An Assessment of the Environmental Impact of Management Options for Waste Wood

Task H: Future Scenario Analyses
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1 Introduction

Preliminary findings for the work AEA is doing on the management of waste wood in the UK include:

- Management of the cleaner grades of waste wood is well established, as was indicated in the Defra Market Information report in 2008. In this report we refer to these as Grades A and B, both of which are untreated and therefore uncontaminated. This wood has a market in panel board production, animal bedding, landscaping and bioenergy. There is a shortage of such wood in some areas of the UK and its price has been increasing over the past 12 months.

- A significant proportion of Grade C wood waste (contaminated or treated waste wood) is sent to landfill or incineration without energy recovery. This is because there is no alternative. This wood is not suitable for panel board manufacture, landscaping or animal bedding. The best potential use for Grade C waste wood is energy recovery, but plants taking this Grade of waste wood must be compliant with the Waste Incineration Directive (WID) and there is a shortage of such plants in the UK at present. However, there are proposals to build 11 new WID compliant dedicated biomass plants that can take waste wood or that can take a mixture of refuse derived fuels (RDF), waste wood and virgin wood grades (see Task G, Appendix 1 for details). The developers intend to be eligible for Renewable Obligation Certificates (ROCs). In addition there is a growing quantity of RDF from mechanical and biological treatment plants in the UK suitable for energy recovery operations. Development of such plants could provide an outlet for Grade C waste wood to be used as a fuel.¹

- Arboricultural waste wood is often used for mulch, but a significant proportion goes to compost or landfill. This could also be more effectively managed, although for it to become suitable for use as a fuel investment is required in infrastructure for storage, drying and processing.

- Rejects from waste wood processing are also sent to landfill. If loads arrive at waste wood processing plants with visible contamination the loads are rejected (no matter how small a proportion of the load) and often the only alternative is landfilling.

- Waste wood from small scale construction and demolition sites that fall under the threshold for site waste management plans is often burnt on site (licensed by the Environment Agency) in open fires without energy recovery or goes to landfill as part of a skip load. This is generally said to be because of lack of room to segregate waste on site; other barriers include the cost and time of segregation of waste; or few alternatives to landfill. This situation could be managed better to enable more recycling or recovery of waste wood from these sites.

- Resources Future (2010) has reviewed work on the composition of waste for Defra. Although the figures they provide give details on how much wood waste there is in MSW there remains questions on how this waste appears in municipal waste and the investment required for infrastructure to recycle it. Further work is needed to understand whether there are any easy ways to segregate such wood, or if it is more cost effective to leave the wood in the mixed waste stream where it might form part of the energy value of RDF.

To examine the impact various Government policies, initiatives or changes in market conditions would have on the diversion of wood waste from landfill we have undertaken a scenario analysis for 2010 to

¹ Note: there is no easy way to distinguish Grade B and Grade C waste wood, except for visual inspection of each load. Detection of treated wood in a load will usually lead to dismissal of that load at the re-processing plant. Such wood is often then sent on to landfill. This leads to the landfill of quantities of Grade B wood present within the load. Improved understanding of what comprises untreated or Grade B waste wood, better segregation and a methodology for detecting contamination cheaply might prevent the mixing of Grade C and Grade B waste wood in the first plant, thus pulling more Grade B waste wood out of the waste stream.
2030. This analysis concentrates on the grades going to landfill at present. Our research shows that the cleaner grades of waste wood (i.e. A and B grades) are generally successfully recycled. Fundamental to the scenario analysis is the development of a business as usual case for waste wood management that will provide an indication of the consequences of continuing current conditions into the future. In addition to this we have examined:

- Two market driven scenarios, one examining the consequence of increased fossil fuel prices, the other examining the impact of a successful international market in wood fuels, resulting in the successful import of large quantities of clean virgin wood (i.e. non recycled) fuel into the UK.

- Two scenarios in which environmental (waste) policy is used to drive changes in waste disposal. The first of these considers the implication of introducing a zero waste to landfill policy by 2020. This considers the policies on zero waste to landfill being introduced in Scotland and Wales (and any other relevant policies being considered elsewhere). The second of these scenarios examined incentivisation of diversion of specific waste from landfill (other than banning the waste from landfill). In this case incentives might be aimed at specific fractions in the waste stream (e.g. to support segregation of waste wood or the production of fuels from arboricultural residues).

- A scenario in which energy policy is used to further incentivise diversion of waste wood, from landfill to energy recovery. In this scenario we assumed that the EU Renewable Energy Directive 2020 targets remain in place.

- A scenario in which energy and environmental policies work together to incentivise the diversion of waste wood from landfill towards energy recovery.

Each of these scenarios assumes that the Waste Hierarchy as it stands at present will be observed: i.e. recycling will be assumed to take precedent over recovery of energy, except where energy recovery can be demonstrated to be more carbon efficient. The current Waste Hierarchy guidance suggests that energy recovery is better for lower grade waste wood, although the situation for higher grades is not clear cut.

Little of the highest grades of waste wood (A and B) are believed to go to landfill at present. As the main objective of the scenarios is to divert wood from landfill, this is predominantly considered to be lower grade wood (grade C). Therefore, within the scenarios, it is considered most viable to increase energy recovery as a means of landfill diversion rather than recycling. It should also be noted that we are not examining all recycling routes in this analysis. We are only interested in those waste wood streams that currently go to landfill or energy recovery and how more waste wood can be diverted out of landfill.

The document presents a detailed discussion of each of these scenarios, together with a table for each that presents more details on potential Government policies and market conditions that might be introduced and the consequences for that scenario, this is followed by an assessment of the relative changes within the flows of waste wood in the UK between the various scenarios, ending with commentary on the main trends and conclusions that can be drawn.
2 Approach

The final Task on this project for Defra is to examine various future scenarios for both policy and market.

The use of waste wood for energy recovery will be determined by a number of drivers, as well as the availability of appropriate technology and infrastructure for processing and storage of the waste stream. There are two key drivers that will encourage waste wood for energy:

- Environmental policy drivers specifically related to waste management e.g. landfill and incineration gate fees, policies banning biodegradable waste from landfill
- Energy policy drivers designed to increase renewable energy (for heat, power and biofuels).

In addition to policy drivers there are market and technology enablers. These include:

- Available combustion capacity that is appropriately permitted for waste wood and solid recovered fuels.
- Development of infrastructure for the separation of fuel grade waste wood, including appropriate processing and handling infrastructure.
- Market conditions favourable for waste wood. Currently the market for waste wood is heavily influenced by Government policies, but other factors that could enhance this market include high fossil fuel prices, sustainability concerns surrounding alternative biomass fuels and the development of a global market in biomass and wood fuel.

Taking all of the above into account, and in discussion with Defra we have developed seven scenarios to examine the impact of core policy mechanisms and market conditions on the use of waste wood for both energy recovery and other end uses. The scenarios are:

1. **Business As Usual**: Policy drives import of biomass for combustion, large amounts of waste wood go to landfill
2. **Market 1**: High fossil fuel prices lead to increased interest in relatively ‘clean’ biomass wastes such as waste wood grades A, B and C.
3. **Market 2**: Examine the impact of good (unconstrained) solid biomass fuel supply on energy from waste wood.
4. **Environment policy A**: Restrictions on the landfilling of waste wood results in the need to develop alternative treatment for waste wood options that cannot be recycled.
5. **Environment policy B**: In this scenario we examine policy options which would reduce the amount of waste wood going to landfill, without restrictions on landfilling of such wastes. Such policies include increased taxes on the landfilling of specific types of waste; development of policies in favour of energy from waste, encouraging waste wood that cannot be recycled to go to energy recovery instead.
6. **Energy policy**: Concern about the sustainability of biomass and conflicts with alternative land use result in pressures to encourage the potential of energy from biomass wastes in renewable legislation, for example, by encouraging the use of sustainable biomass. This results in refuse derived fuels (RDF) and other waste derived fuels to be developed to contain high biomass content.
7. **Energy and Waste policy Accelerator**: combined environmental and policy options.

We have used the scenarios to examine which scenarios result in the greatest diversion of wood waste from landfill. This could involve the diversion of wood through recycling or energy recovery or the diversion of the residual waste that remains recycling from landfill. Such residual waste may contain wood fractions that cannot easily be separated or recycled.

The scenarios have been commented on over three timescales; 2015, 2020 and 2030. The purpose of this was to see whether the timescale over which management options of policies were introduced influences the outcome.
The rest of this report is set out into three sections:

**Section 3** – explains the context and main headlines of each scenario

**Section 4** – explains the waste wood flow model and looks at the main outcomes of the model

**Section 5** – summarises the main conclusions from the work
3 The Scenarios

3.1 Business as usual

This scenario is specifically defined to show the consequences of continuing with the current situation. This will provide a baseline scenario against which the others can be measured.

3.1.1 Headlines

- Recycling and recovery concentrated on grade A and B wood waste. This does not increase significantly above current levels to 2030 as much of this waste wood is already captured.
- A waste wood protocol is developed, although this only addresses Grade A waste wood.
- Grade C waste wood continues to be managed as at present, with a significant fraction going to landfill as part of mixed waste fraction of MSW. As MBT becomes more established and the capacity to recover energy from the residual fraction of MBT increases, it is likely that more Grade C wood waste will be part of this residual fraction, resulting in energy recovery from the waste wood as part of the RDF stream.
- Landfill Directive targets to decrease the biodegradable waste to landfill to 35% of their 1995 levels would result in about half of the wood waste presently going to landfill being diverted from landfill by 2020 either through MBT and energy recovery from the resulting RDF, or through increased incineration of MSW.
- After 2020 trends are not so easy to discern. We have assumed that landfill becomes more scarce and expensive after this date, resulting in increased combustion at energy from waste (EfW) plant or RDF combustion facilities and continuing decrease in landfill. See below for trends on EfW and RDF. These trends are in line with EC proposals to phase out biodegradable waste to landfill by 2025.²
- We have also assumed that the poor understanding of hazardous wood waste from mixed waste streams and how its disposal is managed continues. Under this assumption we have put management for hazardous waste into an ‘unknown’ category.
- We have assumed that EfW continues much as at present:
  - Concentrated on MSW and C&I waste streams; relatively poor efficiency of conversion compared to other power generation such as dedicated biomass energy recovery; and with little CHP and little deployment of advanced conversion technologies (ACTs).
  - Current EfW plants are not suitable for large quantities of higher calorific value fuels such as Grade C waste wood currently going to landfill. Any increase in recovery of Grade C waste wood is associated with RDF (see below). Some interest in Grade C WID compliant boilers at small sites where it is produced and there is an adequate heat load, stimulated by RHI.
  - RDF is produced as a default from recycling and recovery operations, such as MBT. There is little or no control over its composition. Some increased interest in co-combustion of ‘solid recovered fuels’ processed from the RDF generated by the treatment of residual municipal, and other commercial and industrial, wastes in MBT plants.
- Little separation of green wood waste or waste wood from mixed waste streams.
- Waste hierarchy is legally binding.

3.1.2 Details

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<thead>
<tr>
<th>Issue</th>
<th>Considerations</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Government waste policy</strong></td>
<td>- Waste hierarchy is legally binding.</td>
<td>Little incentive to increase waste wood segregation and re-processing above current levels.</td>
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<tr>
<td></td>
<td>- Emphasis on supporting AD for green waste; no drive to pull waste wood out of garden waste, Diversion of waste from landfill disposal incentivised by landfill tax.</td>
<td>Movement of waste from landfill leads to increase in mass burn combustion with energy recovery.</td>
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<td>- Refuse derive fuel produced from the residual waste from MBT plants, but not optimised for renewable energy content.</td>
<td>SRF goes to industrial or commercial boilers. Some drive to increase the biodegradable content of SRF and to mix it with waste wood to achieve greater biomass content. Demonstration of biomass content remains difficult at least for next 5 years.</td>
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<td>- Biodegradable wastes to landfill targets remain at current levels to 2020. Further decreases may be adopted after 2020.</td>
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<td></td>
<td>- No specific drive to help small construction firms segregate waste</td>
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<tr>
<td><strong>Government renewable energy policy</strong></td>
<td>- Renewable incentives through current Renewables Obligation (RO), the Renewable Heat Incentive Scheme (RHI), and the reforms to the to the electricity market:</td>
<td>Little incentive to increase waste wood segregation and re-processing above current levels.</td>
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<td></td>
<td>- The conditions for the RO are that energy from waste plant and waste containing biomass are only eligible if greater efficiency of use can be generated (i.e. through dedicated heat and combined heat and power use), or if advanced conversion technologies used.</td>
<td>Incentives aimed at introducing heat recovery and deployment of advanced conversion technologies. Some incentive to segregate fuels in order to increase biogenic content of waste to meet the 90% level for eligibility for the RO. Continued difficulty in demonstrating this, at least for next few years.</td>
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<tr>
<td></td>
<td>- Waste wood eligible as biomass if it can be demonstrated that energy content is 90% from biomass components. This can be challenging, depending on level of segregation and sorting carried out prior to use.</td>
<td>Incentives aimed at introducing heat recovery and deployment of advanced conversion technologies. Some incentive to segregate fuels in order to increase biogenic content of waste to meet the 90% level for eligibility for the RO. Continued difficulty in demonstrating this, at least for next few years.</td>
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<td></td>
<td>- Cost of segregation, aggregation and processing of waste wood currently going to landfill not taken into account in renewables incentives. No additional</td>
<td>Incentives aimed at introducing heat recovery and deployment of advanced conversion technologies. Some incentive to segregate fuels in order to increase biogenic content of waste to meet the 90% level for eligibility for the RO. Continued difficulty in demonstrating this, at least for next few years.</td>
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3 Ofgem has recently announced that it will accept the 14C method for the monitoring of the biogenic content of waste. However, this technique remains expensive (£170-300 per sample) and there remain issues with the number of samples required. In addition online monitoring in the flue gas is not straightforward as this is a challenging environment. DECC and Defra are working with Ofgem, industry and other delivery partners to assess the need for a cost effective methodology for determining the biomass content of mixed waste, and where possible solutions might lie.

4 However, the banding review of the RO for example is looking at fuel costs as part of evidence on costs of different technologies and so this will be reflected to some extent in banding levels.
incentives for SRF containing high biomass unless 90% eligibility can be demonstrated (see footnote 2 regarding methodology for detecting this).

derived fuels.

### Issues for grades of waste wood

| Grade A and B can be recycled and re-used as at present. |
| Introduction of RHI has implications on availability of some sources of Grade A waste wood as producers use these grades for heat at their own premises. |
| Grades C & D – separation from mixed waste or source separation remains an issue. |

Continued tight market for grade A and B grades.
Cost of separation of waste wood grades C & D borne by producer and re-processor. Prices paid for end-product insufficient to stimulate increase segregation of waste wood.
Export of Grade C waste wood to WID compliant plants in Europe, where there is a shortage of feedstocks.

### Waste wood protocol

Waste wood protocol agreed for Grade A waste wood only. This means that some fractions of Grade C waste wood that might be classed as grade B continues to be considered Grade C.

Continued confusion on the part of producers about what waste wood is acceptable for energy recovery.

### Combustion technologies for energy from waste

Continue as at present, using combustion as a method to decrease the volume of waste to landfill.
Production of SRF stimulates some development of suitable energy recovery plant in UK. Export of RDF to the Low countries, Scandinavia and Germany continues.

Some development of plants to take Grade C & D waste wood.

### Opportunities for separating out waste wood from mixed waste streams

Few opportunities, although incentives for 90% biomass content in RO may lead to some increased biomass-content SRF produced. Grade C waste wood may be important in this.

See above

### Treatment of arboricultural and other green waste wood

Arboricultural waste continues to be mulched.

Continued use of green waste wood grades for mulch. Little incentive for energy recovery.

### Important planning issues

Public continues to be cynical about waste wood energy recovery and incineration of MSW.

Difficulty in obtaining planning, particularly for WID plants and for plants burning RDF.

### General economy

Slow recovery from current economic crisis

Recession continues to impact the production of Grade A waste wood.

It is assumed that the last two points remain the same for all scenarios.
3.2 Market 1

3.2.1 Headlines

This scenario examines impact of simply using fossil fuel prices to incentivise market for waste wood to energy. In this scenario it is assumed that fossil fuel prices increase by 25% above current levels and remain high through to 2030.

- Only high quality waste wood (Grade A and B), which can demonstrate bio content incentivised under the RO/RHI incentives are used for energy. These grades of waste wood also go to panel board manufacture, which is their prime market.
- Grade C waste wood only used in WID compliant bioenergy plants, which are developed at a slower rate than non-WID compliant plants.
- No new funding for demonstration of new technologies above that at present
- Power generation from biomass linked to Government incentives and desire to increase efficiency of electricity generation or to generation of renewable heat.
- Heat use from Grade A and B only. Use of Grade C for heat limited to WID compliant plants. It is assumed that the number of WID compliant plants increase incentivised by a combination of fossil fuel prices and the RHI and RO.
- Renewable Energy incentives: linked to achieving 90% biomass content fuels for WID compliant plants (i.e. Grade C waste wood energy recovery incentivised, but incentives for RDF are linked to it being able to achieve 90% biomass for the RO/RHI). Increases in fossil fuel prices incentivise more renewable heat.
- Environmental incentives: BAU policies.

3.2.2 Details

Scenario details as for BAU.

3.3 Market 2

3.3.1 Headlines

This scenario examines the impact of high availability of good quality virgin biomass imported from abroad on the market for waste wood. It assumes that this import will influence the market for uncontaminated waste wood. We specifically examine whether or not this creates a gap in the market for waste wood Grades A and B, leading to lower prices for the fraction sold to biomass power plants or if it increases the number of biomass plants operating in the UK.

- It is assumed that the market for WID compliant plants will be restricted to mixed RDF and waste wood plants and that there will be no growth or incentive for WID compliant plants that take Grade C waste wood, except for that stimulated by the RHI at producers sites where there is a heat load.
- Renewable Energy incentives: no additional incentives for waste wood, no consideration of costs of processing of waste wood or of compliance with WID.
- Environmental incentives: BAU policies.

3.3.2 Details

The detail of the scenario is as for BAU, with the addition of large quantities of virgin wood being available for biomass plants. This influences the demand for wood fuel on the market and the cost of that wood fuel, which has implications for the use of waste wood, particularly the lower grades of waste wood that currently go to landfill.

3.4 Environment policy

There are two scenarios in which waste policy is assumed to change (but not energy policy). The first major waste policy change examined is a zero waste to landfill policy. It is assumed that this would be targeted for 2020. We have used current zero waste to landfill policies to inform this scenario; most of these have ambitions to decrease the use of landfill for municipal waste over a period of time. We have assumed that this is extended to commercial and industrial waste and that there are incentives in
place to decrease all biodegradable waste to landfill, which would include wood waste from construction and demolition waste. Assumptions are made according to the common aspirations in other zero waste to landfill plans to achieve targets by 2020.

The second waste policy change assumes that there are incentives in place aimed at diverting specific waste fractions from landfill sites. For example, in this scenario we have assumed that wood waste would be restricted in landfill. This policy scenario would be linked to the waste hierarchy, so that options for diversion of waste include consideration of recycling before recovery, except in those circumstances where life cycle assessment demonstrates the carbon benefits of recovery of energy.

A: focus on zero waste to landfill policy

3.4.1 Headlines

- Government uses incentivisation rather than enforcement to enable policy. We have assumed that the aim is to decrease waste to zero landfill through incentives.
- Target date for achieving policy is assumed to be 2020. This assumes that policies are in place to achieve zero waste to landfill by this date. We have assumed that zero waste to landfill refers to zero biodegradable waste to landfill and that this could be achieved through a combination of policies, such as segregation on site and off site, development of site waste management plans or Action plans for C&I and C&D waste, restriction of biodegradable waste to landfill unless it has been stabilised first. In this case wood waste that currently goes to landfill would go to energy from waste plants or alternative WID compliant biomass plants or co-combustion. It is also assumed that site waste management plans will include an element of waste prevention, which may affect the arisings of waste wood Grades A-C. We have assumed any incentives for driving zero waste to landfill are in place by 2015 and that they aspire to achieve zero waste to landfill by 2020.
- Assumed this is combined with continued increase in value of landfill tax (to £80/t in 2014, after which it will remain at least constant).
- Assume that there will be clarification on planning for sites for waste segregation and storage if it proves to be difficult to obtain planning for such site. This will be important to the storage of waste wood, particularly arboricultural waste wood which will need to be dried Government will look at other regions (e.g. Scotland, Wales, Finland) where there are zero waste to landfill policies in place to see how they are attempting to achieve their aims and select best practice for UK.

3.4.2 Details

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<thead>
<tr>
<th>Issue</th>
<th>Considerations</th>
<th>Consequences</th>
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</thead>
<tbody>
<tr>
<td>Government waste policy</td>
<td>Working towards incentive driven zero waste to landfill by 2020.</td>
<td>Continued drive towards site management plans for C&amp;D waste and expansion of this approach to other sectors. This might decrease waste production but also increase waste wood segregated. Acceleration of waste diversion from landfill leads to increase in mass burn combustion with energy recovery and also to increase in availability of Grades C&amp;D for energy recovery from CA and sorting sites where segregation of waste wood is encouraged SRF combustion plants are built. These</td>
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<td>Initiatives to enable good site management, encouraging reduction in waste, recycling, reuse and energy recovery.</td>
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<td>Support for aggregation, storage and drying facilities for arboricultural waste.</td>
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<td>Other policies as for BAU scenario</td>
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5 DEFRA has announced that it plans to real the Site Waste Management Plans Regulations 2008, but until this happens they remain in force and still have to be complied with. See: http://www.defra.gov.uk/publications/files/pb13728-red-tape-environment.pdf for proposals.
<table>
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<th><strong>Government renewable energy policy</strong></th>
<th>As for BAU</th>
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<tr>
<th><strong>Issues for grades of waste wood</strong></th>
<th>As for BAU</th>
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<tr>
<th><strong>Waste wood protocol</strong></th>
<th>Waste wood protocol developed with the aim of clarifying differences between Grade C and Grade B waste wood. This means that some waste wood currently classed as Grade C may be re-graded as Grade B.</th>
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<tbody>
<tr>
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<td>Increased availability of Grade B waste wood for re-use and energy recovery.</td>
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<tr>
<th><strong>Combustion technologies for energy from waste</strong></th>
<th>Production of SRF stimulates some development of suitable WID compliant energy recovery plant in UK that can take Grade C waste wood. However, export of RDF to the Low countries and Germany continues.</th>
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<tbody>
<tr>
<td></td>
<td>Although greater quantities of Grade C &amp; D waste wood may be available for energy recovery there is little incentive to use it unless it can be demonstrated to be &gt;90% biomass. Suitable methodologies for the demonstration of biomass content of waste wood will be important. It is assumed that the current projects being supported by Government are successful and that appropriate techniques are commercially available in near future.</td>
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<tr>
<th><strong>Opportunities for separating out waste wood from mixed waste streams</strong></th>
<th>As for BAU</th>
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<td>See above</td>
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<tr>
<th><strong>Treatment of arboricultural and other green waste wood</strong></th>
<th>As for BAU</th>
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<td></td>
<td>Continued use of green waste wood grades for mulch. Little incentive for energy recovery.</td>
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### 3.5 Environment policy

#### B: Focus on providing options for reduction in waste wood going to landfill

#### 3.5.1 Headlines

- Incentives in place are aimed specifically at diversion of waste wood from landfill related to reduction, recycling, re-use and recovery of energy from SRF and mixed waste. Before 2020 current biodegradable waste targets are in place. After 2020 continued emphasis on diverting biodegradable waste from landfill.
- Support for systems aimed at source separation of waste wood.
- Support for attempts to decrease the use of treated/contaminated wood in construction industry
- Support for aggregation, processing and storage of waste wood.
- Support for market development for Grade C waste wood.
- Current incentives for renewable energy from waste rely on the generation of heat or the deployment of advanced conversion technologies and require demonstration of biogenic content of waste. There is no change in this. This may mean that the current trends in export of RDF to plants in Europe continues.

### 3.5.2 Details

<table>
<thead>
<tr>
<th>Issue</th>
<th>Considerations</th>
<th>Consequences</th>
</tr>
</thead>
</table>
| **Government waste policy**          | • Incentives developed for source separation of waste wood at site of production, including support to enable construction waste wood to be segregated at small sites.  
• Support for aggregation, storage and drying facilities for arboricultural waste, enabling the use of waste that is currently left to rot or burnt in situ.  
• Remaining policies as for BAU | Incentives increase waste wood segregation and re-processing above current levels. However, they also encourage more efficient use of wood and less waste wood overall.  
Incentives lead to increase in plants able to take Grades C&D for energy recovery. SRF combustion plants are built. These may take some of the segregated waste wood.  
Incentives lead to greater quantities of Grade B waste wood becoming available, but less Grade A waste wood as it is more effectively used on site |
| **Government renewable energy policy** | • Cost of segregation, aggregation and processing of waste wood currently going to landfill not taken into account in renewables incentives.°  
No additional incentives for SRF containing high biomass unless 90% eligibility can be demonstrated. The key is demonstration of biomass content of waste wood. | As for BAU |

Other policies as for BAU

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<tr>
<th>Issues for grades of waste wood</th>
<th>As for BAU</th>
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<tbody>
<tr>
<td>Waste wood protocol</td>
<td>As for Waste policy scenario A</td>
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| Combustion technologies for energy from waste | As for BAU, but with additional Government steer towards energy recovery when options further up the hierarchy are not possible. These policies favour efficient use of the energy content and energy recovery from SRF | Although greater quantities of Grade C & D waste wood may be available for energy recovery there is little incentive to use it. |

| Opportunities for separating out waste wood from mixed waste | Incentivised separation at source and at civic amenity sites | Assumes increased segregation of municipal waste wood at civic amenity sites, producing increased quantities Grade C waste wood. This could have an impact on CA site |

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° However, the banding review of the RO for example is looking at fuel costs as part of evidence on costs of different technologies and so this will be reflected to some extent in banding levels.
3.6 Energy policy

This scenario examines what might happen if energy incentives are introduced that encourage low grade waste wood diversion from landfill to energy recovery. Such incentives include deemed values for the biogenic content of contaminated waste wood or standard methodologies to demonstrate eligibility. ROC/RHI banding reviewed to take into account the cost of segregation and processing of such feedstock.

This scenario examines what might happen if energy policy for renewable energy is changed to provide greater incentives for WID compliant waste wood and co-combustion RDF/waste wood plants for both the RO and RHI. The scenario assumes that the policies described above to encourage more waste wood segregation than at present are not in place.

### 3.6.1 Headlines

- Continued and increased incentivisation of renewable energy including energy from biomass. Although focus is not on waste to energy, there is increased incentive for energy from biomass in waste. This includes evaluation of the costs of segregation and processing of difficult to recover waste wood fractions from mixed waste currently going to landfill.
- Further support for the development of methodologies that demonstrate biomass content of mixed waste streams, e.g. in RDF. Current Defra and DECC supported work produce methodologies that are acceptable to Ofgem for the purposes of the RO and RHI.
- Focus on achieving efficiency of conversion from mixed waste (that includes waste wood), with higher incentives associated with high efficiency technologies.
- Assistance in establishing district heating networks, particularly on industrial sites.
- Development of community incentives to help overcome planning barriers to the development of unpopular combustion infrastructure, particularly that related to any form of waste. Such incentives could include inclusion of communities as shareholders or investment in local community schemes from the profits of the scheme.

<table>
<thead>
<tr>
<th>Issue</th>
<th>Considerations</th>
<th>Consequences</th>
</tr>
</thead>
</table>
| **Government waste policy** | • Emphasis on supporting AD and on combustion technologies for EfW, advanced conversion technologies and energy recovery from high biomass wastes.  
• Other policies as for BAU | Waste wood segregation and re-processing incentivised above current levels for Grades A and B  
Diversion from landfill leads to increase in combustion with energy recovery. Government may decide to incentivise higher efficiency conversion of this waste, which may result in some separation or processing of waste and a consequential increase in availability of Grades C&D for energy recovery in WID compliant plants  
Development of SRF from waste wood streams for combustion plants that take SRF (e.g. cement kilns). These may take some of the segregated Grade C waste wood.  
There is little incentive to examine other possibilities to use Grades C&D rather than just energy recovery. |
### Government renewable energy policy

- Renewable incentives as for BAU, except for increased incentives for energy recovery from waste, providing biomass content can be demonstrated.
- Inclusion of mass burn incineration or other waste containing biomass only if greater efficiency of use can be generated (heat use, or advanced conversion technologies used).
- Waste wood included as biomass for the purposes of the RO and RHI, together with guidance on methodologies for demonstrating eligibility.
- Cost of segregation, aggregation and processing of waste wood currently going to landfill not taken into account in renewables incentives.\(^7\)

<table>
<thead>
<tr>
<th>Issues for grades of waste wood</th>
<th>As for BAU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste wood protocol</td>
<td>No waste wood protocol agreed</td>
</tr>
</tbody>
</table>

| Combustion technologies for energy from waste | As for BAU |

| Opportunities for separating out waste wood from mixed waste streams | Renewable incentives may encourage more separation of waste wood from mixed waste streams. | Greater quantities of waste wood may lower risk associated with developing new energy recovery plants. |

| Treatment of arboricultural and other green waste wood | Renewable energy policy results in some incentive for the separation, storage and processing of waste wood from arboricultural and other green waste wood streams. For example, the costs of the segregation, storage and processing of this waste wood could be taken into account or grants could be made available for investment in this infrastructure. | Should draw out more waste wood from arboricultural streams. |

\(^7\) However, the banding review of the RO for example is looking at fuel costs as part of evidence on costs of different technologies and so this will be reflected to some extent in banding levels.
3.7 Energy and Waste Policy Accelerator

This scenario examines what might happen if complementary development of waste and energy policy happens, such that waste policy encourages the segregation of waste suitable for energy recovery, and its diversion from landfill and energy policy encourages energy recovery from the high biomass fractions of waste.

3.7.1 Headlines

- The main aim of policy is to accelerate renewable energy uptake in UK. The Renewable Energy Directive (RED) definition of biomass content of waste as renewable encourages examination of how the recovery of energy from the renewable content of residual waste (i.e. that remaining after reuse and recycling) could be optimized. This scenario examines a situation in which waste and energy policy are jointly targeted at optimising recovery of energy from biomass waste where other options are not available. This is an extension of current policy, in which DECC’s UK Renewable Energy Roadmap flags up an important role for energy from waste.
- There is a concerted effort to solve the problems associated with the analysis of the renewable content of waste, either through the development of a suitable methodology to measure this content, or the acceptance of a deemed value of renewable content in RDF.
- The use of biomass from all sources is ‘optimised’, so that there is a clear strategy on what is the best route for waste biomass in terms of waste hierarchy (recycling being above recovery except where greater carbon benefit can be demonstrated) and energy use (i.e. heat, power, transport biofuels).
- Waste policy concentrates on diverting waste from landfill so that biodegradable waste from all sectors does not go to landfill beyond 2030. This includes strategies to encourage the segregation of waste wood, or the optimisation of the biomass content of SRF, where the intention is to recover energy from SRF.
- Renewable energy policy clearly incentivises the most effective use of biomass resources, including those in waste.

3.7.2 Details

This scenario combines the incentives from the Environment policy option B and the Energy policy scenarios.
4 Results to the scenario analysis

4.1 Methodology and Setting the BAU

In order to quantitatively assess the impact of the seven scenarios on the quantities and flows of waste wood in the UK, AEA designed a spreadsheet model to compare relative changes between scenarios in the following categories:

- Total arisings of waste wood per year by source:
  - Commercial and Industrial (C&I);
  - Construction and Demolition (C&D);
  - Panelboard (waste produced during manufacture);
  - Municipal Solid Waste (MSW);
  - Railway sleepers and utility poles;
- The proportion and amount of Grades A – D within each source of waste wood per year;
- The total arisings of each grade of waste wood per year;
- Total tonnages going to different end uses per year:
  - Dedicated Biomass Energy Recovery;
  - Dedicated Biomass Energy Recovery (WID compliant);
  - Energy from Waste plants (Combustion with Energy Recovery and co-combustion of waste wood with SRF) (WID compliant);
  - Disposal in Landfill;
  - Animal Bedding (and subsequent land spreading) / Compost / Landscaping;
  - Unknown – meaning that the quantities are not available in national statistics – hazardous landfill, export to Europe, back-filling on construction sites, on-site burning on small-scale construction and demolition sites;
- The proportion and amount of Grades A – D within each end use of waste wood per year.

This analysis was undertaken on 5 year intervals: 2010, 2015, 2020, 2025 and 2030.

The scenario analysis was performed in two stages

Stage 1: Baseline analysis: Populate the Business As Usual (BAU) Scenario with baseline figures for 2010. Figure 4.1 shows the total waste wood arisings and the split of arisings of each grade of waste wood for each sector for the BAU scenario. Figures 4.2 and 4.3 show the end use of waste wood, split for grade of waste wood for the BAU scenario. The data for this stage was sourced from the Task A report, which reviewed the state of our knowledge on waste wood arisings and management. The data for figures 4.1 – 4.3 are derived from the latest research for each sector. An explanation of the arisings and end use data, the sources of data, and the manner in which the totals have been calculated when combining a number of different data sources, is available in Appendix 1 of this report.

One conclusion that can be drawn simply from this stage of the assessment is that there is a lack of real data on both arisings and end uses for some types of waste wood, most significantly Grades C and D waste wood.

Stage 2: Quantitative analysis: Review the changes that may take place between 2010 and 2030 for each scenario. Use expert judgement to translate this to quantitative assessment of all seven scenarios.

Appendix 2 shows the full model, with comments on any changes or assumptions that have been made.

We have examined the likely impact of the various scenarios over four timescales; 2015, 2020, 2025 and 2030. The most significant changes are more likely to happen between 2020 and 2030, as there is a long lead in time for some changes. As has been shown by various schemes designed to implement government policy, there is a very long lag-time between policy implementation and policy impacts, generally spanning more than 6-8 years. Additionally it can take more than five years to

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develop a WID–compliant biomass plant from concept to commission. This is particularly true of plants that are based on mixed waste fuels, such as SRF, due to the time it takes to obtain planning permission.

**Stage 3: analysis of results:** The final stage of this assessment was to identify major trends looking both at specific waste streams, and at the overarching changes that could be achieved in the different scenarios. Section 4.2 highlights the main trends and draws comparisons between the various scenarios.

**Figure 4.1 Pie Charts showing the split of waste wood Grade by source for the Business As Usual Scenario**

<table>
<thead>
<tr>
<th>Category</th>
<th>Tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>C&amp;I</td>
<td>2,344,606</td>
</tr>
<tr>
<td>C&amp;D</td>
<td>1,791,000</td>
</tr>
<tr>
<td>Panelboard</td>
<td>395,469</td>
</tr>
<tr>
<td>MSW</td>
<td>1,065,000</td>
</tr>
<tr>
<td>Railway sleepers/utility poles</td>
<td>50,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5,646,075</strong></td>
</tr>
</tbody>
</table>
Figure 4.2 Pie Charts showing the split of Grade by End Use for the Business As Usual Scenario

- **BAU Dedicated Biomass Energy Recovery**
  - 92%
  - 8%
  - 0%

- **BAU Dedicated Biomass Energy Recovery (WID)**
  - 90%
  - 10%
  - 0%

- **BAU Energy from Waste (WID)**
  - 25%
  - 0%
  - 75%

- **BAU Disposal in Landfill**
  - 23%
  - 0%
  - 77%

- **BAU Animal Bedding / Composting / Landscaping**
  - 70%
  - 30%
  - 0%

- **BAU Unknown: Hazardous landfill, export, on-site use**
  - 64%
  - 21%
  - 15%
Figure 4.3 Table showing the total waste wood tonnages by End Use for the Business As Usual Scenario

<table>
<thead>
<tr>
<th>Category</th>
<th>Tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dedicated Biomass Energy Recovery</td>
<td>800,309</td>
</tr>
<tr>
<td>Dedicated Biomass Energy Recovery (WID)</td>
<td>660,000</td>
</tr>
<tr>
<td>Energy from Waste (Mass Burn with Combustion with Energy Recovery)</td>
<td>446,000</td>
</tr>
<tr>
<td>Disposal in Landfill</td>
<td>2,200,000</td>
</tr>
<tr>
<td>Animal bedding / Compost / Landscaping</td>
<td>551,000</td>
</tr>
<tr>
<td>Unknown (hazardous landfill, export, back-filling, on-site use)</td>
<td>988,766</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5,646,075</strong></td>
</tr>
</tbody>
</table>

Note: these figures are based on WRAP (2009) plus the Defra estimates for wood waste to landfill (Defra 2009).

4.2 Comments on Main Results within each Scenario

For comparison with the other scenarios the results to scenario 1, Business as Usual is shown below. This shows a decrease in diversion of wood waste from landfill and a slow increase in all forms of energy recovery from wood waste, especially EfW. In this scenario we have assumed that current targets for diversion of biodegradable waste from landfill would result in around half of the current waste wood going to landfill being diverted by 2020. We then assume that the trend between 2020 and 2030 is influenced by increasing landfill cost and lower landfill availability. It is assumed that most of the waste wood diverted from landfill will go to EfW or form a component part of RDF, with energy recovery in this country (green line) or exported to other European countries for energy recovery (brown line). Dedicated bioenergy or WID bioenergy plants increase, but at a much lower rate.
4.2.1 Scenario 2: Market 1 - BAU + high fossil fuel prices

- In this scenario we have assumed high and sustained fossil fuel prices (around 25% higher than at present). These high fossil fuel prices provide an incentive for users (especially within the industrial sector) to consider waste wood. This results in development of more waste wood plants, particularly WID compliant plants because of the shortage of Grade A and B waste wood.
• This results in greater demand for waste wood Grade C and a resultant “pull” of more wood waste out of landfill; it also results in a diversion of waste wood that is currently exported (included in the unknown line above) back into UK use. It can be seen that the increase in WID compliant stand alone bioenergy plants is much higher than in BAU and that the export of low grade waste wood and SRF is lower.
• There is a risk that greater demand for wood fuels in general will result in greater demand for higher-priced Grade A wood coming from C&I and C&D, resulting in its diversion from panelboard manufacture straight to energy recovery;
• Fossil fuel prices provide more incentive for producers to use their own waste wood in an on-site biomass boiler / warm air heater; additionally more sorting, MRF and re-processing sites will develop their own WID compliant energy recovery plants for Grade C waste wood.
• This scenario may also stimulate greater interest in co-combustion of waste wood with SRF (seen on the EfW/RDF line above).
• This whole scenario will only happen if the price of fossil fuel increases rapidly in a short timescale, and then remains high.

4.2.2 Scenario 3: Market 2 - BAU + High virgin biomass supply

- This scenario examined what would happen if greater trading in virgin wood fuels enables a stable international market to develop and much greater quantities of virgin biomass from Europe, Russia, and North America are available to the UK. We have assumed between 2-5Mt/y of extra virgin wood are available to the UK as a result. We have also assumed that these market conditions continue to 2030:
- In these circumstances demand for waste wood decreases and the current high price for waste wood decreases as a result.
- There is less incentive for use of grade B and C waste wood for many energy plants.
- Reprocessors may decide to use waste wood for biomass energy themselves.
- We have assumed that there is an increase in export of Grade B and C to Europe (e.g. Germany or Sweden) where there is demand for waste wood in existing WID-compliant plants.
- Waste wood, including Grade A could be co-combusted with SRF in WID compliant plant to help achieve the 90% biomass level.
- More wood waste goes to energy from waste.
4.2.3 Scenario 4: Environment Policy A: Zero Waste to Landfill

- This scenario examines what would happen if a zero waste to landfill policy is adopted, with a target date of 2020. From our understanding and review of other zero waste to landfill schemes these tend to rely on reduction in waste, recycling and re-use to minimise the amount of waste produced together with a restriction on un-stabilised biodegradable waste to landfill. The Scottish Executive is proposing a ban on waste containing >3% biodegradable waste to landfill. We have assumed this would apply to waste wood. This policy would result in zero wood waste to landfill in 2020.
- Incentives for recycling and segregation of waste will pull more waste wood out of mixed streams.
- Mechanisms would be put in place to enable commercial and municipal waste wood to be collected separately, and CA sites have the facility to separate wood from green waste.
- Government would continue with its work in sustainable construction to help C&D sites decrease the waste they produce, and recycle and re-use more successfully, including a greater focus on SMEs. This might result in greater production of Grade B wood waste and less Grade C. This waste would be available for energy recovery.
- In addition we have assumed an education campaign aimed at consumers on the choice of materials when purchasing new items and on segregation of wood at end of life.
- The zero waste to landfill policy may result in more EfW but may also result more dedicated biomass energy recovery (WID) from Grade B&C waste.
- On the other hand there may also be an increase in on-site burning at small-scale construction and demolition sites as the wood cannot be sent to landfill.
- It may also be possible to enable arboricultural and DIY waste from MSW & waste from SME construction companies to be segregated, which may result in Grade A wood waste being produced.
4.2.4 Scenario 5: Environment Policy B: Reduced Waste to Landfill

- This scenario involves incentivisation for diversion from landfill but without the absolute ban on biodegradable waste from landfill. In this scenario we have assumed that it will be unlikely to achieve zero waste to landfill, but by 2030 there will be a significant reduction in the amount of waste wood going to landfill.
- The scenario is similar in many respects to S4, but no additional Grade A waste is likely to be generated, and some wood waste will still go to landfill.
- More Grade B and C waste would be diverted from landfill, with Grade B diversion being more successful.
- Grade B and C will be co-combusted with SRF in order to improve the biomass percentage for eligibility for renewable incentives.
- It is likely that more Grade B will be burnt in dedicated biomass plants, especially on small-scale sites that produce Grade B waste wood in with Grade A.
- In this scenario we assume that wood waste diverted from landfill, either as low grade wood waste or as part of RDF, will initially be exported until a sufficient number of plants are developed in the UK to take these fractions. This is seen in the graph above as an increase in the ‘unknown’ line, followed by a subsequent decrease.
- Energy incentives continue as at present, and are not sufficient to encourage development of large numbers of WID compliant energy recovery plants, so the lower grades of waste wood tend to go to EfW plants.
4.2.5 Scenario 6: Energy Policy

This scenario examined the impact of improvements in energy policy not linked to waste policy. We have examined the impact of increasing incentives for energy from renewables, but assumed BAU waste policies.

- There are greater incentives for renewable energy, including energy recovery from waste and SRF.
- There will be a greater demand for waste wood and prices will increase.
- There will be greater incentives for co-combustion of SRF and waste wood in WID compliant plants built, especially on industrial sites where there is a heat demand.
- There will be incentives to increase wood sorting as a result of the greater demand for renewable fuels. The graph above shows a moderate increase in dedicated bioenergy plants using Grades A and B wood waste as a result.
- There will be a greater incentive to divert Grade C waste wood from landfill or EfW, and co-combust it with SRF to generate incentivised income. The graph above shows the increase in both WID bioenergy plant and SRF and EfW plants as a result.
- Waste wood could be diverted from the panelboard industry to go directly to energy recovery (possibly around 0.4Mt/y less Grade A to panel board manufacture).
- There could be a possible reduction in burning waste wood on site for small construction sites, as the value of this waste wood in reprocessing and fuel recovery increases. However, it is unlikely that Grade A wood waste will be diverted from animal bedding, as the price per bale is still higher than incentives for heat and power.
4.2.6 Scenario 7: Energy and Waste Policy Accelerator

This scenario examines the implications of linking waste and energy policy with the aim of increasing energy recovery from biodegradable waste and encouraging diversion of this waste from landfill. It is assumed that waste policies protect the panelboard industry from the effects of the energy policies. This scenario results in:

- Incentives for increased segregation and sorting.
- Incentives for energy recovery (both heat and power) (as seen in the lines for WID bioenergy and EFW or RDF above).
- Policy ‘push and pull’ of waste wood from landfill leads to a reduction in landfill that achieves zero waste wood to landfill by 2030.
- Economics for plants are sufficient to enable WID boilers, which encourages the use of Grade C waste wood and of co-combustion of mixed waste wood with RDF.
- Increased incentives for sorting wood waste for SMEs (C&D) & MSW, which results in greater quantities of Grade C waste wood being diverted from landfill or EFW (mass burn incineration).
- Increased quantities of RDF produced, which initially are exported to Europe where there is a demand present from existing plants (see ‘unknown’ line above, which includes export of wood waste and RDF). As more plants are developed in UK RDF export decreases.

4.3 Main Impacts on Waste Wood Arisings

The main impact of the various scenarios on waste wood arisings can be seen in the C&I, C&D and MSW waste streams. The amount of waste produced from panelboard sites, and from railway sleepers / utility poles does not change significantly between any of the scenarios. Consequently we have examined the areas where the most change is seen, which is the improved segregation of what is currently classed as Grade C waste wood into Grades A, B and C. The most important gain that could be made from improved segregation is lower contamination of Grade B waste with Grade C waste, which leads to its rejection at re-processing sites. If this segregation could be improved more waste wood would be available for re-use, recycling or recovery.
Commercial and Industrial (C&I) Waste Wood Arisings

Figure 4.4 shows that, for C&I waste wood, the scenarios that predict higher levels of segregation of Grades A and B from Grade C by 2030 are:

- Scenario 2: Market 1 (High fossil fuel prices);

Improved segregation of waste wood from C&I is anticipated in nearly all scenarios, apart from Scenario 3: Market 2, which will have almost the opposite effect due to there being a vastly reduced demand for waste wood for energy recovery.

Construction and Demolition (C&D) Waste Wood Arisings

Figure 4.5 shows that, for C&D, the scenarios that predict higher levels of segregation of Grades A and B from Grade C by 2030 are:

- Scenario 2: Market 1 (High fossil fuel prices);
- Scenario 4: Environment Policy A (Zero waste to landfill);

Improved segregation of waste wood from C&D is anticipated in both waste policy-lead scenarios, although the ban on wood to landfill is predicted to have a larger impact on the demolition sector in particular. As with C&I segregation, Scenario 3: Market 2, will see little change due to there being a vastly reduced demand for waste wood for energy recovery.
Municipal Solid Waste (MSW) Waste Wood Arisings

Figure 4.6 shows that, for MSW, the scenarios that predict higher levels of segregation of Grades A and B from Grade C by 2030 are:

- Scenario 4: Environment Policy A (Zero waste to landfill);
- Scenario 5: Environment Policy B (Reduced waste to landfill);

It can be concluded that waste-lead policies will be the most effective at changing segregation of MSW, rather than energy-lead policies.
Impact on overall arisings

Examination of data from all sources of waste wood, and all comparison between all scenarios shows that some scenarios have more of an impact on segregating Grade C and Grade B more effectively (see Figure 4.7). These include the scenarios with strong environmental or energy policies (scenario 7 being the most successful at this).

Figure 4.7 Comparison of total arisings, per annum, of waste wood by Grade

4.4 Main Impacts on Waste Wood End Uses

Figure 4.8 shows that the most effective scenarios for increasing the amount of energy recovery (including WID-compliant energy recovery) are:

- Scenario 4: Environment Policy A (Zero waste to landfill);
- Scenario 5: Environment Policy B
- Scenario 6: Energy Policy;

In part these results reflect the assumption that landfill will continue to be expensive post 2020 and increasingly scarce, so that an pre-treatment prior to disposal will be necessary and result in diversion to energy recovery for that waste that cannot be recycled.

Interestingly, the analysis shows that energy policy alone is not enough to divert the waste wood out of landfill and into energy recovery, particularly by 2020. What is most likely in the energy policy scenario is that Grade A is diverted from panelboard manufacture directly to energy recovery. Additional incentives are required to divert Grade C wood waste from landfill to dedicated WID bioenergy plants. Some diversion of low grade wood waste may happen in response to an increase in domestic SRF/RDF production, but, before 2020, much of this could be exported to plants in Europe unless there are additional incentives to develop RDF/SRF combustion plants in the UK (this is included in the “unknown” area on the graphs).

Figure 4.8 also shows that the most effective scenarios for the reduction of waste wood to landfill are:

- Scenario 4: Environment Policy A (Zero waste to landfill);
• Scenario 5: Environment Policy B (Reduced waste to landfill);
• Scenario 6: Energy policy;
• Scenario 7: Energy and Waste Policy Accelerator.

From this we can conclude that it is important to have stable waste policies in place for diversion of waste wood from landfill, as the energy policies alone, or scenarios where the wood market is not constrained, do not have as large an impact.

**Note:** The amount of waste wood in the category ‘unknown’ varies between most of the scenarios. This unknown total is generally being changed by increases or decreases in exports of waste wood, and also the amount of on-site use at small-scale construction sites.

Figure 4.8 Comparison of total end use of waste wood per annum by scenario
Comparison total energy use of waste wood - 2030

- BAU: 21%
- S2 Market 1: 10%
- S3 Market 2: 21%
- S4 Environment Policy A: 10%
- S5 Environment Policy B: 12%
- S6 Energy Policy: 8%
- S7 Energy and Waste Accelerator: 8%

Legend:
- Dedic bioenergy
- WID bioenergy
- EFW or RDF
- LF
- Mulch etc
- Unknown
5 Conclusions

The main conclusions that can be drawn from the comparison of various scenarios are listed below:

- A zero waste to landfill policy would have a large impact on the separation and reprocessing industry, increasing the potential for re-processing particularly Grade C waste wood and perhaps for improved separation of Grades B and C. The Grade C waste wood must have somewhere to go and policies to incentivise WID compliant energy recovery plants would provide an answer.

- Other than a zero waste to landfill policy, a balance of both energy incentive and waste disincentives would achieve the most desirable outcome in terms of both reduction of waste wood to landfill, and increased energy recovery.

- The panelboard sector is only protected by waste policies – energy policies and market forces both have a negative impact on the amount of waste wood available for the panel board sector. In other words in these scenarios this wood waste goes straight to energy recovery and not through panel board production first. However, this views waste wood in isolation. In fact energy policies currently encourage all types of biomass use, and if adequate quantities of clean biomass are available to meet targets, bioenergy operators may prefer this source of clean fuel.

- Market forces could have very large impacts on the flow of waste wood, irrespective of any policies that are put into place. This will be particularly important as global markets in biomass develop. The ‘unknown’ fraction could be quite important. There are a number of issues that are not well defined, such as the amount of wood waste burnt on site at construction and demolition sites and the amount of waste wood or RDF containing residual waste wood that will be exported to Europe. In particular exports could account for a significant amount of the renewable resource in waste, including waste wood. The extent to which this might be counterbalanced by the use of RDF or SRF in the UK will be dependent on the rate at which WID compliant plant can be developed in the UK and the degree of ‘over capacity’ overseas.

The main conclusions that can be drawn from the examination of the existing data (including that gathered for Task A) are listed below:

- Grade A wood waste is associated with a value and there is significant demand for this grade of wood waste. Consequently most of the grade produced is currently being re-processed/recycled and it is unlikely that Government can introduce further policies to extract more of this waste wood.

- Likewise much of the wood waste that could be classified as Grade B is being re-processed and recycled or sent for energy recovery. There is an issue with contamination with Grade C wood waste, which means that loads do not meet customer specifications and are rejected, with the result that these loads often go to landfill instead. Government policy could enable this wood waste to be better segregated and to encourage the development of WID compliant waste wood plants where energy can be recovered from low and mixed grade wood waste.

- The construction sector is well managed for larger scale sites; this means that much of the reduction in waste, recycling and re-use that can be done on these sites is being done. Some construction companies are aiming for zero waste to landfill and have site management plans to help this. At the moment the recycling of waste wood by SMEs is patchier, although support for strategic waste management plans on construction sites is improving this. It is important that this best practice becomes the norm for all construction sites, but many SMEs may continue to require help to enable them to achieve this.

- Waste wood can be burnt on site at many construction and demolition sites at present, within permitted limits. More efficient energy recovery from this wood waste could be achieved in purpose built boilers or large-scale power plant, but only if more WID compliant bioenergy plants were built to handle it.

- The data on WID compliant energy recovery is not good – it is very hard to correlate the data as WID compliance is not recorded in the national statistics. This could be tackled by adding WID compliance as a recorded category in ReStats.
• If Government wants to be able to track progress in improving segregation of Grade C into Grades B and C, then better data is needed on segregation and the outlets to which the wood waste goes.

• Data on export of waste wood and of RDF shows that there is interest in this option and that the UK has granted permits for over 1 million tonnes of RDF to be exported (although the actual amount is 67,000t). Nevertheless it is expected that this export will increase at least in the short term, as there is currently no sustainable market in the UK for these products.9

• There is some interest in developing SRF that is eligible for ROCs under the Renewables Obligation. Currently it is not clear where such fuels might originate, but it is likely that C&I waste will be more amenable to such a development than MSW because the composition is easier to control.10 In this work we have had to estimate the potential of such SRF, as no data is available on the potential quantities of such SRF or on their potential composition.

• There is a large amount of uncertainty around the end use for hazardous waste arising from demolition. Railway sleepers and telegraph poles are generally well handled, but there is no data on hazardous waste wood from other sites and no record of where this waste wood ends up. Poor management of such waste wood may cause environmental and human health issues.

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Appendices

Appendix 1  Notes on BAU data
Appendix 2  Waste Wood Flow Model
Appendix 1 - Notes on BAU Data

Arisings Data

Notes on C&I arisings data

1. WRAP (2009) Industrial waste includes: packaging and that arising from furniture manufacture and joinery. From bottom up analysis in WRAP report this is
   a. Packaging: 1047260 (from PRN notes). However, WRAP say this excludes other packaging arisings and give a figure of 1169860t/y (This excludes single use packaging for things that are imported e.g. fruit boxes);
   b. Furniture manufacture: from a survey of a relatively small number of manufacturers WRAP come up with a bottom up estimate of 523001t/y. But they then say that small manufacturers tend to burn wood waste on site (that's 58,488t/y); and that other larger manufacturers are burning it but also looking for other alternatives (e.g. composting or animal bedding). Some companies are trying for 100% recycling and reuse. A large proportion of the waste is panel board or mixed panel board and Grade a wood and this is difficult to recycle.
   c. Joinery: 631745t/y. This is mainly sawn wood, which is Grade A and easier to recover. Typically shavings are used to heat the workshops, using wood burners. Some volumes are sold as anima/equestrian bedding. They conclude that on average the wastage from consumption was around the 5-10% level of which the majority is recycled or consumed.

2. From their top down approach WRAP estimate 15% of wood used in manufacture ends up in the waste stream, (0.46Mt per year).

3. If we add all of the joinery and furniture arisings from the bottom up approach we get: 1154746t/y. However, WRAP have already taken off the amount burnt on site (ReStats – 0.5Mt/y) and the amount directly recycled, to leave 0.46Mt/y. This is the figure that enters the waste stream and it is mainly difficult to recycle wood such as panel board.

Total C&I = Packaging +industrial = 1,169,860 +1,154,746= 2,324,606 = 2.3Mt per year

Notes on C&D arisings data

WRAP (2009) analysis of wood waste in the UK by wood waste stream (thousand tonnes)

<table>
<thead>
<tr>
<th>Packaging</th>
<th>Industrial</th>
<th>Construction</th>
<th>Demolition</th>
<th>Municipal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,169.90</td>
<td>462.5</td>
<td>1,184.50</td>
<td>1,137.40</td>
<td>618.7</td>
<td>4,572.90</td>
</tr>
</tbody>
</table>

Total C&D = 1,184500+1,137,400 - Take off 0.53Mt that will go into the panelboard industry and back out again as C&I or C&D - WRA (2009) = TOTAL 1.8Mt

Comment: WRA (2009) reprocess 2.1Mt of C&I and C&D combined. The remainder is an unknown - although industry says that some of it goes to landfill (at least 50,000t).

Notes on Panelboard arisings data

ReStats 2010 Woodfuel Survey - amount of wood burnt to power large-scale steam boilers on site by WPIF members. This is likely to be all low grade waste wood that the panelboard manufacturers would not use for production of panelboard.
Notes on MSW arisings data
Waste Data Flow – data reported in WRAP 2009

Table 7 Municipal wood waste arising by region in thousands tonnes.

<table>
<thead>
<tr>
<th>Region</th>
<th>Wood waste arising</th>
<th>Wood waste arising tonnes/capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Midlands</td>
<td>36.1</td>
<td>0.008</td>
</tr>
<tr>
<td>Eastern</td>
<td>46.1</td>
<td>0.008</td>
</tr>
<tr>
<td>London</td>
<td>23.4</td>
<td>0.003</td>
</tr>
<tr>
<td>North East</td>
<td>26.9</td>
<td>0.011</td>
</tr>
<tr>
<td>North West</td>
<td>123</td>
<td>0.018</td>
</tr>
<tr>
<td>South East</td>
<td>57.6</td>
<td>0.007</td>
</tr>
<tr>
<td>South West</td>
<td>69.1</td>
<td>0.013</td>
</tr>
<tr>
<td>West Midlands</td>
<td>54.8</td>
<td>0.010</td>
</tr>
<tr>
<td>Yorkshire and Humber</td>
<td>69.3</td>
<td>0.013</td>
</tr>
<tr>
<td>England</td>
<td>506.3</td>
<td>0.010</td>
</tr>
<tr>
<td>Wales</td>
<td>55.4</td>
<td>0.019</td>
</tr>
<tr>
<td>Scotland</td>
<td>28.3</td>
<td>0.006</td>
</tr>
<tr>
<td>Northern Ireland</td>
<td>28.6</td>
<td>0.016</td>
</tr>
<tr>
<td><strong>United Kingdom</strong></td>
<td><strong>618.7</strong></td>
<td><strong>0.010</strong></td>
</tr>
</tbody>
</table>

Total MSW = 0.6Mt

Notes on Railway Sleepers / Utility Poles arisings data
WRAP 2005

Best estimates of wood wastes arising in the commercial and industrial waste streams

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Tonnage</th>
<th>Area covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furniture manufacture</td>
<td>530,511</td>
<td>UK</td>
</tr>
<tr>
<td>Manufacture of panelboards</td>
<td>1,107,074</td>
<td>UK</td>
</tr>
<tr>
<td>Manufacture of wood products for the construction industry (SIC code 20.3)</td>
<td>201,298</td>
<td>England and Wales</td>
</tr>
<tr>
<td>Manufacture of wooden packaging</td>
<td>40,000</td>
<td>UK</td>
</tr>
<tr>
<td>Total wood wastes from industry and commerce other than furniture manufacture, wastes from sawmills or the wood products industry</td>
<td>2,552,312</td>
<td>England and Wales</td>
</tr>
<tr>
<td>Railway sleepers arising</td>
<td>26,000</td>
<td>UK</td>
</tr>
<tr>
<td>Utility poles</td>
<td>23,500</td>
<td>UK</td>
</tr>
<tr>
<td><strong>Total (rounded to nearest thousand tonnes)</strong></td>
<td><strong>4,481,000</strong></td>
<td>UK</td>
</tr>
</tbody>
</table>

Total Railway Sleepers/Utility Poles = 26,000 + 23,500 = 0.05Mt per year
End Uses for Waste Wood

Notes on Data for Energy Recovery (Dedicated Biomass)

Data from ReStats underestimates as it only covers heat and does not include electricity generation. Data also from EnAgri\textsuperscript{11} report on dedicated biomass plants.

Also included is some Grade B (64,000t) as, in reality, a relatively small amount of Grade B is being burnt in non-WID compliant plant.

Total Energy Recovery = 0.8Mt per year

Notes on Data for WID Energy Recovery (Dedicated Biomass)

National statistics show a total of 210,000t/y. However, this is fairly outdated data, and is also an underestimate as it just shows Wilton 10 (Sembcorp) and Slough Heat and Power. Lockerbie (E.ON) and Port Talbot can both take WID waste wood (Grade B) so we have revised the figure upwards.

Total WID Energy Recovery = 0.66Mt per year

Comment: We can clearly source 1.1Mt of Grade A –C waste wood going to dedicated biomass energy recovery from available data, this reconciles with WRAP 2009 estimates of 1.125Mt. We also estimate that additional Grade A wood will be burnt in small scale plant that are not captured by national statistics. Some dedicated biomass plants that are generally be classed as ‘virgin wood’ plants will also take some Grade A waste wood, most likely in the form of pellets, but there are no statistics on this. We have estimated the additional use of waste wood as described above as approximately 300,000t per year.

Notes on Data for Energy from Waste (Mass Burn Combustion with Energy Recovery)

Only 20% of MSW is going to EfW, along with 28,000t packaging waste, and 33,000t non-packaging waste (WRAP 2005)

Total EfW = 385,000+28,000+33,000 = 0.45Mt per year

Notes on Data for Disposal in Landfill

The figure used is the default amount of waste wood going to landfill, according to WRAP 2009. This figure has also been used in other recent reports (e.g. AEA, 2011). There are regional variations in the amount of waste wood going to landfill, with the lowest amount in the South East (source: Environment Agency).

Total Landfill = 2.2Mt per year

Notes on Data for Animal Bedding/Composting/Landscaping

These figures come from the Wood Recyclers Association (WRA) 2009 data:

\textsuperscript{11} The Directory of UK Biomass Generation Plants 2010
## WOOD RECYCLERS’ ASSOCIATION WASTE WOOD TO MARKETS STATISTICS – 2009 (in thousand tonnes)

<table>
<thead>
<tr>
<th>Source</th>
<th>WRA(t)</th>
<th>% Change</th>
<th>Others</th>
<th>% Change</th>
<th>Total</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel Beard (2)</td>
<td>856(797)</td>
<td>+7%</td>
<td>209(329)</td>
<td>-36%</td>
<td>1065(1126)</td>
<td>-5%</td>
</tr>
<tr>
<td>Animal/Poultry Bedding</td>
<td>280(265)</td>
<td>+6%</td>
<td>80(85)</td>
<td>-6%</td>
<td>360(350)</td>
<td>+3%</td>
</tr>
<tr>
<td>Equine Surfaces</td>
<td>60(58)</td>
<td>+3%</td>
<td>15(15)</td>
<td>+0%</td>
<td>75(73)</td>
<td>+3%</td>
</tr>
<tr>
<td>Mulches, Soil Conditioners And Composting</td>
<td>77(75)</td>
<td>+3%</td>
<td>21(20)</td>
<td>-5%</td>
<td>98(95)</td>
<td>+3%</td>
</tr>
<tr>
<td>Pathways and Coverings</td>
<td>16(15)</td>
<td>+6%</td>
<td>2(2)</td>
<td>+0%</td>
<td>18(17)</td>
<td>+6%</td>
</tr>
<tr>
<td>Biomass/Energy</td>
<td>423(320)</td>
<td>+32%</td>
<td>72(50)</td>
<td>+44%</td>
<td>495(370)</td>
<td>+23%</td>
</tr>
<tr>
<td>Totals</td>
<td>1111(1530)</td>
<td>+12%</td>
<td>399(501)</td>
<td>-20%</td>
<td>2111(2031)</td>
<td>+4%</td>
</tr>
</tbody>
</table>

In addition, 83,000 tonnes were exported of which 71,000 tonnes were destined for biomass.

Notes:
1. All WRA tonnages supplied by members.
2. Total figure supplied by the WPIF.

Total to animal bedding/composting/landscaping = 360,000+75,000+98,000+18,000 = **0.6Mt per year**

### Notes on Unknown Data for Other Possible End Uses

Unknown total quantities of waste wood do end up in the following end uses:

- Hazardous landfill – this has not been included in the general landfill figures as there is not any clear data on tonnages
- Back-filling (construction industry – CRWP 2009)
- On-site use (i.e. burnt on site by small scale construction companies – CRWP)
- Export (83,000t was reported by WRA 2009, possible additional 40,000t SRF licensed for export to Europe**12**. Hills Waste also want to export 20,000t SRF as a temporary measure**13** - this is likely to all be Grade B and C. SRF will contain around 5% waste wood - giving a licensed total of 3,000t waste wood for export)

Total unknown data = **1Mt per year**

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Appendix 2 - Waste Wood Flows Model

Please see attached excel spreadsheet