

BIOMASS

ALASDAIR REID

In February and March 2006 the Scottish Parliament Environment and Rural Development Committee will undertake an inquiry into developments in the biomass industry in Scotland, with particular reference to how forestry and agricultural policy can support this development.

This briefing supports and informs the inquiry by providing an introduction to biomass energy and exploring its potential in Scotland.

Scottish Parliament Information Centre (SPICe) Briefings are compiled for the benefit of the Members of the Parliament and their personal staff. Authors are available to discuss the contents of these papers with MSPs and their staff who should contact Alasdair Reid on extension 85375 or email alasdair.reid@scottish.parliament.uk. Members of the public or external organisations may comment on this briefing by emailing us at spice.research@scottish.parliament.uk. However, researchers are unable to enter into personal discussion in relation to SPICe Briefing Papers.

Every effort is made to ensure that the information contained in SPICe briefings is correct at the time of publication. Readers should be aware however that briefings are not necessarily updated or otherwise amended to reflect subsequent changes.

www.scottish.parliament.uk



CONTENTS

KEY POINTS	3
INTRODUCTION	4
SCOTLAND'S OVERALL ENERGY USAGE AND EMISSIONS	5
BIOMASS AS A FUEL SOURCE.....	7
WOOD FUEL	7
ENERGY CROPS	8
APPLIANCES.....	9
<i>Heating.....</i>	<i>9</i>
<i>Electricity.....</i>	<i>10</i>
<i>Combined Heat and Power.....</i>	<i>11</i>
<i>Biomass Scenarios in Scotland</i>	<i>11</i>
USE OF BIOMASS IN SCOTLAND	13
SUPPLY CHAIN	13
<i>Land use, fuel supply, and potential for generation</i>	<i>14</i>
<i>Employment</i>	<i>15</i>
<i>Transport.....</i>	<i>16</i>
CLIMATE CHANGE AND GREENHOUSE GAS EMISSIONS	17
EMISSIONS COMPARISONS	18
POLICY.....	20
EUROPE.....	20
UNITED KINGDOM	20
SCOTLAND	21
<i>Relevant Parliamentary Work</i>	<i>22</i>
FORESTRY COMMISSION SCOTLAND.....	22
<i>FCS Role in Wood Fuel and Climate Change</i>	<i>23</i>
SCOTTISH AGRICULTURE STRATEGY	24
GREEN JOBS STRATEGY.....	24
DIRECT SUPPORT SCHEMES FOR BIOMASS	24
<i>Scottish Forestry Grants Scheme</i>	<i>25</i>
<i>Bio-energy Capital Grants Scheme</i>	<i>25</i>
<i>Bio-energy Infrastructure Scheme</i>	<i>25</i>
<i>Farm Business Development Scheme.....</i>	<i>26</i>
<i>Scottish Community Householder Renewables Initiative</i>	<i>26</i>
<i>Highlands and Islands Woodfuel Cluster Programme</i>	<i>26</i>
<i>Renewables Obligation Scotland</i>	<i>26</i>
REGULATORY ISSUES	28
WASTE	28
SMOKELESS ZONES	28
APPENDIX 1. SCOTTISH CASE STUDIES.	29
WHITEGATES DISTRICT HEATING SCHEME LOCHGILPHEAD	29
PELLET STOVE IN LOG CABIN AVIEMORE	30
APPENDIX 2. FINLAND CASE STUDY	31
SOURCES	32

KEY POINTS

- biomass is a generic term that describes a wide range of organic source materials; other often used terminology includes bioenergy or biofuels
- the use of biomass as a renewable energy source provides opportunities for the forestry and agriculture industries and their supply chains, and the wider rural economy; it also provides a secure supply with opportunities to reduce CO₂ emissions, and fuel poverty
- this paper focuses on woody biomass e.g. forest products, untreated wood products and crops grown on short rotation coppice such as willow
- there are two distinct sectors: wood fuel for heat, and biomass (including wood fuel) for combined heat and power, and electricity; it is important to distinguish between these when considering the potential impacts
- to date, the focus of renewables policy, targets and support mechanisms have been on electricity, not heat; over a third of Scotland's energy consumption is heat
- biomass, particularly wood fuel, is accepted as carbon neutral, where used close to source
- biomass currently provides approximately 64% of the EU's total renewable energy, however virtually none is used in Scotland
- because of existing forestry resources and infrastructure, wood fuel is currently the most viable use of biomass as a renewable energy; there is currently no willow under short rotation coppice in Scotland
- transporting wood fuel is expensive, therefore rural areas are likely to be the most cost-effective areas for using this resource; many rural areas are not connected to the gas grid, and experience high fossil fuel prices
- estimates vary, however smoothed production figures suggest that 8.5 million m³ of permanently sustainable timber is available per annum; of this, it is expected that up to 1 million tonnes of wood fuel will be available without affecting other markets
- wood fuel is thought to be able to supply domestic space and water heating to as much as 11% of Scotland; carbon savings from this supply could equate to as much as 23% of CO₂ emissions from domestic space and water heating in Scotland
- many of the predicted jobs throughout the biomass supply chain are expected to be in rural areas
- biomass as a renewable fuel touches on, and is affected by, a wide range of policy issues, including climate change, energy, rural development, economic development and job creation, agriculture, forestry, waste, and planning
- the relevant domestic policy framework is likely to evolve as a result of imminent reviews of the Scottish Forestry Strategy, Scottish Climate Change Programme, and the recent commitment to develop a Biomass Action Plan

INTRODUCTION

Biomass is a generic term that describes a wide range of organic source materials such as plant or animal matter. For example, wood, forestry and agricultural wastes, and specifically grown energy crops can all be burnt to generate heat, electricity, combined heat and power (CHP), or distilled to produce fuels for transport.

There is a growing consensus, backed up by strong scientific evidence (Intergovernmental Panel on Climate Change 2001), that an over-reliance on burning finite fossil fuels such as coal, gas and oil has caused an increase in atmospheric concentrations of greenhouse gases¹, particularly carbon dioxide (CO₂), which are interfering with the earth's climatic cycles. Therefore, finding viable renewable sources of energy has become a priority, as has reducing CO₂ emissions. In general, biomass, particularly wood fuel, is accepted as carbon neutral (Forum for Renewable Energy Development in Scotland 2005), depending on how far it has to travel before use. This means that it absorbs the same amount of greenhouse gases during its growth cycle as it emits whilst being burnt or decomposing.

The Scottish Parliament Enterprise and Culture Committee carried out an inquiry into renewable energy in 2004. This [concluded](#) (Scottish Parliament Enterprise and Culture Committee 2004) that a concentration on onshore wind power has meant that the use of other fuels and generating technologies such as biomass has not developed. Furthermore, the Committee noted the potential for using biomass for heating and CHP in local community developments.

The Scottish Parliament Environment and Rural Development Committee carried out an inquiry into climate change in 2005. This [reported](#) (Scottish Parliament Environment and Rural Development Committee 2005a) that Scottish agriculture, forestry and land use formed a significant and distinct sector in terms of climate change emissions, accounting for a high proportion of UK emissions in these sectors. It also emphasised the importance in reducing emissions through sequestering carbon during growth, and in using forest products as low carbon energy fuels and construction materials. The inquiry found that there are no clearly explained objectives for the aspirational target for growth of 25% forest cover by 2050 (Forestry Commission Scotland 2000), neither are there any clear connections between forestry policy and climate change.

The potential value of biomass energy to rural development in Scotland is primarily in the expansion of the supply chain, particularly in forestry, agriculture and associated industries.

The following recently published reports have also informed and advanced the debate:

- [Promoting and Accelerating the Market Penetration of Biomass Technology in Scotland](#) – report by the Forum for Renewable Energy Development in Scotland² (FREDS) (Forum for Renewable Energy Development in Scotland 2005)
- [Wood Fuel for Warmth](#) – report by the Sustainable Development Commission Scotland (SDCS) (Sustainable Development Commission Scotland 2005)
- [Commercial Opportunities for Woodfuel Heating in Scotland](#) (Scottish Enterprise 2005)
- [Biomass Task Force](#) – report to UK Government (Department for Environment Food and Rural Affairs 2005)

¹ The principal greenhouse gases are carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O).

² This report considered in detail the potential of biomass for electricity and CHP, not heat
providing research and information services to the Scottish Parliament

These reports note that there are currently a number of issues facing the biomass industry in Scotland. Broadly speaking, these include (Forum for Renewable Energy Development in Scotland 2005):

- fuel supply (resource and supply chain)
- infrastructure
- demand (markets and support mechanisms)
- regulatory issues

In February and March 2006 the Scottish Parliament Environment and Rural Development Committee (2005b) will undertake an [inquiry](#) into developments in the biomass industry in Scotland, with particular reference to how forestry and agricultural policy can support this development. This paper gives a general introduction to biomass energy and explores its potential in Scotland. Also, whilst it is recognised that a number of potential fuels exist, this paper focuses on the production of those that are thought to be relevant and applicable to Scotland (i.e. forest materials and short rotation coppice (SRC), known as energy crops).

There is often a lack of clarity in terminology associated with this subject. Biomass is a generic term; other often used terminology includes bioenergy or biofuels. Similarly, it is frequently forgotten that current renewables targets focus on electricity, not heat production. This has been described as a “significant omission” because heat production forms a major part of the UK’s total energy requirement (Sustainable Development Commission Scotland 2005). The Biomass Task Force (Defra 2005) estimates that energy consumption in the UK splits approximately into equal thirds: one-third heat, one-third electricity, and one-third transport. There are conflicting opinions on this figure, however given Scotland’s relatively cold climate it is likely that a higher proportion of energy is used for heat than the UK average.

The following SPICe briefings give relevant background information:

- [Renewable Energy](#) (Cook and Dewar 2003)
- [Climate Change](#) (Cook 2005)
- [Forestry in Scotland](#) (Reid 2005)

SCOTLAND’S OVERALL ENERGY USAGE AND EMISSIONS

Before considering biomass, and its energy potential in detail, it is important to understand the relevant terminology, and Scotland’s current energy and emissions status.

The kilowatt-hour (KWh) is used for electrical and heat energy, and is described as one unit on an energy bill. It represents a kilowatt of power used for one hour. Multiples of this are used to describe larger amounts. Incrementally, a megawatt-hour (MWh) is 1000 kilowatt-hours, and is commonly used to describe a power plant’s daily output, a gigawatt-hour (GWh) is 1000 megawatt hours, and a terawatt-hour (TWh) is 1000 gigawatt-hours. GWh and TWh are commonly used to describe larger sums, such as overall energy usage for a country.

Large amounts of energy may also be described as million tonnes of oil equivalent (Mtoe). This is because it may be easier to understand in a practical context. 1 Mtoe is equivalent to 11.63 MWh.

Overall, in 2002, Scotland consumed 175 TWh of energy, distributed amongst the domestic, transport, industrial and service sectors (AEA Technology 2006).

The domestic sector is the largest user of energy. Consumption has risen by around 15% since 1990. This is dominated by the increased use of gas for heating. Consumption in the transport sector has risen by 10% since 1990; the principal fuel use is oil. Energy consumption in the industrial sector has fallen by around 30% since 1990; this reflects Scotland's decreasing dependence on heavy industry. The service sector represents a range of business activities such as offices and shops, and public sector services such as hospitals and schools. Tourism dominates this sector. Service sector energy usage has risen by 10% since 1990, particularly that of gas and electricity (AEA Technology 2006).

Gas represents 34% of Scotland's total fuel usage, and is used directly for heating in many sectors, mostly domestic. Since 1990, direct consumption of gas for heating has grown by 22%. Gas generates 19% of Scotland's electricity, all at Peterhead power station (AEA Technology 2006).

Oil represents 28% of Scotland's total fuel usage. Most of this is consumed for transport, although some is used in the industrial, domestic and service sectors (AEA Technology 2006).

Coal represents 18% of Scotland's total consumption. The majority of this generates 37% of Scotland's electricity at Longannet and Cockerhill. Nuclear fuel represents 17% of Scotland's consumption, and 39% of electricity production (AEA Technology 2006).

Renewable sources equate to 3% of consumption, and 5% of electricity production. The use of renewables has increased by 13% since 1990 (AEA Technology 2006).

In 2002, Scotland's production and consumption of energy emitted 44 million tonnes of CO₂ (AEA Technology 2006).

BIOMASS AS A FUEL SOURCE

Biomass has been used for centuries as a primary source of heat and power, and in many parts of the world it is still the principle source of heat. However, the efficiency of modern technologies in comparison to open fires has allowed an increasing range of fuels to be utilised.

As previously noted, biofuels are produced from organic materials, either directly from plants or indirectly from industrial, commercial, domestic or agricultural products. There are two main categories (Energy Saving Trust 2004); this paper focuses on the first:

1. woody biomass includes forest products, untreated wood products, and SRC energy crops such as willow.
2. non-woody biomass includes animal wastes such as meat and bone meal, methane from slurry, animal fat, industrial and biodegradable municipal products from food processing and high energy crops such as rape, sugar cane and maize.

Biomass is unique amongst renewables, as its use is based on harnessing stored energy in the form of a fuel, as outlined above. This gives it a far wider range of applications than most renewable technologies.

Elsewhere in Europe, biomass is a “thoroughly embedded energy source” (Scottish Enterprise 2005), which currently provides approximately 64% of total EU renewable energy utilisation; the majority of this is used to generate heat. Of this total provision, only 1% comes from SRC, the rest comes from wood. “In Scotland however it [biomass] has virtually no market penetration whatsoever” (Forum for Renewable Energy Development in Scotland 2005). Therefore, the development of this sector in Scotland “is seen as an important strategic opportunity both in terms of the country’s forestry resource and in terms of renewable energy uptake and offset of CO² emissions, with additional wider benefits for the rural economy... [furthermore, this] might be said to offer a model of sustainable development” (Scottish Enterprise 2005).

WOOD FUEL

The energy content of wood fuel is related, amongst other things, to its moisture content. High moisture content will slow the combustion process, as the moisture must first boil off before the fuel can burn. Full combustion is the cleanest process, leaving no partial combustion products like carbon monoxide, particulates, or unburnt volatile hydrocarbons (Energy Saving Trust 2004).

Wood fuel is primarily used for heating, and can be derived from a number of sources, including (Sustainable Development Commission Scotland 2005) forestry and woodland, arboricultural arisings, sawdust and offcuts from sawmills, clean recovered wood derived from pallets and untreated wood, pellets of compressed sawdust and wood shavings. In considering specific forms of wood fuel, it is essential that its characteristics and quality are suitable for the chosen appliances. Potential fuels are considered below (Sustainable Development Commission Scotland 2005):

- long logs: used in open fires, closed stoves, manual and semi-automated boilers for central and water heating. Log boilers are usually fully loaded and fired every morning. A second firing may be needed in winter.
- wood chips: rectangular, roughly cut, and produced by specifically designed chipping machines. Used in size and moisture sensitive automatically-fed boilers. Requires

consultation between manufacturer and end-user to ensure chips are suitable, and supply is consistent.

- wood pellets: must contain only pure wood dust. Easy to use in semi and fully automated systems. Pellets from medium density fibreboard, chipboard and other materials must be burnt in purpose designed boilers or power stations. Pellet manufacturing is in its infancy in Scotland, where they are not currently made; imported from England, Ireland, mainland Europe and elsewhere.
- wood briquettes: manually loaded into traditional fires or log boilers. Produced from clean waste wood such as joinery offcuts and sawdust. As with pellets, source material must be uncontaminated. Made in small quantities across Scotland.

Scottish Enterprise (2005) notes the particular opportunities and constraints surrounding the use of wood pellets. Opportunities exist in the domestic sector, particularly in urban areas. However, current constraints include smokeless zones, space, delivery and storage logistics. At present, Scotland has neither an indigenous nor guaranteed supply of pellets. Scottish Enterprise (2005) states:

"...longer term the development of pelletising capacity in Scotland must be seen both as desirable and as an important opportunity for the wood processing sector."

ENERGY CROPS

In Scotland, willow is considered to be the most suitable SRC crop. This is primarily because it thrives in cold wet climates. Also, willow (Scottish Agricultural College 2002):

- produces a lot of biomass in a short period, and is among the fastest growing woody species in northern Europe
- can be grown with low inputs of agro-chemicals
- is easily established from un-rooted cuttings
- re-sprouts vigorously after each harvest
- has an energy balance in the region of 20:1 (i.e. the energy obtained can be 20 times as much as the energy used to grow the crop)
- can be used as a vegetation filter during "bio-remediation" of waste water or contaminated land

Short rotation coppice means that plants are cut back at intervals near ground level, and allowed to re-grow as multiple shoots rather than a single stem. Willow coppice might be harvested up to six times, typically at intervals of three to five years. At the end of that time (perhaps 25 years), the stumps can be removed, and the land re-planted with agricultural crops or more coppice (Scottish Agricultural College 2002).

Scottish Biofuel (2005) elaborates on this process:

"Following a standard arable seed bed preparation, specialist machines plant 15,000 willow trees per hectare of land. 3 years after planting the first harvest can be taken, circa 30 oven dried tonnes per hectare (odt), or 10 odt per hectare per year. The harvesting operation is carried out by a modified forage harvester which converts the willow into chips. The willow naturally repropagates with further crops each 3 years for 20-25 years. Husbandry is of low intensity throughout the cycle."

The potential for biomass to be produced from short rotation willow coppice has been considered by FREDS³, who note that its “importance...should not be underestimated...when developing sustainable integrated energy policies” (Forum for Renewable Energy Development in Scotland 2005). However, currently “there is uncertainty over its sustainable yield on commercial planting” due to the long term land commitment required, “therefore confidence in the availability of a market over this period is needed”.

Willow can be used to produce heat, or electricity on its own, however it is most efficient when heat produced during electrical generation is simultaneously recovered in a combined heat and power plant (CHP), and used on site nearby (Scottish Agricultural College 2002).

Heating, electrical and CHP systems are considered in more detail below.

APPLIANCES

Heating

Manually loaded log burning or multi-fuel stoves have conventionally been used in individual dwellings as space heaters and cooking appliances, as well as to supply hot water or central heating through an integral back boiler. These generally use pellets or logs; however pellets are required for an automatic feed system, and are becoming more commonplace. Stoves such as these can achieve efficiencies of more than 80% (Energy Saving Trust 2004). Domestic log, wood chip and wood pellet burning boilers can also provide central heating and hot water systems. As with stoves, log boilers require manual loading, whilst automatic ones are likely to be more expensive. Boilers can be designed to incorporate a hot water storage or accumulator tank. Capital costs for domestic appliances vary; however a stand alone room heater is likely to have an installed cost of between £1500 and £3000, and a pellet boiler around £5000. Fuel costs are generally dependent on distance from supplier, however “as a general rule the running costs will be more favourable if you live in an off gas area” (Energy Saving Trust 2004).

Whilst domestic appliances are recognised as playing a role in Wood Fuel for Warmth (Sustainable Development Commission Scotland 2005), the potential for automatically loaded wood heating systems in the commercial and public sectors, and for district heating schemes, offers the most scope for growth. This is because wood fuel for heat offers the greatest efficiencies at a large scale. Fully automated wood fired heating systems have been commonplace in Scandinavia, Germany and Austria for nearly 30 years, however they only started being used in commercial and public sector buildings in Scotland about five years ago. At March 2005, there were around 50 automated and semi-automated wood fuel heating schemes in Scotland. These are fuelled by all the main wood fuels described above (except energy crops); they have an estimated total heat output of 4.6 MW which equates to between 3-5,000 odt, and can be found primarily in areas outwith the gas network (Sustainable Development Commission Scotland 2005). As with domestic appliances, the capital cost of wood fuel heating can be up to five times higher than a conventional system. However, over the lifetime of the system, running costs are likely to be considerably less. The SDCS (2005) elaborates:

“In the off-gas areas, the economic basis for wood fuel heating systems is set by the prices of coal, electricity, heating oil and LPG. Significant fluctuations on an underlying upward trend in prices for these heating fuels can be expected in the foreseeable future. This should improve the full life economic feasibility of wood fuel heating systems,

³ SDCS (2005) also recognise the potential of energy crops from SRC, however do not consider them.
providing research and information services to the Scottish Parliament

especially in rural areas of Scotland where other considerations, such as local wood fuel resource potential, are advantageous.”

Furthermore:

“If fossil fuels stabilise at these current high prices or increase ...the market looks set to grow provided that capital grants continue to be available. In other more accessible areas of Scotland and if fossil prices continue to fluctuate, potential users will face a difficult decision before committing to woodfired heating and may need further incentives before investing in this option.”

The SDCS (2005) provides useful case studies on the application of domestic and district scale wood fuel heating systems. These are abbreviated and reproduced in [Appendix 1](#).

Electricity

In the short term, the combustion of forestry biomass in the same mix as coal (known as co-firing) in existing power stations “has considerable potential to act as a catalyst to the development of a viable biomass electricity industry within Scotland”. It is anticipated that this would help considerably with the establishment of a viable SRC supply chain⁴ whilst giving immediate benefits in terms of a reduction in CO₂ emissions (Forum for Renewable Energy Development in Scotland 2005). At present, much of the biomass used in co-firing is olive cake imported from Spain (Smith 2006). Because the heat is generally not usefully used in this process, co-firing is the least efficient biomass generation method.

Co-firing with forestry allows the use of existing infrastructure, rail transport, and grid connections, and provide a secure supply from existing generation plants whilst the necessary planning permissions are granted, and infrastructure developed, to allow biomass specific electricity generating stations to develop.

In the longer term, energy crops (willow) could also be used. The Department of Trade and Industry’s [Cleaner Coal Technology Programme](#) (2004a) identifies the combustion of renewable biomass as the largest growth area for UK electricity supply.

Work has recently begun on a biomass specific [electricity generation plant](#) near Lockerbie (BBC 2006a), which will burn forestry biomass, waste timber and a growing proportion of energy crops. This received funding of £18m from the Big Lottery Fund [Bio-energy Capital Grants Scheme](#), and is expected to be completed early in 2008. The site already has a “cluster” of sawmills and road-haulage specialists, and is situated next to the M74.

Talks are also currently underway between British Nuclear Fuels (BNFL) and Scottish BioPower⁵ to convert Chapelcross nuclear power plant into a co-firing power station whilst it is being decommissioned. Proposals for the staged construction of 2 x 125 MW plants are likely to be submitted to Scottish Ministers under section 36 of the Electricity Act 1989 once the National Grid Company has confirmed whether, and when, a connection will be available. This offer is likely to be made in mid-April 2006; however a connection may not be available until 2015, in which case Scottish BioPower would review the viability of their proposals (Mosco

⁴ It should however be remembered that there is no direct link between the wood fuel for heat supply chain, and the SRC supply chain. Therefore, aside from raising general awareness, the market for wood fuel would not benefit (Luker 2006).

⁵ Scottish Biopower and Scottish Biofuels (quotation p7) are associated with Scottish Coal.
providing research and information services to the Scottish Parliament

2006). Scottish BioPower report (Mosco 2006) that the staged construction of two plants is necessary because there is not enough fuel available to supply one 250 MW⁶ plant.

Combined Heat and Power

When an engine or turbine drives a generator, it converts only 25 - 33% of the energy content of the fuel into electricity; the remainder is emitted as heat. A CHP installation generates electricity and simultaneously recovers the heat. In this way the total efficiency of a CHP system can be increased to 85% or more; it is therefore the most efficient method of generation. To minimise transmission losses, it is most efficient to use the electricity on site; however it can also be sold through a distribution grid. Heat is generally used on site in industrial processes, or as space heating, or in the close vicinity such as in a district heating system (Scottish Agricultural College 2002 and Combined Heat and Power Association 2005). All biomass fuels are suitable for CHP plant.

Two CHP projects currently underway in Scotland are outlined below:

Caithness Heat and Power Ltd. Partnership

The Scottish Executive (2005a) reports that this wood fuel initiative is a partnership between Inver House Distillers (owners of Pulteney Distillery), Highland Council and the Pulteneytown Peoples Project; it is Scotland's first biomass fuelled heat and power scheme. The partnership aims to build a £6m wood fuelled CHP plant in Wick to provide affordable heat to 500 households in the Pulteneytown area of Wick (an area of noted social deprivation) whilst producing 1.5 - 3 MW of electricity for sale via the local electricity distribution system. There are two phases to the project:

1. The provision of heat from both a wood fuelled combustion boiler (adjacent to the Pulteney Distillery) and from the distillation process. Some of the steam generated will be used by the distillery with the heat to the houses derived from a combination of intensified waste heat from the distillery and steam directly produced by the wood chip boiler.
2. Development of a CHP system providing 3 MW of heat for the district heating scheme and 3 MW of steam, generating up to 1.5 MW of electricity for sale.

In the longer term, the project intends to provide heating to several public buildings including local hospitals, schools and hotels.

Tullis Russell Paper Mill

The Tullis Russell Paper Mill at Markinch in Fife is currently building a 50 MW CHP plant. This will initially be fuelled with forestry residue, however within three to five years, it is hoped that SRC willow will also be used. Scottish Biopower (the developer) is currently seeking ten year contracts with local farmers to convert land to SRC. It is estimated that a minimum of 25,000 ha will be required (The Courier 2005). The economics of growing willow on SRC in Fife have been questioned (Tayforth Machinery Ring 2005). These are considered later.

Biomass Scenarios in Scotland

FREDS (Forum for Renewable Energy Development in Scotland 2005) develops a potential future scenario for the Scottish biomass industry, describing the cost-efficient harvesting of tree tops and branches as well as the use of secondary products from sawmilling. Furthermore (Forum for Renewable Energy Development in Scotland 2005):

⁶ 1MW of power output requires 10,000 tonnes of biomass; therefore the Chapelcross proposal may eventually require 2.5 million tonnes per annum.

“The biomass component could be removed in so-called integrated harvesting systems with product separation in the forest. In some cases the tops and branches might be recovered in a second pass operation. The biomass component might be chipped at site to allow more efficient loading to trailers of transport which would be loaded directly from the chipper/trailer. Alternatively, coniferous brash (lop and top) might be baled in the forest, using currently available Scandinavian brash baling technology, thereby compacting the material for efficient extraction and transport on conventional round timber lorries. Such bales can be stacked, stored and dried before chipping and immediately prior to burning at the power/heat plant. Some short term storage of the fuel might be required and this would be managed with a view to reducing moisture content. Some mixing of biomass fuels of different moisture content might be required to meet the specifications of the conversion facility.”

The SDCS (2005) points out that this resource is already exploited commercially in Sweden and Finland, and that the same could happen in Scotland, however neither the technology nor the infrastructure for doing this are currently available. Similarly, due to the severe technical, logistical and economic constraints of harvesting timber in remote areas, the collection of residues is likely to be impractical (Pendlebury 2006). It was also noted that removing residues could lead to negative impacts on soil fertility (Sustainable Development Commission Scotland 2005); however the possibility of removing forestry brash and stumps has been welcomed by some groups due to improved aesthetics, access for recreation, and quicker regeneration of native woodland (Scottish Wild Land Group 2006).

USE OF BIOMASS IN SCOTLAND

Obtaining affordable, secure, continuous and diverse energy supplies are becoming increasingly critical issues (Department of Trade and Industry 2006; Forum for Renewable Energy Development in Scotland 2005). This is highlighted by the recent [dispute](#) over gas supplies between Ukraine and Russia (BBC 2006b). Therefore, a Scottish biomass industry is well placed to help reduce dependence on external fossil fuel supplies and related uncontrolled energy prices. In terms of social justice, Scottish Enterprise (2005) notes that 13% of Scottish households live in fuel poverty, and that in many circumstances woodfuel represents the cheapest and most sustainable way to heat a house.

At present, Scotland's woodland and forest cover equates to 17% of its land area (Forestry Commission 2005). FREDS (Forum for Renewable Energy Development in Scotland 2005) notes that this amounts to 60% of the UK's forestry resource, therefore Scotland has "a substantial existing and expanding resource from managed woodlands and secondary sawmill products which can be accessed for wood fuel almost immediately". Due to this, it is proposed that initial development of a Scottish biomass industry would not require the substantial planting of energy crops, but that this might support further expansion.

Arable residues such as straw may also be valid for the promotion of biomass in Scotland. Both Aberdeenshire and the Borders have the potential to generate sufficient quantities to develop large straw fired energy plants. However, there is currently a good market for this, therefore "straw heat and power will not generate any significant interest for farm, local community or large scale uses" (Forum for Renewable Energy Development in Scotland 2005).

This report also noted that:

"Biomass could provide a real solution to the problems of under-maintained forestry in Scotland, by making forest maintenance economically viable. In turn this could produce long-term, sustainable employment in rural areas."

[Appendix 2](#) provides a short case study of a mature biomass market: Finland.

SUPPLY CHAIN

"Successful development of the wood fuel supply industry depends on the whole supply chain being in place. This needs to be complete even to deliver...at one small installation." (Sustainable Development Commission Scotland 2005)

The biomass supply chain covers a wide range of separate industries; some mature, some fledgling, and some requiring adaptation. These include forestry, farming and land ownership; forest, woodland and farming equipment, harvesting plant suppliers, transport, sawmills, power plant suppliers and installers, central heating firms, energy supply companies, operation and maintenance companies, consultants and advisory funding services (Sustainable Development Commission Scotland 2005). The FREDS report (Forum for Renewable Energy Development in Scotland 2005) documents a similar chain for energy crops. This is likely to be slightly shorter, especially if willow is chipped, stored and dried on site, then transported directly to a power plant.

Fuel processing technologies such as chippers and pellet mills are already well established in other parts of Europe and are increasing in Scotland. Locally produced wood chips and imported pellets are available in some areas. Pellets are made from sawdust (a co-product of

sawmills) for which there exist competitive markets. Due to this there is a finite supply. One of the main suppliers of pellets to the UK market is Balcas, a multiple wood products supplier based in Northern Ireland. Talks are currently underway to establish a new forestry cluster, called Forscot, at Invergordon (Scottish Forest Industries Cluster 2005a), where Balcas are considering locating (Kidney 2006).

At present pellets represent only 5% of the wood used for energy in the EU, although this figure is increasing, and they have made a significant contribution to biomass growth in Austria (Rakos 2003).

The high capital cost of a wood fired heating boiler in comparison to a fossil fuel fired boiler has already been noted; this deters investment and conversion to wood fuels, and is partly because the market is immature and lacks critical mass to drive down costs. Reliable fuel supply is also problematic as the market is currently small and dispersed. This is especially the case for fuel drying and storage systems, along with the technical logistics of transferring fuel from storage to delivery vehicles (Sustainable Development Commission Scotland 2005).

Some of the key opportunities and threats to the biomass supply chain are outlined below:

Land use, fuel supply, and potential for generation

As noted previously, Scotland holds 60% of the UK's forestry and woodland (Forum for Renewable Energy Development in Scotland 2005); 10% of the UK total is in Argyll and Bute (Scottish Parliament Enterprise and Culture Committee 2004). Due to this considerable resource, the timber processing sector is a significant player in the rural economy. There are approximately 80 sawmills in Scotland that annually produce around 1 million m³ of sawn wood (approximately 10% of UK requirements). Additionally, 1.42 million m³ of particle board are manufactured in Scotland each year and there are 12 paper and paper board mills which produce over 0.5 million metres of product per annum (Scottish Enterprise 2005).

It is however important to properly quantify the current and forthcoming availability of Scotland's wood fuel resource. This resource will be predominantly made up of (Forum for Renewable Energy Development in Scotland 2005):

- forest residues and small round wood direct from the standing forestry resource
- secondary products from forest processing industries
- recycled timber

The SDCS (2005) note also that arboricultural residues (wood fuel from urban and peri-urban tree surgery) may be a readily available and (almost) free fuel resource, especially given that up to 18% of this is landfilled.

The total production from Scotland's forests is currently estimated to be around 7 million cubic metres of timber per annum with just over 50% of this now coming from the private sector. Current estimates indicate that timber availability has the potential to rise from this level to over 10 million cubic metres per annum by 2020, and that a sustainable long term supply of 8.5 million cubic metres is possible⁷. [Forestry Commission Scotland](#) (FCS) has estimated that if all the proposed developments⁸ were to be implemented, demand might rise to as much as 15.8 million cubic metres per annum. A study on supply and demand in Scotland and Northern

⁷ 1m³ of timber equates to one wet tonne of wood fuel.

⁸ e.g. proposed sawmill expansion, bioenergy projects and integrated pulp and paper mills such as Forscot.
providing research and information services to the Scottish Parliament

England is currently underway; this is expected to be completed by the end of March 2006 (Forestry Commission Scotland 2006; Scottish Forest Industries Cluster 2006a).

Luker (2006) asserts that the development of a biomass energy market will not be constrained by the availability of the fuel resource. This is reiterated by Scottish Enterprise (2005) who state that "Estimates of the precise quantities of material available to the energy market vary, but considering both availability of raw material and issues of competition, it seems likely that somewhere between 500,000 and 1 million tonnes of material will become available without creating significant market distortions in other sectors". The SDCS (2005) put this into context, and state that:

"...the wood fuel resource...would be able to support between 1.5 and 3.4 TWh per year of delivered energy consumption – enough to account for between 5% and 11% of domestic space and water heating requirements in Scotland. [If used in rural Scotland, this could] equate to [a saving] of between 7% and 23% of CO₂ emissions from domestic space and water heating."

In spite of the forthcoming availability of resource, the Scottish Executive has an aspirational target of increasing forestry cover from the current 17% to 25% by 2050 (Forestry Commission Scotland 2000). This translates to a need to plant between 10,000 to 12,000 new hectares per annum (Scottish Parliament Environment and Rural Development Committee 2005b). New planting in 2000-2001 amounted to 11,600 hectares, by 2004-2005 this had dropped to 5,600 hectares (Forestry Commission Scotland 2006a).

Other factors, such as growing energy crops, could significantly increase the supply of biomass, and energy. Over 15% of the agricultural land in Scotland is capable of growing energy crops. At present, the main obstacle to achieving this is the development of a viable profitable market, which would encourage farmers and land owners (Forum for Renewable Energy Development in Scotland 2005). Care would also have to be taken to limit the environmental and visual impacts associated with planting a willow monoculture.

As noted by Scottish Biofuel, one hectare of SRC willow plantation will yield 10 tonnes per year. This roughly equates to 10,000 KW of electrical output.

The financial viability of planting willow is affected by the availability of grant funding. This is explored later. It has been suggested that research should be carried out into establishing short rotation forestry; this would provide the biodiversity benefit of increasing woodland cover, along with the speed of growth of an energy crop (Pendlebury 2006).

Because willow is not currently grown commercially as an energy crop in Scotland, accurate predictions for future supply and demand, and medium to long term generating potential, have not been made in the same way as for wood fuel from forestry.

Employment

Luker (2004) found that megawatt for megawatt; wood fuel heating creates five to ten times more jobs than other renewables technologies. This is primarily because other technologies collect energy passively, therefore they do not create a chain of employment. A more recent report (Fraser of Allander Institute 2006) presents best case scenarios for wood fuel and construction impacts as follows:

Short-term (2006 – 2010)

- **Wood fuel impact** - creating around 125 permanent new jobs per annum with a wage income in Scotland of around £2.7m
- **Construction phase** - creating around 400 new jobs per annum with a wage income in Scotland of around £15m

Long-term (2010 – 2020)

- **Wood fuel impact** - creating around 2000 permanent new jobs per annum with a wage income in Scotland of around £45m
- **Construction phase** - creating around 6000 new jobs per annum with a wage income in Scotland of around £260m

FREDS (2005) caveat their employment estimates as being conservative because they relate purely to the use of wood fuel in the CHP and electricity sectors and do not take the potential of energy crops into account. Totals for direct, indirect, induced and export jobs involving development, construction, manufacturing, operations and fuel supply were estimated to 2020 at approximately 2000 jobs.

Transport

The transportation of biomass will add to both the CO₂ emissions and the financial costs. The Royal Commission on Environmental Pollution (2004) believes that the emissions used in transporting biomass “are more than offset by the very low conversion emissions, making biomass even more favourable compared to the fossil fuel alternatives”.

However, transport costs are a limiting factor in the price and financial viability of the fuel. It is therefore largely accepted that long-distance transporting of low value, high bulk fuels such as wood chip or logs is not commercially sound (Sustainable Development Commission Scotland 2005). This is reiterated by FREDS (2005) which states that it “remains important that all steps possible are taken to reduce the distances over which the fuel is transported”. This is reinforced by Kidney (2006) who notes that a truckload of undried chips can often be 50% water, 20% air and only 30% wood, and that “trucking loads that are half water really is a mugs game”. Therefore, the only wood fuel that it makes economic sense to transport are pellets.

For wood fuel, the most likely areas where biomass energy will be viable in its early stages will be those with the largest forestry resource i.e. rural areas. The SDCS (2005) show that much of Scotland’s rural areas are outwith the gas network and that because of the high and increasing cost of fossil fuel heating alternatives such as oil, LPG and electricity, fuel poverty can be a considerable issue.

The use of energy crops in CHP or co-firing plants has similar financial and logistical problems with bulk transport and storage. At present, Scottish Biopower are only looking to enter into growing contracts with farmers who are within a 50 mile radius of their forthcoming plant in Fife (Scottish Biofuel 2005).

Due to potential transport and waste synergies with wood processing plants, “well located biomass projects, including co-location of integrated energy users of electricity and heat, and innovation in the supply chain present opportunities to reduce cost” (FREDS 2005). However, this has not been done at the electricity plant that is currently under construction at Lockerbie, in spite of the presence of neighbouring sawmills and forest product manufacturers. This is due to the incentives in the current Renewables Obligation Scotland (ROS) which reward electricity production, not heat. The ROS regime is discussed later.

The SDCS (2005) suggests that wood fuel for heat could become more viable in Scotland's Central Belt if a strategically located "wood fuel refinery" were to be developed.

"Such a development could accept clean, untreated wood from a variety of sources and in different forms and moisture contents and process it to a given fuel specification. It could also invest in a variety of delivery equipment to facilitate lower capital cost boiler and fuel store installations, manufacture wood pellets, briquettes and soil conditioner, undertake ash collection and disposal, and, if required, provide full energy supply company or operation and maintenance functions." (Sustainable Development Commission Scotland 2005)

Taking transport issues into account, the SDCS (2005) concludes:

"...the equipment supply chain is limited by the capacity of the small firms supplying and installing equipment. The fuels supply chain, although functioning well in some locations, is certainly embryonic or non-existent in many places. There is little choice for the consumer and often no alternative if the initial wood fuel supply should fails [sic] for any unavoidable reason. The disincentives to preparing for wood fuel supply expansion, in terms of capital costs, are significant and, if it is to happen, considerable practical and financial support will be needed for the infant wood fuel industry to enable it to become fully commercial against a currently competing fossil fuel background of fluctuating yet steadily-rising prices."

CLIMATE CHANGE AND GREENHOUSE GAS EMISSIONS

A recent [topic paper](#) (Forestry Commission Scotland 2005) published to stimulate the consultation on the Scottish Forestry Strategy Review (detailed below) considered climate change and Scotland's forestry in detail. This stated that:

"Scotland's forests already play an important part in the national greenhouse gas budget...Carbon uptake by growing forests in Scotland is of a similar magnitude to the carbon emissions from transport...In CO₂ terms, the loss of Scotland's present forest carbon sink would be the equivalent to an additional 1.5 million cars on the road. However, the current status of forests within Scotland's "carbon economy" almost certainly underestimates the potential contribution that the sector could make over the next 50 years and beyond."

The Environment and Rural Development Committee (2005b) found that land use, forestry and agriculture play a significant role in maintaining Scotland's greenhouse gas budget, because of the high carbon content of its soils, together with extensive cover of blanket bogs and peaty soils. It was estimated by a witness that:

"...in Scotland nearly 170 times more carbon is locked up in soils than is stored in all vegetation. Much of Scotland is covered in deep, peaty soils. On a European scale, that is incredibly important. We hold a disproportionately large amount of the European organic matter of soil because of those peats."

Therefore, agriculture and forestry practices that disturb the soil, such as draining or ploughing, have the potential to rapidly increase the loss of carbon in the form of CO₂ to the atmosphere as soil organic matter oxidises. For this reason, an accelerated expansion in afforestation will have to be sensitive to the primary carbon content of the soil.

EMISSIONS COMPARISONS

Both the Royal Commission on Environmental Pollution (RCEP) (2004) and the SDCS (2005) have stated that one of the key rationales for the promotion of biomass is the reduction in greenhouse gas (GHG) emissions.

In order to effectively map emissions from bioenergy, it is important to analyse areas such as fuel transportation distance, and the thermal efficiency of the plant. The SDCS (2005) has done this in detail. The RCEP (2004) states:

“Realistically in woodfuel there is some net release of CO₂ in field and processing operations, or if the transport of products uses fossil fuel. This can be minimised by using the resource locally. In addition many schemes will not add any further carbon as the forestry operations are being conducted anyway. The transport emissions are minimised by using a fuel source close to demand, and processing by air drying or using waste heat.”

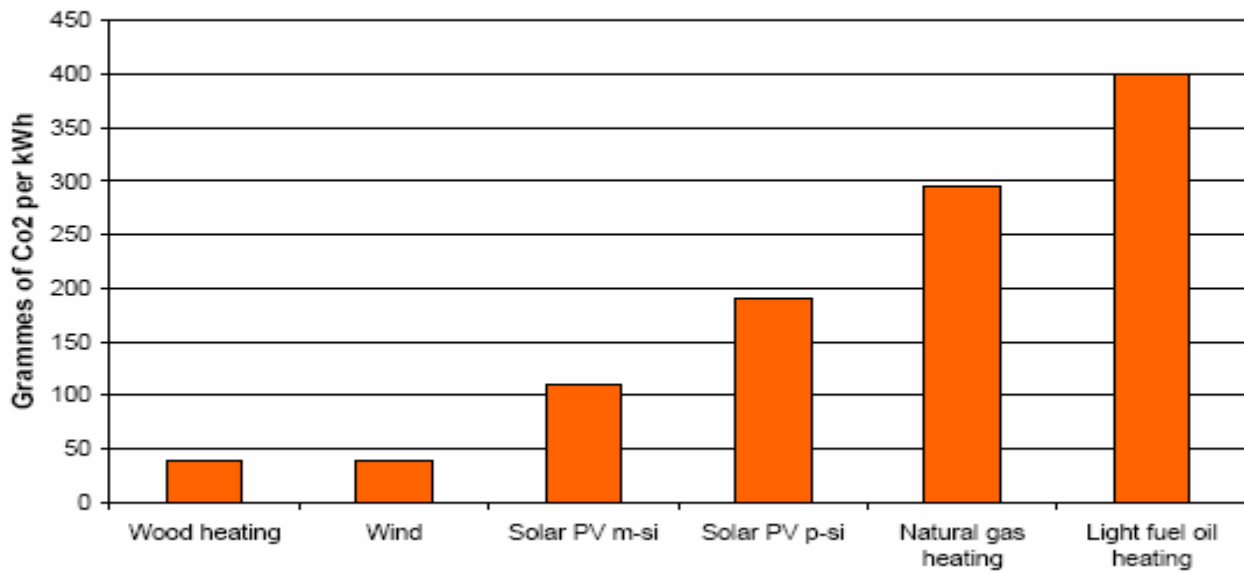
The main value in using biomass is the offset of carbon emissions from fossil fuels. Estimates of net savings in GHG emissions from biomass depend primarily on the type of conventional system⁹ against which the comparison is made. The largest net saving in total GHG emissions (89% - 96%) can be achieved when wood fuel heating systems replace or displace electric radiant heating supplied by the national grid. The smallest savings are between 73% and 90%, when compared to natural gas fired systems (Sustainable Development Commission Scotland 2005). To put this into context, the SDCS (2005) reports that, even when very large transportation distances are assumed for wood fuel, positive and large net savings are recorded. This could amount to up to “23% of total CO₂ emissions from domestic space and water heating in Scotland”.

CHP typically achieves a 35% reduction in primary energy usage compared with power stations and heat only boilers. This can allow the host organisation to make economic savings where there is a suitable balance between the heat and power loads. The current mix of CHP installations achieves a reduction of over 30% in CO₂ emissions in comparison with generation from coal-fired power stations, and over 10% in comparison with gas fired combined cycle gas turbines. The newest installations achieve a reduction of over 50% compared with generation from coal-fired power stations (Combined Heat and Power Association 2005).

Scottish Enterprise (2005) provides the following comparison table:

⁹ Natural gas, LPG, oil, coal and electricity.

CO2 emissions per unit of energy supplied



POLICY

Biomass as a form of wood heating in particular, and of renewable energy in general, touches on, and is affected by, a wide range of policy issues. Scottish Enterprise (2005) notes the necessity for policy synergies in the following areas:

- wider energy policy which, alongside climate change, is driven by a need for security of supply, alleviation of fuel poverty, and competitive markets
- rural development policy, especially relating to forestry and agriculture diversification and economic development/regeneration. It is these issues which the Environment and Rural Development Committee wish to address
- waste policies designed to reduce landfill, particularly the landfilling of carbon based materials
- regional and sub-regional planning policies
- employment and job creation

EUROPE

In December 2005, the European Commission (2005) adopted a detailed [action plan](#) designed to increase the use of energy from forestry, agriculture and waste materials. The plan outlines measures in the heating, electricity and transport sectors. The Commission (2005) estimates that:

“... the measures in the plan will increase the use of biomass to about 150 Mtoe¹⁰ by 2010 (compared with 69 Mtoe in 2003) without increasing the intensity of agriculture or significantly affecting domestic food production. It forecasts that this will reduce greenhouse gas emissions by 209 million tons CO₂-equivalent per year; provide direct employment for 250-300 000 people; and reduce reliance on imported energy from 48% to 42%.”

The European Parliament strongly backed future EU targets for renewable heating and cooling in February 2006, when the energy commissioner reiterated his promise to issue legislative proposals by the end of 2006. The Parliament called for national support schemes within an EU framework to double the current EU 10% share of renewables in heating and cooling by 2020 (ENDS Environment Daily 14 February 2006).

The European Environmental Bureau (2006) has however [urged](#) the Commission to be careful of the wider social and environmental impacts of growing more energy crops, especially in developing countries.

UNITED KINGDOM

The UK Government Energy White Paper (Department of Trade and Industry 2003) sets a target for a 60% reduction in CO₂ emissions by 2050, with real progress by 2020. It sets out three further key strategic goals for UK energy policy:

- to maintain the reliability of energy markets and security of supply
- to promote competitive markets in the UK and beyond
- to ensure that every home is adequately and affordably heated

¹⁰ 150 Mtoe = 1745 MWh, compared to 803 MWh in 2003.

Scottish efforts to help achieve this are discussed below.

At a UK level, the most significant recent development has been the publication of the Biomass Task Force recommendations “to help the Government and the industry develop biomass energy in support of renewable energy targets and sustainable farming and forestry and rural objectives” (Defra 2005). [Emerging conclusions](#) are specifically directed at England and Wales, however many are relevant to Scotland in a wider sense (Department for Environment Food and Rural Affairs 2005).

The Renewable Innovations Review (Department of Trade and Industry 2004b) concluded that constraints on the development of biomass energy were due to large scale developments and immature supply chains therefore the Government should focus on small, regional scale biomass projects, and “develop [the] energy crops option and exploit heat markets to kick start fuel [supply] chains”.

The House of Commons Environment, Food and Rural Affairs Committee (2006) has recently announced an inquiry into [The Role of Bioenergy](#). This is part of a broader series of linked inquiries into aspects of climate change policy. Their call for evidence closed on 3 February 2006. Evidence sessions are scheduled for 1 and 8 March 2006; subsequent oral evidence sessions have yet to be scheduled.

SCOTLAND

As previously noted, the relevant policy framework within which biomass sits is diverse, and likely to evolve as a result of imminent reviews of the [Scottish Forestry Strategy](#) (SFS) (Forestry Commission Scotland 2000), and [Scottish Climate Change Programme](#) (SCCP) (Scottish Executive 2000), and the recent publication of the [Scottish Sustainable Development Strategy](#) (Scottish Executive 2005b). Indeed, in a recent [parliamentary statement](#) on *Forests for Scotland*, the Deputy Minister for Environment and Rural Development, Rhona Brankin, stated (Scottish Parliament Official Report 2006) that the revised SCCP:

“...will recognise the vital role that forestry can play in delivering emissions savings. It will include a commitment to develop a biomass action plan for Scotland and will set an ambitious emissions savings target for the whole forestry sector.”

Additionally:

“As part of the process of developing new targets for combating climate change, we are looking at significant targets for planting in Scotland...We have recognised the importance of forestry and have been working with the private sector on stocking levels, which are being examined in the context of the review of the forestry strategy.”

The aforementioned Biomass Action Plan is likely to be recommended under the forthcoming EU Biomass Action Plan. The Executive has also recently recognised the current disproportionate focus on electricity generation rather than all energy (including heat), and has [announced](#) (Scottish Executive 2006a) that it will develop a renewable heat strategy as part of its forthcoming climate change programme. FREDs is expected to reconvene its Biomass Energy Group in March 2006 to discuss wood fuel for heat, this was omitted from its previous report (Forum for Renewable Energy Development in Scotland 2005).

With reference to the aspirational UK target for a 60% reduction in CO₂ emissions by 2050, the Scottish Executive has committed to increasing the amount of energy generated from

renewable sources to 18% by 2010, rising to 40% of electricity generated by 2020¹¹. “However, like the rest of the EU and the UK, the focus on RE [renewable energy] development has been on electricity, with the heat market and specifically the biomass heat market being largely neglected from the policy and support perspective” (Scottish Enterprise 2005).

Relevant Parliamentary Work

As previously noted, the Scottish Parliament Environment and Rural Development Committee carried out an inquiry into Climate Change in 2005. Also, the Enterprise and Culture Committee carried out an inquiry into renewable energy in 2004. The former noted substantial interest in the potential for farming and agriculture to contribute to the development of a low emissions economy by growing biomass crops for energy. Therefore, it was recommended that (Scottish Parliament Environment and Rural Development Committee 2005a):

“...much greater political priority [should be] accorded to the role of forestry in addressing climate change... Rural development funding, and other support mechanisms, should be examined urgently to assess how they can provide appropriate incentives to develop forestry for carbon sequestration...”

Furthermore:

“...urgent consideration should now be given to climate change issues in agriculture policy... [and that] further development of policy (for example, to encourage energy crops) can stimulate a greater contribution from agriculture to a lower-carbon energy future, such as through biomass...The Committee recommends that the Executive thoroughly examines the opportunities that may be created through rural development funding and other support mechanisms to encourage farm development and diversification into businesses that will be part of this future.”

Two members’ bills with relevance to biomass are currently under consultation.

Sarah Boyack MSP has proposed the [Energy Efficiency and Micro Generation Bill](#) (Boyack 2005). This aims to promote energy savings by requiring the Scottish Executive to support small scale renewable and low carbon energy production both in new and existing households and business premises by regulatory, administrative, and financial measures. This might include amending building standards, setting national targets for micro-power, and providing financial incentives to households. Consultation closes on 17 March 2006.

Shiona Baird MSP has proposed the [Green Micropower Bill](#) (Baird 2005). This would legally require the Executive to adopt a range of measures to encourage the generation of electricity and heat from homes and businesses as an alternative to larger scale power stations. Consultation closes on 6 March 2006.

FORESTRY COMMISSION SCOTLAND

The Forestry Commission Scotland’s framework document for the long term development of forestry is the Scottish Forestry Strategy (Forestry Commission Scotland 2000). Published in 2000, this sets out five strategic directions for Scottish forestry as follows:

1. to maximise the value to the Scottish economy of the wood resource becoming available for harvesting over the next 20 years

¹¹ Targets relate to the amount of renewable electricity generated in Scotland as a proportion of Scottish demand. This is expected to equate to approximately 6 GW of installed capacity by 2020.

2. to create a diverse forest resource of high quality that will contribute to the economic needs of Scotland throughout the 21st century and beyond
3. to ensure that forestry in Scotland makes a positive contribution to the environment
4. to create opportunities for more people to enjoy trees, woods and forests in Scotland
5. to help communities benefit from woods and forests

It states:

“Successful delivery of the Strategy will depend upon effective partnership and co-operation - between the private sector, the Scottish Executive, local Government and the voluntary sector. The Strategy is intended as a framework, to help shape programmes and priorities.”

FCS Role in Wood Fuel and Climate Change

The assessment and development of opportunities for wood-fuel is identified as a priority in the SFS, and the contribution that wood fuel makes to non-fossil fuel use is recognised as a suitable indicator of progress.

The SFS also recognised the scope for small wood fired electricity and heating plants to service rural communities, and the wider role that wood fuel could play in cutting carbon emissions. The FCS further [notes](#) (2006b) that “Bio-energy sources such as wood, residues from harvesting of forests and sawmill co-products...have the potential to make a significant contribution to...rural employment.”

FCS, with support from the Scottish Executive, Scottish Enterprise and Highlands and Islands Enterprise, has recently set up a Bio-energy Information Officer network. Future priorities for FCS in this area include promoting the development of the bioenergy sector and liaising with the National Farmers Union of Scotland to help promote biomass as a fuel within the farming community. Priorities include developing a research programme and [website](#) (Forest Research 2006) to highlight the benefits of wood fuel.

Public consultation on a first stage [review](#) of the Scottish Forestry Strategy closed on 16 September 2005. A draft of a revised strategy, together with an Environmental Report drawn from a Strategic Environmental Assessment is currently being prepared. A second 12 week public consultation on both the revised draft and Environmental Report is due to start in February 2006.

The SFS review consultation document notes that “woodlands can help mitigate climate change by substituting wood for fossil fuels in the production of heat and electricity (biomass energy)”. It further asks whether “woodlands should play a greater role in helping Scotland deal with climate change; if so how?”. This question is supported by a topic paper (Forestry Commission Scotland 2005) on climate change that identifies the potential for wood fuel output from Scotland’s forests as making an additional contribution of 0.6 to 1.5 million tonnes of carbon of avoided emissions per annum, provided that there is an expansion of woodland and forestry to more than 20% land cover. However, the paper further notes that at the current rate of establishment, Scotland’s forest area will fall significantly short of the SFS aspiration of 25% woodland cover by 2050.

One way in which FCS engages with the private sector is by supporting the [Scottish Forest Industries Cluster](#) (SFIC). This was formed in 2000 as a commercial partnership between the forest industries ([Confederation of Forest Industries](#)) and Scottish Enterprise. Its priorities are to develop knowledge, new products and markets, networks, and links with the wider community.

The SFIC (2005b) is focusing on developing the energy market for wood fuel by:

- articulating and disseminating the benefits
- supporting project evaluation and pre-commercial development
- promoting bio-energy schemes
- forming new networks of interest and informing policy development
- supporting the development of a database of wood fuel suppliers

SCOTTISH AGRICULTURE STRATEGY

The current [Scottish Agriculture Strategy](#) (Scottish Executive 2001) recognises that biomass offers scope for development, and undertakes to fund further research. The latest [progress report](#) (March 2005) refers to the FREDS study as the most recent development in this area (Scottish Executive 2005c). Work on updating and reviewing this strategy is currently being taken forward by the [Agriculture Strategy Group](#), which has yet to report, or consult on a revised strategy.

GREEN JOBS STRATEGY

[Going for Green Growth: a green jobs strategy for Scotland](#) (Scottish Executive 2005d) aims to “seize the business opportunities and advantages arising from our belief in and commitment to sustainable development”. It focuses on the opportunity for developing more jobs through new business opportunities in the renewable energy sectors. The Green Jobs Fund amounts to £22m, and is currently supporting the work of FREDS.

DIRECT SUPPORT SCHEMES FOR BIOMASS

As well as the broad policy frameworks pertaining to energy, sustainability, climate change, forestry, employment, rural development etc, there are specific sectoral programmes in place to support specific areas of the biomass supply chain. This section summarises the main funding opportunities that support biomass development in Scotland. Scottish Enterprise (2005) recognises the “complex web” of financial and policy instruments that cover the supply, demand and infrastructure requirements of the biomass supply chain. The SDCS (2005) states:

“These industries are backed up and controlled by different and entirely separate support and administrative systems, often with no areas of overlap, and in some cases with policy (particularly around funding) which actually prevents overlap.”

Concerns over a lack of integration are reinforced by the Environment and Rural Development Committee’s Climate Change Report (2005a), when they state:

“Grant schemes to encourage the creation of farm woodlands have recently been redeveloped. However, again evidence suggested that there is no direct link in these schemes to climate change considerations and no indication of the potential contribution that they could make to reducing emissions. The Minister for Environment and Rural Development suggested that part of the difficulty in developing forestry was a lack of integration between standard agricultural activity and forestry compared to other European countries, and he acknowledged that this needed government action to achieve an attitudinal change.”

This is supported by Scottish Enterprise (2005) who hope that:

“...the current consultations and policy developments will create a simpler, stronger and longer term set of support mechanisms specifically for biomass heat...”

Scottish Forestry Grants Scheme

This [scheme](#) helps implement the Scottish Forestry Strategy, and is the main way FCS engages with the private sector. It provides approximately £20m per annum support to forestry outside the national forest estate (Scottish Executive 2005e), and aims to encourage farmers, landowners and crofters to create and manage woods and forests to provide economic, environmental and social benefits. Grants are available for forestry and woodland expansion, restocking, improvement (called stewardship), and planting on land that has previously been in agricultural use (farmland premium). Planting grants of £1000 per hectare are available for SRC to farmers who have a supply contract with an end user (e.g. a power generating company). This has been welcomed by the National Farmers Union Scotland (2005); however, even at £1000 per hectare the economics of SRC in Fife have been questioned (Tayforth Machinery Ring 2005). This is due to the costs of both fertilising and rabbit proofing the crops. Initial calculations show that profits would be comparable with cereals, therefore:

“...unless yields or the buying price is higher, this is never going to be a very profitable crop. If, however, you were to use free human sludge cake as a fertiliser, as in Ireland, the yields would rise dramatically.”

In a recent statement (Scottish Parliament Official Report 2006b), the Deputy Minister for Environment and Rural Development stated that:

“We support woods other than those in the national forest estate through the Scottish forestry grants scheme and we are now working out the detail of how to integrate the support mechanisms for agriculture, forestry and other activities...to ensure that adequate measures are in place.”

Bio-energy Capital Grants Scheme

This is a UK wide programme funded by the DTI and Big Lottery Fund, and is now closed to new applications. It provides grant funding towards the cost of equipment for biomass fuelled heat, CHP and electricity generating plants (e.g. Lockerbie). The scheme prefers plants to use SRC, although forestry material and agricultural by-products are eligible if there is not a reliable SRC source (Scottish Enterprise 2005).

Total funding amounting to £66m, is to be committed by March 2006 and spent by March 2010. Of this total, £3m was allocated to small scale heat, some of which was still available in December 2005 (Scottish Enterprise 2005).

Bio-energy Infrastructure Scheme

This [scheme](#) applies to both energy crops and forestry wood fuel; it is funded by Defra, and managed in Scotland by the FCS. It is designed to help develop the supply chain required to harvest, store, process and supply biomass to energy end users by funding the establishment of producer groups. Eligible costs include the administrative costs of setting up the group, training and hire or purchase of specialist equipment and storage space (Department for Environment Food and Rural Affairs 2004). The following answer to a parliamentary question (Scottish Parliament 2005) is relevant:

S2W-21425 - Mary Scanlon (Highlands and Islands) (Con) (Date Lodged 5 December 2005) : To ask the Scottish Executive what grants are available to develop the necessary infrastructure to establish the required parts of the biomass supply chain,

providing research and information services to the Scottish Parliament

as outlined in the Forum for Renewable Energy Development in Scotland's report.

Answered by Nicol Stephen (23 December 2005): The Highlands and Islands Development Programme is stimulating considerable interest in woodfuel supply. With funding from the Programme, work is already underway in five areas to develop woodfuel clusters and supply chains. The recent increase we announced to the Forestry Commission Scotland's grant for short-rotation coppice, now up to £1,000 per hectare will also help in this respect.

Grant offers are also being made by Forestry Commission Scotland under the Bio-energy Infrastructure Scheme to help develop the supply chain required to harvest, store, process and supply biomass to energy end users. Along similar lines, the commission is also now trialling a farm woodland energy scheme. Other sources of aid include Regional Selective Assistance which is delivered by the Executive, working closely with partners such as the local enterprise companies. In addition to financial support, information and advice is available from the Woodfuel Information officers appointed by the commission.

Farm Business Development Scheme

This [scheme](#), administered by the Scottish Executive, aims to increase quality of life and prosperity in rural Scotland by providing grant assistance to farming families seeking to diversify. Diversification into growing energy crops, retailing processed products, and the processing of forest products are eligible. A maximum of 50% funding is available, up to £25,000 per business. The scheme is discretionary and competitive (Scottish Executive 2006c).

Scottish Community Householder Renewables Initiative

The [Scottish Community and Householder Renewables Initiative](#) (SCHRI), is financed by the Scottish Executive, and managed jointly by the Energy Saving Trust, and Highlands and Islands Enterprise. This provides both an advisory service, and a grant scheme; biomass projects are eligible. This has guaranteed funding from the Scottish Executive until 2008. There is a grant of 30% for capital costs, and up to £4000 is available to householders. A grant of up to £100,000 is available, for both feasibility studies and capital investment, to organisations including community groups, charities, local authorities, and schools (Energy Saving Trust 2006).

At a recent conference Kearns (2006) suggested that the Executive was, in general, looking to re-focus the SCHRI towards communities, and in particular towards biomass within communities. The Executive is also considering how grants to individual households might better serve those on lower incomes, thus helping to address the fuel poverty agenda. Currently, individual households are obliged to fund 70% of capital costs themselves.

Highlands and Islands Woodfuel Cluster Programme

This has benefited from SCHRI and Bio-energy Infrastructure Scheme funding. It aims to develop six wood fuel clusters across the Highlands and Islands, and provides grants of up to 50% for wood fuel suppliers (chippers, storage facilities etc) and small/medium sized users (boilers, hoppers etc) (Scottish Enterprise 2005).

Renewables Obligation Scotland

The Renewables Obligation (Scotland) Order (ROS), introduced in 2002, obliges licensed suppliers to provide increasing proportions of their electricity from renewable sources. This has the effect of guaranteeing a market for electricity generated from renewable sources. This

scheme has helped the wind sector in particular, which is now more competitive in the electricity market (Scottish Enterprise 2005).

Electricity supplier compliance with the obligation is demonstrated through supplying the regulator, Ofgem, with Renewables Obligation Certificates (ROCs). ROCs are provided to renewables generators in respect of eligible metered generation, and can be sold to suppliers so they can fulfil their obligation. If suppliers do not provide enough ROCs they can pay a buyout price (Scottish Enterprise 2005).

The current version of the ROS ([Renewables Obligation \(Scotland\) Order 2005](#)) came into force on 1 April 2005, and supports direct electricity generation from biomass (e.g. the Lockerbie plant), as well as the co-firing of biomass material with coal (in proportion to the quantity of biomass used in the fuel mix). There is no limit in the legislation¹² to the percentage of biomass material that may be burnt e.g. either forestry waste or SRC, however from April 2009 a minimum proportion of the biomass material (starting at 25%, and rising to 75% by 2011) must come from bespoke energy crops (SRC). This is to provide an incentive for the growth of energy crops. Co-firing in any form will not be eligible for support from April 2016.

Consultation on the [Renewables Obligation \(Scotland\) Review 2005/6](#) (Scottish Executive 2005f) closed in December 2005; this proposed a number of changes that may have an impact on the use of biomass in electricity and CHP plants, and are expected to come into legal effect on 1 April 2006. They include (Scottish Enterprise 2005):

- The lowering of the biomass fuel purity threshold to 90% pure (rather than the current 98%) – this may encourage the use of recycled timber in CHP projects
- reducing the administrative burden for biomass fuels by clarifying that biomass blended off site is eligible. This avoids the expense of mixing and measuring the biomass with coal on site

Scottish Enterprise (2005) concludes:

“...while there are many concrete fiscal and other measures which directly or indirectly support the development of biomass heat, it is clear that the substantial support mechanisms available for renewable electricity (e.g. the ROS) are not available. Furthermore, the capital grants aimed specifically at biomass heat and fuel supply are small and short term, with no clear roadmap for the long term.”

¹² There may however be practical limits.

REGULATORY ISSUES

WASTE

Both FREDS (Forum for Renewable Energy Development in Scotland 2005) and the SDSCS (2005) called for the Scottish Environment Protection Agency (SEPA) to re-examine and clarify how it implements the provisions of the EU Council Directives on waste¹³ and on the incineration of waste¹⁴.

FREDS (Forum for Renewable Energy Development in Scotland 2005) stated:

“Industry has also expressed concern that SEPA practice appears to be to treat each supply of biomass material on a case by case basis. In the absence of transparent and clear guidance, such an approach introduces delay, uncertainty and problems with inconsistency of interpretation which hinder investment.”

In October 2005 SEPA published guidance to staff entitled [Is it waste? Understanding the definition of waste](#). This gives four examples of waste scenarios as follows, and states:

“It is also important to check for consistency in approach and consider the impacts of a decision on other processes and waste streams, as well as the regulatory impact.”

- 1. Fuel produced from waste remains waste until it is burned to produce energy. This principle applies to dried sewage sludge pellets, recovered fuel oil, tallow, refuse derived fuels, sawdust from used or treated wood, off cuts from chipboard manufacture, etc.*
- 2. Biofuel from timber and other crops grown to be used as biofuel is not waste.*
- 3. Wood chips and sawdust from virgin timber which is processed into timber products for use as e.g. biofuel or chipboard manufacture, are unlikely to be waste where the processor can demonstrate that the material is not being discarded and there is no intention or requirement to discard it during the harvesting and processing activities.*
- 4. Forestry brash, lop and top is unlikely to be waste if it is being produced for a specific use and there is certainty that it will be used for that purpose.”*

SMOKELESS ZONES

The Clean Air Act 1993 (c.11) allows the creation of Smoke Control Areas, which local authorities enforce. Currently, wood fuel boilers, regardless of their emissions, must have passed tests to confirm that they are capable of burning wood fuel without emitting smoke. Fuel and appliance manufacturers must either submit their product for testing or provide sufficient information and evidence to allow exemption. Scottish Statutory Instruments permits these exemptions. [3G Energi](#) state (2006):

“Getting appliances exempted for use in a Smoke Control Area, is an expensive, time consuming and costly exercise. A blanket exemption for wood pellet fuelled appliances would be a huge leap forward in tackling the urban/sub-urban markets. This exemption could be based on European emission standards if required.”

¹³ The Framework Directive on Waste [75/442/EEC](#) (as amended).

¹⁴ The Waste Incineration Directive [2000/76/EC](#).

APPENDIX 1. SCOTTISH CASE STUDIES.

The following case studies have been adapted from the SDCS (2005) report.

WHITEGATES DISTRICT HEATING SCHEME LOCHGILPHEAD

This is the first large-scale wood fuel heating scheme in Scotland. It supplies a local housing association development of 50 residential properties and a respite care home; it was built as a partnership project between Fyne Homes and a local builder.

The heating scheme consists of an energy centre (boiler house and fuel storage) and a network of underground heating circuits delivering metered hot water to all properties where it supplies independent central heating and hot water. The boiler house is comparable in size to a domestic garage. The flow temperature of the water is approximately 77°C and returns at about 50°C. There is spare capacity in the system that could supply two buildings in close proximity: the local Forestry Commission offices, and Adult Learning Centre, which currently run on fossil fuelled devices. A survey and estimate of costs has recently been carried out to connect the Adult Learning Centre to the system, as well as to develop a package of improvements to the system as a whole. The package of improvements are needed because the system has experienced a number of operational problems, due primarily to this being the first of its kind, and also due to the original installer, Torren Energy, going bankrupt. It is likely that an application to the SCHRI will be made to enable this development.

The operation and maintenance of the plant is run by Vital Energy of Bolton, who are carrying out a programme of capital improvements, and who provide local on site management and liaison with residents. Vital Energy also administers a card prepayment system that enables residents to purchase heat credits in advance from the local supermarket, thereby avoiding getting into debt. Fyne Homes pays directly for the supply of all wood fuel, and heating oil for the back-up generator.

Wood chips are currently supplied by a family business near Campbeltown which has diversified from farming into sawmilling; this represents a 104 mile round journey, with the lorry returning empty to Campbeltown. Wood chips are derived from the sawmilling process and from purchasing small roundwood that has been felled and air dried locally. The sawmill has recently obtained a 50% grant¹⁵ towards the construction of a new storage and drying facility; it is hoped that this will help to stabilise the moisture content of the wood chips, which has caused some operating problems in the past. Grant funding of £20,000 was obtained from the SCHRI to enable Fyne Homes to buy the wood chip boiler.

The total installation costs were £230,000, and the overall running costs have been estimated at £28,453 per annum. All other costs considered, this works out at a cost for heat to the occupiers of 3.7p per kWh, in comparison to 4.31p per kWh for oil. The SDCS (2005) state:

“Burning wood chips would save around 226 tonnes of carbon dioxide, assuming that the wood chips replace oil and the oil boiler is not used at any time. Offset against this would be the amount of fuel used in deliveries. The sawmill is 52 miles away from Lochgilphead, a round trip of 104 miles per delivery.”

¹⁵ Provided under the Highlands and Islands Woodfuel Cluster Programme.

PELLET STOVE IN LOG CABIN AVIEMORE

This two bedroomed log cabin near Aviemore is let to holidaymakers throughout the year, mostly weekends in winter. A pellet stove has been installed as a space heater. This is easy to use, and visitors are not required to fill the hopper, or empty the ash. It is self-lighting using electric ignition, with a thermostat and timer.

The stove is rated at 5 KW, with an approximate efficiency of 90%. Heat output can be adjusted to 2 KW. The hopper holds 11 kg of pellets; because of the short term nature of the lets, it does not require filling very often. Constant use of the stove would require the hopper to be filled every three days. Ash is removed every two months. The flue exits through the wall behind the stove, and required individual building control from the local authority.

The total purchase cost was £2343.22; the owner saved costs by installing it himself. The unit cost of the pellets is 5.9p per KWh. If it had not been installed, the alternative fossil fuel would be electricity.

APPENDIX 2. FINLAND CASE STUDY

This case study has been adapted from a presentation made at a recent Bioenergy Conference (Hulkonen 2006). Whilst the development of biomass in Finland is noteworthy, it is important not to make over-simplistic assumptions about the degree to which this may be replicated in Scotland.

Finland is one of the world's leading countries in biomass utilisation. It has a strong forest industry, with a mature wood delivery chain, logistics and infrastructure. At present, biomass represents approximately 21% of primary energy consumption, spread via:

- 113 municipal district heating plants
- 67 industrial heating stations
- 30 municipal and 17 industrial CHP plants

The majority of these plants are situated in the south of the country, close to the main forest resource.

In a policy context, biomass sits within Finland's action plan for renewable energy; this is part of the 2001 National Climate Change Strategy. Currently, Finland is aiming to produce 8.3m tonnes¹⁶ of oil equivalent energy from biomass by 2010. This includes sub targets for electricity production, biofuels for transport, and the use of forest chips. By 2010, Finland aims to have 30,000 domestic properties using pellets to supply heat, and 400-500,000 hectares of land growing energy crops.

Investment grants are available for conventional biomass technology at 25-30%, with innovative projects receiving 40%. Additionally, wood harvesting for energy receives support of €7 per solid m³. This is paid to the supplier when the user has received the fuel, and amounted to €3.9 million in 2003. Tax refunds are also available for renewable electricity generation at a rate of €6.9 per MWh for forest residues, and €4.2 per MWh for other wood fuels. A CO₂ tax is also in place for fossil fuels.

The most recent predictions (2005) show that Finland's total consumption of renewable energy is likely to be 25% by 2015, and 40% by 2025. This is partly due to an energy mix of the following fuels increasing from 2% in 2004 to 6% within 10-15 years:

- wood chips from logging residues
- agricultural biomass
- recycled fuels
- biogas

A new nuclear power station is currently [under construction](#) in Finland (BBC 2006c).

¹⁶ 8.3 Mtoe = 96.5 TWh

SOURCES

3G Energi [Online]. Available at: <http://www.3genergi.co.uk/>

3G Energi. (2006) Submission to Scottish Parliament Environment and Rural Development Committee Biomass Inquiry. [Online]. Available at: <http://www.scottish.parliament.uk/business/committees/environment/inquiries/biomass/bio-3G.pdf>

AEA Technology. (2006) *Scottish Energy Study*. Edinburgh: Scottish Executive. Available at: <http://www.scotland.gov.uk/Resource/Doc/89781/0021572.pdf>

Baird, S. (2005) *Green Micropower Bill Consultation paper: Small is Beautiful*. Edinburgh: Scottish Parliament. Available at: http://www.scottish.parliament.uk/business/bills/pdfs/mb-consultations/micropower_consultation.pdf

Boyack, S. (2005) *The Energy Efficiency and Micro-Generation Bill Proposal*. Edinburgh: Scottish Parliament. Available at: <http://www.scottish.parliament.uk/business/bills/pdfs/mb-consultations/microgeneration.pdf>

BBC. (2006a) *Work Begins on Bio Power Station*. [Online]. Available at: <http://news.bbc.co.uk/1/hi/scotland/4652292.stm> [Accessed 14 February 2006].

BBC. (2006b) *Ukraine and Russia Reach Gas Deal*. [Online]. Available at: <http://news.bbc.co.uk/1/hi/world/europe/4579648.stm> [Accessed 14 February 2006].

BBC. (2006c) *Nuclear Industry Looks to Finland*. [Online]. Available at: <http://news.bbc.co.uk/1/hi/scotland/4683248.stm> [Accessed 14 February 2006].

Combined Heat and Power Association. (2005) *How does CHP work?* [Online]. Available at: <http://www.chpa.co.uk/aboutchp.htm> [Accessed 7 February 2006].

Confederation of Forest Industries [Online]. Available at: <http://www.confor.org.uk/>

Cook, G. (2005) *Climate Change*. SPICe Briefing 05/04. Edinburgh: Scottish Parliament. Available at: <http://www.scottish.parliament.uk/business/research/briefings-05/sb05-04.pdf>

Cook, G and Dewar J. (2003) *Renewable Energy*. SPICe Briefing 03/89. Edinburgh: Scottish Parliament. Available at: <http://www.scottish.parliament.uk/business/research/briefings-03/sb03-89.pdf>

The Courier. (5 August 2005) *Fife to Produce "Green" Paper*. Dundee: DC Thomson. Available at: <http://www.thecourier.co.uk/output/2005/08/05/newsstory7405185t0.asp> [Accessed 7 February 2006].

Department for Environment Food and Rural Affairs. (2004) *Bio-energy Infrastructure Scheme*. London: Department for Environment Food and Rural Affairs. Available at: <http://www.defra.gov.uk/farm/acu/energy/infrastructure.htm>

Department for Environment Food and Rural Affairs. (2005) *Energy: Biomass Task Force*. London: Department for Environment Food and Rural Affairs. Available at: <http://www.defra.gov.uk/farm/acu/energy/biomass-taskforce/index.htm>

Department of Trade and Industry. (2003) *Our Energy Future – creating a low carbon economy*. London: Department of Trade and Industry. Available at: <http://www.dti.gov.uk/energy/whitepaper/index.shtml>

Department of Trade and Industry. (2004a) *The UK Cleaner Coal Technology Programme*. [Online]. Available at: <http://www.dti.gov.uk/energy/coal/cfft/cct/index.shtml>. [Accessed 10 February 2006].

Department of Trade and Industry. (2004b) *Conclusions of the Renewables Innovation Review*. London: Department of Trade and Industry. Available at: http://www.thecarbontrust.co.uk/carbontrust/about/publications/renewable_innovations_review.pdf

Department of Trade and Industry. (2006) *Welcome to the Joint Energy Security of Supply Working Group*. [Online]. Available at: <http://www.dti.gov.uk/energy/jess/index.shtml>. [Accessed 10 February 2006].

ENDS Environment Daily. (14 February 2006) *Parliament Backs EU Renewable Heating Targets*. London. Ends Environmental Data Service.

Energy Saving Trust. (2004) *Biomass – Small Scale*. Factsheet 8. [Online] Available at: <http://www.est.org.uk/download.cfm?p=0&pid=76>. [Accessed 8 February 2006].

Energy Saving Trust. (2006) *Scottish Community and Householder Renewables Initiative*. [Online]. Available at: <http://www.est.org.uk/schri/>. [Accessed 10 February 2006].

European Commission. (2005) *European Commission Proposes Ambitious Biomass and Biofuels Action Plan and Calls on Member States to do More for Green Electricity*. [Online]. Available at: <http://europa.eu.int/rapid/pressReleasesAction.do?reference=IP/05/1546&format=HTML>. Press release 7 December 2005.

European Environmental Bureau. (2006) *Biofuels No Panacea*. [Online]. Available at: http://www.eeb.org/press/pr_biofuels_no_panacea_080206.htm. Press release 8 February 2006.

Forestry Commission Scotland [Online]. Available at: <http://www.forestry.gov.uk/scotland>

Forestry Commission Scotland. (2000) *Scottish Forestry Strategy*. Edinburgh: Forestry Commission Scotland. Available at: <http://www.forestry.gov.uk/forestry/cmar-5j8l7s>

Forestry Commission. (2005) *Forestry Facts and Figures 2005*. Available at: [http://www.forestry.gov.uk/pdf/fcfs205.pdf/\\$file/fcfs205.pdf](http://www.forestry.gov.uk/pdf/fcfs205.pdf/$file/fcfs205.pdf)

Forestry Commission Scotland. (2005) *Climate Change and Scotland's Forestry*. Topic Paper No. 1. [Online]. Available at: [http://www.forestry.gov.uk/pdf/topic_paper_1.pdf/\\$FILE/topic_paper_1.pdf](http://www.forestry.gov.uk/pdf/topic_paper_1.pdf/$FILE/topic_paper_1.pdf) [Accessed 10 February 2006].

Forestry Commission Scotland. (2006a) *Personal Communication*. [Unpublished].

- Forestry Commission Scotland. (2006b) *Bio-energy* [Online]. Available at: <http://www.forestry.gov.uk/forestry/infd-6b2jgg> [Accessed 13 February 2006].
- Forest Research. (2006) *Woodfuel Information Pack*. Farnham: Forest Research. Available at: <http://www.forestresearch.gov.uk/fr/infd-66shag>
- Forum for Renewable Energy Generation in Scotland. (2005) *Promoting and Accelerating the Market Penetration of Biomass Technology in Scotland*. Edinburgh: Scottish Executive. Available at: <http://www.scotland.gov.uk/Resource/Doc/1086/0007305.pdf>
- Fraser of Allander Institute. (2006) *The Economic Impact of Wood heat in Scotland*. Glasgow: Fraser of Allander Institute. Available at: http://www.forestryscotland.com/pages/download.asp?file=Fraser_of_Allander_Woodheat_Economic_Study.pdf
- House of Commons Environment, Food and Rural Affairs Committee. (2006) *Climate Change: EFRA Committee to Examine the Role of Bioenergy*. [Online]. Available at: http://www.parliament.uk/parliamentary_committees/environment_food_and_rural_affairs/efra_pn16_051215.cfm [Accessed 13 February 2006].
- Hulkonen, S. (2006) *Presentation to Scottish Renewables Bio Energy Seminar*. Friday 10 February 2006. [Unpublished].
- Intergovernmental Panel on Climate Change. (2001) *Climate Change 2001: The Scientific Basis*. Available at: http://www.grida.no/climate/ipcc_tar/wg1/index.htm
- Kearns, S. (2006) *Presentation to Scottish Renewables Bio Energy Seminar*. Friday 10 February 2006. [Unpublished].
- Kidney, E. (2006) *Presentation to Scottish Renewables Bio Energy Seminar*. Friday 10 February 2006. [Unpublished].
- Luker, S. (2004) *Woodfuel Prices for Heating*. [Online]. Available at: http://www.forestryscotland.com/pages/download.asp?file=Woodfuel_prices_for_heating_Steve_Luker_Sept04.pdf. [Accessed 15 February 2006].
- Luker, S. (2006) *Personal Communication*. [Unpublished].
- Mosco, L. (2006) *Personal Communication*. [Unpublished].
- National Farmers Union Scotland. (2005) *Warm Welcome for Coppice Grant Change*. [Online] Available at: http://www.nfus.org.uk/news_detail.asp?newsID=670&homepage=yes. [Accessed 17 February 2006].
- New Opportunities Fund; Bio-energy Capital Grants Scheme* [Online]. Available at: <http://www.nof.org.uk/default.aspx?tc=394&tct=1&fc=63&fct=2>. [Accessed 17 February 2006].
- Pendlebury, J. (2006) *Presentation to Scottish Renewables Bio Energy Seminar*. Friday 10 February 2006. [Unpublished].
- Rakos, C. (2003) *How Biomass Use Developed in Austria*. [Online]. Available at: http://www.bioheat.info/pdf/pichl_rakos_at.pdf. [Accessed 17 February 2006].

The Renewables Obligation (Scotland) Order 2005. SSI 2005/185. London: HMSO. Available at: <http://www.opsi.gov.uk/legislation/scotland/ssi2005/20050185.htm>

Reid, A. (2005) *Forestry in Scotland*. SPICe Briefing 05/67. Edinburgh: Scottish Parliament. Available at: <http://www.scottish.parliament.uk/business/research/briefings-05/SB05-67.pdf>

Royal Commission on Environmental Pollution. [Online]. (2004) *Royal Commission Study on the use of Biomass for Heat and Power Production*. Available at: <http://www.rcep.org.uk/energycrops.htm>. [Accessed 14 February 2006].

Scottish Agricultural College. (2002) *Energy from Willow*. [Online]. Available at: <http://www1.sac.ac.uk/envsci/External/WillowPower/>. [Accessed 14 February 2006].

Scottish BioFuel. (2005) *Energy Crop Opportunities for 2006 Planting*. Gartlove: Scottish BioFuel Ltd.

Scottish Enterprise. (2005) *Scoping Study: The Commercial Opportunities of Wood Fuel Heating in Scotland*. Glasgow: Scottish Enterprise. Available at: [http://www.forestryscotland.com/download.asp?file=Econergy Woodheat Final report.pdf](http://www.forestryscotland.com/download.asp?file=Econergy%20Woodheat%20Final%20report.pdf)

Scottish Environment Protection Agency. (2005) *Is it Waste? Guidance for SEPA Staff*. [Online]. Available at: http://www.sepa.org.uk/pdf/guidance/waste/is_it_waste.pdf. [Accessed 14 February 2006].

Scottish Executive. (2000) *The Scottish Climate Change Programme Review*. [Online]. Available at: <http://www.scotland.gov.uk/Topics/Environment/Climate-Change/16327/SCCPReview>. [Accessed 14 February 2006].

Scottish Executive. (2001) *The Agriculture Strategy*. [Online]. Available at: <http://www.scotland.gov.uk/Topics/Agriculture/Agricultural-Policy/17289/7902>. [Accessed 16 February 2006].

Scottish Executive. (2005a) *Scotland's Enterprising Spirit - Whisky Industry Case Studies*. Press release 28 November 2005. Edinburgh: Scottish Executive. Available at: <http://www.scotland.gov.uk/News/News-Extras/whiskyindustry>

Scottish Executive. (2005b) *Choosing Our Future: Scotland's Sustainable Development Strategy*. Edinburgh: Scottish Executive. Available at: <http://www.scotland.gov.uk/Publications/2005/12/1493902/39032>

Scottish Executive. (2005c) *Agriculture Strategy 2001, Progress Report*. [Online]. Available at: <http://www.scotland.gov.uk/Topics/Agriculture/Agricultural-Policy/17289/13971>. [Accessed 16 February 2006].

Scottish Executive. (2005d) *Green Jobs Strategy*. Edinburgh: Scottish Executive. Available at: <http://www.scotland.gov.uk/Topics/Business-Industry/Enterprise/18320/13232>

Scottish Executive. (2005e) *Draft Budget 2006-07*. Edinburgh: Scottish Executive. Available at: <http://www.scotland.gov.uk/Publications/2005/09/06112356/23573>

Scottish Executive. (2005f) *The Renewables Obligation (Scotland) Review 2005/6*. Edinburgh: Scottish Executive. Available at:
<http://www.scotland.gov.uk/Publications/2005/09/13105127/51301>

Scottish Executive. (2006a) *Renewable Heat Strategy in Pipeline*. Press release 8 February 2006. Edinburgh: Scottish Executive. Available at:
<http://www.scotland.gov.uk/News/Releases/2006/02/07163339>

Scottish Executive. (2006b) *Farm Business Development Scheme*. [Online]. Available at:
<http://www.scotland.gov.uk/Topics/Agriculture/grants/BDandM/FBDS/Intro>. [Accessed 15 February 2006].

Scottish Forest Industries Cluster [Online]. Available at: <http://www.forestryscotland.com/>

Scottish Forest Industries Cluster. (2005a) *Summary report of the Third Cluster Conference, 'Opportunities for Investment in Scotland's Forest Industries' 3-4 February 2005*. [Online]. Available at:
<http://www.forestryscotland.com/pages/displaypressrelease.asp?pr=148&loc=latest>. [Accessed 13 February 2006].

Scottish Forest Industries Cluster. (2005b) *Bioenergy and Woodfuel*. [Online]. Available at:
<http://www.forestryscotland.com/pages/bio.asp>. [Accessed 13 February 2006].

Scottish Forest Industries Cluster. (2006) *Personal Communication*. [Unpublished].

Scottish Parliament Enterprise and Culture Committee. (2004) *6th Report 2004: Renewable Energy in Scotland*. SPP 194. Edinburgh: Scottish Parliament. Available at:
<http://www.scottish.parliament.uk/business/committees/enterprise/reports-04/elr04-06-01.htm>

Scottish Parliament Environment and Rural Development Committee. (2005a) *5th Report 2005: Report on Inquiry into Climate Change*. SPP 342. Edinburgh: Scottish Parliament. Available at:
<http://www.scottish.parliament.uk/business/committees/environment/reports-05/rar05-05-vol01-01.htm>

Scottish Parliament Environment and Rural Development Committee. (2005b) *Developments in the Biomass Industry* [Online]. Available at:
<http://www.scottish.parliament.uk/business/committees/environment/inquiries/biomass/env-biomass-home.htm> [Accessed 1 February 2006].

Scottish Parliament. (2005) *Written Answers Monday 19 December 2005 to Friday 23 December 2005*. S2W-21425. Edinburgh: Scottish Parliament. Available at:
<http://www.scottish.parliament.uk/business/pqa/wa-05/wa1223.htm#12>

Scottish Parliament. (2006a) *Official Report 26 January 2006*. Col 22851. Edinburgh: Scottish Parliament. Available at:
<http://www.scottish.parliament.uk/business/officialReports/meetingsParliament/or-06/sor0126-02.htm#Col22848>

Scottish Parliament. (2006b) *Official Report 26 January 2006*. Col 22849. Edinburgh: Scottish Parliament. Available at:
<http://www.scottish.parliament.uk/business/officialReports/meetingsParliament/or-06/sor0126-02.htm#Col22848>

Scottish Wild Land Group. (2006) *Winter Newsletter No.65*. Edinburgh: Scottish Wild Land Group.

Smith, B. (2006) *Presentation to Scottish Renewables Bio Energy Seminar*. Friday 10 February 2006. [Unpublished].

Sustainable Development Commission Scotland. (2005) *Wood Fuel for Warmth*. Edinburgh: Sustainable Development Commission Scotland. Available at:
http://www.sd-commission.org.uk/news/download_pdf.php?attach_id=T472CQY-76G8X6J-RPAG47Z-5THHT8H

Tayforth Machinery Ring. (2005) *Autumn 2005 Newsletter*. [Online]. Available at:
<http://www.tayforth.co.uk/newslett.htm>. [Accessed 20 February 2006].