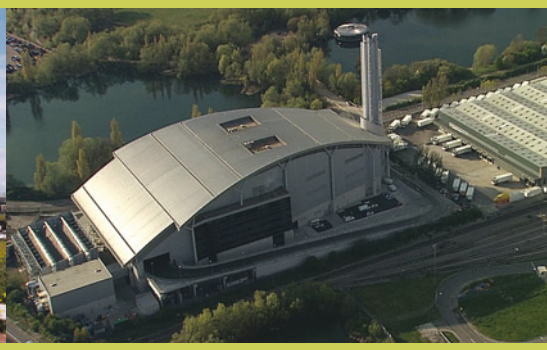
RENEWABLE ENERGY ASSOCIATION





ENERGY FROM WASTE

A GUIDE FOR DECISION-MAKERS

What is Energy from Waste?

Energy can be recovered from waste by various (very different) technologies. It is important that recyclable material is removed first, and that energy is recovered from what remains, i.e. from the ***residual*** waste. This leaflet covers the following energy from waste (EfW) technologies:

- **Combustion**, in which the residual waste is burned at 850 C and the energy recovered as electricity or heat
- **Pyrolysis and gasification**, where the fuel is heated with little or no oxygen to produce "syngas" which can be used to generate energy or as a feedstock for producing methane, chemicals, biofuels, or hydrogen
- **Anaerobic digestion,** which uses microorganisms to convert organic waste into a methane-rich biogas that can be combusted to generate electricity and heat or converted to biomethane. This technology is most suitable for wet organic wastes or food waste. The other output is a biofertiliser.

It is also possible to harness energy from waste after it has been disposed of in a landfill. As the UK has traditionally landfilled much of its waste, we are currently exploiting this legacy at many landfills, by capturing landfill gas produced as waste decomposes. Landfill gas contains methane, which is a powerful greenhouse gas. Capturing it prevents it from polluting the atmosphere. The production of landfill gas will slowly decline as we move towards more sustainable and efficient practices of waste management, focusing on the technologies described in this guide.

Harnessing energy from waste has many benefits:-

- It helps the UK reduce its dependency on energy imports
- It contributes towards reducing carbon emissions and meeting renewable energy targets
- When used for electricity generation, these technologies have a steady and controllable output, sometimes referred to as providing "baseload" power
- It has very good sustainability and greenhouse gas saving characteristics, as it makes further use of materials that have already been discarded. This is reflected in the methodology used under the Renewable Energy Directive for assessing carbon and sustainability characteristics.

About this guide

This guide has been produced to:

- Show how much energy can be recovered from waste, after recycling has taken place
- Illustrate how EfW contributes to the UK's energy needs and renewable energy targets
- Give an overview of the various types of technologies used
- Describe the financial incentives in place to promote deployment of EfW
- Show decision-makers what high-level actions need to be taken in order that the UK can convert more residual waste to energy

Cover Images LEFT:BiogenGreenfinch's Westwood Anaerobic Digestion plant MIDDLE:SITA UK's energy-from-waste facility in Teesside RIGHT: Lakeside EfW Ltd is a joint venture of Viridor and Grundon Waste Management. Located near Slough, the award-winning design of the building fits and enhances the local landscape.

These technologies have very different characteristics and it is important to

Combustion

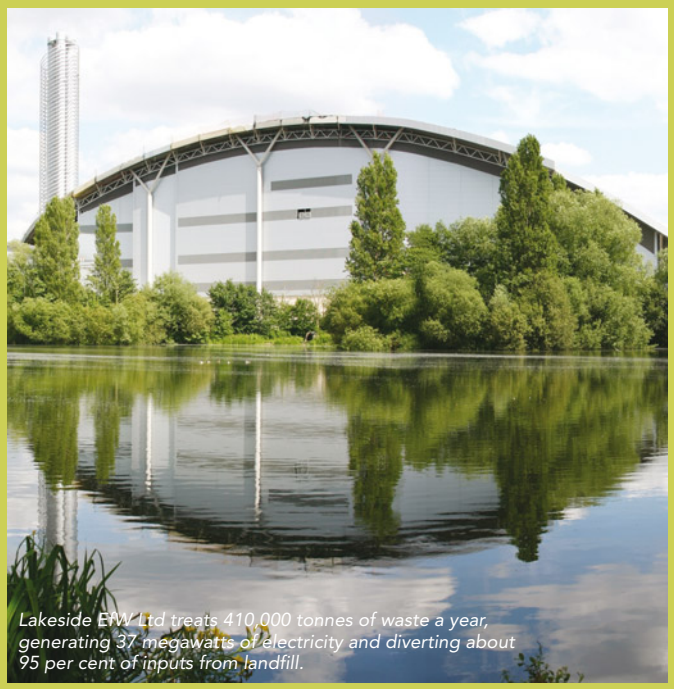
Combustion plants are often referred simply as EfW plants. They have a boiler to capture and convert the released heat into electricity and steam, and extensive air pollution control systems that clean the combustion gases to comply with regulatory emission limits before they are released to atmosphere through a chimney. These plant typically use between 50 – 300 thousand tonnes per year of fuel.

Typical fuels

- Municipal Solid Waste (MSW)
- Commercial & Industrial Waste (C&I)
- Refuse derived fuel (RDF) or Solid Recovered Fuel (SRF)

Outputs

- **Electricity or Heat** – or both together if a Combined Heat and Power Plant (CHP)
- **Bottom ash** - This is what is left after combustion and it can be used as an aggregate or road bed material. If metal was not removed pre-combustion, it is recycled at this point.
- **Fly ash** - This is the material collected by the pollution control equipment.



Lakeside EfW Ltd treats 410,000 tonnes of waste a year, generating 37 megawatts of electricity and diverting about 95 per cent of inputs from landfill.

Gasification & Pyrolysis

Sometimes referred to as ATTs (Advanced Thermal Treatments), gasification and pyrolysis plants thermally treat fuels without allowing enough oxygen for complete combustion. They are typically smaller and more flexible than combustion plants and typically consume between 25 and 150 thousand tonnes of waste per year, although some variations can consume up to 350 thousand tonnes per year.

Typical fuels

- Municipal Solid Waste (MSW)
- Commercial & Industrial Waste (C&I)
- Refuse derived fuel (RDF) or Solid Recovered Fuel (SRF)
- (non-waste fuels, e.g. wood / other forms of biomass)

Outputs

- **Electricity or Heat** – or both together if a Combined Heat and Power Plant (CHP)
- **Syngas**, which can be purified to produce "biomethane", biofuels, chemicals, or hydrogen
- **Pyrolysis oils** – these can be used to fuel engines, or turned into diesel substitute
- **Feedstocks for the chemical industry** – allowing biomass to substitute for oil in the production of plastics for example
- **Bottom ash, Char, or Slag** – by-products which can be used for beneficial purposes such as aggregates or road bed material
- (**Fly ash** produced by some but not all plants)

Advanced Plasma Power's Gasplasma® Gasification Plant

appreciate this.

Anaerobic Digestion (AD) / Biogas

Biogas/AD plants operate at low temperature, allowing microorganisms to work on the feedstock, turning it into biogas, which is a mixture of carbon dioxide and methane. They are typically much smaller than the combustion or gasification plants. A biogas plant is most appropriate for wet organic wastes, such as food waste, sewage sludge, agricultural residues or energy crops.

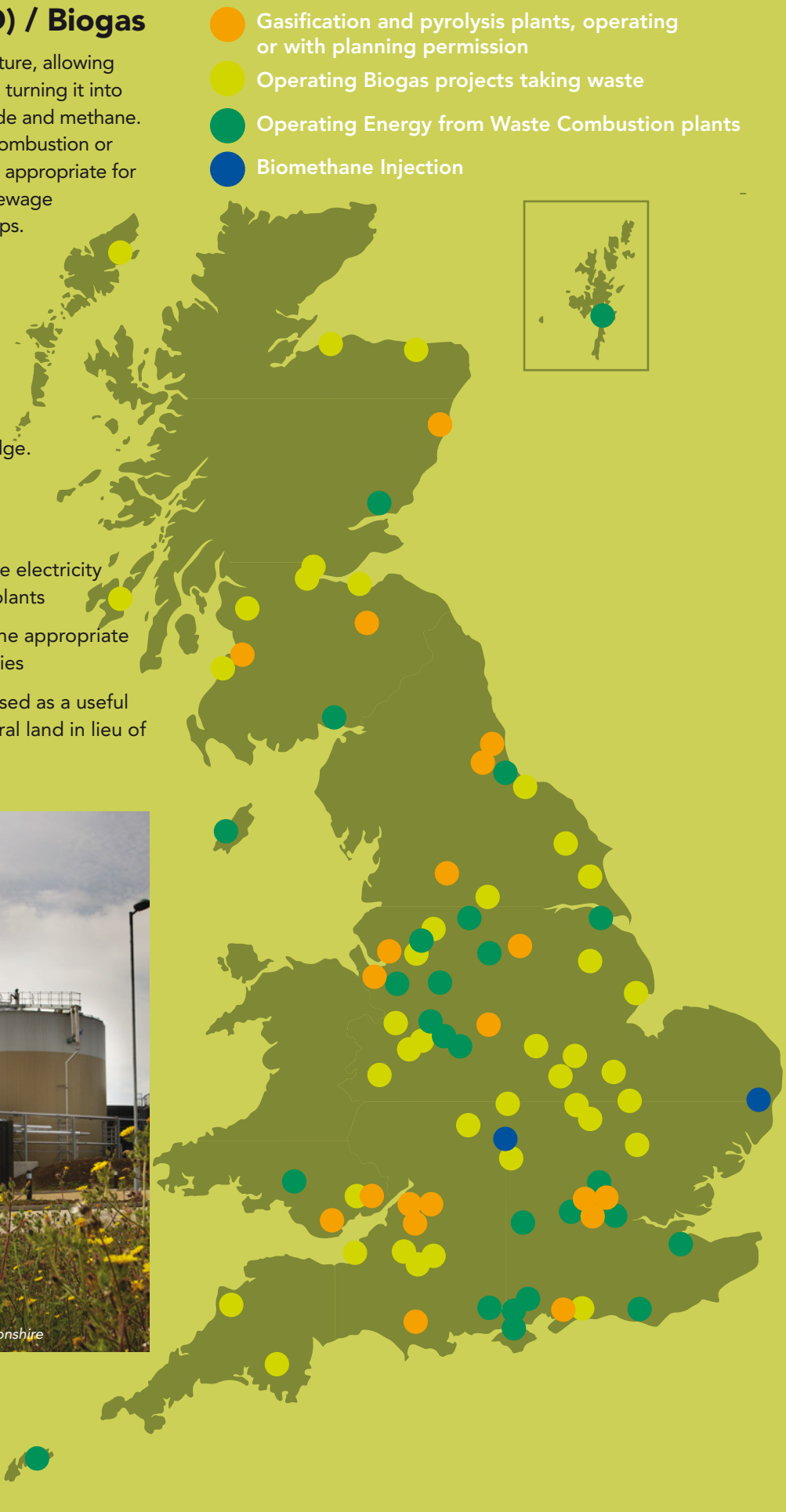
Typical fuels

- Food wastes
- Some forms of industrial and commercial waste, e.g. abattoir waste
- Agricultural materials and sewage sludge.

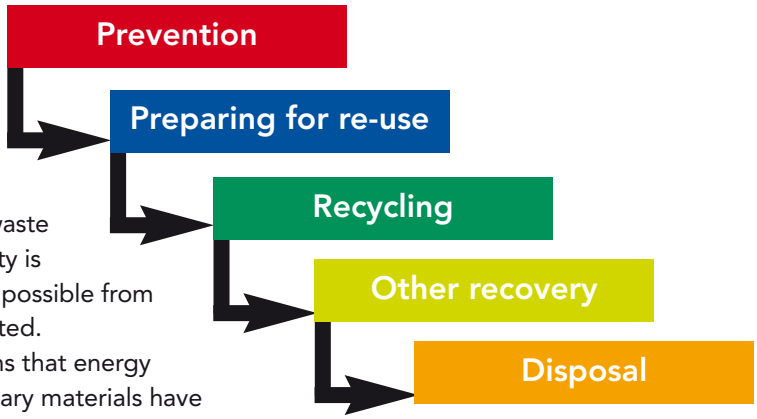
Outputs

- **Biogas**, which can be used to generate electricity and heat – CHP is the norm for such plants
- **Biomethane for the gas grid**, with the appropriate gas scrubbing and injection technologies
- **Digestate** - a material which can be used as a useful fertiliser / soil conditioner on agricultural land in lieu of chemical fertilisers

BiogenGreenfinch's Westwood AD plant, Northamptonshire



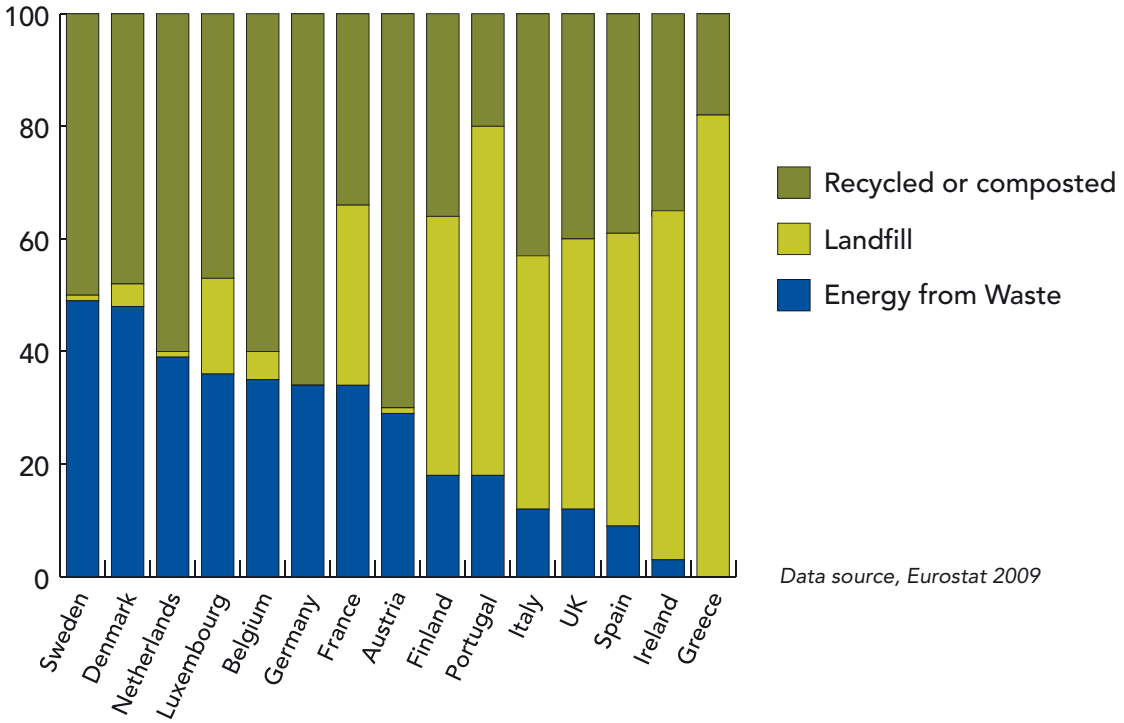
Energy from waste and the waste hierarchy



The waste hierarchy has been fundamental in designing national strategies and policies that move the UK away from its dependence on landfilling. After minimising the amount of waste that is produced in the first place through waste prevention and reuse, the next priority is to recycle as much useful material as possible from the waste that is unavoidably generated. Respecting the waste hierarchy means that energy is recovered from waste after secondary materials have been removed for recycling. Only after extracting the maximum value from waste (both materials and energy) should the remaining waste be disposed of safely.

EfW does not act as a disincentive to materials recovery and recycling. Evidence from Europe indicates that high recycling (including composting) rates can be sustained alongside high energy recovery rates.

The fact that Sweden, Denmark and the Netherlands have the highest contributions from EfW in Europe, but also show the highest recycling rates is proof that both recycling and EfW can co-exist without the latter crowding out the former. In the UK, EfW currently makes one of the lowest contributions to the total waste management solution, but this contribution could be much higher with the introduction and support of additional EfW technologies.



Data source, Eurostat 2009

Energy in residual waste

"Our aim is to get the most energy out of genuinely residual waste, not to get the most waste into energy recovery."

Source
Government
Waste Policy
Review, DEFRA
July 2011

In 2009/10, the UK generated approximately 32 million tonnes of municipal (i.e. local authority collected) waste, of which 39% was recycled, 48% was landfilled, and energy was recovered from the remaining 13% in EfW plants. During the same period approximately 58 million tonnes of commercial & industrial waste (C&IW) were generated, of which 50% was recycled and 25% was landfilled. The remaining 25% of C&I waste was subjected to other forms of treatment, with energy recovery in EfW plants contributing a very small fraction. The Institution of Civil Engineers has estimated that residual wastes could account for as much as 17% of total UK electricity consumption in 2020[1].

"There are a range of technologies for recovering energy from waste. It's a question of matching the right technology with the right fuel, depending on the nature of the fuel and the desired outputs"

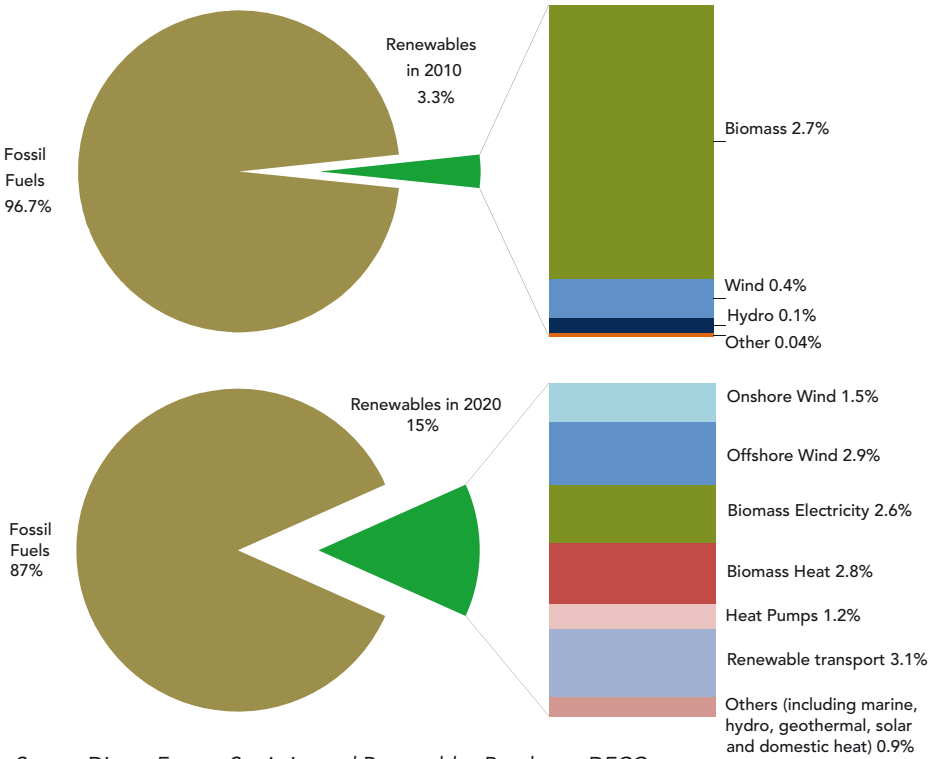
Source,
Liz Goodwin,
Chief Executive,
Waste and Resources
Action Plan

Approximately 65% of residual municipal waste and 61% of residual C&I waste is biomass, i.e. of biological origin. Energy from biomass is renewable energy.

The current proportion of electricity generated from renewables in the UK is 7.4%. Energy recovered from landfill gas contributes roughly one-third. **So waste to energy as a whole already provides almost one-half of the UK's renewable energy mix**.

The UK produces over 100 million tonnes of wet organic waste each year that could be used to produce biogas, which could represent 4-8% of the UK's 2020 renewable energy target.

Food waste, BiogenGreenfinch

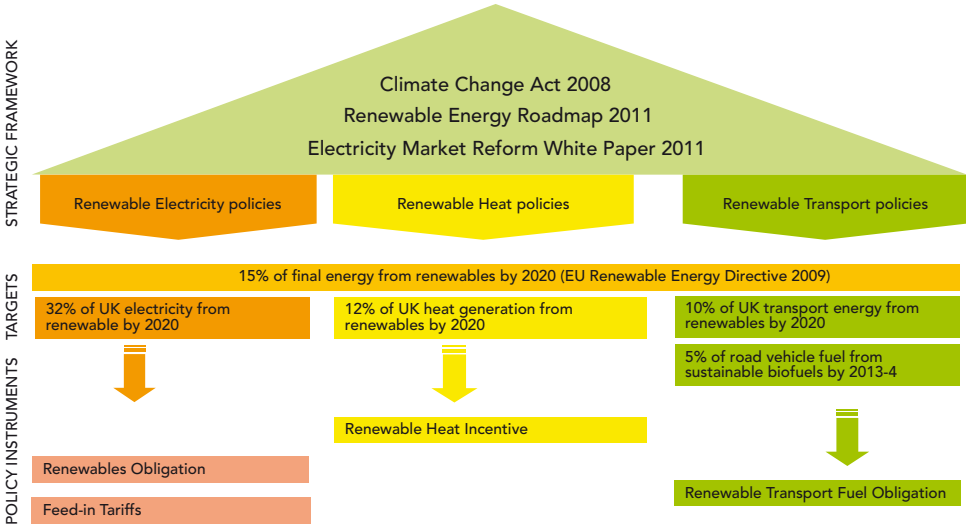


Source Digest Energy Statistics and Renewables Roadmap, DECC.

[1] *Quantification of the Potential Energy from Residuals (EfR) in the UK*. The Institution of Civil Engineers and the Renewable Power Association, March 2005.

The UK renewable energy policy framework

The UK has a legally-binding target of achieving 15% of its total energy (electricity, heat and transport fuel) from renewables by 2020. EfW has a significant role in all of these energy sectors.



The UK's energy policy objectives

A quarter of the UK's existing generating capacity is scheduled to shut down over the next ten years as old coal and nuclear power stations close. Added to that, the UK's national and international commitments to combat climate change means that energy generation will have to shift to low carbon and renewable energy sources. The UK's energy policy addresses four key policy objectives:

- **Save energy** with the Green Deal and support vulnerable consumers. Reduce energy use by households, businesses and the public sector, and help to protect the fuel poor
- **Deliver secure energy** on the way to a low carbon energy future. Reform the energy market to ensure that the UK has a diverse, safe, secure and affordable energy system and incentivise low carbon investment and deployment
- Drive ambitious **action on climate change** at home and abroad. Work for international action to tackle climate change, and work with other Government departments to ensure that we meet UK carbon budgets efficiently and effectively
- **Manage our energy legacy responsibly** and cost-effectively. Ensure public safety and value for money in the way we manage our nuclear, coal and other energy liabilities

Renewable energy targets

The Renewable Energy Directive (RED) requires the UK to source at least 15% of its total energy from renewables by 2020. To meet this target, the Government has estimated that renewable sources will need to contribute:

- **At least 32%** of the UK's electricity, with one-third of this coming from biomass, of which waste forms a part. Currently renewables account for 7.4%.
- **At least 12%** of UK heat requirements. At present this is less than 1%.
- **At least 10%** of UK road transport fuel requirements. Current renewable fuel production is less than 3%.

Renewable energy incentives

The Government has introduced a range of financial incentives to encourage the deployment of renewable sources of energy.

The Renewables Obligation (RO)

Under the RO, electricity suppliers must acquire a growing number of Renewable Obligation Certificates (ROCs) each year, or buy themselves out of this obligation. ROCs are produced by renewable generators, at different rates, according to the technology used. Landfill gas earns ¼ ROC /megawatt hour (MWh) of electricity, whereas a tidal power station in Scotland would earn 5 ROCs. The RO will close in 2017 (following Electricity Market Reform) and replaced by a new incentive: "a Feed in Tariff with Contract for Difference".

The Renewable Heat Incentive (RHI)

The RHI is designed to encourage installation of renewable heat generation equipment in the commercial, public and domestic sectors. There is also a tariff for every kilowatt hour (kWh) of biomethane injected into the gas grid. The RHI will pay a set tariff for each kWh of renewable heat produced, for 20 years. There are some inconsistencies for EfW technologies which need to be addressed. The RHI is being introduced in two stages; the first phase from September 2011 and then in October 2012 the scheme will be widened to include more technologies and extended to include households.

The Renewable Transport Fuel Obligation (RTFO)

The RTFO places an obligation on transport fuel suppliers to substitute a growing percentage of petrol or diesel with biofuels (i.e. bioethanol, biodiesel or biomethane). This will mostly be achieved by blending biofuels with traditional fossil fuels. The obligation currently increases annually until 2013/14 when it reaches 5%. It will need to be increased further to meet the 10% target required under the Renewable Energy Directive. Biofuels can be made from wastes or biomass, and because of their excellent sustainability credentials, they will receive twice the financial incentive compared to other biofuels.

The Small Scale Feed-in Tariff (FiT)

Small projects, of less than 5 megawatts, qualify for a set tariff for every unit of electricity generated. Of the various EfW technologies, only biogas qualifies. This scheme is aimed at businesses, communities and individuals who have not traditionally engaged in the electricity market.

SITA UK's energy-from-waste facility on the Isle of Man

The barriers to uptake

Any infrastructure project can be difficult to take through the planning process and into operation; renewable energy projects are no exception and EfW combustion plants are among the most challenging.

Presently the Government's legislative programme seeks to move the focus of planning decision making to local communities and this may make consents harder to obtain. Only very large EfW projects (above 50MW power output) will remain outside local planning control. These large projects will be dealt with by the Major Infrastructure Panel with the final say given by ministers.

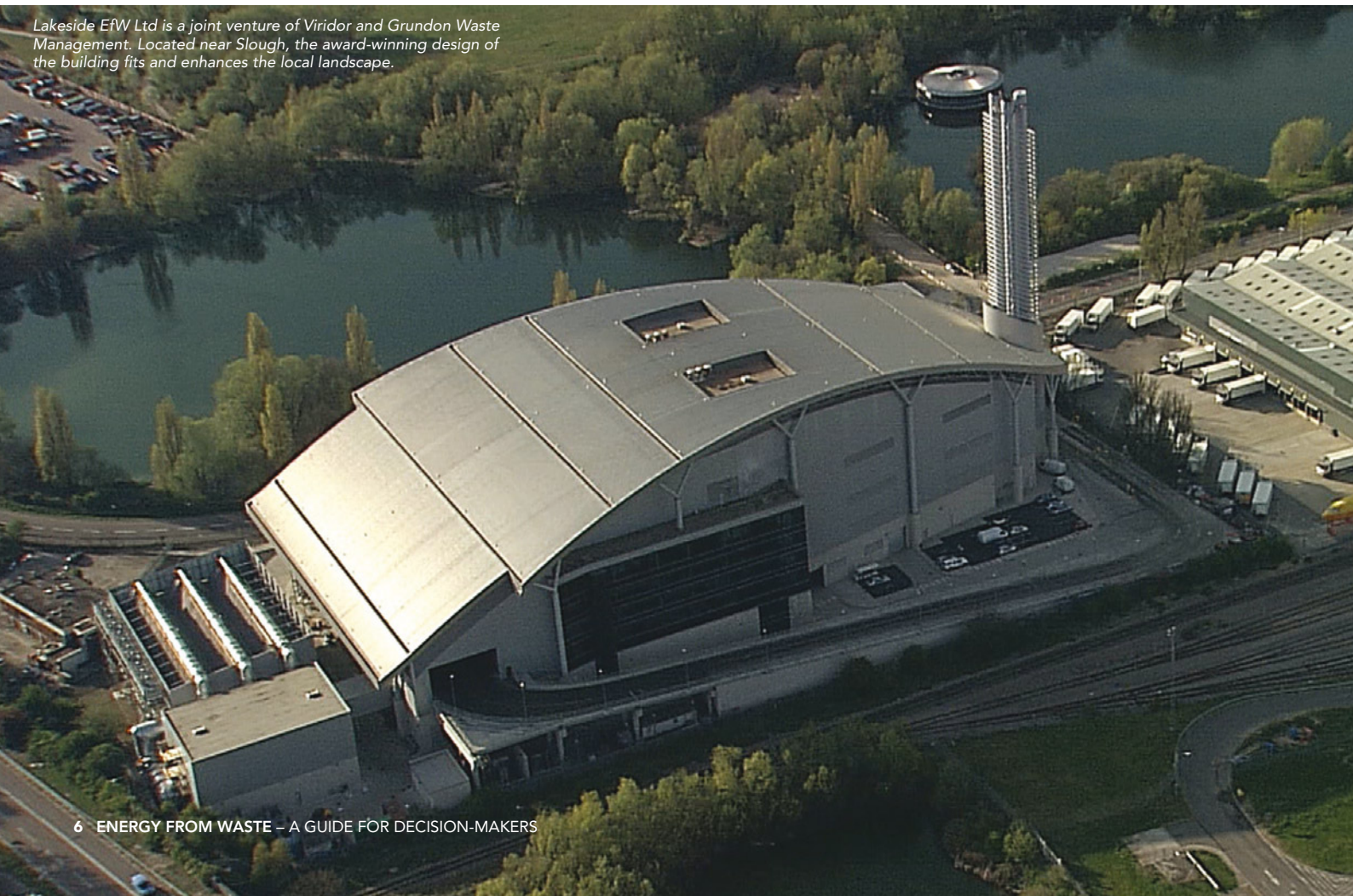
The Government has also announced a "Presumption in Favour of Sustainable Development". As currently set out in draft, this may not be quite what it sounds. However there is scope for EfW developers to define sustainable development in terms of the carbon benefits accruing from projects, as well as showing local benefits for example favourable energy tariffs.

The National Planning Policy Framework is intended to replace the current suite of Planning Policy Statements documents, with the exception of the one on Waste (PPS10). This will remain in place, until a new National Waste Management Plan is published. Local development plans, some of which identify the sites for EfW projects, will remain and the new system will encourage the adoption of plans by assuming consent will be granted where no plan exists.

Successive governments have viewed EfW as primarily a waste management solution rather than a valuable energy source. Consequently, its full potential has not been realised and there is a lack of coordination between the energy and waste management arms of policy-making. This has resulted in poorly-drafted legislation and inconsistent guidance, which has impeded deployment. The proposed electricity market reform measures, plus reviews of existing financial incentives, have introduced uncertainty. Unless this is resolved investor confidence will be damaged, making it difficult to finance new projects.

The table below shows which EfW technologies qualify for which financial incentives

Financial Incentive	EfW Combustion	Gasification / Pyrolysis	Anaerobic digestion
Renewables Obligation	Only qualifies for ROCs if it is CHP	Eligible, and currently earns 2ROCs/MWh	Eligible, and currently earns 2ROCs/MWh
Renewable Heat Incentive	**Inconsistent** Only MSW is eligible. C&I waste does not qualify Receives 2.7p/kWh	**Inconsistent** Installations are only eligible if below 200kW. Biomethane injection qualifies at any scale. Receives 6.8p/kWh	**Inconsistent** Installations only eligible if below 200kW. Biomethane injection qualifies at any scale. Receives 6.8p/kWh for biogas combustion or biomethane injection (Landfill gas is excluded)
Renewable Transport Fuel Obligation	**Not applicable** Biofuels are not produced by EfW combustion plant	Pyrolysis plant could produce renewable diesel and gasification plant biomethane	Biomethane qualifies for the RTFO, but requires suitable vehicles to use it – also, the RTFO provides a far weaker financial incentive than the RHI
Feed In Tariffs	**Not applicable**	**Inconsistent** Not eligible	Biogas plant are eligible for FITs



Lakeside EfW Ltd is a joint venture of Viridor and Grundon Waste Management. Located near Slough, the award-winning design of the building fits and enhances the local landscape.

Ten actions

1

Develop an Action Plan for the *thermal* EfW technologies (combustion and gasification and pyrolysis)

Defra published an Anaerobic Digestion Strategy and Action Plan in 2011, setting out its plans for developing the potential of biogas. As energy from waste is a priority for the coalition government, the thermal EfW technologies (combustion, gasification and pyrolysis) should receive similar attention, and their own specific Action Plan.

2

Maintain the current levels for Gasification and Pyrolysis and AD in the RO banding review

Gasification, Pyrolysis and Anaerobic Digestion projects are not being deployed to anything like their full potential. If their support is reduced in the imminent banding review, deployment will suffer. Decisions on the banding review will be made by the end of this year, and legislation put in place in April 2012. It is essential that these technologies continue to receive 2 ROCs per megawatt hour for their output.

3

Introduce a band for electricity-only EfW combustion

Waste combustion should be eligible for ROCs for its renewable (i.e. biomass) content. The more income a project earns for its energy output, as opposed to gate fees for taking in waste, the greater the incentive for it to operate efficiently. It is inconsistent that these plant do not qualify, when their output contributes to meeting the renewables target.

4

Ensure that all EfW technologies play their full part under the new electricity market arrangements

Energy from waste combustion, gasification and pyrolysis and AD should all be eligible for the "Feed in Tariff with Contract for Difference", envisaged under the new electricity market once it is reformed. In the first phase, when the CfD FITs are set by an administered process, they need to be sufficient to encourage deployment. If a competitive process is introduced, and the CfD FIT contracts must be tendered for, all EfW technologies must be eligible to take part in the competition.

5

Extend the Renewable Heat Incentive to encompass the biomass component of all waste streams

At present only municipal waste is eligible for the RHI. Many Commercial & Industrial (C&I) waste streams are suitable for heat production, and for consistency and target achievement they should be included. The exclusion currently creates difficulties, as some C&I waste is collected together with municipal waste at present, and this makes the entire waste stream ineligible. Besides creating additional complexity as this is inconsistent with the RO, only including municipal waste reduces opportunities for innovation as most MSW is already tied into long-term contracts. Landfill gas also qualifies for the RHI, but the 200kW size limit should be removed.

6

Recognise the difference between EfW Combustion and Gasification & Pyrolysis in the environmental permitting process

The Environmental Permitting Regulations 2010 recognise gasification and pyrolysis as being different types of thermal treatment. Guidance to the Regulations could be strengthened to emphasise the differences, thus reducing opportunities for confusion.

7

Clarify the presumption in favour of sustainable development

Encourage the Government in its emerging National Planning Policy Framework and National Waste Management Plan to develop the "presumption in favour of sustainable development" to clearly favour projects with lower carbon footprints such that this might act as a counter-weight to inevitable localised concerns at the location of infrastructure.

8

Ofgem should enable electricity suppliers to distinguish between customers to enable communities that host EfW plants to benefit from lower tariffs

The Government would like to see communities able to benefit directly from energy projects in their locality. As well as allowing a proportion of the business rates to be kept within the community, as recently proposed, there are other options. Some suppliers would like to be able to offer lower electricity tariffs as a community benefit. One reason why electricity supply companies cannot do this is that the electricity regulator (Ofgem) prevents them from offering lower tariffs on the basis of postcode. This restriction should be lifted.

9

Set clear future targets for biofuels as soon as possible

The current RTFO does not set levels beyond 2013/14. The Government's current schedule means these are unlikely to be confirmed in legislation more than a few months in advance. As this only gives a few years to 2020, the targets must also be set for the years beyond 2020, to give projects sufficient certainty in the market to invest. This is doubly true for innovative technologies - such as most of those being considered for wastes - which need support to realise their potential for the UK.

10

Facilitate the implementation of biomethane injection

Action to remove regulatory and technical barriers to biomethane injection to the grid must be accelerated to widen the options available for the use of biogas energy. At this early stage of industry development, innovation in plant design, feedstock preparation and digestate use should not be prematurely restrained by excessive regulation or unnecessary codes of practice.

Glossary / explanations

- **ATTs** (Advanced Thermal Treatments) a term often used for gasification and pyrolysis
- **Biofuel** (liquid) fuel made from biomass
- **Biogas** mixture of carbon dioxide and methane, produced by breakdown of biomass in the absence of oxygen
- **Biomass** biological material from living or recently living organisms
- **Biomethane** biogas which has been treated such that it is identical to gas flowing in the gas distribution network (i.e. "natural" or "north sea" gas)
- **BioSNG** Synthetic Natural Gas / alternative name for biomethane
- **DECC** Department of Energy and Climate Change
- **DEFRA** Department of Environment, Food and Rural Affairs
- **CEWEP** Confederation of European Waste-to-Energy Plants
- **EMR** Electricity Market Reform. After 2017 this will result in new form of contract for low carbon electricity, such as renewables.
- **FIT** feed in tariff
- **GGCS** Green Gas Certification Scheme
- **I&CW** industrial and commercial waste
- **kWh** kilowatt hour – i.e. a unit of electricity
- **MSW** municipal solid waste ("black bin bags" from households)
- **MWh** megawatt hour – 1000 units of electricity
- **NPPF** National Planning Policy Framework
- **RDF** Refuse derived fuel. A fuel made from Municipal Solid Waste, also called SRF
- **REA** Renewable Energy Association
- **RED** Renewable Energy Directive (2009 / 28 / EC)
- **RO** Renewables Obligation
- **ROC** Renewable Obligation Certificate
- **RTFO** Renewable Transport Fuel Obligation
- **SRF** Solid Recovered Fuel, see also RDF

RENEWABLE ENERGY ASSOCIATION

About REA

The Renewable Energy Association represents renewable energy producers and promotes the use of all forms of renewable energy in the UK. A trusted voice for the industry, the represents the full range of the renewable energy technologies across power, heat, transport and renewable gas. Our ever-increasing membership ranges from major multinationals through to sole traders.

For more information see www.r-e-a.net

The REA's subsidiary, REAL runs certification schemes for digestate from Biogas plants and for biomethane injection. For more information see

The Green Gas Certification Scheme

This scheme tracks biomethane, or 'green gas', through the supply chain to provide certainty for those that buy it. For more information see **www.greengas.org.uk/**

GreenGas CERTIFICATION SCHEME

Biofertiliser Certification Scheme

This scheme provides assurance to consumers, farmers, food producers and retailers that biofertiliser is safe and of good quality. For more information see **www.biofertiliser.org.uk/**

Biofertiliser certification scheme

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