

Arboricultural Arisings Scotland Study

Report to the Forestry Commission Scotland

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Executive Summary

Study objectives

In September 2009, The Forestry Commission Scotland appointed International Synergies, in association with Nevin Associates, to carry out a study assessing the available woody biomass resource from arboricultural arisings across Scotland. The purpose of the study is to secure accurate estimates of the tonnages of arboricultural arisings in Scotland, and provide information on the extent to which these resources can be used for biomass energy generation, through the recovery of arboricultural waste as logs, wood chips or pellets.

Study Approach

In order to meet the study objectives, the project team undertook the following tasks:

- *A supply side analysis*, drawing on both existing information and new surveys of businesses and local authorities, to quantify the overall availability of wood biomass resources in Scotland generated from arboricultural arisings;
- *A demand side assessment*, assessing the uses currently made of wood biomass from arboricultural arisings; and
- *An economic analysis*, underpinned by a cost model, to help inform consideration of the appropriate measures to promote the recovery of wood biomass.

The study was carried out in three phases:

- Part A, a survey of commercial biomass resources in Scotland;
- Part B, an analysis of the local authority sector, to assess the tonnages they deal with each year and the facilities currently in place to recover wood biomass; and
- Part C, an economic analysis of the factors driving recovery of arboriculture arisings.

The study team also reviewed and collated information from previous research undertaken on the sector.

These sources provided valuable information on the tonnage of wood biomass generated by different types of arboricultural activity in Scotland and the cost structure associated with its recovery and use as a wood fuel in different forms ranging from cut logs to high quality 6 millimetre (mm) wood pellets.

Biomass in Scotland – The Current Situation

There has been no formal study of arboricultural arisings in Scotland, although the Forest Research Woodfuel Resource Study 2003, which covered the whole of the UK, produced some estimates for arisings in Scotland. The Wood Fuel Task Force (WFTF) was launched in June 2007 with the aim of increasing the supply of wood for renewable energy production. The WFTF highlighted arboricultural arisings as a high priority material that, with appropriate infrastructure, could be utilised as a wood fuel, in line with EU targets – which envisage that renewable energy such as biomass should provide 20% of total EU energy consumption by 2020. The WFTF also proposed that regulations should ensure that



“available material from arboricultural arisings is not classified as waste and is treated the same way as green forest industry residues.”

In Scotland, installed capacity for dedicated biomass heat and power is currently less than 100 MWe, most of which comes from three sites: EoN at Lockerbie, UPM in Irvine, and EPR at Westfield, Fife. This capacity does not include any co-firing into existing coal plants such as Scottish Power at Longannet, and does also not include smaller scale ‘heat-only’ biomass installations. However, there are a number of proposals for biomass facilities in Scotland. The Combined Heat and Power (CHP) plant for Tullis-Russell Papermakers in Glenrothes is under construction, and in December 2009 Forth Energy announced that it has submitted scoping requests for three 120MWe biomass power plants to be sited at the ports of Dundee, Grangemouth, and Rosyth and one 200MWe at Leith. Together these five plants will have a combined demand for biomass of about 4.5 million tonnes per year.

The development of new biomass facilities has triggered an interest in biomass material. There are concerns that currently there is not enough woody biomass being produced in a useable form to support these projects. If untapped biomass resources can be developed within Scotland to supply this growing demand, the benefits could include reduced costs (compared to importation) and the creation of local jobs.

Woody Biomass Tonnages Arising in Scotland

Prior to this study, only indicative estimates existed of the tonnage of woody biomass material produced in Scotland. To the extent that these were based on surveys, the surveys had relatively low sample sizes, and therefore high margins of error. For example, one source estimated approximately 70,000 green tonnes of arboricultural arisings in Scotland, compared to more than 350,000 green tonnes in Northern England, which seems intuitively implausible as Scotland has over 50% of the total UK’s managed woodland area .

Our estimates are based on a wider sample population than has previously been surveyed, with the total number of bodies approached covering:

- **The public sector:** the 32 Scottish Local Authorities responsible for collecting arboricultural waste, of whom 16 responded;
- **The private sector:** 100 Forestry Service Companies, 258 Tree Surgery Companies and 788 Landscaping Companies – giving a total of 1,146 organisations of whom 56 responded, giving an overall response rate of 5%;
- **The waste management sector:** 28 Waste Management Companies responsible for treating arboricultural waste, all of whom are believed to process over 500 tonnes a year, of whom 18 provided full responses and 8 provided partial responses;

It should be noted that these organizations operate at different points in the arboricultural supply chain. A further validation of the results was that the responses given by organizations at different points in the supply chain were broadly consistent and reconciled with each other – for example, the data generated by local authorities with respect to the tonnages collected by them and the prices charged to treat / dispose of those tonnages, were consistent with the responses given by waste management companies for the tonnages they treat, and the price of treatment through methods such as windrow composting.

In order to estimate the arboricultural arisings from the private (business) sector the following simple equation was used, keeping the companies within the three distinct groups (Tree Surgeons, Landscapers and Forestry Services):

$$\text{Total Arisings from Respondents in Group} / \text{Number of Respondents} \times \text{Number of Companies within Group} = \text{Estimated Arboricultural Arisings}$$

Based on the results of the surveys, this study estimates that just over 700,000 tonnes of arboricultural arisings are produced in Scotland each year, composed as shown in the Table below, which distinguishes between:

- 'Green', that is leafy material and grass cuttings, which would have little value for biomass energy production.
- 'Brash', that is thin branches where the woody material is generally less than 2 inches thick.
- 'Heavy Timber/Round Wood', woody material more than 2 inches thick, which is the material which would have the most potential for biomass energy generation.

Type of Organisation	Type of Arboricultural Material (Tonnes)			
	GREEN	BRASH	ROUND WOOD	TOTAL
Local Authorities	158,548*	158,548*	55,000*	372,096*
Landscapers	59,079	62,033	26,586	147,698
Tree Surgeons	14,171	72,429	70,854	157,454
Forestry Services	3,450	17,250	13,800	34,500
Total	235,248	310,260	166,240	711,748

*Figure based on the most conservative estimate of LA arisings, and assumes that 15% of the materials is Round Wood, while the remaining material is split evenly between green and brash material.

It should be noted that, in order to avoid double counting, the table does not contain the tonnage being processed by utility companies, large landowners or waste management organisations. Double counting is avoided by assuming that large landowners and utility companies sub-contract work to tree surgeons, landscapers or forestry service companies. Waste management companies do not produce arisings, they only process the material.

Current Treatment and Disposal of Woody Biomass Tonnages in Scotland

The Private Sector. Based on the survey responses, this study estimates that the current methods that the private sector uses for treating and disposing of woody biomass tonnages is as follows:



- **Landscapers:** of the total of approximately 148,000 tonnes of arboricultural arisings collected by landscapers, we estimate that approximately 49,000 tonnes is landfilled or burnt on open ground, 37,000 tonnes is composted, 6,000 tonnes is sold as firewood, 24,500 tonnes shredded and used for landscaping, 1,500 tonnes shredded and left on-site and 30,000 tonnes used for wood manufacture, animal bedding etc.
- **Tree surgeons:** of the total of approximately 158,000 tonnes collected by tree surgeons, we estimate that approximately 11,500 tonnes is landfilled or burnt, 3,000 tonnes is composted, 57,000 tonnes is sold as firewood, 24,000 is chipped and sold for wood fuel (of which approximately 8,000 tonnes is transported by AW Jenkinson), 8,500 tonnes shredded and used for landscaping, 41,000 tonnes shredded and left on-site, and 13,000 tonnes used for animal bedding and other uses. It should be noted that the uses made of material collected by tree surgeons is generally higher value – e.g. for firewood and wood chip / wood pellets – than that made of material collected by landscapers, reflecting its higher quality, with a higher proportion of round wood in the collection stream. Overall, over 25% (c 41,000 tonnes) is shredded and left on-site – mostly lower quality material, where the transportation costs mean it is uneconomic to make any use of the material. Very little of the material is taken to composting sites, reflecting the low percentage of ‘green’ arisings.
- **Forestry Services:** of the total of approximately 34,500 tonnes collected by forestry services, we estimate that approximately 300 tonnes is composted, 7,600 tonnes is sold as firewood, 5,400 tonnes is sold as timber, 4,400 is chipped and sold for wood fuel (of which approximately 2,700 tonnes is transported by AW Jenkinson), 9,600 tonnes shredded and used for landscaping, 6,700 tonnes shredded and left on-site, and 500 tonnes used for animal bedding and other uses.

Local Authorities. It is not possible to get exact tonnages of arboricultural waste collected by Local Authorities, as none of those surveyed has a separate kerbside collection of wood waste. Most collect it as part of a comingled green and garden waste collection, with a minority also collecting food waste in the comingled “brown bin” organic collection. In addition to kerbside collections, Local Authorities collect arboricultural waste through Civic Amenity and Household Waste Recycling Centre sites. This waste is then generally treated via composting – mostly open windrow. However, in cases where garden waste is collected in comingled form with food waste, this is not permissible for health and safety reasons, and comingled waste is generally treated through In-Vessel Composting (IVC).

The average cost of kerbside collection, at approximately £70 per tonne, is close to the collection cost for residual waste, so it could be said that the *incremental* cost of collecting wood waste in a mixed green and garden waste collection is very low. Put another way, it costs local authorities very little to collect green and garden waste separately from other forms of waste, particularly where they run an alternate weekly collection cycle for organic and residual waste.

The cost of collection through Civic Amenity Sites is lower than for kerbside collections, as the transport costs are effectively transferred from the local authority (which has to bear all transport costs for a kerbside collection) to the CA site user, who has to bear any costs of transport to bring green and wood

waste from the point where they arise to the site. In addition, collection in a CA Site results in an automatic “bulking” of green and woody waste – as well as other types of waste – with much lower labour costs than in a kerbside collection.

The average treatment cost per tonne for kerbside garden waste collections, for those authorities for which financial information is available, was £26.50. However, the average may be slightly misleading, as it represents an amalgam of open windrow composting for green waste – where an average cost could be typically £15 - £25 per tonne, - and treatment of mixed food and garden waste in an IVC - where an average cost is typically £40 - £50 per tonne.

The average landfill gate fee for the authorities for which information was provided was £26.58, with a minimum value of £12 and maximum of £40. Adding landfill tax to this, at £40 per tonne in 2009/10, the average total landfill cost would be £70 per tonne in 2009/10. Therefore, given this cost, it is likely to be worth doing something with wood waste rather than landfilling it.

In reality, few local authorities currently send their arboricultural wood waste to landfill. The Survey revealed that the "opportunity cost" to using biomass for power generation is not landfill, but rather windrow composting – as this is the least cost alternative use.

Waste Management Companies. The private sector and local authority analysis above relates to the primary stage of the supply chain – the collection of arboricultural waste. At the secondary stage – processing, treatment and disposal – the survey of waste management companies indicated that they accept some 243,850 tpa of waste annually – of which 231,600 tonnes (95%) is composted, 7,300 tonnes (3%) used as biomass, 1,750 tonnes (0.7%) recovered as firewood and 3,200 tonnes (1.3%) applied to other uses such as panel board manufacture or horse arena surfacing.

Mass Balance Analysis

A mass balance for arboricultural arisings in Scotland established from surveys is shown in the Figure below, with the source of the arisings given on the left and the material being disposed of or processed is on the right side of the mass balance equation.

Landscapers Tree Surgeons Forestry Services	+	L.A. Collections	=	L.A. Composting Site	+	Waste Management Composting	+	Other i.e. Personal use, Paper Mill, Panel-board	+	Dumped i.e. landfill, shred & Used
339,651		372,096		181,103		231,600		144,920		154,124

The mass balance assumes that any material from Utilities Companies or Large Landowners will be carried out by Landscapers, Tree Surgeons or Forestry Services – so in order to avoid double counting the estimated tonnage from these organisations has not been included in the mass balance.

The Economics of Wood Biomass Recovery

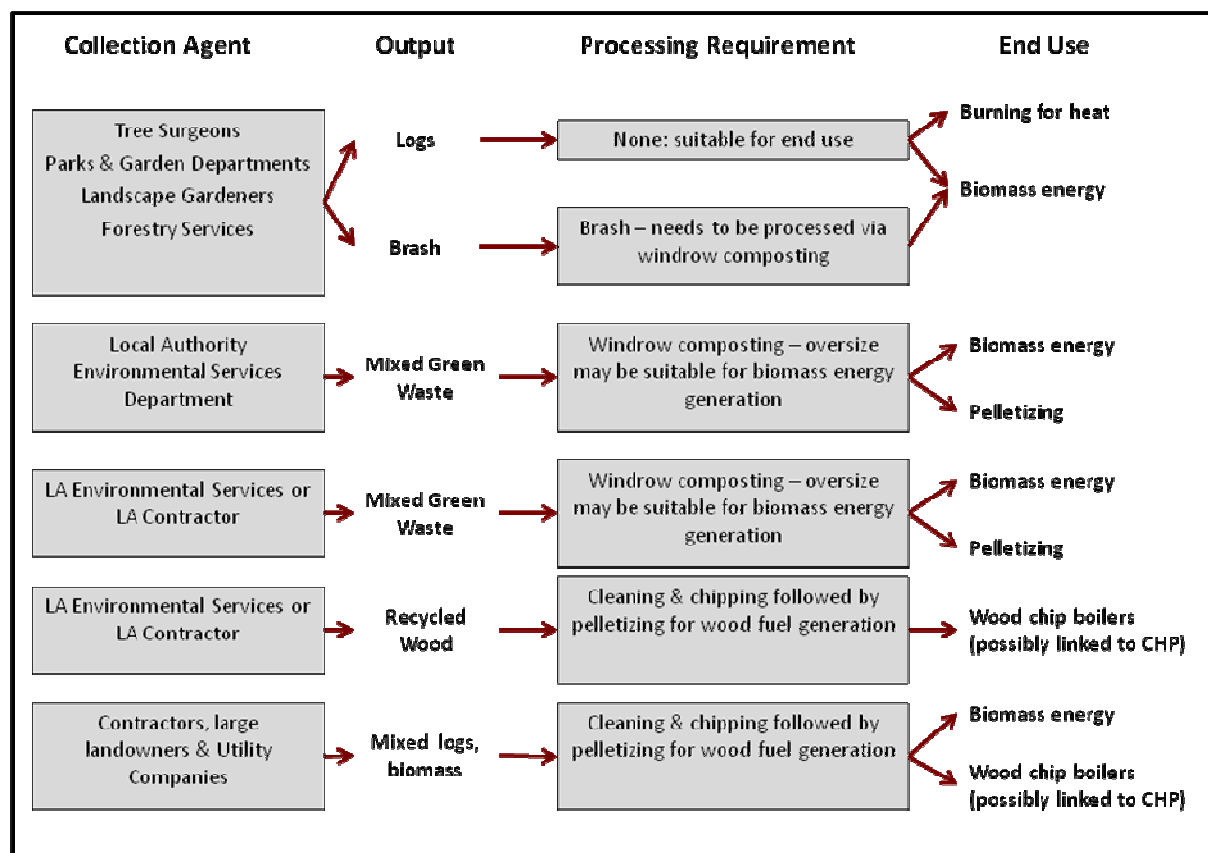
The use that is made of wood biomass depends upon the relative profitability of different options. If biomass is disposed of on-site – for example, by mulching – then it suggests that the site operators believe that there would be a net cost to recovering it and using it as a form of fuel. In order for wood waste recovery to be viable, the *price per tonne* secured for the end product must be greater than the *cost per tonne* of securing that end product, including:

- *the cost of securing wood feedstock in a form suitable for use*: woody biomass may be collected in a comingled green and garden waste stream, so there may be costs involved in extracting the wood from other green waste (leaves, grass etc);
- *the cost of preparing raw wood / biomass* so that it is in a usable form, including drying, chipping and bagging;
- *the costs of processing the prepared wood* so that it is in a form for use – e.g. pelletizing it into 6mm chips for wood boilers;
- *the costs of transport* to the end-user.

Only if the end price per tonne is greater than the sum of these costs would it be viable to recover wood waste, rather than leaving it to mulch on site or treating it in comingled form with other compostable material.

The Figure overpage illustrates possible supply chains for woody waste. The most basic involves chopping timber generated by tree surgery into logs used for firewood. The results of our surveys suggest this already happens. More complex supply options involve recovering woody biomass from mixed green and garden waste, and then chipping it for use in boilers. The feasibility of this option depends on the quality of the chipped wood that can be recovered, and the tolerance of different types of boiler for lower grade wood chips. There is also growing interest in the use of 6 mm wood pellets in domestic and commercial boilers, which is supported by the subsidies given to renewable energy generation which has helped to drive up the market price of wood pellets in recent years.

Based on an analysis of the cost structure of different supply chain options, the conclusion of this report is that the market for arboricultural arisings is working reasonably efficiently in Scotland: i.e. where it is economically viable to do so, woody waste is being recovered and value extracted from it. However, transport costs often mitigate against the recovery of arboricultural arisings. For example, on the assumption that a price of £45 per green tonne could be secured for logs, transporting logs in small quantities for even a modest distance is only marginally viable as a commercial operation. The economics of log recovery become more attractive if they can be collected in bulk and stored, so that, instead of being transported in relatively small transit vans, they can be transported in bulk in articulated lorries.



The commercial viability of a wood pellet operation is far less sensitive to changes in transport mileages than log or woodchip production. The reason is that, because the value of the end product is so much greater – at approximately £140 per tonne wholesale in the illustrative figures used in our cost analysis – the proportion of the price that is absorbed by transport costs is much lower than in the case of logs or low-grade woodchip. Therefore the economics of the operation are less sensitive to fluctuations in transport costs and distances.

However, the viability of wood pellet manufacture is very sensitive to:

- the costs of the pelletization process itself – which rise as the capacity of the plant falls, reflecting significant economies of scale in the manufacturing process; and
- the availability and cost of suitable feedstock.

The economic analysis indicates the importance of the Proximity Principle. Minimisation of the distances between the source of biomass arisings and the end use makes sense in economic as well as in environmental terms, as the viability of recovering woody biomass is strongly influenced by transport distances and costs, particularly for lower grade material.



A second conclusion is the importance of price. It seems likely that in the medium-term the trend of prices of all forms of woody biomass will be upwards, reflecting the emphasis that the Government is placing on promoting all forms of renewable energy, including energy from biomass.

Potential business opportunities that could encourage greater recovery of more marginal forms of wood biomass from arboricultural arisings could include:

- the development of bulk collection and storage facilities to collect logs and other wood waste, possibly within existing Civic Amenity site networks, so that wood biomass can be bulked into more economic quantities for recovery and energy generation;
- the promotion of pre-processing and chipping facilities close to the source of arboricultural arisings, so that it becomes cheap and easy to recover woody waste rather than leave it to mulch onsite;
- the construction of comparatively small biomass energy plants close to bulk collection and storage facilities (including composting sites) , capable of using a mix of arboricultural wastes, and not exclusively dependent on high quality wood chips and pellets.

1 Introduction

1.1 Background and purpose of the study

In September 2009, The Forestry Commission Scotland appointed International Synergies, in association with Nevin Associates, to carry out a study assessing the available woody biomass resource from arboricultural arisings across Scotland.

The purpose of the study is to improve knowledge of the quantities of arboricultural arisings in Scotland in order to get a clearer picture as to whether or not this resource is a feasible option for biomass use. The need to explore currently underused resources is becoming more urgent as the use of woodfuel and the number of people supplying it has grown rapidly over the last 5 years. A large number of companies in the UK now supply woodfuel, either as logs, wood chips or pellets to a range of customers.

Arboricultural arisings could represent a significant resource for the bio-energy sector, but it is believed that it is currently underexploited ^[11]. The limited use of arboricultural arisings for biomass may reflect the lack of systems currently in place for the collection, storage, treatment and use of the material for energy.

With the growth in demand for wood fuel, there is also a demand both from the end-user and suppliers themselves to mobilise additional wood fuel resources to support the development of a reliable, good quality and secure wood fuel supply.

The Scottish Wood Fuel Task Force Report (WFTF) published in January 2008 looked at the available waste wood and arboriculture arisings resource across Scotland. This report represented a useful starting point in estimating the annual biomass potential from arboriculture arisings and from other sources. However, the Wood Fuel Task Force recognised the need for more accurate information to be collated by further engagement with the arboricultural and composting sectors. Subsequently, The Scottish Government commissioned Remade Scotland to carry out a study looking at the waste wood resource across Scotland. This did not however include arboriculture arisings.

To address the gaps identified by the Wood Fuel Task Force and as part of its commitment to the development of biomass markets, Forestry Commission Scotland therefore commissioned this study to provide further information on the available biomass resource from arboriculture arisings, and assess *“the potential biomass resource available solely from arboriculture arisings across Lowlands & Uplands Scotland from Local Authorities, Transport Scotland, Charities and*

commercial operators. The economic implications around recovering arboriculture arisings should also be assessed.”

1.2 Our Approach

In order to meet the requirements of the terms of reference, the project team undertook the following tasks:

- A *supply side analysis*, drawing on both existing information and new surveys of businesses and local authorities, to quantify the overall availability of wood biomass resources in Scotland from arboricultural arisings;
- A *demand side assessment*, calculating the uses made of wood biomass from arboricultural arisings;
- An *economic analysis*, underpinned by a cost model, to help inform consideration of the appropriate measures to promote the recovery of wood biomass.

As set out in the terms of reference for the study, it was carried out in three phases:

- Part A, which involved a survey of commercial biomass resources in Scotland;
- Part B, which involved a specific analysis of the local authority sector, to assess the tonnages they deal with each year, and the facilities currently in place to recover wood biomass; and
- Part C, which comprised an economic analysis of the recovery of arboriculture arisings.

To gather the data for the supply side and demand side analysis, the study team carried out two surveys on potential biomass resources available from arboriculture arisings across Lowlands & Uplands Scotland:

- A survey of private sector enterprises engaged in collecting wood biomass from arboriculture arisings, including tree surgeons, forestry services, landscape gardeners, composting sites, wood recyclers, and organisations involved in major construction projects, including the utility companies, Transport Scotland and British Waterways; and
- A survey of the 32 Scottish Local Authorities, of whom 15 responded.

We also reviewed and collated information from previous research undertaken on the sector.

These sources provided valuable information on the tonnage of wood biomass generated by different types of arboricultural activity in Scotland and the cost structure associated with its recovery and use as a wood fuel in different forms ranging from cut logs to high quality 6 millimetre (mm) wood pellets. This data underpinned the economic analysis set out in the final section of this report, which assesses the current costs and returns from different supply chain options for wood biomass, and potential opportunities for increasing the rate of biomass recovery in the future.

1.3 Structure of this Report

This report has six sections, which broadly replicate the scope of work completed, as follows:

- Section 1 introduces the background and layout of the report;
- Section 2 of the report summarises key results of previous research on the quantity of biomass resources generated by arboricultural arisings in Scotland;
- Section 3 sets out the scope, methods and results of our survey of private sector activity in the sector;
- Section 4 sets out the scope, methods and results of our survey of the Local Authority sector;
- Section 5 shows the mass balance of the arboricultural arisings; and
- Section 6 analyses the economics of different supply chain options, leading to a consideration of how the rate of recovery of wood biomass from arboricultural arisings might be increased in the future.

2 Review of Previous Research

2.1 Introduction

There has been no formal study of arboricultural arisings in Scotland; although the Forest Research Woodfuel Resource Study 2003, which covered the whole of the UK, produced some estimates for arisings in Scotland. Before this study it had been suggested that the majority of arboricultural arisings are composted or land-filled. However, previous estimates of the resource availability are constrained by a lack of good quality data ^[1].

The Wood Fuel Task Force (WFTF) was launched in June 2007 with the aim of increasing the supply of wood for renewable energy production. The WFTF highlighted arboricultural arisings as a high priority material that, with appropriate infrastructure, could be utilised as a wood fuel. The WFTF also highlighted that regulations should ensure that 'available material from arboricultural arisings is not classified as waste, and is treated the same way as green forest industry residues ^[1].

This literature review aims to establish the following:

- the market drivers for increased biomass demand in Scotland;
- a critical review of previous studies on biomass availability in Scotland;
- summary of gaps and uncertainties with regards to arboricultural arisings;
- confirm the key gaps to be addressed in this study and deliverables;

In calculating overall biomass availability in Scotland, a ratio of 1 oven dry tonnes (odt) to 2 green tonnes is utilised. Other ratio factors include:

- Coniferous Wood: 1 cubic metre over bark = 0.82 green tonnes
- Recycled Wood: 1 dry tonne = 1.2 green tonnes

This has been used in previous reports and to avoid confusion, throughout this report all units used will be in green tonnes ^[23] unless otherwise specified.

2.2 Demand for Biomass

The EU has established high level targets for renewable energy, one of which is that it is to provide 20% of the overall EU energy consumption by 2020. The Scottish Government is committed to increase the use of renewables in power production, combined heat & power, and in heat only supply ^[21].

Current renewable power capacity for power generation in Scotland is dominated by hydrological and wind power, with installed capacities of 1490 MWe and 1882 MWe in

December 2009^[33]. The future growth in hydrological power is likely to be small, as most viable medium and large scale hydrological power projects are already established and in operation. However, wind capacity is expected to grow significantly, with a large number of on-shore and offshore wind installations currently being developed and more currently going through the planning process.

In contrast, the current installed capacity for dedicated biomass heat and power is still relatively small. There is currently less than 100 MWe in Scotland, the bulk of which comes from three sites: EoN at Lockerbie, UPM in Irvine, and EPR at Westfield, Fife. This capacity does not include any co-firing into existing coal plants such as Scottish Power at Longannet and also does not include smaller scale 'heat-only' biomass installations.

There is however an increasing number of proposals for biomass facilities in Scotland. The CHP for Tullis-Russell Papermakers in Glenrothes is under construction, and in December 2009 Forth Energy announced that it has submitted scoping requests for three 120MWe biomass power plants to be sited at the ports of Dundee, Grangemouth and Rosyth along with a 200MWe unit in Leith. Together these five plants will have a combined demand for biomass of about 4.5 million tonnes per year^[22].

The development of new biomass facilities has triggered an interest in biomass material from all sources within Scotland. There are concerns that currently there is not enough woody biomass being produced in a useable form to support this growing demand^[10]. In order to reduce the need to import woody biomass material from other countries, the WFTF was established to develop untapped biomass resources from within Scotland to supply this growing demand. Aside from the environmental benefits of using more locally sourced material additional benefits of developing the woody biomass market in Scotland include reduced costs (compared to the alternative of importation) and the creation of local jobs.

2.3 Previous Studies

Prior to the *“Wood Fuel Resources in Britain – 2003”* report, other studies attempting to establish the quantities of arboricultural arisings were inconclusive on a national scale. This was mainly due to a lack of accurate data on the quantity and type of material being produced and limited information on what happened to the material once it had being produced^[15].

The estimates for arboricultural arisings in Scotland in the *“Wood Fuel Resources in Britain – 2003”* report were based on 16 responses to a survey sent out to 126 arboricultural companies, tree officers and local authorities in Scotland. This report estimated the arboricultural arisings in Scotland to be 34,717odt/year. To date this is the only recent study carried out to establish arboricultural arisings in Scotland through a survey technique^[17].

All reports after the 2003 study base their estimates for arboricultural arisings on the figures provided in the *“Wood Fuel Resources in Britain – 2003”* report. There are however, significant differences in the numbers, for instance the *“Wood-fuel Task Force – 2008”* report estimated that arboricultural arisings will be approximately 268,000odt from 2007/11; giving an annual figure of 53,600odt/year^[1]. While the *“Woodfuel for Warmth – 2005”* report suggests an estimated total arisings of 34,710odt/year yet both reports calculate the figures using the numbers quoted in the *“Wood Fuel Resources in Britain – 2003”* study.

A clear calculation for the “Wood Fuel Task Force – 2008” figure is not given, though it clearly states that the numbers are based on the “Wood Fuel Resources in Britain – 2003” report.

The “Woodfuel for Warmth – 2005” report also estimates arisings using a three scenario approach to investigate the available wood fuel. Scenario 1 represented the wood immediately available to a newly established wood based heating industry. Scenario 2 represented the wood available if growth of the wood fuel industry was allowed and encouraged in the near future, and it assumes that some wood feeding existing markets would be diverted to the developing wood fuel supply chain. Scenario 3 is the theoretical total for 100% un-marketed material and represents the total potential in Scotland for wood production. Scenario 1 gave a total of 0, with scenario 2 and 3 giving a total of 34,710 odt/year^[7].

The difference in the figures can be accounted for by different definitions of ‘arboricultural arisings’ and the methodologies applied in order to obtain the estimates.

2.4 Gaps and Uncertainties

A common definition along with common terminology throughout the UK would be beneficial to these studies to avoid conflicting estimates in different reports. It is evident that all three estimates from previous reports are different, yet all are based on the same data from the 2003 study which indicates variation in the definition and calculation methodologies.

The “Forest Research Woodfuel Resource Study 2003”, on which all subsequent reports based their figures, has a high margin for error. The figure was based on the number of contractors calculated in Britain (2,174) with the majority of these (1,943) based in England. The report focused more on England with greater detail on English regions. Only 150 of the 2,147 companies who received the questionnaire responded, giving a 7% response rate. Also a portion of these questionnaires were not fully completed, again reducing the integrity of the survey results^[17].

The “Forest Research Woodfuel Resource Study 2003” report suggests that there are 126 contractors in Scotland, but our initial findings suggest that this may be a significant underestimation. The methodology used by “Forest Research Woodfuel Resource Study 2003” to calculate the contractors was the yellow pages listings of ‘tree work contractors’ along with the Forestry Contracting Association and contacts from the records of the Arboricultural Association. This is only a small proportion of companies whose services produce arboricultural arisings in Scotland, as it does not include many of the tree surgeons and landscape gardeners who also handle significant volumes of arisings.

The average tonnage from responses calculated in the report was 258 odt/year. This figure was multiplied by the total number of contractors to give a British total of 560,892 odt/year. Averages were then calculated separately for each region and multiplied by the number of contractors in that country and then added together for England, Scotland and Wales to give a total arisings figure of 472,170 odt/year^[17]. This shows that from 16 responses in Scotland, the average was calculated and multiplied by 126 contractors. The average was based only on 16 responses, some of which may not have been fully completed, and then multiplied by, what is likely to be a low number of contractors. The report also divided the arisings into stem wood, chipped, branch wood and foliage and calculated the average percentage of the arisings by these material types. Stem wood totaled 53%, chipped 23%, branch wood 20% and the

remaining 4% was foliage. However, this split may not be applicable to Scotland as there are significant variations in the composition of arisings by geographical region as indicated in the “Wood fuel Task Force Report – 2008”.

A report prepared for the Wood Fibre Processing and Supply Industry in 2006 “Forecast Wood Fibre Availability & Demand in Scotland & Northern England to 2016” highlights concerns over the 2003 reports figures, especially when compared to the figures for Northern England.

TABLE 2.4: Estimated Potential Availability of Arboricultural Arisings in Scotland & Northern England in 2003 in Green Tonnes

Country	Stemwood	Branchwood	Woodchips	Foliage	Collected Arisings	Utility Work	Total Arisings
Scotland	11,532	7,744	10,614	2,402	25,742	11,400	69,434
Northern England	141,858	52,028	48,780	11,932	97,762		352,360
TOTAL	153,390	59,772	59,394	14,334	123,504	11,400	421,794

Source: McKay, H. 2003. Woodfuel Resource in Britain

There is a striking difference between the total arboricultural arisings in the two areas, with Scotland having a much lower arisings figure. This would appear to be inaccurate as Scotland has over 50% of the total UK’s managed woodland area ⁽²⁴⁾.

2.5 The Scope for this Study

An exact figure for the arboricultural arisings in Scotland is impossible to establish due to the very large number of companies handling such material, the variation in the way that the material is handled and the annual variation in volumes being produced.

This study aims to determine a figure reasonably close to an actual figure, and takes care to avoid ‘double’ or even ‘triple’ counting of materials as they are handled by the different parts of the biomass supply chain in Scotland. This study surveyed:

- 32 Local Authorities
- 28 Waste Management Companies
- 100 Forestry Service Companies
- 258 Tree Surgery Companies
- 788 Landscaping Companies

- A total of 1206 organisations.

3 The Commercial Sector Survey

3.1 Scope

From the onset of the study the organisations within the commercial sector were divided into three distinct groups, allowing the appropriate survey questions to be asked for specific types of organisations; these three groups were:

1. Large Landowners and Transport Corridors;
2. Smaller Organisations (Tree Surgeons, Forestry Services and Landscape Gardeners);
3. Waste Management Companies .

However, it was not possible to establish the arisings for the Large Landowners and Transport Corridors through questionnaire responses so a calculation had to be adopted instead (Section 3.2.1)

3.1.1 Large Land Owner and Transport Corridor Scope

A list of the major transport and utility companies was drawn up alongside a list of the largest landowners in Scotland. The organisations were then contacted by telephone and asked to carry out the survey but it quickly became apparent that due to the way the materials were handled very few of these organisations would be able to quantify the tonnage of arboricultural material they produced. There was also concern over double counting as many of the organisations employed tree surgeons and forestry service contractors to carry out the work and these companies were already been surveyed under 'smaller organisations'. A high level calculation was then produced in order to establish an estimate of the potential arisings from track and roadside in Scotland, using figures on the land take of trackside and roadside figures in Scotland.

3.1.2 Smaller Organisations Scope

In order to assess arboricultural arisings from smaller businesses the following three types of organisation were searched for using www.yell.com:

- Tree Surgeons;
- Landscapers; and
- Forestry Services.

This search allowed the development of a detailed list of generally smaller organisations likely to produce arboricultural material as part of their work. Some businesses were listed under more than one category, geographic area or were no longer in activity; these were removed from the list.

TABLE 3.1.2: Number of Smaller Organisations Identified from the Search on www.yell.com

Business Type	Number of Businesses Identified:		
	In Initial Online Search	With Duplications removed	Still In Activity and Correctly Listed
Tree Surgeons	334	268	258
Landscapers	1062	813	788
Forestry Services	150	143	100
Total	1946	1224	1146

Once the list of organisations had been developed a survey questionnaire was produced (*see Appendix 3*) and the companies were contacted by phone, post or via email. It was explained that responses would be on a non-attributable basis. In summary, the responses provided information on:

- current tonnages of wood biomass produced by each organisation;
- how the material produced was currently managed, including the costs;
- the organisations views on the potential for developing this woody waste for biomass energy generation;
- the respondent's views on current barriers to developing wood waste, e.g. quality standards, the costs of collection, recovery, transportation and the availability of viable end markets, etc.

Of the 1146 organisations identified for this part of the survey work 56 responded to the survey giving an overall response rate of 5%.

3.1.3 Waste Management Company Scope

The Waste Management Company Survey covered 28 waste management companies in Scotland, all of whom are believed to process over 500 tonnes a year. Each company was contacted and sent the questionnaire by email or post (*see Appendix 2*). It was explained that responses would be on a non-attributable basis. In summary, the responses provided information on:

- current tonnages of wood biomass collected by each company;
- how these collections are currently treated – e.g. are they sent to another contractor, separately recycled, or composted on site;
- current costs of treatment;
- facilities used by companies to treat wood biomass – e.g. composting plants, bio-fuel generation plants, wood chip processors, etc;
- the companies views on the potential for developing sources of wood waste collection; and

- the respondent's views on current barriers to developing wood waste, e.g. quality standards, the costs of collection, recovery, and transportation, the availability of viable end markets, etc.

18 of the 28 Waste Management Companies to whom the survey was sent provided full responses and 7 provided partial responses. (see Table 3.2.3)

3.2 Methodology

Different methodologies were applied in gathering data from the three groups, in order to achieve the best data and to reduce the potential for double counting.

3.2.1 Large Landowners and Transport Corridors

Initially it was hoped that large landowners along with companies managing transport corridors in Scotland would be surveyed. However, from the onset of the interviews with these organisations it became apparent that the road and trackside work was mainly carried out by contractors. Therefore this material will be accounted for in the 'small organisations' section of this report and was not included in the total arising figure to reduce the risk of double counting.

These initial findings were discussed with the Forestry Commission, and it was agreed that some quantification of the track and roadside arisings should be carried out for this study. In order to quantify the potential arisings from the road and trackside the following, high level calculation was used to determine the potential tonnage.

This calculation only takes into account the road and trackside land in rural areas as road and trackside in urban areas is unlikely to be hedge, tree or shrub and therefore will produce little in terms of arboricultural material. The overall land-take by transport corridors in rural areas is 87,000 hectares⁽²⁵⁾; this includes the road and track area as well as roadside and trackside.

In order to estimate the potential arboricultural arisings from this land the proportion of it which is covered by woodland or hedges must be known. The 2007 Countryside Survey for Scotland⁽³⁰⁾ provides information on the linear landscape features. Linear landscape features include any feature on the land which is linear, such as path, hedgerows, walls and fences. This report gives the following breakdown of the linear features:

- 227,000 km of Fence (63%);
- 79,000 km of Wall (22%); and
- 46,000 km of Hedge/Trees/Shrub (13%).

The 2007 report covers all linear landscape features in Scotland, but if it is assumed that the same proportions can be applied to just the rail track and roadside land this allows the area of rail track and roadside land to be estimated. If it is assumed that 13% of the 87,000 hectares of transport corridors is hedge/tree and shrub then the area producing arboricultural arisings next to road and rail track in Scotland is 11,300 hectares.

However, calculating the yield from this area is not straightforward. Little information exists on the yields of material from these areas. The closest information on yields this study was able to find were for willow giving a yield of 3 to 9 tonnes⁽³¹⁾ of oven dried material per hectare annually. The useful biomass yield from unmanaged hedges, shrubs, and trees is likely to be significantly lower. However, if it is assumed that the willow yield was the same as the yield from Hedge/Trees and Shrubs then this provide an estimated yield of 33,900 to 101,700 of oven dried material a year.

The main barrier to collection of material for use in biomass is the very wide dispersion of the material along almost 60,000 km of rail track⁽²⁹⁾ and road⁽²⁸⁾ throughout Scotland. Only in areas where there is a high concentration of suitable biomass and potential local markets for the collected materials is this likely to be economically attractive.

This dispersion, and the uncertain value for the material are the probable reasons why most contractors 'chip and mulch' as it is a simple and cost-effective approach to dealing with roadside and trackside arboricultural arisings.

3.2.2 Smaller Organisation Methodology

Initially 25% of the organisations identified to be surveyed were contacted by telephone or post, however this did not produce the desired response rate, so additional follow-up was carried out. Landscaping businesses for instance proved to be particularly problematic with 24 of the 198 companies contacted not willing to participate in the survey.

TABLE 3.2.2: Total Number of Companies, the Number Contacted, the Anticipated Response Rate and Actual Response Rate.

Business Type	Number of Businesses:					
	Active & Correctly Listed	Total Contacted	% Contacted	Anticipated Response	Actual Response	Actual Response Rate
Tree Surgeons	258	80	31%	16	13	5%
Landscapers	788	200	25%	28	30	4%
Forestry Services	100	57	57%	10	12	12%
TOTAL	1146	337	29%	54	55	5%

The data from the survey responses was then collated onto a spreadsheet for each organisation type (Tree Surgeons, Landscapers and Forestry Services), total results and averages for these organisations were then calculated.

In order to estimate the arboricultural arisings from these businesses the following simple equation was used, keeping the companies within the three distinct groups (Tree Surgeons, Landscapers and Forestry Services)

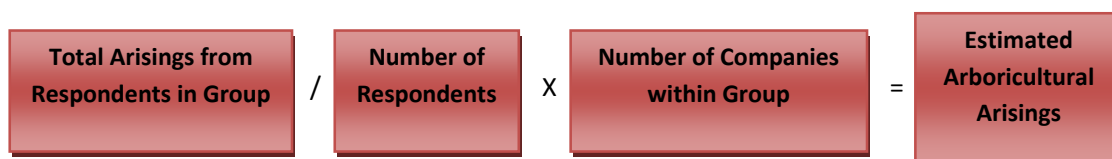


Figure 1 - Estimating Arboricultural Arisings Equation

3.2.3 Waste Management Company Methodology

Of the 28 companies contacted 18 provided full responses, those companies that did not complete the initial survey were contacted by telephone and/or email and asked to supply an approximate tonnage of the arboricultural arisings they process. This partial response information has been included in the estimate of the total tonnage of arboricultural material being processed by the waste management sector. Only 3 of the 28 waste management companies provided no figures for arboricultural arisings at all.

TABLE 3.2.3: Number of Full and Partial Responses to Survey

Companies contacted	Full responses		Partial responses		No. Response	
	No.	%	No.	%	No.	%
28	18	64%	7	25%	3	11%

The results from the 18 fully completed surveys were used to produce a mass balance for actual arboricultural arisings accepted by the waste management companies in Scotland. After the surveys were returned the respondents were contacted again to ascertain the end point for the woody material, as this was not asked in the original survey but was required to reduce the issue of double counting and establish the material flow.

For the 3 non responses telephone conversations with the companies revealed that:

- Only one company did not have on site composting, and therefore landfilled the material. Due to this they were unable to distinguish the arboricultural material from the other wastes being disposed of to landfill.
- One company did not respond at all.
- Another company said that while they did collect arboricultural material it was all transported to one of the other companies already being surveyed for composting. Therefore they did not wish to participate further in the survey as the material was already being counted.

Actual tonnage data from the 18 full responses and the 7 partial responses was added together to produce an overall estimate for the arboricultural arising processed by the waste

management sector. Although not all of the companies responded the overall estimate does include material collected by (company C) as this is processed by another organisation that has already responded to the survey. However the estimate of the total tonnage is still a conservative one, as it does not include data from (company A) and (company B).

3.3 Results

It is estimated that 711,747 tonnes of arboricultural arisings are produced in Scotland each year.

TABLE 3.3: Tonnage of Arboricultural Material from Organisations Producing these Arisings

Organisation Type	Type of Arboricultural Material (Tonnes)			
	GREEN	BRASH	ROUND WOOD	TOTAL
Local Authorities	158,548*	158,548*	55,000*	372,096*
Tree Surgeons	14,171	72,429	70,854	157,454
Landscapers	59,079	62,033	26,586	147,698
Forestry Services	3,450	17,250	13,800	34,500
Total	235,248	310,260	166,240	711,748

*Figure based on the most conservative estimate of LA arisings, and assumes that 15% of the materials are Round Wood, while the remaining material is split evenly between green and brash material.

NB: to avoid double counting the table does not contain the tonnage being processed by utility companies, large landowners or waste management organisations. Double counting is avoided by assuming that large landowners and utility companies sub-contract work to tree surgeons, landscapers or forestry service companies. Waste management companies do not produce arisings, they only process the material.

3.3.1 Large Landowners and Transport Corridor Results

The results from the high level calculation gave an estimated tonnage of between 33,900 and 101,700 tonnes of oven dried material a year from the rural transport corridors in Scotland. These results are explained in more detail in Section 3.2.1 of this report.

3.3.2 Smaller Organisation Results

In total 1146 companies were identified as being smaller organisations who would produce arboricultural arisings. This includes 788 landscaping companies, 258 tree surgeons and 100 forestry services. In total these organisations produced an estimated 339,651 tonnes of arboricultural arisings annually.

Initially 25% of the companies were contacted via telephone/email or post, however this did not produce the desired response rate; so additional contact was carried out.

The questionnaire responses gathered from the smaller organisations focused on:

- Location of arisings;

- Tonnage being produced;
- Type of 'woody' material being produced;
- What happened to the material once it had arisen; and
- Cost of dealing with the material.

The respondents were also asked what barriers they believe existed to the utilization of this material for biomass and also how they believed these barriers could be overcome. (See *Appendices 11, 12 & 13*)

For the responses in this section the type of material the companies were producing was divided into three types, defined for this report as being:

- 'Green', that is leafy material and grass cuttings, which would have little value for biomass energy production.
- 'Brash', that is thin branches where the woody material is generally less than 2 inches thick.
- 'Heavy Timber/Round Wood', woody material more than 2 inches thick, this is the material which would have the most potential for biomass energy generation.

3.3.2.1 Landscapers

The arisings from landscaping companies as estimated from the questionnaire responses is 147,698 tonnes. A summary of this total is outlined in *Appendix 9*. Thirty responses were received in total from landscaping companies from all around Scotland.

The survey results highlighted that the majority of the material arising from this sector was lower value material with 42.8% being 'green'. The percentage of 'brash' and 'heavy timber/round wood' arisings were approximately equal with 'brash' comprising 28.4% and 'heavy timber/round wood' being 28.8%. These are illustrated in *Figure 2* below.

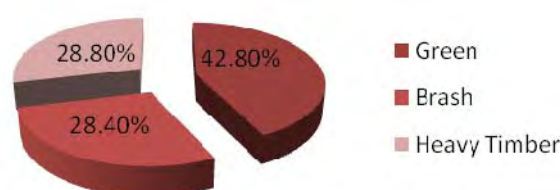


Figure 2 - Breakdown of Arboricultural Arisings collected

General patterns existed regarding the end use of this material with location of the arisings affecting the end uses, because landscapers in the central belt have more options than those in more rural areas. For example, a lack of facilities for landscapers located in Dumfries and Galloway leads to material being landfilled or burnt.

From the total of 147,698 tonnes of arboricultural arisings collected by landscapers, the largest proportion of this is being landfilled or burnt on open ground (48,958 tonnes). (37,233 tonnes) of material is composted either through local authority or commercial composting sites. *Figure 3* below outlines the material flow of arboricultural arisings along with quantities gathered by landscapers. Furthermore, it illustrates the end use of the material.

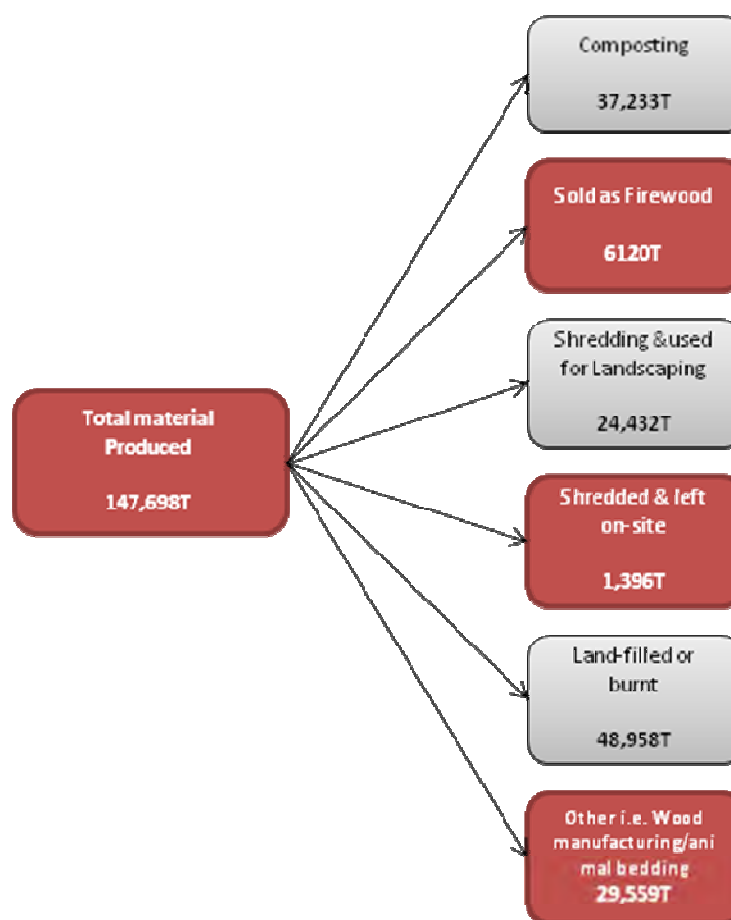


Figure 3 - Material flow of Landscapers Arisings

From the survey results, the average cost of each end use was calculated and outlined in Table 3.3.2.1 below. The table shows the costs involved in preparing the material and includes gate fees, where appropriate for different end-uses. Responses from the survey vary due to some responses including certain costs, such as labour, transport, gate fees, machinery/skip hire and fuel for machinery while others only included their processing costs. Most responses were only estimates as no actual data was available.

TABLE 3.3.2.1: Cost Associated with End-uses of Arisings

Landscapers	End-use	£/Tonne
	Sell it as firewood	0
	Landfill/burnt	49
	Used for landscaping	7.5
	Shred it & leave on-site	0
	Transported to composting site	27.5
	Chip & sell	20

The table above shows what it costs landscapers to process the material. From the survey responses, information on how much this material could be sold for as firewood or chip is unknown so no analysis on current profitability of producing firewood and chip could be undertaken.

The largest end use cost is landfill. High landfill tax rates, high gate fees and skip hire are the most significant costs. Many landscapers take mixed materials (including compostables) to landfill sites where the material is landfilled. Many of these sites (mainly local authority), have composting facilities on-site and could compost the green and brash material if they were segregated therefore reducing costs. If segregated, heavy timber could also be reused. Individual Landscapers need to calculate if the financial savings from not landfilling the material outweighs the additional labour cost of segregation.

3.3.2.2 Tree Surgeons

The arisings from tree surgeons, as estimated from the questionnaire responses, is 157,453 tonnes. A summary for the breakdown of this material is outlined in Appendix 9. Fourteen responses were received in total from tree surgeon companies from all around Scotland, the majority of which were located in the Central Belt, Aberdeen and Inverness.

The responses highlighted that the majority of the material arising from this sector was of higher value, with nearly half 50% being 'heavy timber/round wood'. 'Brash' comprises most of the remaining material at 46% and only 4% 'green' material (3.95%) as shown in *Figure 4* below.

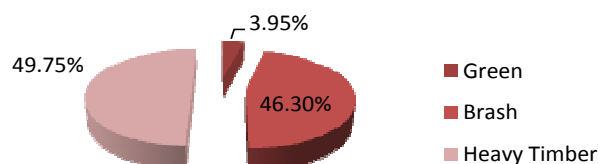


Figure 4 - Breakdown of Arboricultural Arisings collected

The tree surgeons were adopting eight different end uses for the material. Due to the majority of material being higher value 'heavy timber/round wood', many tree surgeons sold the material produced as firewood, animal bedding or onto a wood processor (i.e. AW Jenkinsons). They have increased market opportunities in comparison to landscapers and forestry services.

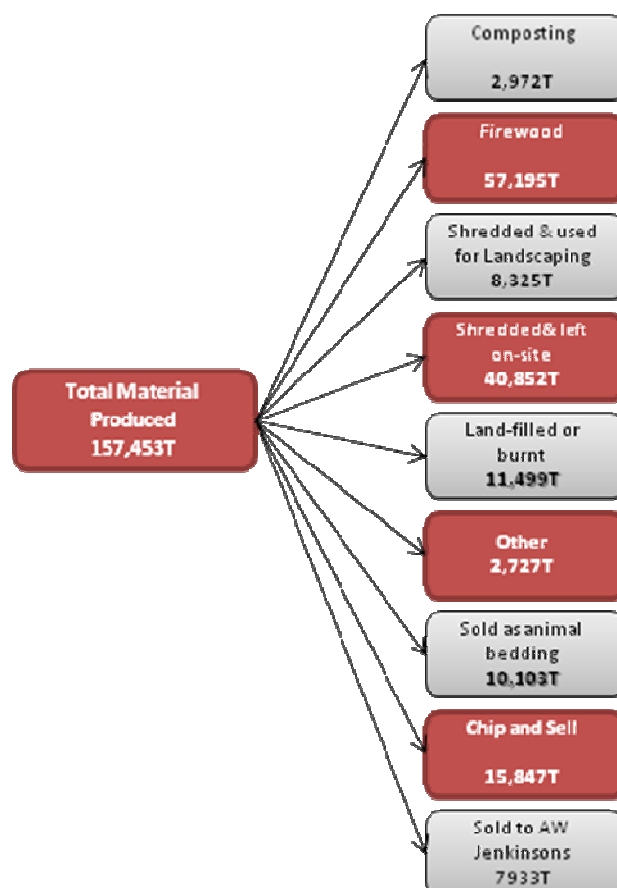


Figure 5 - Material flow of Tree Surgeon Arisings

From the total of 157,453 tonnes of arboricultural arisings collected by tree surgeons, the largest proportion of this is being used and sold as firewood (57,195 tonnes). Over 25% (40,852 tonnes) of material is shredded and left on-site, this is done to remove any transportation costs. Very little of the material is taken to composting sites, which may link to the low percentage of 'green' arisings. *Figure 5* above outlines the material flow of arboricultural arisings produced by tree surgeons.

From the survey results, average costs associated with each end use of material was calculated and is outlined in Table 3.3.2.2 below. The table shows the costs involved in preparing the material along with profit and includes gate fees, where appropriate for different end-uses. Responses from the survey vary due to some including certain costs, such as labour, transport,

gate fees, machinery/skip hire and fuel for machinery while others only included their processing costs. Most responses were only estimates as no actual data was available.

TABLE 3.3.2.2: Cost Associated with End-use of Arisings

Tree Surgeons	End-use	£/Tonne
	Sell it as firewood	-51.43
	Used for landscaping	7.5
	Sold as timber	-20
	Transported to composting site	29.5
	Chip & sell	-25
	Shred & sell to AW Jenkinsons	-7.5
	Sell it as animal bedding	-11.5
	Landfill/burnt	33

A minus figure in the Table indicates a net receipt from sales. Since there are more markets available to tree surgeons, reflecting the high value material collected, many tree surgeons take advantage of this. Table 3.3.2.2 clearly shows negative costs (profit) for all material being sold. Tree surgeons make greatest profit from heavy timber sold as firewood along with material being chipped and sold.

3.3.2.3 Forestry Services

The arisings from forestry service companies as estimated from the questionnaire responses is 34,500 tonnes. A breakdown summary of this material is outlined in *Appendix 9*. Twelve responses were received in total from forestry services companies from all around Scotland.

The responses indicate that the arisings from this sector are higher value materials with over half 53% being 'brash', 39% 'heavy timber/round wood' and only 8% 'green' material (as shown in *Figure 6* below).

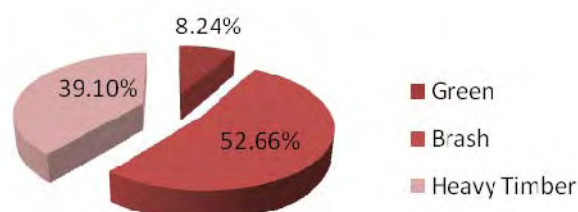


Figure 6 - Breakdown of Arboricultural Arisings collected

As with the tree surgeons, the forestry service companies dealt with the arboricultural arisings in eight different ways. Any higher value heavy timber/round wood was collected and sold as

timber, firewood, animal bedding or onto a wood processor (i.e. AW Jenkinsons). Some material was also chipped and sold.

Interestingly no material from forestry service companies was being burnt on open ground or sent to landfill. From the total of 34,500 tonnes of arboricultural arisings collected by forestry services, the largest proportion of this material was cut and left (9614 tonnes). That been said 15% (7666 tonnes) was sold as firewood. As shown in *Figure 7* below, only a small proportion of this material is composted which again coincides with a small percentage of 'green' arisings.

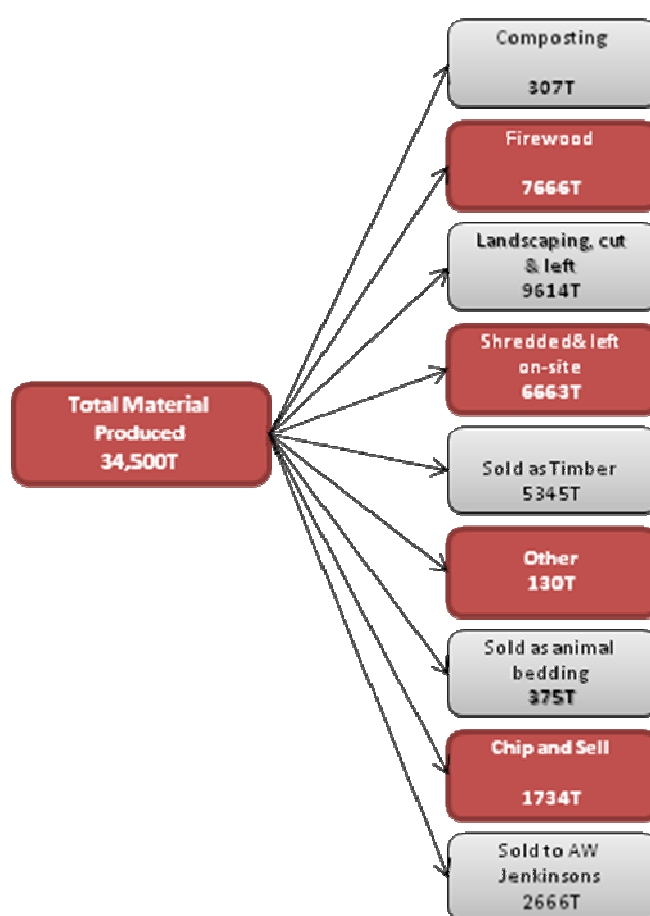


Figure 7 - Material flow of Forestry Services Arisings

From the survey results, average costs associated with each end use of material were calculated and is outlined in Table 3.3.2.3 below. These costs include processing the material for sale and profit made along with gate fees where appropriate. Responses from the survey vary due to some including certain costs, such as labour, transport, gate fees, machinery/skip hire and fuel

for machinery while others only included their processing costs. Most responses were only estimates as no actual data was available.

TABLE 3.3.2.3: Cost Associated with End-use of Arisings

Forestry Services	End-use	£/Tonne
	Shred & sell to AW Jenkinsons	60
	Sell it as firewood	-28.33
	Used for landscaping	12.5
	Leave on-site	28
	Sold as timber	-20
	Transported to composting site	59
	Chip & sell	10

Again, forestry services like tree surgeons have high value material in comparison to landscaping companies. This is evident from table 3.3.2.3 above showing profit from 'sell it as firewood' and 'sold as timber'. Potential profit could be made by 'shred & sell to AW Jenkinsons' and 'chip and sell', however the figures given only show the cost of processing the material for sale.

3.3.3 Waste Management Company Results

From the 18 waste management companies providing full responses, 243,850T of arboricultural arisings were collected and processed at their 28 different sites. *Figure 8* shows the breakdown of the material collected by the Waste Management Sector. The majority of the materials are classified as Green (139,891 tonnes) and Brash (60,482 tonnes). From the 18 full responses, 2 of the companies were unaware of the breakdown of the material and this information is accounted as the 6% that 'Do not Know'.

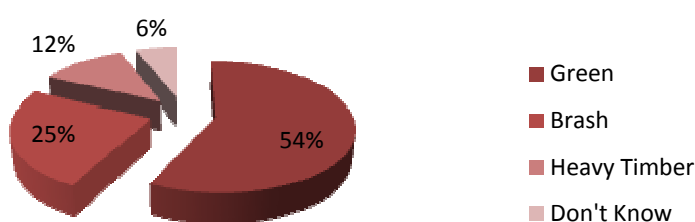


Figure 8 - Breakdown of Arboricultural Arisings collected and processed by the Waste Management

Of the 243,850 tonnes of arboricultural material collected, 231,600 tonnes (95%) is currently composted by 20 sites throughout Scotland, the other 8 sites did not carry out composting. The majority of this material (205,500 tonnes) is composted by 6 main companies who manage 11

sites throughout the major conurbations of Scotland. *Figure 9* shows the material flow of arboricultural arisings through the different processing companies in Scotland. Of the 5% of material that is not composted, the majority of this (7,500 tonnes) is used for Biomass and a relatively small quantity (720 tonnes) is sent to landfill.

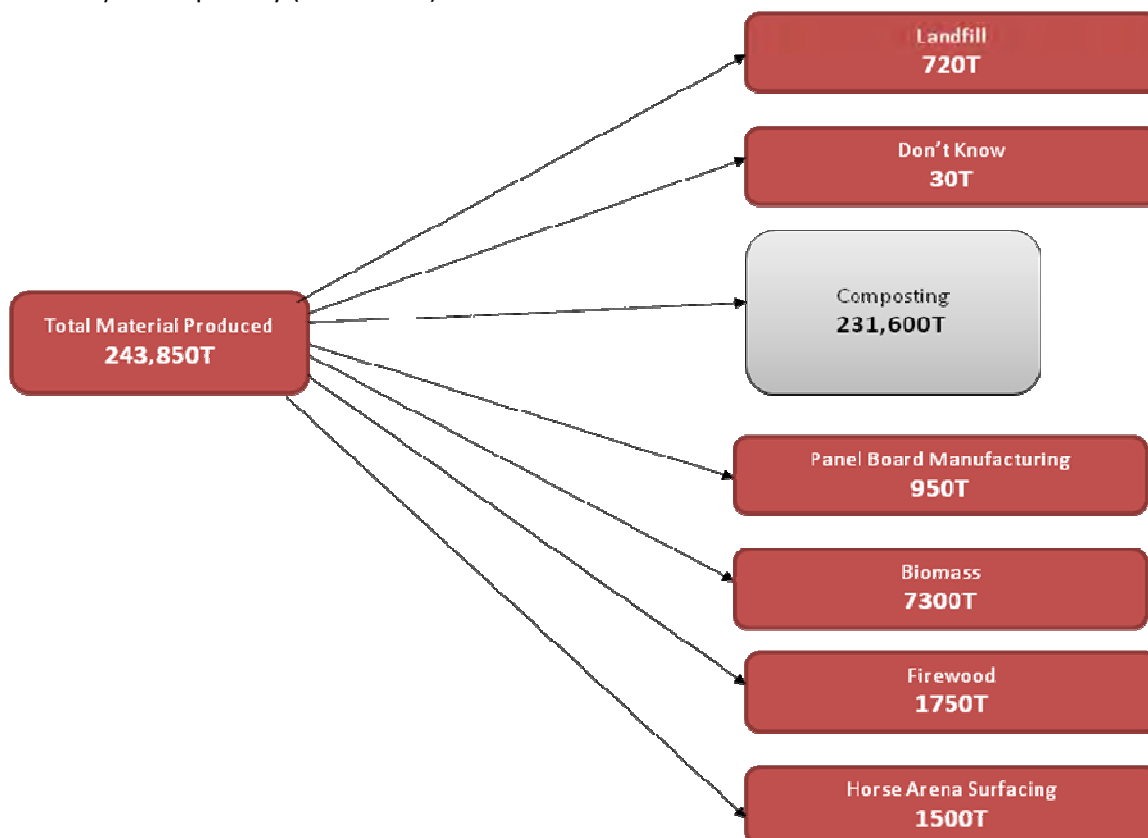


Figure 9 - Material flow through Processing Companies

The seven partial responses included three composting sites that process a total of 28,400 tonnes of arboricultural arisings, three companies that deliver material to the companies that have completed the survey and one that were not involved in collection or processing of the material.

By including the partial responses, the total amount of arboricultural arisings collected and processed by 89% of the companies identified is 272,250 tonnes.

4 The Local Authority Survey

4.1 Scope

The Local Authority Survey covered all 32 Scottish Local Authorities. Each authority was first contacted by FCS and then sent the Survey Form (*see Appendix 1*). It was explained that responses would be on a non-attributable basis. In summary, the responses provided information on:

- current tonnages of wood biomass collected by each authority, distinguishing between tonnages directly collected from construction projects implemented by the authority, local authority tree surgery work, household collections of green and garden waste, and collections through civic amenity sites and bring centres;
- how these collections are currently treated – e.g. are they sent to a contractor, separately recycled, or processed through a composting operation;
- current costs of collecting and treating wood waste by each of these methods, as identified in Council budgets;
- facilities used by Local Authorities to treat wood biomass – e.g. composting plants, bio-fuel generation plants, wood chip processors, etc;
- the Local Authority's views on the potential for developing sources of wood waste collection, and any plans or initiatives that could increase the rate of wood waste recovery e.g. by segregating wood waste from other forms of organic material prior to composting;
- the respondent's views on current barriers to developing wood waste, e.g. quality standards, the costs of collection, recovery and transportation, the availability of viable end markets, etc.

Fifteen of the 32 Authorities to whom the survey was sent responded, representing more than 40% of the Scottish population. This is a sufficiently high response rate to provide confidence that the results are genuinely representative of the Scottish Local Authority sector as a whole.

4.2 Methodology

Survey implementation was carried out through an initial postal and e-mail communication. Most respondents replied by e-mail. In certain cases, telephone interviews were conducted to confirm or clarify the data received. The raw data was then collated on a single spreadsheet, total results obtained and averages across the responding authorities computed. These averages were then multiplied by the total Scottish population to secure estimates of the total value of different parameters for Scotland. The results were then analysed and key findings are given below, on a non-attributable basis as agreed with the survey participants.

The Local Authorities that participated in the survey were (in alphabetical order):

- Argyll & Bute;
- Clackmannanshire;
- Dumfries & Galloway;
- Dundee City;
- East Ayrshire;
- East Dunbartonshire;
- East Renfrewshire;
- Edinburgh City;
- Inverclyde;
- Midlothian;
- North Ayrshire;
- Perth & Kinross;
- South Lanarkshire;
- Stirling;
- Western Isles.

4.3 Results

In total, 15 of Scotland's 32 Local Authorities responded to the survey, covering a combined population of 2,084,000 people (40.3% of the Scottish total).

Not all responses were completed in full. In particular not all the authorities completed the financial/budgetary data on the grounds of commercial confidentiality or in some cases because they did not have separate budget data for green and wood waste. Nevertheless, with a 46% response rate enough information was provided to arrive at interesting and robust conclusions.

4.3.1 Collection Methods

Firstly, no Local Authority in the sample has a separate kerbside collection of wood waste. Most collect it as part of a comingled green and garden waste collection, with a minority also collecting food waste in the comingled "brown bin" organic collection. Where food waste is included, the collection cycle needs to be weekly for health and hygiene reasons. Where the green and garden waste collection excludes food waste, it can be on a fortnightly collection – some authorities run an Alternate Weekly Collection (AWC) cycle with green and garden waste collected in one week, and mixed residual waste collected in the other week.

In addition to kerbside collections, the second most important source of collection is through Civic Amenity (CA) and Household Waste Recycling Centre (HWRC) or "Bring" sites. As the name would suggest, these are sights to which customers bring their recyclable waste, which is then placed in separate containers for glass, plastics, paper and organics. One advantage of this is that it facilitates collection of source-segregated recyclable and organic waste from tenements and other difficult-to-serve properties where it might not be feasible to collect individually in a

number of separate containers. Another is that it enables waste to be bulked (to a degree) at the source of collection.

In both kerbside and Bring Centre collections, wood waste from trees and branches is generally collected in comingled form with other garden waste, such as grass and leaves. It is unclear whether there would be a positive response from households if an Authority sought to segregate wood waste from other sources of garden waste at the point of collection, or whether this is feasible.

This waste is then generally treated via composting – mostly open windrow. However, in cases where garden waste is collected in comingled form with food waste, this is not permissible for health and safety reasons. The Animal By-Products Regulations require that food waste is treated through a controlled and enclosed process, such as In-Vessel Composting (IVC) or Anaerobic Digestion (AD), both of which are more expensive than open windrow composting.

4.3.2 Collection and Treatment Costs

Average collection costs per tonne across the sample, for those authorities for which financial information is available, are as shown in Table 4.1 below.

TABLE 4.3.2(a): Average Collection Costs per Tonne

Type of Collection	Cost per tonne (£)
Kerbside 'garden waste' collections	£69.25
From tree surgery	£50.00
In Civic Amenity sites and Bring Centres	£30.00
From LA Parks & Gardens	£76.81

Source: Local Authority Survey. NB: for CA sites and HWRCs, the costs of green/wood waste collection are often not separated out from other operating costs (for collecting paper, plastics etc...)

The following comments need to be made on Table 4.3.2 (a)

The average cost of kerbside collection, at approximately £70 per tonne, is close to the collection cost for residual waste, so it could be said that the *incremental* cost of collecting wood waste in a mixed green and garden waste collection is very low. Put another way, it costs local authorities very little to collect green and garden waste separately from other forms of waste, particularly where they run an AWC (alternate weekly collection) cycle for organic and residual waste.

The cost of collection through CA and Bring Sites is lower than for kerbside collections, as would be expected, given that the transport costs are effectively transferred from the local authority (which has to bear all transport costs for a kerbside collection) to the CA site user (who has to bear any costs of transport to bring green and wood waste from the point where they arise to the site). In addition, collection in a CA Site results in an automatic “bulking” of green and

woody waste – as well as other types of waste – with much lower labour costs than in a kerbside collection.

The per tonne collection costs for local authority tree surgery and Parks & Gardens activities need to be caveated. These costs were secured by dividing through the quoted budgets for these activities by the reported tonnages of wood waste collected. However, in reality the *incremental* costs of wood waste collection by these means is very low, as they would have to be carried out whether or not any woody biomass was secured from them, to keep parks, gardens, highways and public properties clean and tidy. Any wood collected from undertaking these activities is therefore a by-product of its main objective, rather than their central purpose.

Average treatment costs per tonne across the sample, for those authorities for which financial information is available, are as shown in Table 4.3.2(b) below:

TABLE 4.3.2 (b): Average Treatment Cost per Tonne

Type of Treatment	Cost per tonne (£)
Kerbside 'garden waste' collections	£26.50
From tree surgery	£23.33
In Civic Amenity sites and Bring Centres	£20.01
From LA Parks & Gardens	£42.28
From highway maintenance activities	£42.87

Source: Local Authority Survey.

The following comments need to be made on Table 4.3.2 (b).

- The average may be slightly misleading, as for kerbside collections it is an amalgam of open windrow composting – where an average cost could be typically £15 - £25 per tonne, and other methods such as IVC where it may be higher (c £40 - £50 per tonne).
- For the last two categories, the sample is very small. The comparatively high cost of approximately £42 for these categories may therefore not reflect the full population, as the tonnages involved are very small.

Local Authorities were not specifically asked about how they were encouraging the use of arboricultural arisings for biomass energy use. However, through discussions with the LA's and the questionnaire responses no evidence emerged that any of the LA's provide specific incentives for the use of arboricultural arisings for energy.

Due to the current fiscal environment, the principal concern of LA's appears to be a treatment and disposal route that is as cost-effective as possible. The survey results indicate that this is overwhelmingly through disposal of arboricultural arisings, along with other green and garden waste, to composting contractors for treatment. This typically costs £20 - £25 per tonne, and avoids landfill tax as the organic waste is then diverted from landfill. This implies that it would

be best to incentivise the use of biomass for energy through the composting contactors rather than the LA's.

4.3.3 Collection Tonnages

With respect to the Local Authority sector, the average kilogrammes per capita of green waste collected, as calculated from the sample, is 72 kgs p.a., based on the population data provided by the General Register Office for Scotland. This equates to 372,096 tonnes of green material collected by Local Authorities in Scotland, as calculated by the 5,168,000 total Scottish population per GRS.

In addition, a further 15% could be "brash" material – i.e. lower quality branches, twigs and other woody waste not suitable for use as logs. This would imply $72 \text{ kgs} \times 5,168,000 \times 15\% = c 55,000 \text{ tpa}$ of potential brash waste could be kerbside collected via mixed green and garden waste collections in Scotland pa (10 - 11kgs per capita).

Collections from CA and HWRC sites might add 10% - 25% to this total, based on the survey returns. The exact percentage would vary between areas, depending on the demographics, household structure (flats v houses) and refuse collection policies of different Councils, for example the relative weight they give to kerbside versus CA Site and Bring Centre collections.

Overall, the total potential biomass that might be secured from local authority green and wood waste collections across Scotland might be:

- between 35,000 and 40,000 tpa green tonnes of wood waste suitable for use as logs, and
- between 50,000 and 65,000 tpa green tonnes of lower quality woody biomass.

This is a theoretical maximum potential tonnage. A practical recoverable tonnage might be towards the lower end of this range.

4.4 Conclusions

The average landfill gate fee for the authorities for which information was provided was £26.58, with a minimum value of £12 and maximum of £40. Adding landfill tax to this, currently at £40 per tonne (2009/10), rising to £48 per tonne in April 2010, the average total landfill cost would be c £75 per tonne in 2010/11. Therefore, given this cost, it is likely to be worth doing something with wood waste rather than landfilling it.

In reality, few local authorities currently send their arboricultural wood waste to landfill. The survey revealed that the "opportunity cost" to using biomass for power generation is not landfill, but rather windrow composting – as this is the least cost alternative use.

Based on these findings, a tentative initial conclusion is that it could be worth separating this wood waste from other green and garden waste if;



- a) the residual green and garden waste would still be compostable at c £20 per tonne using open windrow methods, while
- b) the net cost of extracting the wood waste from mixed green and garden waste, and using the wood waste as a biofuel (after allowing for pre-processing and chipping costs) would be less than £20 per tonne.

5 Mass Balance

An overall mass balance for the arboricultural arisings in Scotland (*Figure 10*) has been established from surveys. The estimate for the source of the arisings is on the left and the material being disposed of or processed is on the right of the mass balance.

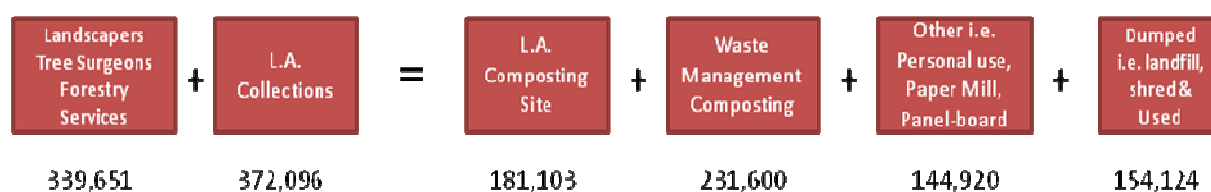


Figure 10 - Mass Balance of Arboricultural Arisings

The mass balance assumes that any disposal of material from Utilities Companies or Large Landowners will be carried out by Landscapers, Tree Surgeons or Forestry Services – so in order to avoid double counting the estimated tonnage from these organisations has not been included in the mass balance.

- The Landscapers, Tree Surgeons and Forestry Services arisings totalling 339,651 tonnes was calculated from the survey responses using the equation in *Figure 1*.
- The LA collection figure of 372,096 was calculated by multiplying the total population of Scotland (5,168,000) by 72 kilograms, the average kg/person of green waste - see section 4.3.3. (NB: The mass balance assumes that material from the L.A. Collections would not enter 'Other' or 'Dumped').
- The Waste Management composting figure was acquired through the survey total.
- 'Dumped' material comprises material being shredded and used for landscaping (*Appendix 5*) or shredded and left on site (*Appendix 6*) and material being land-filled or burned (*Appendix 7*).
- 'Other' material was calculated through the survey responses from Landscaper, Tree Surgeons and Forestry Services, it includes biomass sold to wood processing companies (i.e. panel board manufacturing, paper mills and animal bedding). It also includes biomass that was used personally by those surveyed (*Appendix 8*).

The figure for LA composting was the only 'unknown' in the mass balance. This was calculated by subtracting figures from Waste Management Composting, 'Other' and 'Dumped' from the total arisings, and it is the only figure not calculated by solid sources or survey responses.

5.1 Potential Concerns

There are two main concerns with the estimate of total arboricultural arisings in Scotland; these are double counting of materials and high estimates.

5.1.1 Double Counting

Possibly the biggest concern with the figures in *Figure 10* is the issue of double counting. This can be mitigated to a certain extent by a basic examination of the flow of arboricultural material from the point in which it becomes an arising to the point in which the material is being disposed of or processed. The flow of arboricultural material between organisations is very complicated as shown in the *Figure 11* below:

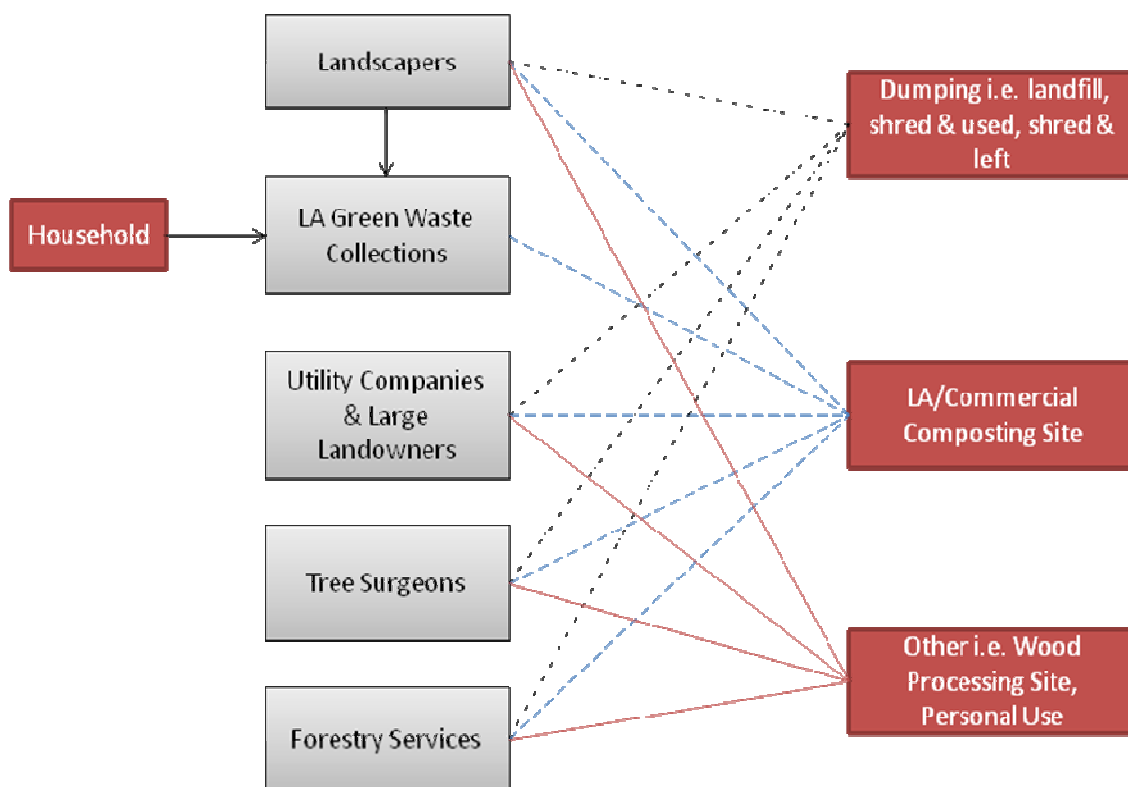


Figure 11 - Material Flow of Arboricultural Arisings

Throughout this report, considerable care has been taken to avoid double counting; these steps are explained in the following result sections. The risk could however not be eliminated entirely.

For this report it is assumed that large landowners and utility companies sub-contract out to either, tree surgeons, forestry services or landscapers. *Figure 11* above outlines the material from utility companies and large landowners going to composting sites, 'other' and 'dumping'. In *Figure 12* below, it is assumed that all material arising from this sector is counted for through the smaller commercial organisations.

From interviews carried out with large landowners and utility companies it was clear that only small tonnages of arboricultural material from this source would enter into treatment at composting sites. Due to commercial and time restraints these organisations were much more likely to 'dump' or send to 'other' processing.

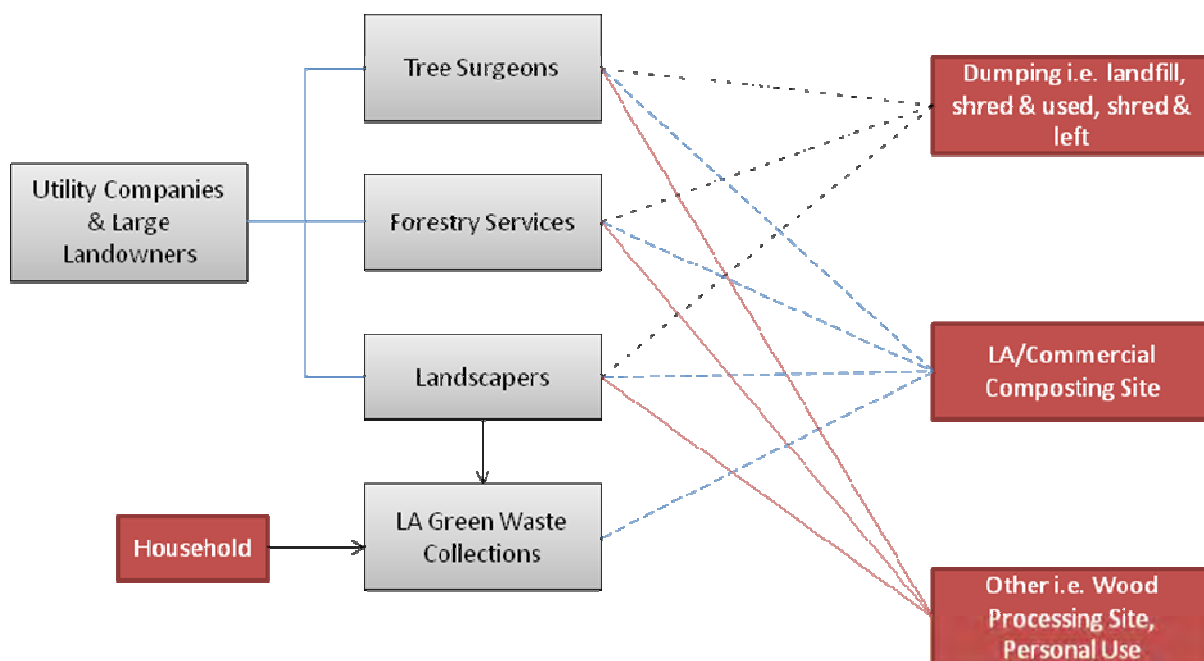


Figure 12 – Utility & Large Landowners Material Flow

Lack of information as to whether material is taken to commercial composting sites or Local Authority sites creates the most potential for double counting from the smaller commercial organisations. It is estimated from the surveys that the landscapers, tree surgeons and forestry services send approximately 40,311 tonnes of arboricultural arisings to composting facilities (see *Appendix 4*). However, from the survey responses it became clear that neither tree surgeons nor the forestry services were likely to transport material to composting sites, though landscaping companies more commonly did. Therefore, to avoid double counting any material produced by landscapers which was known to go into local authority collections was only accounted for in the local authority collections and not within the arisings figure for landscaping companies.

There was limited concern regarding double counting within the Local Authority figures. This report estimates that approximately 372,096 tonnes of arboricultural arisings are collected by Local Authorities annually. This figure is consistent with the 394,416 tonnes published in the SEPA Waste Data Flow Figures (*Appendix 10*). A certain number of these Local Authorities undertake in-house composting and others transfer the material to a merchant composting site.

5.1.2 High Estimates

The majority of the organisations estimated their tonnage of arboricultural arisings and a tendency towards overestimation was noted. To minimise the potential for this to influence results, the lowest estimates or values where ranges were provide were used to calculate results.

6 The Economics of Wood Biomass Recovery

6.1 Drivers of Wood Biomass Recovery

The use that is made of wood biomass depends upon the relative profitability of different options. If biomass is disposed of on-site (e.g. by mulching), then it suggests that the site operators believe that there would be a net cost to recovering it and using it as a form of fuel. This may be because they have insufficient information about the commercial opportunities that exist for wood biomass recovery. However, it would be premature to come to this conclusion without a fuller examination of the facts. It could be that they are right and there is a net cost to recovering wood waste in certain circumstances.

In order for wood waste recovery to be viable, the *price per tonne* secured for the end product must be greater than the *cost per tonne* of securing that end product, including:

- *the cost of securing wood feedstock in a form suitable for use.* As described earlier in this report, woody biomass may be collected in a comingled green and garden waste stream, so there may be costs involved in extracting the wood from other green waste (leaves, grass etc);
- *the cost of preparing raw wood / biomass* so that it is in a usable form, including drying, chipping and bagging;
- *the costs of processing the prepared wood* so that it is in a form for use – e.g. pelletizing it into 6mm chips for wood boilers;
- *the costs of transport* to the end-user.

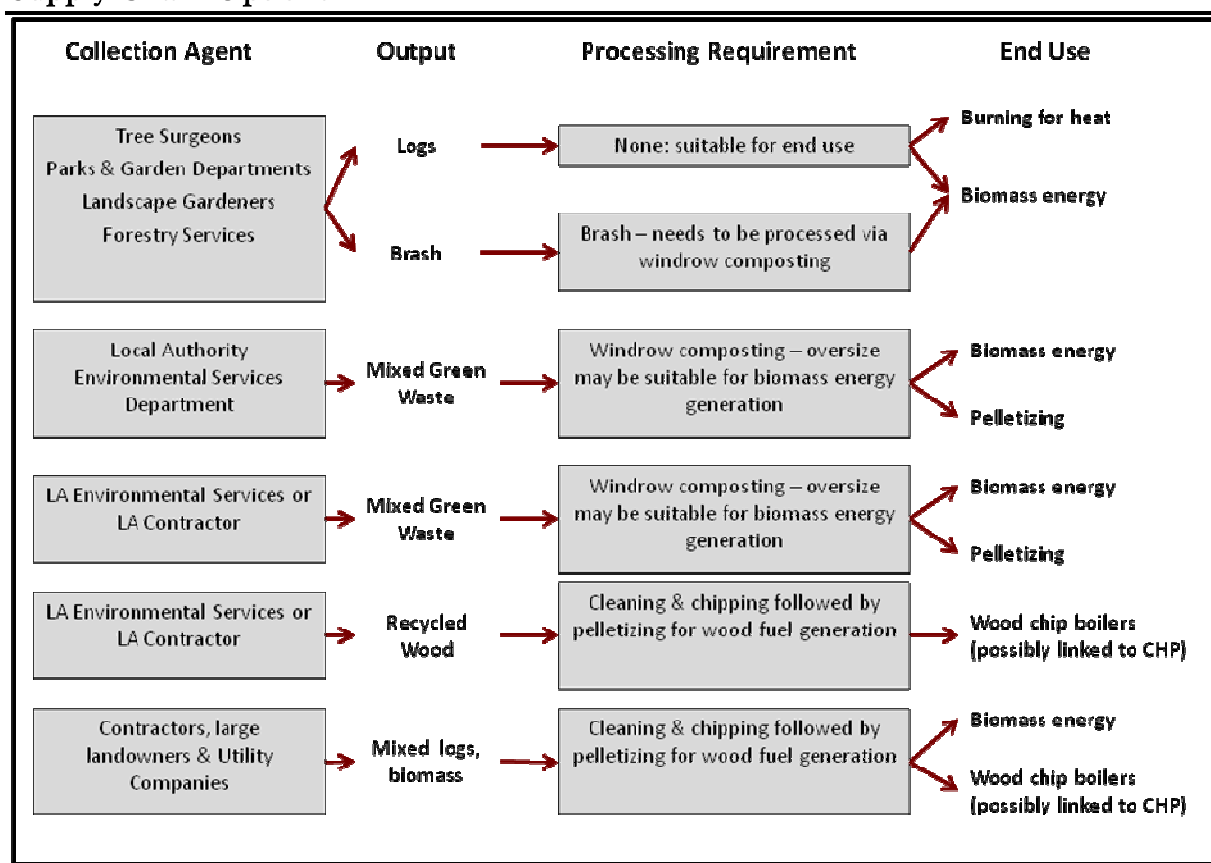
Only if the end price per tonne is greater than the sum of these costs would it be viable to recover wood waste, rather than leaving it to mulch on site or treating it in comingled form with other compostable material.

6.2 Possible Methods of Wood Biomass Recovery

Figure 13 below illustrates possible supply chains for woody waste. The most basic involves chopping timber generated by tree surgery or the maintenance of parks and gardens into logs used for firewood. The results of our surveys suggest this already happens. More complex supply options involve recovering woody biomass from mixed green and garden waste, and then chipping it for use in boilers. The feasibility of this option depends on the quality of the chipped wood that can be recovered, and the tolerance of different types of boiler for lower grade wood chips. There is also growing interest in the use of 6mm wood pellets in domestic and commercial boilers, which is supported by the subsidies given to renewable energy generation which has helped to drive up the market price of wood pellets in recent years. However, the

viability of this operation depends on the availability of a sufficient tonnage of feedstock for pelletization, at prices that provide a sufficient margin to cover the costs of running a pelletization plant. The recent liquidation of one major wood pellet manufacturer, Welsh Biofuels Ltd, indicates that these conditions are not necessarily always easy to achieve in practice.

Figure 13:
Supply Chain Options



For the purposes of the economic analysis, five supply chain options are considered:

- the collection of logs by commercial tree surgeons in small quantities;
- the collection of logs by Forest Services or composting sites in large quantities;
- low-quality woodchip;
- high-quality woodchip; and
- wood pellets.

6.3 Logs

Arboricultural arisings generated by tree surgery can be relatively easily chopped into logs that can then be sold as firewood. Logs can also be recovered from the activities of Parks and

Gardens departments in local authorities and by the segregation of mixed green waste within a composting process. As logs are recovered as a by-product of other operations, the incremental costs associated with their recovery are comparatively modest. They need to be chopped into marketable sizes, then bagged and transported to an end market.

On the assumption that a price of £45 per green tonne could be secured for logs, and based on the transport cost model given in *Appendix 15*, it turns out that transporting logs in small quantities for even a modest distance is only marginally viable as a commercial operation. An illustrative financial model for log recovery by tree surgeons is given in *Table 6.3* below.

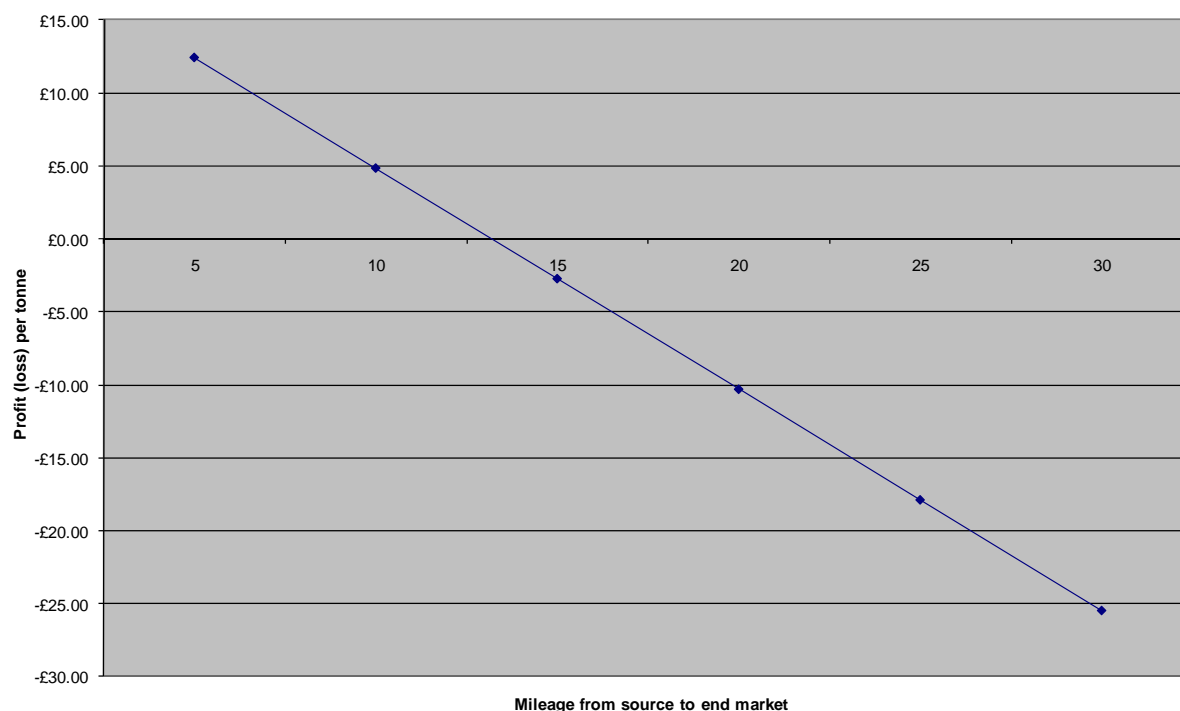
Table 6.3:
Log recovery by tree surgeons: Financial returns per tonne

Parameter	Value	Comments
[1] End market price per tonne	£45.00	
[2] Incremental recovery costs per tonne	£0.00	Very low – logs are recovered as a by-product of surgery
[3] Pre-processing costs per tonne	£5.00	Estimated cost of stacking and drying - manpower costs
<u>Transport costs</u>		
Mileage from source to end market	15	
[4] Transport cost per tonne	£22.74	Based on transport in a small transit van in 1-tonne loads
[5] Processing costs	£15.00	Costs of chopping & splitting seasoned logs into firewood
[6] Other costs	£5.00	Costs of bagging the logs
<u>Profitability analysis</u>		
Baseline profit per tonne	-£2.74	Computed as [1] - ([2]+[3]+ [4]+ [5]+ [6])

Tree surgeons give their clients the option of keeping logs that are produced as result of tree surgery, or leaving the responsibility for disposal with the surgeon. For the purposes of the cost model, it is assumed that tree surgeons use small transit vans to transport logs to an end market. As the transport cost of carrying logs in such small quantities is relatively high, the cost analysis suggests that it may be uneconomic to transport them more than a very short distance.

A series of sensitivity analyses was run to model the impact of different journey distances on the profitability of recovering and marketing logs. The results are shown in *Figure 14* below. The Figure shows that – on the basis of the cost model given in Table 6.3 and the transit model in the Appendices – it is only profitable for tree surgeons carrying small quantities of logs to transport them 11 miles. For longer distances, the costs of transport increasingly outweigh the price likely to be secured.

Figure 14:
The Profitability of Transporting Logs in Small Quantities over Varying Distances



Source: NAL Economic Model of Biomass Recovery

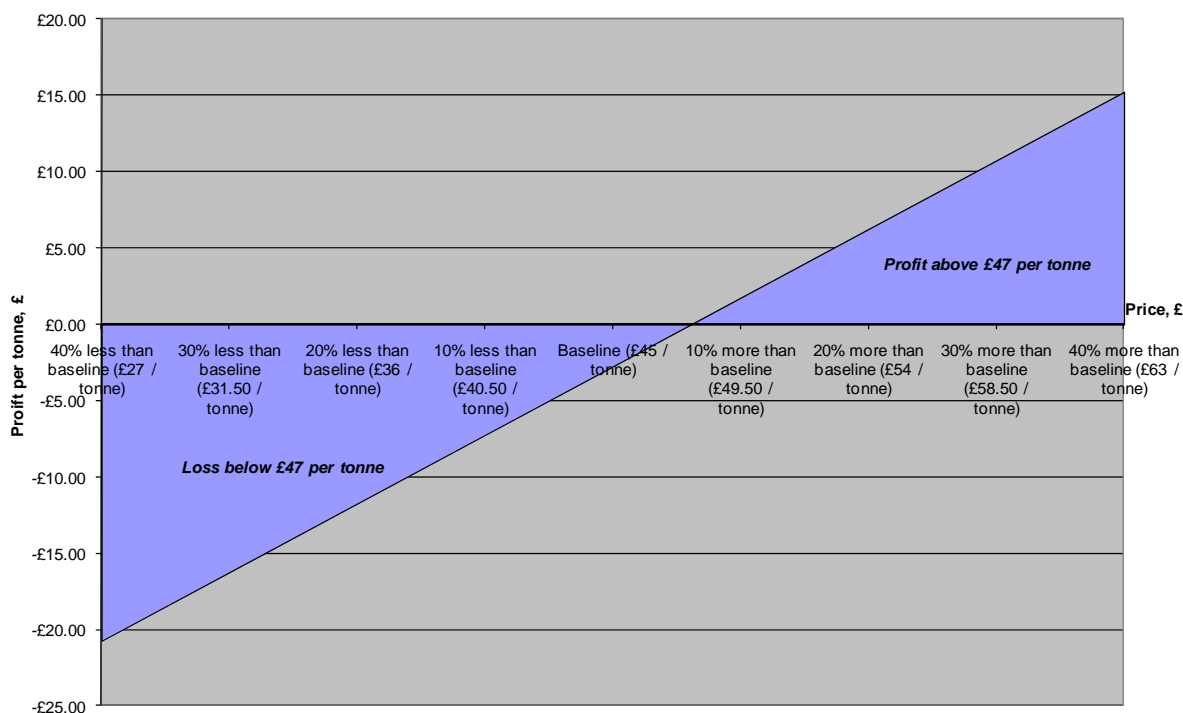
The other key driver of the economic return on logs is the end market price. In *Figure 15* below, the profitability of log recovery from tree surgery is plotted on the vertical axis, against the end market price, which is plotted on the horizontal axis. It can be seen that profitability is quite sensitive in relation to price changes. Overall, on the cost assumptions set out in *Table 6.3*, it becomes economically viable to transport logs a distance of 15 miles at a price of £47 per tonne or more.

Overall, the commercial attractiveness of log recovery depends on the distance that the logs have to be transported to reach an end market and the price that can be secured from the end market.

This rudimentary analysis of the economics of log recovery suggest that, on plausible assumptions, it is viable to carry logs recovered from tree surgery 10-20 miles, but not much more. The marginal viability of this operation is confirmed by a report that a composting site offering to accept logs at no charge has secured good business from tree surgeons looking to dispose of logs as close to source as possible – a zero return which minimizes transport distance

and cost being superior from their viewpoint to a higher return involving longer transport distances.

Figure 15:
The Profitability of Recovering Logs in Small Quantities at Varying Prices, with a distance of 15 miles to market



Source: NAL Economic Model of Biomass Recovery

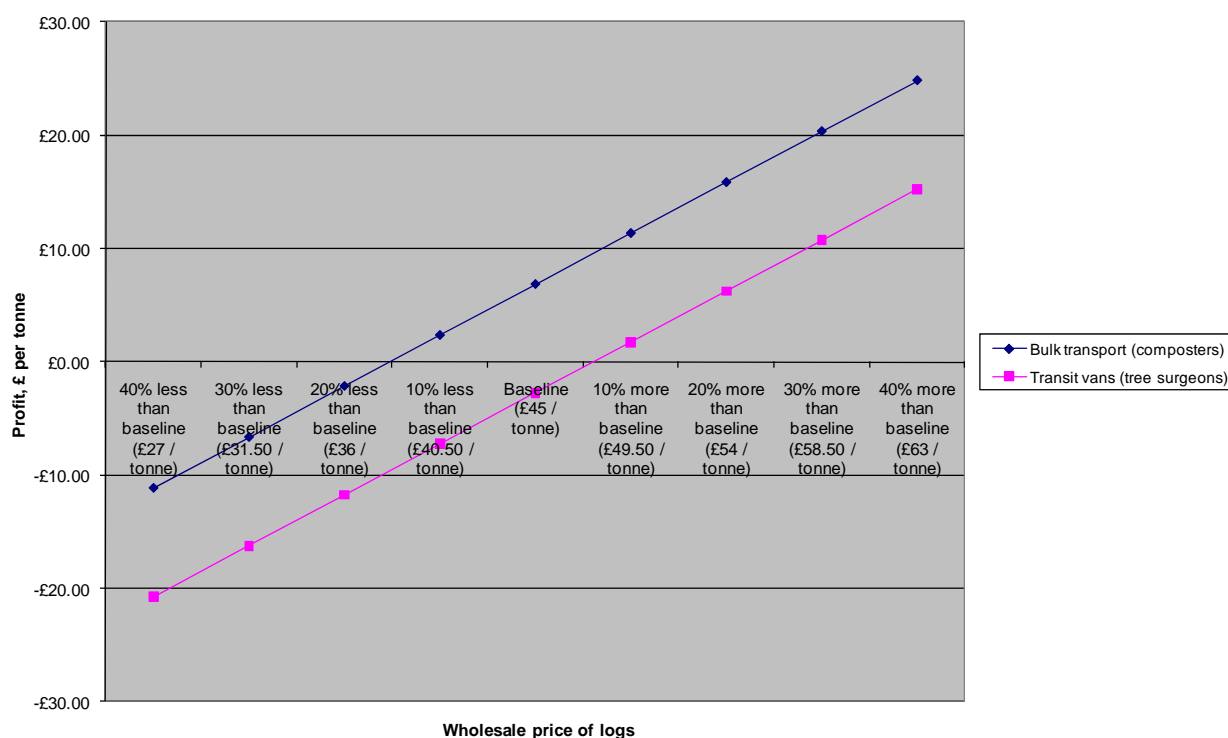
The economics of log recovery become more attractive if they can be collected in bulk and stored, so that, instead of being transported in relatively small transit vans, they can be transported in bulk in articulated lorries. These are much cheaper on a per tonne basis than transit vans.

In modeling the cost of log recovery in bulk by Parks & Gardens Departments or composting sites, a cost of £5 per tonne has been added for cost item [2] in *Table 6.3* (incremental recovery costs per tonne) to cover the costs of recovering logs from mixed green waste accepted on a composting site. Otherwise, the cost structure is the same as that given in *Table 6.3*, except that logs are bulked in a skip prior to onward shipment and are then transported in 15-tonne loads in articulated lorries – as opposed to 1-tonne loads in transit vans. This is a crucial difference, as the cost of transport is significantly lower under this option.

The comparative profitability of the two transport scenarios is illustrated graphically in *Figure 16* below, over a range of prices, assuming a transport distance of 15 miles between the source and

the end market for the transit vans run by tree surgeons for 1-tonne deliveries, and 30 miles between the source and end market for articulated lorries run by composting sites for 15-tonne deliveries. The end market price is assumed to be £45 per tonne in both options.

Figure 16:
The Comparative Profitability of Transporting Logs in 1-tonne quantities over 15 miles and 15-tonne quantities over 30 miles



Source: NAL Economic Model of Biomass Recovery

It can be seen that the economics of log recovery improve dramatically if bulk transport can be used. It becomes viable to transport logs longer distances under this option. The breakeven price for it to be worthwhile transporting logs 30 miles by bulk transport is £36 per tonne, whereas the breakeven price for transporting logs 15 miles by transit van is £47 per tonne.

Assuming a price of £45 per tonne, a tree surgeon would lose £2.70 per tonne over a distance of 15 miles, whereas a bulk transport operation would make a profit of £10.90 – a difference of approximately £13.60 per tonne.

The implication is that it could be worthwhile for Local Authorities, either separately or in partnership, to set up bulk transfer stations specifically to collect logs and other wood waste, possibly within their existing CA site networks, so that wood biomass can be bulked into more economic quantities for recovery and energy generation.

6.4 Woodchip

The same two drivers – of price and distance between source and point of end-use – determine the economic viability of woodchip recovery. Low quality woodchip can be recovered from oversize material in a composting operation, which may be usable in a limited range of industrial boilers for energy recovery. A small number of the composting contractors covered in our commercial survey indicated that they do seek to recover low quality woodchip from composting operations and from lower grade logs that may not be suitable for use as firewood. This indicates that it can, under certain circumstances, be a marginally profitable operation. Table 6.4 below gives an indicative cost structure for such an operation.

Table 6.4:

Low quality woodchip recovery from composting operations: Financial returns per tonne

Parameter	Value	Comments
[1] End market price per tonne	£45.00	
[2] Incremental recovery costs per tonne	£0.00	Very low – recovered as a by-product of composting
[3] Pre-processing costs per tonne	£5.00	Estimated cost of stacking and drying in yard
<u>Transport costs</u>		
Mileage from source to end market	30	
[4] Transport cost per tonne	£8.16	Based on bulk transport in 15-tonne artics
[5] Processing costs	£10.00	Source: <i>Biomass in Fife</i> - costs of shredding and chipping
[6] Other costs	£25.00	Costs of log purchase
<u>Profitability analysis</u>		
Baseline profit per tonne	-£3.16	Computed as [1] - ([2]+[3]+ [4]+ [5]+ [6])

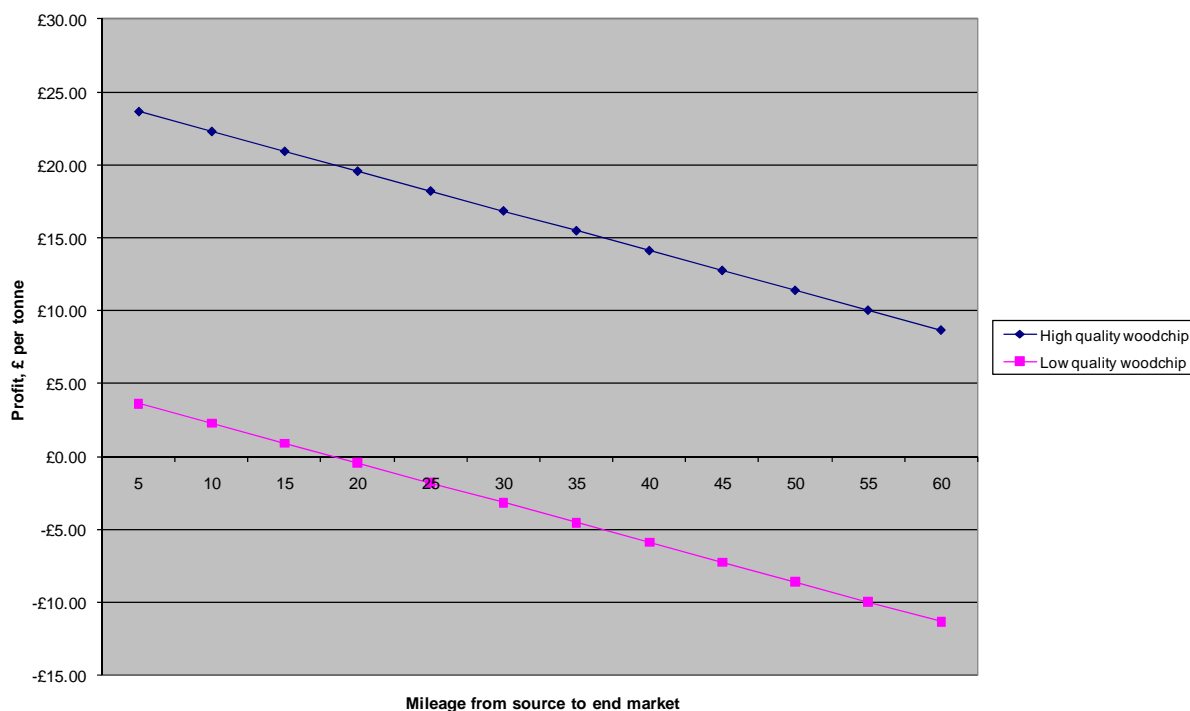
It will be seen that, on the assumptions in Table 6.4, the recovery of low quality woodchip is only marginally profitable. This is confirmed by sensitivity analyses.

A key factor driving profitability is the end market price, which is assumed to be £45 per tonne – i.e. the same price as for green logs. Price is in turn related to woodchip quality. Higher prices can be secured for high quality EN woodchip. If a price of £70 per tonne could be secured, the economics of woodchip recovery improve dramatically.

The influence of price on profitability means that the recovery of high grades of woodchip, with superior energy yields, appears to be commercially attractive. Assuming similar recovery and pre-processing costs, the comparative profitability of high quality (£70 per tonne) and low

quality (£45 per tonne) woodchip over a range of different distances from source to end-market is shown graphically in *Figure 17* below.

Figure 17:
The Comparative Profitability of High Quality and Low Quality Woodchip over a range of distances, assuming similar production costs



Source: NAL Economic Model of Biomass Recovery

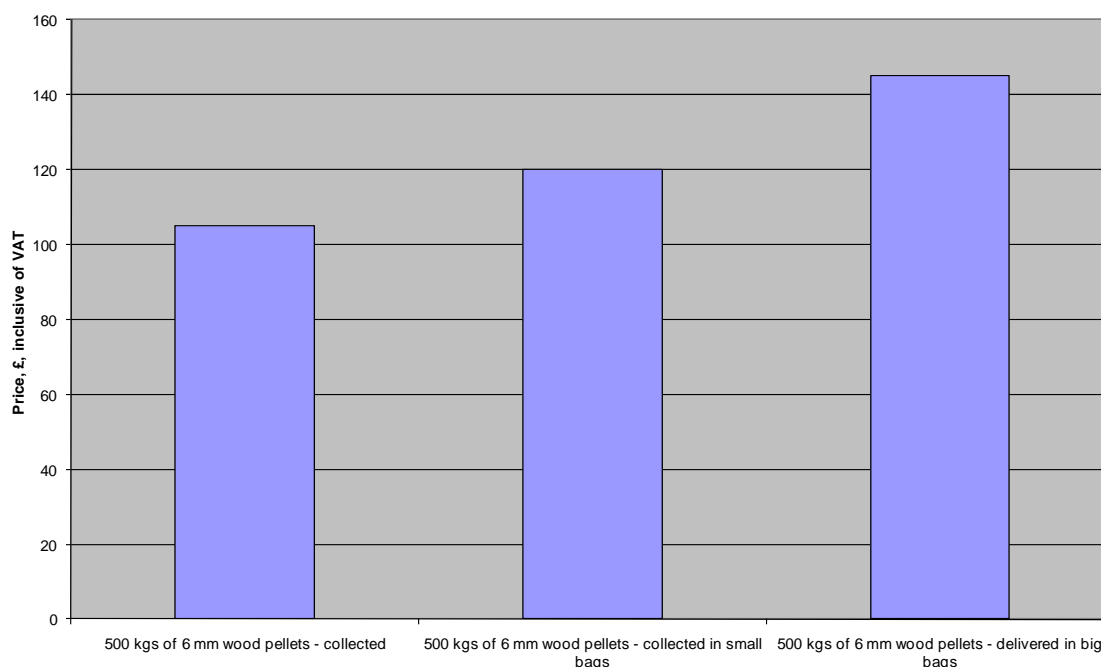
The estimates assume bulk transport.

With a policy drive towards increasing the amounts of renewable energy, woodchip prices are likely to trend upwards over time, which would make woodchip recovery more commercially attractive. The implication would seem to be that more of the marginal low-grade woody biomass that is currently mulched on site or composted is likely to be segregated, chipped and bagged for energy recovery.

6.5 Wood Pellets

Wood pellets produced to 6mm diameter and suitable for use in a wide range of domestic and wood boilers are at the top end of the wood biomass renewable energy cycle. This is reflected in the premium retail price they command, as reflected in the February 2010 price quotes of one supplier, illustrated in Figure 18 for 500kg bulk bags. High grade pellet commands a premium price of almost £300 per tonne delivered.

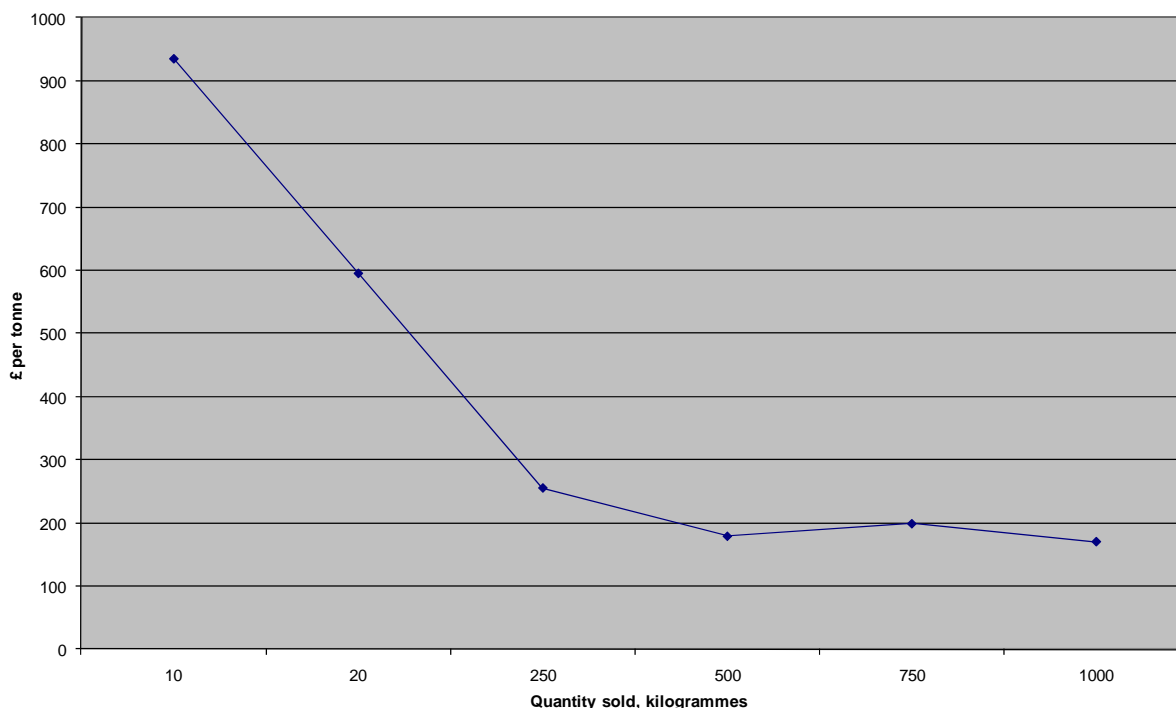
Figure 18:
Quoted prices for 500 kg bags of wood pellets, February 2010



Source: <http://www.liverpoolwoodpellets.co.uk/ourshop/> - prices quoted at February 1st 2010

Using the same source, *Figure 19* graphs the prices quoted for different quantities of wood pellets collected from the supplier. The Figure shows that there is an inverse relationship between the price quoted and the quantity sold. The quoted price given in *Figure 18* is inclusive of VAT. To convert into a consistent comparison, the VAT element has been netted out and the quotation has been converted into an equivalent price per tonne – for example, by multiplying the quote for a 10 kilogramme bag by 100.

Figure 19:
Quoted prices for wood pellets of varying quantities, February 2010



Source: Adapted from data given by www.liverpoolwoodpellets.co.uk at February 1st 2010

From *Figures 18 and 19*, it can be seen that the price quoted depends upon the specification and quantity of pellets, and whether they are collected from the supplier or delivered to site.

While the price that wood pellets command is higher than for other types of wood biomass, the costs of manufacturing wood pellets are also greater. The viability of pelletization depends on:

- the margin, or difference between the cost of feedstock and the end market price, and
- the cost of the pelletization process.

For the purposes of the rudimentary viability analysis given in *Table 6.5* below, it is assumed that:

- An end market wholesale price of £136 per tonne can be secured at the factory gate for wood pellets – being 80% of the retail price for a 1-tonne bag quoted in February 2010 by www.liverpoolwoodpellets.co.uk;
- The cost of feedstock is £70 per tonne – i.e. equivalent to high quality woodchip wholesale prices; and

- The costs of the pelletization process itself are derived from a feasibility study undertaken for a commercial client in 2006 for a 30,000 tpa pelletization plant, adjusted for inflation.

Table 6.5:
Wood Pellet Manufacture: Financial returns per tonne

Parameter	Value	Comments
[1] End market price per tonne	£136.00	
[2] Feedstock costs per tonne	£70.00	Based on high quality woodchip price
[3] Pre-processing costs per tonne	£11.50	Estimated cost of stacking and drying
<u>Transport costs</u>		
Mileage from source to end market	30	
[4] Transport cost per tonne	£8.16	Based on bulk transport in 15-tonne artics
[5] Processing costs	£31.00	Source: <i>An initial commercial feasibility study of a plant manufacturing biofuel from wood chippings</i> , prepared by Michael Nevin, Managing Director, Caledonian Economics Ltd, for Bedmax Ltd, November 2005, for a 30ktpa plant, adjusted for inflation
[6] Other costs	£5.00	Marketing and Selling Costs
<u>Profitability analysis</u>		
Baseline profit per tonne	£10.34	Computed as [1] - ([2]+[3]+ [4]+ [5]+ [6])

It can be seen that, on the assumptions in *Table 6.5*, wood pellet manufacture is a viable operation, assuming a 30-mile delivery distance to the end market. Sensitivity analysis indicates that it remains viable – albeit with a lower profit margin – even if the transport distance were to double to 60 miles.

In other words, the commercial viability of a wood pellet operation is far less sensitive to changes in transport mileages than, say, log or woodchip production. The reason is that, because the value of the end product is so much greater – at approximately £140 per tonne wholesale in the illustrative figures given in *Table 6.5* – the proportion of the price that is absorbed by transport costs is much lower than in the case of logs or low-grade woodchip. Therefore the economics of the operation are less sensitive to fluctuations in transport costs and distances.

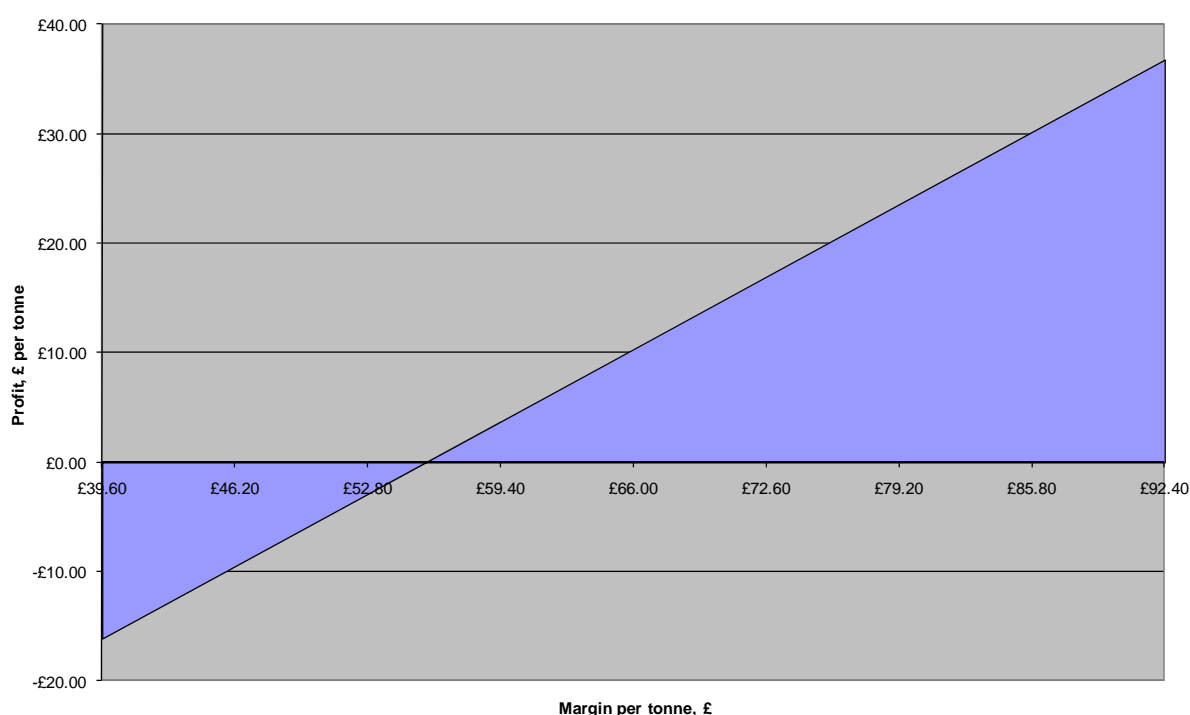
However, the viability of wood pellet manufacture is very sensitive to:

- the costs of the pelletization process itself – which rise as the capacity of the plant falls, reflecting significant economies of scale in the manufacturing process; and
- the availability and cost of suitable feedstock.

Figure 20 shows the Relationship between the profitability of wood pellet manufacture and the margin, or difference between pellet prices and feedstock prices. The Figure reveals that – on the assumptions underpinning the cost model in Table 6.5 – a wood pellet manufacturer would need a margin of £55 per tonne to cover costs. This is for a 30 ktpa pelletization plant, which requires a significant quantity of high quality feedstock. For a smaller plant, processing costs per tonne would be greater, and a higher margin would be required for viability.

Figure 20:

Relationship between the profitability of wood pellet manufacture and the margin, or difference between pellet prices and feedstock prices



Source: NAL Economic Model of Biomass Recovery

One practical problem encountered by wood pellet manufacturers is the availability of suitable feedstock in sufficient quantities.

6.6 Conclusions

The economic analysis indicates the importance of the Proximity Principle. Minimisation of the distances between the source of biomass arisings and the end use makes sense in economic as well as in environmental terms, as the viability of recovering woody biomass is strongly influenced by transport distances and costs, particularly for lower grade material.

A second conclusion is the importance of price. This is self-evident, but is worthy of mention, as it seems likely that in the medium-term the trend of prices of all forms of woody biomass will be upwards, reflecting the emphasis that the Government is placing on promoting all forms of renewable energy, including energy from biomass.

Potential business opportunities that could encourage greater recovery of more marginal forms of wood biomass from arboricultural arisings could include:

- the development of bulk collection and storage facilities;
- the promotion of pre-processing and chipping facilities close to the source of arboricultural arisings, so that it becomes cheap and easy to recover woody waste rather than leave it to mulch on-site;
- the construction of comparatively small biomass energy plants close to bulk collection and storage facilities (including composting sites) , capable of using a mix of arboricultural wastes, and not solely dependent on high quality wood chips and pellets.

Local authorities could play a key part in promoting such facilities – ideally in partnership with commercial partners who could raise the finance required to develop new projects on a project finance basis – i.e. meeting financing obligations on a fully commercial basis from the revenue streams generated by biomass energy revenues. At a time of national fiscal constraint, it is unlikely Local Authorities will, themselves, have extensive financial resources to promote and finance these projects. However, they do have considerable resources in the form of the wood waste that they directly collect – which could provide the anchor feedstock for biomass plants – and their purchasing power. For example, local authorities and other public bodies could encourage (or even contractually require) their contractors to develop wood fuel resources by separating out wood waste in their construction activities, and delivering it to easily accessible recovery centres where it can be cost-effectively bulked and chipped as required.

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