Systems Engineering in Environmental and Energie Systems HSLU, Semester 1

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Part I

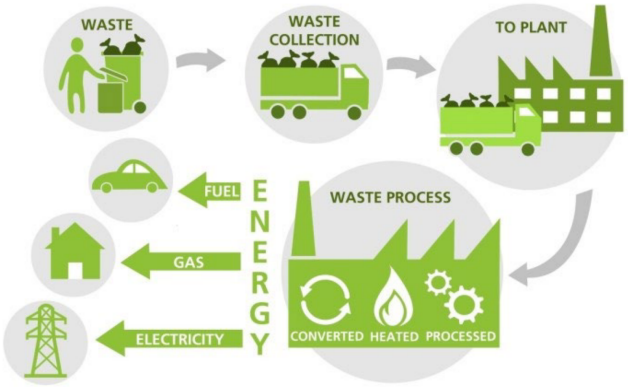
Week 1

1 Waste to energy (WtE)

Waste to energy refers to a variety of treatment technologies that convert waste to electricity, heat, fuel or other usable materials, as well as a range of residues.

WtE can occur through a number of processes such as:

- incineration;
- gasification;
- pyrolysis;
- anaerobic digestion;
- landfill gas recovery.



1.1 Incineration plants

Thermal waste to energy, also known as incineration with energy recovery, is a major waste treatment method and the most widely adopted technology that dominates the global WtE market.

An incineration plant is a waste management facility designed to burn solid waste at high temperatures, converting in into ash, gases and heat.

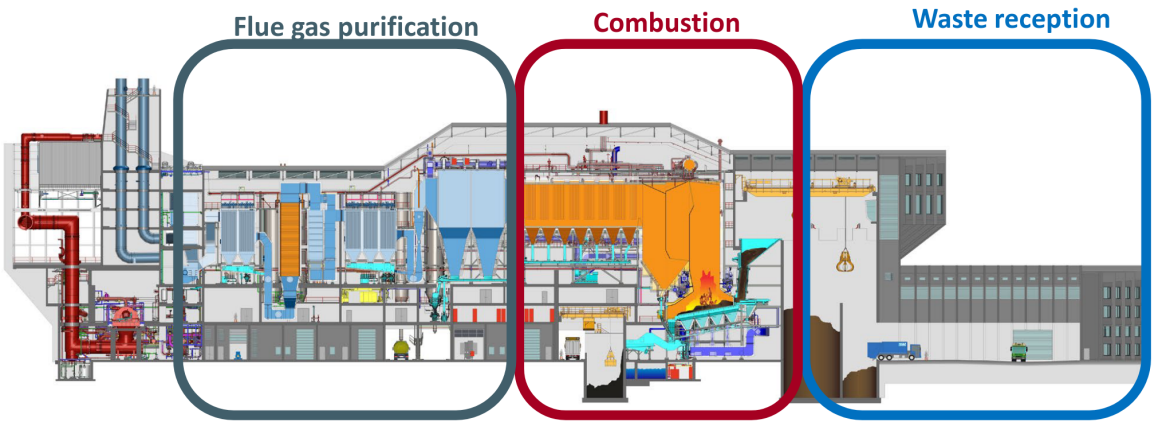
Incineration plays a crucial role in modern waste management strategies, contibuting to environmental protection and resource recovery.

- Volume reduction of waste (90%);
- Energy production: waste has the same energy value as wood chips or lignite;
- Reduction of contaminant spectrum: bacteria, viruses and problematic organic compounds are destroyed at or over 1'000 °C;
- Low pollutant emissions (modern incineration plants);
- Avoidance of methane emissions that results from direct deposition of organic waste in landfills;
- Chemical stability of residues/slag (compared to biological processes);
- Possibility of recovering metals from slag (80kg of iron, 20kg of aluminium and 2kg of copper are recovered per each tonne of slag).

1.1.1 4-key Components of an incineration plant

1. Waste handling system: responsible for loading, sorting and feeding waste into the combustion chamber;
2. Combustion chamber: primary unit where waste is incinerated at temperature between 800 and 1'200 °C;
3. Air pollution control system: filters and scrubbers to minimize harmful emissions and comply with environmental regulations;
4. Energy recovery system: utilizes the generated heat to produce electricity or heat for district heating.

1.1.2 Incineration plant scheme



1.2 Types of wastes that can be converted into energy

1.2.1 Municipal Solid Waste (MSW)

Municipal wastes can be converted into energy by thermochemical or biological technologies.

At the landfill sites, gasses produced by the natural decomposition of MSW can be collected, scrubbed and cleaned before feeding into internal combustion engines or gas turbines to generate heat and power.

The organic fraction of MSW can be biochemically stabilizen in an anaerobic digester to obtain biogas (for heating and power) as well as fertilizer.

1.2.2 Wood Wastes

Wood processing industries primarly include sawmilling, plywood, wood panel, furniture, building component, flooring, particle board, moulding, jointing and craft industries.

Wood wastes generally are concentrated at processing factories (e.g. plywood mills and sawmills). In general, processing 1'000kg of wood in the furniture industries, will lead to waste generation of 45%.

1.3 Current status of waste to energy

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1.3.1 Waste production per person in CH

In Switzerland, people produce 700kg of waste per person per year.

1.4 Waste hierarchy

The hierarchy helps us rethink our relationship with waste based on five priorities ranked in terms of what is best for the environment:

1. Produc prevention;
2. Preparing for re-use;
3. Recycle;
4. Recovery;
5. Waste disposal.

1.5 Advantages and disadvantages of the Swiss system

1.5.1 Advantages

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1.5.2 Disadvantages

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2 System thinking

2.1 Benefits

Rigorous way of integrating: people, purposes, process and performance and:

- ...

2.2 Feedback loops

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3 Case study part 1

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Part II

Week 2

4 Situation analysis and system thinking