Regional Biomass Active Demand Mapping Project

Commissioned By Natural England

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Cover Picture: Willow harvesting in Nottinghamshire courtesy of 'Strawsons Energy' and 'Koolfuel'

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Executive Summary

In October 2007, JHWalter was commissioned by Natural England to conduct a *Regional Biomass Active Demand Mapping Project* across the East Midlands to identify current and future demand alongside producing a contact database.

The East Midlands is at the forefront of the UK biomass market, with approximately 5,500 hectares planted, yielding 60,000 – 70,000 Oven Dried Tonnes Per Annum (ODTPA). The concentration of biomass in the East Midlands is due to both the ARBRE project which, despite its failure, encouraged the growth of Short Rotation Coppice (SRC) in the 1990's; and the large demand for biomass from the concentration of power generators in the region, driven by Renewable Obligation Certificates (ROCs) introduced in 2002.

The demand for biomass certainly exists and is growing, exemplified by power generator co-firing targets, set to increase six fold by 2010 from 300,000 to 1,988,000 ODTPA (N.B the majority of this is imported). Alongside this, demand from current and proposed biomass boilers is set to double by 2010 from 17,500 to 35,000 ODTPA. Whilst the majority of proposed installations are still in the feasibility/planning stages, the level of commitment communicated is very high. Thus unless something radical happens within the sector to deter existing interest, a significant number of further installation across all scales can be expected throughout the region.

The supply of UK biomass, principally Energy Crop and Forestry Round Wood (FRW), seems most suited to the production of woodchip (or cobs in case of Miscanthus) used to supply large local biomass heat or power generation systems of 200kW+. Producing woodchip (or cobs) is the preferred fuel type due to the questionable economics of producing pellets competitive with those from sawmill co-products or waste wood. Supplying local biomass systems of 200kW+ is the most effective supply-chain dynamic due to the physical characteristics of woodchip (or cob), which make fuel delivery economics and fuel performance higher in this scale of system.

Relatively few 200kW+ biomass heating systems exist at present and as such, the majority of biomass entering the market is supplied to power generators for co-firing. However, a number of interesting large scale district heating and Combined Heat and Power systems have been identified, evidencing the potential for the future. With Renewable Obligation Certificates (ROCs) guaranteed until 2027 this creates a stable base in the Biomass market allowing time for such schemes to be developed.

There are a number of organisations, for example, Natural England, Bical and the Forestry Commission, making significant efforts to promote and develop the supply of Energy Crop and FRW respectively. Promoting the production of Energy Crop faces significant hurdles at present due to current commodity prices, namely the high price of wheat which has made farmers reluctant to diversify. Whilst there is certainly the potential to increase the supply of FRW the key barrier faced is the development of a dedicated supply infrastructure.

Unlike in energy crop production, where farmers can utilise existing machinery and storage facilities, the majority of that required for FRW production will have to be specially developed.

For the supply of schemes in the range of 200kW - 1MW, which would require approximately 120 - 590 ODTPA, equivalent to 10 - 51 hectares of energy crop, the use of biomass grown or harvested locally or indeed "on-farm" may be viable. However certainly for larger schemes of 1MW+, and for the majority of 200kW+ boilers, there will be a need to attract biomass from a number of sources. As such group activity will be essential to coordinate production and supply. The establishment of producer cooperatives, as proven by the success of the Renewable Energy Growers (REG) cooperative in the East Midlands, highlights the benefits of pooling supplies, collective contract negotiation and sharing the cost of specialised machinery.

As new boilers are installed it should not be expected that new producers will automatically supply them. It is probable that demand would be met by existing producers diverting biomass away from co-firing, especially if a premium can be obtained. New producers should be able to easily secure a contract with power generators as their targets for co-firing are so large. This highlights the fact that as new boiler systems and new producers enter the market it will not simply be the case that new supply meets new demand, but complex market re-adjustments will occur, obviously dependant to a large degree on geography.

Specific Objectives

I. Identify Current Public and Private Sector End Users

Identify across the East Midlands those using biomass heating units which will include public bodies, private companies and individuals, and power generators. The project team will also establish and record existing schemes using community heating systems.

II. Identify Future Public and Private Sector End Users

Identify across the East Midlands estimates of future demand for those public bodies, private companies and individuals, and power generators with existing biomass heating units.

Identify estimates of future demand for public bodies, private companies and individuals who are intending to install biomass systems up to and beyond 2010. Once again this would include schemes seeking to use community heating systems.

III. Identify Current Supply and Demand Issues

Identify across the East Midlands the current supply and demand issues, alongside possible strategies to improve the supply chain in the future.

IV. Produce an Information Contact Database

As a result of research and investigational work carried out, the Project will produce a data base of contact information of all those approached for use by Natural England.

1. Introduction - The East Midlands Biomass Market

Since recognition of the negative environmental effects of burning fossil fuels alongside their finite nature, the diversification into renewable energy supplies has been led by international and national policy, for example the EU Renewable Directive 2001[1]. Biomass qualifies as a renewable energy source as the crop fixes as much carbon as is released when it is burnt, leading to no net atmospheric carbon gain. The key types of biomass currently used in the East Midlands and the UK are produced from Short Rotation Coppice (SRC), Miscanthus and Forestry Round Wood (FRW). There is also limited use of biomass from waste, including wood, food and animal waste, but this is likely to increase over the next few years, with the production of wood pellets from waste wood being of particular interest.

The East Midlands is at the forefront of the UK's Woody Biomass Market, with approximately 5,500 hectares of SRC (2,000 hectares) and Miscanthus (3,500 hectares) planted at present, yielding in the region of 60,000 - 70,000 ODTPA[2]. This is a result of both the pioneering ARBRE (Arable Biomass Renewable Energy) project in the 1990's and the concentration of coal-fired power generators who are now economically driven to co-fire biomass due to the introduction of Renewable Obligation Certificates (ROCs).

The demand for biomass certainly exists. Power generators in the East Midlands currently consume approximately 300,000 ODTPA, but this volume is projected to increase six times over, to 1,988,000 TPA by 2010 principally due to Drax's ambitious plans for co-firing. Currently 95% of this biomass is imported, despite the fact that the ROC system rewards UK grown Energy Crop[3] more favourably than imported biomass, because there simply isn't enough UK Energy Crop to meet such demand.

Such demand is complimented by the growing number of biomass boilers being installed throughout the East Midlands in both the public and the private sector at scales currently ranging from 5 – 3500kiloWatt (kW). The capacity of biomass boiler installations in the region is set to double by 2010, from 30,000kW to 60,000kW based on the information collected, leading to an estimated increase in biomass demand from approximately 17,500 ODTPA to 35,000 ODTPA (values relate to

[1] **EU Renewable Directive 2001** – Target of 12% of total energy and 22% of electrical energy to be from renewable sources by 2010.
[2] SCR average yield of 10 ODT per annum. Miscanthus average yield of 13ODT per annum.
[3] **Energy Crop** - a plant domesticated for use in agriculture and is produced as a low cost and low maintenance, harvested to be used to make biofuels or directly exploited for its energy content.

woodchip at 35% Moisture Content and 3000kWh per tonne). With respect to both current and future biomass boilers approximately 25% of installations are greater than 200kW capacity, but this 25% accounts for over 80% of current and predicted biomass demand. This highlights the significance of large installations (>200kW) in terms of generating significant biomass demand.

Very large biomass systems including a proposed 30MW biomass and gas district heating systems heating 3000-4000 homes in Bedfordshire, and a 2.5MW Electrical and 8-10MW thermal Combined Heat and Power (CHP) system in Staffordshire have also been identified. Whilst outside of the East Midlands, such examples highlight the fact that private investors are looking into investing in large scale biomass projects. Projects that could potentially be replicated in the East Midlands especially when considering the large housing developments currently planned, for example the development of 37,000 homes in Daventry, Northamptonshire.

The key sources of biomass in the East Midlands are from Energy Crops, SRC and Miscanthus, FRW. For supply to the biomass boiler market the key debate surrounds the associated pro’s and con’s of woodchip versus wood pellet. Woodchip has much lower production costs and embodied carbon than pellets, but a lower calorific value per weight and volume. This makes woodchip less economical to transport and less suited to smaller boiler installations (<200kW), due to boiler performance and the size of on site storage capacity required. The economics of producing pellets from energy crop or FRW however cannot compete with imported pellets produced from sawmill co-products and are unlikely to be able to compete with pellets produced from reclaimed timber, which should soon enter the market. As such UK produced biomass is most suited to the production of woodchip (or cobs in the case of Miscanthus) and should be targeted to supply large, local, biomass heating systems 200kW+. Leaving boilers <200kW to be primarily supplied by pellets produced from other sources.

With the demand for biomass growing, a number of organisations for example Natural England, Bical and the Forestry Commission are making significant efforts to promote and develop the supply of solid biomass across the East Midlands. Increasing the production of energy crop at present is particularly difficult, because the currently high cereal price has created reluctance amongst farmers to diversify into energy crop production. The potential to increase the supply of FRW is however significant. The Forestry Commission believe that nationally they can bring an additional two million tonnes (90,000 tonnes in the East Midlands) of forestry round wood to market, annually, by 2020. The key barrier faced to achieving such goals is the development of a dedicated supply infrastructure. Unlike in energy crop production where farmers can utilise existing machinery and storage facilities, the majority of that required for FRW production will have to be specially developed.

For the supply of schemes in the range of 200kW – 1MW, which would require approximately 10 – 51 hectares of energy crop, the use of biomass grown or harvested locally or indeed "on-farm" may be viable. However certainly for larger schemes of 1MW+, and for the majority of 200kW+ boilers, there will be a need to attract biomass from a number of sources and as such group activity will be essential to coordinate production and supply. The establishment of producer cooperatives, as proven by the success of the Renewable Energy Growers (REG) cooperative in the East Midlands, highlights the benefits of pooling supplies, collective contract negotiation and sharing the cost of specialised machinery. Cooperative may prove particularly effective under present market conditions, whereby due to high cereal prices individual farmers are unlikely to commit serious areas to energy crop production, but multiple farmers could grow smaller areas of energy crop on their marginal land.

The supply and demand for biomass has and certainly is growing, however barriers to both supply and demand exist. For example the reluctance of farmers to grow energy crop at present and the high capital cost of boiler installation. In order to overcome these barriers targeted grant schemes, promotional and education activities must be employed to aid the sustainable development of all aspects of the supply chain simultaneously to avoid the 'chicken and egg' conundrum of what comes first, the supply or the demand for biomass.

Note:

Whilst our research has been extensive the data collated on the number of current and proposed biomass installations is by no means exhaustive. A number of people and organisations contacted declined to respond, including some who acknowledged that they knew of boiler installations, but couldn't pass on information due to confidentiality reasons. Also there will undoubtedly be installations that we have not discovered. As such we believe our predictions to be conservative and fully expect new installations and biomass demand to come to our attention in the near future.

2. Renewable Energy Policy and Biomass and Power Generation Renewable Obligation Certificates (ROCs)

The increasing investment and demand for renewable energy, due to recognition of the detrimental effects of burning fossil fuels on the environment and issues of fuel security, has been driven by the introduction of policy at a range of scales. Biomass represents one of many renewable energy sources within which policy induced investment has resulted.

2.1 The UK Energy Market

Energy in its simplest terms is used for three purposes:
Transport of goods and people.
Heating of spaces and in process.
Generating Electricity for lighting, equipment and heat.

The UK economy was founded on, and then grew thanks to abundant supplies of cheap energy, namely coal. However things are changing, fossil fuel supplies are finite and declining, increasing their cost. There is also recognition of the significant environmental degradation caused by burning fossil fuels, causing localised pollution and global climate change as result of the emission of toxic particulates and green house gases, most notably Carbon Dioxide (CO_2).

2.2 Renewable Policy Drivers

Recognition of the negative environmental effects of burning fossil fuels, and their finite nature has led to the diversification into renewable energy supplies brought about by international and national policy.

-1997 – Kyoto Protocol
Set legally binding targets for reductions in Greenhouse gas emissions, notably CO_2. The UK target is a 12.5% reduction on 1990 levels by 2010.

-2001 - EU Renewable Directive
Set targets for 2010 of 12% of total energy from renewables and 22% of electricity from renewables.

-2002 – Renewable Obligation Certificates (ROCs)
Since April 2002 all UK licensed electricity suppliers have been obliged to obtain a proportion of the electricity they sell from a selection of eligible renewable sources, currently 6.9%. Every year the renewable obligation level increases; it started in 2002/3 at 3%, and will reach 10% by 2010, and 15.4% in 2015/16. The goal is to reach 20% by 2020.

For every 1,000 units (1MWh) of green electricity an energy company generates they receive one ROC. A company that generates more than its renewable obligation, for example a wind farm, can sell ROCs to energy suppliers who have failed to meet their RE obligation, for example coal firing power stations, in turn creating a system by which power companies are financially motivated to invest in renewable energy generation projects. ROCs currently trade around the £40 mark and are guaranteed to 2027.

2.3 Renewable Energy - Biomass

Biomass refers to the living and recently dead biological material that can be used as fuel or for industrial production. Most commonly biomass refers to plant matter grown for use as fuel, but it also includes plant or animal matter used for production of fibres, chemicals or heat. Biomass may also include biodegradable wastes that can be burnt as fuel. It excludes however organic material which has been transformed by geological processes into substances such as coal or petroleum.

Biomass fuels, unlike fossil fuels, are considered renewable as they are carbon neutral. When they are burnt the carbon they release is equivalent to the carbon they fix from the atmosphere during their growth. As such when burnt there is no net gain of carbon in the atmosphere. Unlike when fossil fuels are burnt liberating ancient carbons into the atmosphere leading to net atmospheric carbon gain.

"Globally, biomass use amounts to nearly one billion tonnes of oil equivalent, a level comparable to the consumption of natural gas or coal. This makes it the largest renewable source in use today." [1] This figure can be accounted for by the fact that a significant proportion of the world's population in 'less developed' countries burn biomass for all their energy requirements. However "awareness of biomass is very low, with 94% of respondent saying that they had never heard of it." [2]

The advantages of biomass over other renewable energy sources, is that biomass can replace fossil fuels in all three sectors of the energy market: heating and process fuels, electricity generation and transport fuels, whereas most other renewable energy sources cannot. As Biomass is a fuel, its supply is schedulable unlike other renewable energy sources, for example wind or solar power, which are dependant upon external factors such as the weather. Developing the Biomass market also has significant potential in terms of rural job creation, which other renewables do not.

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[1] Renewable Energy World, July 2005
[2] Renewable Energy World, July 2005

2.4 Key sources of Biomass in the UK

2.4.1 Energy Crop

An energy crop is a plant domesticated for use in agriculture, produced at low cost and low maintenance because the crops recycle their own nutrients and do not need fertiliser. Energy crops are harvested to make bio-fuels or directly exploited for their energy content by burning. Dedicated energy crops in the UK include:

***Short Rotation Coppice (SRC) Willow* –** A robust fast growing tree, which grows to a height of 3-5m after 3years. Harvested in late winter or early spring when there is no leaf mass every three years after initially being cut back in the first year. Yielding approximately 30 oven dried tonnes (ODT) per hectare every three years, an average of 10 ODT per hectare per year. Once dried it is used to produce woodchip and wood pellet.

***Miscanthus* -** A robust, fast growing Asia grass which grows to a height of 2-3m. Harvested annually in late winter spring producing dry matter yields of 12-14 ODT per hectare, which can be bailed, cobbed or pelleted.

2.4.2 Forestry Round Wood

Forestry round wood is harvested from managed forests. Once seasoned round wood can be processed into woodchip or wood pellet.

2.4.3 Waste wood

***Sawmill co-products* –** Sawmills typically recover only 40-60% of logs to produce timber. The waste slab wood and sawdust was traditionally sent to landfill or partially used for animal bedding respectively. The slab wood however is ideal for chipping, whilst the sawdust is ideal for wood pellet production.

***Reclaimed Timber* -** The construction industry generates thousand of tonnes of waste wood annually of which most was traditionally sent to landfill at a price. Whilst there are issues of removing/dealing with contaminants, such as nails, glue and paint, reclaimed timber provides a low moisture and low bark content wood source ideal for producing wood pellets.

2.4.4 Wet Agricultural Waste

The waste from livestock, primarily pigs and cattle, can be utilised through anaerobic digestion, producing biogas (methane), which can then be burnt to drive electrical turbines producing electricity.

3. Power Generator Demand for Biomass

The current demand for biomass from power generators in the East Midlands is approximately 300,000 ODTPA. This is estimated to increase six times over to 1,988,000 ODTPA by 2010, however the majority of this biomass will be imported.

3.1 The History of Biomass in the East Midlands

The East Midlands is at the forefront of the UK power generation biomass market due to the ARBRE (Arable Biomass Renewable Energy) project and concentration of power generators in the region, driven to burn biomass by the Renewable Obligation Certificates (ROCs) introduced in 2002.

The pioneering ARBRE project at Eggborough, Selby, North Yorkshire, encouraged farmers in the region to plant Short Rotation Coppice (SRC) during the 1990s. Whilst the project failed, due to technical difficulties, leaving an uncertain future for regional SRC growers, the combination of the introduction of national Renewable Obligation Certificates (ROCs) in 2002 and the concentration of large coal fired power stations (Cottam, West Burton, Ratcliff-on-Trent and Selby) in the East Midlands, has created a significant market for biomass in the region.

3.2 ROCs and Biomass Demand

Whilst the structure of the ROC system rewards UK grown EnergyCrop (one ROC per MWh) more favourably than imported biomass (a quarter ROC per MWh), the demand of power generators is so large that UK supplies simply cannot meet this demand. As a result 95% of biomass currently co-fired is imported.

With ROCs guaranteed until 2027 and with the total percentage of energy that power generators are obliged to produce from renewable sources being set to increase along a sliding scale until 2027, energy providers are conveying the message that they will take whatever the domestic energy crop market can produce. However whether the price they pay for energy crop can compete with the current high cereal prices is debateable. This demand, whilst distorted by policy drivers, does though provide a stable base market for biomass in the East Midlands and the UK, guaranteed until 2027.

3.3 Cottam and West Burton Power Stations – (EDF Energy)

The West Burton and Cottam co-firing coal and biomass Power Stations, both owned by EDF Energy, are located less than 15mins apart just outside Retford, alongside the River Trent. Their combined annual biomass consumption is in the region of 100,000 tonnes, estimated to produce approximately 150GWh of renewable energy per annum, with a roughly equal share between the two stations.

95% of the biomass is imported, including SRC, olive cake, wood pellets, sunflower husk pellets, shea meal pellets. Currently their only UK supplier is JD Strawson, supplying Willow Coppice woodchip, but they have a contract for miscanthus with Bical starting in 2010. As such the percentage of biomass they source from the UK will increase from 2010. A spokesperson for EDF said that they would take other supplies from the UK, but suitable products have not been forthcoming.

EDF were unwilling to speculate publically about their future consumption of biomass. However they did disclose that the current percentage of energy produced from biomass at Cottam and West Burton relative to total energy produced was 1-2%, but they are aiming for 3% by 2010. As such it could be inferred that there is a potential for a doubling of their biomass consumption, however this is unconfirmed.

3.4 Ratcliffe-on-Soar Power Power Station – (E-on)

At the Ratcliffe-on Soar Power Station, owned by E-ON, there is no biomass co-firing at present. However the power station is currently undergoing a refurbishment over the next 8 years, which includes plans to introduce a new biomass co-firing system. E-on would not speculate about exactly when the plant is predicted to begin co-firing or the projected volume of biomass that would be consumed, but confirmed that the likelihood of this system being installed within the next 3years is high and that a substantial volume of biomass that would be consumed.

3.5 Burton-on-Trent Woodchip Power Station – (E-on)

E-ON are however currently in the process of developing a 3MW woodchip electrical generation facility at Burton-on-Trent in Derbyshire due to be operational by 2010. This facility is predicted to require 25,000 ODTPA of locally sourced woodchip.

3.6 Selby Power Station – Drax

The Drax Co-fired Coal and Biomass co-firing Power Station, whilst just outside of the East Midlands, located at Selby, North Yorkshire is a crucial aspect of the UKs developing biomass market. Drax produce roughly 8% of the UK's electricity and is the largest power station in Europe. At present it co-fires approximately 10 million tonnes of coal and 200,000 ODTPA of biomass, with biomass estimated to produce 1~1.5% of their total energy output.

The majority, 95%, of the biomass burnt is imported and includes, SRC, olive cake, wood pellets, sunflower husk pellets, shea meal pellets. Their largest UK supplier is Renewable Energy Growers (REG), alongside supplies from Strawson, Bical and Coppice Resource Ltd.

Drax plan to increase the volume of co-fired biomass from the current 200,000 ODTPA to 1.5million ODTPA by 2009, in turn increasing their biomass energy output from roughly 1% to 10% of their total output. Whilst Drax confirmed that they are keen to support local growers, the supplies in the UK aren't sufficient to meet this demand, thus most will continue to be imported. They hope to develop a system whereby biomass can be delivered by rail in a similar way to how coal is delivered already, as they can't accommodate the huge increase in road haulage that would be required to meet these targets.

3.7 Sleaford Renewable Energy Plant – Eco2 Ltd

The Sleaford Renewable Energy Plant is a proposed 40MW Straw-Fired Power Station to be built at Sleaford, in the heart of Lincolnshire. If successful this will be the largest Straw fired Power Plant in the world, taking over from the 38MW Straw Fired Power Station in Ely Cambridgeshire commissioned in 2000 and upon which the project is modelled (N.B both stations were set up by the same company, however they have changed name in between the two projects).

The Planning application was submitted to North Kesteven District Council on the 11.09.07, accompanied by a full Environmental Statement that covers all aspects of the plant, including transportation, landscape and visual impact, ecology and nature conservation, noise, air quality, archaeology and heritage. Initial support for the project was high and Andrew Toft, the Commercial Director of Eco2 Biomass, is confident that the power station will be up and running by 2010.

The power station is estimated to require 238,000 TPA of straw per annum to maintain a thermal input to the electrical generator of ~120MW, producing an electrical output of 40MW and in turn approximately 280GWh per annum.

The cereal straw for the plant is to be sourced from Lincolnshire, stated on the Eco-2 website as "the heart of the bread-basket of England", with supply contracts estimated to be in the region of £6million per annum. According to Andrew Toft, government figures estimate there to be 3 million tonnes of cereal straw on the market in the UK annually, with relatively limited demand. As such he argues that there is the potential for up to four 40MW Straw-fired Power Stations to be operational before existing straw markets will be affected.

3.8 Current and Future Demand for Biomass from Co-firing Power Generators

The current demand for biomass from co-firing power generators in the East Midlands is predicted to increase from the current 300,000 tonnes per annum (ODTPA) to 1,988,000 ODTPA by 2010, principally due to Drax's plans to increase their co-firing from 200,000 ODTPA to 1,500,000 ODTPA by the end of 2009.

Power Station	Current Annual Demand-2007 (ODTPA)	Predicted Future Annual Demand - 2010 (ODTPA)
Cottam Power Station (EDF)	50,000	100,000

West Burton Power Station (EDF)	50,000	100,000
Radcliffe-on-Soar (E-on)	0	25,000
Burton-on-Trent (E-on)	0	25,000
Selby (Drax)	200,000	1,500,000
Sleaford	0	238,000
Total	300,000	1,988,000

Figure 1 - Table to show current and predicted future demand of co-firing power generators.

Whilst the majority of this biomass will be imported due to the inability of UK supplies to meet such demand, all power generators conveyed the message that they would take as much supply as the UK market could produce, however at what price is debatable.

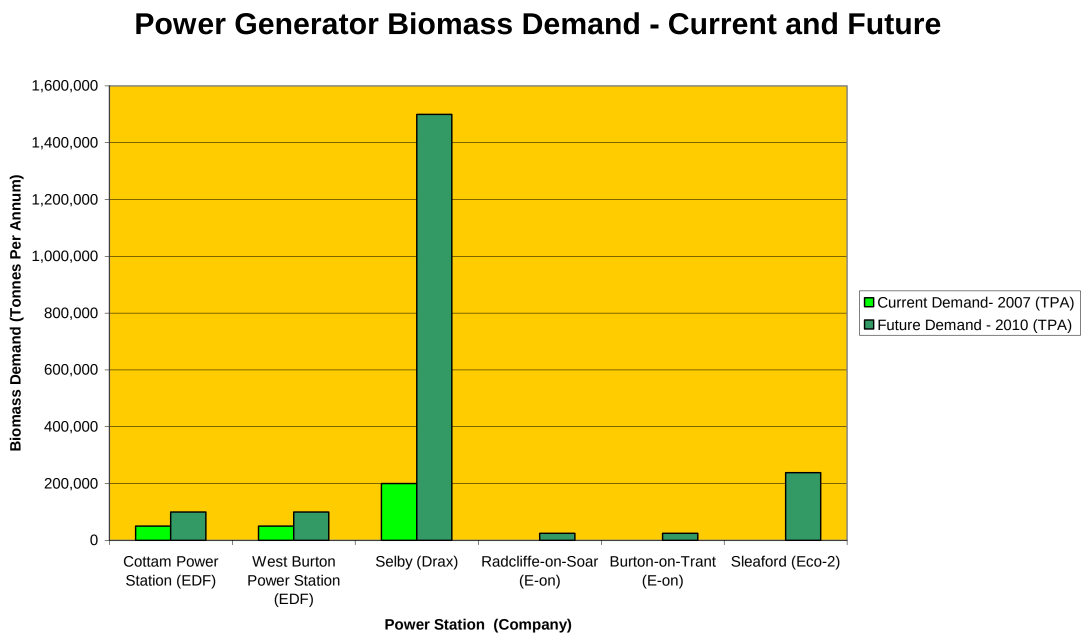

Figure 2 - Bar Chart to show the current and future biomass demand from power generators.

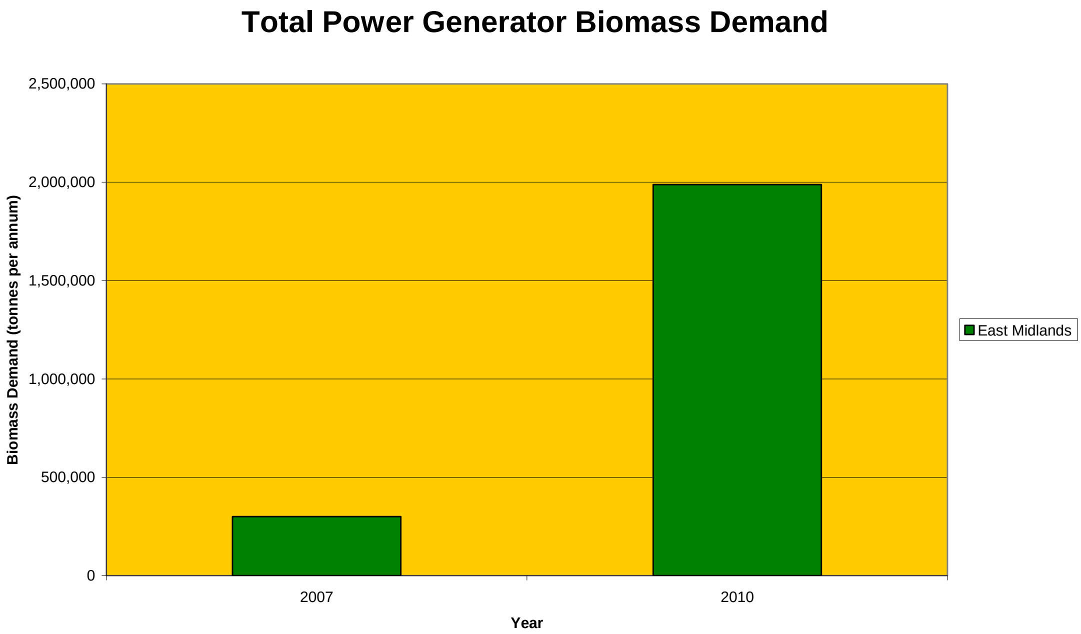

Figure 3 - Bar Chart to the total current and future biomass demand from power generators.

4. Biomass Boilers and Biomass Demand

There are an increasing number of biomass boilers being installed throughout the East Midlands in both the public and the private sector across the entire range of scales, from domestic boilers <50kW to industrial heating boilers up to 3500kW (3.5MW). The capacity of biomass boiler installations in the region is set to double by 2010, from 30,000kW to 60,000kW based on the information collected, leading to an estimated increase in biomass demand from approximately 17,500 ODTPA to 35,000 ODTPA.

The installation of biomass boilers has been led by certain areas of the public sector with grant schemes and installations in their own buildings. However such activity has not been uniform, with only a handful of councils having actual policy or grant schemes implemented.

Increasing numbers of biomass boilers are also being installed in the private sector, particularly in industrial facilities, for example a 2MW heating system for a glasshouse in Lincolnshire and by high-end domestic users with sizeable heat requirements and a commitment to renewable energy. Demand from the private sector is again non-uniform, seeming to mirror public sector demand, with Nottingham, Leicestershire then Lincolnshire exhibiting the first, second and third highest concentration or installations respectively.

Such concentrations of biomass installations, evident by the difference in county level installed and proposed installations, are undoubtedly linked to public sector schemes alongside individual biomass suppliers and boiler providers promoting the fuel and the technology in their local area, for example Rural Energy Limited in South West Leicestershire.

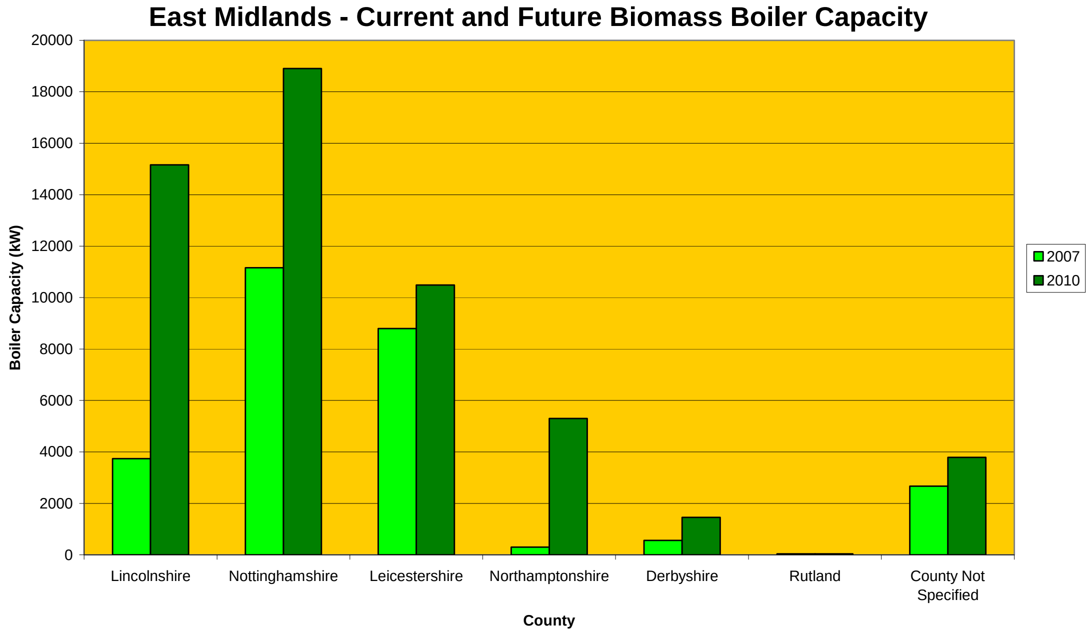

Figure 4. Bar chart of current and future Biomass Boiler Capacity

County	Currently Installed Boiler Capacity (kW)	Proposed Boiler Capacity by (kW)
	2007	**2010**
Lincolnshire	3740	15155
Nottinghamshire	11164	18902
Leicestershire	8798	10488
Northamptonshire	300	5300
Derbyshire	560	1460
Rutland	40	40
County Not Specified	2665	3790
Total	27267	55135

Figure 5. Table of current and future Biomass Boiler Capacity

Based on these figures estimates about the biomass demand can be made using calculations used by boiler manufacturers when quoting customers. (See Appendix 8.1)

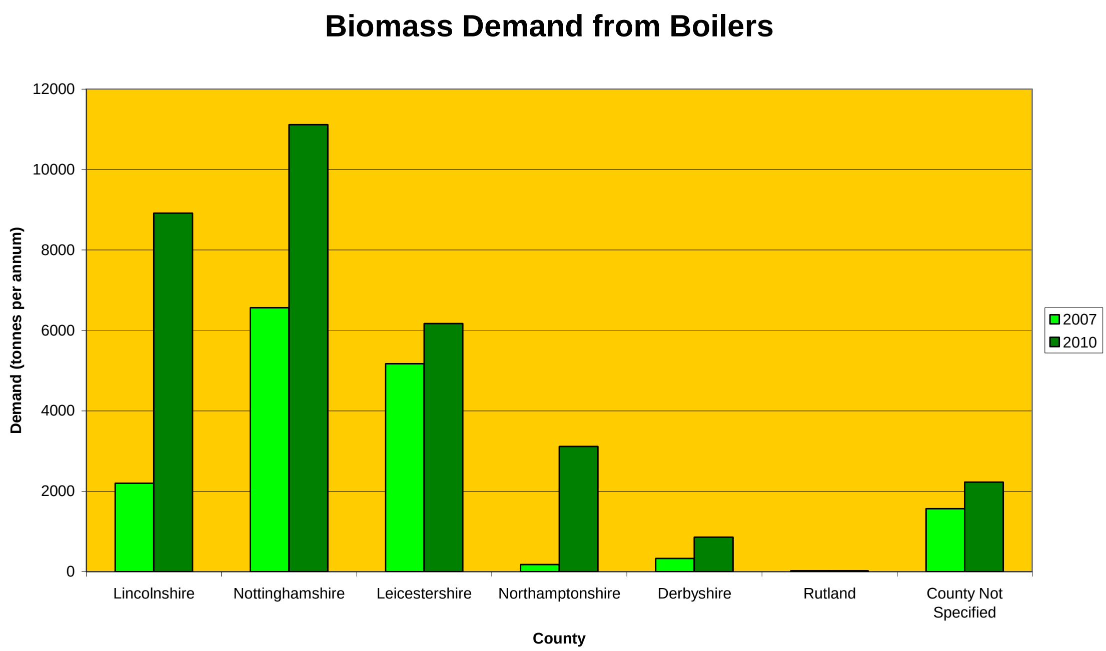

Figure 6. Bar chart of current and future Biomass Demand from Boilers

A number of very large 10-30MW private sector installations are also proposed. Whilst such examples are outside of the East Midlands, they are of particular interest as they highlight the potential of large projects that could be replicated in the East Midlands.

4.1 The Public Sector

The public sector has played a key role in developing the biomass boiler market in the East Midlands. However such activity has not been uniform.

Nottingham and Lincolnshire public sector bodies have been the most proactive. Whilst Leicestershire public sector bodies have been active, the majority of systems installed have been initiated by Rural Energy Trust a private biomass consultancy based in Leicestershire. Derbyshire and Northamptonshire, whilst conducting feasibility studies into biomass have no dedicated policy and very few installations to speak of.

Whilst all County, District and Borough Councils stated that they are currently considering biomass in relation to government led debate over issues of sustainability, renewable sources of energy and carbon footprints, only a handful have made significant progress in terms of implementing strategies to achieve actual installations. However the impact of those that have, for example the 'Lincolnshire County Council LIGHT' project and the 'Nottinghamshire County Council Woodheat Project' have been crucial, with private installations seeming to follow on from their example. If such schemes can be replicated throughout the public sector the potential for new installations would be considerable.

Key council facilities suitable for biomass include secondary schools, leisure centres and retirement homes all of which have high heat energy requirements. Incorporating biomass boilers into new builds also offers one of the best means to develop the most appropriate storage and delivery facilities.

As such of particular interest is the 'Schools for the Future' programme currently underway across the UK. With the recent government announcement of plans to award a £500,000 top up to each development for use on incorporating sustainable technology into the projects. As such the potential for a significant number of sizeable biomass boilers could be installed within the next 10years throughout the East Midlands.

4.1.1 Nottinghamshire

A. Nottinghamshire County Council – Woodheat Project

Nottinghamshire County Councils Woodheat project has led to 20 schools converting their existing coal boilers to biomass or installing new biomass boilers in schools throughout Nottinghamshire; ranging in size from 90kW to 2.2MW and with a combined heat capacity of 7MW. A further 16 schools are also due to change to biomass by 2009, creating some further 4MW of output.

The conversions of traditional coal boilers have been particularly cost effective, with a customised conversion costing about one fifth of the price of a completely new system. Conversion also on average improves the boiler efficiency by approximately 30%, (55% to 85%). Such conversions typically involve modifications to the fuel bunker and control system. The fuel bunker and feed mechanisms are modified to allow them to use wood pellets instead of coal, while the control system is upgraded to measure the oxygen content of the flue gases and vary the flow and pellet feed rate accordingly. They have experienced some issue of dust from pellets, pellets becoming jammed in the feeding mechanisms and poor quality pellets. However such issues have been overcome, with silo storage and higher quality pellet supplies being used.

Representatives from the Woodheat Project identified how it was often difficult to get school governors to "see beyond the bottom line, often being put off by the higher initial capital costs. They argue however that 'with biomass boilers there are indeed higher initial capital costs, but in the long run the energy cost savings speak for themselves.'

Whilst the Woodheat project offers support funding to schools changing to Biomass, with grants offering 36% of the difference in cost between gas and woodfuel, the cost difference remains the key barrier to entry for many schools.

B. Newark and Sherwood District Council Policy

Newark and Sherwood District Council have introduced a policy that every boiler in council property due for replacement by default must be replaced with a biomass boiler. That is unless through a special application process it can be justified that installation of a biomass boiler is not suitable. For example, installing a biomass boiler in a terraced house may not be feasible due to the relatively large size of the boiler and the volume of onsite storage capacity required for biomass. In such instances special permission will be granted to allow installation of a traditional, but energy efficient oil boiler instead.

Whilst at present in Newark and Sherwood there are almost no boiler due for replacement in the next 6-7years, the potential for future installation of biomass boilers beyond this time frame is significant.

Newark & Sherwood's Energy officer, David Pickles, indicated that his future ambitions were for this policy to be introduced across all districts throughout the Nottinghamshire County and hopefully into neighbouring counties and beyond. As such, there exists a potential wide-reaching and sizeable increase in the future demand of biomass throughout the East Midlands public sector property stock if such a policy is more widely adopted.

4.1.2 Lincolnshire

Lincolnshire County Council introduced 'The Lincolnshire LIGHT project' to kick-start the use of biomass renewable energy in the county of Lincolnshire. The project offers an advisory service, demonstrations, training and capital grants for boiler installations.

The project has run for 2 years and has provided advice to individuals and organisations, produced feasibility studies, organised a conference attended by 200 delegates and provided capital grants for 27 new biomass installations. Due to its success the scheme is currently being considered for continuation.

4.1.3 Leicestershire

Currently Leicestershire county council have seven schools running biomass boilers, however they have no policy or programme promoting biomass as such. These schools have taken it upon themselves to install biomass, some of which have been through cooperation with Rural Energy Trust and Rural Energy Limited.

The Energy Officer, Melvin Harrisson is however thinking of making a targeted approach to all schools and council buildings with coal boilers about the possibility of them converting to pellet. In his opinion, conversion is a much more appropriate option than the installation of new biomass boilers because of the high capital cost of biomass boilers. Conversion of old coal boilers can be achieved at costs in the region of £5,000, whilst a new biomass boiler could be upwards of £25,000.

4.1.4 Derbyshire

At present Derbyshire County Council only has one 150kW biomass boilers installed and they don’t have any grant schemes in place to encourage the use of biomass. They are however considering further installations, with tenders out at present for three 400kW biomass boilers to heat three schools. They are also thinking about plans to promote the use of biomass in the future. They do however conduct feasibility studies into all fuels currently available for any new public development, including all traditional and renewable options, thus there is potential.

The 150kW biomass boiler installed is at the Markum Vale Environmental centre. The Centre is the flagship business centre for the Markham Vale business park, an 85ha business park development that is hoped to bring about 5,000 new jobs to the area and £130 million of private investment and also transform the old colliery site, through environmental landscaping, new planting, trails and the creation of habitats for plants and wildlife.

This boiler is fuelled from 60ha of willow grown on the colliery tips. The willow grown not only provides a renewable source of fuel, but also controls leaching and stabilises the slopes. The fuel from this 60ha has the potential to fuel a possible 6 boilers of a 150kW capacity.

4.1.4 Northamptonshire

The County Council are only aware of one proposed biomass boiler installation at present, but they are looking into policy to promote renewable energy sources. This is exemplified by the Core Strategy Planning document currently being issued, outlining plans for all new developments to source at least 30% of their energy from local renewable energy supplies. This is of particular interest with respect to the large scale developments planned for Northamptonshire as outlined below.

West Northamptonshire Development Corporation (WNDC)

WNDC is tasked with facilitating the delivery of 37,000 homes, 37,000 new jobs and regenerated town centres of Northampton, Daventry & Towcester by 2021

In Daventry there are a proposed 6-7,000 new homes to be developed, doubling the population from 20,000 to 40,000 by 2021. Daventry District Council is heavily involved in the promotion of sustainable development and has commissioned a feasibility study for the use of biomass in the proposed new development, which is being conducted at present. As Gary Underhill outlined, biomass is the preferred renewable energy source as unlike other sources of renewable energy it provides the opportunity to support the local rural economy. As biomass is intended to be sourced from the surrounding 25 mile radius, the potential rural job creation is significant.

4.2 The Private Sector

The installation of biomass boilers in the private sector is increasing in the East Midlands, particularly in industrial facilities and by high-end domestic users with sizeable heat requirements and a commitment to renewable energy.

Demand is again non-uniform, seeming to mirror public sector demand, with Nottingham, Leicestershire then Lincolnshire exhibiting the first, second and third highest concentration of installations respectively. This can partially be attributed to the fact that such installations are often linked to Public capital cost grant schemes, for example the Lincolnshire County Council LIGHT project, but not exclusively.

A number of large private investments into biomass heating and power generation systems are also evident, driven to varying degrees by inherent energy cost savings, individual commitment to renewable energy and the opportunity to gain a comparative advantage over competitors by increasing companies' or facilities' green credentials. For example the installation of biomass heating systems at the Hexgrave Hall Business Centre, Nottinghamshire was driven by all such factors.

Examples of very large heating systems, for example a 30MW Biomass and Gas district heating system in Bedfordshire have been identified. Whilst outside the East Midlands they provide an indication of private interest in biomass schemes and the potential for the replication of such systems in the East Midlands in years to come.

4.2.1 Industrial Facilities

The installation of a number of large biomass boilers in privately owned industrial facilities and applications throughout the East Midlands highlights the potential of similar schemes being introduced in the future. Such installations are ideal for biomass systems with large relatively constant heat requirements on sites with good access and room for the development of onsite biomass storage facilities. For example:

Warehouses, Burrough Court, Leicestershire 200kW
A 200kW woodchip boiler, installed by Rural Energy Limited provides heat to several large warehouses and a group of offices, burning an estimated 120 ODTPA of woodchip.

Bells Brother Nurseries, Boston, Lincolnshire 2MW
A 2MW woodchip boiler provides heat for a series of glasshouse growing bedding and flowering pot plants, burning an estimated 1500 ODTPA of woodchip.

ELYO Suez, Pilgrim Hospital, Boston, Lincolnshire 2.5MW
A 2.5MW woodchip boiler installed to heat the hospital complex.

4.2.2 High End Domestic Users

A number of "High-End domestic users" i.e. those with large heat requirements, a commitment to renewable energy and the means to cover the high capital cost of biomass boilers, have also been identified in the East Midlands.

With growing awareness of the rising cost of fossil fuels, issues of fuel security and benefits of biomass this again provides an example of an area where the more biomass installations can be expected.

4.2.3 Large Proposed Biomass Systems

Sustainable Technology Solutions Limited 5MW, Northamptonshire
This consultancy firm outlined a 5MW woodchip system in the final stages of planning, but refused to confirm the name of the client they are working for.

Singleton Birch Ltd 8MW Biomass Powered Lime Kilm, Lincolnshire
Singleton Birch Ltd own a lime Quarry, Melton Ross Quaries, in North Lincolnshire and currently operate four large Lime Kilns. They are currently developing a fifth Kiln proposed to be Miscanthus fired. If all goes to plan the 8MW kiln, within the next five years, will be operational 365 days a year at high capacity requiring in the region of 25,000 ODTPA of Miscanthus.

A number of other interesting private projects identified in this study, whilst outside of the East Midlands, provide an indication of projects that could potentially be replicated in the region. For example there is a proposed 30MW Biomass and Gas district heating system for a 3,000-4,000 home development in Bedfordshire in the final stages of planning. With large housing development projects underway in the East Midlands, for example plans to build 37,000 new homes in Daventry, the potential for the incorporation of large district biomass heating systems is substantial.

The growth of Combined Heat and Power (CHP) Biomass systems is also expected as the technology, previously marred by technical difficulties has begun to prove itself. For example Talbots[1] are now installing their BG100 CHP system (currently 5 in the UK), providing 100kW electrical and 200kW thermal output throughout the country. If they prove reliable, their size makes them ideal for wide range of industrial applications including swimming pools and factory buildings, again providing further potential for the growth of the biomass market demand in years to come.

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[1] **Talbotts** – A UK boiler supplier.

4.3 Boiler Suppliers

Speaking with a wide number of boiler providers throughout the East Midlands and UK, as most operate nationally, the general consensus is that they are working 'flat out' and are confident that there will be considerable growth in sales over the three years. For example speaking with Mr Dagley, the Marketing Director of Hoval, he believes "the next two-three years will be the key growth period" for the biomass heating sector, with the "present interest and number of orders increasing exponentially driven by the rising price of oil, government policy and low carbon building legislation. However it must be noted that there exists an inherent lag-time between the decision to install a biomass boiler and when it becomes operational. This long gestation period before installations is due to the fact that planning permission for new developments or fuel storage facilities is more often than not required.

Boiler suppliers highlighted that biomass boilers sell well into areas with historic coal use, such as the East Midlands, as customers are used to deal with solid fuel and many buildings still have old coal bunkers which can be used for biomass storage. For example a significant number of schools in Nottingham who installed boilers in conjunction with the Nottingham woodheat project converted coal boilers to biomass and modified coal bunkers for biomass storage. Also acknowledged was the fact that biomass boiler installations are, and will, continue to be driven forward by the Public sector, as they have the ability to introduce policy based on renewable obligations and then stick to them without being swayed by differences in the bottom line costs.

There are a wide variety of boiler systems available on the UK market, the majority of which are imported from Europe. There are a whole host of different sizes, specifications and additional features such as electronic control systems, automatic de-ashes and flue condensing systems, not to mention the different mechanical fuel delivery systems, fuel agitators and storage facilities. As a result of this the onus is often very much on the customer to ensure that they are getting the system most suitable for their needs, alongside obtaining like for like quotes from different suppliers. To date firms such as, Rural Energy Trust or Sustainable Technology Solutions Limited have operated as consultancies aiding customers to navigate the plethora of products available on the market as well as providing design solutions for their installation. There is evidence that the continental boiler suppliers are looking more closely at the UK to develop both boiler supplies and consultancy. All consultancy firms spoken to confirm the increasing demand for biomass installations and too predict significant growth in the market over the next three years.

4.5 Barriers to Biomass Boiler Installation

Whilst all boiler suppliers and consultancies predict significant growth in the market they recognise the fact that the key concerns of potential customers are the high capital costs and securing a quality fuel supply.

Biomass boilers do have inherently higher capital cost than traditional systems and boiler suppliers recognise that this is the principle reason why many customers after investigation into biomass do not go through with installing a system. As such they see the opportunities offered by capital grant schemes to reduce the initial costs as an integral part of continued development.

In terms of securing a quality fuel supply a whole host of factors must be considered (discussed in section 5 & 6). However customer concerns highlight the fact that the supply of biomass, whilst improving, still does not have an established enough supply chain or assurances of quality sufficient for some customers. This however comes back to the 'chicken and egg' conundrum of what comes first the supply of or the demand for biomass - alongside issues of communication and links between those supplying biomass and those who require a supply.

5. Maps of Current and Predicted Biomass Demand

The following maps serve as a visual representation of the information gathered upon the current and future demand for biomass within the next three years across the East Midlands, but should not be taken to be geographically exact.

Whilst the majority of installed biomass boiler locations are accurate in some cases they can only be approximate due to the nature of the information received. For example boiler suppliers were often only able to disclose broad location details about systems that they had installed due to issues of consumer confidentiality. Similarly for proposed biomass boilers whilst we were able to gather precise locations for a significant number of proposed installations, we were unable to get exact location details for all. As such the following maps should only be used as a approximate guide to the regional demand for biomass across the East Midlands.

Note, although the maps were plotted at a scale of 1:250,000, the printed documents are not to scale.

The size of circle represents the boiler/co-firing capacity and thus demand for biomass. Not the area of biomass required to supply the installation, nor the area from which biomass would be sourced. See table below for reference to approximately what weight and thus what planted area of biomass would be required to supply a boiler of specific size. Obviously the amount of biomass a boiler requires will vary depending upon its use. However for rough estimates boiler manufacturers generally use an average figure of 1500 full load hours equivalent (FLHE - the number of hours at which the boiler is run full bore) per annum, upon which the figures below are based.

Boiler Size (KW) (N.B 1000KW = 1MW)	Weight of Biomass Required per annum (Oven Dried Tonnes)	Grown Area of Biomass required per annum (Hectares)	Grown Area of Biomass required per annum (Acres)
5	3	1	1
10	6	1	1
20	12	1	3
50	29	3	6
100	59	5	13
200	118	10	25
500	294	26	63
1,000	588	51	126
2,000	1,176	102	253
5,000	2,941	256	632
10,000	5,882	512	1,263
20,000	11,765	1,023	2,527
50,000	29,412	2,558	6,317
100,000	58,824	5,115	12,634

Figure 7 - Table to show Weight and Area of Biomass Required for Specific Boiler Size
(Based on 1500FLHE, Woodchip at 35%MC and 11.5 ODT of Biomass yield per hectare).

6. Biomass as a Fuel

The key sources of biomass in the East Midlands are from energy crops, SRC and Miscanthus, forestry round wood and reclaimed timber. The moisture content of woodfuel is crucial because as the wood dries the moisture content falls, but the calorific value increases.

For supply to the biomass boiler market the key debate surrounds the associated pro's and con's of woodchip versus wood pellet. Woodchip has much lower production costs and embodied carbon than pellets, but a lower calorific value per weight and volume, which makes woodchip less economical to transport and less suited to smaller boiler installations, <200kW, than pellet.

The economics of producing pellets from energy crop or forestry stem wood are questionable with the majority of respondents highlighting the fact that such pellets cannot compete in terms of cost with imported pellets produced from sawmill co-products and are unlikely to be competitive with pellet produced from reclaimed timber.

6.1 Moisture Content of Woodfuels

When harvested, wood fuels have a moisture content (MC) in the region of 50%. However as the woodfuel dries, the MC falls, but the calorific value of the woodfuel increases. This is because when burnt there is less energy wasted heating the water. As such the energy output of burning green wood, 50% MC is much lower than burning seasoned round wood (35% MC). Chipping round wood allows it to dry further, to 20-25% MC increasing the calorific value again, whilst pelleting drives the moisture content down to 12-15% MC increasing the calorific value even further. As such the lower the MC of the biomass the larger the kilowatt hour energy output per tonne. As such when considering biomass it is important not to think solely in terms of the weight of biomass, but at what MC the material is at and thus how many kWh of energy you have.

Fuel	kiloWatt/hour (kWh)
Woodchip (50% MC)	2100 per tonne
Woodchip (35% MC)	3000 per tonne
Woodchip (25% MC)	3750 per tonne
Wood Pellet (12%MC)	4700 per tonne
Wood-Oven dried (0% MC)	5200 per tonne
Heating Oil	10.6 per litre
LPG	7.8 per litre

Figure 8 Table to show relationship between MC and kWh

The MC of woodfuel is also important when considering the economics of transporting woodfuel. For example if you're delivering 10 tonnes of woodchip at 35% MC, you're delivering 30,000kWh of energy, but 35% of the load by weight is water and 60% by volume is air. Further as MC falls, biomass density decreases and thus volume per weight increases. As a result to deliver equivalent amounts of energy, a much greater volume of woodchip is required than wood pellet, since woodchip has a higher MC, a lower calorific content and a much lower density.

6.2 Woodchip versus wood pellet

Whilst woodchip is much cheaper and has significantly lower 'embodied carbon'[1] than pellets woodchip has a much lower density and thus a lower calorific value per volume. This in turn makes it uneconomical to transport woodchip over long distances. Likewise a greater number of deliveries or larger onsite storage facilities are required for woodchip boilers. Achieving uniform particle size and moisture content is also more difficult in the production of woodchip than in pellet.

Woodchip also has poor flow characteristics and more variable particle size than pellet, resulting in more sophisticated fuel delivery systems and more regular boiler maintenance being required. This obstacle is why some boiler producers, for example 'Hoval', strongly advise the installation of pellet systems as they believe that "they cannot guarantee their high standards of performance with woodchip."[2]

Whilst woodchip systems are indeed feasible, the view of many boiler suppliers and commentators is that due to such issues, woodchip boiler systems are only viable for installations upward of 200kW, on sites with plenty of storage space and good access that are ideally within a maximum of a 30 miles radius from the fuel source. For example rural schools, leisure centres, glasshouses and industrial facilities are perfect for woodchip, with large heat requirements, open space for the development of storage facilities and a proximity to fuel supplies. Domestic users or city centre offices for example are not suited to woodchip, due to low energy requirements and more difficult access at distance from fuel sources. In such cases Pellet systems are more applicable.

6.3 Economics of Pelleting

The economics of and the quality of wood pellets produced from UK woody Biomass has been questioned by numerous respondents. Woody biomass, harvested at 50-60% moisture content must then be dried, then chipped and then pelleted - all with associated

[1] **Embodied Carbon** – The total amount of carbon released over the entire life cycle of a product. Including its production, distribution, use and disposal.

[2] Quote from Ian Dagley, Hoval Sales Director.

costs. The cost of this production process is argued by some, for example John Strawson, Managing Director of 'Koolfuel Ltd', to be uncompetitive with pellets produced from sawmill co-products in Europe and America, despite the additional cost of importing them. In such facilities, which are numerous in these regions, the waste sawdust, already dried and with very low bark content, is in an ideal form for the production of wood pellets without any additional processing costs.

Similarly, the waste wood pellet market is also developing and offers potentially better economics of production to that of energy crop. Waste wood, primarily from the construction and demolition industry, offers qualities similar to sawmill co-products, with the already dried and low bark content wood being ideal for pellet production once contaminants such as nails have been removed. Whilst dealing with contaminants such as nails, glue and paints prove challenging, it is certainly worth developing. Due to the present cost of sending such wood to land fill, which is where the majority is sent, contractors are paid to take it away. This offers very different economics of producing pellet compared to that of energy crops, where the crop must be paid for initially. One respondent in the East Midlands is currently developing his waste wood pelleting plant and is hopeful to produce 25 tonnes of pellet an hour once his technology has been fully refined. Such pellets are likely to be on the Market by 2010.

Despite some respondents claiming that it was impossible for the pelleting of energy crop to stack up, other respondents, for example 'Bio-joule' and 'CJGrain' were confident that they can produce wood pellets from SRC and Miscanthus at a competitive price. However as of yet they have produced low volumes and future results remain to be seen.

7. Future Supply of Biomass

With the demand for biomass evidently growing, the question is now can supply meet this growing demand. At present the demand from co-firing is no-where near being met from UK biomass supplies, with 95% of it imported. With this demand set to increase six times over by 2010, this ratio is likely to be maintained. However meeting the demand of co-firing should not be the ambition of the UK biomass market. ROCs were introduced to encourage the investment in and the development of renewable energy supplies. Ultimately with the aim to remove them once the renewable energy market has developed. Initially introduced up until 2016, ROCs were extended up until 2027 under their review in spring 2007. Thus whilst co-firing provides a stable base to the biomass market up until 2027, this demand cushion should be used to aid the market develop and allow time for alternative biomass schemes to be installed.

With the demand from biomass boilers set to at least double over the next three years increasing the supply of biomass is essential and opportune. Increasing the volume of Energy Crop, Forestry Round Wood and Waste wood, carries a number of obstacles however, that must be overcome.

The current commodity prices have made farmers reluctant to diversify into energy crop production. However energy crop should not be grown on prime cereal land but there remains the potential for some increase in the volume of energy crop produced on more marginal land. The problems created from the reduction in planting grants will however need to be addressed

The Forestry Commission believe that nationally they can bring an additional two million tonnes (90,000tonnes in the East Midlands) of FRW to market, annually, by 2020. This would be achieved through the management of un-managed and under-managed woodland. Whilst the potential supply of biomass from this source is not a major issue, extraction may be as developing a whole new dedicated supply infrastructure is required. Possibilities exist for existing SRC groups to assist in developing the FRW infrastructure.

Whilst the potential supply of biomass pellets from waste wood is significant developing machinery to process waste wood, especially of the reclaimed variety poses a significant challenge.

7.1 Energy Crop Supply

7.1.1 Current Energy Crop Supply

There are currently approximately 2,000ha of SRC planted in the East Midlands. These have principally been planted by two cooperatives, Renewable Energy Growers (REG) and Coppice Resource Limited and one individual, Mr John Strawson - the largest individual grower of SRC in the UK. East Midlands SRC produces an estimated 18-20,000 ODTPA of woodchip of which the majority is currently co-fired.

Bical inform us that they have 3,500 ha of Miscanthus planted in the East Midlands and 12-13,000ha across the UK. This equates to an estimated annual yield of 45,000 ODT in the East Midlands. However the majority of this crop has only been planted in the last two years. As such very little has come to market, because of the two years it takes to establish the crop, making it difficult to establish their market size. The majority of Miscanthus grown by Bical is contracted for co-firing, however they are now looking into opportunities for pelleting.

7.1.2 Key Producers

Mr Strason (Koolfuel) - Mr John Strawson was one of the leading promoters and investors into the UK biomass market being the largest individual grower of energy crop for project 'ARBRE'. Despite its failure, he continued to invest in and promote the sector bringing industrial technology, knowledge and lessons back from the more developed biomass markets in

Europe. With 333ha planted at present and a additional 30ha due to be planted next year, he is the largest individual producer of SRC in the UK, supplying 3,500 ODT of woodchip annually.

The harvested willow is processed, into a ‘granular’ woodfuel, which he then sells to local power stations and customers with woodchip biomass boilers. He believes the UK biomass market will be driven by pellets due to their more economical transport and storage, but having invested significant amounts of time and money into developing a biomass pelleting facility, he now imports pellets sourced from sawmill co-products. He does however believe that the market for his woodfuel is growing and that he could supply 10 times the amount he does at present.

Renewable Energy Growers (REG) - is a co-operative producer group with 50 members set up in the wake of project ARBRE. REG currently has 1,150ha of SRC willow on its books, producing 7,000 ODT of willow woodchip per annum. Through the cooperative system they benefit by sharing the cost of specialised machinery, marketing initiatives and can negotiate large supply contracts. REG also counts as an ‘end user’ allowing producers to obtain the energy crop grant. In order to qualify for planting grant, energy crops must have a contracted end use when they are planted. REG can then sell woodchip to individual boiler installations.

Coppice Resource Ltd – is a cooperative which acts as an intermediary between growers and customers. Within the East Midlands, Coppice Resource limited has 435ha of Short Rotation Coppice (SRC) on it books. 250ha of which are on open-contracts, whereby the biomass produced is sold to the highest bidder, for example the Drax co-firing plant and 150ha of which are contracted for 10 years to supply the pellet plant at Retford, owned by Bio-joule.

Bical – A Miscanthus rhizome seller and biomass contract supplier actively promoting the growth of Miscanthus throughout the UK. Bical has an estimated 3,500 hectares of Miscanthus in the East Midlands and a total of 12-13,000 hectares in the UK.

Grower/ Cooperative	Area (Hectares)	Biomass Tonnes Per Annum
Strawson (SRC)	350	3,500
Renewable Energy Growers (SRC)	1,150	11,500
Coppice Resource Limited (SRC)	435	4,350
Bical (Miscanthus)	3,500	45,500
Total	**5,435**	**64,850**

Figure 9 - Table to show key producers, the area and the tonnes per annum they produce.

7.1.2 Future Growth

Whilst Bical and Coppice Resource limited are making significant efforts to encourage more farmers to grow Miscanthus and SRC respectively, the current state of the commodity market is making this a very hard task.

With the price of wheat peaking around the £180 a tonne mark this summer and being predicted to remain at least at the £120 a tonne mark for the next three years, famers are very reluctant to diversify into energy crop production. Driven by the high price of wheat and their familiarity of the crop, many farmers have put as much land as possible into wheat production, including their more marginal land.

It is argued however by some, e.g. Mr Wardle, from FWAG (Farming and Wildlife Advisory Group) that many farmers have failed to fully acknowledge that whilst the commodity prices have indeed increased, so too has the price of fuel and nitrogen required for their production. As a result some farmers risk making much lower margins than they expected due to the poorer yields from marginal land. As such farmers need to recognise that on marginal land the growth of energy crop may still be more.

7.2 Forestry Round Wood

The Forestry Commission is the largest landowner in the UK, with the largest volume of harvestable biomass. The Forestry Commissions goals are to protect and expand Britain's forests and woodlands and increase their value to society and the environment. One of the major strategies employed to achieve this involves working with private landowners to improve the management of their woodlands.

The growth of the biomass market actually provides a fantastic opportunity to encourage this, as it presents an easily identifiable economic incentive for applying woodland management strategies, which involve harvesting and selling wood-fuel biomass. As such the Forestry Commission is focusing upon developing partnerships with private woodland owners, especially of woodlands which are unmanaged or undermanaged, outlining the benefits of sustained management programmes.

Through such work the forestry commission believe that nationally they can bring an additional two million tonnes (90,000tonnes in the East Midlands) of forestry round wood to market, annually, by 2020 - to be achieved through the management of un-managed and under-managed woodland. Whilst the potential supply of biomass is not an issue, as it is already there, achieving a quality woodchip product is. Similarly, developing a whole new dedicated supply infrastructure presents a challenge.

7.3 Waste Wood

Every year 10 million tonnes of wood is produced for disposal in the UK primarily from the construction and demolition sector. Presently only 1.5 million tonnes is recycled, the rest is sent to landfill. Land filling organic materials such as wood leads to emissions of methane. This is 21 times more damaging to the environment than carbon dioxide.

Reclaimed Timber offers a source of seasoned, low bark content wood ideal for processing into wood pellets once contaminants have been removed. Whilst this is a challenging process it is certainly feasible and once the technology is refined there is a plentiful supply of waste wood that can be processed each year.

8. Conclusions

From a relatively low base, the market for biomass is definitely growing. However the linkages between production and demand remains relatively weak. The report prepared in 2004 by ERIN Research Ltd for the Forestry Commission and the East Midlands Regional Assembly suggested that at the time a "chicken and egg" situation existed in terms of 'what comes first the boilers or the fuel?' This issue of confidence in both the supply and demand of biomass, from customers planning to install biomass boilers and producers planning to grow biomass respectively is still a problem. Such issues are partly due to a lack of market information and communication between users and suppliers. This study has addressed this issue through providing a detailed market analysis that allows actors considering entry to the biomass market to make informed decisions about the market potential that exists.

Due to the competition from imported sawmill co-product and the developing waste wood pellet market; many respondents argued that it is very difficult to make the production of pellets from Energy Crops or FRW competitive. As a result it seems that the UK biomass market, principally Energy Crop and FRW, should focus their efforts on supplying high quality woodchip (or cobs in the case of Micanthus) to power generators and large scale heating systems, upwards of 200kW. Leaving boilers <200kW to be supplied by pellets produced from waste wood, be they produced from sawmill co-products abroad or from developing reclaimed timber wood pellet in the UK which should soon enter the market.

Whilst there are relatively few 200kW+ systems at present in the East Midlands there are a significant number planned to be installed over the next 3years. There are also a number of interesting large district heating and CHP schemes, ranging from 200kW to 30MW have been identified in the UK indicating the future potential. Whilst such schemes will take time to develop and thus to require a supply of biomass, the demand of power generators, which whilst distorted by policy driven economic incentives, provides a stable and growing base to the biomass market allowing time for such systems to be developed.

For the supply of smaller schemes 200kW – 2MW, the use of biomass grown or harvested locally or indeed "on-farm" may be viable. However for larger schemes there will be a need to attract fuel from a number of sources. In this instance group activity will be essential to coordinate production and supply. The establishment of producer cooperatives, as proven by the success of the Renewable Energy Growers (REG) cooperative in the East Midlands, highlights the benefits of pooling supplies, collective contract negotiation and sharing the cost of specialised machinery. An ideal system under present market conditions, whereby individual farmers are unlikely to commit significant hectares to energy crop due to high cereal prices, but multiple farmers could grow smaller areas of energy crop on their marginal land, and then form local cooperatives to negotiate sizeable supply contracts.

Cooperative groups also offer an attractive structure for developing the forestry round wood supply, with the potential to share the capital costs of machinery and storage facilities alongside negotiating large supply contracts. Grant schemes such as the proposed DEFRA 'Bio Energy Infrastructure Grant' would prove particularly useful in aiding the establishment of cooperatives.

9.Appendix

9.1 Heat Requirement and Required Woodchip Volume Calculations

Full heat load calculations are carried out by calculating surface area of buildings and calculating the 'U' values of each type of surface (walls, windows, etc) and taking into account 'air exchange rates'. Computer programmes are available to do this e.g BRE. However a 'rule of thumb' used in the industry is to calculate the volume of the building (in m^3) and multiply by 0.035 to give an approximate heat load in kW.

- Floor area (m^2) × Average Ceiling Height (m) = Building Volume (m^3)

- Building Volume (m^3) × 0.035 = kW Boiler Required

Annual energy usage is measured in Kilo Watt Hours (kWh). For example a 15kW boiler running at full output for two hours will provide 30kWh of heat. Theoretically the yearly maximum energy usage would be if the boiler were run at full capacity for all 8,760 hours, however this is very unlikely as on average boilers are only run at full capacity for a few hours a day.

To get an idea of the annual energy usage of a building, you must consider the 'Full Load Hours Equivalent' (FLHE), i.e. how many hours will the boiler be operational at full capacity annually. This will vary depending upon the energy requirements of the building, with factors such as usage and outside temperature affecting the heat demand, with obvious seasonal changes in temperature affecting usage. Some facilities, for example swimming pools however require a very constant heat demand throughout the year.

The kW boiler required is then multiplied by the estimated FLHE to obtain the total kilo watt hour (kWh) of energy (fuel) required to run the boiler for this length of time.

- kW Boiler × FLHE = Total kWh

Fuel can be considered in terms of how many kWh a unit of weight or volume will provide when burnt, determined by its calorific value. For biomass, a crucial factor affecting the calorific value is the moisture content, with the lower the moisture content the higher the calorific value. This is why allowing biomass to dry is so important and why pellets, which through the pelleting process are force dried, have a higher calorific value, and in turn kWh value, than woodchip.

Fuel	kWh
Woodchip (35% MC)	3000 per tonne
Woodchip (25% MC)	3750 per tonne
Wood Pellet (12%MC)	4700 per tonne

Wood-Oven dried (0% MC)	5200 per tonne
Heating Oil	10.6 per litre
LPG	7.8 per litre

- Table to show average kWh value of wood fuel, with traditional heating fuel for comparison.

To calculate the amount of fuel required per annum the total kWh is divided by the fuel kWh per unit value, which is then divided by the efficiency of the boiler (for new biomass boilers 85% is quoted as the minimum efficiency, thus we divide by 0.85).

- Total kWh ÷ fuel kWh per unit ÷ 0.85 = Number of Units fuel required

Then total cost of fuel per annum can be calculated.

- Number of units required × price per unit = Total annual cost

9.1.1 Assumptions for this study

For this study often respondents were only able to give us details of the boiler capacity, as they didn't know about their annual fuel consumption without taking time to calculate it. Alongside the fact that a significant volume of information was from secondary sources including boiler suppliers, councils and funding bodies, who only knew the boiler capacity. However as we know the boiler capacity, based on assumptions of the FLHE we can estimate the total volume of woodchip or woodpellet used annually by existing installations and predict the future volume of biomass required for proposed installations.

High energy use buildings, FLHE = av. 2630
High energy use buildings require a relatively constant supply of heat throughout the year, for example retirement homes, swimming pools or glasshouses. In such examples boilers are expected to be operating at full capacity for 25-35% of the year.

Medium energy use buildings, FLHE = av. 1500
Average energy use buildings require heat for only part of the day, for example schools and offices. In such examples boilers are expected to be operating at full capacity for 15-20% of the year.

Low energy use buildings, FLHE = 2180
Low energy use buildings require heat for only part of the day, but may be high thermal efficiency new builds that require minimal heating or are buildings that are used sporadically or infrequently, for example community halls. In such examples boilers are expected to be operating at full capacity for 10-15% of the year.

For all unknown values:

- FLHE will be taken as 1500, an average of High, Medium and Low use
- Woodchip will be assumed to be 30% MC and 3000kWh per tonne
- Pellet will be assumed to be 12% MC and 4700kWh per tonne

9.2 Lorry Loads –

- Standard haulage lorry trailer is 100m3, and holds 24tonnes woodchip. (J. Strawson, 2007)
- Renu states their lorries can hold 20tonnes of Pellet & 12 tonnes of woodchip. Thus, they can transport 40% more weight of pellet per load than woodchip.

9.3 SRC Yield –

30 ODT tonnes per hectare every 3years as harvested on a 3 year cycle, thus an average of 10 ODT per hectare per year.

9.4 Miscanthus Yield

Based upon an average yield of 13 tonnes per hectare annually.