SET FI THE W

Diana Baganz, Doosan Lentjes GmbH, Germany, explains how waste-to-energy can be part of a sustainable global waste management solution.

Driven by dynamic economic and population growth, global waste generation is expected to increase by 60% by 2050. In 2016, waste generation in East Asia and the Pacific amounted to approximately 468 million t, but forecasts show that it will increase to 714 million t by 2050. The picture is similar in South Asia, where forecasts predict that the amount of waste produced will increase by half by 2050, compared to 2016. In Europe and Central Asia, waste generation was 392 million t in 2016, while it is expected to increase by 25% by 2050.

Sustainable disposal method for non-recyclable waste

Thermal waste treatment is the only proven large scale method to treat non-recyclable municipal waste in a safe and environmentally friendly way. According to the European waste hierarchy, it is part of a sustainable waste management concept that gives priority to thermal treatment over simple landfilling. By treating residual waste, waste-to-energy (WtE) plants make an important contribution to human health and efforts to reduce humanity's ecological footprint.


RE TO
VASTE

Figure 1. Two-track water-cooled counter-reciprocating grate applied at the 280 000 tpy waste-to-energy (WtE) plant in Harlingen, the Netherlands.

Figure 2. Visualisation of the new WtE plant in Olsztyn, Poland, which will thermally treat 110 000 tpy of refuse-derived fuel from the region when completed.

Since only waste that is at the end of its recyclability or of contaminated nature is fed into the WtE process, it helps to rid the circular economy of hazardous or unusable materials. At the same time, thermal treatment ensures that the residual waste does not end up in landfills. This has a positive impact on the environment, as landfilling produces toxic methane gases (greenhouse gases) that are 86 times more harmful than CO_2 over a 20-year period.

Recovery of valuable energy and materials

During incineration, the energy contained in the waste is harnessed to generate electricity and heat. Since more than half of the energy contained is of biogenic origin, it is biomass – the use of which helps to achieve renewable energy targets. Using the energy also saves CO_2 emissions that would otherwise be produced by burning climate-damaging fossil fuels. The recovered energy can be used for domestic, industrial, or business applications.

In addition, the bottom ash produced during incineration is increasingly fed into recycling processes, e.g. used as road construction materials or as additives for cement raw materials and in concrete production. Valuable metals can also be recovered from the bottom ash. The possibilities for recovering energy and materials make it possible to exploit fewer primary raw materials and virgin fuels.

Emissions in accordance with regulations

With maximum resource efficiency, WtE plants produce low emissions that are in line with the legally required levels according to the EU's revised Waste Incineration Best Available Techniques Reference (WI BREF) documents. In the process, official institutions monitor the type of pollutants emitted, the emission limits, and the operating conditions in real-time.

How does the waste-to-energy process work?

A modern waste incineration plant consists of a reception and storage area, the combustion chamber with boiler, flue gas cleaning, and water-steam-cycle (WSC). The waste is collected in the tipping bunker and mixed by cranes to ensure uniform calorific values and waste properties. The waste is fed from the cranes into the chutes through which it enters the heart of the WtE plant, which is the thermal treatment. Grate incineration is actually the world's most commonly used large scale thermal waste treatment technology, successfully deployed in hundreds of plants around the world. This is due to the high flexibility of the grate technology, which can be adapted to changing waste characteristics over the lifetime of the WtE plant. European plant manufacturers such as Doosan Lentjes, an environmental technology company located in Ratingen, Germany, have extensive experience with this technology and have supplied a large number of the WtE plants operating worldwide.

On the grate, the waste is incinerated and heats the water in the boiler tubes, which evaporates. The residue from this process, the bottom ash, is collected in a slag bunker for further processing. The steam produced can be extracted for external purposes or is used to drive a steam turbine to generate electricity. A small part of the generated power is used for the self-sufficient operation of the WtE plant, while the larger part is fed into the public grid.

Optimisation of the incineration process plays a key role in keeping primary emissions low. Adapting the combustion concept to the specific fuel properties enables uniform waste distribution, movement across the grate surface, and combustion with high ash burnout. Based on the principle of selective non-catalytic reduction (SNCR), ammonia solution (NH_3) is injected into the combustion chamber to reduce nitrogen oxide (NO_x) emissions.

In a downstream flue gas cleaning system, harmful acid gases such as HCl, SO_2, SO_3, and HF, as well as heavy metals and organic substances such as dioxins and furans are removed. This usually involves dry or wet processes in which additives such as hydrated lime ($Ca(OH)_2$), activated carbon, or sodium bicarbonate are injected into a reactor, which react chemically with the components in the flue gases and neutralise them. After the chemical cleaning process in the reactor, the solid particles are separated in a downstream bag filter. A large amount of the separated particles is fed back into the reactor which improves the consumption efficiency of the utilised reagents. In case of more stringent limit values to be complied with, the flue gases can be denitrified in a selective catalytic reduction (SCR).

Drivers for establishing thermal waste treatment

Drivers for the establishment of thermal waste utilisation as a disposal method are manifold. First of all, there is a need for a clear legal basis in which the framework conditions are defined. This requires a commitment by political decision-makers and a consistent technology promotion. Economic aspects also play a key role because the costs of thermal waste utilisation are usually significantly higher than the very low costs of simple landfilling. Moreover, the acceptance of the people is essential, without which the realisation of the projects will hardly be possible. Growing environmental awareness, with which simple landfilling is not compatible, as well as lack of space are also important drivers for the establishment of thermal waste treatment.

Thermal treatment plants around the globe

There are now more than 40 countries in which thermal waste treatment is an established disposal method for the climate- and resource-friendly treatment of residual waste. In addition, there are approximately 150 countries in which the technology is not yet used or is only used to a limited extent.

In Western Europe, thermal waste treatment is an established disposal method. A dense network of plants has been established in recent decades, but their advanced age often makes replacement and modernisation investments necessary.

In Eastern and South-Eastern Europe, Poland is the market with the highest potential. Seven new plants have gone into operation there in recent years. Another three are in the construction phase. In Warsaw, the largest WtE plant in the country is currently being built with the participation of Doosan Lentjes as technology provider. Once completed, the facility will process a total of 265 200 tpy of municipal solid waste (MSW) and make a decisive contribution to improving the local disposal infrastructure. With Doosan Lentjes acting as general contractor, another new waste incineration plant is currently being built in Olsztyn, which is scheduled to go into operation in 2023. The new plant will be able to treat up to 110 000 tpy of refuse derived fuels (RDF) from the greater Olsztyn area. The new plant will meet approximately 30% of the district heating demand in the region and will help to compensate for the heat loss that will come with the closure of the local coal-fired Michelin power plant in the near future. This will ensure a continuously reliable and environmentally-sound district heating supply for the local citizens.

Positive developments can be observed in some countries around the world, e.g. Indonesia. There, the Indonesian government is in the process of realising reliable legal framework conditions for waste incineration projects. At present, however, the country's overall economic situation and the inconsistency of the authorities still stand in the way of the actual development of such projects.

In Australia, the attitude towards thermal waste utilisation has changed significantly in recent years. The reasons for this are the Chinese import ban on plastic waste and the significant increase in landfill taxes in some Australian states. The country's first WtE plant is currently being built in Perth and is scheduled to start operation at the end of 2021. Other projects are in various stages of development. It can be assumed that these projects will be concentrated in the metropolitan regions, as there is not enough space to build more landfills there. Australia is thus gradually becoming an attractive market for thermal waste treatment.

Interest in thermal waste treatment is high worldwide. This is encouraging, as this technology is the only proven large scale solution for the environmentally friendly and safe disposal of the world's increasing volumes of non-recyclable waste.

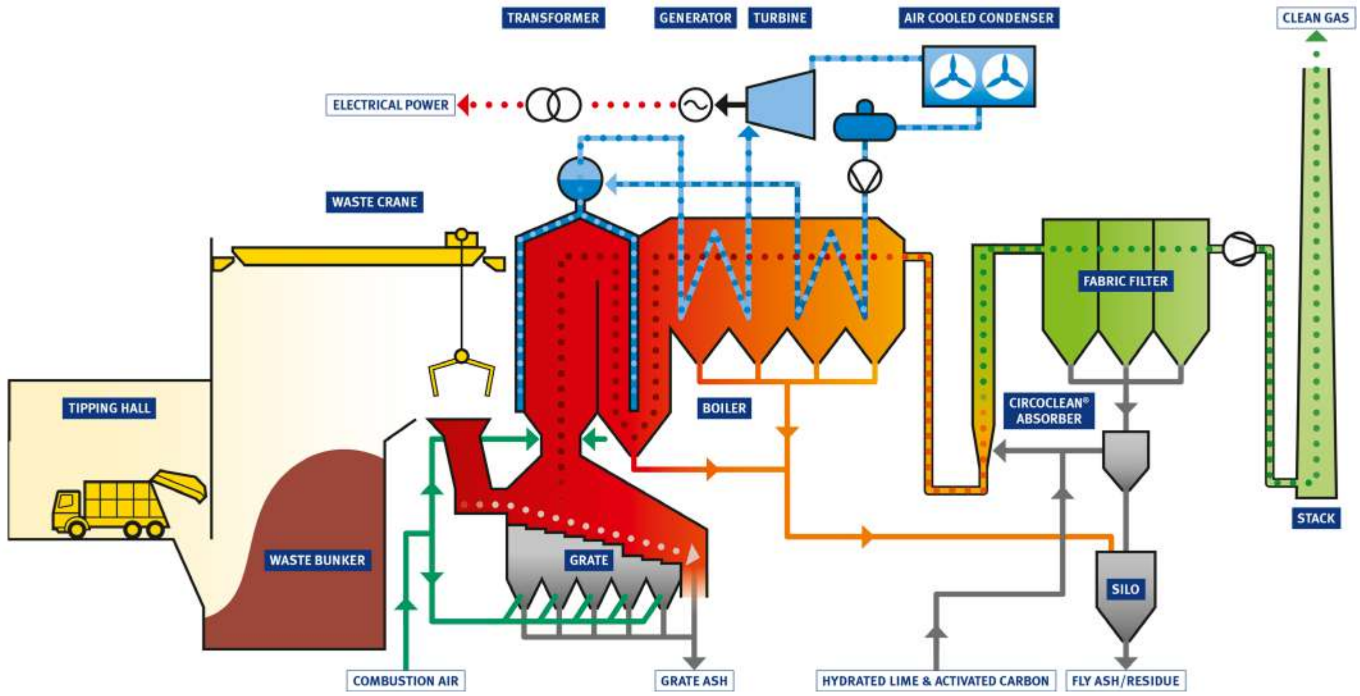

Figure 3. The waste-to-energy process.