

WOODFUEL AND WOODLAND MANAGEMENT

A CASE STUDY

Kathy Norman, Paul Burgess, Alistair Yeomans and Gabriel Hemery review existing and projected impacts of the emerging woodfuel market on woodland management, using a case study of an English estate.

As oil prices increase, wood becomes more competitive as a fuel source. For example, the wholesale price of Brent crude oil increased from 1.4 pence per kWh in January 2009 to 3.1 pence per kWh in October 2010 (US Energy Information Association, 2010; Federal Reserve, 2010; BFIN, 2010). Using sustainably produced wood as an alternative to fossil fuels can also reduce net greenhouse gas emissions (Carbon Trust, 2009).

The UK Renewable Energy Strategy proposed that the proportion of heat generated from renewable sources, including wood, could increase from 1.6% in 2009 to 12% by 2020. In October 2010 the UK government confirmed provision of £860 million for the Renewable Heat Incentive (RHI) scheduled for April 2011, which will provide support to reduce the net cost of renewable energy systems, such as biomass boilers, relative to fossil fuel systems. At the same time national woodfuel consumption for electricity production will increase as new large biomass power projects are commissioned. The annual feedstock requirements of these large projects could exceed the equivalent of 40 million green tonnes of woodchip per year (Hawkins Wright Ltd, 2010).

It is estimated that in 2000 the annual wood increment of conifers and broadleaves in the UK was 16.8 million m³ and 4.4 million m³ respectively (Forestry Commission, 2002). This is equivalent to about 13.7 million green tonnes of softwood and 4.0 million green tonnes of hardwood, substantially below the anticipated levels of demand described above. The annual

amount harvested in 2000 was even less, equivalent to about 7.4 million green tonnes of softwood (54% of the annual increment), and 0.65 million green tonnes of hardwood (16% of the annual increment) (Forestry Commission, 2010). In fact, in 2000 the UK only supplied about 15% of its demand for wood.

The Woodfuel Strategy for England (Forestry Commission, 2007) indicated that the proportion of the annual increment harvested could increase, creating an additional supply of up to 2 million green tonnes per annum. This will not be straightforward as woodland ownership is fragmented (Yeomans and Hemery, 2010), and the public perceive a wide range of services provided by woodlands that can create negative attitudes to tree felling (Agbenyega et al., 2009). Additionally, the wood processing sector has raised concerns about the impact of potential woodfuel price rises, driven by the RHI subsidy, on their production system (WPIF, 2010). This leads to a key question:

Will the increased demand for woodfuel stimulate domestic production and a renaissance in woodland management, or will it simply result in more imports and in wood supply problems for existing wood industries?

Current woodland management

Most woodland on traditional estates is actively managed, although even here the level of management has reduced in recent decades (Nicholls and Young, 2006) due to low financial returns. The majority of woodlands in England

are not owned by the Forestry Commission (FC) and of these 71% are currently without a FC approved management plan (Yeomans and Hemery, 2010), which suggests that a considerable proportion may be undermanaged. Management operations such as thinning can improve the quality of standing timber and during the normal thinning period of a woodland rotation, up to 70% of the maximum mean annual increment may be removed without compromising the volume of future timber production (Savill et al., 1997).

Appropriate extraction of trees to provide woodfuel can provide benefits such as local employment (McKay, 2005) and the effect on biodiversity can also be positive (Keith Kirby, personal communication, 2009). However extraction, especially if it involves the removal of stumps and roots, can reduce carbon sequestration by the soil (Vanguelova and Nisbet, 2010) and increase soil erosion.

An English estate case study

We studied an English estate consisting of 750ha (1850 acres) of woodland (Table 1). Conservation, under the guidance of Natural England, and game management are the primary objectives of 200ha of the woodland area. The management of the remaining 550ha is the focus of this case study.

The main woodland area is managed according to a FC-approved plan and is covered by English Woodland Grant Schemes. Under these schemes an agreed annual programme of thinning and pruning is implemented mainly by contractors. Approximately 1700 tonnes of

timber have been harvested annually in recent years. The woodlands are managed to Forestry Stewardship Council (FSC) standards with all timber produced FSC certified.

Wood products

In 2009 data produced by a contractor indicated that the estate harvested 1801 tonnes of wood, of which 1292 tonnes (71%) was softwood (Table 2). The softwood went to a range of markets. The hardwood, with the exception of one load of oak logs, was small diameter material and sold as firewood.

In 2009 a total of 940 tonnes of timber were sent to the biomass energy market. The average price received for the 472 green tonnes of hardwood firewood was about £6 per tonne. For the 468 green tonnes of softwood chipwood, the estate actually paid about £2 per tonne to remove and transport the material. Therefore the harvesting and transport costs of softwood chipwood were effectively covered by the sale of other timber grades (Estate Manager, personal communication, 2010).

Modelling potential wood production

The woodland area on the estate from which woodfuel could be potentially extracted covered 550ha and the approximate mix was 30% conifer and 70% broadleaf. An estimated 15% of the area was roads, rides and clearings. In our modelling we assumed yield classes (YC) of 12 for conifers and YC4 for broadleaves (mainly oak). Assuming the woodlands were within the normal thinning period, 70% of maximum mean annual increment over the remaining area

Table 1. Description of the woodland estate.

Description	Primary objective	Area (ha)	Area (acres)
Parkland	Conservation of mixed broadleaf ancient woodland pasture and Sites of Special Scientific Interest.	100	250
Game plantations	Amenity and financial income from game.	100	250
Main woodland area	Amenity and timber production	550	1350
Total		750	1850

Table 2. Wood products from the English estate for a calendar year (2009).

Tree type and product type	Product	Minimum length (m)	Diameter (cm)	Sold wood (green tonnes)	Sold wood (tonnes at 30% moisture content)
Conifers					
Timber	Green logs	2.4	18-30	539	309
Timber	Stake blanks	1.7	5-12	66	37
Timber	Medium bar	2.2	14-22	204	117
Timber	Short bar	1.9	12-18	15	9
Woodfuel	Chipwood	2.3	min. 7	468	267
	<i>Sub-total</i>			1292	739
Broadleaves					
Timber	Green logs	5.5	25	37	29
Woodfuel	Firewood	2.3	min. 7	472	371
	<i>Sub-total</i>			509	400
All trees	Total			1801	1139

provided an initial annual estimate of 2094 green tonnes in total; 1178 green tonnes of softwood and 916 green tonnes of hardwood (Table 3).

Yield class measures annual timber volume gained by the marketable stems (above 7cm diameter) and represents only a proportion of total volume gained. To assess realistic woodfuel potential, we excluded stumps and roots, and assessed potential production from branchwood, defined by Crockford (1987) as: “the woody portion of a tree other than the stem and roots, but including the top part of the stem which is

less than 7cm in diameter”. For conifers the proportion of branchwood to stemwood decreases with the mean height of the stand before stabilizing at about 15% for heights greater than 15m (Crockford, 1987). For broadleaves, although the proportion varies over a wide range, we used 45% branchwood as a proportion of stemwood (based on oak with 35cm dbh and timber height at 60% of tree height) (Crockford, 1987). Adding these proportions to the initial estimates provided an estimated total potential production of 1355

Table 3. Wood production per year from the estate (2009) compared to estimated potential.

Tree type and wood type	Sold wood (green tonnes)	Sold wood (tonnes at 30% moisture content)	Potential wood (green tonnes)	Potential wood (tonnes at 30% moisture content)
Conifers				
Stemwood		Not specified	1178	673
Branchwood			177	101
<i>Conifer total</i>	1292	739	1355	774
Broadleaves				
Timber		Not specified	916	720
Branchwood			412	324
<i>Broadleaf total</i>	509	400	1329	1044
All trees	1801	1139	2684	1818

green tones of softwood and 1329 green tonnes of hardwood, a grand total of 2684 green tonnes (Table 3). Table 3 shows that 1292 green tonnes of softwood were harvested in 2009 so there was minimal opportunity to increase production; however, annual hardwood production could be increased from the current level of 509 green tonnes to 1329 green tonnes.

Converting 1355 green tonnes of softwood at an estimated 60% moisture content (wet basis) and 1329 green tonnes of hardwood at an estimated 45% moisture content to woodchip at 30% moisture content provides an estimate of 774 and 1044 tonnes of softwood and hardwood respectively. The total of 1818 tonnes of woodchip (30% moisture content wet basis) gives a yield of about 3.3 tonnes per hectare. This is slightly above a general estimate provided by the Biomass Energy Centre of 2.9 tonnes of 30% moisture woodchip per hectare per annum (Biomass Energy Centre, 2010a).

In total the material sold currently as woodfuel (Table 2) is equivalent to 638 tonnes of woodchip at 30% moisture. Assuming that the same quantity of wood continues to be sold into non-fuel markets, there is limited potential to sustainably increase the production of softwood woodchips. However there would be potential to increase hardwood production by 820 green tonnes, equivalent to 645 tonnes of woodchip at 30% moisture.

Potential for in-house use of woodfuel

As an alternative to selling chipwood at a loss or at low prices, the estate has investigated the possibility of using woodfuel to meet their

heating needs. A report prepared by a consultant recommended replacement of the gas boilers and storage heaters in the main house with a new system based mainly on biomass boilers. The higher capital cost of the biomass boilers compared to an equivalent fossil fuel system could be subsidised by the RHI, and there would be savings in fuel cost if woodchip was generated and used on-site. Furthermore, there would be a public-relations benefit from installing a more carbon-lean system of heating.

The annual gas consumption for heating the house from April 2009 to March 2010 was about 2.1 million kilowatt hours (kWh) at a cost of 3.3 pence per kWh (Table 4). The delivered cost of woodchip was given as £90 per tonne; as the energy density at 30% moisture content (wet basis) is 3500 kWh per tonne (Biomass Energy Centre, 2010b), resulting in a cost for bought-in woodchip of 2.6 pence per kWh. The cost of woodchip generated on-site has been estimated based on data supplied by the Biomass Energy Centre as 1.6 pence per kWh. Approximately 600 tonnes of 30% moisture woodchip per annum would be required to heat the house and this could be supplied using the material sold currently into biofuel markets.

Relative to a conventional gas-fired boiler, a woodchip boiler would incur additional costs. Nearby storage would be required to protect around 100 tonnes of woodchip (estimated peak monthly consumption) from the rain, as wet woodchips burn less efficiently and can degrade due to composting. Woodchip is a low density fuel and needs a storage volume of around 4m³ per tonne. The house is a listed building and

Table 4. Estimates of demand and costs for heating the main house using gas or woodchip.

	Energy use for heating (kWh/year)	Energy density of woodchip (kWh/tonne)	Cost of fuel (£/tonne)	Cost per kWh (£/kWh)	Annual cost (£)
Gas	2,100,000	-	-	0.033	70,000
Woodchip: bought-in	2,100,000	3500*	90	0.026	55,000
Woodchip: in-house	2,100,000	3500*	55	0.016	34,000

All data quoted to two significant figures
*Assuming a moisture content of 30% (wet basis)

therefore presents considerable planning challenges regarding permission for the location and construction of a large storage facility. The boilers and storage could be located in a service area away from the main building, however this would require a substantial additional pipe network. Woodchip boilers also require regular manual intervention and the cost of additional labour needs to be included in the comparison.

Conclusions

The woodlands at this large English estate are managed actively and a significant proportion of the estimated sustainable annual increment is harvested. Assuming timber sales into non-fuel markets continue at present levels, the 940 green tonnes currently sold as woodfuel is potentially available for use on the estate. This report also estimates that an additional 820 green tonnes of hardwood timber and woodfuel per annum is available for extraction. This presents a seemingly compelling case for a woodfuel heating system at the estate as wood chip could be produced and consumed internally. However this needs to be considered in the context of the additional investment of a woodchip boiler, planning regulations with regard to required infrastructure, and the additional in-house capacity to process and maintain a woodfuel supply chain.

An alternative option would be the hire or lease of a chipper and for the estate to supply woodchip to local end users. With production costs estimated as £55 per tonne and a price for delivered woodfuel of around £90 per tonne, this could give a better financial return than the current situation where woodchip grade material is essentially harvested at a loss. However it is currently considered that the local market for high grade wood chip is in its infancy with local demand being inconsistent.

Current government interventions such as the RHI focus support on the demand end of the supply chain, with the intention of stimulating a pull-through effect leading to increased local supply of timber. The UK Renewable Energy Strategy (Department of Energy and Climate Change, 2009) envisions “Increasing supply through bringing more woods back into

management”. However increased home-grown woodfuel supply will depend on the successful establishment of local and regional supply chains, in order to realise the carbon lean benefits from woodfuel energy generation. Support for increasing supply chain capacity will need to be carefully planned, with due regard given to good silvicultural practice, to ensure the full range of benefits arising from sustainable forest management are achieved. Furthermore an ongoing awareness is required of the pressures that international timber supplies may have on woodfuel prices, as it is anticipated that much of the forecasted demand for woodfuel in the UK will need to be met by imported timber.

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