thermal gasification project.[22]

Storage

The energy or hot gas produced by waste-to-energy plants is not stored. It is used to produce energy, either to sell to an electric company or business or to produce steam for other purposes.

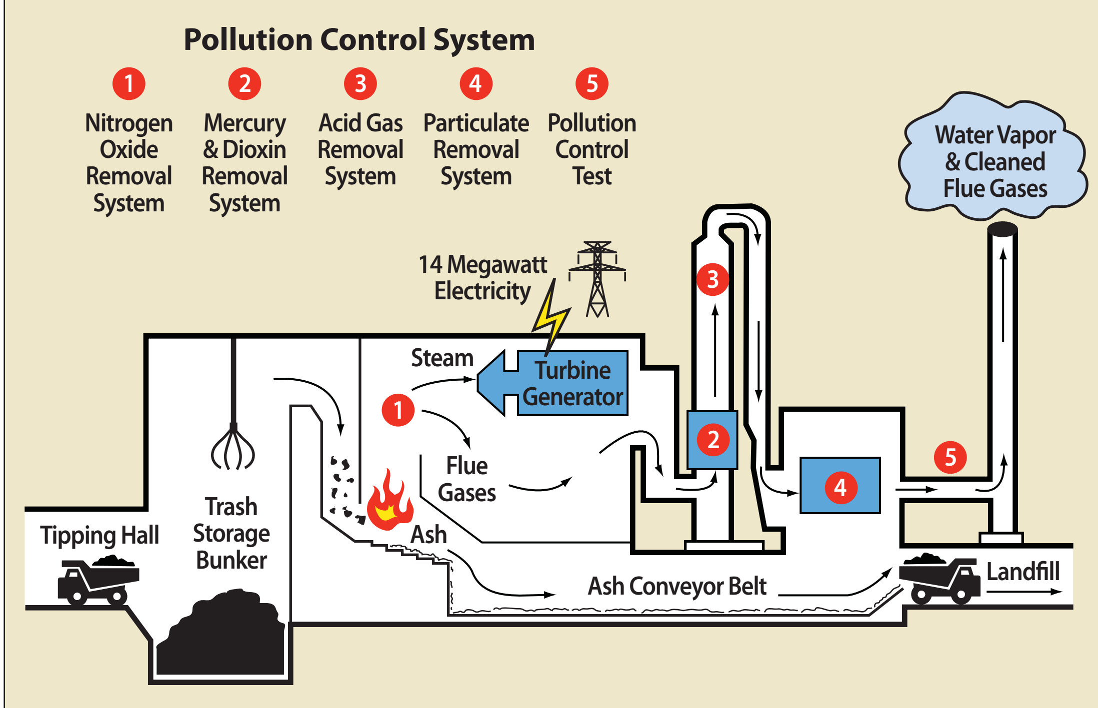
Availability

The nation's 87 waste-to-energy facilities are mostly located in the Northeast, but 25 states have at least one. Their generating capacity is a total of 2,720 megawatts of power, enough electricity to power all the homes in Maine, New Hampshire, Vermont, Rhode Island and most of Massachusetts. They can process 28.7 million tons of waste each year.[23] Most sites burn all types of solid waste, but some burn material separated from the main waste stream, such as tires, wood or paper.

According to a Columbia University survey published in *BioCycle* magazine, the U.S. generated about 388 million tons of municipal solid waste

Exhibit 18-1

Waste to Energy Plant Diagram



Source: ecomaine.

A typical waste-to-energy plant generates about 500 to 600 kWh per ton of waste.

in 2004. Of this amount, about 28.5 percent was recycled and composted; about 7.4 percent was burned in waste-to-energy plants; and the majority, 64.1 percent, was put in landfills (**Exhibit 18-2**).[24]

The U.S. Environmental Protection Agency (EPA), using a different methodology, estimates that the U.S. generated 251.3 million tons of garbage in 2006. Of this amount, 81.8 million tons (32.5 percent) were recycled and composted; and 31.4 million tons (12.5 percent) were burned for energy production. The remaining 138.2 million tons (55 percent) were placed in landfills (**Exhibit 18-2**).

The waste-to-energy industry has been outpaced by the growth of recycling and composting. In 1990, recycling and composting accounted for 33.2 million tons of waste; that rose to 81.8 million tons in 2006, an increase of 146 percent. The amount of waste burned for energy recovery in 2006 (31.4 million tons) is only slightly larger than that in 1990, 29.7 million tons — a 0.3 percent average growth rate.[25]

Costs and Benefits

In 2005, an official of one of the leading U.S. companies operating municipal waste combustion facilities, American Ref-Fuel Company, testified before Congress that a new facility that can generate 60 megawatts of electricity from about 2,250 tons of trash daily would cost about $350 million. Its operating costs would be about $28 million a year.[26] This would be a very large plant; only fourteen locations in the U.S. have the capacity to combust more than 2,250 tons of trash per day.[27]

Exhibit 18-2

U.S. Waste Disposal

	EPA Estimate, 2006	BioCycle Estimate, 2004
Amount of Waste Generated	251.3 million tons	388 million tons

Mode of Disposal	Percent	Percent
Combusted	12.5	7.4
In Landfills	55	64.1
Recycled or composted	32.5	28.5

Sources: U.S. Environmental Protection Agency and BioCycle Magazine.

A typical waste-to-energy plant generates about 550 kWh per ton of waste. At an average price of four cents per kWh, revenues per ton of solid waste would be $20 to $30.

Even so, waste-to-energy plants are undeniably expensive. According to the Waste-to-Energy Research and Technology Council (WTERT), capital costs to build a facility range from $110,000 to $140,000 per daily ton of capacity. Thus a plant that processes 1,000 tons of municipal solid waste per day might cost from $110 million to $140 million. It would also require a staff of about 60, and materials, supplies and the cost of ash disposal also would add to operating costs.[28]

Due in part to the high cost of their construction, no new U.S. waste-to-energy facilities have been built in the last ten years. But rising energy costs and tax and other incentives enacted in the Energy Policy Act of 2005 have prompted some existing waste-to-energy facilities to expand their capacity, and the industry is encouraging governments to build new ones. In Florida, the Lee County Solid Waste Resource Recovery Facility in Fort Meyers has begun an expansion of its facility that will expand its operations by 50 percent.[29]

The economic benefits generated by such plants include the value of the energy generated; the trash disposal fees paid by communities contracting with the waste-to-energy company; and the value of scrap collected.[30] Both the fees paid to the plant for trash disposal and fees paid for generating electricity are key to the facilities' economic success, but these are not sufficient to cover the total costs of building new facilities. Federal tax credits help to make up the difference.[31]

Environmental Impact

Burning solid waste produces nitrogen oxides and sulfur dioxide as well as trace amounts of toxic pollutants such as mercury compounds and dioxins.

The nature of the waste burned affects the composition of its emissions. If batteries or other materials containing heavy metals are burned, particularly toxic materials can be released into the air.[32] Some of these materials, such as dioxins, furans and metals, do not degrade quickly when released, and may be deposited on plants and in water. Animals and fish may absorb them, and humans may be exposed if they eat the contaminated animals or fish. Particulate matter, hydrogen chloride, carbon monoxide and nitrogen oxides also can be released into the air and absorbed into the environment.[33]

Waste-to-energy power plants use water in boilers and in cooling. When this water is discharged, its higher temperature and pollutants it contains can harm aquatic life and reduce water quality.

Scrubbers — devices that use a liquid spray to neutralize acid gases — and filters to remove particles are used to treat the emissions created when solid waste is burned. Ashes representing about 25 percent of the weight of the original combustible material are generated when waste is burned. Metals must be removed from this ash, and the ash must be tested to ensure that it meets environmental standards before it is recycled for use in roadway construction or placed in a landfill. Ash may be used as daily cover at landfills, but its disposal still represents a considerable operational cost for most waste-burning facilities.[34]

In 1995, EPA ordered waste-to-energy facilities to meet maximum pollution control standards by 2000. This required the facilities to significantly reduce their emissions of dioxin, mercury, lead, cadmium, hydrochloric acid and particulates. Between that time and the present, EPA estimates that these requirements reduced emissions of dioxins and furans from waste-to-energy plants by more than 99 percent; metals by more than 93 percent; and acid gases by more than 91 percent. In 2006, EPA further tightened standards for large municipal waste burners.[35]

A Renewable Resource?

Should waste-to-energy be regarded a renewable source of energy? Fifteen states have categorized waste-to-energy as a renewable resource in their renewable portfolio standards and some federal laws have categorized it as a renewable resource.[36] On the other hand, some federal and state tax advantages given to other renewable resources are not available to waste-to-energy facilities. In Texas, some consumer groups have opposed including waste-to-energy in Texas's renewable energy goals.[37]

Noise also may be an issue with waste-to-energy plants. Trucks that bring solid waste to the facility, plant operations and fans can be sources of noise pollution.

In addition, electricity generation from waste can require some water. Estimates of water use place many biomass waste products – wood biomass, feedlot waste, municipal solid waste – in a single category. Depending on the plant type, electricity generation from waste requires withdrawals of between zero and 14,658 gallons per million Btu of heat energy produced. This is the amount of water extracted from a water source; most of the water withdrawn is returned to that source.

Water consumption refers to the portion of those withdrawals that is actually used and no longer available. Electric generation using waste consumes between zero and 150 gallons of water for each million Btu of heat energy produced.

Other Risks

The expense of waste-to-energy plants poses a considerable financial risk. Assessments of their viability should include accurate projections of the amount of waste that is available to burn; the potential price for the energy produced; and potential customers for this energy.[38]

Subsidies and Taxes

A federal production tax credit of one cent per kWh is available for energy produced from municipal solid waste. Chapter 28 contains more information on biomass subsidies.

State and Federal Oversight

Federal and state pollution laws regulate waste-to-energy power plants. As mentioned previously, EPA ordered waste-to-energy facilities to reduce their emissions of dioxin, mercury, lead, cadmium, hydrochloric acid and particulates significantly.[39]

These facilities are also regulated under Texas' environmental pollution laws in the Health and Safety Code, which establishes air quality and environmental standards to protect public health and the environment.[40]

Scrubbers — devices that use a liquid spray to neutralize acid gases — and filters to remove particles are used to treat the emissions created when solid waste is burned.

Other States and Countries

Again, most municipal solid waste combustion facilities are in the Northeastern or mid-Atlantic states.

Federal statistics for power generation from waste-to-energy plants are combined with those for power generation from landfill gas. In combination, Florida generates more energy from waste-to-energy facilities and landfill gas than any other state – an estimated 3.0 billion kWh in 2005. New York, with 2.2 billion kWh and Pennsylvania, with 2.1 billion kWh were second and third in 2005. Texas generated only 207 million kWh and most of this was from landfill gas.[41]

In 2005, there were over 430 waste-to-energy plants in Europe burning about 50 million metric tons of waste.[42] This is more than one-and-a-half times the 33.4 million tons of materials the U.S. burned in 2005.[43]

Japan incinerated 69 percent and Denmark incinerated as much as 54 percent of its solid waste for energy in 2003 (latest figure available); France and Belgium burned 32 percent each, in 2005 and 2003, respectively.[44]

Outlook for Texas

The primary advantage of waste-to-energy plants is that they consume wastes from highly populated urban areas, relieving the burden on landfills. The electricity the plants generate, however, is more costly than energy produced by coal, nuclear or hydropower plants.[45] In addition, the costs of waste-to-energy facilities are much greater than the cost of landfills — if the latter are available.[46]

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The potential pollution problems of waste-to-energy facilities involve perceptions as well as realities. The public is likely to perceive these facilities as more polluting than other types of energy. Any new waste-to-energy plant would require zoning, air and water permits, and many communities might reject such a proposal on the basis of air pollution, noise or odors.[47]

Many urban areas in Texas already have air pollution problems, and a new waste-to-energy facility could add to them. Yet, new waste-to-energy plants must be located near large cities, because they require large amounts of waste, and the cost of transporting waste from remote locations would be prohibitive. Also, increases in recycling could affect the financial viability of waste-to-energy facilities, which depend upon dumping fees from users.

In all, the outlook for waste-to energy plants in Texas is challenging. The expense of building plants, the availability and lower costs of landfill space, air pollution problems and other issues pose considerable obstacles.

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