WHAT IS WASTE-TO-ENERGY?

Waste-to-Energy (WtE), also known as energy-from-waste, is a complicated technology in the realm of renewable energy. The waste that is neither recycled nor used is converted to energy in the form of heat, steam or electricity. The electricity generated is fed into the grid and distributed to the households, industries, communities, etc. Hence, WtE provides a cost effective and hygienic alternative to treat residual waste, reducing its volume by 90% [1]. WtE is an integral part to reach 100% RE in future along with other renewable sources.

A CLOSER LOOK AT WtE

There are a lot of hidden truths and myths about this technology that people need to be aware of. WtE turns the non-recyclable waste to useful energy and raw materials in a sustainable manner. WtE projects can actually provide baseload power that is used to serve consumers and the grid.

Waste management includes collection, transportation, and treatment of all types of waste (i.e. solid, liquid, gaseous, industrial, household, and biological). Waste collected is transported to the plant facility after waste segregation. Segregation of waste helps to apply different processes to the waste like composting, recycling, and incineration. These processes then generate electricity, heat, and steam.

Figure 1: Process of Waste Management [3]

THE FIVE WtE TECHNOLOGIES AT MUNICIPAL SCALE

1. Incineration

Controlled process that reduces commercial/untreated domestic waste volume and mass by 90% and 75% respectively. This process makes waste chemically inert through a combustion process that releases energy in the form of heat [4].

2. Co-processing

Energy recovery and material recycling from waste derived from industrial and commercial processes. This occurs mainly from cement industry and thermal plants. The waste is converted to refuse derived fuels (RDF) through various pre-treatment processes. This process helps to prevent hazardous emissions (CO, CO$_2$, NO$_x$, SO$_2$, HCl, HF) into the environment [4].

3. Anaerobic digestion (AD)

Decomposition of biodegradable organic waste produces a gas with a high methane content which is 25 times more potent than CO$_2$ on climate change [1]. This technology reduces methane emissions by converting the biogas generated to electric/thermal energy. AD technology has received wide-spread acceptance, especially in urban areas.
A modern, large plant treating half-million tons of municipal solid wastes per year can generate more than 400 million kWh of energy per year, meeting the electricity needs of more than 150,000 families. [6]

Waste-to-energy projects are extremely complicated and expensive to build. Most of the investor economic interest is driven by financial incentives, renewable identification numbers, tax credits, etc. In addition to other economic streams, waste-to-energy projects usually require high tipping fees. A tipping fee is what the trash hauler has to pay in order to dump the trash at the facility. With WtE projects, the tipping fee can end up being 50-60% of the overall revenue stack.

A WtE plant of capacity 40,000 tons per annum (tpa) costs about $41 million, or $1,026 per ton of annual capacity. Medium-sized WtE plant with 250,000 tpa costs about $169 million, or $680 per ton of annual capacity [8].

<table>
<thead>
<tr>
<th>WtE Technology</th>
<th>Incineration</th>
<th>Co-processing plant</th>
<th>Anaerobic digestion plant</th>
<th>Landfill gas capture collection</th>
<th>Pyrolysis/gasification plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>150'000 t/a</td>
<td>50,000 t/a, 20y operation</td>
<td>50,000 - 150,000 t/a, 20y operation</td>
<td>390,000 - 850,000 t/a, 21y operation</td>
<td>250,000 t/a, 20y operation</td>
</tr>
<tr>
<td>Initial Investment</td>
<td>25 - 64 million $</td>
<td>4 – 21 million $ including preprocessing</td>
<td>10 – 17 million $</td>
<td>5 million $(CDM-Brazil)</td>
<td>4.5 million $(CDM-China)</td>
</tr>
<tr>
<td>Capital costs per ton of waste input</td>
<td>18-46 $/t</td>
<td>8 – 21 $/t</td>
<td>10 – 16 $/t</td>
<td>0.7 $/t</td>
<td>1.2 $/t</td>
</tr>
<tr>
<td>O&amp;M costs per ton</td>
<td>17 - 30 $/t</td>
<td>8 – 17 $/t</td>
<td>8 – 13 $/t</td>
<td>0.7 $/t</td>
<td>0.25 $/t</td>
</tr>
<tr>
<td>Total cost per ton</td>
<td>35 - 76 $/t</td>
<td>17 – 38 $/t</td>
<td>18 - 29 $/t</td>
<td>1.3 $/t</td>
<td>1.4 $/t</td>
</tr>
<tr>
<td>Revenues from energy sales per ton</td>
<td>1.7 - 8.5 $/t (electricity)</td>
<td>0.8 – 4 $/t</td>
<td>6 – 13 $/t</td>
<td>2 $/t</td>
<td>2.8 $/t</td>
</tr>
<tr>
<td>Cost to be covered per ton waste input</td>
<td>34 - 15 $/t</td>
<td>16 – 34 $/t</td>
<td>12 – 15 $/t</td>
<td>0.7 $/t</td>
<td>1.4 $/t</td>
</tr>
</tbody>
</table>

**Table 1: Approximate Cost Estimates of Five WtE Technologies in Developing Countries [4].**


**REFERENCES**