EU WASTE MANAGEMENT STRATEGY AND THE IMPORTANCE OF BIOGENIC WASTE

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ABSTRACT

Waste management inside the EU is almost totally regulated by EU directives which supply a framework for specific national regulations. The main target in view of sustainability is the prevention of direct disposal of reactive waste on a landfill. The tools to comply with these principles are recycling and material recovery as well as waste incineration with energy recovery as final inertisation step. The adaptation of the principles laid down in the EU directives is an ongoing process. A number of countries has already enacted respective national regulations and the realisation shows that recycling and incineration are not competing but both essential parts of integrated waste management systems. In the EU like in other industrialised countries the amount of residual waste available for energy recovery can supply approx. 1 % of the primary energy demand. About 50 % of the energy inventory of MSW in most EU countries is of biogenic origin and MSW is in to the same extent to be looked upon as regenerative fuel. Hence part of the CO_2 released from waste incineration is climate neutral. In the EU this share can cause savings in the order of 1 % of the annual CO_2 emission if energy from MSW replaces that derived from fossil fuel.

KEYWORDS

EU Directives, waste recycling, energy recovery, biogenic waste, CO_2 savings

1. INTRODUCTION

Municipal solid waste (MSW) is a mix of all kinds of materials which have to be finally disposed of in an environmentally acceptable way. In history of mankind waste disposal meant landfilling. However, MSW contains reactive biogenic constituents which cause problems on a landfill considering the formation of climate active methane and of the risk of groundwater contamination by leachates. The following report describes the strategies the EU and its member states have developed to cope with that problem. Furthermore, the opportunities of the biogenic fraction in MSW in view of energy recovery are discussed. The results presented in the following base to a great extent on the activities of the EU Bioenergy Network of Excellence (NoE).

2. LEGISLATIVE REGULATIONS ON WASTE MANAGEMENT IN THE EU

2.1 Waste Disposal

In the EU the waste management sector is almost totally regulated by EU Directives which have already been or will in near future be adopted by all member states. This practice started very early in the 70th of the last century already and resulted in a harmonisation of national regulations in terms of management strategies, technological measures, and environmental standards.

The fundamental Framework Directive on Waste Disposal 75/442/EEC was issued in 1975. It gives general advises on waste management and disposal. Its objectives are the prohibition of uncontrolled discarding, discharge and disposal of waste and the promotion of the waste management hierarchy following the steps prevention, recycling and conversion of wastes with a view to their reuse.

Under the umbrella of this Framework Directive a number of directives have been decided upon which regulate the disposal and/or recycling of specific waste streams, among others sewage sludge, packaging waste, ELV (end of life vehicles), WEEE (waste from electrical and electronic equipment), PCBs and PCTs, batteries and accumulators.

Another directive of fundamental importance for the disposal of MSW is the Landfill Directive 1999/31/EC (LD). The LD is intended to prevent or reduce the adverse effects of direct disposal of untreated waste on human health and on the environment, in particular on surface water, groundwater, soil, air and sets up a system of operating permits for landfill sites.

The most important part is Article 5 which requires a reduction of biodegradable waste going to landfills. The targets are a reduction of biogenic waste compared to the situation in 1995 by

- 25 % in 2006,
- 50 % in 2009, and
- 75 % in 2016.

The newly accessed countries have transitional periods for full adoption of these EU regulations.

Measures to achieve those targets should include in particular recycling, composting, biogas production or materials and energy recovery. Consequently this Directive does not only promote recycling and composting but even

more waste incineration which is for the time being the only proven and efficient technology to destroy organic matter. Criteria to be followed for the acceptance of waste on a landfill include basic characterisation, compliance testing, and on-site verification.

The LD specifies only general criteria and principles to be obeyed for the acceptance of a waste or residue on a landfill but it does not contain specific parameters and their limit values. Each country is obliged to define procedures and set standards which have to be met by a material to be listed for a specific class of landfill.

An efficient instrument used in some EU countries to divert biogenic waste from landfills is a landfill tax which is imposed on untreated waste going to disposal sites like. This tax exceeds in Austria and The Netherlands 80 €/Mg which doubles almost the typical landfill fee of approx. 100 €/Mg in these countries. Sweden and Denmark charge around 50 €/Mg as tax, in the UK the actual tax of 30 €/Mg increases annually by approx. 4.30 €. Other countries like Germany rely on legislative regulations which guarantee the compliance with the respective targets of the Landfill Directive. In Germany national regulation has enforced a landfill ban for reactive waste since 1. June 2005.

2.1 Waste Incineration

The efforts to keep reactive waste away from final disposal sites call for an inertisation of the leftovers after all recycling and recovery activities. For the time being this is preferentially waste incineration with energy recovery. For this area the Waste Incineration Directive 2000/76/EC (WID) has been issued in 2000 which resembles the legal framework for the incineration and co-incineration of waste or waste derived fuels like SRF (solid recovered fuel) in industrial furnaces and utility boilers. The main topic is the regulation of the emission to air. Furthermore there is a demand for energy recovery and the residues should have a quality which allows recycling where appropriate. Most old member states have already adapted the WID into national law or the respective standards have been enacted already earlier (e.g.Germany, The Netherlands) and hence the air emission limits in the EU are almost identical in all countries and are among the most stringent ones in the world.

3. PRACTICE OF WASTE DISPOSAL IN THE EU

In the EU the generation of MSW ranges from approx. 250 kg per person and year in Poland to 660 kg per person and year in Spain with the new member states at the lower end. The data compiled in Table 1 are taken from the EU statistical office Eurostat.

Table 1 Generation of MSW in kg/cap/y and recycled (REC), incinerated (INC) and landfilled (LF) fraction in % for selected countries in 2004

country	*MSW*	*REC*	*INC*	*LF*	*country*	*MSW*	*REC*	*INC*	*LF*
Austria	627	58	22	20	***Greece***	433	8	0	92
Belgium	469	57	33	10	***Italy***	538	32	11	57
Czech Republic	278	6	14	80	***Netherlands***	624	63	34	3
Denmark	696	42	54	4	***Poland***	256	5	1	94
Estonia	449	37	0	63	***Portugal***	434	5	22	73
Finland	455	30	10	60	***Spain***	662	39	6	55
France	567	29	33	38	***Sweden***	464	44	47	9
Germany	600	59	24	17	***United Kingdom***	600	23	8	69

Most countries, especially many old EU members, implemented extensive programs to divert and recycle all kinds of waste fractions like paper, glass, metals, plastics and organic fractions, the latter ones for composting and anaerobic digestion. Recycling quota, which are for some materials like packaging waste or end of life vehicles laid down in legislative regulations, reach almost 60 % in Germany and Austria. In the new member states and in some southern countries with low recycling this will significantly increase in future driven by the EU directives.

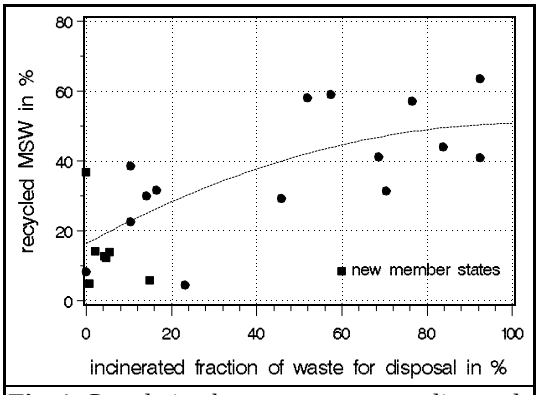

Fig. 1 Correlation between waste recycling and incineration of residual waste fraction

Composting is included in the recycling numbers in Table 1. This strategy is mainly applied in Austria (36 %) and in The Netherlands (23 %), Germany and France compost about 15 % of their MSW but in most other countries the composting rate is well below 10 %.

For the residual waste, the leftovers after all recycling activities, the preferred inertisation process prior to final disposal is incineration. The respective data for 2004 are included in Table 1. Countries like Denmark, The Netherlands or Sweden incinerate almost all of their residual waste already and the number given for Germany is expected to reach almost 40 % in 2006 after the landfill ban is fully enacted. Hence for the time being several countries which have already over-fulfilled the demands of the

Landfill Directive. The wide application of waste incineration in these countries will most likely soon be seen in other member states which have still to meet the LD's targets.
As Fig. 1 points out, the development in the EU is a good example for the equivalent and beneficial role recycling and waste incineration play in an integrated and sustainable waste management concept. Other than complaint by incineration opponents we find a high share of incineration in those countries where also a high share of recycling is established. Countries with both, low recycling as well as low waste incineration are the new member states; Greece and Portugal.

3. ENERGY INVENTORY IN MSW AND ITS BIOGENIC FRACTION

One of the goals of waste management is the conservation of resources which means not only material recycling but also the recovery of the energy inventory of the residual waste in the waste combustion process. In fact all modern waste incineration plants are equipped with a boiler and the WID makes energy recovery mandatory.

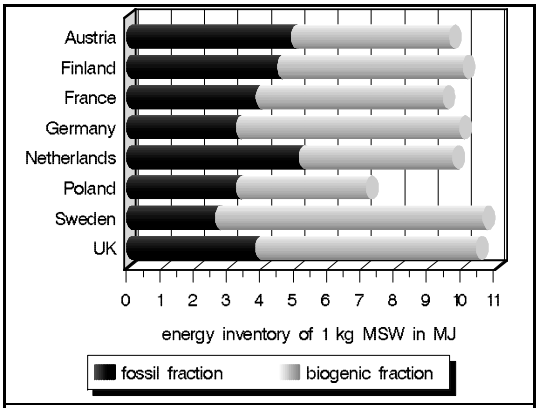

Fig. 2 Lower heating value and biogenic energy in MSW for selected countries

If the waste composition is known, its lower heating value can approximately be calculated using published data of heating values of the various waste fractions [1-3]. From such calculations it can be concluded that the average lower heating value in the highly industrialised old EU member states is in the order of 10 MJ/kg [4]. For the eight countries where the members of the NoE are coming from the obtained lower heating values are depicted in Fig. 2. The numbers range from approx. 7 MJ/kg in Poland to more than 11 MJ/kg in Sweden.
The waste composition data allow also the identification and quantification of the energy inventory in MSW which is supplied by the organic MSW fraction food and garden waste, wood, paper and partly also by textiles and diapers. The bar plot in Fig. 2 visualises this biogenic energy fraction in MSW separately. An overview for all EU countries – although in some cases based on rather vague data – reveals an average biogenic energy inventory in MSW of (55 ± 9) % with a range from 36 % in the Czech Republic to 74 % in Sweden [4, 5]. The fact that a certain fraction of the energy in MSW is of biogenic origin has meanwhile been acknowledged by some EU countries like The Netherlands and Finland. In these countries power generated in waste incineration plants is rewarded by tariffs partly subsidised according to the national regenerative energy acts.

3. ENERGY SUBSTITUTION AND CO_2 REDUCTION

MSW is in the EU mainly burnt in dedicated combustion facilities, preferentially in European mass burners which are based on grate technology. Co-combustion of MSW in utility boilers and industrial furnaces plays in some countries like Germany an important role in the concepts of waste management. However, although large efforts are made to standardise the quality of SRF this strategy focuses mainly on defined waste fractions from the commercial and light industrial sector. For the time being the market for such secondary fuel is not stable and the role SRF will play in the waste as well as in the energy market is still difficult to predict. The major problems are uncertainties concerning the fate of waste born pollutants as well as the economy of such practice [6].

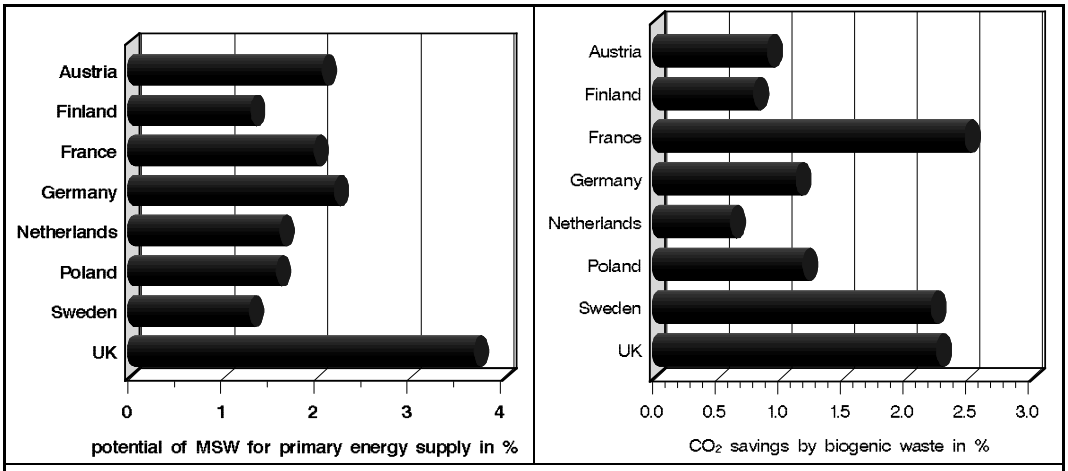

Fig. 3 Percentile potential of MSW for primary energy supply (left graph) and expected CO_2 savings in this case if fossil fuel is substituted (right graph)

A modern waste incinerator has a high potential for energy recovery. Its primary or boiler efficiency exceeds 80 %, the power efficiency amounts to 20 – 25 % and in modern plants with new boiler concepts to even more to than 30 %. The best strategy, however, is combined heat and power (CHP). In such configurations the overall energy efficiency can reach more than 60 %. Unfortunately today only power from renewable sources is profiting from renewable energy tariff regulations.

The potential of MSW incineration for the supply of primary energy has been estimated based on the amount of MSW which is available for waste-to-energy – that means all MSW which is today recycled has been excluded. The left graph in Fig. 3 documents the results for the eight countries which have been selected above already. The bar plot indicates a substitution potential between 1 and 2 %. The estimate for the UK seems too high since in this country a much higher share of recycling has to be expected in future.

Combining such calculations with the results obtained for the inventory of biogenic energy in MSW the potential of greenhouse gas savings can be estimated. Under the condition that all MSW derived energy replaces energy from fossil sources the results are for the same eight countries presented in the right graph in Fig. 3. A conservative scenario would most likely come to an average saving between 0.5 and 1 % of the current annual CO_2 emissions in the EU countries. The high numbers for France and Sweden are not likely to be realised since in these countries water and nuclear power have a high share in the energy supply. The result of UK is for the above mentioned reasons over-estimated.

4. CONCLUSIONS AND OUTLOOK

Biogenic waste and its disposal has been a problem since early times, starting with the health risk associated with its handling and later becoming more interesting due to the evolution of greenhouse gases on landfills and the formation of organic leachates. In Europe the EU and a number of its member states started already decades ago to develop strategies of waste disposal which avoid such risks. The EU Framework Directive in combination with the LD and the WID set principles for environmentally acceptable waste disposal based on increased effort in recycling and material recovery and on the strict prevention of landfilling of any reactive waste. The latter target should especially be achieved by the implementation of thermal waste treatment with energy recovery.

These efforts were rather effective already in many of the old member states and will pave the road to sustainable waste disposal in all EU member states in due time.

As a consequence of the EU regulations waste-to-energy concepts based on waste incineration are gaining in importance in Europe and eventually in other parts of the world as well. If adequately implemented these scenarios allow in most countries a significant contribution to the primary energy demand. This fact is even more important once the share of biogenic energy inventory of MSW is taken into account. This biogenic energy share is in the EU countries roughly in the order of 50 % and this fact has already been acknowledged by a number of national authorities. In these countries power from waste incineration is to a certain extent rewarded as coming from renewable energy sources.

The biogenic fraction in MSW means also that the respective share of emitted CO_2 has to be looked upon as climate neutral and could be categorised as such in CO_2 trading systems. For the highly industrialised EU countries this accounts for approx. 1 % of the annual CO_2 emission.

Taking into account that the current discussion on climate change and global warming initiated a world wide strong political support for bioenergy, the need for inertisation of residual waste prior to final disposal should be seen as a chance to exploit the energy in waste as extensively as possible. Such tendency is seen in Europe and is reason to expect waste incineration being the fastest growing bioenergy sector in the EU during the next years. The positive results obtained so far in the EU could be a model for other parts in the world.

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