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Current Developments in European Waste-to-Energy

Ferdinand Kleppmann and Ella Stengler

The Juncker Commission started its work at the end of 2014 by announcing that the Circular Economy package, which was recently published by the previous Commission, would be withdrawn in order to be replaced by a *broader and more ambitious* proposal by the end of 2015.

In parallel, the European Commission is working on the Energy Union Package, a strategy that will be at the core of the institution's work for the next years and in which Waste-to-Energy will play a role.

This article is therefore a timely opportunity to explore which role the Waste-to-Energy (incineration with energy recovery) sector can play in the current and forthcoming proposals from the European Commission concerning energy and waste.

1. The EU Circular Economy Package

Europe's future Circular Economy package should be ambitious in minimising landfilling of recyclable and recoverable waste, in order to maximise the use of waste as a resource. It should take a holistic approach that considers supply of raw materials as well as supply of secure and sustainable energy, which is an important part of the European Energy Union. This approach would be in line with Better Regulation and would benefit the environment, jobs and growth in Europe.

The following topics should be tackled as key priorities for a full Circular Economy:

a) Minimising landfilling of waste and maximising the use of waste as a resource

b) Tackling Quality Recycling – Only a Clean Circular Economy is a good Circular Economy

d) Uniting the Circular Economy and Energy Union goals – taking a holistic approach

1.1. Minimising landfilling and maximising the use of waste as a resource

The new proposal needs to set an ambitious timeline to phase out landfilling of recyclable and recoverable waste. This should cover not only municipal but also other waste. Waste that continues to be allowed for landfilling should have a Total Organic Carbon lower than five percent or ignition below three percent in order to ensure that the waste cannot be used in a more beneficial way.

There can be a step-by-step approach with interim targets, considering the different levels achieved by the Member States (Figure 1). However, it should be considered that already the current Waste Framework Directive requires separate collection of at least paper, metals, plastics and glass from 2015. It would be difficult to understand why these waste streams should be allowed for landfills once they have been collected separately.

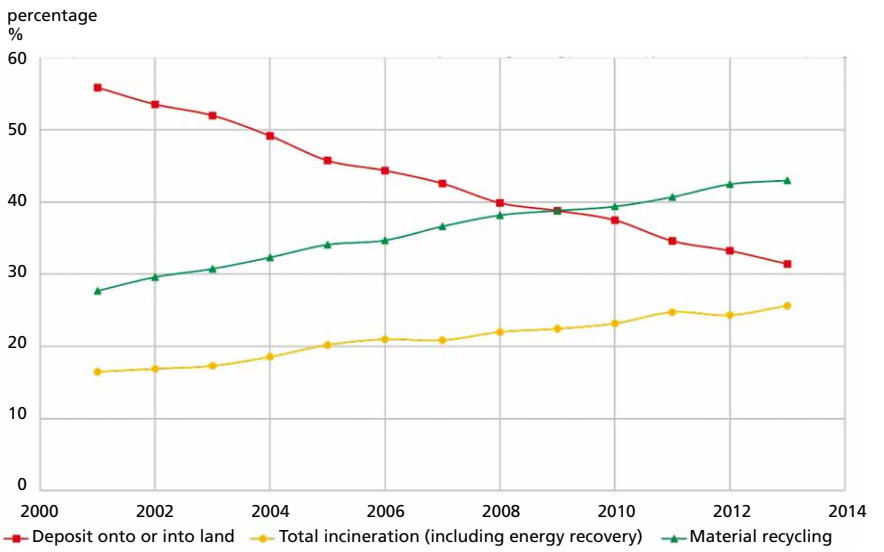

Figure 1: Municipal solid waste treatment trends in Europe, 2001 to 2013

Source: EUROSTAT

Phasing out landfilling as soon and as much as possible would unleash the full potential of waste as a resource by increasing recycling and energy generation from the remaining waste.

This opportunity should not be missed or delayed considering the significant amount of waste that is still landfilled in EU28 – about 74 million tonnes of municipal waste alone every year. This is a tremendous amount taking into account the potential danger of landfilling for groundwater due to possible leachate and the fact that methane emissions from landfills are significant contributors to Greenhouse gases.

For more than a decade, the EU waste targets set in the Landfill Directive have driven European Member States to improve their waste management systems. Landfill bans and taxes led to a decrease by 25 percent of the share of landfilling in the treatment of municipal waste between 2001 and 2013, and a growth of the share of recycling and incineration by 15 percent and 10 percent, respectively (Figure 1).

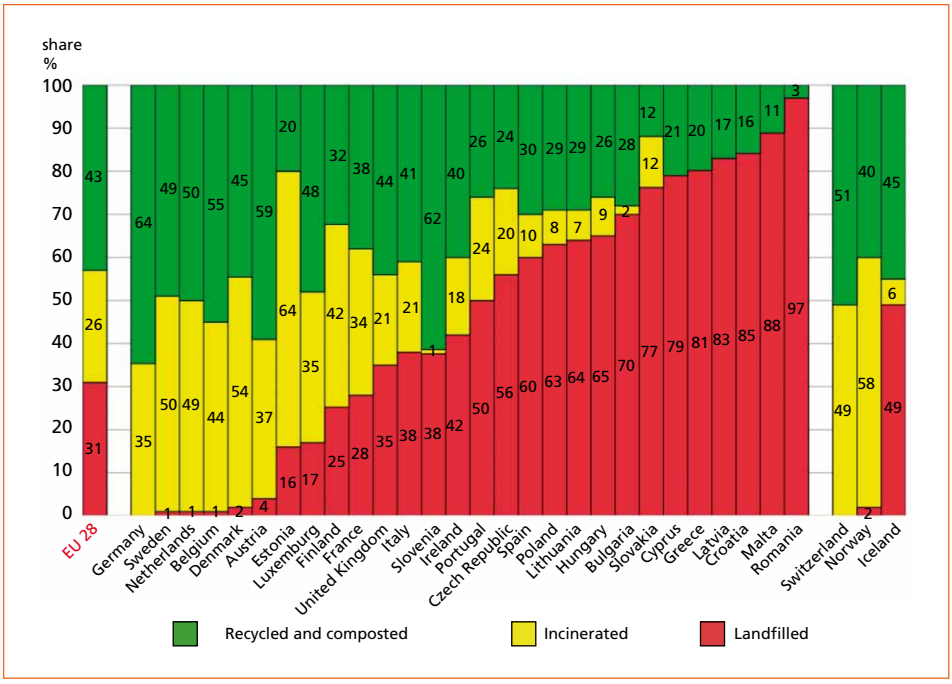

Figure 2: Municipal waste treatment in 2013

Source: EUROSTAT

In EU28, six countries managed to phase out landfilling almost completely: Germany, Belgium, Sweden, the Netherlands, Denmark and Austria. In these countries, recycling and Waste-to-Energy work hand-in-hand. They landfill a maximum of four percent of their municipal waste: this low threshold was achieved thanks to landfill bans. The bans allow for a legal certainty which facilitates the investments needed to build the necessary treatment capacities, i.e. recycling and Waste-to-Energy infrastructures.

Many European countries display a strong potential for the reduction of landfilling. 12 countries out of the 28 EU Member States still landfill 60 percent and more of their municipal waste (figure 2). It is therefore self-explanatory why the Juncker Commission wants to focus on the implementation of EU legislation. Waste-to-Energy can help to improve the implementation of the current legislation by providing an efficient and reliable alternative to landfill, and by helping moving up the waste hierarchy if developed in an integrated approach together with recycling.

1.2. Tackling quality recycling – only a clean circular economy is a good circular economy

Waste-to-Energy (WtE) helps to achieve sustainable recycling by treating the remaining waste that is not clean enough for Quality Recycling. Pollutants should stay out of the production cycle. The use of Waste-to-Energy plants allows for an improved quality of recycling, by insuring industries and consumers that polluted and contaminated waste is safely treated.

In addition, degraded waste after repeated recycling and mixed materials where the single components cannot be separated in an economically viable way can still provide electricity, heat and steam to office buildings, private housing or for industrial purposes.

Quality Recycling is a vital issue and plays an important role in order to ensure that supply meets demand, i.e. that the market trusts recycled materials and uses them. Rather than just focusing on quantity, quality should receive greater attention in the future Circular Economy**.** In order to realise the full potential of the circular economy, it is crucial that the European Commission and decision makers recognise the importance of the demand side of the equation in the circular economy. The original circular economy proposals on waste targets were mainly about the supply side of recycled materials.

The monitoring of recycling rates must be clearly defined and harmonised within EU28. An *output* approach, i.e. discarding the rejects from the recycling process, is the most appropriate way of calculating real recycling rates and ensuring Quality Recycling. However, it has to be considered that changing the monitoring of recycling rates to output measurement is already an ambitious step forward. The currently available data is mostly based on the input into sorting or recycling plants and sometimes even on the amount of waste collected for recycling. Further raise of quantitative targets must be evidence-based.

We need clear definitions, accurate measurement, better data and transparency about what goes in and what goes out of sorting and recycling facilities. Greater transparency is also necessary in order to avoid that the EU's *recycling* targets are simply achieved by shipping the waste to countries with poorer environmental and social standards than those in Europe[1].

[1] Today, about 50 percent of post-consumer plastic waste is shipped outside the EU 27+2 mainly to China and other Asian countries with little or no checks on how this material is then treated at the final destinations with regard to health and environmental implications

For Waste-to-Energy comprehensive information is available as WtE plant operators strictly document what goes into the plant and what goes out, i.e. energy and residues. The R1 Energy Efficiency formula introduced in the Waste Framework Directive 2008/98/EC has proven to be instrumental in increasing energy efficiency of WtE plants. It would be useful to develop also quality criteria for recycling.

1.3. Uniting the circular economy with the Energy Union goals – taking a holistic approach

A full Circular Economy shall consider both, material recovery and energy recovery. Europe needs raw materials as well as affordable energy for its citizens and industry.

WtE plants transfer non-recyclable waste into low carbon energy and supply electricity, heating and cooling to residents and industry, often in cogeneration. Energy from WtE plants is also a reliable (base load) and cost effective energy. It contributes to Europe's climate and renewable energy goals and helps to make Europe less dependent on fossil fuel imports.

These aspects are important with regard to the European Energy Union and should be considered in a comprehensive Circular Economy package. WtE plays a role in both, an integrated waste management system as well as in sustainable energy systems.

In Europe, recovered energy from waste for District Heating systems represents 50 TWh per year, i.e. around ten percent of the total heat delivered through District Heating systems. Studies [1] suggest that the potential for using heat from waste equals to 200 TWh per year by 2050, which means there are considerable opportunities for further development.

In some European cities WtE plants cover 50 percent and more of the local heat demand – at a very cost-effective price[2].

Furthermore, it is expected that DHC (District Heating and Cooling) will function as the backbone of smart cities. DHC will be used as infrastructure to provide efficient exchange and redistribution of energy, including better use of local resources like waste.

Transition from individual heating based on fossil fuels to a combination of more efficient, renewable and competitive energy supplies, incl. WtE, will significantly improve air quality.

In a *broader* approach that is *not just half the circle*, as stated by the European Commission's First Vice-President Frans Timmermans[3], energy aspects have a role to play alongside material recovery in the upcoming Circular Economy package.

[2] See some examples for good energy recovery practice [2]

[3] At the occasion of the presentation of the Commission's work programme 2015

2. Waste-to-Energy's role in the Circular Economy

Waste-to-Energy already (indirectly) had a role to play in the first legislative package on the Circular Economy, which included high waste recycling targets and landfill restrictions. More specifically, Waste-to-Energy can indeed help to close the circle by dealing with the waste that cannot be recycled in an environmentally sustainable or economically feasible way.

In order to improve resource efficiency – another key aspect of the circular economy – Waste-to-Energy plants recycle the bottom ash that results from the combustion process. Collected at the end of the grate, bottom ashes contain ferrous and non-ferrous metals that can be extracted and recycled into new products such as aluminium castings for the automotive industry. Other remaining minerals can be used as secondary aggregates, e.g. in road construction or in building products.

The European Commission plans to keep waste targets in the next proposal, which will include a roadmap concerning product design in order to maximize the recycling potential of European goods. According to Karl Falkenberg, the Commission's Director-General for Environment, Waste-to-Energy will also have a place in the Circular Economy. In a recent public debate, he indeed declared that *there will always be a mixed fraction of waste that we will not be able to separately collect and recycle. It then makes a lot of sense to at least recover the energy from that waste, rather than landfilling it.* [5] This shows that the European Commission acknowledges the need for waste incineration with energy recovery in the Circular Economy, in order to complete the circle by using the full potential of the waste as a resource.

This opinion is shared by local authorities, as shown by the recommendations on Circular Economy recently adopted by the Committee of the Regions. The representatives of cities and regions *regret that the [original Commission's] proposal for a directive does not give enough attention to the waste-to-energy recovery for non-recyclable waste, as final step of a waste valorisation process, even though it would make it easier for the Member States to achieve the ambitious objectives they have all been set and would improve the EU's energy independence at the same time;* thereby showing how important Waste-to-Energy is from a local perspective, and how this technology can help authorities to reach their targets in recycling rate.

3. Waste-to-Energy's contribution to an Energy Union

In February 2015, the European Commission launched its Energy Union strategy. As one of the core priorities of the Commission for the next five years, the Energy Union aims to create a unique European energy market that would *ensure secure, affordable and climate-friendly energy for citizens and businesses*.

The European Commission is aware of the role that Waste-to-Energy can play in developing the Energy Union. In its February communication, the Commission indeed announced that it would *further establish synergies between energy efficiency policies,*

resource efficiency policies and the circular economy. This will include exploiting the potential of waste-to-energy. A policy paper concerning Waste-to-Energy will be published in the coming year.

Using waste as a fuel allows for important savings of fossil fuel and therefore reduces CO_2 emissions. It also reduces the methane emissions by diverting waste from landfills (where it would release methane during its decomposition process).

Waste-to-Energy plants produce affordable energy, which is a strong requirement for both industries and citizens. A recent study by UNEP showed that Waste-to-Energy is the cheapest source of heat (Figure 3). The report points out that *Waste incinerators produce very low-cost heat and often initiate development of a city's district heating network.* Switching from individual (fossil fueled) boiler heating to district heating, supplied inter alia by Waste-to-Energy, also helps cities to comply with clean air requirements. The use of residual waste for heating represents a local, cost-effective, secure and sustainable energy source. It allows for a reduced primary energy consumption, and answers to a strong need from cities.

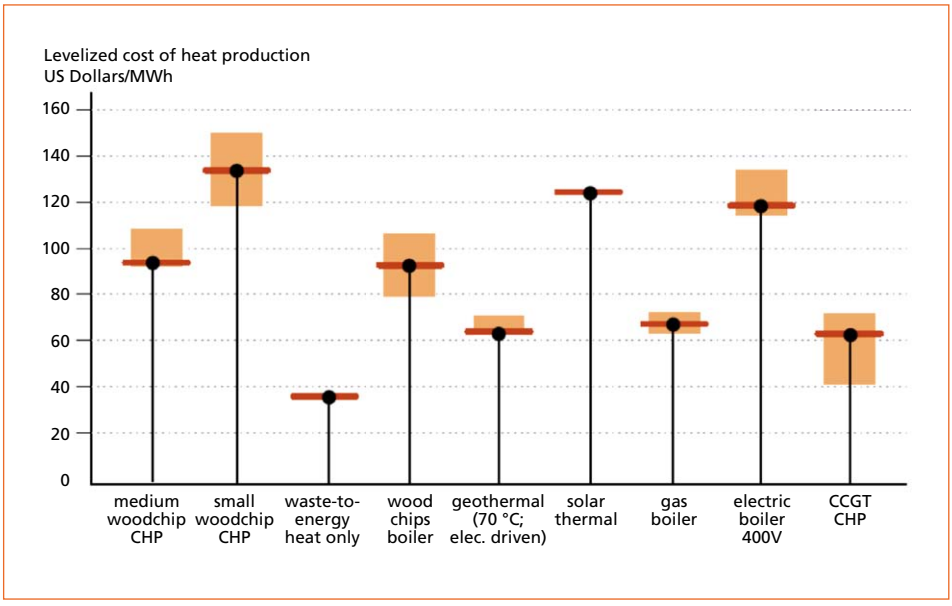

Figure 3: Comparative costs of district heating sources

Source: UNEP – District Energy in Cities: Unlocking the Potential of Energy Efficiency and Renewable, 2015: http://www.unep.org/newscentre/Default.aspx?DocumentID=2818&ArticleID=11153&l=en

By providing energy from local resources, Waste-to-Energy plants can help Europe to **become less dependent on fossil fuel imports**. According to Eurostat, in 2012 the EU 28 imported four million TJ of natural gas from Russia. The energy content of the waste treated by Waste-to-Energy plants in Europe amounts to 19 percent of these gas imports.

Already in some European cities, Waste-to-Energy provides 50 percent or more of the local heat demand. Waste-to-Energy could even contribute more, if the appropriate connection to heat (or steam) customers would be stimulated. Studies suggest that the potential for using heat from waste can quadruple (from 50 to 200 billion kWh per year) by 2050 (see above).

Moreover, **Waste-to-Energy is a renewable energy source**, as interpreted by the Renewable Energy Sources Directive. Indeed, EU legislation considers the biodegradable fraction of municipal and industrial waste to be biomass and thereby a source of renewable energy. About 50 percent of the energy produced by WtE plants comes from biodegradable parts of the waste. Therefore, Waste-to-Energy helps European countries to reach their targets in share of renewables in the energy consumption.

In the Netherlands, for instance, the contribution of Waste-to-Energy in providing renewable energy is significant. In 2013 nearly 12 percent of all renewable energy produced in the country came from Waste-to-Energy plants.

Some good examples for efficient Waste-to-Energy

The energy produced by Waste-to-Energy plants can easily be used by both citizens and businesses as it is the case in Rotterdam, where the AVR Rozenburg plant supplies steam to the industry located in the Rotterdam harbour, and heat to the District Heating network of the city. In 2013, this plant supplied 416 GWh of process steam to several industrial plants via a pipeline. The current 26 km pipeline provides heat for 50,000 households while a new District Heating pipeline, to be opened in 2015, will supply heat to 95,000 households.

The Twence plant in the Netherlands supplies 838,000 tonnes of steam per year to AkzoNobel Industrial Chemical's salt production plant via a 1.5 km steam pipeline. The company managed to reduce its consumption of natural gas by 80 million m^3 per year thanks to this steam network. Additionally, the plant is connected to the district heating network of the city of Enschede and provides 180 GWh of heat, which corresponds to the needs of around 13,000 households.

For instance, the A2A Waste-to-Energy plant in Brescia, Italy delivers heat through a District Heating network to one third of the inhabitants of the city of Brescia. The plant produced 561 GWh of electricity and 805 GWh of heat in 2013. This represents fossil fuel savings of about 150,000 tonnes of oil equivalent, and reduces the CO_2 emissions by 400,000 tonnes.

Around 60 percent of Waste-to-Energy plants in Europe provide, as the A2A Brescia plant, both electricity and heat (combined heat & power), as it is the most efficient way of recovering energy from waste.

Waste-to-Energy is a secure energy source as the plants operate all through the year, every day and every hour, and are able to provide base load energy to their customers.

4. Waste-to-Energy is a clean and safe technology

Waste-to-Energy is regulated by stringent environmental legislation, which leads to very low, strictly controlled and well-monitored emissions. The plants use sophisticated filtering devices that deal with the pollutants that come from the waste and minimise emissions into the environment. In 2010, Environment Commissioner Janez Potočnik answered to a written question asked by a MEP concerning Waste-to-Energy by stating that *Directive 2000/76/EC on the incineration of waste makes the incineration of waste one of the most stringently regulated and controlled industrial activities.*

Thanks to the use of the latest technology for filtering and cleaning the flue gases, the emissions of the plants are reduced to a minimum and they are strictly controlled.

Independent studies are conducted regularly to evaluate the possible effects of Waste-to-Energy plants on their surroundings, and they always confirm that Waste-to-Energy does not represent a threat to human health. [3] A recent Dutch long-term study [4] focusing on the effects of Waste-to-Energy plants on the quality of vegetables and milk produced nearby did not find any impact. Levels of cadmium, mercury and polychlorinated aromatic hydrocarbons found in vegetables grown near an incinerator were found similar to those of vegetables grown further. As for milk, the levels of dioxins and dioxin-like PCBs were comparable to national average for the Netherlands.

5. Summary and outlook

Considering Waste-to-Energy in the Energy Union and Circular Economy Package is an important step towards a holistic approach. This approach should move us away from silo thinking and should not only consider material recovery, as this was the case in the former Circular Economy Package, but also energy recovery because European citizens and industry need both (secondary) raw materials and affordable and secure energy.

The new Circular Economy Package should be ambitious regarding:

- Minimising landfilling of waste and maximising the use of waste as a resource
- Tackling Quality Recycling and
- Uniting the Circular Economy and Energy Union goals – taking a holistic approach

Waste-to-Energy has a role to play to make a better use of waste as a resource as explored above. A crucial step towards a better waste management is minimising landfiling as soon and as much as possible in order to unleash the full potential of waste as a resource. This would increase recycling rates and energy generation from the remaining waste, which would produce secure sustainable energy and make Europe less dependent on fossil fuel imports.

Concerns that diverting waste from landfills would just mean that it goes to Waste-to-Energy rather than being recycled are not justified as Quality Recycling and Waste-to-Energy are complementary options in order to divert waste from landfilling, and Waste-to-Energy capacity is needed to treat the residues from recycling facilities.

Currently, some stakeholders fear that overcapacities of Waste-to-Energy Plants will be created in Europe. Actually, a few countries (e.g. Sweden, Netherlands and Denmark) have some spare capacities. However, at the same time they achieve high recycling rates and have practically phased out landfilling. They are currently offering spare capacities in their highly efficient plants to countries that would otherwise landfill the waste. Eight EU-Member States have no or negligible Waste-to-Energy capacity and still rely heavily on landfills.

Also, capacities may be overestimated in a country in cases they are based on municipal waste generation only. However, Waste-to-Energy plants also take a significant amount of industrial and commercial waste (similar to municipal waste) in order to treat it in an environmentally sound way and turn it into energy.

Considering that millions of tonnes (74 million tonnes for municipal waste alone) are still landfilled, the EU as a whole is far from showing overcapacity of Waste-to-Energy. The Waste-to-Energy sector will furthermore not hamper ambitious recycling targets as both go hand-in-hand towards Quality Recycling. However, the quality aspect of recycling should play a more significant role rather than the discussion being purely focused on quantitative targets. In the end supply of recycled materials must meet demand and Waste-to-Energy is necessary to ensure that Quality Recycling is possible.

6. References

[1] Heat Roadmap Europe 2050 (Second pre-study for the EU27), May 2013

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