Proceedings of the Institution of Civil Engineers
Energy 163
May 2010 Issue EN2
Pages 79–86
doi: 10.1680/ener.2010.163.2.79
Paper 900005
Received 22/01/2009
Accepted 14/10/2009
Keywords:
landfill/public policy/waste management & disposal

Tooraj Jamasb
Faculty of Economics, University of Cambridge, Cambridge, UK

Rabindra Nepal
Bremer Energie Institut, Jacobs University Bremen, Bremen, Germany

Hande Kiamil
Faculty of Economics, University of Cambridge, Cambridge, UK

ice Institution of Civil Engineers

Waste to energy in the UK: policy and institutional issues

T. Jamasb PhD, R. Nepal BA and H. Kiamil BA

A sustainable waste management policy is necessary to manage the growing stream of municipal solid waste in ecologically sustainable ways. Although landfill has been the dominant form of waste management in the UK there is a need to comply with the European Union landfill directive. Waste to energy (WtE) is a viable waste management option to reduce the reliance on landfills and reap the energy benefits of waste. The first waste-fired power plant was built in the UK in 1885 but several barriers have constrained the use of WtE. This paper assesses the policy and institutional context for the development of WtE in the UK. It discusses how public opinion and choice of technology are important factors in achieving a wider acceptance of WtE in the UK. There is a need to devise coordinated policies on sustainable waste management at the regional and local levels. Furthermore, making all WtE technologies eligible for renewable obligation certificates could support the development of the technology and divert waste from landfills. The absence of efficient heat delivery networks is also a barrier to fulfilling the potential for WtE in the UK.

1. INTRODUCTION

Modern economies produce large quantities of waste as a by-product of economic activity. This tendency is compounded by economic and population growth. In 2005–2006 the UK produced almost 29 million tonnes of municipal solid waste (MSW) (Defra, 2007), as well as around 85 million tonnes of industrial and commercial waste. How this waste is managed can have significant economic, environmental and energy implications. The majority of waste disposal options – including landfilling and recycling – use energy as an input. In contrast, waste to energy (WtE) technology uses MSW to generate electricity and heat.

Energy from waste is estimated to increase from the current 9% of total MSW to around 25% by the end of 2020 in the UK (Defra, 2006). WtE is a unique source of energy in terms of the cost of fuel. Fuel cost constitutes a significant share of total cost of energy from thermal sources. Most renewable energy generation (such as wind, solar, marine and hydroelectric) is capital intensive but has no direct fuel cost. A notable exception is biomass energy from crops. MSW is essentially a biomass energy resource, however its use as an input in WtE incurs a negative fuel cost because plants receive gate fees for accepting delivery of the waste. These payments account for most of the earnings of WtE plants.

The European Union (EU) directive 1999/31/EC requires the quantity of MSW sent to landfill to be minimised. In the UK, landfill for waste disposal has been favoured in the past due to the naturally impermeable ground conditions. In April 2004 the landfill tax rate for active waste was increased by £1 to £15 per tonne and the rate as of 2008–2009 is £32 per tonne. The tax is scheduled to rise to £48 per tonne by 2010, making the UK's tax rate comparable with other EU countries such as Sweden and Denmark. WtE can reduce the amount of waste sent to landfill in the UK. In addition, the compatibility of WtE with recycling means that WtE could be an important alternative energy source in the UK (Lea, 1996). However, achieving the environmental and energy benefits of WtE can only occur through sustainable waste management and energy policies.

Climate change and a constant supply of waste are challenging policy issues. The UK has a target of generating 10% and 20% of its electricity from renewable resources by 2010 and 2020, respectively. Therefore, it is important to assess the potential for, and the significance of, WtE in the context of the UK's energy and environmental policy. In 2004, the amount of electricity generated from renewable sources was 14 171 GWh – that is, 3·6% of the total electricity generation (Defra, 2006). Landfill gas and WtE from combustion of biodegradable MSW accounted for 23% and 10% of total renewable electricity, respectively (Defra, 2006).

This paper presents a descriptive and analytical assessment of the policies and institutional arrangements affecting WtE in the UK. The paper discusses whether the UK's waste management policies can help reduce its dependence on landfills and meet the EU landfill targets. Institutional factors and factors conducive to the development of WtE are discussed. The paper is structured as follows. The next section reviews the UK's current waste management policy. Section 3 provides a brief policy discussion. Section 4 concludes the paper.

2. THE UK'S WASTE TREATMENT POLICY

The disposal of waste through incineration dates back to 1874 when the first fully functional incinerator was constructed in Nottingham. The facility remained in operation for 27 years, with the ash from the plant being used as a building material. The world's first waste-fired power plant was constructed in

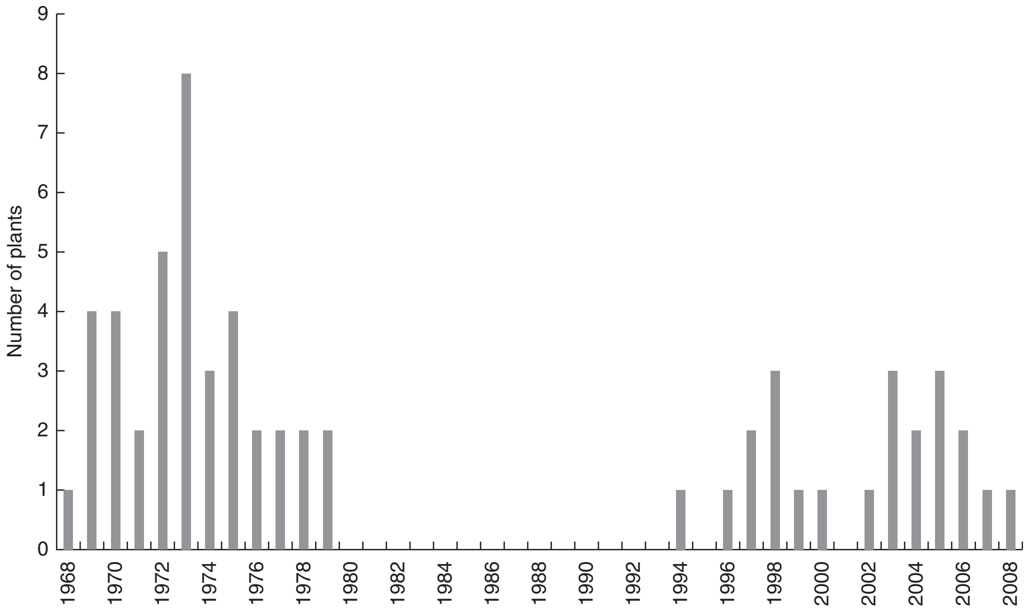


Figure 1. WTE plants commissioned in the UK (1968–2008) (CIWM, 2003)

Shoreditch, London in 1885. By 1912, there were some 300 waste incinerators in the UK, 76 of which generated electricity (CIWEM, 2007). The early plants emitted ash, dust and charred paper, which was scattered over the surrounding neighbourhoods. Local opposition dampened the development of the technology in the UK and efforts to deploy WtE came to a halt during World War II. As mining and quarrying opened up large cavities for cheap waste disposal, WtE gradually became redundant.

The 1960s and 1970s saw a new period of plant construction. About 40 incinerators were built, but because the main objective was to reduce the volume of waste to ease the pressure on landfills, only five plants were equipped for power generation. Technical knowledge of WtE in the UK had virtually disappeared and the new firms entering the industry constructed facilities using overseas designs at low cost. Maintenance costs rose above expectations, however, and numerous plant breakdowns made it necessary to provide emergency disposal sites for diverted waste. Landfill proved to be the more reliable alternative (Waste Online, 2007). Furthermore, there was a growing awareness of the invisible environmental and health implications of the largely unregulated emissions from WtE plants, with relatively basic emissions control equipment.

By the end of the 1980s, public opinion about WtE began to change due to increased awareness of the volume of waste sent to landfills. A further 18 plants have since been approved by the Environmental Agency, with many smaller private projects authorised under environmental health powers granted to district and borough councils (Swindon Borough Council, 2005: 10). Figure 1 shows the highs and lows of WtE plant construction in the UK from 1968 to 2008 (see CEWEP (2009) for the number of WtE plants operating in the UK and Europe).

Figure 2 shows MSW management in England by region during 2005–2006. Of the 28·7 million tonnes of waste, 17·9 million (62%) were sent to landfill, down from 19·8 million tonnes (67%) in 2004–2005 (Defra, 2006). Around 37% of the waste was recycled, composted or incinerated with energy recovery, but with considerable regional variations. In the West Midlands, almost 31% of the total waste was incinerated with energy recovery, while the figure was only 9% across England. Such variations in waste incineration across different regions in the UK are due to differences in public opinion, the varying priorities and needs of each region, as well as different regional and local policies.

Establishing competitive markets for waste management externalities through the allocation of property rights is generally desirable but inherently difficult. However, it may not always be the most suitable option because market designs in countries like Spain and Austria have performed better in terms of technology deployment and environment. The number of agents involved (on a local, national and global scale) makes defining rights difficult and the accompanying transaction costs prohibitively high. The alternatives are either market-based incentives or command-and-control policies. These policies are capable of achieving a Pareto optimal outcome under the assumption of a first-best world, in which government is benevolent and there is perfect competition and perfect information on the market. In reality, based on the degree to which these assumptions break down, certain policies can be more appropriate than others. These may bear elements of market-based incentives and command-and-control policies. In the European context, feed-in tariffs and renewable obligation certificates are the main policies to achieve government targets.

This section evaluates the policies that influence WtE decision-making, taking into account the circumstances within which they operate. Figure 3 is a simplified representation of England's waste management decision-making structure. It depicts the relationships between the main bodies and policy documents; it can be referred to throughout this section as a

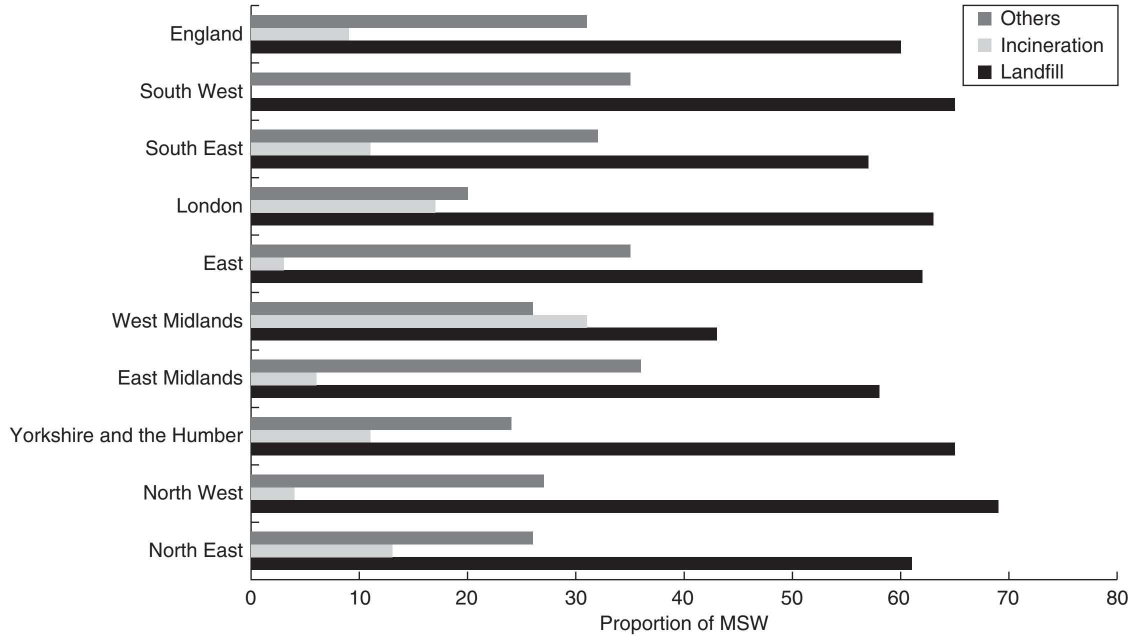


Figure 2. Municipal waste management in England by region (compiled from Defra, 2007)

guide to how policy and policy-making components fit together. While the systems in Scotland, Wales and Northern Ireland are similar, the nature of local government and the names of equivalent bodies differ. The remainder of this section analyses the five important policy areas affecting decisions regarding WtE in the UK.

2.1. Landfill tax

In principle, a Pigouvian tax is the most efficient way to correct market failure from negative externalities (Pasour, 1994). For example, internalising the external effect of a waste management option on global warming would involve taxing the non-carbon neutral greenhouse gases (GHGs) emitted. One tonne of biodegradable municipal waste produces between 200 and 400 m^3 of landfill gas as it decomposes. As of 2001, the methane emissions from landfill accounted for 25% and 2% of the UK's total methane and GHG emissions, respectively (Defra, 2005a).

It is difficult, however, to determine whether the emissions are carbon neutral as this depends on the type of materials in the waste stream and the landfill facilities used. The information requirement and high transaction costs, therefore, make it difficult to use Pigouvian tax to internalise the costs of global warming. Such a tax also involves evaluating the marginal social damage at the optimal (not current) level of emissions and requires information on the damage functions of individual agents and costs of abatement. Imperfect information leads to second-best options and hence implementing landfill tax is justifiable. Furthermore, the benefits of a simple-to-operate landfill tax can outweigh those of a complex system aiming to correct each externality separately and directly.

The landfill tax was introduced in 1996 at a rate of £7 per tonne of MSW based on an assessment of the external cost of landfill. The tax aimed to account for all the external costs of landfill using a single instrument. The tax is a 'green tax' because it is not levied directly on emissions but on the tonnage of waste produced, a quantity which is correlated with the externalities of landfill.

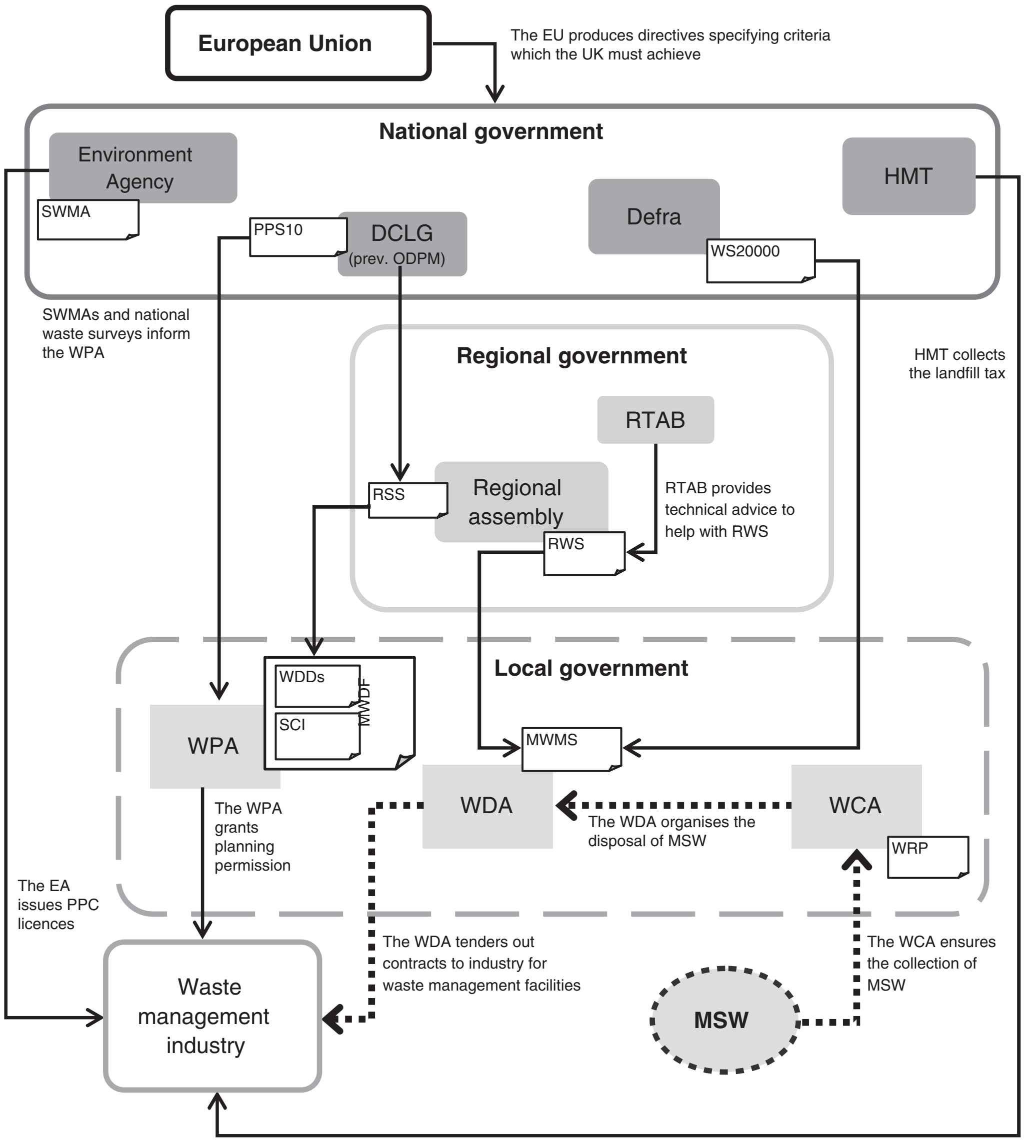
The introduction of a 'landfill tax escalator' in 1999 first raised the tax by £1 per year, then by £3 per year from 2005. From 2008, the tax has risen by £8 per year. These increases were initially justified because the original research on deciding the landfill tax was a lower-bound estimate of the cost of landfill, having excluded the disamenity consequences from the calculation (Turner *et al.*, 1998). The latter tax increases have been justified as a method of achieving targets for the diversion of waste from landfill.

The landfill tax and landfill tax credit scheme (LTCS), introduced on 1 October 1996 with subsequent reforms made on 1 October 2003, move in tandem and can influence each other. The LTCS enables waste operators to provide funding to organisations through tax credits for qualifying environmental projects. It also enables landfill operators to claim a credit against their landfill tax payment if they make voluntary contributions to an approved environmental body for an approved project (Morris and Read, 2001).

Introducing landfill tax can encourage the use of WtE and recycling as the cross-price elasticity of demand for the different waste management options is positive. However, the increase in landfill tax has also led to an increase in fly-tipping as the tax was directly passed on to the consumers (Morris and Read, 2001). The environmental and health impact of this waste can only be addressed when it is found and moved to an authorised place of disposal.

2.2. Landfill allowance trading scheme

Article 5 of the EU landfill directive (1999/31/EC) sets caps on the quantities of biodegradable MSW that can be sent to landfill based on three target dates. The directive aims to minimise the impact of landfilling biodegradable waste on health and the



DCLG	Department of Communities and Local Government	RTAB	Regional Technical Advisory Board
Defra	Department for Environment, Food and Rural Affairs	RWS	Regional waste strategy
EA	Environment Agency	SCI	Statement of community involvement
HMT	HM Treasury	SWMA	Strategic waste management assessments
MSW	Municipal solid waste	WCA	Waste Collection Authority
MWDF	Minerals and waste development framework	WDA	Waste Disposal Authority
MWMS	Municipal waste management strategy	WDD	Waste development document
ODMP	Office of the Deputy Prime Minister	WPA	Waste Planning Authority
PPC	Pollution prevention and control	WRP	Waste recycling plan
PPS10	Planning Policy Statement 10	WS2000	Waste Strategy 2000
RSS	Regional spatial strategy		

Figure 3. Waste management policy in the UK (compiled from DCLG, 2009; Bulkeley *et al.*, 2004; Swindon Borough Council, 2005)

environment, particularly with regard to methane emissions. The UK can landfill about 75%, 50% and 35% (from the 1995 tonnage) of biodegradable municipal waste by 2010, 2013 and 2020, respectively.

The targets of the directive have been translated into local authority allowances and have been grandfathered on the basis of past landfilling activity. In England these allowances have been tradable since April 2005 under the landfill allowance trading scheme (LATS). Under this scheme, each waste disposal authority (WDA) is assigned a limited allowance for landfilling bio-degradable municipal waste in England. The LATS aims to minimise the effect of waste management on global warming, as well as reducing local pollution and improving the use of raw materials. Tradable allowances aim to achieve an aggregate quota at the lowest cost. A market for the permits establishes one price for a tonne of waste landfilled and ensures that the marginal cost of abatement is equal across local authorities. Authorities that can divert waste from landfill at low cost will do so, while those that find reducing landfill expensive can purchase allowances instead. However, the cost of an allowance is unknown and the government does not set price floors or ceilings. In theory, the cost will be determined by supply and demand; it could be £0 per tonne when supply is in excess or it could rise to the level of the penalty (£150 per tonne) if allocation is exceeded. If a WDA misses its target for any year, the government has indicated that it will fine the authority at a rate of £150 for each additional tonne (LATS, 2005). However, the LATS only applies across England. In Wales, by contrast, there is a landfill allowance scheme developed from the Waste and Emissions Trading Act, which is based on £200 per tonne and no trading. Furthermore, Wales also has set limits on the amount of MSW that can be treated via WtE technology. Such differences in the allowance schemes can reflect differences in acceptability of WtE technologies in the UK.

Achieving the correct allowance price requires a competitive market, which currently does not exist. Most local authorities are operating at their allocated allowances so there are only a small number of them in the market. As the targets become more stringent over time, the differences in costs of landfill will become more apparent. Consequently, new entrants to the market will encourage a competitive market for allowances. The level of allowances will be reduced from year to year to ensure that the EU directive's overall limits are met. The LATS will drive MSW away from landfills resulting in a greater amount of energy being derived from waste. Therefore councils who incinerate waste in the UK will be rewarded (House of Commons, 2005).

2.3. Renewable obligations

The renewable directive (2001/77/EC) aims to increase the share of electricity generated from renewable sources to achieve sustainable development, strengthen the reliability of energy supply and reduce GHG emissions. The directive was translated into UK law in April 2002 in the form of the Renewable Obligation Order, replacing the Non-Fossil Fuel Obligation (NFFO) as the policy for supporting the development of renewable energy. Under this scheme, suppliers can purchase annually increasing percentages of their electricity from accredited renewable sources up to a maximum of 20% by 2015–2016. The proposal on banding of the renewable obligation will also encourage other groups that need similar levels of support and incentives for driving forward innovation and technical progress in generation solutions (see the White Paper, *Meeting the Energy Challenge* (DTI, 2007) for more details).

The licensed renewable electricity generators are issued renewable obligation certificates (ROCs) by the Office of the Gas and Electricity Markets. These certificates are tradable and there is a buyout price for each MWh of the statutory requirement that is not met to prevent the price of ROCs from reaching unacceptably high levels. Figure 4 shows a breakdown by technology of ROCs issued in England in 2007–2008. Landfill gas accounted for 45% of the total ROCs issued during this period and biomass 13%.

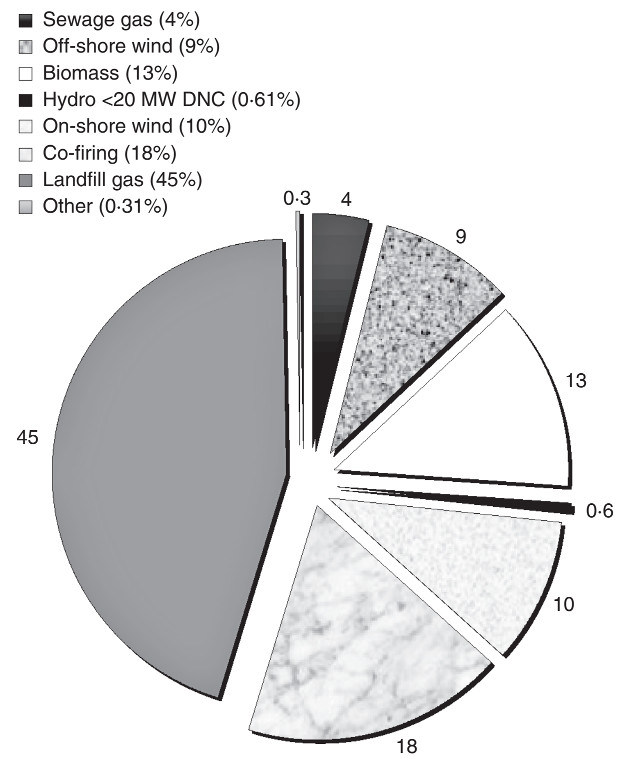


Figure 4. Renewable obligation certificates by technology type in England (compiled from Ofgem, 2009)

Pyrolysis, gasification and landfill gas are eligible waste-based energy sources. Pyrolysis and gasification are eligible for 2 ROCs/MWh if qualified as 'advanced pyrolisis' and 'advanced gasification', respectively. In addition, waste containing 90% biomass is eligible as biomass while renewable obligation is neutral to solid recovered fuel in a co-fired generator. Although biodegradable waste processed in WtE plants qualifies as a renewable energy source in the directive, it is not eligible for ROCs. WtE can be a source of renewable energy and the policy of not issuing ROCs to WtE plants may, therefore, need to be revised. In March 2006 it was decided that a WtE plant would qualify for ROCs only in the form of a combined heat and power plant. A report by ILEX Energy for the DTI found no environmental basis for differentiating between technologies for energy recovery from waste, as all plants have to meet the same emission targets as specified by the waste incineration directive (2005).

The decision to exclude WtE (and large hydro) from ROCs is justified by the government on the grounds that the technology is already capable of competing with electricity from fossil fuels without additional support (DTI, 2000). In addition, since WtE plants already receive revenue from gate fees for accepting waste, ROCs are not offered to WtE plants that adhere to the 'polluter pays' principal. Moreover, measuring the biomass content of MSW has also been an obstacle for WtE plants qualifying for ROCs. Nonetheless, by distinguishing between renewable technologies, ROCs take on a second policy aim – to encourage the advancement of technologies that are not currently commercially viable. Using ROCs in this way can reduce the chances of achieving the original goal of increasing renewable energy generation while helping to deliver more efficient technologies in the longer run.

2.4. Pollution prevention and control licences

The integrated pollution prevention and control directive (96/61/EC) provides the basis for the UK's waste licensing system. It requires the existence of a waste regulation authority and sets limits for air, water and soil pollution. More recently, stricter limits have been specified for WtE emissions in the waste incineration directive (2000/76/EC). The limits were chosen using the best practicable environment option principle, which aims to minimise health and environmental damage at an acceptable cost. In addition, more air quality requirements are set to take effect from 2009 under the sustainability scheme in the renewable energy directive. The proposal on biomass sustainability criteria specifies a minimum requirement for GHG saving of at least 35%, while the figure for fossil fuel is 50% by 2017. For new installations, the requirement is 60%.

In England and Wales, the Environment Agency is responsible for issuing pollution prevention and control (PPC) licences to plants meeting the relevant criteria (Environment Agency, 2007). The introduction of PPC licences has led to significant cuts in the emissions of pollutants from WtE plants. Between 1993 and 2003, sulfur dioxide emissions fell by 99·38%, lead emissions by 99·5% and dioxin emissions by 99·99% (ESA, 2006). Cost of compliance has also resulted in the closure of some WtE plants.

However, health concerns remain a sticking point in many WtE plant applications due to the perceptions of local residents. In some cases, plants which have secured a PPC licence have been refused planning permission on the grounds that the perception of effects would negatively affect the use of the surrounding land (CIWM, 2003). Government reports indicate that the impact on human health from WtE emissions is minimal (Defra, 2004) compared with landfills, which can blight an area and cause a fall in house prices and personal wealth (BMBC, 2006). The emission limits are far stricter than for other forms of electricity generation (ILEX Energy, 2005).

2.5. Planning permission process

In addition to a PPC licence, new WtE facilities must obtain planning permission from the local waste planning authority (WPA). The process ensures that firms consider the impact of the plants on the local community and internalise and minimise local concerns about disamenity, congestion and health. To help speed up the process, each WPA is required to produce a waste development document setting out the criteria on which planning permission requests will be judged. These documents also list specific sites that are well suited to development and therefore most likely to be granted planning permission.

The planning permission process has been criticised for its separation from the management side of waste facility provision. The WDA is responsible for negotiating contracts with the waste management industry for MSW plants. The authority produces a municipal waste management strategy (MWMS), which details its programme for sustainable waste management, including the types of facilities needed to achieve national and regional targets. Industry is then invited to outline proposals for achieving the MWMS and to choose the most preferred contract. Industry therefore needs to find a way to meet the requirements of both the MWMS and the planning permission process. The coordination between the waste development document and the MWMS is insufficient due to their different processes and timetables and can lead to tension between the two authorities (Bulkeley *et al.*, 2004).

The division of planning and management policies is a recognised problem, and there are initiatives to improve coordination. Planning Policy Statement 10 (PPS10) made the production of a regional spatial strategy mandatory for each regional assembly (SITA UK, 2007). The strategy provides guidance from the regional level on land that is acceptable for planning permission. The regional assembly also produces a regional waste strategy and is therefore in a position to coordinate planning and management. Regional government is expected to encourage coordination on waste management between adjoining local authorities. This is beneficial given that waste often crosses local authority boundaries for disposal. Joint management also gives authorities greater flexibility in the size and type of WtE facilities.

3. POLICIES FOR IMPROVED WASTE MANAGEMENT OPTIONS

Achieving the potential benefits of ambitious waste management and WtE options requires a new institutional and policy framework. Our review of the policy framework for WtE decisions in the UK has shown that a range of policies are currently originating from different levels of government.

Conflict of objectives can cause policy failure. For example, the landfill directive intends to phase out landfill sites while the renewable obligation encourages landfill and discourages WtE unless as combined heat and power (CHP) technology. The landfill tax and LATS aim to internalise the externalities associated with landfill. However, problems with the collection of landfill tax and the operation of the LTCS have provided an additional burden to the waste management system. Tax collection in the past failed because not all sites have a weighbridge and non-weight calculations are open to abuse. It is claimed that the LTCS is ineffective due to a lack of transparency and independence (Morris and Read, 2001). These issues have prompted questions as to what extent the management of waste has improved after the introduction of the landfill tax and to what extent the money raised through the LTCS has been used to promote better waste management (Morris *et al.*, 1998).

The government can improve the waste strategy by managing municipal, commercial and industrial waste together to minimise the conflict of objectives among policies, improve efficiency, and reduce transaction costs. In addition, increased transparency and autonomy would reduce potential conflicts of interest. The PPC licence and planning permission process work towards internalising the local costs of WtE, in particular those relating to health and disamenity effects. Even though the PPC licence sets stringent emission levels for WtE plants, there is often opposition to new plants because of health concerns and this has an impact on planning permission outcomes (Defra, 2005b). Similarly, the national policy statement on renewable energy prescribes standard environmental regulations concerning WtE technology, although it is less likely to have a significant impact on plants with a capacity of less than 50 MW.

To reduce the influence of local campaigners with vested interests, policy should be issued from higher government levels. For example, the Department of Communities and Local Government could use the PPS10 to remove strict health concerns as a criterion for rejecting planning permission. At the same time, the role played by community-led approaches such as community volunteerism should not be undermined.

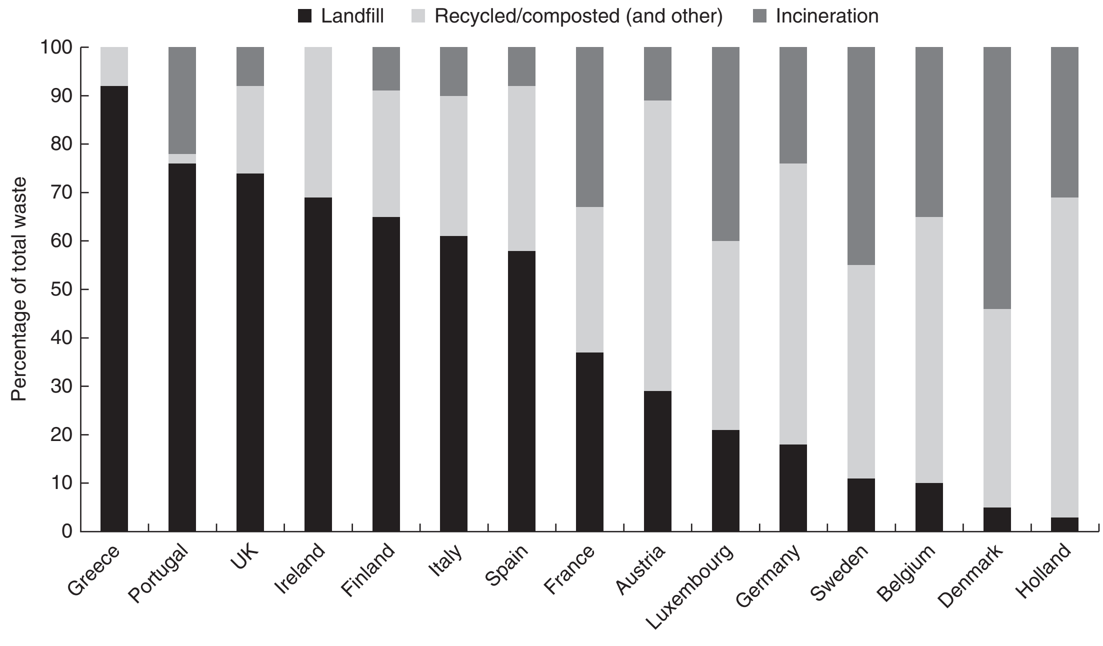


Figure 5. Municipal waste management in the EU 2005–2006 (compiled from Defra, 2006)

A further barrier to renewable sources of energy such as WtE was the new electricity trading arrangement (NETA) (Connor, 2003), now superseded by the British electricity trading and transmission arrangement. NETA was a mechanism to balance the electricity supply market in the UK, but it has been criticised as unfavourable to generators with less predictable outputs. The mechanism did not take into account the advantages of distributed generation technology. As a result, some economic advantages of renewable energy technologies have been ignored, which makes them less cost-effective, less desirable and therefore less likely to be competitive (Connor, 2003).

A final shortcoming of WtE policy is the absence of elaborate and distinct mechanisms for internalising the external benefits of WtE in terms of net reductions in GHGs and increased security of energy supply. However, the EU emissions trading scheme and the renewable obligation as a technology support scheme to some extent contribute to promoting energy diversity and security of supply. WtE is currently excluded from ROCs on the grounds that it is a commercially viable technology despite having positive externalities. The eligibility of pyrolysis, gasification and CHP, and the ineligibility of WtE offer a comparative advantage to newer thermal treatment technologies.

The proliferation of a technology significantly depends on public acceptance. Public perception of WtE differs from country to country. Figure 5 shows the practice of waste incineration across several European countries. Countries such as Denmark and Sweden have been able to fully utilise the energy benefits from WtE technology compared with the UK. Denmark, for instance, has 100 years of experience with WtE and the population is familiar with the technology. As such, Denmark also has delivery networks for heat distribution from WtE plants. Therefore, national energy policy, flow control, fiscal and legislative measures, as well as a ban on the landfill of combustible waste have promoted WtE in Denmark, which is already meeting the targets set under the EU directive (Dalager, 2006). In addition, the presence of efficient energy delivery networks has helped the development of WtE technology. Public involvement and increased voluntary participation towards community development through proper waste management in the waste planning process could also mitigate local opposition and foster balanced opinions on WtE. The UK government is currently planning to encourage WPAs to produce statement of community involvement documents specifying how stakeholders will be consulted, and how their views can feed into the waste development document process (The Planning Inspectorate, 2005).

4. CONCLUSIONS

In this paper the authors have discussed the institutional and policy framework affecting the development of WtE plants in the UK. Promoting WtE as an effective waste management practice and as an alternative energy source is vital for the UK to meet the targets set under the EU landfill directive. However, an effective waste management policy needs to be in place as a first step. Differences in public opinion and the choice of WtE technology act as barriers in realising the full benefits from WtE plants. In addition, difficulty in proving the amount of biodegradability of a material is also a severe barrier against the proliferation of WtE technology in the UK.

A coordinated and harmonised combination of regional and local policies on MSW management may help to achieve public acceptance of WtE technology. In addition, it will provide a level playing field for WtE technology against other renewable energy sources. It would be helpful to make WtE eligible for ROCs, which is not current UK policy. While it remains difficult to prove the amount of biodegradability of a material, the UK government could allocate a portion of ROCs to incineration technology, as in the Netherlands. Granting ROCs to all WtE technologies is vital in reducing overdependence on landfills and in meeting the 2020 renewable targets. However, achieving the full advantages of WtE technology can only be realised with the development of effective energy networks. The energy benefits from WtE plants can be increased with efficient heat delivery networks. The absence of these networks can also act as a barrier to investment in WtE plants as a renewable energy source in the UK. Further research, however, is recommended.

ACKNOWLEDGEMENTS

The authors acknowledge the support of the ESRC Electricity Policy Research Group. They are also grateful for constructive comments from an anonymous referee. Any remaining errors remain the responsibility of the authors.

REFERENCES

BMBC (Barnsley Metropolitan Borough Council) (2006) *Municipal Waste Management Strategy, Headline Strategy, Draft for Consultation*. BMBC, Barnsley. See http://www.barnsley. gov.uk/ for further details (accessed 16/11/2009).

Bulkeley B, Watson M, Hudson R and Weaver P (2004) *The Governance of Municipal Waste Management*. Working Paper, Centre for the Study of Cities and Regions, Department of Geography, University of Durham.

CEWEP (Confederation of European Waste-to-Energy Plants) (2009) *Facts and Figures: Maps of European WtE Plants*. CEWEP, Brussels. See http://www.cewep.eu/ for further details (accessed 29/6/2009).

CIWEM (Chartered Institution of Water and Environmental Management) (2007) *Policy Fact Sheets: Waste Incineration*. CIWEM, London.

CIWM (Chartered Institution of Waste Management) (2003) *Energy from Waste: A Good Practice Guide*. CIWM, Northampton.

Connor PM (2003) UK renewable energy policy: a review. *Renewable and Sustainable Energy Reviews* **7(1)**: 65–82.

Dalager S (2007) *Waste Incineration in Denmark*. RAMBOLL. See http://www.dbdh.dk/images/uploads/pdf-waste-and-DH/waste-incineration.pdf (accessed 30/04/2010).

DCLG (Department of Communities and Local Government) (2009) http://www.communities.gov.uk (accessed 07/12/2009).

Defra (Department for Environment, Food and Rural Affairs) (2004) *Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes – Extended Summary*. Defra, London.

Defra (2005a) *Climate Change and Waste Management: The Link*. Defra, London.

Defra (2005b) *Integrated Pollution and Control: A Practical Guide*. Defra, London.

Defra (2006) *Review of England's Waste Strategy – A Consultation Document*. Defra, London.

Defra (2007) *Waste Strategy for England, Presented to Parliament by the Secretary of State for Environment*. Defra, London.

DTI (Department of Trade and Industry) (2000) *New and Renewable Energy – Prospects for the 21st Century*. DTI, London.

DTI (2007) *Meeting the Energy Challenge: A White Paper on Energy*. DTI, London.

Environment Agency (2007) *Strategic Waste Management Information 2002–2003*. EA, London.

ESA (Environmental Services Association) (2006) *Incineration: Energy from Waste*. ESA, London.

House of Commons (2005) *Waste Policy and the Landfill Directive*. Government Response to the House of Commons Environment, Food and Rural Affairs Committee Fourth Report of Session, London.

ILEX Energy (2005) *Eligibility of Energy from Waste – Study and Analysis, The Options for, and Implications of Amending the Renewables Obligation Eligibility Rules for Energy Recovery from Mixed Wastes*. Report for the Department of Trade and Industry, London.

LATS (Landfill Allowance Trading Scheme) (2005) *Landfill Allowance Trading Scheme – Briefing*. Friends of the Earth, LATS.

Lea RW (1996) Plastic incineration versus recycling: a comparison of energy and landfill cost savings. *Journal of Hazardous Materials* **47(1–3)**: 295–302.

Morris JR, Phillips PS and Read AD (1998) The UK Landfill Tax: an analysis of its contribution to sustainable waste management. *Resources Conservation and Recycling* **23(4)**: 259–270.

Ofgem (Office of Gas and Electricity Markets) (2009) *Renewable Obligation – Annual Report 2007–2008*. Ofgem, London.

Pasour EC Jr (1994) Pigou, Coase, common law, and environmental policy: implications of the calculation debate. *Public Choice* **87**: 243–258.

SITA, UK (2007) *Waste Policy and Legislation*. SITA, Berkshire. See http://www.sita.co.uk/ for further details (accessed 16/11/2009).

Swindon Borough Council (2005) *Wiltshire and Swindon Waste Local Plan*. SBC, Swindon. See http://www.swindon.gov.uk/ for further details (accessed 16/11/2009).

The Planning Inspectorate (2005) *Local Development Frameworks: Lessons Learnt Examining Development Plan Documents*. LDF, Bristol.

Turner RK, Salmons R, Powell J and Craighill A (1998) Green taxes, waste management and political economy. *Journal of Environmental Management* **53(2)**: 121–136.

Waste Online (2007) *Beyond the Bin: The Economics of Waste Management Options*. A final report to Friends of the Earth, UK Waste and Waste Watch by ECOTEC Research and Consulting Limited, London.