Delivering the UK's renewable heat objectives through wood fuel

Sustainability Position Paper

March 2014

Executive Summary

Renewable energy from wood fuel has major potential as a sustainable and efficient way to produce heat which can be used to warm homes and businesses, provide hot water and drive industrial processes. However, the benefits accrued from utilising wood fuel for this purpose depend on the sustainability of the source and emissions accruing from land-use production, harvesting, transportation and conversion.

This briefing sets out the position of some of the UK's leading pellet manufacturers, distributors and suppliers of wood pellet boilers for heating on the issue of sustainability. It provides data obtained from current production and distribution within the UK wood pellet industry and emissions of CO_2 from every stage of the supply chain are analysed.

As long-term investors in this industry the authors recognise that the robust scientific evidence base for utilising bio-energy in heat must be backed up by standards and by real practice. They support the Government's Bioenergy Strategy[i] which states that policies supporting bioenergy should deliver genuine carbon reductions as well as the introduction of sustainability standards by t through the Renewable Heat Incentive (RHI) and the development of a Biomass Suppliers List.

In the following pages, the authors have sought to illustrate the journey and emissions from supplying biomass pellets typically available in the UK. It is of course not intended to replace academic or official work on this subject but to provide insight into a real journey from forest to radiator. The results show that wood pellets supplied through a high quality supply chain significantly exceed DECC's requirement for 60% reduction in GHG's.

On the basis of this clear sustainability, the paper further supports wood pellets as a cost effective source of renewable heat when compared to other technologies within the RHI and those supported through other Government initiatives.

About the authors

- CPL Renewables, part of CPL Industries, is focussed on the development and distribution of wood pellet heating solutions for commercial and public sector organisations within the UK.
- Hoval Ltd, part of Hoval Group, deliver efficient and ecologically sound commercial heating solutions including biomass wood pellet boilers.
- Land Energy is a renewable energy business, focused on biomass, including the manufacture of premium quality wood pellets and the supply of biomass boilers.
- Verdo Renewables, part of the Danish Verdo Group manufacture premium quality wood pellets, from virgin timber, locally sourced within the UK.

Background

The sustainability of biomass use as a wood fuel substitute to fossil fuel depends on a number of complicated factors including the rate of CO_2 uptake by forests and emissions associated with production, harvesting, transportation and energy conversion. Although the evidence base in favour of using sustainable biomass is strong, greater scrutiny is underway as the role of biomass for use in meeting renewable and decarbonisation targets increases.

Biomass has the potential to contribute to renewable targets in power generation, transport and heating, however the authors of this note believe it is particularly well suited to heat generation. The typical conversion efficiency in using biomass for electricity is around 30-35%, by contrast burning biomass to produce heat is 85% efficient.

Of course, the first step in reducing emissions from heating is to reduce demand through energy efficiency. Measures such as thermal insulation prevent heat from escaping and improve the energy efficiency of a building. Once demand has been reduced, it is necessary to combine an efficient heat conversion system (such as a high efficiency boiler) with a sustainable heating fuel.

This paper describes a wood pellet lifecycle using real data from the supply chain to demonstrate that biomass is a sustainable and efficient way to produce heat.

Sustainability Criteria and the RHI

The Renewable Heat Incentive (RHI) includes a number of sustainability requirements for biomass including a Biomass Supplier List which will be launched in Spring 2014 (becoming a requirement from autumn 2014) to ensure that all pellets used come from a verifiable supplier. Requirements include demonstrating a 60% Green House Gas (GHG) saving against the EU fossil heat average, assuming boiler efficiency of 70% and certain land criteria. Compliance for domestic consumers is to be demonstrated by either using the approved supplier list. Non-Domestic consumers may use the list or regular self-reporting. In addition, there are air quality standards in place for biomass boilers.

At an EU level, emerging developments may merit the inclusion of Indirect Land Use Changes (ILUC), water consumption and the potential application of a hierarchy for the use of biomass. Thus far it has proved difficult to provide a clear definition of GHG effects of these complex issues. The biomass sustainability criteria currently under development in

Europe cover all uses of biomass and the draft version of these requirements includes similar GHG savings to those applied to the RHI.

Furthermore, the government has developed a reporting mechanism for solid and gaseous biomass based on a recommendation paper published by the European Commission in February 2010. Ofgem's Biomass and Biogas Carbon Calculator has been developed for calculating the carbon intensity and greenhouse gas (GHG) saving of solid biomass and biogas used for electricity and heat generation. The Calculator incorporates the calculation methodology outlined in the Renewable Energy Directive, taking account of the recommendations set out by the European Commission in their report on sustainability requirements for solid and gaseous biomass.

UK Supply Chain

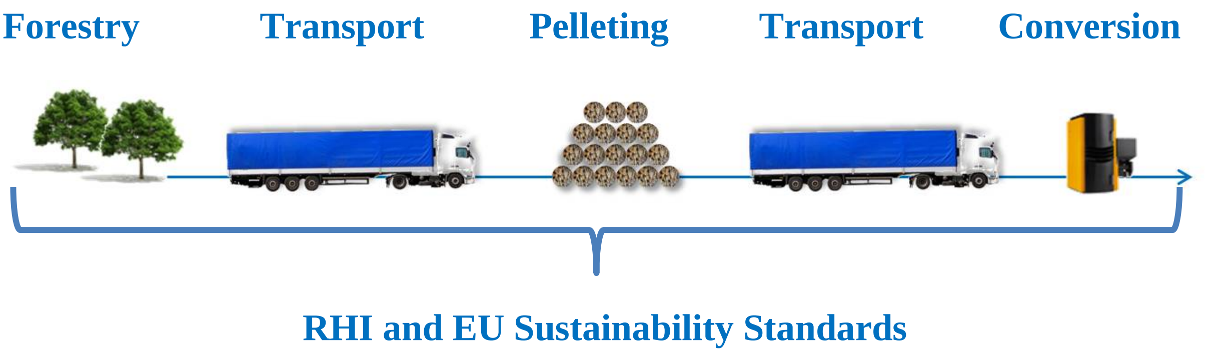
Clear and enforceable sustainability criteria have a key role in distinguishing between bioenergy production and use which is consistent with sustainability and that which is not. In considering the sustainability of biomass for heating it is important to understand the supply chain responsible for taking wood from a forest and delivering heat energy.

The main processes in the biomass supply chain include forestry, harvesting, pelleting, transportation and burning in boilers to produce heat onsite. The carbon released is part of the existing carbon cycle, absorbed by the trees before felling, and over time will be reabsorbed by new trees planted in sustainably managed forests. The development of a short term 'carbon debt' by the use of biomass is gaining acceptance where whole trees are used but is largely negated for wastes and residues which form a large part of the material used in UK pellets today.

Biomass supply chains are complex with significant investment required to develop the facilities and infrastructure where they are needed. It is estimated that around £150 million has been invested into UK pellet mills and distribution facilities to date. Because of this, the embryonic UK supply chain is relatively concentrated with the authors of this paper responsible for supply of over 60% of the pellets burnt for heating in the UK today.

A simplified description of the Biomass Heating Supply Chain is shown in the schematic below:

Figure 1: Supply Chain and Standards Map



Harvest

Despite some studies pointing to high future biomass imports, the majority of wood sourced for use today in the UK heating industry comes from indigenous sources, and utilises either sawmill waste or the low quality parts of the forestry crop. Most biomass has to be locally sourced otherwise transportation costs make it uneconomic as an energy source. As an example, the majority (c.65%) of wood raw material for the Verdo Renewables pellet plant in Andover is chip from three sawmills within a fifty mile radius.

Many forests supplying the UK pellet industry are inspected and certified against strict standards based on the international Forest Stewardship Council and other similar schemes. In order to be given FSC certification a forest must be managed in an environmentally appropriate, socially beneficial and economically viable manner. The FSC standard applies ten principles or rules for responsible forest management including; complying with laws and FSC principles, to maintain or restore the ecosystem, its biodiversity, resources and landscapes and to have a management plan, implemented, monitored and documented.

FSC certification requires a full audit to assess the company's qualification for certification. Forests that meet these strict standards are given FSC certification and the timber allowed to carry the FSC label. Once obtained the certificate is valid for five years subject to annual surveillance audits to verify continued compliance.

According to a report produced by the FSC in 2012, UK forests absorb a substantial amount of CO_2 from the atmosphere. Net CO_2 uptake by UK forests (after taking into account the removal through harvesting of approximately 6.5MtCO_2 per year) has been estimated between 9 and 15 MtCO_2 per year[ii].

Forestry management in the UK is a predominately mechanised process and therefore emissions associated with forest establishment, production and harvesting are largely from diesel powered equipment. Annual wood production in the UK is estimated by FSC at 8.48 million tonnes of softwood and 0.53 million tonnes of hardwood. FSC estimates total emissions from harvesting and forwarding to be 0.071 million tonnes of CO_2 per year which equates to 7.9kg CO_2 per tonne of wood harvested.

During the pelleting process, wood moisture is removed and energy density increased so a tonne of biomass pellets is actually produced using up to two tonnes of greenwood. Using this simple ratio, we calculate that harvesting generates emissions of 15.76kg CO_2 per tonne of biomass pellets produced for heating or 0.00394kg/CO_2e/kWh of heat energy assuming one tonne of pellets provides 4,700kWh of net heat energy.

A strong case has been made that changes in land use and alternative uses for biomass material can have an emissions impact and this has not been included within existing sustainability methodology. The supporters of this paper agree that further analysis of the emissions from bioenergy is welcome and support DECC's work in investigating issues such as carbon debt and land use change. These factors may need to be taken into account in the future to ensure sustainability standards keep pace with scientific understanding.

Production/Pelleting

Following harvest, the raw material is transported from the forest (see transportation section for transport emissions) and then processed at a pellet production plant.

Typical emissions from the pellet production process are around 0.03kg/CO_2e/kWh, however with investment and the right site specific conditions it is possible to reduce emissions further. Land Energy has a pelleting process that utilises an on-site biomass CHP plant. The emissions associated with production in this plant are estimated at just 0.011kg/CO_2e/kWh.

In addition to the low level of emissions associated with production, wood pellets in Europe must also comply with the quality standard ENplus. ENplus includes the supply chain from production to delivery to the customer. It also includes two quality classes; Class A1 is the premium quality used in private household boilers or stoves and Class A2 is used in larger installations. The standard sets parameters for size, particles, ash content and ash melting temperatures.

The quality requirements for pellet producers and pellet traders that wish to certify are laid down in the ENplus handbook. CPL, Land Energy and Verdo Renewables were all founder members of the UK Pellet Council which manages the ENplus scheme in the UK, under licence from the European Pellet Council.

Transportation

There are two stages of transportation to consider. The first stage is the transportation of feedstock to production facilities; the second is transportation of the finished pellet product to the end consumer. Biomass content is usually transported by road and the feedstock is sourced from the local area. Delivery to end-users requires further transportation.

The emissions produced through biomass transportation are low compared to the immense energy used to transport electricity and gas. They are also low when compared to other parts of the wood pellet supply process, meaning sustainability of source and production is likely to have a greater impact on emissions compared to distance travelled, even when importing from abroad.

Based on Land Energy's data, an average tonne of feedstock travels 56km to reach the plant. Assuming 0.123Kg CO_2e/tonne is emitted per Km travelled and 3 tonnes feedstock (pellet+fuel) is sufficient to create 1 tonne pellets this represents = 20.66Kg CO_2e/tonne pellet or 0.0044kg/CO_2e/kWh.

CPL Industries has analysed the emissions associated with delivery of pellets from production facility to point of use. Over the period 1st April to 31st August, CPL distribution vehicles travelled a total of 65,000 miles making over 300 deliveries and delivering 2,500 tonnes of pellets. This equates to an average of 200 miles per delivery of pellets, with average CO_2 emissions per delivery of 270.3kg. This represents 0.007kg/CO_2e/kWh.

Figure 2: Data associated with delivery of pellets 2013[iii]

Tonnes delivered	**2,572**
MWh delivered	12,346
Miles travelled	63,651
Deliveries	300
Miles per tonne/pellets	24.7
t/CO2 emitted	85.67
kg CO_2 emissions per kWh	0.007
Average size of delivery (tonnes)	8.57

Heating Efficiency

The concept of burning organic matter to provide heat has been in existence for millennia however technology is constantly improving to allow conversion of embodied energy into useful heat output. A biomass boiler is a modern method of carrying out this process and provides efficient and cost-effective supply of heat where it is needed.

A biomass boiler can operate at over 90% net efficiency which is higher than the level of many gas boilers currently in use.

The European Union is setting standards for performance and labelling of energy using products including biomass space heating through directive 2009/125/EU on the ecodesign of energy-related products (ERPs), together with the directive 2010/30/EU on energy labelling. Set out below are the efficiency ratings of two biomass boilers currently available and eligible for the RHI, both above 90% efficiency:

Figure 3: Pellet Boiler efficiencies at nominal output[iv]

Manufacturer	Model	Output	Efficiency
Hoval	Biolyt	50-160kw	>90%
Hoval	STU	195-975kw	>90%

Summary GHG emissions analysis

This paper provides real world data from leading pellet production and distribution operations in the current UK pellet supply market.

The report shows that the method of production has a greater influence over carbon emissions of the supply chain than does the transport of raw material or finished product movement. Plants using biomass CHP to provide heat for drying the incoming source timber have carbon emissions of 0.011kg/$C0_2$e/kWh compared to 0.03kgCO_2e/kWh for a plant using gas heated rotary dryers. This supports the payment of RHI for drying of raw materials providing the basis for the investment in CHP (CHP plants are eligible for RHI for heating and 1.5 ROC's on electricity generation provided they have not received the ROC uplift under the RO. It should be stressed that both methods of pellet production produce high quality pellets which more than exceed the most stringent DECC and EU sustainability requirements.

Overall harvesting and transport to the production plant represent only c 20-25% of supply chain emissions and are likely to remain consistent as economics requires that raw materials should be sourced local to the production plant.

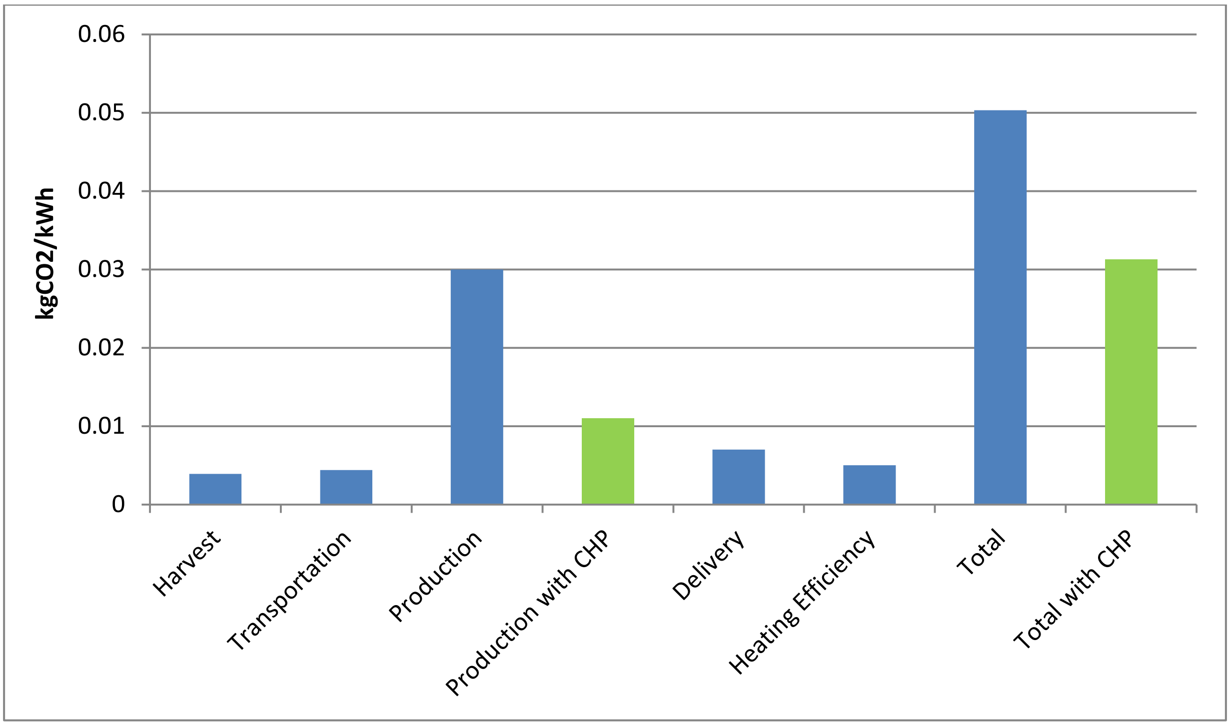
At the current stage of market development, delivery to the final customer also represents about 25% of carbon emissions within the supply chain. At present, given the low volumes within the overall market, delivery distances are high at c 200 miles per delivery. Should the market develop however (with the support of the RHI), it can be expected that these distances will reduce significantly, with a direct correlation to the emissions from this stage of the supply chain.

A summary of emissions from each stage of the supply chain set out in this paper is shown below in Figure's 4 and 5.

Figure 4 – Stage by stage emissions per/kWh heat energy

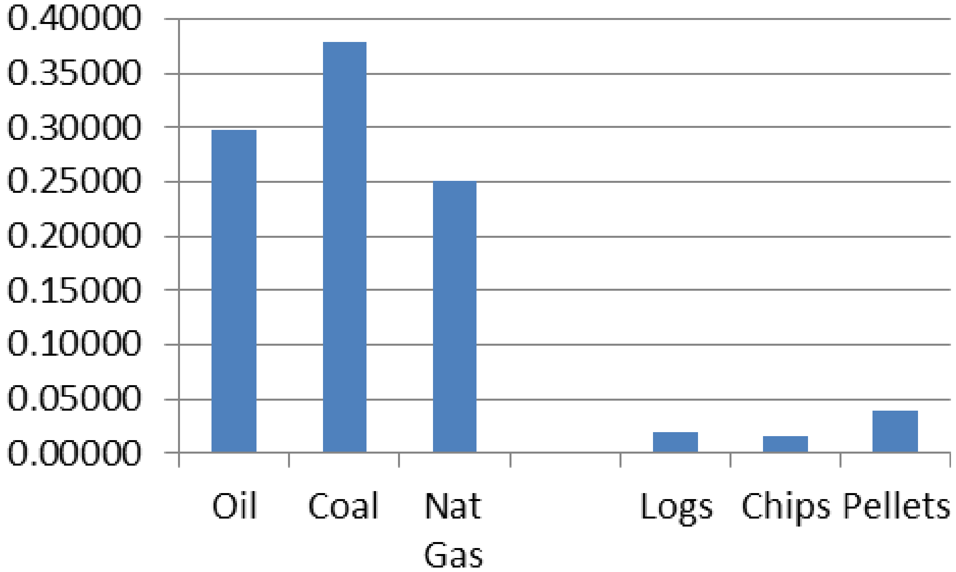
Direct emissions from typical UK Biomass Pellet Supply Chain	**KgCO_2e/kWh**
Harvesting and Forwarding (FSC sourced Forest in UK)	0.0039
Transportation from forest to production facilities (Approximately 42 miles)	0.0044
Production based on a production plant without CHP	0.0300
Production based on a production plant with CHP	0.0110
Transportation from production facility to end-user (Average 200 miles per delivery)	0.0070
Heating efficiency losses assuming boiler is 90% efficient	0.0050
Total	0.0304 – 0.0504

Figure 5 – Stage by stage emissions per/kWh heat energy



This analysis can be compared to other fuels by using published emissions factors. The data shown in Figure 6 is taken from the 2012 greenhouse gas conversion factors for company reporting, provided by DEFRA. Wood pellets have a low emissions factor of just 0.04kg (average of Figure 5 above) CO_2e/kWh compared to oil (0.29kg/CO_ee/kWh), coal (0.37kg/CO_2e/kWh) and natural gas (0.25kg/CO_2e/kWh).

Figure 6 – DEFRA/DECC 2012 CO_2 emissions per kWh – heating fuel comparison[v]



The company reporting guidelines developed by DECC/DEFRA and shown in Figure 6 for wood pellets (0.04kg/CO_2e/kWh) represent a mid-point in the range 0.03 – 0.05 kg/CO_2 per kWh of outputs developed for this paper.

Conclusion

As outlined in our analysis, this report shows that wood pellets produced and distributed by some of the leading providers to the UK market provide an 80-90% reduction in CO_2 emissions compared to oil (which is in most cases the fuel being replaced), comfortably in excess of DECC's requirement for a 60% reduction. With total supply chain CO2 emissions per kWh ranging from 0.03 to 0.05kg compared to 0.3kg for oil.

A further point that can be extrapolated from the results is that the CO_2 emissions of importation (particularly in reasonable quantities from Europe) would not significantly increase CO2 emissions provided that the source is sustainable. The most important issue with imported pellets is that the production model is as outlined in this paper and the raw material is from an authenticated source.

The authors are aware of the emerging discussions regarding the cascade principle of biomass usage and the more developed models of indirect land use changes (ILUC). Based on the evidence currently available it is clear that the low CO_2 emissions from pellet usage allow considerable scope for any CO_2 emissions applied as a result of ILUC considerations.

Under the RHI wood pellets continue to offer excellent value, with medium and large biomass in particular representing low cost renewable deployment in comparison to other technologies within the RHI and support for renewables through other policy interventions. For example the large biomass tariff of 2p/kWh compares very favourably with the 4.4p/kWh for power station conversion to biomass or the c 8.3p/kWh (2 ROCs) support for off shore wind available in 2014/15.

The development of a wood pellet supply chain (for heating) in the UK has involved around £150 million of private sector investment. Many of the jobs created in production have replaced heavy industry which has closed or relocated abroad. This combined with the growing installer base means that the biomass supply chain is now a significant employer in the rural areas where this solution has greatest potential.

Finally, the sector has developed a high quality supply chain capable of meeting market demand and expanding should market demand grow. Wood pellet boiler technology is proven with low CO_2 emissions, high (90%+) efficiency and low emissions of particulates, VOC's, Chlorides and other pollutants.

Wood pellets represent at present the most scalable of renewable heat technologies which should continue to lead the development of renewable heat out to 2020 and beyond. Ongoing deployment should however be supported by sustainability standards and the authors of this paper look forward to working with policymakers as these develop, particularly the preferred supplier scheme proposed for implementation in Autumn 2014. More generally, the authors look forward to ongoing dialogue with all stakeholders to support widespread deployment of renewable heating in the UK.

ENDS

[i] UK Bioenergy Strategy 2012
[ii] FSC 2012 – Understanding the carbon and greenhouse gas balance of forests in Britain http://www.forestry.gov.uk/pdf/FCRP018.pdf/$file/FCRP018.pdf
[iii] Data supplied by CPL Industries calculated using standard road transport fuel emissions factors.
[iv] Data supplied by Hoval
[v] 2012 greenhouse gas conversion factors for company reporting, DECC