

WASTE MANAGEMENT

Incineration and Landfill

Dr. Paolo La Rosa & Ing. Roberto Ingraldi

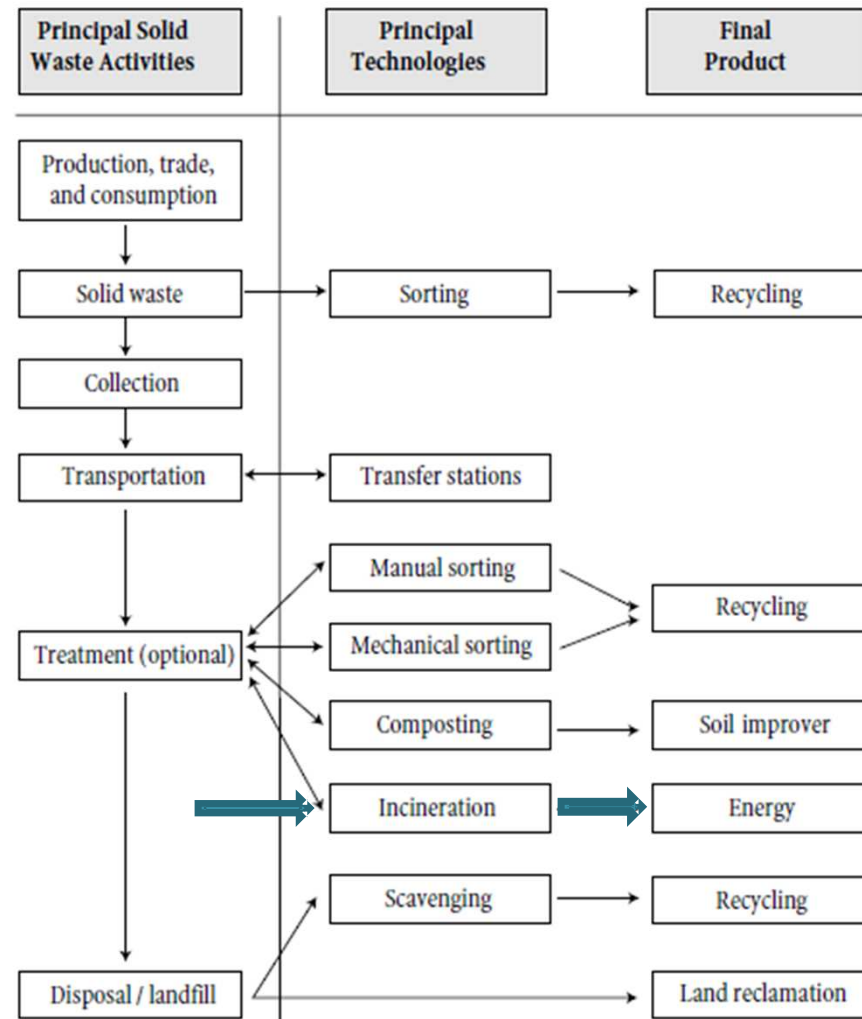
X-Geo Switzerland GmbH



The Flow and Management of Solid Waste

Solid waste arises from human activities, domestic, commercial, industrial, agricultural, waste water treatment, and so on.

Waste treatment involving mechanical plants requires large investments and operating costs. Hence, it should be only introduced after gaining profound **knowledge of the existing system and waste generation** which is quite a challenge, except in a highly organized waste management system.



The Flow and Management of Solid Waste

Incineration is found at the most advanced level of the **waste disposal/treatment**: indiscriminate dumping, controlled dumping, landfilling, sanitary landfilling, and mechanical treatment.

Incineration does **not completely eliminate**, but does significantly reduce, the volume of waste to be landfilled, but it reduce it significantly.

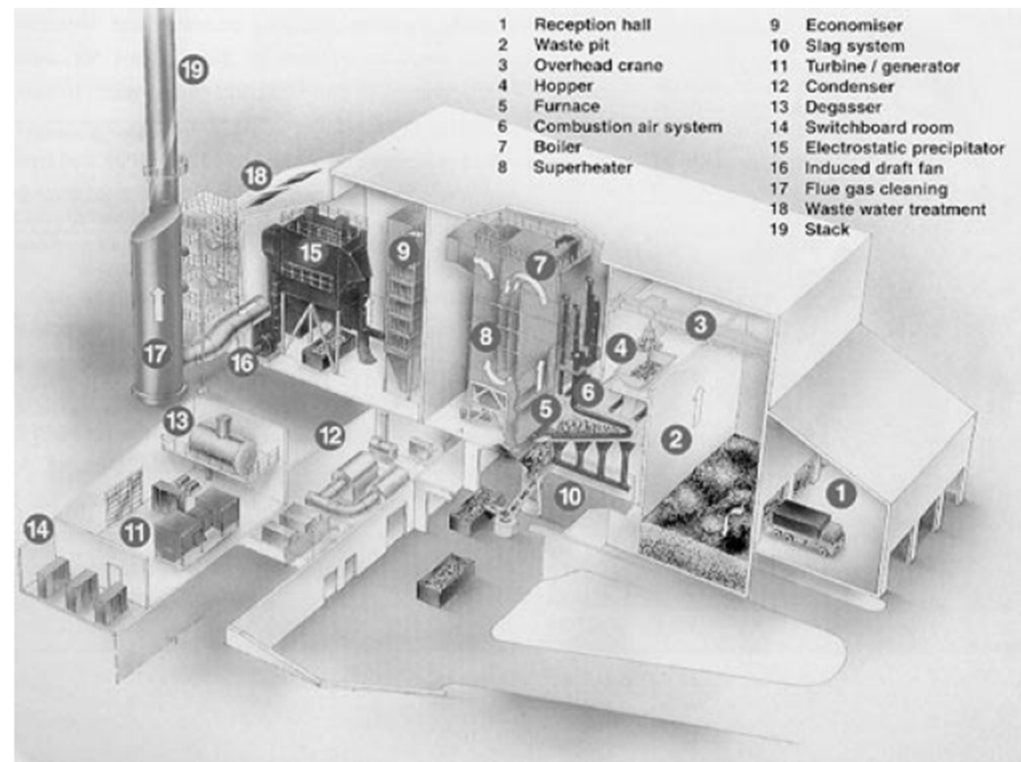
The reductions are approximately 75 percent by weight and 90 percent by volume.



The Flow and Management of Solid Waste

Several types of incineration technologies are available today, and the most widely used is mass “burning incineration”.

Mass burning technologies are generally applied for large-scale incineration of mixed or source-separated municipal and industrial waste.



The Flow and Management of Solid Waste

KEY ISSUES

The successful outcome of a waste incineration project first depends on fairly accurate data on the future **waste quantities and characteristics** that form the basis for the design of the incineration plant.

Waste for incineration must meet certain basic requirements. In particular, the energy content of the waste, the so-called **lower calorific value (LCV)** must be above a minimum level.

The specific composition of the waste is also important. Some types of waste, such as demolition waste and waste containing certain hazardous or explosive compounds, are not suitable for incineration.



The Flow and Management of Solid Waste

KEY CRITERIA

The average lower calorific value of the waste **must be at least 6 MJ/kg** throughout all seasons. The annual average lower calorific value must not be less than 7 MJ/kg.

The annual amount of waste for incineration should **not be less than 50,000 metric tons** and the weekly variations in the waste supply to the plant should not exceed 20%.



Waste Forecasts & Survey

To be economically feasible, waste incineration plants must have a life span of **at least 15 to 20 years**. Waste quantity and composition should be forecast over the lifetime of the incineration plant. If reliable waste data and record keeping systems are not available, a **waste survey** should be used to generate statistically significant results.

The survey must consider **a large number of parameters** selected according to the objective of the study, for example, waste quantity or composition.

Sampling Weighing	The collection vehicle from the representative collection district is intercepted according to the plan. The vehicle is weighed full and later empty resulting in the total weight. The waste volume is determined/ estimated and the average density calculated.
Subsampling	Sometimes sorting of full truck loads is too time consuming. Preparing a representative subsample (perhaps 100 kg) often makes it possible to sort waste from more trucks and thereby makes the result more significant. However, preparing a representative subsample is not simple, and a detailed procedure for this routine must be prepared – for example, accounting for drained-off water.
Sorting	The waste is unloaded on the floor of the sorting building. It is then spread in layers about 0.1 meter thick on sorting tables covered by plastic sheets. The waste is manually sorted according to the predetermined material categories. The leftover on the table is screened (with a mesh size of about 12 mm). The screen residues are again sorted manually, and the rest is categorized as “fines.” This procedure is followed until the entire load or subsample – including floor sweepings – has been divided into the appropriate fractions.
Physical Analysis	All fractions are weighed and the moisture content determined through drying after shredding at 105° C until a constant weight is obtained (about 2 hours). The moisture content is determined on representative samples of all fractions on the day of collection.
Chemical Analysis	The chemical analysis should be performed at a certified laboratory. The key parameters are ash content and combustible matter (loss of ignition at 550° C for the dried samples) and Net Calorific Value for at least the food and the fines fractions. Samples must be homogenized through proper repetitive mixing and grinding, and at least three analyses should be performed on each fraction to minimize analytical errors.
Data Processing	The wet and dry weight waste composition are calculated together with the interval of confidence.

Waste Forecasts & Survey

Sorting categories should be based on the amount of the characteristic categories and their influence on the calorific value.

<i>Component</i>		<i>H_{awf}</i> <i>(MJ/kg)</i>
<i>Main category</i> <i>(mandatory)</i>	<i>Subcategories</i> <i>(optional)</i>	
Food scraps and vegetables (to be analyzed in each case)		15–20
Plastics	Polyethylene (bottles, foil, etc.)	45
	PVC (bottles, etc.)	15–25
	Polystyrene (wrapping)	40
	Polypropylene	45
Textiles		19
Rubber and leather		20–25
Paper	Dry	16–19
	Wet	16–19
Cardboard	Dry	16–19
	Wet	16–19
Wood and straw		19
Other combustible		*
Metals		0
Glass		0
Bones		0
Other non combustible		0
Hazardous wastes		*
Fines (<12 mm mesh)		15

(to be analyzed in each case)

Note: * = Depends on chemical makeup of material.

Incineration Plant Economics and Finance

The **investment** cost for a waste incineration plant depends **on a wide range of factors:**

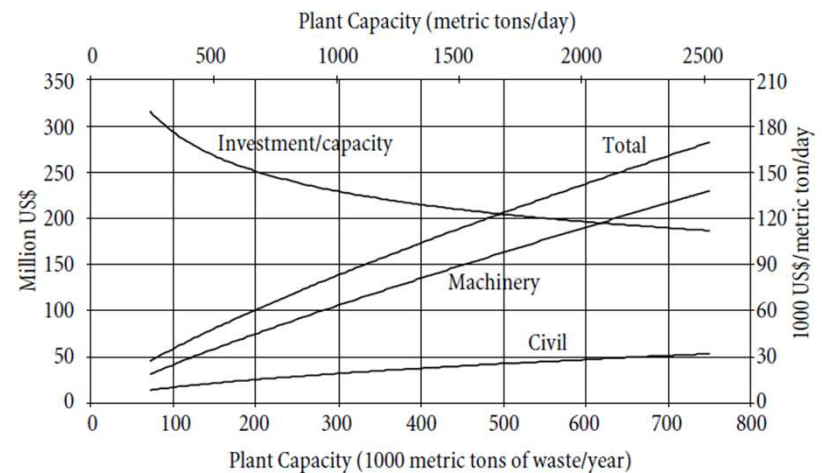
- ❑ size capacity of the plant
- ❑ the number of metric tons per year or day
- ❑ the corresponding lower calorific value of the waste

Low-capacity plants are relatively more expensive than high-capacity plants in terms of investment cost per metric ton of capacity.

The investment **costs as a function of the annual (and daily) capacity** for a typical new waste incineration plant are estimated in Figure.

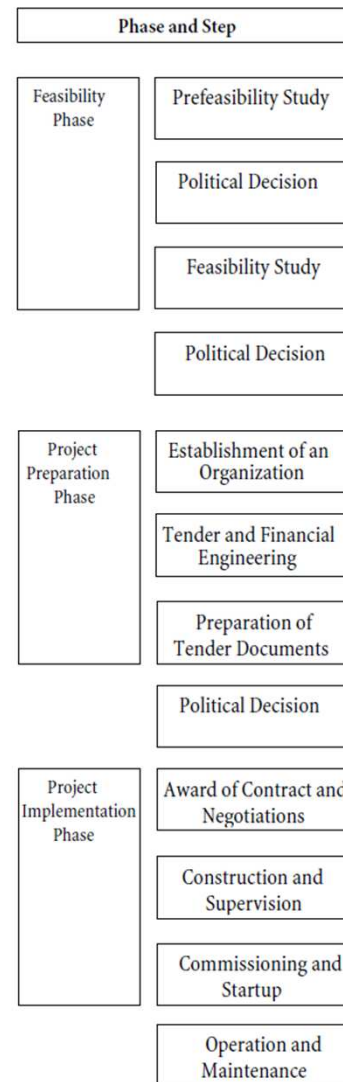
A lower calorific value of the waste of 6 MJ/kg is assumed as the design basis. A higher calorific value will increase the actual investment costs and vice versa.

A main benefit of solid waste incineration is the possibility of reusing the waste as fuel for energy production



The Project Cycle

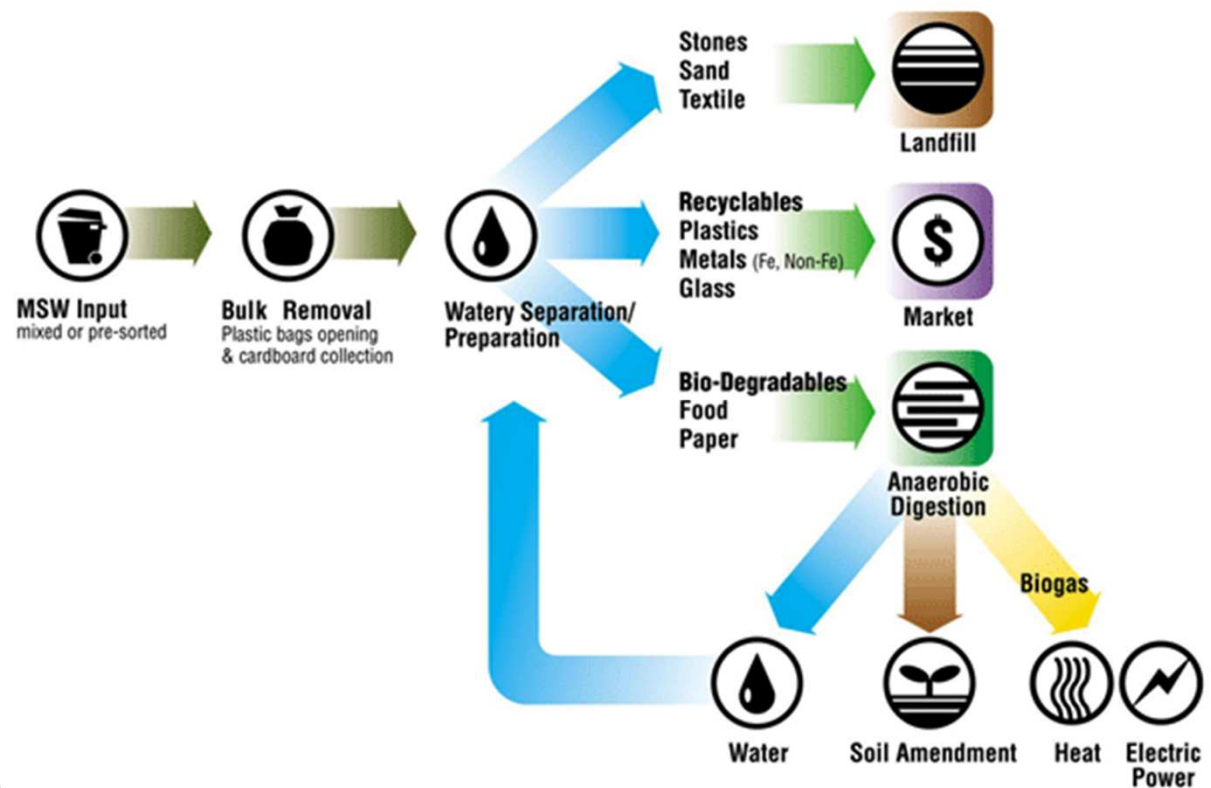
Implementation Plan for
Constructing a Waste Incineration
Plant



Incineration Technology

The heart of an incineration plant is **the combustion system** which can be divided in two broad categories:

- ❑ mass burning of “as-received”, and inhomogeneous waste,
- ❑ burning of pretreated and homogenized waste.

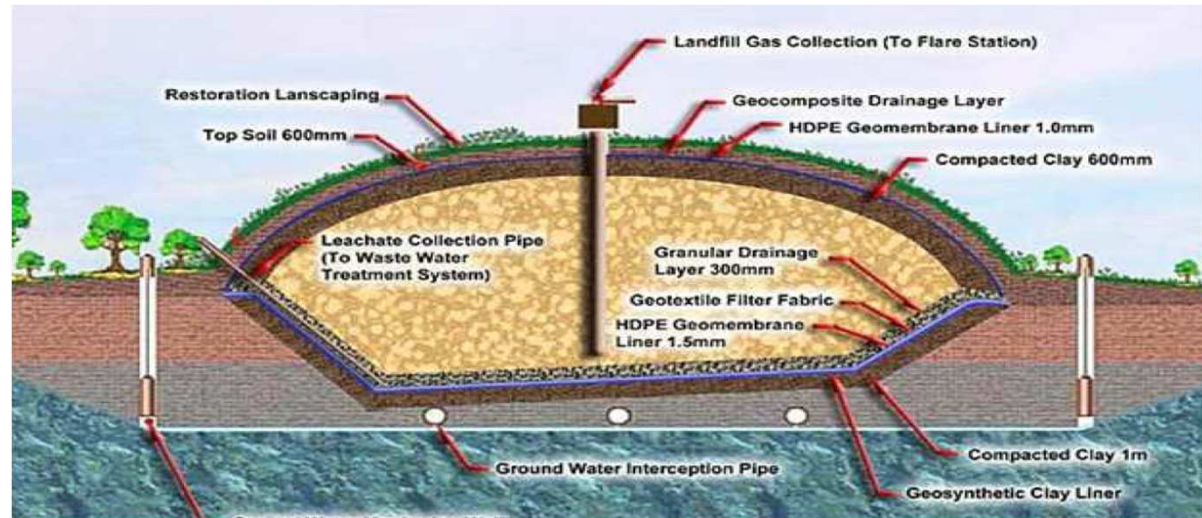


Incineration Residues

During the **incineration process**, most of the waste is combusted and converted to harmless gases such as carbon dioxide (CO₂) and water vapor (H₂O). These gases are discharged as a flue gas into the atmosphere through the stack of the plant.

However, part of the waste is incombustible and is removed from the incineration furnace as **slag, and a solid residue**. The flue gas cleaning processes also produce residues.

Depending on the local circumstances, some of the slag may be used or recycled, but the flue gas treatment residues are normally useless and must be **landfilled**.



Incineration Residues

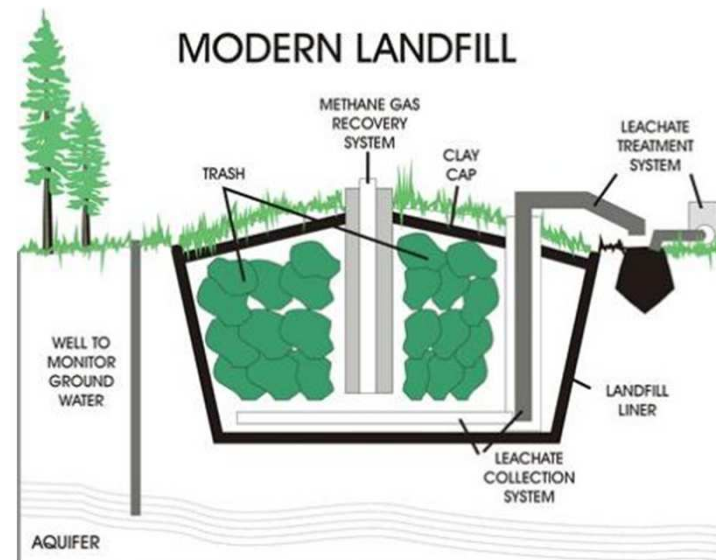
A controlled and well-operated landfill **must be available** for residue disposal. The landfill must be large enough to receive the entire quantity of solid residual products generated at the incineration plant.

The landfill must be located, designed, and operated in such a way **as to prevent water pollution resulting from the leachate from the residues.**

Scrap iron may be **recovered for recycling** by magnetic separation of the slag.

By **sorting or sieving the slag**, a “synthetic gravel” fraction may be recovered for utilization.

The **dry residues** should be prevented from generating dust at the **landfill site.**



Incineration efficiency

The “**energy efficiency** of an incinerator is variable between **19 and 27%** if you retrieve only the electrical energy” but increases greatly with heat recovery (cogeneration).

For example, in the case of the incinerator **in Brescia “200.000 People”, IT:**

- ❑ **yield of 26% in electricity production**
- ❑ **58% into heat for district heating,**
- ❑ **with an index of fuel use by 84%**

Typically, for every ton of treated waste can be produced about 0.67 MWh of electricity and 2 MWh of heat for district heating