SUPPORTING BIOMASS ELECTRICITY IN THE RENEWABLES OBLIGATION (SCOTLAND)

PREPARED FOR
FORESTRY COMMISSION SCOTLAND & THE SCOTTISH GOVERNMENT

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TABLE OF CONTENTS

ACRONYMS

Acronym	Full Term
CCC	Committee on Climate Change
CCGT	Combined Cycle Gas Turbine
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
EMR	Electricity Market Reform
EST	Energy Saving Trust
FiT CfD	Feed in Tariff with Contract for Difference
GHG	Greenhouse Gases
GW	Gigawatt (1,000 MW)
GWh	Gigawatt hour (1,000 MWh)
kg eq. CO_2/MWh	Kilogram equivalent of CO_2 per MWh
kW	Kilowatt (1,000 watts)
kWth	Kilowatt (thermal energy)
MW	Megawatt (1,000 kilowatts)
MWe	Megawatt electrical
MWh	Megawatt hour
odt	Oven Dried Tonnes
RHI	Renewable Heat Incentive
RO	Renewables Obligation
ROC	Renewables Obligation Certificate
ROS	Renewables Obligation Scotland
SDC	Sustainable Development Commission
TWh	Terrawatt hour (1,000 GWh)
XE	Xero Energy

Executive Summary

This report was commissioned by the Forestry Commission Scotland and the Scottish Government as background material for its review of support for large and small scale biomass electricity only plant under the Renewables Obligation Scotland. Our work has been to assess what is the best use of wood fibre given demands from different users, and to consider the circumstances when it might be appropriate to use wood fibre for electricity generation, and at what scale.

We have found that a threshold can be justified, in part because of greenhouse emission levels but also because of the need to limit wider impacts on Scotland's wood fibre resource.

Key findings

- ➔ Supporting smaller wood fuelled electricity plant in Scotland would be expected to bring local economic development and incentivise use of inaccessible resources. Electric only plants could act as "first markets" to encourage active forestry management and potentially the development of wider heat markets.
- ➔ We would recommend setting a 10MW threshold level, based on the finding that a moderate level of development (a limited number of between five and ten 10MW plants) could be met within Scotland's estimated net available resource.
- ➔ A threshold capacity below 50MW is clearly justified as beneath this level supply will be coming from domestic sources, and so likely to impact on supply to other users. However, even down to a 20MW threshold level, such a threshold capacity could lead to too high an impact on other wood fibre users.
- ➔ Greenhouse gas emission modelling shows that heat only biomass plant has lower emissions/MWh than power only, and electricity from CHP plant generally has lower emissions/MWh than power only plant. However electricity from larger "poor quality" CHP plants sourcing fuel over longer distances, and electricity from small scale power only plants sourcing fuel locally, both have comparable emissions/MWh.

In setting any threshold capacity, the Scottish Government needs to recognise that it will have to factor in a range of competing issues, of which emissions and available resource are the most significant. While both factors suggest it is right to be cautious about supporting use of wood fibre for electricity generation, some support for biomass electricity only schemes can still clearly be justified. We see that this justification comes in part because of questions about how quickly available resource will be taken up by other users, and also because of the benefits of appropriately sited smaller plant.

On balance we judge that a threshold level of around 10 MW would incentivise localised deployment of appropriate scale schemes, and that this would be consistent with the Scottish Government's National Planning Framework. Critically, a limited deployment of schemes up to 10MW could be met from net available resource.

However, we recognise that there are risks associated with this rather qualitative approach that should be debated with the wider industry as part of the Renewable Obligation Scotland Banding Review consultation. In particular the Scottish Government will want to test the recommended threshold, as well as assumptions on expected levels of development and the impact this would have on other wood fibre users.

1 Introduction

Scotland has renewable electricity and heat targets that mean biomass – here defined as virgin wood fibre and recycled/waste wood - is naturally seen as a significant source of fuel for both the electricity and heat sector. There is a significant potential resource of wood – both from commercial forestry and from waste sources.

However, while this wood resource is a sustainable and renewable one, the amount useable – either from domestic or global stocks - at any given time is finite. These limits stem from the available resource that can be felled or diverted from the waste stream. In addition there are other wood-based industries who have expressed concerns to the Scottish Government about ongoing availability of the resource, should fuel demands from the energy sector increase. While the renewables sector is set to grow, sawmill and wood panel industries also share aspirations for growth over time.

Because of this the Scottish Government wishes to consider whether biomass use should be prioritised in any way. A more detailed description of its rationale is set out in Appendix 8.1. In particular it needs to be aware of how different support mechanisms – notably the Renewables Obligation (RO) and Renewable Heat Incentive (RHI) – work together.

This report forms one of three pieces of work by which the Scottish Government is fulfilling its commitment to review support for large and small scale biomass electricity-only plant under the Renewables Obligation Scotland (ROS). Its current consultation proposes setting a capacity threshold under the ROS, above which support for dedicated biomass stations would no longer be available. It is currently seeking views and evidence on:

- Its proposal not to incentivise new large scale dedicated biomass electricity;
- The circumstances under which it may be appropriate to set a threshold for electricity only generation; and
- What the threshold should be [1] [2].

As part of this research Xero Energy (XE) was asked to provide policy support to accompany some technical research – specifically, a Scottish biomass review sponsored by Forestry Commission Scotland and managed by Forestry Research:

- To consider what is the best use of wood fibre given the opportunities both for renewable energy generation and the production of timber products from the conventional wood using industries;
- To consider the circumstances when it might be appropriate to use wood fibre for electricity generation, and at what scale.

While sources of wood and fibre are available from both domestic and imported sources, it is important to understand the impact that increasing demand will have on Scotland's wood products industry, as well as to question if sufficient material will be available to fuel renewable electricity and renewable heat installations incentivised under the RO and RHI. Broadly, this report considers the impact of these policy decisions on domestic (i.e. Scottish) supplies of wood and fibre.

This report is organised with the following layout:

- Section 1 Introduction – this section.
- Section 2 Background
- Section 3 Methodology
- Section 4 Carbon Impacts of Bioenergy
- Section 5 Woodfuel Availability and Demand in Scotland
- Section 6 Discussion
- Section 7 Recommendations

The appendices include supplementary figures including more detailed information and data from relevant reports.

2 Background

2.1 Scottish Government Policy Support

The Scottish Government has significant policy aspirations to see renewable electricity and heat projects deployed across Scotland. With a renewable electricity target of 100% of domestic demand by 2020, and a renewable heat target of 11% of heat demand by 2020 [1], significant changes will be required to our current energy mix. Scotland has delivered approximately ¼ of each target (25% and 2.8% respectively) which demonstrates strong progress in a relatively short time period, but also highlights the changes still required.

Bioenergy is one of the few forms of renewables that is well suited to both electricity and heat production[1]. However, unlike other forms of renewables such as wind or hydro power that rely solely on the natural elements for their resource, bioenergy relies on either forestry or agricultural activities (or waste streams that come from these activities), and the potential exists to exhaust any available resource before it can be renewed.

The Scottish Government supports the development of renewable energy in a number of ways. Most recently this was in the form of grants to encourage installations – for example the Scottish Biomass Heat Scheme. Market support for electricity production is in the form of the ROS - legislation which sets an Obligation on supply companies in Scotland to either source a percentage of their electricity from renewable sources, or alternatively to pay a penalty.

The Scottish Government has set out that it "would prefer to see biomass deployed in heat-only or combined heat and power schemes, off gas-grid, at a scale appropriate to make best use of both the available heat, and of local supply" [3].

2.2 Support of Biomass through the ROS and RO

The ROS is an executively devolved policy so is the responsibility of the Scottish Government. It stems from UK laws which set separate Obligations for England and Wales (E&W), Scotland and Northern Ireland. The Obligations are similar and Renewable Obligation Certificates are tradable throughout the UK, but each region has the ability to flex eligibility for ROCs to meet specific requirements. Whilst the UK Government is committed to extending use of bioenergy for electricity generation through the E&W Obligation, the Scottish Government and other Scottish bodies have expressed concern about ongoing use of bioenergy in electricity generation, and whether it is correct to incentivise its use through the ROS.

The Scottish Government is currently consulting on proposed banding levels for the ROS. Following consultation which will end in early 2012, the Scottish Government is expected to announce its decision on levels prior to 1st April 2013, for new levels which will apply between 1st April 2014 and 31st March 2017.

It is clear that the UK and Scottish Governments have differing views for the role of bioenergy. While the Scottish Government has set out its preference for biomass to be used in heat-only and CHP installations [3], the UK Government foresees a significant role for biomass (primarily sourced from non-UK sources) as a fuel for renewable electricity generation.

[1] And in some cases for transport fuels, though these are not covered within this report.

The UK already has 2.5GW of biomass electricity capacity, accounting for 11.9TWh of generation, which makes biomass the UK's largest contributor to renewable electricity targets. While the majority of this contribution comes from waste (62% of which is predominantly from landfill gas), 21% of this comes through co-fired biomass and 17% from dedicated biomass plant [4]. The use of biomass to meet electricity targets has been predominantly in England and Wales rather than Scotland or Northern Ireland. The UK Government projects an increasing contribution of biomass electricity towards UK targets, and its "central range for deployment" indicates that biomass could contribute up to 6GW by 2020 [4].

Continued UK Government support for biomass in electricity generation would be alongside support for use of biomass to meet renewable heat targets. In 2010 the UK generated 12.4 TWh of renewable heat from biomass, and the UK Government sees that using the RO and the new Feed in Tariff with Contract for Difference (FiT CfD) mechanism[2] could deliver between 32 and 50TWh by 2020, with the majority of the increase coming from biomass generation (including CHP). An increase from 12.4TWh to 50TWh would require a 17% annual growth rate [4] [5].

The UK Government's priority is to focus support (in the RO in England and Wales) over the 2013-2017 period on "cheaper and more transitional technologies of conversion[3] and co-firing"[4] [5]. Its view is that these "new biomass electricity bands for these will enable us to provide appropriate support for the use of existing infrastructure. Although existing plants may use biomass feedstocks less efficiently than new power stations, this policy offers reduced costs and reduces the risk of locking in long-term feedstock demand" [5].

However, the Scottish Government has concerns over the availability of feedstocks to supply this growing demand, noting that if "imports prove more expensive (which is likely) or difficult to access in an increasingly competitive global market, electricity generators may again seek to tap into the existing forest industries' supply chains. Even if this were to be for only a small part of their needs, we believe the impacts on the existing wood processing industries and delivery of the renewable heat target could be significant [3].

The UK Government expects the overwhelming majority of fuels for expansion of biomass electricity to come through imports. Based on research commissioned for the RO Banding Review the UK Government has made the assumption that larger plant (50-300MW) will import bulk feedstock from outside the UK, while plants below 50MW will use a wider range of locally sourced feedstocks. The UK Government has assumed a 10:90 domestic to imports ratio for plants over 50MW in size and 90:10 for those below 50MW in size [5].

The UK Government's proposals to shift the focus towards more transitional technologies are backed by RO support payments (and comparative Scottish Government proposals). They are detailed in Appendix 8.2.

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2 The FiT CfD is a part of the UK Government's Electricity Market Reform programme.

3 By conversion, the UK Government means former fossil fuel generating stations (including co-firers) which convert, or have already converted, to generate all their electricity from biomass.

4 The UK Government is proposing a new band for enhanced co-firing, which will be for co-firing generators using biomass to generate at least 15% of their gross output.

2.3 Electricity Market Reform

The UK Government has proposed changes to the way low-carbon electricity generation is supported. Its White Paper on Electricity Market Reform (EMR) [6] sets out at a high level how a new system of support will be introduced in place of the RO. However, it is not yet clear how all aspects of the EMR programme will apply in Scotland, with information on the full scope of the programme not expected until publication of the UK Government Energy Bill in May 2012.

Assuming the Energy Bill is given assent by Parliament within the proposed timescale, primary legislation will be enacted in Spring 2013. The UK Government is planning that FiT CfDs will be available to new technologies in Spring 2014, but that the RO will also remain open until Spring 2017.

The Scottish and UK Governments have yet to set out the respective roles for each Government regarding delivery in Scotland. A critical decision[5] for the Scottish Government is whether to adopt the transition arrangements set out by the UK Government in an annex to its EMR White Paper [6].

While some developers may choose to use the FiT CfD when it is introduced, until they have more understanding about its detailed operation, and support levels, they will continue to plan schemes based on understanding what levels of support will be available through the RO. Many may continue to choose the RO until its expected closure in 2017.

However, while any decisions made by the Scottish Government as part of its current ROS Banding Review will significantly influence delivery of 2020 targets, these are only expected to influence industry activity stimulated by the ROS in place in the four year period 2013-2017. With changes being proposed through EMR, policy towards biomass may change post 2017.

While details about how this may change will only emerge over time, it is clear that an objective within EMR is to move towards a market based approach and also to limit the role of government in giving differential support to individual technologies. While initially, Government will be using an “administrative price setting measure” that in practice may look very similar to the current RO, the UK Government is clear it wants to move to an auctioning system towards the end of this decade [6]. If this evolution proceeds as planned, then post 2020 biomass generation may be competing with other renewable technologies for support (and over a longer time period perhaps with all other low carbon technologies). This being the case, then the Scottish Government may need to rely on planning powers rather than setting parameters of financial support if it wishes to see biomass energy schemes of a particular kind coming forwards.

2.4 The Renewable Heat Incentive

While the RO is important in stimulating investment in renewable electricity, support for renewable heat is strongly influenced by other programmes, notably the RHI. The RHI applies across GB, and will be implemented in two phases. A first phase opened to applications on Monday 28th November covering non-domestic generators. This will be followed by a second phase in autumn 2012 which widened the scheme out to other

[5] The Scottish Government is consulting on this as part of its RO Banding Review consultation.

technologies (including possibly establishing an uplift in support levels for district heating) and to households [7].

The scheme has been delayed due to problems with state aid clearance. The European Commission only agreed to state aid approval on the condition the tariff for large biomass is reduced. The RHI support rates for biomass are shown in Appendix 8.3.

Reductions in levels of support to large scale heat installations will almost certainly lead to a reduced level of development, as some projects may now be deemed uneconomic. A further result will likely be increased interest in CHP rather than heat only development, with developers looking to fund projects using both the RO and RHI. However, overall demand for biomass is likely to remain high. DECC estimates that by 2020 13.9 million green tonnes (approx 6.95m tonnes odt) of wood[6] will be required to meet the RHI target as shown in Figure 2-1.

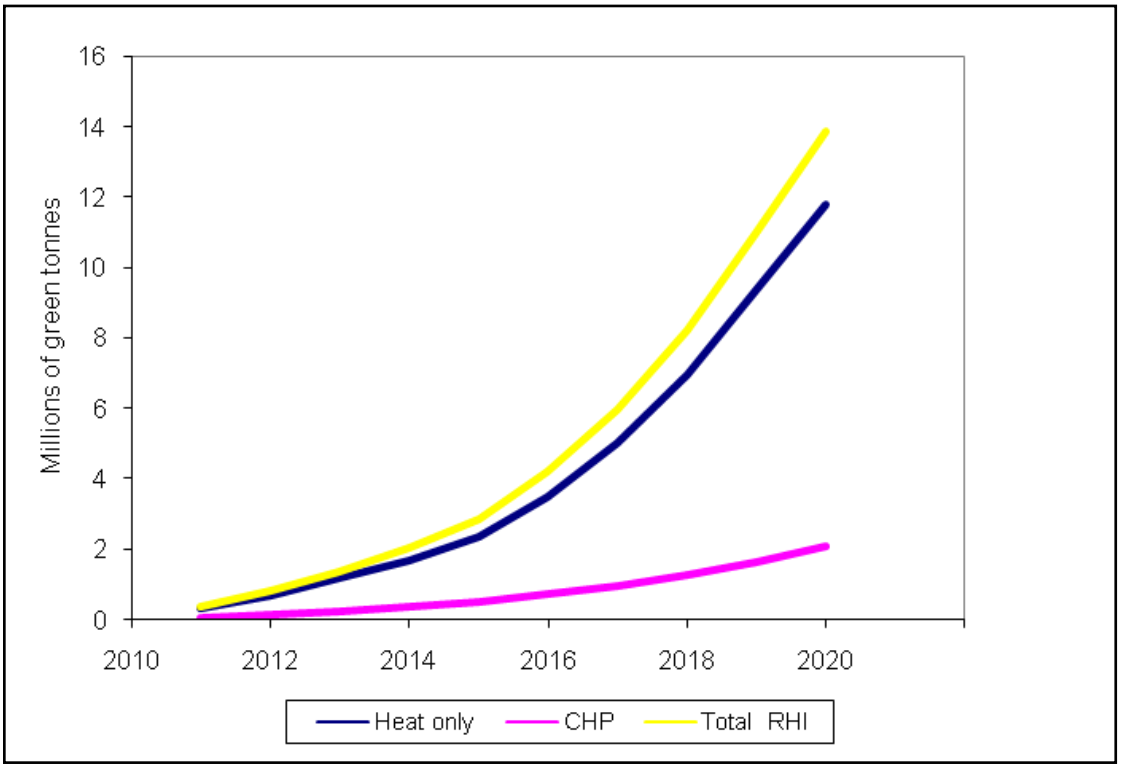

Figure 2-1: Millions of green tonnes of wood required to meet RHI projections

2.5 Advice from the Committee on Climate Change

In early December 2011, the Committee on Climate Change (CCC) reported on the role of bioenergy in meeting carbon budgets, and the extent to which bioenergy can be judged as sustainable [8]. Following its research, the CCC has concluded that there is likely to be some limited supply of bioenergy which will be needed to meet carbon budgets. Given the limits to bioenergy, they recommend optimising its use, and stress the importance of successful deployment of carbon capture and storage technology for use in heat and power bioenergy applications so that negative emissions can be achieved. It is important to highlight that the

[6] DECC calculate 13.9m green tonnes as equivalent to 6.2m odt, a conversion factor of 0.44. Based on the conversion factor of 0.5 used in this report, our estimate of odt is 6.95m.

CCC is also concerned with UK use of a global supply of biomass, rather than just how to optimise use of domestic supply.

Most relevant are the recommendations it makes on power generation and industry, which are as follows:

- **Power generation.** There should be limited if any support for new large-scale dedicated biomass generation.
    - Any longer-term role for new dedicated biomass power plants without CCS should be very limited given its relatively high cost compared to other options for power sector decarbonisation.
    - Detailed analysis of the power sector suggests this result also holds in the near term, and that any near-term investment should be limited to biomass co-firing and the conversion of existing coal-fired power plants.
    - Therefore while the [UK] Government's current focus on co-firing and conversion is appropriate, safeguards should be introduced to ensure that proposed support for new dedicated biomass under the Renewables Obligation (RO) does not result in unnecessary cost escalation or increased emissions. For new dedicated biomass power plants, support should be limited to small-scale plants and combined heat and power (CHP) plants, or at a minimum, support for large-scale new dedicated biomass should be limited to a very small number of projects.
- **Industry.** Continued support for the use of biomass in industry is appropriate. In addition, industry CCS should be developed and the scope for using wood in construction explored further.
    - There is a clear role for the long-term use of biomass in energy-intensive industry, whether or not CCS is viable. Therefore support for this should be continued under the Renewable Heat Incentive (RHI).
    - Given the importance of CCS in industry, which in conjunction with biomass would become a negative emissions option, the Government should develop a plan for demonstration and/or deployment of this technology.
    - There may be some significant emission reductions through the use of woody biomass in construction. This opportunity and supporting policies should be considered further by the Government.

Broadly, the CCC's recommendations highlight the important role it sees for forestry resource being used as wood within construction, both because of carbon benefits as well as because of resource concerns. The CCC clearly wants to see renewable heat prioritised over electricity generation and while it supports co-firing and conversion, it has concerns about large scale dedicated biomass plant.

2.6 Reviewing support levels for biomass electricity

Any Scottish Government decisions relating to bioenergy and the use of the RO are therefore important in helping the Scottish Government deliver on its electricity and heat targets and its climate change targets, while not impacting on the wider forest based industry sector. Based on the above discussion it is important to remember the following:

- Decisions relating to changing RO Banding will apply between 2013 and 2017. This four year window is a critical development period in work to deliver UK and Scottish 2020 renewable electricity targets. However, post-2017 how renewable projects are supported financially will likely change due to EMR. It might also be that Governments decide to progressively reduce support in a staged way within this four year period[7];
- There remains uncertainty surrounding the implementation of EMR within Scotland, particularly relating to transitional arrangements, and moves from administrative price setting to an auction based system. An auction system will likely mean that Ministerial control over support given to individual technologies will become more constrained;
- Changes and delays within the RHI mean that there remains uncertainty about future development of renewable heat installations. This is particularly the case for large scale installations (because of a drop in expected support), and for district heating and smaller scale installations (as this element of the RHI will not be introduced until autumn 2012);
- However, there remain a number of significant proposals for biomass heat-only and CHP plant in the planning system and it may be that the economic case for individual larger heat plant means that these schemes still progress despite the drop in support levels. Appetite on the ground for development of heat only and CHP plant is evidenced by the Scottish Government's district heating loan scheme; all nine of the approved applications were for biomass based schemes [9];
- While the Scottish Government wishes to prioritise use of biomass for heat and CHP installations, different priorities elsewhere in the UK will mean that there remains a strong demand for biomass fuels from electricity plant outside Scotland. This demand may well be met by imports of fuels from outside of the UK, but will also likely include imports from Scotland. This will affect the Scottish forestry and bioenergy sectors.

[7] For example the UK Government is proposing offering 1.5 ROCs for dedicated biomass up to 31 March 2016, and 1.4 from 1 April 2016 to 31 March 2017

3 Methodology

This study began with a review of the research report commissioned by Forestry Commission Scotland and the Scottish Government [10]. This research focused on greenhouse gas emissions stemming from using biomass for energy production. Working from the main findings further analysis was undertaken looking at wider policy factors that need to be taken into account when looking at setting of a threshold for biomass generation.

Xero Energy (XE) was asked to advise and support this review. Specifically XE was asked to provide policy expertise to consider:

- What is the best use of wood fibre given the opportunities both for renewable energy generation and the production of timber products from the conventional wood using industries?
- When it might be appropriate to use wood fibre for electricity generation, at what scale, and likewise for CHP, and what the likely deployment level might be?

In conducting this work XE has reviewed related Scottish and UK policy and background research. Relevant factors considered include:

- The Scottish Government's renewable energy targets, and related policy aspirations set out in its Renewable Heat Action Plan and its Draft Electricity Generation Policy Statement (as well as other policy documents) and Route Map;
- UK Government policy including on the RO, EMR and the RHI;
- The perspectives of the forestry industries and wider bioenergy sector, with particular emphasis on the most recent work of the Wood Fuel Taskforce Report;
- Questions relating to woodfuel availability and use, and whether concerns about undue pressures on national woodfuel supply chains are also being found at a regional or local level.

Data used has come either from referenced reports or has been provided by the Forestry Commission Scotland and the Biomass Energy Centre [11].

This work has not benefited from stakeholder survey or wider analysis[8]. A joint Scottish Government - Forestry Commission Scotland proposal to review these findings through stakeholder events, while the RO Banding Review consultation is open, is therefore welcome.

[8] However as part of the analysis phone discussions were held with representatives of the Forestry Commission, the Biomass Energy Centre, the Scottish Government, UK Government, Confor, Scottish Renewables, North Energy Associates and Hudson Consulting

4 Carbon Impacts of Bioenergy

The second piece of research commissioned by the Forestry Commission and Scottish Government sought to estimate total greenhouse gas (GHG) emissions associated with the use of forest and waste woodfuel for energy production in Scotland.

Using life cycle analysis, North Energy Associates examined 21 biomass chains (with different variables depending on source of wood, transport needs, processing and end use). It modelled and then compared GHG emissions across different types of heat only, CHP and electricity only applications [10]. Broadly speaking this modelling used typical plant characteristics and would be expected to bring out relative differences in thermal efficiencies between plant. This modelling confirmed that lower total GHG emissions will result using woodfuel for heating and most CHP applications rather than for wood fired power only plants.

Modelling was then supplemented by considering transport distances between fuel source and end user. "Idealised" models for a power only plant and a heating only or CHP plant were used to enable this work, with modelling for local (50km) regional (200km) and national (500km) supply radii analysed[9].

The report then goes on to set out the conditions that need to be met for heat and CHP-only projects to maintain their GHG advantage in comparison to electricity only plants. The main factor altering the relative merits of plant is wood supply distances (e.g. locally, regionally or nationally), and, for CHP, the heat-to-power ratio. Other considerations are wood type (e.g. roundwood, waste wood, forest residues) and process type (e.g. logs, chips, pellets).

The study conclusions can be summarised as follows:

- The use of forest biomass for heat, CHP or electricity generation results in total GHG emissions that are an order of magnitude lower than those of equivalent heat and/or electricity production from conventional fossil fuels;
- Assuming typical ranges for woodfuel transport distances and for plant design specifications, total GHG emissions associated with all wood-fired heating and some CHP applications are markedly lower than those for power only generation when 1MWh of electricity is compared directly with 1MWh of heat;
- However, there is overlap between the GHG emissions associated with power only generation and generation of electricity from wood-fired CHP plants. CHP plants could be responsible for similar emission levels as electric only plants, if through design and/or operation they have a low heat-to-power ratio and generate a lot of electricity and relatively low levels of heat. This is due to the electricity / heat ratio of the CHP plant.
- Wood supply distances can also impact on relative merits of plant in GHG terms, such that there is no simple relationship between capacity, plant type and emissions.

Data & figures showing different greenhouse gas emissions for different plant sizes are set out in Appendix 8.4. The figures show that using both roundwood and forest residues heat only applications of any size will lead to lower greenhouse gas emissions. However, blocks showing modelled CHP and electricity only schemes in both figures demonstrate an overlap.

[9] Note these distances need to be doubled to gain Round Trip Distance.

The overlap (in GHG emissions) shown for the results of electricity (but not heat) generated from all wood fired CHP plants and power only plants is due to a number of factors.

CHP plants modelled range from 0.4 to 50 MW, whilst those for the power only plants range from 5 MW to 350 MW. The overlap is for plants with output power ratings of between 5 MW and 50 MW. The overlap in terms of total GHG emissions arises from the upper range in GHG emissions of the results for CHP plants and the lower range of the results for power only plants.

While this demonstrates that above 50MW the GHG emissions/MWh of power-only plants will likely be higher, the overlap is primarily because of the fact that CHP plant size will tend to be limited to up to 50MW, rather than because of any noticeable step change in performance between <50MW and >50MW stations. Generally however, GHG emissions/MWh will increase with the size of plant due to increasing distances required in woodfuel supply chains.

North Energy Associates explain that this overlap occurs "when electricity from relatively large scale, 'poor quality' CHP plants which source woodfuel over relatively long distances is compared with electricity from relatively small scale power only plants that obtain woodfuel over relatively short distances" [10].

Modelling demonstrates that using a direct comparison between 1 MWh of electricity and 1MWh of heat, that heating from CHP plants will have lower total GHG emissions than those of power only plants using the same source of wood fuel. However, the modelling also shows for electricity from CHP plants comparisons are less clear cut. There are overlaps in efficiency levels – and resulting GHG levels - when comparing electricity only plant and electricity generated in CHP plant. Relevant variables affecting GHG levels are overall plant efficiency and the heat to power ratio of the plant.

As regards the question of whether greenhouse gas emissions can be used to set a threshold for the size of CHP plants, the North Energy Associates report highlights that while GHG emissions for CHP will tend to increase with size because of increased transport distances, the link is less clear for CHP plants using waste wood as their fuel source. This is because there could be significant variability in where such plants source waste wood from, so the scale and geographical spread of any supply chain, will affect emission levels. Importantly overall efficiency of CHP plant using waste wood is also dependent on the heat-to-power ratio of an individual plant: i.e. what proportion of output is electricity and heat. Figures for what GHG emissions are produced depend on what weighting is put on the value of electricity to the value of heat.

Because of the factors outlined above, North Energy Associates conclude that "it is unlikely that a clear and simple rule for the threshold capacity of wood-fired CHP plants can be established with complete confidence." [10]

5 Woodfuel availability and demand in Scotland

For a summary of the availability of, and demand for, woodfuel in Scotland, this report has relied predominantly on the Forestry Commission's 2011 *Woodfuel Demand and Usage in Scotland: Update Report* [12], carried out by Hudson Consulting, the Wood Fuel Task Force's 2011 Report *The Supply of Wood for Renewable Energy Production in Scotland* [13], and the Energy Saving Trust 2011 study *Renewable Heat in Scotland* [14].

5.1 Scotland's available wood fibre resource

From a total resource of 4.2m odt in 2009/11 (rising to 4.7m odt in the period 2012/16) and 5.0m odt for 2017/21), the Wood Fuel Task Force estimates that potential wood fibre surplus to existing market consumption will be 0.9m in 2012-16, and 1.2m odt in 2017-21. It is important to note that the Task Force figures are projections and that actual levels (and split by source) will differ in reality, but the data set out reveals important trends about the development of the sector. A full set of figures is set out in Appendix 8.5.

It is worth highlighting that this is total available wood fibre, not just that available for the energy sector, and that there might therefore be competing demands on this resource. Almost 50% of the virgin wood fibre from the increasing harvest will be sawlogs which will have a greater carbon and economic value as sawn timber. Much of the remaining 50% will be co-products or small round wood that is attractive to both the wood fuel and the wood panel and paper sectors[10]. A significant amount available is brash which is more problematic to use for energy generation (particularly smaller scale plant). Brash is currently used in larger scale electricity only and CHP plants, in limited volumes, mixed in with other fuel.

Reviewing figures on meeting the Scottish Government's renewable heat target of 11% [11], the Task Force reported that if the remainder of the target was to come from woody biomass from heat-only installations an additional 1.3 million odt would be required. However, it also noted that if the remainder of the target came through using woody biomass in CHP plants, then an additional 3 to 10 million odt of material would be needed[12].

The Task Force Report expressed concern about the potential displacement of the existing wood industries because of heightened biomass demand; stating that:

"Almost all the Task Force members take the view that care needs to be taken to ensure that the most effective use is made of the finite wood resource and, in general terms, large scale electricity only biomass plans are not an efficient use of the resource. The Task Force supports the Scottish Government's policy position, prioritising biomass for renewable heat." [13]

[10] Forestry Commission data highlights that around 25% of the Scottish forest harvest of stem timber is forecast to be small roundwood and the remaining 75% is sawlogs of various sizes. When sawlogs are processed the conversion rate to sawn timber is 50-60% with the rest being sawmill co-products.

[11] While the Task Force report makes use of both research by the SDC (subsequently updated by the EST, and 2010 Wood Fuel Demand and Use study by Hudson Associates (now updated for 2011), these figures remain relevant and illustrative of the issue. While published in advance of the EST work, the Task Force report based its analysis on an estimated 2.8% which is in accordance with EST analysis.

[12] The difference between the 3 and 10m figures is due to differences in heat and power ratios. A plant with a high heat to power ratio would require 3m odt. A plant with a low heat to power ration would require up to 10m tonnes.

5.2 Renewable Heat levels in Scotland

5.2.1 EST reports on progress towards the 11% target

Subsequent to the 2nd Task Force publishing its analysis, the EST produced a report for the Scottish Government on progress towards meeting the 2020 11% renewable heat target. This found that in 2010 the level was 2.8% [13]. Furthermore the EST estimated that if all of the projects under construction or with consent and half of the projects in planning were to come to fruition, then 4.5% of Scotland's heat needs would be coming from renewable sources.

Between 2008/09 and 2010, there was growth across the different elements of the heat market (biomass, waste, solar thermal and heat pumps). However, despite the fact that biomass is by far the largest contributor to renewable heat it continued to grow faster than all other renewable heat types, both in absolute and percentage terms. In 2008/09 biomass sources represented some 85.5% of renewable heat output; by 2010 this had risen to 90% [15] [14].

The most significant growth also came from (in heat terms) larger plants (i.e. those using over 10,000 ODT per year) rather than smaller schemes. In 2008/09 75.4% of Scotland's renewable heat came from plants of 1MW+; by 2010 this had risen to 85%. According to the EST most of this increase came from "increases in installed capacity and output at a small number of large (1MW+) wood processing installations, which use biomass primary combustion or biomass combined heat and power, often to supply process heat."

5.2.2 Forestry Commission Scotland estimates on woodfuel usage

Forestry Commission Statistics show that the Scottish timber harvest in 2010 was 6.2m green tonnes, the largest harvest ever. This was a result of high demand for sawn timber and panel products as well as the ever growing biomass market. The harvest was split evenly between the public and private sectors but the private sector harvest was particularly strong as prices of standing timber and logs rose rapidly in 2010 and early 2011.

Sawmill consumption rose by 9% between 2009 and 2010 and panel mill consumption (including co-products and recycled wood fibre) rose by 13%. The use of UK fibre by the UK's two pulp and paper mills was down 17% in 2010 on 2009 figures. Woodfuel use in 2010 was 1.2m green tonnes (comprising 31% recycled material) [16].

The EST report made use of interim figures provided by Hudson Consulting, which reports to the Forestry Commission Scotland. The Task Force made significant use of its 2010 study. The 2011 Woodfuel Usage Update [12] has now been published and unsurprisingly confirms the trends highlighted above. As Figure 5-1 shows, total wood fuel use has quadrupled between 2004/05 and 2009 and is forecast to continue.

The 2011 Update highlights that total woodfuel usage in 2010 by major commercial and industrial users[14] increased by 105k odt to 559k odt; a 19% increase. The report estimates that demand from existing plants will see this increase (but then stabilise) at around 589k odt. Woodfuel usage by smaller commercial and industrial users[15] increased from 23k to

[13] 2.8% is a doubling from the 2008/09 figure previously calculated by the Sustainable Development Commission, which the EST was asked to review and update. However, note, the Task Force had factored in a 2.8% figure for renewable heat.

[14] Defined as plants using over 10,000 odt/yr.

[15] Defined as plants using between 1,001 and 10,000 odt/yr.

31k odt. This 25% increase is still small in absolute terms compared to the increase in volume seen in larger plant.

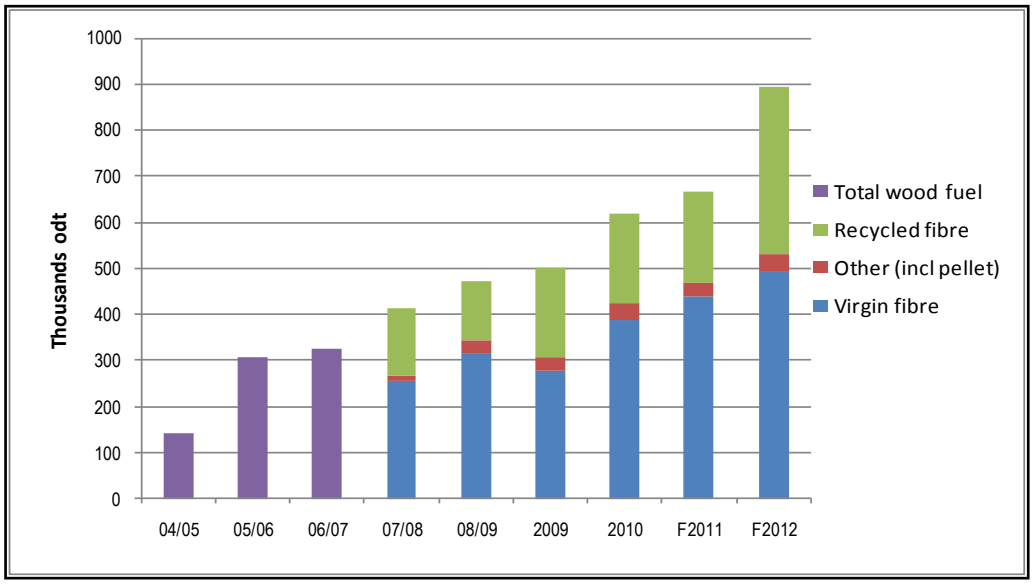

Figure 5-1: Total Wood Fuel Use – All Industry/Commercial – 2004/05 to 2010 and forecast for 2011 and 2012 [12]

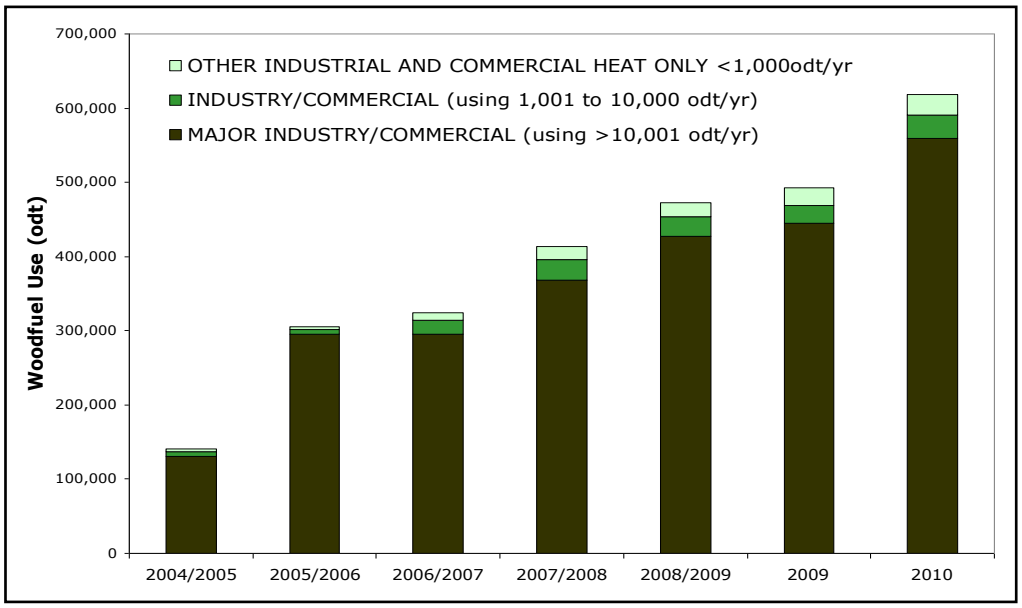

Figure 5-2: Total Wood Fuel Use – All Industry/Commercial – 2004/05 to 2010 and forecast for 2011 and 2012 [12]

Wood fuel use has quadrupled from a relatively low base in 2004, to around 1.2 million green tonnes in 2010, largely because of use in larger scale biomass electricity and CHP plants. 31% of this supply is recycled or waste wood. [12] The growth in woodfuel use for different sized users is shown in Figure 5-2.

The Update highlights that between 2005 and 2010 the number of operational plants using woodfuel rose from 43 to 249, and that the sector is dominated by large scale wood

processing plants using biomass for onsite heat needs and increasingly by electrical generation. These two types of plant use some 96% of all woodfuel in Scotland.

This clearly demonstrates that woodfuel continues to make a significant contribution towards both renewable electricity and heat targets. Furthermore, without woodfuel as a resource, almost no progress would have been made towards the renewable heat target. This also highlights that the sector is growing ahead of the launch of the RHI.

The Update also reports that there are four pellet manufacturing plants operating in Scotland using some 83,000 odt of wood in 2010. The Update predicts that this demand will grow substantially to 114,000 odt/yr in 2011. However, it is worth considering how these pellets are being used. A total of 551,000 tonnes of wood pellets were imported into the UK in 2010 at a value of £68.6 million. Exports totalled 60,000 tonnes, with a value of £6.8 million in 2010 [16].

While it is hard to get reliable evidence because individual pellet companies are understandably cautious about revealing what contracts they have in place, it seems very likely that the major market for pellets at present is for co-firing, and that the vast bulk of this is for plants outside of Scotland[16]. With the UK Government looking to focus its support on transitional technologies, demand for pellets for co-firing is likely to continue, though pellet producers will of course be looking to the RHI to stimulate additional demand for pellets from a growing heat market, so over time supply may shift from co-firing to heat.

Demand from English generators for fibre from Scotland is not surprising, given the number of existing coal plants making use of co-firing, and existing/ongoing support through the RO. Within Scotland however, there are clearly less opportunities for co-firing of woodfuel. Scotland has two coal stations: Longannet and Cockenzie. Cockenzie is scheduled for closure as a coal fired station in 2015, but plans have been developed to refurbish the station as a CCGT station. [17] With the breakdown of discussions between the UK Government and the consortium of ScottishPower, National Grid and Shell, [18] Longannet will not be used as a demonstrator of carbon capture and storage technology. While Longannet has used woodfuel in co-firing, ScottishPower has yet to publically set out its alternate plans for the future of Longannet.

In its 2009 Report the Sustainable Development Commission (SDC) highlighted that there was “very significant potential for a substantial increase in small and medium heat only biomass.” [15] Much of the current development has been use of biomass within the sector itself (e.g. process heat for drying of wood). There are only a limited number of such sites, though introduction of the RHI will likely drive demand at both large and medium scale sites in the short term and to a lesser extent within the domestic market in the medium term.

[16] Research by Hudson Consulting into the domestic market in the Grampian region suggest that annual demand in the north east of Scotland is as low as approximately 800 tonnes of wood pellet per year. Based on available data and discussion with practitioners, it is estimated that at least 90% of Scottish pellets are currently being used for co-firing, with the bulk of this being co-firing outside of Scotland [23].

6 Discussion

6.1 Opening Comments

In making a decision on how to support renewable energy, it is suggested that the Scottish Government has a number of factors it needs to take into account. These are:

- Climate change impacts and benefits of supporting particular technologies and types of generation;
- Availability of woodfuel and questions over maximising the benefits of its use;
- Stimulation of woodfuel markets without undue impact on other forest products industries;
- Taking into account UK wide and international market pressures and impacts;
- Knowledge of local and regional woodfuel market pressures which may be different to those seen at a national level.

The work by North Energy Associates demonstrates that there are clear benefits to using available wood resource for heating rather than electric only installations.

However, the benefits of CHP compared to electric only installations are less clear cut, and will depend on factors relating to individual applications. While heat from CHP is clearly better in terms of greenhouse gas emissions per MWh than electricity from electricity only plant, the same distinction cannot be found between electricity produced in a CHP plant to electricity produced in an electric only plant, Modelling shows a strong overlap between CHP and electricity only schemes up to 50MW in size.

This factor would suggest that if the Scottish Government sought to rely solely on GHG emissions as a basis for targeting support, then it should prioritise heat only projects. However, given the demand for electricity as well as heat, and considering GHG emissions in isolation, it would be difficult to justify giving preference to electricity from CHP plants over small and medium scale electricity only plants.

In seeking to give preference to renewable heat ahead of renewable electricity Scottish Government is also in accordance with the views of the Wood Fuel Task Force. However, the Scottish Government needs to be aware of other relevant factors.

- Government must take account of ongoing demand for woodfuel from England and Wales, where the UK Government continues to support use of biomass as an electricity feedstock[17].
- Delays to the opening of the RHI mean there remain some questions as to the speed at which renewable heat projects will be developed, though demand levels are still expected to be high. DECC projected the RHI would require 13.9m tonnes of green wood by 2020 and lead to 28TWh [19] of biomass being burned. The bulk of this is projected to be in heat only applications. However, the fact that the scheme will not

[17] Ofgem data for 2010/11 shows that 5 million tonnes of all types of biomass was used in power generation. Wood accounted for 58% of the total in 2010/11 and 55% of the total in 2009/10. 31% of wood used in power generation came from imported sources, and the remainder from the UK. Although the total amount of wood used in power generation increased by 35% over the period, the amount of UK supplied wood increased by only 2%, while the amount of imported wood for power generation more than tripled (for example Canada supplied 447,237 tonnes of pellets in 2010/11).

open to the domestic sector until autumn 2012 also means there will be uncertainties around how quickly a domestic market will grow and what woodfuel demands this will lead to.

- To date the renewable heat market has been dominated by large installations linked to the wood products sector such as paper mills, sawmills and board plants. The rapid development of sites using wood to provide process heat for timber, board and paper manufacturing has been the largest single factor in Scotland making rapid progress towards meeting its heat targets. However, there are a limited number of such sites in Scotland[18], and Forestry Commission data [12] indicates that demand from existing sites is expected to level off. A reduction of support for larger installations under the RHI will exacerbate this factor.
- If demand for woodfuel for use in large on-site process heat applications is likely to level off, this will mean that the Scottish Government will need to look to medium scale plants (with on-site heat needs); small scale and domestic markets, energy from waste and district heating demand to deliver on its heat target. Such installations would likely be from a combination of heat only and CHP plant.

Overall then, there are valid questions to be asked as to how quickly new renewable heat (and electric) projects will be developed, and what additional demand this will bring for woodfuel. And the next issue is to question how much demand new developments will place on woodfuel supply markets.

As set out above, existing Scottish pellet plants are selling predominantly into the English and Welsh electricity market, not a Scottish or GB-wide heat market. If the renewable heat market evolves, and if supplying this market makes better economic sense than continuing to supply to more distant renewable electricity generators, then existing pellet plants may be able to switch supply to a growing heat market within Scotland (contractual obligations notwithstanding).

6.2 Supporting Local Fibre and Woodfuel Markets

Another issue for the Scottish Government to consider is how local markets might develop. A relevant question is whether there are parts of Scotland where development of heat only infrastructure will be unviable, owing to either lack of significant heat loads, or because of very low building densities that will work against making district heating development economic. There will also be parts of Scotland where the level of resource is greater than potential local heat demand.

Also relevant is whether demand from more distant heat or other forestry products markets will act as sufficient stimulus for local forestry management, timber extraction and replanting. This is most acute in Scottish islands - high transport costs set a higher hurdle for economic utilisation of existing forestry resource – but there may also be examples of timber resource on the Scottish mainland where cost of extraction is higher than can be justified by a return on investment. Counter to this is needs to be recognised that increasing competition and rising prices for resource will increase the viability of harvesting across Scottish woodlands.

[18] Note a 2008 study by Pöyry Energy identified only two potential Scottish sites (St Fergus and Grangemouth) suitable for very large scale, industrial CHP development. [24]

An ideal case would be for the bioenergy sector to make use of wood supplies that have low or marginal value to other markets. Furthermore, the development of local bioenergy supply might also act as a "first market" which will bring in necessary investment that enables local forest owners to supply wider wood markets which have not been economically viable before. Correctly scaled, support for renewable electricity might also act as a stimulus for development of renewable heat markets. Development of both local heat and electricity market would mean shared costs for related infrastructure (e.g. investment in local chipping or pelleting plant). Development of CHP plant could provide heat for on-site or near-site process heat. Electricity only plant can still provide low-grade heat for use locally.

It may therefore be that some support of using biomass for electricity generation represents an effective way to utilise such localised forestry resources. If done at the correct scale, then stimulating such local woodfuel supply for electricity generation could also incentivise and support the development of local heat markets, by making available local chip and pellet production for wider use.

The challenge here will be in understanding what level of cumulative development of biomass electricity would be desirable, without leading to undue competition for forestry supplies between different users.

6.3 Balancing Policy Risks between Emerging Energy Markets

Given that the RHI is not opened up to the domestic market until late 2012 it is difficult to predict with certainty how quickly a domestic market for renewable heat (pellets or chips) will develop in Scotland[19], and to what extent the RHI alone will stimulate local woodfuel markets. It may be the case that local woodfuel markets would be better incentivised if also supplying to the electricity sector.

It is also worth highlighting that both the Scottish and UK Governments share concerns about lock-in of wood fuel for electric only plant that could undermine longer term development of renewable heat markets. UK support for biomass conversion is aimed at incentivising rapid development of biomass electricity to help meet renewable electricity targets, while also building biomass supply chains, but across the longer term the UK Government wishes to see a move to use biomass in heat markets.

The UK Government describes its approach to supporting biomass for electricity generation as a "cautious" one, because of issues of cost-effectiveness as well as the availability of feedstocks for both energy and non energy users. UK Government proposals therefore aim to "manage the risks associated with long-term locking in of feedstock demand in this sector compared to potentially more cost effective ways of meeting wider longer term government objectives through alternative uses [5] [20].

Based on a proposed 1.5 ROCs for dedicated biomass, modelling and analysis for the UK Government states that: "based on Arup cost evidence, biomass fuel price assumptions from the AEA report, and Pöyry modelling for the banding review there would be no deployment of large scale dedicated biomass" and furthermore that "in the Pöyry model, we get new

[19] Correspondence between HETAS and Forestry Commission Scotland indicates that a significant uptake of RHI within the domestic market is not expected, partly as a result of successful uptake under existing/previous support programmes.

[20] Also relevant is the proposed UK Bio-Energy Strategy currently in development and expected for publication in late 2011. This strategy will consider the relative role of dedicated biomass at different scales in delivery of renewable energy and carbon reductions alongside other electricity technologies and biomass using sectors as well as lock-in implications of development.

build of small biomass <50MW under the RO over the banding review period which contributes an annual output of 0.5TWh towards the 2020 renewables target. Large biomass does not get built as it requires more ROCs to cover its assumed higher fuel costs (despite lower capital costs)" [5] [20].

The Northern Energy Associates modelling also references this 50MW level in comparing electricity only and CHP plant. However, a dilemma facing government is that plant up to 50MW is more likely to use domestic sources of biomass, whereas larger plants will tend to rely on imports. The UK Government assumption is that plant up to 50MW in size will source 90% of woodfuel needs from the domestic market. [5]

Thus if the Scottish Government sought to set a threshold at a 50MW level, and to offer 1.5ROCs for plant up to 50MW, then the Scottish Government would be looking to achieve the same outcome as the UK Government (i.e. that the result on the ground would be plant up to 50MW being delivered), albeit more explicitly.

However, the Scottish Government has also set out that its priority is using biomass to support renewable heat, and has expressed concern about competition for available woodfuel. This position has received support from the Wood Fuel Task Force, which has stated that:

"The Task Force believes that biomass policy, rather than making a dash for biomass through a series of large scale electricity only power stations, should encourage the incremental growth of the biomass industry, focussing on heat and combined heat and power, and avoiding lock in of the resource to a small number of plants." [13]

And if the Scottish Government were to adopt the RO levels being proposed by the UK Government it would have the likely result of promoting electricity only biomass plants up to 50MW in size, i.e. the type of plant most likely to draw on domestic woodfuel market for its feedstock. The UK Government wishes to avoid lock-in of resource by focusing industry effort for > 50MW plant on conversion and enhanced co-firing.

If Longannet does not use biomass, and given the lack of other opportunities conversion and co-firing may not be as relevant for the Scottish Government. This being the case, bioenergy developments in Scotland are more likely to be limited to dedicated biomass plant. Therefore this is where the development effort is likely to be focused in Scotland, and the Scottish Government may wish to place greater checks on its development – and hence limit the draw on domestic biomass resource – than the UK Government.

Against this we need to balance questions as to whether ongoing support of renewable electricity generation could be used in a way which underpins rather than undermines development of local heat markets, while encouraging good resource management. In short above what scale of plant would biomass electricity generation dominate rather than integrate with the wider renewable heat and forestry sectors?

If the Scottish Government were to adopt the 1.5ROC band proposed by the UK Government, or to set a threshold of 50MW, the question then becomes what would be the impact on Scottish woodfuel markets of developments up to the 50MW scale?

6.4 Estimated Resource Use of Biomass Electricity

Based on figures provided by the Biomass Energy Centre, it is assumed that electricity only plant will require approximately 6,500 tonnes odt per MW[21]. This would be the equivalent of approximately 13,000 tonnes per MW of green wood[22]. Figure 6-1 shows estimated annual tonnage requirements for different sizes of plant up to 50MW.

The Wood Fuel Task Force 2011 Update estimates that the total wood resource is currently 4,176,100 odt, but that this will rise to 5,017,400 by 2017/21 (see Appendix 8.5). Current net available resource is estimated to be 432,400 odt, which is expected to rise to 1,183,700 odt by 2017/21.

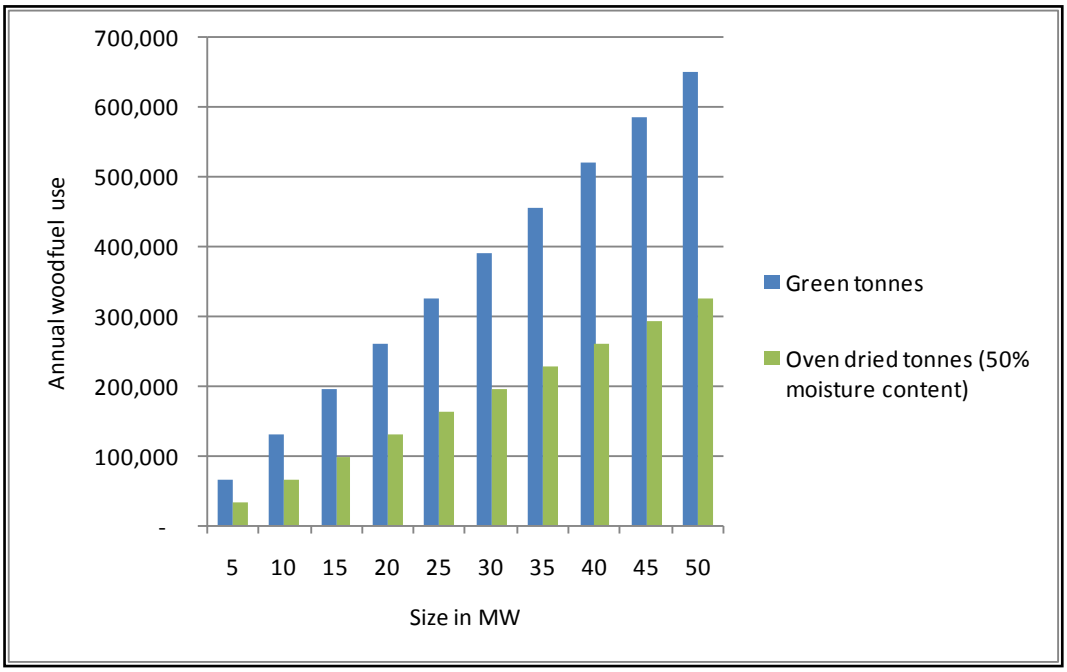

Figure 6-1: Estimated woodfuel use for electric only plant up to 50MW

Based on this data it can be estimated that one 50MW plant would consume about 2.5% of the 2010/11 annual harvested forestry resource, but more than the net available resource (i.e. the resource that is additional to current demand from other users).

The Scottish Government committed to review the level of support available under the RO for biomass electricity plants. Within its RO Banding Review Consultation it is seeking views on four key areas:

- Removing support for large scale dedicated electricity stations;
- Establishing whether a capacity threshold should be set for small scale electricity only plants;
- Whether to mirror UK incentives for enhanced co-firing and conversion;
- Whether a maximum threshold for biomass CHP plants is required [2].

[21] Note actual tonnage required will depend on many factors, including boiler efficiency, operating time and moisture content. 6,500 odt is based on BEC data and sets out estimated tonnages required for plants of 10-50MW scale.

[22] A conversion factor of 0.5 for comparing green tonnes with odt has been used, to follow the same assumptions used by the Wood Fuel Task Force.

UK Government proposed rates for dedicated biomass are based on the assumption that provision of 1.5ROCs will incentivise plants up to 50MW. However, significant development of plants up to 50MW in scale would go well beyond available woodfuel resource as it would lock in domestic woodfuel supplies into electric only plant. This could undermine efforts to develop woodfuel supply chains for renewable heat schemes, and may also impact on non-energy wood supply chains.

The challenge for the Scottish Government is in setting a capacity threshold for small scale electricity only plants will be finding a level that meets the following general criteria:

- Does not lead to demonstrably worse GHG emissions than equivalent CHP development;
- Can support the development of local wood supply chains that could act as a "first market" i.e. which could make other activities – such as local heat markets – economically viable;
- Can make use of brash, branches and some thinnings, but without making a significant impact on the available wood fibre resource.

To meet these criteria, the Scottish Government is going to need to set a level that incentivises the development of electric only plants which develop and make use of local supply chains. However, there will remain risks associated with this. In particular continuing support for smaller electric only biomass schemes might lead to multiple smaller scale plants having a similar impact as one large scheme.

The Scottish Government might also be able to manage the scale of development either through setting different levels of support for domestic or imported bioenergy, or by setting an overall cap on the level of development. However, it is not recommended that either of these routes is chosen.

Trying to incentivise use of imported bioenergy over domestic supplies would likely be counter to rules on international trade and therefore likely to meet legal challenge [2]. Setting a cap on overall level of renewable electric plant would have the merit of being able to stop development beyond an agreed threshold, but it would likely bring negative consequences; for example while it would encourage early movers so could see an initial increase in development, risks for following developers would increase significantly, meaning either that developers might abandon projects, or that costs rise as lenders increased debt and equity costs because of increased risk. The Scottish Government itself highlights that any mechanism to impose a cap would be burdensome on suppliers and the regulator [2]. It is clear from this that there needs to be an acceptance that that there is not a clear way to establish a threshold. Instead it must seek to balance a number of competing factors.

One challenge for the Scottish Government is in understanding what the likely level of development might be given different support levels under the RO and different thresholds. The new RO bands will apply for a four year period between 2013 and 2017. To enable analysis this report has defined small scale development as seeing up to 5 plants built within this RO banding period and moderate development as seeing up to 10 plants being built. More detailed figures are set out in Appendix 8.6, but a summary of this analysis is set out below in Table 6-1.

		Percentage of 2017/21 overall Scottish resource[23]		
Plant size (MW)	**Annual fuel input in odt (single plant)**	**1 plant**	**5 plants**	**10 plants**
10	65,000	1.3	6.5	13.0
20	130,000	2.6	13.0	25.9
50	352,000	6.5	32.4	64.8
		Percentage of 2017/21 net available Scottish resource		
Plant size (MW)	**Annual fuel input in odt (single plant)**	**1 plant**	**5 plants**	**10 plants**
10	65,000	5.8	29.1	58.1
20	130,000	11.6	58.1	116.2
50	352,000	29.1	145.3	290.6

Table 6-1: Estimated woodfuel use of electric only plant compared to potential Scottish resource.

As this report is concerned with the period 2014 to 2017, Wood Fuel Task Force data for the period 2017/2021 (i.e. at the end of this period) has been used. This higher figure is judged the more appropriate given that any plants built are likely to begin operation sometime between 2014 to 2016 but to operate across (and beyond) the whole 2017-2021 period.

The above analysis shows that a 50MW plant could be assumed to require 352,000 odt of wood per annum. This represents approximately 6% of available Scottish wood fibre resource (2017/21), and 29% of the net resource.

These figures are based on the assumption that such plants would make use of only Scottish wood fibre resource, so should be treated with some caution. Some fuel supplies might be imported (particularly if supply chains start to develop on the back of growing import into English biomass generation), while some may come from forestry resource in England. Using the UK Government's estimate that plants under 50MW are likely to source 90% of supplies from domestic sources would mean reducing the figures by a factor of 0.9[24].

Even **based on a low level of deployment (5 plants), a 50MW threshold would see up to 145% of net available Scottish resource (32% of total wood and fibre resource) being used for electricity generation**. Given its existing advice to Scottish Ministers, such a high level of development would be expected to raise concern of groups such as the Wood Fuel Task Force as well as other industries relying on forestry materials [13].

Even a lower threshold level would lead to a significant percentage of net available resource being used for electricity generation. For example a low deployment rate (5 plants by 2017) of 20MW would lead to use of up to 58% of net available resource (13% of Scottish wood and fibre resources). **A low deployment rate of 10MW plants would still require 29% of net available resource (6.5% of Scottish wood and fibre resource).**

[23] As defined by the Woodfuel Task Force 2. Note the Woodfuel Task Force 2 report does not set out data for beyond 2021.

[24] It is worth nothing that there may be differences in Scotland. For example, plants in remote Scottish locations with poor access to port facilities will have less access to imported materials, so the proportion of domestic supply could be higher than the 90% estimate.

It also needs highlighting that **these figures have not modelled increasing demand for woodfuel from the Scottish heat sector** because of uncertainties in the scale of development of this sector, and how much of this may come from existing sources (e.g. diversion of pellets from co-firing to supply into heat markets).

Demand from this emerging heat market is expected to be significant however. It is worth reiterating that **Forestry Commission Scotland estimates that each additional 3% of heat supplied from biomass will require an additional 0.5m odt of woodfuel resource, which would equate to 10% of total available resource, and 42% of the net available resource**. UK Government analysis estimates that the RHI will stimulate GB demand of biomass from current levels of 0.2m odt to 6.95m odt by 2020[25].

6.5 Setting a Threshold that will support Local Supply Chain Development

As highlighted above (see Section 7.2) a relevant consideration is what role electric only plant can play in supporting rather than threatening local markets, by acting as a first market for local based wood supply.

There will likely be areas of Scotland where development of smaller scale electric only plants could make a valuable contribution to forestry management and development of wood fuel supply chains able to support the plant itself as well as an emerging heat market, while not threatening wider, more national based wood supply chains. Development of smaller renewable installations that can make use of local markets will also mean the avoidance of transport costs, which can be a significant part of wood fibre harvesting and processing.

However, in the absence of good data on local wood fuel markets, it would be difficult for the Scottish Government to set a threshold capacity able to incentivise smaller plant within local wood fuel markets, while being sure about minimising impacts on wider wood fuel supply networks. Even a moderate level of development of plants at a smaller capacity would impact on other woodfuel markets.

It is worth highlighting at this point that Paragraph 148 of the National Planning Framework (NPF) [21] states that “Biomass plants should be sited where they can make best use of locally available resources.”

Paragraph 164 of the NPF encourages dispersed decentralised generation and supply and “harnessing components of the waste stream and other biomass offers the potential to develop new, smaller combined heat and power (CHP) stations close to communities. In some areas, particularly in rural Scotland, wood or other biomass may provide the most appropriate fuels for local heating schemes.”

It will likely be that should the Scottish Government see it appropriate to set a threshold level for biomass electricity generation, it will remain necessary for planning authorities to ensure that the location of plant is appropriate to make use of locally available resources and maximise local economic development opportunities.

[25] Note that the UK Government uses a different conversion rate from that chosen for this report. Its estimate is that biomass demand will grow from the current level of 0.4 million green tonnes to 13.9 million green tonnes by 2020. It equates these amounts as 0.18m odt and 6.25m odt respectively.

7 Recommendations

Based solely on greenhouse gas emissions, there is insignificant justification for the Scottish Government to set a threshold capacity figure on electric only biomass plant (large or small). However, it is clear that as the scale of electric only plant increases so do GHG emissions/MWh. This is largely due to increased transport needs, though the relationship is less clear for waste wood, where supply chains may work differently.

The recent CCC report on biomass also highlights the challenge of using biomass sustainably while there are concerns about availability, and when different uses have different impacts on emission reductions. The recommendation that support for new dedicated biomass plant should be limited to small-scale plants and CHP is very pertinent.

50MW is the scale up to which the UK Government expects a level of 1.5ROCs for dedicated biomass plant to support. It also expects such plants to get most of their woodfuel supply from domestic sources. However it is important to stress that in looking at the viability of using a 50MW level as any thresholds, that the fact that modelling puts 50MW at the "edge" of any overlap is more a product of the fact that CHP plant at scales above 50MW will be rare so has not been modelled in the North Energy Associates research.

If the Scottish Government were to support plants up to 50MW with 1.5ROCs even a low level of development (here defined as up to 5 plants built between 2013 and 2017) would impact significantly on Scottish woodfuel resources.

For this reason it is clear that the Scottish Government is justified in setting a threshold capacity for biomass electricity only schemes if it wishes to protect biomass supplies being monopolised by one sector. Given UK Government assessments, any threshold would need to be lower than 50MW (below which plant will tend to rely on domestic supply). However, it also seems that support for some level of biomass electric only plant is justified for the following reasons.

Firstly, use of biomass for renewable heat remains focused at industrial processing sites serving the wood processing sector, and in the waste sector. To be able to deliver on its renewable heat targets the Scottish Government will need to see biomass being used in a wider range and scale of applications. However, given the reduction in the level of RHI support for larger installations, it may be that an increased proportion of development will come from CHP schemes and medium scale heat only schemes. There are a significant number of smaller installations in the commercial and public sector, but cumulative contribution to heat targets remains low.

Secondly, the Scottish Government cannot act in isolation from the UK Government, because of the GB nature of the renewable energy sector. Ongoing support through the RO in England and Wales will continue to incentivise co-firing, conversion and dedicated biomass south of the border, and hence create demand on woodfuel resources harvested in Scotland. However, Scottish and UK aspirations for biomass energy are far from conflicted, though there are differences in approach. Both Governments express a desire to avoid lock in of supplies of resource that will undermine future development of renewable heat. The fact that the energy market works as one across GB means that the Scottish Government should limit changes to those related to differences within this market.

Thirdly, reliable data on supply levels are hard to come by, but it is clear that the vast majority of wood pellets being produced in Scotland are being exported for co-firing in

England or abroad. With the RHI now active, this will likely stimulate a growing alternate market in Scotland for using these pellets to generate heat. If not, then given UK Government support for co-firing and conversion, it is likely that Scottish pellets will continue to be used for electricity generation irrespective of what the Scottish Government decides to do.

Fourthly, in the absence of strong local renewable heat markets, some level of electric only plant could act as a useful "first market", stimulating not only better local forest management (by incentivising harvesting of lower quality forest material), but also enabling activity able to be feed into future heat markets.

Fifthly, it may be that there are areas of Scottish local woodland not currently being fully managed or utilised, because of the current cost of extraction and the fact that existing markets are either too remote or cannot pay sufficiently to cover extraction and transport costs.

This report has defined a low to moderate level of development as between 5 and 10 electricity only plants being developed up to 2017. This level of development needs to itself be tested as part of any consultation. If this is seen as a likely level, then it is recommended that the Scottish Government seeks to set a low threshold capacity to ensure that resource remains available for other users.

The above leads us to the conclusion that **while some threshold beneath 50MW can be justified, a level from 50MW down to 20MW would be insufficient (i.e. too high) to limit wider impacts on Scotland's wood fibre resource**.

Our recommendation would be for a 10MW threshold, given that a low to moderate deployment of plants up to 10MW level would use between approx 30% (equivalent to five 10MW plants) and 60% (equivalent to ten 10MW plants) of net available resource. We see this as a pragmatic balance between different risks and sector pressures to enable the Scottish Government to best meet a number of different policy objectives highlighted within this report.

However, having tested stakeholder views on what level of deployment is seen as likely, The Scottish Government and Forestry Commission Scotland also need to test wider stakeholder views as to how much of net available resource different stakeholder groups would be comfortable being used for electricity generation (and therefore not available for use in heat or other markets).

However, it should be noted that if a threshold is set below 10MW in scale, the Scottish Government would first want to consult with industry as to the likelihood of any renewable electricity projects coming forwards[26]. Stopping new wood fuelled electricity plant would avoid any risks of available resource being threatened, but may also mean missed opportunities for local economic development and using inaccessible resources. Without some level of electricity only scheme being developed there may be risks that Scottish woodfuel supply chains will not quickly develop any further, in which case deployment of renewable heat may also be impacted. In this case, the dominant driver in the market would remain RO support within England and export of roundwood, co-products and pellet to supply co-firing and biomass conversion plants.

[26] Both in seeking planning consent and also moving through to construction and operation.

8 Appendices

8.1 Scottish Government Rationale for the role of biomass.

The Scottish Government's Draft Electricity Generation Policy Statement sets out that it "would prefer to see biomass deployed in heat-only or combined heat and power schemes, off gas-grid, at a scale appropriate to make best use of both the available heat, and of local supply". Its rationale is that:

- Evidence suggests that the use of biomass for heat-only or combined heat and power use will be essential in order to meet Scotland's target for renewable heat;
- Use of available heat in heat-only and CHP schemes achieves 80-90% energy efficiency for the former and 50-70% for the latter as opposed to 30% in electricity only schemes. Clearly with a limited resource, maximum efficiency needs to be encouraged;
- The use of biomass first and foremost off the gas-grid ensures the highest carbon savings (given that in most cases it will be displacing oil or coal), and can also make the greatest impact on alleviating fuel poverty;
- Whilst the Scottish Government is not categorically opposed to large scale development, it is likely that the larger the proposed scale, the more difficult it will be for the developer to utilise the heat generated and to source supply locally. Hence any development should be scaled appropriately to make efficiency use of the available heat and local supply. Large scale developments which do not maximise heat use may also displace supply from our priority of delivering our heat target;
- The use of local supply minimises carbon emissions from transport and provides the best opportunities for economic and employment benefits. It also decreases the risk to security of supply and ensures the development can act as a decentralised energy plant, in line with stated Scottish Government aims. Scaling in accordance with local supply may also help to reduce the impact on other competitors, such as the timber processing industries which deliver low carbon products for the construction and other sectors and contribute to economic development; and
- There may be a significant role for imported biomass. However, the global market is an immature one and is likely to be volatile given projections of increased global demand. Its use will be dependent on price, availability and evidence of sustainability. As with local resource, its use should be in plants that support maximum heat use and de-centralised energy production [3].

8.2 Scottish and UK Government proposed RO banding levels for biomass

	Scotland RO Banding Proposals		England & Wales (UK Govt) Banding Proposals		Change
Renewable electricity technologies	**Current support, ROCs/MWh[27]**	**Proposed ROC support/MWh[28]**	**Current support, ROCs/MWh[29]**	**Proposed ROC support/MWh[30]**	
Biomass conversion	No current band but eligible to claim 1.5ROCs under current banding arrangements	1 Call for evidence	No current band but eligible to claim 1.5ROCs under current banding arrangements	1 Call for evidence	Proposal for a new band.
Co-firing of biomass	0.5	0.5	0.5	0.5	Changes proposed to add fossil derived bioliquids.
Co-firing of biomass (enhanced)	No current band but 0.5 ROCs under current banding arrangements	1 Call for evidence	No current band but 0.5 ROCs under current banding arrangements	1 Call for evidence	Proposal for a new band.
Co-firing of biomass with CHP	1	1	1	1	Changes proposed to add fossil derived bioliquids, to exclude enhanced co-firing and to close this band to new accreditations from 1 April 2015.
Dedicated biomass	1.5	1.5	1.5	1.5 to 31 March 2016 1.4 from 1 April 2016	Scottish Government seeking views on possibility of capacity threshold for eligibility. UK Government Proposal to exclude biomass conversions and to add fossil-derived bioliquids.
Dedicated biomass with CHP	2	2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17	2	2 in 2013/14 and 2014/15	Scottish Government seeking views on possibility of capacity threshold for eligibility. Proposal to close this band to new accreditations from 1 April 2015.

[27] Different levels of support may apply to certain types of generating station accredited before 1 April 2009. The default rate of 1 ROC/MWh applies to eligible generation that does not fall within any other banding provision.

[28] Years refer to obligation periods under the RO. For example, 2013/14 refers to the period 1 April 2013 to 31 March 2014.

[29] Different levels of support may apply to certain types of generating station accredited before 1 April 2009. The default rate of 1 ROC/MWh applies to eligible generation that does not fall within any other banding provision.

[30] Years refer to obligation periods under the RO. For example, 2013/14 refers to the period 1 April 2013 to 31 March 2014.

8.3 RHI Support levels for biomass

Levels of support					
Tariff name	**Eligible technology**	**Eligible sizes**	**Tariff rate (pence/kWh)**	**Tariff duration (Years)**	**Support calculation**
Small biomass	Solid biomass; Municipal Solid Waste (incl. CHP)	Less than 200kWth	Tier 1: 7.6	20	Metering. Tier 1 applies annually up to the Tier Break, Tier 2 above the Tier Break. The Tier Break is: installed capacity x 1,1314 peak load hours, i.e.: **kWth x 1,314**
			Tier 2: 1.9		
Medium biomass		200 kWth and above; less than 1,000kWth	Tier 1: 4.7		
			Tier 2: 1.9		
Large biomass		1,000kWth and above	1.0 (reduced from 2.7)		Metering

8.4 Comparison of Total Greenhouse Gas Emissions for Providing Heat and/or Electricity from Fossil Fuels and Wood

Option	Total Greenhouse Gas Emissions (kg eq. CO_2/MWh)
Domestic Heating:	
- coal-fired	492 – 689
- oil-fired	330 – 440
- natural gas-fired	229 – 295
- wood-fired (roundwood logs)	39 – 43
- wood-fired (roundwood briquettes)	54 – 60
- wood-fired (roundwood pellets)	40 – 47
- wood-fired (forest residue pellets)	22 – 29
- wood-fired (clean waste wood briquettes)	19 – 20
Commercial or Industrial Heating from Heat Only Plant:	
- coal-fired	431 – 492
- oil-fired	293 – 377
- natural gas-fired	229 – 295
- wood-fired (roundwood chips)	43 – 60
- wood-fired (forest residue chips)	36 – 36
- wood-fired (clean waste wood chips)	11 – 20
- wood-fired (unclean waste wood chips)	29 – 39
Commercial or Industrial Heat from CHP Plant:	
- coal-fired	335 – 439
- oil-fired	256 – 335
- natural gas-fired	201 – 263
- wood-fired (roundwood chips)	30 – 59
- wood-fired (forest residue chips)	9 – 31
- wood-fired (clean waste wood chips)	2 – 13
- wood-fired (unclean waste wood chips)	18 – 35
Commercial or Industrial Electricity from CHP Plant:	
- coal-fired	673 - 878
- oil-fired	515 - 673
- natural gas-fired	403 - 526
- wood-fired (roundwood chips)	60 – 117
- wood-fired (forest residue chips)	18 – 62
- wood-fired (clean waste wood chips)	4 – 27
- wood-fired (unclean waste wood chips)	37 – 70
Electricity from Power Only Plant:	
- coal-fired	985 – 1,379
- oil-fired	754 – 1,055
- natural gas-fired	459 – 688
- wood-fired (roundwood)	84 – 127
- wood-fired (forest residue chips)	34 – 78
- wood-fired (forest residue pellets)	53 – 77
- wood fired (clean waste wood chips)	24 – 48
- wood-fired (clean waste wood pellets)	39 – 51
- wood-fired (unclean waste wood chips)	60 – 85
- wood-fired (unclean waste wood chips)	76 – 88

Source: Forest Research and North Energy Associates Ltd (2011) Biomass Thresholds for Electricity, CHP and Heat Generation

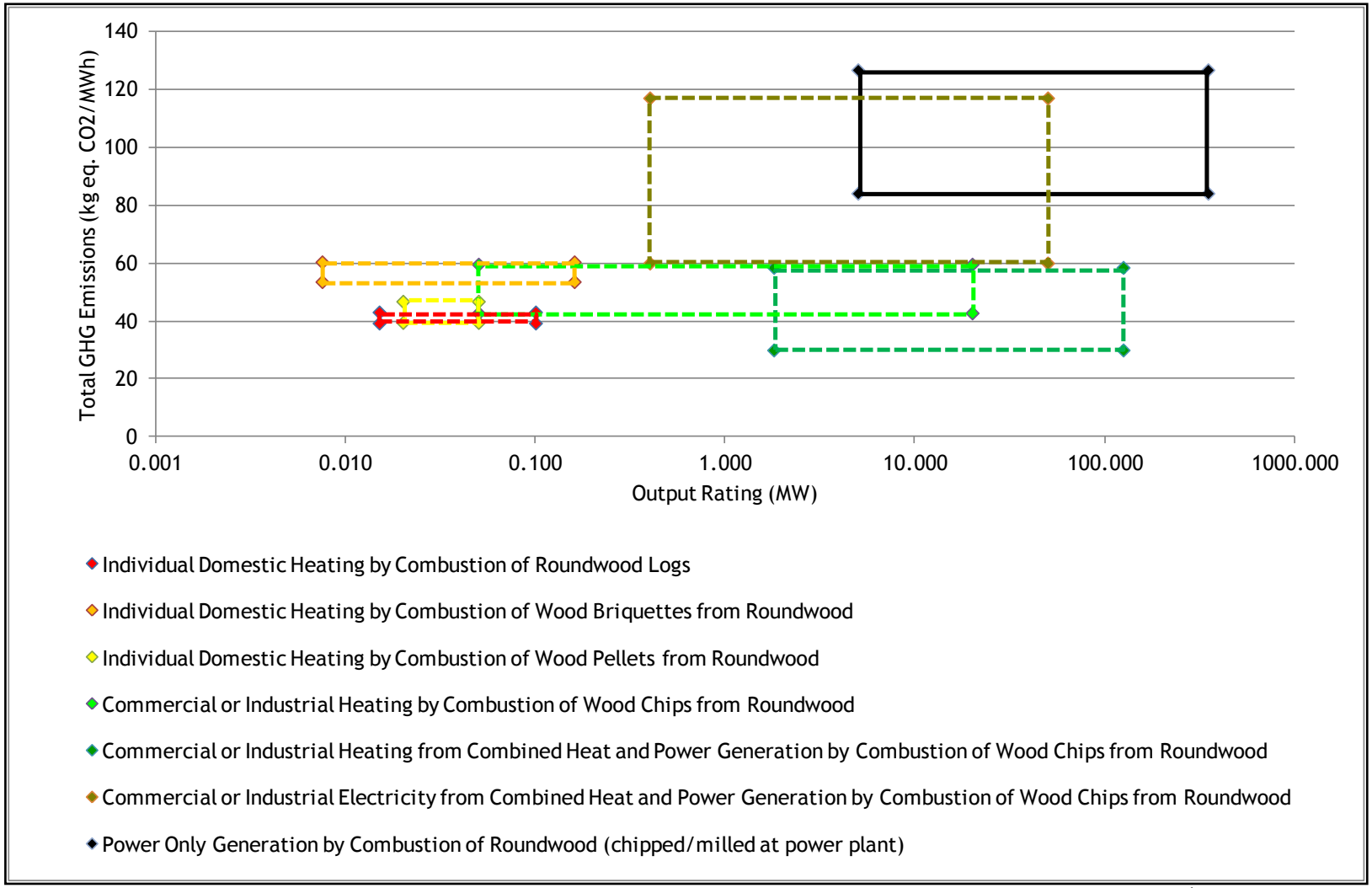

Figure 8-1: Range of Typical Results for Total Greenhouse Gas Emissions for the Use of Roundwood[1]

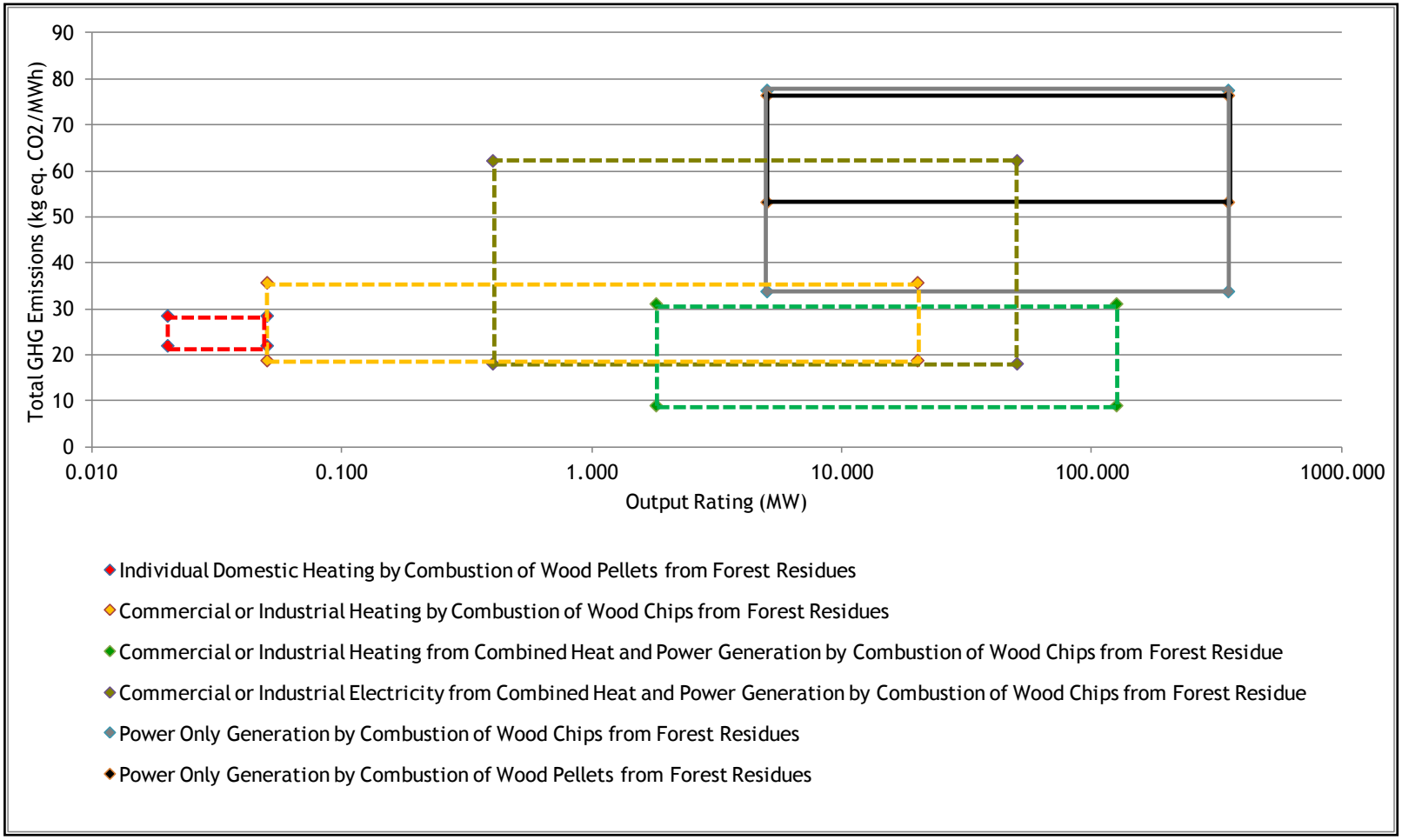

Figure 8-2: Range of Typical Results for Total Greenhouse Gas Emissions for the Use of Forest Residues

Notes to aid interpretation of figures: The original research also includes figures for clean and dirty waste wood which are not reproduced here. It should be noted that different scales on each set of axes is used for clarity in comparison of results. Logarithmic scales are also used. To assist interpretation, the areas covered by the ranges of scales and estimated total GHG emissions are bounded by boxes with dashed lines for heat and CHP plants and by boxes with solid lines for power only plants.

8.5 Wood Fuel Task Force Estimates

Type of material	2009/11 Oven Dry (t)	2012/16 Oven Dry (t)	2017/21 Oven Dry (t)
Hardwood – Logs	112,500	110,700	103,400
Softwood (incl. logs, chips and SRW)	2,819,200	3,333,400	3,657,300
Softwood Brash / Branchwood	382,700	395,000	395,000
Softwood Stumps / roots	35,000	35,000	35,000
Small & Neglected woods	50,000	50,000	50,000
Arboricultural arisings	172,100	172,100	172,100
Short rotation coppice	2,400	2,400	2,400
Short rotation forestry	0	0	0
Recycled and waste wood	602,200	602,200	602,200
Total	**4,176,100**	**4,700,800**	**5,017,400**

Table 8-1: Total Estimated Potential Resource

Type of material	2009/11 Oven Dry (t)	2012/16 Oven Dry (t)	2017/21 Oven Dry (t)
Hardwood – Logs	20,500	20,500	20,500
Softwood (incl. logs, chips and SRW)	2,603,000	2,603,000	2,603,000
Softwood Brash / Branchwood	20,000	20,000	20,000
Softwood Stumps / roots	0	0	0
Small & Neglected woods	0	0	0
Arboricultural arisings	120,200	120,200	120,200
Short rotation coppice	0	0	0
Short rotation forestry	0	0	0
Recycled and waste wood	306,000	306,000	306,000
Total	**3,069,700**	**3,069,700**	**3,069,700**

Table 8-2: Material Already Committed to Existing Markets

Type of material	2009/11 Oven Dry (t)	2012/16 Oven Dry (t)	2017/21 Oven Dry (t)
Hardwood – Logs	92,000	90,200	82,900
Softwood (incl. logs, chips and SRW)	216,200	730,400	1,054,300
Softwood Brash / Branchwood	362,700	375,000	375,000
Softwood Stumps / roots	35,000	35,000	35,000
Small & Neglected woods	50,000	50,000	50,000
Arboricultural arisings	51,900	51,900	51,900
Short rotation coppice	2,400	2,400	2,400
Short rotation forestry	0	0	0
Recycled and waste wood	296,200	296,200	296,200
Total availability	**1,106,400**	**1,631,100**	**1,947,700**
Less Forecast Additional demand			
Increase in sawlog (less chip) demand	174,000	174,000	174,000
Increase in wood panel demand	190,000	190,000	190,000
Increase in pulp/paper and paperboard demand	Small increase	Small increase	Small increase
Additional biomass demand	170,000	260,000	260,000
Total wood pellet production demand	140,000	140,000	140,000
Net availability	**432,400**	**867,100**	**1,183,700**

Table 8-3: Material Already Committed to Existing Markets

Source: Scottish Wood Fuel Task Force Report, March 2011. For data sources see full report.

8.6 Estimated Woodfuel use of electricity only plant compared to overall potential and net available Scottish resource

Plant size (MW)	Annual fuel input in odt (1 plant)	Annual fuel input in green tonnes (1 plant)	% 2017/20 Scottish resource (single plant)	Annual fuel input in odt (5 plants)	Annual fuel input in green tonnes (5 plants)	% 2017/20 Scottish resource (5 plants)	Annual fuel input in odt (10 plants)	Annual fuel input in green tonnes (10 plants)	% 2017/20 Scottish resource (10 plants)
5	32,500	65,000	0.65	162,500	325,000	3.24	325,000	650,000	6.48
10	65,000	130,000	1.30	325,000	650,000	6.48	650,000	1,300,000	12.95
20	130,000	260,000	2.59	650,000	1,300,000	12.95	1,300,000	2,600,000	25.91
30	195,000	390,000	3.89	975,000	1,950,000	19.43	1,950,000	3,900,000	38.86
40	260,000	520,000	5.18	1,300,000	2,600,00	25.91	2,600,000	5,200,000	51.82
50	325,000	650,000	6.48	1,625,000	3,250,000	32.39	3,250,000	6,500,000	64.77

Table 8-4: Estimated woodfuel use of electric only plant compared to potential Scottish resource

Plant size (MW)	Annual fuel input in odt (1 plant)	Annual fuel input in green tonnes (1 plant)	% 2017/20 Scottish resource (single plant)	Annual fuel input in odt (5 plants)	Annual fuel input in green tonnes (5 plants)	% 2017/20 Scottish resource (5 plants)	Annual fuel input in odt (10 plants)	Annual fuel input in green tonnes (10 plants)	% 2017/20 Scottish resource (10 plants)
5	32,500	65,000	2.91	162,500	325,000	14.53	325,000	650,000	29.06
10	65,000	130,000	5.81	325,000	650,000	29.06	650,000	1,300,000	58.02
20	130,000	260,000	11.62	650,000	1,300,000	58.12	1,300,000	2,600,000	116.24
30	195,000	390,000	17.44	975,000	1,950,000	87.18	1,950,000	3,900,000	174.36
40	260,000	520,000	23.25	1,300,000	2,600,00	116.24	2,600,000	5,200,000	232.48
50	325,000	650,000	29.06	1,625,000	3,250,000	145.30	3,250,000	6,500,000	290.60

Table 8-5: Estimated woodfuel use of electric only plant compared to net available Scottish resource

9 References

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