



UK WASTE COMPOSITION WASTE TO ENERGY

# UK WASTE MANAGEMENT: GROWING OLD OR GROWING CLEAN?

**Recycling, composting and waste to energy go hand in hand in the UK, which strives for sustainable waste management. In order to assess what the best alternatives are, it's important to first understand the generation and composition of municipal solid waste. A recent academic study by Columbia University set out to do just that.**

By Nickolas Themelis and Athanasios Boutsalalas

As the UK strives to achieve its obligations under the EU Landfill Directive, it has turned increasingly to a range of alternative disposal options. These include increased recycling, composting, anaerobic digestion and the use of thermal treatment facilities to recover energy from waste.

Many new facilities have entered service over recent years and several others are in the pipeline. But to ensure the correct mix of technologies are deployed, it is important to first understand the composition of the waste to be treated.

With this in mind the objective of the recent study was to carry out a critical analysis and cross check various sets of data - either already available in current literature or solicited from various government agencies - and develop information which can guide the future research of the Waste to Energy Research and Technology Council UK (WERT-UK) - headquartered at Imperial College London.

The research presents a detailed analysis of the current management of municipal solid wastes (MSW) in the UK and future challenges. It includes characterisation of the generation and disposition of MSW at the national and regional levels.

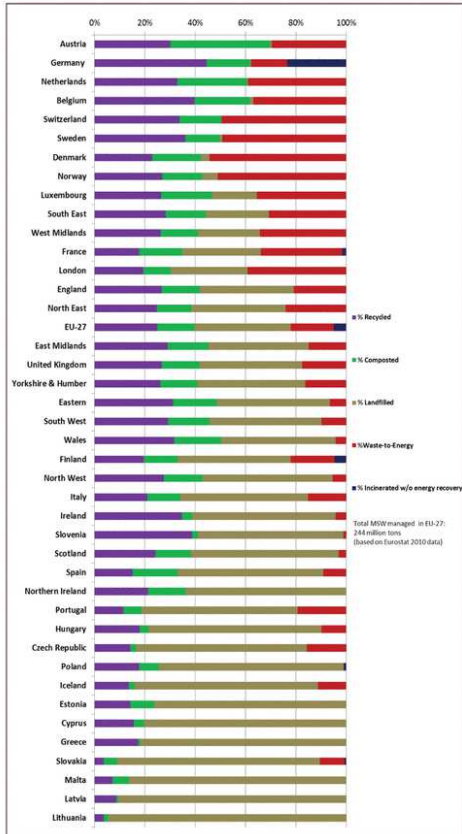
## MSW PRODUCTION & COMPOSITION

Recycling, changing habits due to the economic slump and the successful application of sustainable waste management programmes have resulted in a reduction to the generation of MSW in the UK.

According to figures published by the UK government's Department for Environment, Food & Rural Affairs (Defra), in 2012 the UK produced about 31 million tonnes of Municipal Solid Waste (MSW). The figures show that this MSW consists mostly of residential, commercial and market wastes, with the reported 31.1 million tonnes generated in 2012 representing an 11% decrease compared to 2007, and 13.1% decrease from 2002. The per capita generation was 0.49 tonnes, and ranged from a high of 0.60 in Scotland to a low of 0.48 tonnes per capita in England.

The generation of MSW is predicted to continue to decrease over the next 20 years from 32.3 million tonnes in 2010 to 29.5 million tonnes in 2030. This forecast is based on the Bogner and Matthews model, which shows a linear relationship between the energy consumption of a nation and its generation of MSW, as well as on an energy consumption forecast published by the UK

**WASTE TO ENERGY UK WASTE COMPOSITION**



government's Department of Energy and Climate Change (DECC).

The average composition and calorific value of MSW in the UK is calculated to be 12 MJ/kg. This value corresponds to an equivalent of 3.3 MW per tonne of waste per hour. Plastics have the highest calorific value, contributing 8.8% to the total calorific value of MSW. Waste paper and cardboard represent the highest percentage in the total composition of the UK MSW, while also contributing a large fraction of the calorific value of MSW (Table 1).

In recent years, a combination of recycling and composting has become the largest means of managing wastes, accounting for 26.7% and 15.5%, respectively, of the total MSW generated. A total of 73% of the composted waste is treated in open air windrows. However, 40.3% is still sent to landfill while only 16% is combusted in 24 waste to energy facilities which recover 1594 GWh of electricity annually - this equates to some 0.41 MWh of electricity generated for every tonne of MSW combusted.

**REUSE, RECYCLING & COMPOSTING**

As noted, recycling/reuse together with composting have become the dominant methods of waste management in the UK, accounting for 42.2% of the total MSW. In 2012 a total of 13.1 million tonnes of MSW was recycled or composted in the UK, representing an increase of 27.3% since 2002. The per capita recycling and composting for UK residents is 0.21 tonnes. England recycles and composts the least with 0.20 tonnes per capita (42% of the total MSW produced in England), followed by Northern Ireland (0.21); 39% of the total MSW produced in N. Ireland), Wales and Scotland (0.25 each; 50.1% and 42% of the total MSW produced in each country accordingly).

According to the Anaerobic Digestion & Biogas Association (ADBA) there are currently well over 100 operational anaerobic digesters, not counting those operating at water treatment facilities.

In 2012, there were also 203 composting sites (149 open windrow, 41 in-vessel and 13 combined open windrow and in-vessel), the majority of which are located in the east of England (38), followed by the south east (35) and north west (27).

In the same year, there were 2341 recycling facilities operating, 749 of which processed end-of-life vehicles (ELV), 761 were vehicle dismantling facilities, 60 vehicle de-pollution sites and 771 metal recycling plants.

**LANDFILLING**

The 40.3% of MSW landfilled in the UK is sent to the country's 725 active landfill sites; producing some 4979 GWh of electricity from the methane recovered.

Notably, almost 1700 landfill sites have stopped operation since 2001, showing that the country is moving away from landfill as an option for waste management.

England is landfilling less with 0.18 tonnes per capita, followed by Wales (0.23), N. Ireland (0.32) and Scotland (0.33).

**ENERGY RECOVERY**

Of the total MSW produced in the UK in 2012 some 16.1% was processed in waste to energy plants. This accounted for some 5% of the country's total Renewable Energy Sources (RES) - an increase in the contribution of made by waste to energy plants of some 300% since 1996. A total of 1739 GWh electricity and heat combined.

There are 24 plants currently operating, while 14 new facilities are in various stages of construction. In England, 0.09 tonnes per capita were processed in Waste to Energy plants in 2011/12. In Scotland and Wales, however, only 0.02 tonnes per capita was sent to energy

**Table 1. Composition of MSW and calorific value**

Material	% In MSW	Contribution to calorific value (MJ/kg)	
		MJ/kg	MJ/kg
Plastics	8.80%	34.51	3.03
Glass	9.00%	0.20	0.01
Textiles	3.30%	16.12	0.53
Paper & Cardboard	21.35%	17.23	3.68
Food waste	17.33%	4.20	0.73
Garden waste	13.68%	18.49	2.53
Other natural organics	2.12%	4.18	0.08
Metal	4.00%	0.00	0
HHW	0.63%	0.00	0
WEEE	2.25%	0	0
Fines	1.52%	7.40	0.11
Other combustibles	10.82%	12.07	1.3
Other non-combustibles	5.20%	0.00	0.00
<b>Total</b>	<b>100.00%</b>		<b>12.00</b>



**UK WASTE COMPOSITION WASTE TO ENERGY**

recovery facilities. There was no energy recovery at all in Northern Ireland.

Additionally, Mechanical Biological Treatment (MBT) facilities in England processed 1.4% of the total MSW generated in the UK in 2012 to produce Solid Recovered Fuel (SRF) or Refuse Derived Fuel (RDF). This percentage corresponds to only 0.008 tonnes per capita.

In Scotland and in Northern Ireland there are no MBT plants, while in Wales 0.005 tonnes per capita were processed into RDF. In total, there was an increase of 0.8% of MSW treated by MBT plants since 2002.

In total, there are about 19 facilities in the UK using various MBT processes with a production capacity of approximately one million tonnes of SRF, used mainly in the cement industry.

The total energy produced by bioenergy based technologies and waste treatment operation sites was 12,973 GWh. This represented an increase in energy production these sources of 620% from 1996.

The oil equivalent of the energy produced from wastes in 2011 was 750 thousand tonnes. Of this 717,300 tonnes equivalent was due to the production of electricity from waste – an increase of 928% since 1990. An additional

32,700 tonnes of oil equivalent came from the generation of heat from wastes.

**THE ECONOMICS OF WASTE MANAGEMENT IN THE UK**

The gate fee for landfilling lies between £73 and £127 per tonne, with the median fee paid by local authorities in 2012 being £85 per tonne. By contrast, the average gate fee paid at an MRF was just £9 per tonne of recyclable materials, or £26 per tonne at facilities which entered service after 2011.

Open air windrow composting sites averaged £24 per tonne, in-vessel composting and anaerobic digestions plants both charged £43 per tonne.

The gate fee paid by local authorities at waste to energy plants was £54 per tonne for those facilities built prior to 2000 and £73 per tonne for plants built after the year 2000. The gate fees at MBT plants were £84 per tonne of waste. It is clear to see then, that the most economically viable form of waste management, other than prevention, is the reuse and recycling of materials, with an average gate fee of only £9 per tonne of waste.

**CONCLUSIONS ON THE GLOBAL STATUS OF WASTE MANAGEMENT IN THE UK**

A Chinese proverb states: "The longest journey starts with a single step". This reflects the progress made towards improving the waste management situation in the UK.

The country has rapidly increased its sustainable waste management practices over recent years, and has achieved this by placing an emphasis on recycling and composting. This is while also significantly increasing its waste to energy capacity. Using statistics provided by Eurostat, the Confederation of European Waste-to-Energy Plants (CEWEP) and the published data of several other nations, the global waste management 'ladder' (p45), along with the position of UK on the ladder.

The concept is to show that nations that recycle more of their municipal solid waste, and process more of their residual MSW in waste to energy facilities, therefore less landfilling, are higher up the ladder of sustainable waste management.

The countries were ranked according to their result on the formula below, where waste to energy (WTE) includes MBT facilities:

$$R = 1.2 * (\text{RECYCLING} + \text{COMPOSTING}) \% + \text{WTE} \%$$

Taking into account that the UK's Gross Domestic Product (GDP) per capita (on a purchasing power parity basis) is approximately 1.1 times higher than the European average, as well as its position on the global sustainable waste management ladder, the country is below several other European nations.

Therefore, while the UK has now taken several steps on its journey towards sustainable waste management practices, the road is long and there is considerable room for further advancement.

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**Table 2. Gate fees paid for waste management techniques in the United Kingdom**

Treatment	Grade/material type of facility	Prices		Median		% change since 2011
		£	€	£	€	
MRF	All	- 66 to 73	- 82 to 90.5	9	11	-40.0%
	Contracts starting in 2011 or later	- 55 to 4	- 68 to 5	-26	-32	-750.0%
Landfill	Non-hazardous waste gate fee only	9 to 63	11 to 78	21	26	5.0%
	Non-hazardous waste gate fee plus Landfill tax	73 to 127	90.5 to 157.5	85	105	11.8%
	Hazardous waste gate fee (code 17 05 03)	23 to 50	28.5 to 62	29	36	
	Hazardous waste gate fee (code 17 06 01)	40 to 95	50 to 118	85	105	
WtE	Hazardous waste gate fee (code 17 06 05)	30 to 60	37 to 74	40	50	
	Pre 2000 facilities	32 to 75	39 to 93	64	79	18.5%
	Post 2000 facilities	44 to 101	55 to 125	82	102	12.3%
	Defra Gate fee data					
MBT	<200 kt	79 to 131	98 to 163	90	112	
	200 kt to 300 kt	56 to 102	69 to 127	76	94	
	350 kt to 450 kt	57 to 78	71 to 97	68	84	
Organics	Open-air windrow(OAW)	15 to 53	19 to 66	25	31	4.2%
	In-vessel(IV), food& garden waste	28 to 60	35 to 75	44	55	2.3%
	Anaerobic Digestion (AD)	35 to 60	43 to 75	41	51	-4.7%