

# International Perspectives of Energy from Waste – Challenges and Trends

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Energy from waste technologies (EfW) constitute a meeting point for waste management and energy sectors to work together and benefit from each other in the most efficient manner. EfW technologies provide a solution for waste management; while generate energy (e.g. electricity, heat or fuel transport) to meet the actual fossil-free fuels high demand. Selection of the most suitable technology is based on social, economic and technical factors and environmental strategies to ensure the best outcomes.

This paper describes the importance of EfW in today's society, gives a picture of the situation of the EfW market in different regions all over the world and discuss the main challenges that the EfW market is challenging.

## 1. The waste problem

The current global amount of municipal solid waste (MSW) generated is 1.3 billion tonnes and it is expected to increase significantly to 2.2 by 2025 [18]. However, global waste averages must be considered only as estimations due to the difficulty in collecting generated waste data and large variations between regions. Climate, degree of industrialization, consumption habits, income level, population growth, urbanization and environmental policies influence on MSW generation rates.

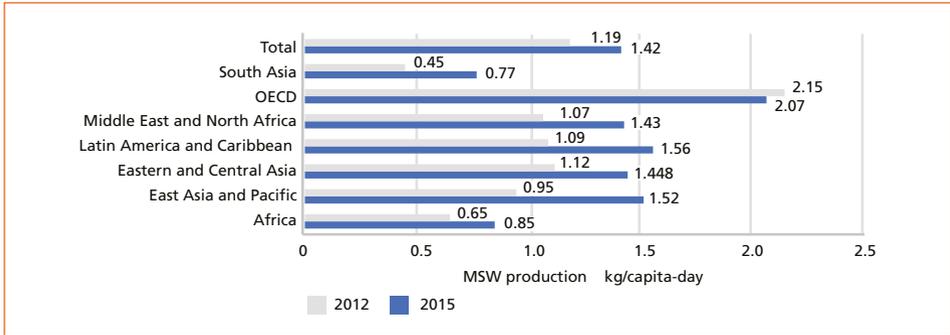


Figure 1: MSW generation per capita per region in 2012 and expected by 2025

Source: Hoornweg, D.; Bhada-Tata, P.: *What a Waste: A Global Review of Solid Waste Management*. World Bank: 2012

The World Bank presented in *What a Waste* report (2012) [18] a comparison between the current MSW generation and a forecast for 2025 in different regions (Figure 1). On average, the annual MSW generation will increase from 1.19 to 1.42 kg/capita-day. The member countries of the OECD are responsible for half of the MSW generated globally. On the other hand, underdeveloped regions such as South Asia and Africa present the lowest rates, which could also be attributed to a lack of data. It is remarkable the expected increase in MSW generation per capita in East Asia and Pacific – from 0.95 to 1.52 kg/capita-day – which is mainly due China's and India's rapid economic and urbanization development. The efforts done in OECD countries towards improvement of waste reduction and waste handling will lead to a decrease of the average MSW generated per capita in this area by 2025 [33]; while developing regions will face an increase of waste per capita which could be acute in emerging cities.

A study carried out by Hoornweg et al. [19] showed that in the long run, the global waste production will not peak this century as long as the current trends remain. While OECD countries as well as Asian and Pacific countries will peak in 2050 and 2075 respectively, waste rates will continue increasing in developing areas such as sub-Saharan Africa.

## 2. Energy from waste approach

As consequence of the global rapid urbanization and population growth phenomena, not only larger amounts of waste are produced, but also the world's demand for energy rises. A recent study states that the energy consumption will increase in 9 % in the OECD countries and in 41 % in the non-OECD countries between 2015 and 2040 [2]. The fact that waste generation and energy demand are strongly influenced by the same factors make them often go hand in hand in many scenarios.

Energy from Waste (EfW) technologies - also referred as Waste-to-Energy (WtE) - provide a viable alternative for waste treatment, where the mass and volume of waste is reduced, hazardous materials (e.g. pathogens, pharmaceutical residues and persistent organic pollutants) are destroyed and other hazardous elements (e.g. Cd, Pb and other heavy metals) are concentrated and taken care of in a safe way. At the same time the energy from the process can be recovered and provide a partly renewable energy source that can reduce the fossil fuels dependency.

EfW technologies includes:

- (i) Thermal conversion (incineration, pyrolysis, gasification and torrefaction),
- (ii) Biochemical conversion (anaerobic digestion, ethanol fermentation), and
- (iii) Landfill processes.

The future trends in the area are in the direction of

- (i) Biological hydrogen production (photobiological process and dark fermentation),
- (ii) Bioelectrochemical process (microbial fuel cells (MFC) and microbial electrolysis cells (MEC)), and
- (iii) Hydrothermal carbonization.

Each technology provides a solution for a specific situation [6] where available feedstock and product generated are the backbone. The selection of EfW technologies is based on economic aspects, waste properties, waste management systems available in the area, geographical location, policies and legislation, land availability, labor skills and costs or state of art of technologies in the area [25, 33].

### 3. Global perspective of the energy from waste market

EfW plays an exceptional role globally in handling challenging waste fractions and its contribution to the alternative energy market is also becoming significant. It is estimated that the worth of the global market will reach USD 40 billion in 2023 [33]. The current global value of all the EfW technologies has been estimated to be almost USD 20 billion by 2018 and expected to reach USD 37 billion by 2025 [25] (Figure 2). It is expected that the EfW market will continue growing due to

- (i) an increase in waste generation,
- (ii) supportive governmental actions (e.g. policies, taxes, subsidies),
- (iii) the need to increase the share of renewable energy sources, or
- (iv) development of new technologies.

The growth of the market might lead to a reduction of the cost for EfW technologies, from which developing countries would benefit [33].

Currently, there are more than 2,200 thermal waste treatment plants all over the world with a total capacity of 300 Mtons/year. It is estimated that more than 600 new EfW facilities will be built by 2025 [10] with a capacity of 170 Mtons. Thermal conversion alternatives dominate the market with an 88 % of the total EfW share in 2013 [33]. Incineration is leading this group due to its relatively low costs, versatility and efficiency compared to other technologies (Figure 3), and Asia is expected to be the main investor [25] followed by Europe. Gasification and pyrolysis are the most suitable alternative for countries with limited land and strong economy, and it is expected that they will increase their capacity in the future. Biochemical conversion technologies are expected to experience the fastest growth (9.7 % per year) as a consequence of an increase of available technology in the market [33] and an improvement of the waste sorting

systems. Figure 4 shows the role of EfW technologies within the waste management process by presenting the distribution of utility plants all over the world grouped by technology type.

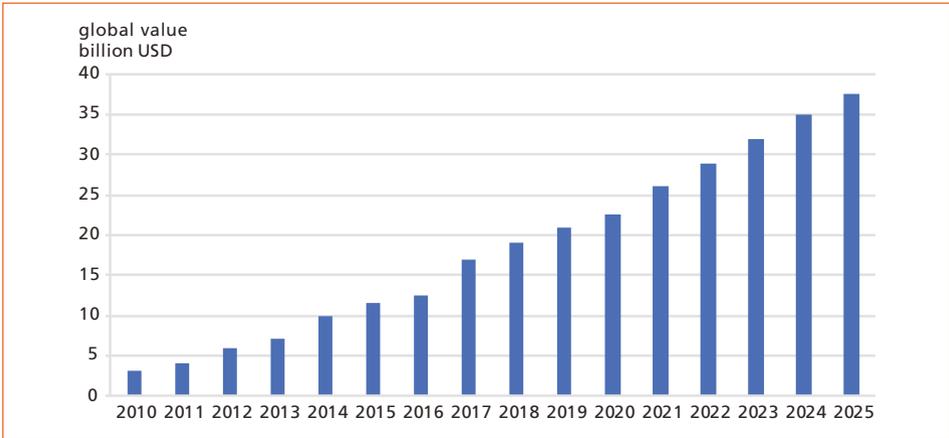


Figure 2: Growth of the global EfW technologies and a conservative forecast up to 2025

Source: Ouda, O. K. M.; Raza, S. A. In Waste-to-energy: Solution for Municipal Solid Waste challenges- global perspective, 2014 International Symposium on Technology Management and Emerging Technologies, 27-29 May 2014, 2014; 2014; pp 270-274

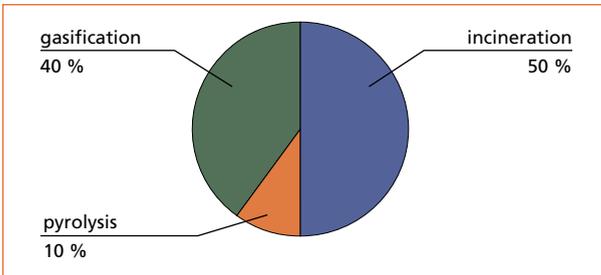


Figure 3:

EfW market share by thermal conversion technology in 2016

Source: Satsangi, S.: Waste to Energy Market by Technology (Thermal and Biological) - Global Opportunity Analysis and Industry Forecast, 2017-2023; <https://www.alliedmarketresearch.com/waste-to-energy-market>, 2017; p 210

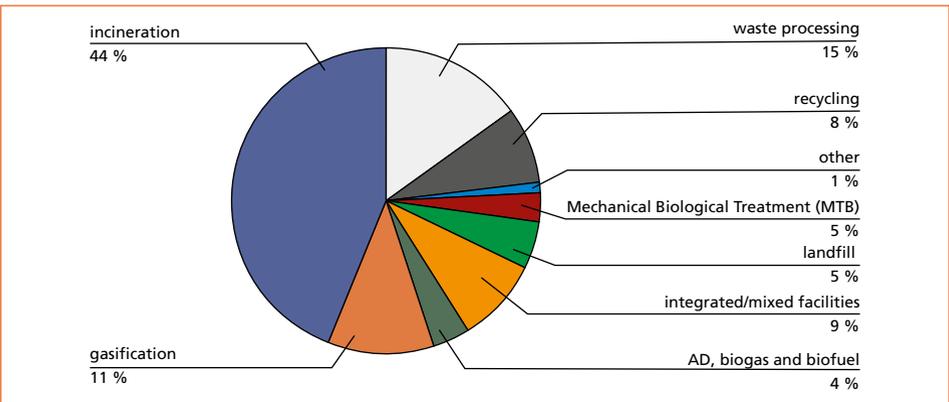


Figure 4: Distribution of utility plants according to waste management technology used; data collected from 93 countries during 2013-2014 in a total of 2,723 facilities around the world

Source: PRESCOUTER What are some of the latest waste-to-energy technologies available? (14th June 2018)

## 4. Regional perspective of the EfW Market

Regarding regions, Europe remains as the largest market (47.6 % of the total market in 2013) [33] followed by Asia – driven mainly by India, China and Japan – and Middle East. The market in Australia/Oceania and India have gained somewhat in importance. The lack of capital and developed waste management systems difficulties the development of EfW technologies in low income countries.

### Europe

Europe is by far the most important market for the EfW companies, and the region with the most advanced technology. The Ministry of Environment or/and Energy of each Member State or Associated Countries (e.g. Norway) is responsible for implementation of the EU framework and policies into national laws. The EU waste legislation considers incineration as an energy recovery alternative, while technologies such as anaerobic digestion fall into recycling. Regarding gasification, there are few full-scale gasification plants in Europe, which can be due to the heterogeneity of the solid fuel that difficulties the gasification process itself [33]. Fermentation is used to produce bio-ethanol from mainly starchy sources.

### Sweden

Sweden is one of the countries leading the waste to energy market in Europe. There are 34 incineration plants with a 6 Mton waste total capacity that generated 16 TWh of heating and 2 TWh of energy during 2016 [5, 21]. Sweden, as well as Norway, Germany and The Netherlands, have what is known as *incineration overcapacity*, which means that these countries do not generate enough waste to meet the waste fuel demand and they import waste from neighbor countries. Sweden imported 0.4 Mton household during 2016 [5]. Incineration overcapacity is a relevant topic of discussion nowadays, as it is discussed later in this text. Sweden also have increased its capacity for anaerobic digestion and typically the generated biogas is upgraded and used as vehicle fuel. There are few gasification plants in commissioning, but only one was operative in 2014. These plants intend to use virgin biomass or waste wood as feedstock [31].

### UK

The UK government strongly encourages the use of anaerobic digestion due to its benefits for energy recovery. However, there is lack of feedstock due to a not well-performed food waste separation and most of it remains in the residual household waste fraction [21, 33]. There are 47 operational incineration units and 4 gasification plants. The development of EfW in UK has been driven by a high landfill tax, while specifically the gasification plants also have been eligible to other incentives [20].

### Others

Estonia built its first EfW facility in 2013, and since then it has positioned as one of the countries in Europe with a highest and rapid shift towards energy recovery, from a 16 % in 2012 to 56 % in 2014, and been close to overcapacity by 2015 [21]. On the

other hand, the lack of a developed EfW system in countries like Poland might be due to the lack of high investments in technology and opposition from society [21]. Greece is also one of the few countries in the EU that has not still incorporated EfW to its waste management system, which could be motivated by the lack of a landfill tax [21].

## Asia

In the last years, Asia-Pacific region has experienced the fastest growth in the EfW market (in terms of market size) due to the continuous increase in waste generation and the support from governments in terms of policies and incentives [33]. China and India are the main drivers of this phenomenon, while Japan for a long time have been the most developed country in the Asian EfW market. Asia will continue investing in incineration; but it will also support low cost technologies for specific local wastes.

## Japan

Japan has traditionally dominated the EfW market in Asia. Its limited land availability and strong economy have favored the use of EfW technologies. Historically, legislative demands on vitrified ash also prompted solutions such as pyrolysis or gasification rather than incineration. However, this has changed during later years when the demand of vitrification has been abolished [30]. It is estimated that 39 Mton/year of waste are thermally treated in Japan [26]. Regarding waste incineration, 1,161 plants were operational in Japan during 2014 [28].

## China

China is at present the largest market of new EfW plants due to its rapid economic and urbanization growth in the last years, and the need for finding new waste disposal alternatives and energy sources. Incineration plays an important role in this sense in China, and has the support from the government (USD 41.3 billion from 2006–2020 [34]) and private investors. The first incineration plant was constructed in China in 1988 [34]. By 2013, the number of MSW facilities in China was 166 with a total capacity of 46 Mtons/year, and it is estimated that in 2014, 18.7 billion kWh was generated by incineration [34]. Incineration in China is mainly facing three challenges at present:

- (i) MSW quality;
- (ii) high cost associated to technology, and
- (iii) public opposition.

The waste management systems in China are less developed than in other countries, leading to MSW with higher food waste and moisture content and low efficiency in the incineration process. At present, China is building the largest WtE plant in Shenzhen with a capacity of 5,000 tones/day, and it is expected to be operational by 2020. Table 1 presents some figures about incineration plants in China in 2015. Table 2 summaries important figures related to EfW in China.

Table 1: Figures regarding incineration facilities in China, 2015

Inhabitants	million	1,371	Number of waste incineration plant		243
Municipal waste disposed	1,000 t	163,91	Incineration capacity	1,000 Mg/a	81
WtW net gate fee for MSW	EUR/Mg	4-24	Average age of incineration lines		6
Electricity from waste	GWh	12,956	Share of total electricity production 2014	%	0,2
Heat from waste 2014	TJ	38,645	Share of total heat production 2014	%	1

Source: Ecoprog: Waste to Energy 2016/2017 Technologies, plants, projects and backgrounds of the global thermal waste treatment business (extract); 2016, 2016

## India

Together with China, India has registered one of the fastest growth in the EfW market [33]. The Indian government estimated that potentially 1.5 GW of energy could be recovered from solid MSW and 266 MW from sewage sludge [11], and only 2 % is being used. Therefore, it is actively promoting EfW technologies by means of financial support both on research and industrial projects on industrial and urban solid waste. India has the target of adding 175 GW of renewable energy to the grid by 2022; and it is estimated that the solid waste generated has the potential to generate 500 MW and could reach 1,075 MW by 2031 and 2,780 MW by 2050 [24]. Figure 5 shows the market share in India between 2013 and 2024 for thermal and biological conversion EfW technologies. At present, there are only 8 incineration plants with a capacity of 94.1 MW (only one operative at present) and 172 anaerobic digestion facilities [23]. As in many other developing countries, a significant number of EfW projects have failed due to the poor quality of the waste, lack of financing, or lack of expertise in the field.

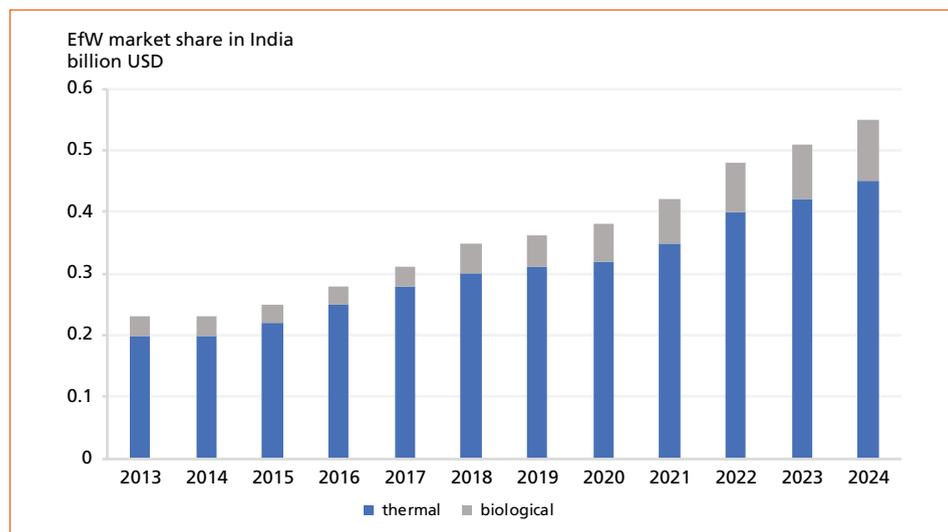


Figure 5: EfW market share in India by technology, 2013 to 2024

Adapted from: Global Market Insights Waste to Energy (WTE) Market Size By Technology (Biological, Thermal [Incineration, Pyrolysis & Gasification], Industry Analysis Report, Regional Outlook (U.S., Canada, UK, Germany, France, Italy, Sweden, China, India, Japan, South Korea, Australia, Thailand, Indonesia, Malaysia, Philippines, Argentina, Brazil, Chile, Kenya, Nigeria, South Africa, Qatar), Application Potential, Price Trend, Competitive Market Share & Forecast, 2016–2024; 2017

## Indonesia

The Indonesian government has set target of achieving 23 % renewable energy by 2025 [7]; and anaerobic digestion emerges as the best alternative [27] due to the significant amount of crop waste and manure that are generated in the country. Indonesia has a large experience in micro and small anaerobic processes in different types of food industry [16]; and anaerobic digestion processes are playing an important role in converting e.g. palm oil waste into biogas.

## Africa

Despite of the increasing amount of waste generated (Figure 1), developing economies such as Sub-Saharan Africa show no or very slow increase on EfW market. This is due to several factors:

- (i) the high investment costs associated to EfW technologies;
- (ii) lack of developed waste management systems;
- (iii) lack of knowledge on the technologies and labor as well as benefits that could bring; and
- (iv) the availability of landfill sites that provide a cheaper alternative for waste disposal.

Despite all these disadvantages, projects like the construction of the first incineration plant in Ethiopia (50 MW and 1,400 tons waste per day [29]) shows the potential of Africa in EfW and the benefits that could bring to this region. South Africa shows a high potential for small to medium-scale EfW plants including biogas and landfill gas [8].

## US

The low prices of oil and gas in the US and relatively low fees associated to landfilling favored the disposal of waste in landfills instead of being handled in a more suitable way. However, the lack of land available for landfilling purposes might favored the growth of EfW in the country. Only 13 % of the MSW generated in the US during 2014 was incinerated. At the end of 2015, there were 71 incineration plants in the US with a capacity to produce 2.3 GW of energy, and most of them built before 1995 [12]. There are more than 2,200 sites producing biogas in the US: 250 anaerobic digesters on farms, 1,269 waste resource recovery facilities using anaerobic digester, 66 systems for food waste digestion and more than 650 projects on landfill gas [3]. According to the Global Syngas Technologies Council there are eight waste/biomass gasification plants in the US with a total capacity of approximately 130 MW<sub>th</sub> [15].

## 5. Challenges in the EfW industry

The current challenges faced by EfW industry varies mainly due to the degree of development of the country. Level of technological development, resources/feedstock availability, waste and energy strategies, policies, environmental impact or social acceptance are key aspect determining the development of EfW all over the world. In this section we will discuss about some of the main arguments against the use of EfW technologies nowadays.

### EfW role in a circular economy

A circular economy (CE) is that which maintains the value of materials and products for as long as possible, while minimizing the generation of waste reducing the resource consumption. This concept brings both economic and environmental benefits to the societies. In 2015, EU adopted an action plan for transition towards CE that involves all Member States and motivates them to complement it with national policies. At the beginning of 2017, the EU Commission published a communication [13] highlighting the role of EfW in the transition towards a CE, and affirming its support as long as the waste hierarchy guidelines were prioritized. The introduction of new/higher incineration taxes is also expected in the EU Member States.

#### *Lack of waste to burn in incineration facilities*

There is an ongoing discussion in Europe about the role of EfW in the CE, especially about incineration. One may argue that there will be no place for incineration in the CE since once the material loop is closed, there will not be waste left to be burnt. Unfortunately, there is a high probability that there still will be a residual waste fraction left that cannot be reused or recycled due to economic and/or environmental aspects. In that case incineration might be the most suitable option when phasing out unwanted pollutants accumulated in the material through several recycling processes loops. However, in the future the incineration process might be a more integral part of the material recycling, providing energy to the recycling processes.

On the other hand, the use of EfW technologies for converting renewable materials/sources biomass into energy via biochemical conversion have gained popularity in the last years. The inclusion of food waste fraction as renewable material has enable to many Members States to reach, or at least, be closer to the recycling rates established by the EU. Furthermore, they will also play a key role for reaching the recently updated energy targets set by the European Commission (27 % share of renewable energy by 2030). They will also play an important part in the circular economy where nutrients are recycled in a safe way.

### Public perception

#### *Waste management and energy interact with society*

The use of land close to urban/high populated areas for construction of EfW facilities has been on debate and is still going on all over the world. On one hand, citizens want to be able to live and enjoy surrounding and feel safe and they do not want EfW facilities interact with their lives. On the other hand, the waste and energy industry stresses the environmental and economic benefits of locating EfW facilities close to the areas where waste is generated and collected, and where energy (heat) will be consumed.

During the last decades there has been a paradigm shift in the way cities perceive proximity to industry and, in this particular case, to incineration facilities. Examples of this new trend are Spitelau in Vienna, Amager Bakke in Copenhagen or the plant in Shenzehn that is still under construction. These facilities are located in urban areas and are equipped with the latest EfW technology to guarantee the highest efficiency and best environmental performance. At the same time, they have also been designed to give an added value in other ways, either by exterior design or functionality.

Amager Bakke is the first plant in the world integrating industrial and recreational areas. The plant's architecture includes ski slope on its roof, climbing wall and hiking area for the city residents' recreation. The plant is owned by the local authorities, who also in an early stage declared that a significant part of the plant should be integrated with the public.

Strong local opposition can make projects fail. Therefore, it is important to be open and share inform with the local representatives regarding what the plans are, and what benefits and inconveniences that are associated with it.

### *Incineration encourages waste production and discourages recycling*

It is true that incineration overcapacity exist in some Member States in the EU. However, recent statistics published by Eurostat [14] on MSW generation and treatment in the EU (Figure 6) show that incineration has increased over the years, but not as much as recycling or composting. Several studies showed [32] that Europe has an uneven EfW capacity distribution, and that Germany, Sweden, Italy, The Netherlands, UK and France account for almost three quarters of the overall capacity in EU. The European Commission approached this issue [13] and stated that new incineration facilities should only be constructed as long as the feedstock supply is ensured and will not interfere with recycling and reusing alternatives, and avoid potential overcapacity. At the same time, waste and energy experts discuss about the need of taxing carbon emissions from incineration, which could be considered as an incentive to move from EfW to other waste handling alternatives higher in the waste hierarchy.

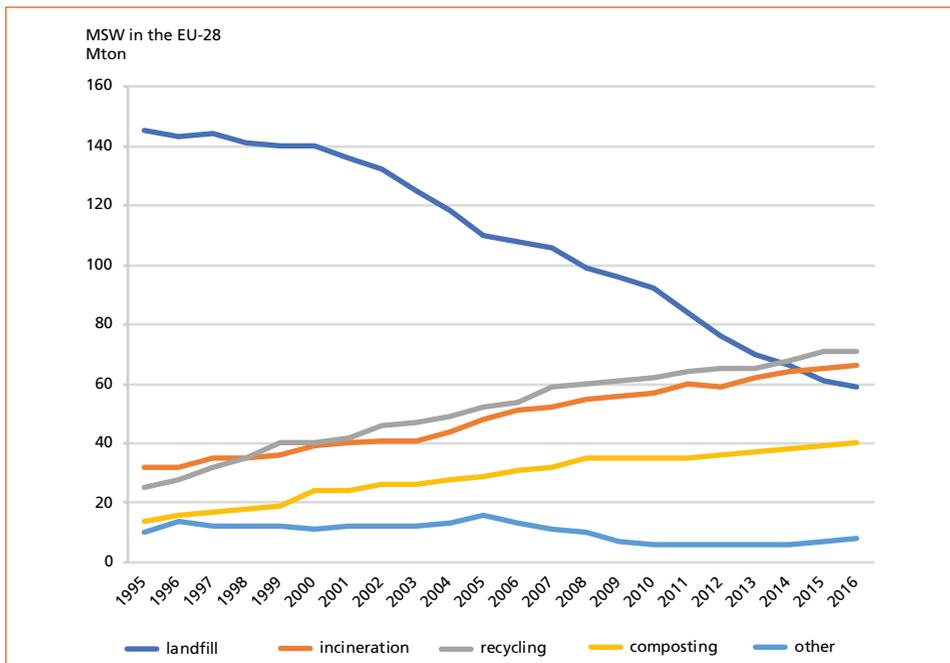


Figure 6: MSW treated in Europe from 1995 to 2016

Source: Eurostat: Municipal waste statistics. In: [http://ec.europa.eu/eurostat/statistics-explained/index.php/Municipal\\_waste\\_statistics](http://ec.europa.eu/eurostat/statistics-explained/index.php/Municipal_waste_statistics), 2018.

Contrary, the reasons behind the thought of *decreasing* of recycling rates may be due to the fact that

- (i) waste industry is having troubles to find end-user for a continuously increasing stream of recyclable products;
- (ii) recycling technology still has technical and economic limitations;
- (iii) the more recycling cycles a material goes through, the lower its quality is; and
- (iv) not all materials can/should be recycled [22].

There is also the aspect of that the recycled plastics compete with plastics from virgin oil production where the oil prices are volatile and will affect the market.

#### *EfW has a negative impact on environment*

The environmental impact of the EfW facilities has been extensively discussed. Due to the introduction of restrictive legislation regarding EfW plant, its impact on the environment and human health has decreased considerably over the years. In terms of operation, at present, EfW facilities are equipped with the most advanced technology and operate according to environmental and safety protocols. The use of EfW technologies results in greenhouse reduction emissions due to [33]:

- (i) gas (e.g. mainly  $\text{CH}_4$  and  $\text{CO}_2$ ) released from waste landfills can be recovered and used for energy production;
- (ii) the use of energy from EfW plants will imply a reduction of the use of fossil fuel; and
- (iii) in the case of incineration, metals (ferrous and non-ferrous) can be recovered reducing the demand for these metals and emissions derived from their extraction.

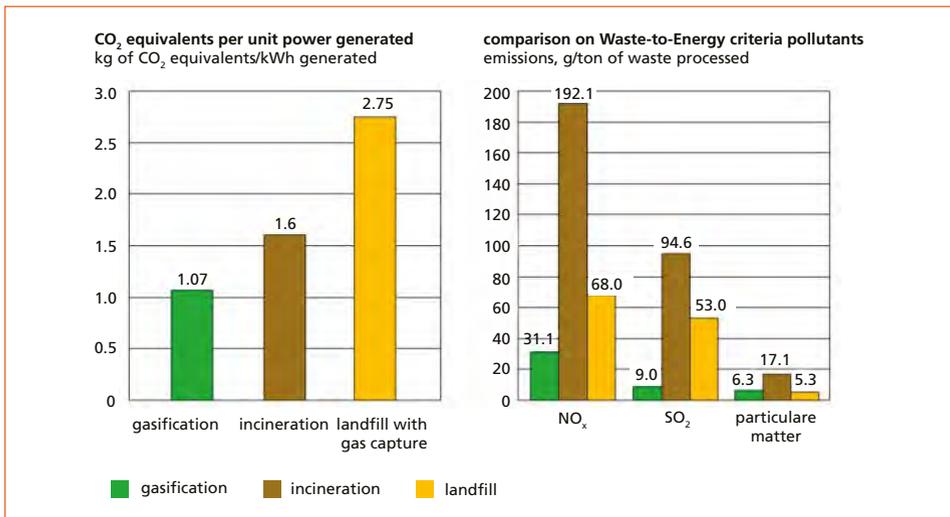


Figure 7: Comparison of greenhouse equivalent emissions and regulated pollutant emissions per kWh of energy generated by gasification, incineration and landfill gas

Source: Riera L; B.W., W. In Municipal Solid Waste as Renewable Resource, 4th Global Economic Leaders' Summit, Changchun China, 2015; Changchun China, 2015

Despite the emission from waste incineration have reduced considerably during the last decades (e.g. 99.9 % dioxin emissions reduction), incineration is still considered as the one with a higher negative impact on the environment. Alternative EfW technologies to incineration, such as gasification, are proved to have a lower impact on the environment and no ashes are generated.

At present, there is an ongoing debate about the toxicity of bottom ashes from waste incineration processes and their suitability for specific applications as well as their disposal (see section Policies and Incentives).

### Developing countries

Developing and transition countries face a large variety of challenges which, in some cases, prevents implementation of EfW in the area. The main reasons why projects in the EfW fail area discussed below, and are mainly related to the lack of resources, knowledge and social education. At the same time, the current lack of information and data available on these areas, compared to developed countries, makes it difficult to evaluate the situation of the EfW and its challenges

#### *Lack of effective waste management systems and its influence in the feedstock quality*

The lack of well-established waste management systems, including collection and transportation, in developing and transition countries is a barrier for material recycling as well as implementing EfW systems. The viability of the EfW plants depends on the possibility to deliver energy to the clients, gate fees and the quality of the waste. The most important factors influencing the feedstock quality are:

- (i) High food waste content: The waste energy content is closely related to the economic development of a country. Waste in developing and transition countries presents a lower calorific value due to the high organic waste content (because of the lack of sophisticated food waste sorting systems) and low plastic and cardboard content, compared to developed countries. Because of the high moisture content due to the food waste, biochemical technologies have a higher potential to develop in these areas [33];
- (ii) Seasonal variations: precipitation/snow is an important factor, especially in those countries where the waste is storage in open areas or transported in open vehicles;
- (iii) Scavengers: Scavengers have a strong influence on the waste composition and this has to be considered when performing studies for implementation of EfW facilities in the area. Implementation of new waste management systems will also lead to changes in scavengers' activities and fuel composition.

#### *High investment costs*

The high cost associate to EfW technologies in comparison with landfilling is one of the biggest barriers for the EfW development in low and middle-income countries. Growth in the market might decrease prices and make the technology more accessible for these countries. Governments can play an important role in this matter trough incentives.

At the same time, implementation of small plants for covering local communities needs in decentralized areas using local waste could be a more practical and cheaper solution for some specific areas under development [33].

#### *Lack of knowledge and awareness of benefits*

Lack of trained personnel with knowledge on the processes and able to handle the process is the most efficient and safe way is a barrier for implementation of EfW systems in developing countries. On the other hand, implementation of EfW could bring education and employment opportunities for the area [33]. Another important aspect is that these societies are not aware of benefits of EfW systems implementation [33]. It is responsibility of the government and local authorities to improve public awareness by provide education and information to those who need it. As an example, scavengers could be educated for working at waste and EfW facilities, which would have a significant impact on their lives [4].

## 6. Policies and incentives

Policies, legislation and incentives have a crucial role in directing waste management towards sustainable solutions. However, they act both as a large challenge as well as an opportunity for EfW.

#### *Ever changing policy and incentives*

In some countries the vision of a fossil free energy system is becoming more common. Large investments that have a long life-span is dependent on predictability in the market. Since policy, legislation, and incentives have a large impact on the market, the continuity and possibility to predict the development concerning these factors is often mentioned by the industry as one of the most important factors affecting the investment decision.

#### *An incineration tax or ban will solve everything*

The introduction of high landfill taxes or landfill bans have been successful in diverting waste from landfills in several countries. [1] Will the next logical step then be to proceed in the same way regarding waste incineration? A tax has been introduced in several countries. Sweden introduced a waste incineration tax was in 2006 with the primarily aim of diverting fossil waste from EfW and stimulating the power production from EfW plants. An evaluation during 2009 [17] concluded that it did only have a marginal effect and thus it was abolished in 2010. A recent investigation carried out in 2017 about introducing an incineration tax again came up with the same conclusion [9].

## 7. Conclusions

EfW plays an important role in an integrated waste management, which depends on several factors such as; policy, legislation, integration into the energy system, market prices and how mature the waste management system is. These factors will also govern the development of EfW.

The future of EfW will also depend on technological developments: new technologies or new applications to existing ones able to better utilize the value in the waste materials and generate new high value materials or fuels Energy might still be the most preferable by-product. This also relates to one of the largest challenges EfW faces- how to find its role in the circular economy?

During the transition towards a circular economy, there will be plenty of materials that need to be phased out because they cannot be material recycled either because of economic reasons or that they contain unwanted substances that we do not want to enter the techno sphere. The most suitable alternative in this case would be EfW even if landfilling (or long-term storage) in wait for better material recycling methods could be an option. During this transition, EfW will most likely play a larger role than today – especially on developing markets.

As earlier mentioned a fully circular economy is an ideal picture that we probably never fully reach, but hopefully we can come closer to it (and certainly much closer than today). In that future, EfW will still play an important role, since there will still be materials that we cannot reuse or recycle for one reason or another. However, it might not play as important role in those countries with a mature waste to management systems. Furthermore, it might also be more integrated with the material recycling context than it is today

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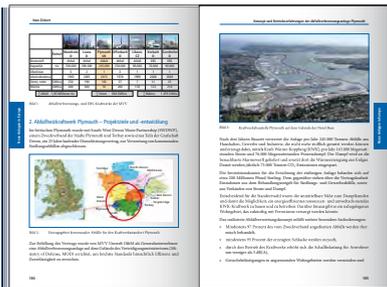
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