CARBON FOOTPRINT 14

CONTENTS

Appendices

INTRODUCTION

14.1 An assessment of the greenhouse gas emissions (or the "Carbon Footprint") that will be generated throughout the lifetime of the proposed Energy from Waste (EfW) facility has been undertaken. This section details the assessment methodology, as well as its results, and any assumptions made in the assessment. The emissions related to other forms of waste treatment including landfill and Advanced Thermal Treatment options have also been assessed in order to enable comparison and to demonstrate the advantages associated with the proposed EfW facility.

14.1 The South West Devon Partnership has concluded that an Energy from Waste Facility management solution is the most effective environmental solution to achieve sustainable Waste Management requirements in respect of the criteria set out below:

- uses clean and proven technology;
- reduces carbon footprint and reliance on landfill;
- is economical, with minimal environmental effect;
- fits the needs of the local community; and
- can be located close to the source of waste

14.2 As such, the proposed development at New England Quarry is a response to the SWDWP requirement.

14.3 This carbon footprint assessment has considered only the emissions relating to the plant infrastructure and operations, including the process itself, the construction of the facility, and the removal of residues. Emissions related to the transport of waste to the site, ancillary offices, staff transport and amenity facilities have not been included, as it is considered that these will largely be the same for all of the scenarios modelled and will be insignificant in their quantities in comparison to the main processes.

PLANNING POLICY, GUIDELINES AND INDICATORS

Introduction

14.4 The need to achieve sustainable development is enshrined at planning policies. A brief summary is included below, and highlights sustainability considerations not reviewed at section 5 above. A more comprehensive Sustainability Appraisal is included at Appendix 14-1.

14.5 Nationally PPS 22 sets out the Government's policies for renewable energy, which planning authorities should have regard to when preparing local development documents and when taking planning decisions. The PPS recognises that increased development of renewable energy resources is vital to facilitating the delivery of the Government's commitments on both climate change and renewable energy. Positive planning which facilitates renewable energy developments can contribute to all four elements of the Government's sustainable development strategy:

- Social progress which recognizes the needs of everyone – by contributing to the nations energy needs, ensuring all homes are adequately and affordably heated and providing new sources of energy in remote areas;
- Effective protection of the environment by reductions in emissions of greenhouse gases and thereby reducing the potential for the environment to be affected by climate change;
- Prudent use of national resources by reducing the Nation's reliance on ever-diminishing supplies of fossil fuels; and
- Maintenance of high and stable levels of economic growth and employment through the creation of jobs directly related to renewable energy developments, but also in the development of new technologies.

14.6 Through the use of life cycle assessment software, an assessment can be undertaken to demonstrate the environmental impact of an EFW compared to other competing technologies. As a result, the selected technology can be considered in terms of in environmental impacts such as global CO_2 emissions.

14.7 In regional terms, energy from Waste is identified in the Draft Regional Spatial Strategy for the South West (RSS) as a source of 'renewable heat'. The target for renewable heat generation in the South West is 100MW by 2010 and 500MW by 2050.

14.8 The following draft policies in the RSS relate directly to the carbon footprint of the proposed New England Development:

14.9 Policy RE1 requires Local Development Documents to include positive policies to enable the achievement of the following targets: by 2010 a minimum target of 509 to 611 MWe installed generating capacity, from a range of onshore renewable electricity technologies.

14.10 By 2020, the regional target will increase to 850 MWe installed generating capacity from a range of onshore renewable electricity technologies. This onshore target, together with offshore renewable electricity capacity, will help to provide at least 20% of the region's electricity demand by 2020.

14.11 Policy RE5 states that larger-scale developments will be expected to provide, as a minimum, sufficient on-site renewable energy to reduce CO_2 emissions from energy use by users of the buildings constructed on site by 10%.

14.12 It is within this policy context that the consideration of carbon footprint has been undertaken.

METHODOLOGY OF WRATE ANALYSIS OF PROPOSED FACILITY

Introduction

14.13 The Waste and Resource Assessment Tool for the Environment (WRATE) assessment undertaken by SLR outlines the main assumptions, results and interpretation of a carbon footprint and Life Cycle Assessment analysis to support the planning application for Viridor's Energy from Waste (EfW) facility at New England Quarry, Devon.

14.14 The WRATE assessment assessed the global warming potential (carbon footprint) of the proposed New England EfW which is designed to manage up to 275,000 tonnes per annum of municipal, and commercial and industrial waste that can not be recycled.

Methodology

14.15 The Environment Agency life cycle assessment software 'Waste and Resource Assessment Tool for the Environment' (WRATE) was utilised to model the environmental impacts of the proposed facility.

14.16 The WRATE software is a life cycle assessment tool specifically designed to model environmental impacts of waste and waste management processes. Its use is endorsed and encouraged by the Environment Agency (EA) and Department for Environment, Food and Rural Affairs (Defra).

14.17 In summary, the environmental burdens for global warming potential have been calculated for the processing of 275,000 tonnes per annum of municipal and commercial and industrial residual solid waste through a number of waste treatment processes, as follows:

- Energy from Waste (EfW) with power export only[1];
- Energy from Waste (EfW) with Combined Heat and Power (CHP)[2];
- Advanced Thermal Treatment (ATT), specifically Pyrolysis[3];
- Mechanical Biological Treatment (MBT) with Refuse Derived Fuel (RDF) to EfW[4]; and
- Mechanical Biological Treatment (MBT) with Refuse Derived Fuel (RDF) to landfill[5].

14.18 This assessment utilises the MBT (Ecodeco) WRATE processes as modelled in the South West Devon Waste Partnership Technical Note 1 (April 2008)[6]

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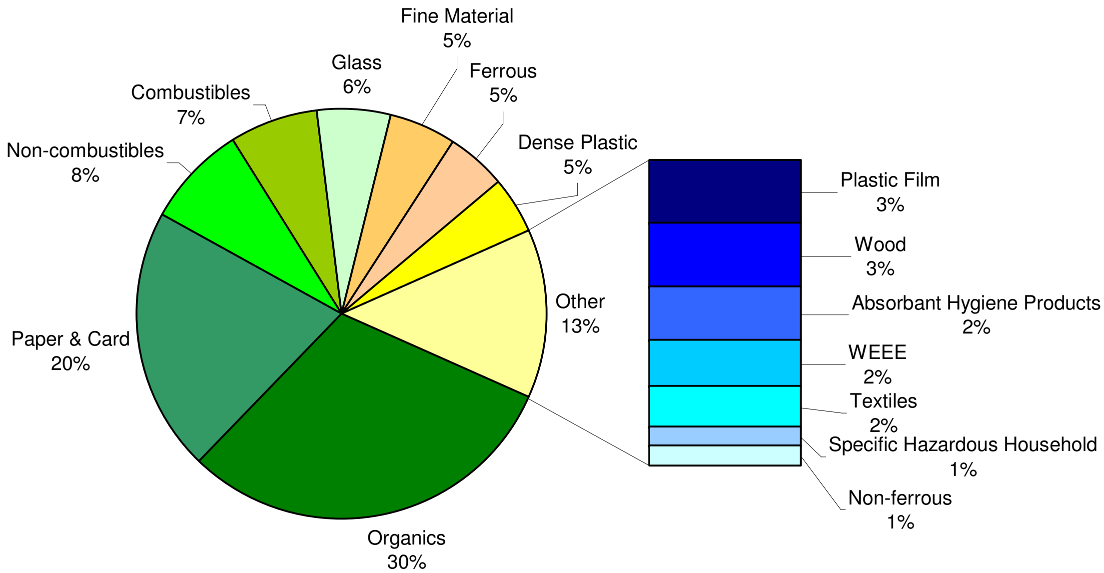
[1] WRATE Process – Landfill (Clay Liner, Clay Cap) (12255)
[2] WRATE Process – Incinerator large, power BILLINGHAM (11264)
[3] WRATE Process – Incinerator with district heat and power SHEFFIELD (21396)
[4] WRATE Process – Pyrolysis (MSW and RDF) WASTEGEN process (21252)
[5] WRATE Process - MBT bio-drying & RDF ECODECO process (11216) & Incinerator large, power BILLINGHAM (11264)

Figure 0-1

WRATE default waste composition



14.19 The proposed facility will process circa 25,000 to 50,000 tonnes per annum of commercial and industrial (C&I) wastes in addition to municipal waste. The C&I wastes destined for treatment at the facility are likely to be those included under the Environment Agency (EA) heading ‘mixed waste’ as outlined in the EA Strategic Waste Management Assessment 2002/03 survey of C&I waste[7].

14.20 A recent study by SLR for the Environment Agency Wales[8] demonstrates that the ‘mixed’ commercial and industrial waste stream is similar in composition to municipal waste. For this reason, the use of the WRATE default municipal waste composition (Figure 14-1) to characterise both municipal and C&I wastes is deemed suitable for the purposes of this comparative technology assessment.

14.21 Since a number of the waste management processes produce electricity an assumed energy mix must be defined in order to calculate the avoided burdens (from not having to produce the electricity from traditional generation methods). WRATE has default energy mixes for the UK available; the energy mix for the year 2020 has been selected as a suitable long term assessment year at which time, if planning is granted and the necessary environmental permits obtained, the planned treatment facility will be constructed and operational.

14.22 WRATE contains a number of default technology templates; these have been used as the basis of the 6 waste management scenarios. For example, the Billingham incinerator, a large power only incinerator, has been used to model EfW with power export only.

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[6] http://www.plymouth.gov.uk/appendix_4b_-_swdwp_wrate_final_technical_note_08227i1__ente~1.pdf

[7] http://www.environment-agency.gov.uk/subjects/waste/1031954/315439/923299/1071046/?version=1&lang=_e

[8] http://www.environment-agency.gov.uk/regions/wales/816243/1913565/?version=1&lang=_e

14.23 The outputs from WRATE are life cycle impact assessment (LCIA) indicators, these can be specified by the user and measure the potential impacts of the waste treatment technologies. Paragraph 14.26 below presents the Global Warming Potential (GWP 100), commonly referred to as Carbon Footprint, of the selected waste treatment processes, and a basic scoring mechanism to assist in the comparison of the selected scenarios. The scores are derived by 'normalising' the overall performance scores on a scale of 0 to 1, where 0 represents the worst scenario and 1 represents best scenario. Using this methodology, the higher the score the more sustainable the option is considered to be.

14.24 Sankey[9] flow diagrams for each of the scenarios are presented in below in Figure 14-2 to 14-7

Figure 14-2

Landfill Sankey Diagram

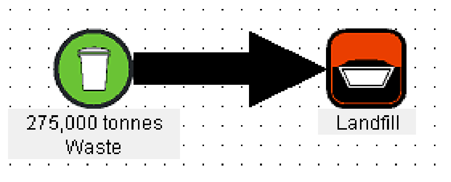


Figure 14-3

EfW Sankey Diagram

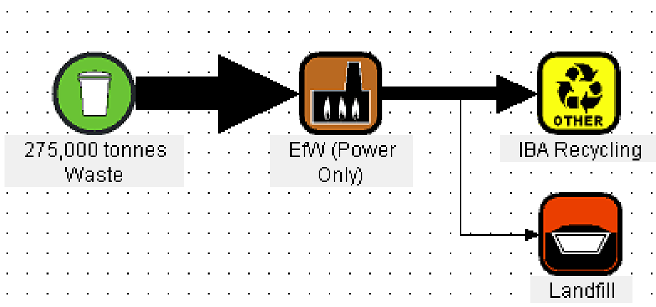


Figure 14-4

EfW with Combined Heat and Power Sankey Diagram

[9] Sankey flow diagrams help to visualise the dominate flow of waste material within the waste treatment process. The widths of the arrows in the Sankey diagram are proportionally to the tonnage of waste transferred between the different process stages.

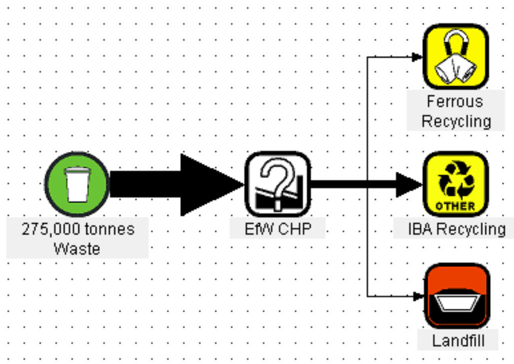


Figure 14-5

Advanced Thermal Treatment (ATT) Sankey Diagram

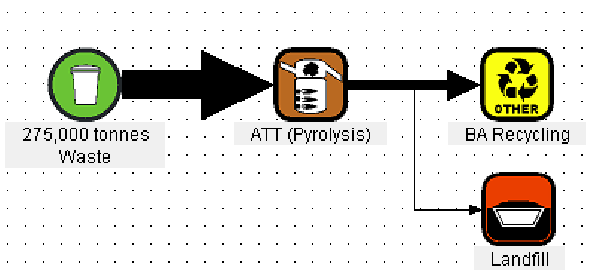


Figure 14-6

Mechanical Biological Treatment (MBT) with Refuse Derived Fuel (RDF) going to Energy from Waste (EfW) Sankey Diagram

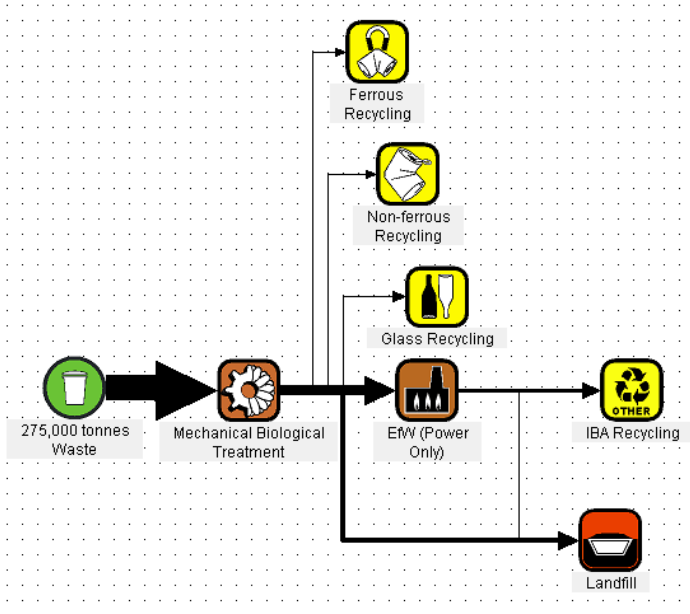
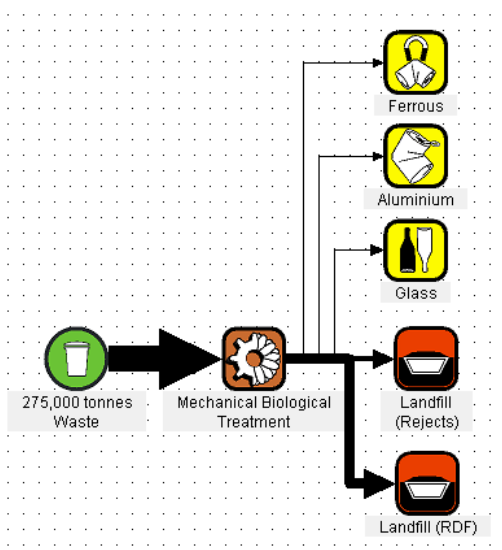


Figure 14-7

Mechanical Biological Treatment (MBT) with Refuse Derived Fuel (RDF) going to Landfill Sankey Diagram



RESULTS OF THE WRATE ANALYSIS

Characterising Environmental Impacts

14.25 The WRATE software uses a 'life cycle', or gate to grave approach to estimate environmental impact. For waste management approaches this requires the identification and quantification of the following environmental impacts:

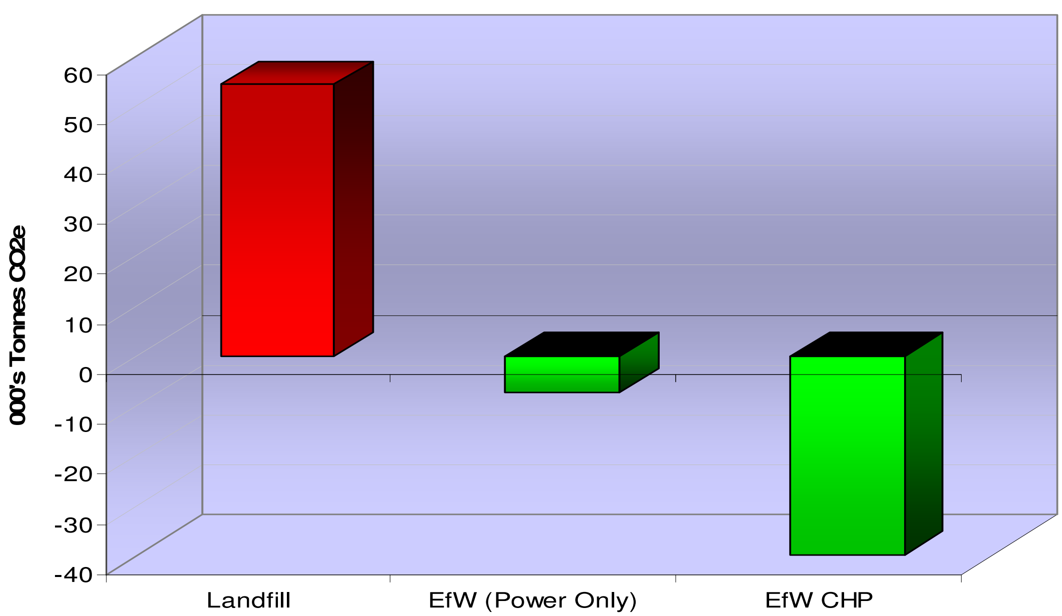
- **Direct Burdens** - defined as emissions from the process itself, for example carbon dioxide as a consequence of combustion or aerobic degradation;
- **Indirect Burdens** - associated with the supply of energy and materials to the process, for example construction materials, electrical energy for motors and fans and chemicals for pollution abatement equipment;
- **Avoided Burdens** - associated with the recovery of energy and materials from the waste stream resulting in the avoidance of primary energy production, and mineral extraction.

GWP – Comparison of New England EfW against Landfill

14.26 The carbon footprint of the baseline scenario (waste to landfill) is compared against the Energy from Waste processes in Figure 14-8 Landfill of waste exhibits a clear environmental burden when compared to Energy from Waste as an alternative treatment, which demonstrates not only a reduction in carbon footprint, but an avoided burden of CO_{2e} emissions.

Figure 14.8 Life Cycle

Global Warming Potential



14.27 The results shown in Figure 14-8 illustrate the carbon footprint of the New England Quarry Energy from Waste facility generating power only, and potentially the additional recovery of heat.

14.28 As shown in Figure 14-8 the additional recovery of heat has a significant impact on the overall avoided environmental burdens associated with Energy from Waste, resulting in an additional ~32,000 tonnes CO_{2e} avoided burden.

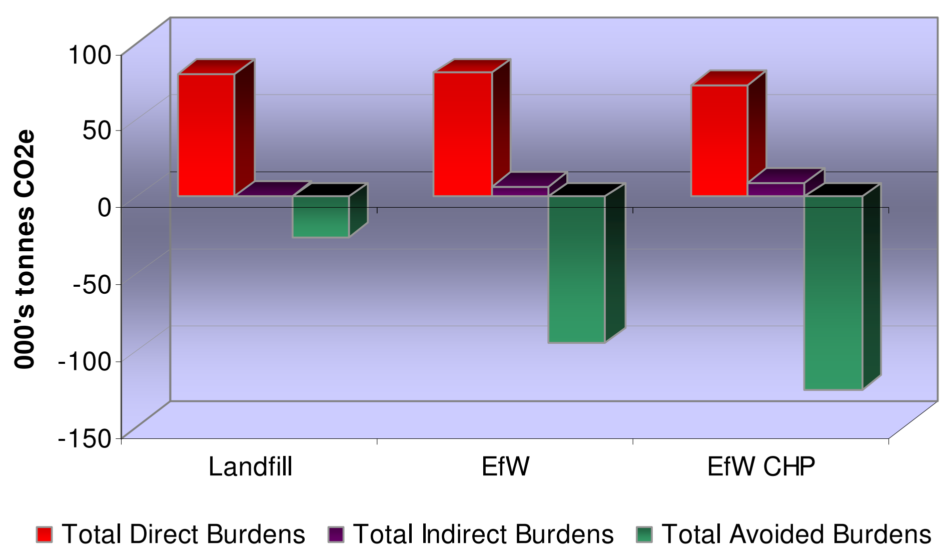
14.29 Both EfW with power export only and EfW with CHP demonstrate an avoided burden associated with CO2 emissions. Heat recovery can significantly improve the performance of the EfW facility and a Heat Plan has been prepared (App 14-8) with this application to assess the potential for recovery of heat and supply to users within a 5km radius of the New England site. The heat plan report concludes; that there are a number of potential heat users within a 5km radius. In the context of a predominantly rural location, the opportunities are relatively significant, and will be subject to more consideration during the course of the planning application process and, if planning permission is forthcoming, during the construction period."

14.30 Therefore at the current time it is deemed appropriate to assess the environmental impacts of EfW power export only and EfW with CHP. The selected EfW power export only WRATE process has an efficiency of 23.6% and the selected EfW with CHP WRATE process has an improved efficiency of 35% due to the additional utilisation of heat.

14.31 Figure 14-9 shows the scenarios sub-divided into direct emissions, indirect emissions and avoided emissions to provide further analysis of the main sources of environmental burdens and avoided burdens.

Figure 14-9

Direct, Indirect and Avoided Life Cycle GWP



14.32 Direct burdens result from the direct processing of waste in the landfill or EfW facility. Direct burdens are shown to have a large positive impact on the environment and are the result of fugitive methane emissions from landfill or combustion of plastics and other fossil fuel derived materials for EfW. The direct burdens for all three scenarios are all within 10% (~8,000 tonnes CO_{2e}) of each other.

14.33 Indirect burdens result from construction, maintenance, energy input and operational materials. The energy from waste process clearly exhibits greater indirect impacts than those associated with landfill, based on the comparison illustrated above in Figure 14-9.

14.34 The majority of the indirect burdens for energy from waste are associated with operational material inputs (chemicals for gas and water treatment) which have high embodied energy contents due to the large degree of processing required.

14.35 Avoided burdens include the benefits of recycling materials (for example metals or incinerator bottom ash) and generating electricity (and heat). The landfill scenario contains an avoided burden which is associated with the capture of landfill gas and subsequent combustion to generate electricity through on site gas turbines.

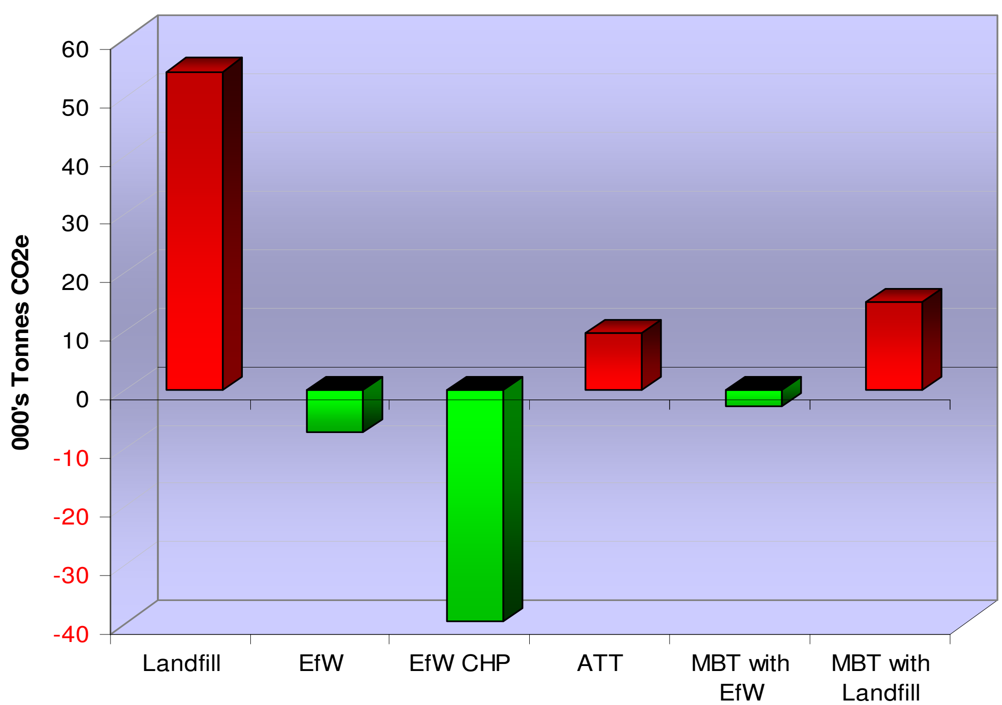
14.36 The avoided burdens for EfW and EfW CHP are considerably greater, and these are associated with the recycling, the electrical energy and heat recovery. Electricity and heat utilisation offset the extraction, processing and combustion of fossil fuels resulting in an avoided environmental burden.

GWP – Comparison of Alternative Waste Treatment Technologies

14.37 The following section presents the results of the global warming potential of alternative waste treatment technologies and compares the environmental impact against that of waste to landfill and waste to EfW (electricity export only and CHP).

Figure 14-10

Global Warming Potential (GWP 100) Impact Results



14.38 The Global Warming Potential results presented in Figure 14-10 can be explained as follows:

Technology	Justification of Results
Landfill	Combustion of recovered methane generates electricity, which avoids the need to produce electricity from non-renewable (fossil) sources, however this saving is negligible and there is a positive overall impact associated with fugitive emissions of methane and other GWP compounds.
Energy from Waste (EfW) with power	EfW releases carbon dioxide from combustion of plastics and other fossil fuel derived materials. Recovered energy avoids the need to produce electricity from non-renewable (fossil) sources which in turn reduces emissions associated with the extraction and combustion of fossil fuels. Recovery of ferrous metals displaces production from virgin materials, and subsequently reduces energy requirements.
Energy from Waste (EfW) with Combined Heat and Power (CHP)	As above (for EfW), but with the further enhancement due to the additional recovery of heat.
Advanced Thermal Treatment (ATT)	ATT releases carbon dioxide from the processing of plastics and other fossil fuel derived materials. Recovered energy avoids the need to produce electricity from non-renewable (fossil) sources which in turn reduces emissions associated with the extraction and combustion of fossil fuels. Recovery of ferrous metals displaces production from virgin materials, and subsequently reduces energy requirements. Although the benefits of energy production are similar for ATT and EfW, the burdens from operational material input is greater, and the avoided burdens from operational product output are less, leading to ATT scoring worse than EfW energy export only overall.
Mechanical Biological Treatment (MBT) with Refuse Derived Fuel (RDF) to EfW	Recovery of ferrous metals, non ferrous metals and glass displaces production from virgin materials, and subsequently reduces energy requirements. Benefits are less than those for EfW only, despite the increase in calorific value, the additional burdens associated with construction of the MBT facility, the rejects sent to landfill, higher electricity input for operation of front end equipment and due to the formation of nitrous oxide from the biological oxidation of nitrogen containing compounds.
Mechanical Biological Treatment (MBT) with Refuse Derived Fuel (RDF) to landfill	Recovery of recyclable ferrous metals, non-ferrous metals and glass from front end processing displaces production from virgin materials, and subsequently reduces energy requirements. Positive impact is associated with fugitive emissions of GWP compounds from the RDF material consigned to landfill and nitrous oxides from the biological oxidation of nitrogen containing compounds.

14.39 All residual treatment technologies result in reduced CO2e emissions compared to landfill. Three scenarios (EfW power export only, EfW with CHP, and ATT) outperform the other scenarios and result in a net avoided burden of carbon dioxide, i.e. the avoided burdens of recycling and energy/heat recovery outweigh the positive releases (direct and indirect) of carbon dioxide.

14.40 The estimated Global Warming Potential of the 6 waste treatment scenarios is tabulated in Table 14-8; the GWP impact values are valued to provide a score of between 0 and 1, with 1 representing the most sustainable waste treatment technology.

14.41 Table14-8 indicates that EfW with CHP significantly outperforms the other scenarios in respect to the Global Warming Potential impact assessment.

14.42 The next 2 highest scoring technologies from Table 14-8 (EfW power export only and MBT with EfW) are within 0.05 points, indicating that the global warming potential impact assessment scores of these two scenarios are relatively close.

14.43 The worst performing technology is landfill with a score of 0. All technologies result in a reduction in environmental impact compared to landfill (the baseline situation).

14.44 Other non environmental impacts have not been included as part of this study, but all play important roles in the decision making process.

Table 14-8

Normalised Performance Scores

Impact Assessment	Unit	Landfill	EfW	EfW with CHP	ATT	MBT with EfW	MBT with Landfill
Global Warming Potential (GWP 100)	Kg CO_2 eq.	54,389,973	-7,258,182	,39,608,147	9,699,433	-2,796,517	14,918,587
Global Warming Potential (GWP 100)	Valued Score	0.00	0.66	1.00	0.48	0.61	0.42

Final Summary of WRATE Results

14.45 The global warming potential[10] (commonly known as carbon footprint) for the processing of 275,000 tonnes of residual waste have been presented through a number of different residual waste treatment processes. Modelling has been carried out using the Environment Agency's Life Cycle Assessment Tool, WRATE.

14.46 The WRATE modelling results indicate that when considering the environmental impact global warming potential criteria in WRATE, the best performing option is Energy from Waste with Combined Heat and Power, followed by Energy from Waste with power output only.

14.47 In conclusion, through the use of the WRATE life cycle assessment software, it can be demonstrated that Energy from Waste, preferably with Combined Heat and Power, yields a carbon footprint impact that is superior to the other competing technologies.

14.48 On this basis it is concluded that the proposed New England Quarry EfW facility will result in a negative environmental footprint, that is, an overall reduction of global CO_2 emissions compared to landfill.

[10] WRATE Life Cycle Impact Assessment - Default Impact Assessment, Global Warming (GWP100)