

## WASTE-TO-ENERGY

### 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.

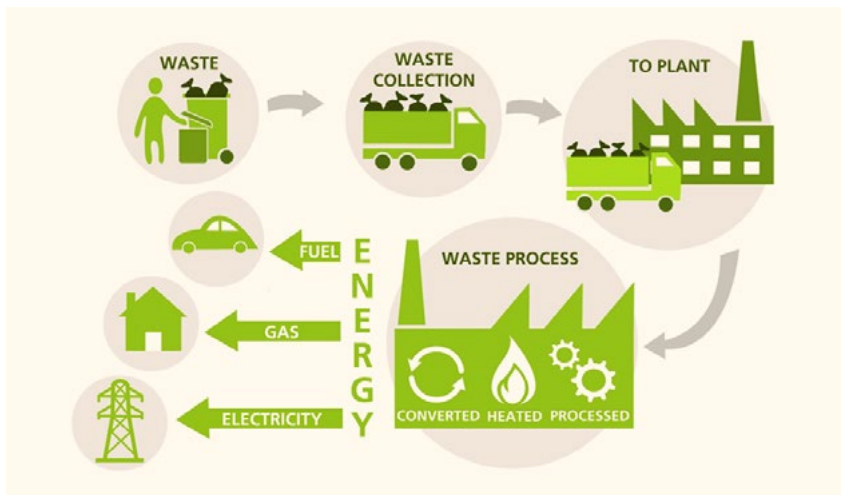


Figure 1: Process of Waste Management [3]

### KEY FACTS



The world generates approximately over 2 billion tons of solid waste per year with at least **67% WASTE** that can be treated in an **environmentally safe manner** [2].

For every one ton of waste diverted from a landfill to Waste-to-Energy, an average of **ONE TON OF GREENHOUSE GASES** can be avoided [9].



**WtE PLANTS PRODUCE ZERO WASTE** by reducing 90% of the Municipal Solid Waste (MSW) and yielding ash as a by-product, which if reused claims 100% recovery from waste [10].

In the USA, on average, the WtE plants produce about **14 MILLION MWh OF ELECTRICITY** per year [12].



In Sweden, **49% OF HOUSEHOLD WASTE IS RECYCLED** and about 50% of the residue is incinerated in WtE plants [11].



### 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<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, 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<sub>2</sub> 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.

## THE FIVE WtE TECHNOLOGIES AT MUNICIPAL SCALE

### 4. Landfill Gas Capture

Landfill gas (LFG) contains 45-55% of methane, which is used for electricity generation. Sanitary landfill operation will essentially mitigate negative environmental impacts by capturing methane gas. However, this process is not considered to be an effective WtE technology due to its disadvantages, such as air pollution, groundwater contamination, and foul odor [5].

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]

### 5. Alternative technologies

Compared to incineration, pyrolysis is an alternative solution referred to as non-pollutant technology. This process reduces the waste volume and mass by enabling energy recovery and recycling of chemical/material content. The recycled products like oil, coke, and syngas are either converted to biodiesel or used as raw materials in power plants. This process is a viable option for a highly organized waste system [4].

## FINANCIAL FACTS

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].

WtE Technology	Incineration	Co-processing plant	Anaerobic digestion plant	Landfill gas capture collection		Pyrolysis / gasification plant
Capacity	150'000 t/a	50,000 t/a, 20y operation	50,000 - 150,000 t/a, 20y operation	390,000 - 850,000 t/a, 21y operation		250,000 t/a, 20y operation
Initial Investment	25 - 64 million \$	4 - 21 million \$ including preprocessing	10 - 17 million \$	5 million \$ (CDM-Brazil)	4.5 million \$ (CDM-China)	68 - 101 million \$
Capital costs per ton of waste input	18-46 \$/t	8 - 21 \$/t	10 - 16 \$/t	0.7 \$/t	1,2 \$/t	25 - 32 \$/t
O&M costs per ton	17 - 30 \$/t	8 - 17 \$/t	8 - 13 \$/t	0.7 \$/t	0.25 \$/t	25 - 34 \$/t
Total cost per ton	35 - 76 \$/t	17 - 38 \$/t	18 - 29 \$/t	1.3 \$/t	1.4 \$/t	55 - 72 \$/t
Revenues from energy sales per ton	1.7 - 8.5 \$/t (electricity)	0.8 - 4 \$/t	6 - 13 \$/t	2 \$/t	2.8 \$/t	1.5 - 4 \$/t
Cost to be covered per ton waste input	34 - 15 \$/t	16 - 34 \$/t	12 - 15 \$/t	0.7 \$/t	1.4 \$/t	53 - 68 \$/t

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

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Supported by:



based on a decision of the German Bundestag

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