Waste Management 4.0 at the North/South/West/East Viewpoint

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1. Introduction and present situation

Last time it seems everybody is speaking about the Industry 4.0. Almost everybody know, what is mean, but really?

What can we expect from Industry 4.0 at the field Waste management or Waste utilization? Are the same situation is for everybody in whole Europe or whole World?

If we concern us on the Europe:

Although production of MSW has decreased in recent years, mixed municipal solid waste (MSW) is the largest group of waste within the group of municipal waste, and with respect to the ban of landfilling in 2024, it will be necessary to use the complete production in a different way.

The situation is different at the so called west and north countries, south countries have also a specific situation.

But almost all of them have major techno-economic and logistical concepts:

- The method of direct energy use (WtE plant – Waste-to-Energy plant)
- Technology of so called small incinerators (20–50 kt)
- Mechanical-biological treatment associated with energy use of calorific fraction
- Gasification technologies (pyrolysis, plasma)
- Exporting MSW for energy recovery abroad (in a lot of countries the current legislation does not allow it).
All the technological concepts of MSW utilization are associated with energy recovery; therefore, dealing with this issue should always be conceived in relation to the real conditions of the state energy sector, or with the possibility of heat recovery.

**What is the new challenge of Waste 4.0?**

- By the year 2024, all MSW, or bulky waste production has to be disposed of in other ways than through landfilling.
- The whole MSW production has to be used at home.
- Solutions must be coordinated between a number of agents (cities and municipalities) and by the selected operator.
- Solutions must be sustainable and acceptable to the population.

All of these can offer big potential for W4.0.

**Utilization of domestic MSW abroad**

One possibility, which is confirmed by the interest of foreign, is exporting MSW for energy recovery abroad. This possibility is based on a certain surplus capacity of incinerators in those countries.

This is also a challenge – you need to arrange the logistic for transport, storage, etc., but this is probably one of the worst scenarios of waste management, because it would not only mean exporting valuable energy resources, but in the long term, there would be an outflow of funds from the population and ultimately the companies producing the concerned waste. Moreover, there is a conflict with the legislation and the principle that everything that is produced as a by-product in this country should be processed here as well.

Waste management has changed considerably over the past years in the whole Europe. Today, it is a complex cycle that requires a high level of organization and administration. What has already become a reality in other industries with industry 4.0 now also helps to efficiently co-operate with all stakeholders (producers, transporters, waste disposal companies, recycling companies, authorities, etc.) in waste management. Waste Management 4.0 optimizes the processes to ensure that they run digitally through powerful digital equipment.

**2. Interesting projects**

In the meantime, garbage trucks are part of everyday life and are nowadays no longer the vehicles, where waste is dumped and transported to the rubbish dump as before. Today, they are computer-controlled high-tech machines that work in an environmentally friendly manner and offer their operators a clean and ergonomic workplace.

A smart waste management solution has already been implemented in Barcelona. Garbage containers automatically send signals that they are over eighty percent full and need to be emptied. Via the mobile network, the signals are transmitted to a
web-based software application, which is used by the waste disposal company. Level sensor is based on ultrasonic technology. Waste vehicles only drive the containers that have to be emptied.

Smart waste management in the Czech Kolin, sixty kilometres east of Prague – the core of the system is a sensor and a special label attached to each refuse bin. A battery-operated device in the lid of the waste container measures the filling level by ultrasound and sends it automatically to the control centre. A label with integrated NFC chip and printed QR code – an intelligent product from smart-TEC – also sticks to the refuse bin. Employees of the city and the garbage collectors can thus record the filling level and the location of the waste containers with their smartphone and forward them to the central office.

In Boston, the Big Belly Solar was developed and exported from there worldwide. The solar-powered garbage compacting system is a world novelty. It presses with a compression of 1:7 and has a pressing force of 780 kg. The capacity is 700 litres. A radio connection permanently informs about the filling level of the container so that the emptying takes place at the right moment.

In Sweden, the system of waste disposal via vacuum systems has been known since the early 1960s and has been established to this day. A Swedish manufacturer therefore offers high-tech versions of the waste pipe mail: With the help of vacuum, the waste passes through a pipe system at a speed of 60 to 70 km/h to a collecting point at the edge of the block of houses picked up. The steel tubes have a diameter of 50 centimetres. The distance between the longest entry point and the end station may be up to two kilometres. The waste tunnels save the residents from the noise of garbage vehicles circulating in the district and smells. More than six hundred refuse collection systems are currently active in thirty countries.

Also the waste separation in sorting factories is economically and ecologically sensible. Test runs show that machine waste can now be separated better and cheaper than humans. There are a variety of different sensors used for the identification and sorting of waste.

3. Outlook and summary

The objective of the digitalized circulation system 4.0 is to link all areas – from the extraction of raw materials through production to recycling – via computer simulations and optimization models, while at the same time optimizing them in a material and energy-efficient manner. In addition to the efficient use of primary raw materials during production, the reuse of substances as well as the material and energetic utilization of waste form the decisive basis for a flourishing recycling industry.

Today, 3.5 million tonnes of waste are lost every day. By the year 2025, this volume will increase further to 6 million tonnes despite the complex recycling processes and up to the year 2100, even more than 11 million tonnes of waste per day will be handled in the solids sector alone.
With the help of digitalization and the life-cycle orientation in the complete recycling of materials, the cycle management creates a basis for the material-efficient and therefore cost-effective production as well as a consistent resource saving throughout the entire value chain. In addition to the associated cost reduction, the emission of climate-damaging substances (such as CO₂) in production is reduced, thus contributing to achieving the targets of global climate protection [1].

It should be borne in mind that in many countries waste is collected in unsuitable conditions, it has a high proportion of biological waste and can not yet be considered for the W4.0.

The digitalization of processes can bring many advantages to the company concerned. Which are the details, depends strongly on the goals of the company and its products. The opportunities and risks must be thoroughly analysed.

4. Sources

This book carries forward the survey of waste-to-energy plants in the Federal Republic of Germany which started in the 1990’s. This edition comprises:

- 52 plants that treat municipal solid waste.
- 1 plant that treats hazardous waste.

The investigation provides extensive information about the installed technology and the environmental impact of the waste-to-energy plants. The quality of the inquiry has been extended in terms of the technical data. Existing gaps regarding the data were partially filled, as a comparison with the survey of 1994 reveals. This is the result from the considerable assistance of numerous plant operators. The publication on hand shall be seen as an interims report. The work on the data acquisition will be continued. For this reason we ask plant operators and manufactures to critically review the release data.

The further investigations will be extended to the missing German waste-to-energy plants as well as to plants in other countries.
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