CHAPTER 9

The Economics of Energy From Waste

Waste-to-energy combustion plants are complex industrial installations and they are expensive to build. Since the capital cost weighs heavily on the economics of a power station, electricity produced by these plants is not competitive with other sources of electricity when treated solely as an electricity generation station. Some other types of waste-to-energy plant, such as landfill gas or anaerobic digestion units, can offer more cost-effective sources of electricity, while waste-to-energy plants that burn agricultural biomass wastes can also be economical to run. These latter are normally considered to be biomass plants. Municipal solid waste may also be considered a renewable source in some jurisdictions.

Fortunately for plants that burn municipal solid waste to generate power, the economics do not rely solely on the sale of electricity. The disposal of municipal waste is an expensive business no matter how it is handled and there are fees associated with disposing of municipal waste. A waste-to-energy combustion plant can expect to earn an income from the waste it accepts, often known as a gate fee or tipping fee, and this will greatly affect the overall economics. Besides that, environmental legislation in some regions now encourages that all options be pursued before waste is buried in a landfill site, and this encourages the use of combustion as a preferred alternative to landfill.

The economics of a waste-to-energy combustion plant will depend upon how the tipping fee compares to the cost for burying the same waste in a landfill site. Table 9.1 compares the average tipping fees for waste-to-energy plants and landfill sites in three different countries, Sweden, the United Kingdom, and the USA. In Sweden, the tipping fee for a landfill site is \$193/t of waste, while for a waste-to-energy plant the fee is \$84/t. The very large difference encourages the use of waste-to-energy plants since the economic advantages are significant. In the United Kingdom, the average tipping fee for a landfill site is \$153/t, while for a waste-to-energy plant, the average fee is \$148/t.

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Table 9.1 Tipping Fees for Waste to Energy and Landfill

Country	Average Tipping Fee for a Waste-to-Energy Plant (US$/t)	Average Tipping Fee for a Landfill Site (US$/t)
Sweden	84	193
United Kingdom	148	153
USA	68	44

Source: World Energy Council.[1]

The difference here is much smaller than in Sweden but can still help tip the balance in favor of waste combustion. In the USA, in contrast, the tipping fees for landfill sites average $44/t, while the fee for waste-to-energy plants averages $68/t. Not surprisingly, the use of waste-to-energy plants in the USA is much lower than in Sweden.

WASTE-TO-ENERGY PLANT COSTS

A study carried out for the Mayor of London and published in 2008 looked at the cost of the principle waste combustion technologies. The main findings are shown in Table 9.2. The study concluded that a conventional incineration facility would cost around £45 m for a plant with the capacity to treat 100,000 t/year of municipal solid waste (MSW), while for a 200,000 t/year plant, the cost would be £76 m. With the maximum power output from the smaller plant put at 6 MW, this equates to a capital cost of £7500/kW, while the larger plant has a maximum output of 12 MW, equating to a capital cost of 6300/kW.

Advanced thermal treatment plants such as gasifiers and pyrolysis plants have slightly higher costs, as shown in the table. Their potential power outputs are also slightly lower. As a consequence, the capital cost of a 100,000 t/year advanced plant is £9100/kW, while for the 200,000 t/year plant, the capital cost is £7700/kW. Operating costs for the plants are broadly similar at between £40/t and £70/t of capacity depending upon plant size.

These UK costs are similar to estimates for plant costs in the USA where the cost of a typical municipal waste combustion plant was put at $5000/kW to $10,000/kW during the middle of the first decade of the 21st century. Again, smaller plants are relatively more expensive than larger plants.

[1]World Energy Council, World Energy Resources: Waste to Energy 2016.

Table 9.2 The Cost of Waste-to-Energy Plants in the United Kingdom

Plant Waste Treatment Capacity (kt/year)	Conventional Incineration (m)	Advanced Thermal Treatment (m)
100–115	£45	£50
150	£60	£68
170–200	£76	£85

Source: Mayor of London.[2]

To put these costs into perspective, figures from the US Energy Information Administration for its 2016 Annual Energy Outlook show that the cost of a new modern coal-fired power plant in 2015 was $4649/kW, and for a new nuclear plant, it was $5288/kW. From the same source, the cost of a new onshore wind farm was $1536/kW, and for a solar photovoltaic power plant, it was $2362/KW. Clearly, a waste-to-energy combustion plant would not be an economical choice if the sole aim was to produce electricity as cheaply as possible.

LEVELIZED COST OF ELECTRICITY FROM WASTE-TO-ENERGY PLANTS

The cost of electricity from a power plant of any type depends on a range of factors. First, there is the cost of building the power station and buying all the components needed for its construction. In addition, most large power projects today are financed using loans so there will also be a cost associated with paying back the loan, with interest. Then, there is the cost of operating and maintaining the plant over its lifetime, including fuel costs if the plant burns a fuel. (In the case of the waste-to-energy plant, this is an income rather than a cost.) Finally, the overall cost equation should include the cost of decommissioning the power station once it is removed from service.

It would be possible to add up all these cost elements to provide a total cost of building and running the power station over its lifetime, including the cost of decommissioning, and then dividing this total by the total number of units of electricity that the power station actually produced over its lifetime. The result would be the real lifetime cost of electricity from the plant. Unfortunately, such calculation could only be completed once the power station was no longer in service. From a practical point of view, this would not be of much use. The point in

[2]Costs of incineration and nonincineration energy-from-waste technologies, The Mayor of London, 2008.

time at which the cost-of-electricity calculation of this type is most needed is before the power station is built. This is when a decision is made to build a particular type of power plant based normally on the technology that will offer the least cost electricity over its lifetime.

In order to get around this problem, economists have devised a model that provides an estimate of the lifetime cost of electricity before the station is built. Of course, since the plant does not yet exist, the model requires that a large number of assumptions be made. In order to make this model as useful as possible, all future costs are also converted to the equivalent cost today by using a parameter known as the discount rate. The discount rate is almost the same as the interest rate and relates to the way in which the value of one unit of currency falls (most usually, but it could rise) in the future. This allows, for example, the cost of replacement of a plant component 20 years into the future to be converted into an equivalent cost today. The discount rate can also be applied the cost of electricity from the power plant in 20-year time.

The economic model is called the levelized cost of electricity (LCOE) model. It contains a lot of assumptions and flaws but it is the most commonly used method available for estimating the cost of electricity from a new power plant. One particular problem is that the model does not take into account cost risks. For example, the cost of natural gas can fluctuate widely so that it may be cheap to buy gas when a plant is built, but 5 years later the cost is so high that operation of the plant is uneconomical. The level at which the discount rate is set can also be problematical. It is typical to use a discount rate of 5% and 10% in calculations. However, in the middle of the second decade of the 21st century, the actual interest rate is close to zero.

The LCOE model can be applied to any type of power station, including a waste-to-energy plant. Table 9.3 shows figures for the

Table 9.3 Levelized Cost of Electricity from Waste-to-Energy Plants

Technology	US Levelized Cost ($/MW h)
Waste-to-energy combustion plant	80–210
Landfill gas	45–95
Source: World Energy Council/Bloomberg.[3]	

[3]World Energy Perspective: Cost of Energy Technologies, World Energy Council/Bloomberg New Energy Finance, 2013.

LCOE for two types of waste-to-energy plant. The estimated cost for electricity from MSW combustion, waste-to-energy plant in the USA is \$80–210/MW h, while for a landfill gas installation in the USA, the LCOE is \$45–95/MW h. The estimates for similar plants in Western Europe are the same. Landfill gas installations in China can produce electricity for \$34–83/MW h, slightly lower than in the USA or Europe.

Another estimate of the costs in the USA put the cost of energy from a landfill gas installation in 2007 at around \$82–99/MW h, while for anaerobic digestion, the cost of electricity was \$62–128/MW h.[4] Landfill gas is usually a cost-effective way of generating power because the fuel is free. Anaerobic digestion of waste is relatively more expensive but can still provide cost-effective power when supplying energy directly to end users where the competition is with the retail cost of the same electricity from the grid. Anaerobic digestion plants and landfill gas plants are normally small-scale installations that operate in this way.

[4]Arizona Renewable Energy Assessment, Arizona Public Service Company, Salt River Project, Tucson Electric Power Corp, prepared by Black and Veatch Corp, 2007.