

WOODFUEL RESOURCE IN BRITAIN

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EXECUTIVE SUMMARY

Objectives

1. The objectives of the study were to:
 - estimate the woodfuel resource from traditional forests, sawmills, urban areas, roadsides, powerline routes and short rotation coppice in a sound and consistent way and at the finest resolution justified by the data
 - forecast future availability of the resource from traditional forests
 - summarise information at a medium geographical and temporal scale in paper and electronic form
 - provide commentary on potential commercial availability, making clear the location and general scale of existing competing markets
 - allow the user, via an interactive website, to sift through summarised information to identify the woodfuel type of interest
 - allow the user to submit an electronic request with a defined area of interest, resource type, and a future time interval (with an undertaking to provide the user with refined information within one working week at minimal cost)
 - develop a dynamic tool to update summary data tables with the purpose of both meeting users' information needs more exactly and facilitating the process of updating tables as new information becomes available or existing information is refined
2. Two outputs have been produced in addition to the original objectives:
 - data were summarised for English Regions to assist strategic decision making
 - a methodology was developed to estimate the current and future carbon pools in all components of tree biomass, excluding the fine roots, in Britain; the facilities developed for the main project – summarisation at a range of scales and forecasting periods - are especially valuable in this context

Methods

3. Traditional forestry. Two sources of information on the existing forest resource (>2 ha) are available: the subcompartment database for areas managed by Forest Enterprise (an agency of the Forestry Commission) referred to here as public forest and the National Inventory of Woods and Trees for all other forest areas (referred to here as private forest). Growth rates for the parts of the stem presently marketed are obtained from these data sources. Relationships were determined to extrapolate from this portion of the stem to all biomass components (excluding fine roots). These relationships were used in conjunction with existing forecasting models to estimate future growth of all tree components. In the case of harvesting brush, site and environmental constraints on the fraction of the biological production that could be taken off harvesting sites were determined for each of the 30 Forest Enterprise Forest Districts; estimates are therefore described as 'operationally available'.. These constraints were extrapolated to all other forests using best available information.
4. Sawmill conversion products were derived from the 2000 Annual Sawmill Survey and the co-incident Biennial Sawmill Survey. These provide information on volume, form and use of conversion products.
5. Arboricultural arisings were estimated by questionnaire to arboricultural companies, tree officers and local authorities.
6. Short rotation coppice. The area established since 1992 was determined from the databases of the Woodland Grant Scheme and the Energy Crops Scheme. Biomass

production was estimated using assumptions of average annual yield.

7. None of the estimates takes account of the costs of harvesting, extracting, comminuting, drying or transporting the biomass; in some instances estimates are therefore described as 'potential' since few energy end-uses are sufficiently developed to give definite figures for paying capacity.

Results

Traditional forestry.

Current.

8. The current annual biomass production (excluding fine roots, stumps, and deciduous leaves) that can be removed from harvesting sites once site constraints have been taken into account is 5.63 million oven dried tonnes (odt). The annual production of operationally available resource for all end markets is mainly in Scotland and England (2.59 and 2.21 million odt respectively) with Wales producing about 15% of the total. Within England the main resources are in the South West and South East Region. Within Scotland the total annual production of operationally available biomass of all harvestable tree components is over 200 thousand (k) odt y¹ in each of the following districts: Tay, Cowal and the Trossachs, the Scottish Lowlands, Scottish Borders, Galloway and Ae. There is greater a range in resource availability within English Forest Districts than in Scotland. On one hand the operationally available resource in the South East District is over 400 k odt y¹, while Peninsular and Kielder have resources of 257 and 315 k odt y¹ respectively but on the other hand, Northants has an operationally available resource of just 56 k odt y¹. Of the four districts in Wales, Llanmyddfri has the greatest resource at 275 k odt y¹. A substantial fraction of the annual biomass production is stemwood of sufficient diameter that it is unlikely to be made available for woodfuel. Availability of small roundwood (i.e. a diameter of 7-14 cm) will depend on price and competing markets. Poor quality stems might already be used for firewood on an informal basis though it is probable that most is currently unused and could be made available for woodfuel. There are few current markets for branches and stem tips (stems less than 7cm in diameter).
9. In the private sector, the annual operationally available biomass is estimated to be 3.61 million odt y¹ for Britain as a whole. Poor quality stems, branches, stem tips and small roundwood contribute 279 k, 316 k, 21 k and 560 k odt y¹ respectively, giving a total of 1.18 million odt y¹. In all three countries the poor quality stem category is dominated by broadleaved species. Branches and stem tips are mainly broadleaved species and spruces. The species composition of small roundwood differs within GB with availability in Scotland and Wales being dominated by spruce but with a more even split among the species groups in England; availability of small roundwood will depend on price and competing markets. If we take a more conservative view of the fractions available for energy end uses and consider just poor quality stems, tips and branches, the operationally available biomass from the annual harvest is reduced from 1.18 million odt y¹ to 615k odt y¹.
10. Although the public forest managed by Forest Enterprise has a considerably smaller standing biomass than the private sector, it is generally more productive with the annual potential operationally available resource estimated at 2.02 million odt y¹. Branches, stem tips and small roundwood contribute 94k, 10k and 472k odt y¹ respectively giving a total of 577k odt y¹. In Forest Enterprise, stemwood is not classified by quality therefore there is no public sector entry in the poor quality category. In all countries, branch, stem tips, and small roundwood are dominated by spruce which comprises 60% of the total operationally available biomass though in England pines are also important contributors to the branch and tip categories. If we take a more conservative view of the fractions available for energy end uses and consider just poor just tips and branches, current felling plans indicate that 105k odt is harvested annually and operationally available.
11. If we assume that all the poor quality stems, tips and branches plus 10% of the small roundwood could be made available to energy end uses without disruption of existing markets, we estimate that 823k odt y¹ would be available from traditional forests for new energy uses. Public forest managed by Forest Enterprise has the potential to provide 22% of this with the bulk being available in the private sector.

Forecast

12. In the private sector, the total operationally available biomass of small roundwood, poor quality stems, stem tips, and branches together increases from 1.18 million odt y⁻¹ in 2003-2006 to 1.27 million odt y⁻¹ by the third forecast period, i.e. 2012-2021, and then decreases slightly to about 1.22 million odt y⁻¹. The main increase is in spruce; broadleaved species and pine remain about the same and there is a decrease in the biomass produced by conifers other than spruces or pines. If we take a more conservative view of the fractions available for energy end uses and consider just poor quality stems, tips and branches, the forecast annual biomass harvest increases from 615k odt y⁻¹ in 2003-2006 to about 666k odt y⁻¹ by the third period. The increase is largely due to spruce, particularly in Scotland.
13. The predicted quantities of operationally available biomass from the public sector are about four times smaller than that predicted from the private sector. Considering first the categories small roundwood, tips, and branches (in the public sector there is no equivalent category to poor quality stems), the total biomass remains around 575k odt y⁻¹ across Britain as a whole for the first two forecast periods and then falls slightly to reach 557k odt y⁻¹ by 2017-21. The biomass of spruce, the dominant species group, increases from about 358k odt y⁻¹ in the present period to about 379k odt y⁻¹ by 2017-2021 with much of the increase occurring in the first 5 years. As with the private sector, most of this increase occurs in Scotland. The overall spruce increase is balanced by the decrease in biomass of pine and the other conifers. Considering just tips and branches, current felling plans will lead to a general increase in harvested biomass from about 105k odt y⁻¹ to 110k odt y⁻¹. Much of the increase occurs within spruce by the second prediction period. The forecast increase in broadleaved tips and branches in the final period is counterbalanced by the decrease in conifers other than spruces or pines.

Sawmill conversion products

14. The annual production of conversion products in Britain is estimated at 859 k odt y⁻¹. Almost half (47%) comes from Scottish mills with 34% from England and 19% from Wales. Within England there are striking contrasts - the West Midlands accounts for 35% of English production and 12% of British output but the neighbouring East Midlands produces less than one tenth of this. The other important English Region is the North East.
15. Overall, 66% is in the form of chips, 20% is sawdust and 11% is bark. About 2% is already used as woodfuel with most being used by the sawmills themselves and only 3 k odt y⁻¹ sold externally as firewood – firewood production is concentrated in the South West and the East Midlands. Latest estimates indicate that overall 83% of the total conversion products is already sold to the wood processing industries with almost no differences between countries. Miscellaneous markets account for 15% of conversion products.

Arboricultural arisings

16. The average annual biomass of arboricultural arisings produced per respondent was 258 odt. If the average is applied to the estimated total number of contractors (2,174) this gives a total of 561 k odt y⁻¹ of arboricultural arisings across Britain. To obtain more refined figures, respondent averages calculated separately for Scotland, Wales and English were used giving a total GB estimate of 472 k odt y⁻¹. Almost all arisings are in England (94% total). Total non-marketed arisings are estimated at 321k odt y⁻¹, i.e. 68% of total estimated arisings. Utility work companies produce an additional 20 k odt annually (11 k in England, 6 k in Scotland and 3 k in Wales) giving a total of 492 k odt y⁻¹.
17. The waste woody material segregated from collected household waste and civic amenity sites across Britain is 179 k odt y⁻¹ (WRAP, 2002). If this material is included, the total availability of this potential wood fuel resource is estimated to be 670 k odt y⁻¹.

Short rotation coppice

18. The total area planted up to June 2003 under the Woodland Grant Scheme and the Energy Crops Scheme is 2086 ha of which the vast majority (95%) is in England. Assuming an average annual production of 8 odt ha⁻¹ y⁻¹, this equates to 17 k odt y⁻¹. Within England, just under half is within the Yorkshire and Humber Region with the East Midlands being the other main area of short rotation coppice (SRC).
19. Of the total area planted in England (1987 ha), 21% has been established under the Energy Crops Scheme which is conditional on the crop having a guaranteed energy end market; this applies particularly in the East Midlands. Many of the earlier crops established under the Woodland Grant Scheme in the Yorks and Humber Region were contracted to Project Arbre but their availability on the open market is uncertain at present.

Total

Present potential resource in the absence of competing markets

- 20 The total potential operationally available woodfuel in Britain during the present forecast period of 2003-06, in the absence of competing markets, is 3.1 million odt y⁻¹. The main sources are small roundwood followed by sawmill conversion products (potential to contribute around 1.03 and 0.86 million odt y⁻¹ respectively) with arboricultural arisings providing about 14% of the total. Approximately equal quantities are available in England and Scotland but the composition is substantially different. Arboricultural arisings form the major element in England though sawmill conversion products, small roundwood, and branches are all significant components. In Scotland and Wales, small roundwood and sawmill conversion products are the dominant resources with all other potential resource streams playing only a minor part. Unless establishment of fast growing species as short rotation coppice increases substantially, it will remain a minor component of the potential woodfuel mix.

Current potential operationally available woodfuel resource (in the absence of competing markets) by country (thousand oven dried tonnes y⁻¹)

Product	England	Scotland	Wales	Britain
Stemwood 7-14cm diameter	298	607	128	1032
Poor quality stemwood	95	113	71	279
Stem tips	14	12	5	31
Branches	225	116	69	410
Sawmill conversion products	290	404	166	859
Arboricultural arisings	456	22	14	492
Short rotation coppice	16	0.6	0.2	17
Total	1,394	1,275	453	3,119

Present potential resource taking account of existing industries

- 21 The potential GB resource that could be made available to new woodfuel projects without serious disruption to existing wood-using industries is estimated to be 1.26 million odt y⁻¹. Assumptions on market availability are:

- 10% of the small roundwood
- 100% of the poor quality stemwood, stem tips and branches
- 10% of sawmill conversion products
- 100% unmarketed arboricultural arisings
- 100% of material from clearance of utilities and roadside maintenance
- 80% of short rotation coppice in England, i.e. all coppice other than that established under the Energy Crop Scheme, and 100% short rotation coppice in Scotland and Wales.

Current potential operationally available woodfuel resource (in the presence of competing markets) by country (thousand odt y¹)

Product	England	Scotland	Wales	Britain
Stemwood 7-14cm diameter	30	61	13	103
Poor quality stemwood	94	113	70	278
Stem tips	14	12	5	31
Branches	225	116	68	410
Sawmill conversion products	29	40	17	86
Arboricultural arisings	313	18	10	341
Short rotation coppice	13	0.6	0.2	14
Total	718	361	183	1,263

- 22 The databases compiled within this project can be interrogated for smaller geographical areas to identify the zones of greatest development potential and to evaluate the risks of regional or local imbalances in supply and demand created by new energy end use markets.

Future potential resource in the absence of competing markets

- 23 Operationally available woodfuel in the form of small roundwood, poor quality stems, branches, tips and foliage from traditional forestry is expected to remain relatively stable at just under 2 million odt y¹ up to 2020.
- 24 Even though the smaller and poor quality fractions are expected to remain relatively stable, the availability of larger dimension material is expected to increase substantially. Assuming the sawmilling sector expands to use this resource, conversion products will increase proportionately.
- 25 Operationally available arboricultural arisings cannot be forecast with any certainty but seem unlikely to change dramatically.
- 26 Availability of short rotation coppice will depend on many factors of which Renewables Obligation co-firing conditions, CAP reform, support schemes, proof of energy end-markets and profitability of coppice relative to alternative crops are likely to be the most influential.

Significance of estimated resource

- 27 The total operationally available resource (3.1 million odt y¹), if used for electricity

generation, equates to 3.6 terawatt-hours y^{-1} or $TWH_e y^{-1}$ (assumes calorific value of $20GJ odt^{-1}$ and 25% conversion efficiency) or 0.44 gigawatts or GW (assumes a generating time of 8000h per annum). The 10% UK electricity target for renewable generation is equivalent at present to 3 GW of which about 1 GW is hoped to come from biomass. If all the operationally available woodfuel is used to generate electricity it could therefore provide just under half of the notional target for biomass. This estimate should be reduced by a factor of three if existing markets are considered.

- 28 If woodfuel is used to generate heat, the operationally available resource of 3.1 million $odt y^{-1}$ would generate about $12.1 TWH_{th} y^{-1}$ (assuming 85% conversion efficiency). This estimate should be reduced by a factor of three if existing markets are considered.
- 29 In the future, biomass could be used to produce transportation fuels. The current annual demand is 1600 petajoules or PJ (1 petajoule = 1,000 terajoules or 1,000,000 gigajoules). The conversion efficiency of woody biomass to ethanol or methanol is about 65% (Eyre *et al.* 2002). If all the operationally available woodfuel is used to produce transportation fuels this would give about $40PJ y^{-1}$, i.e. 2.5% of current demand. EU Directive 2003/30/EC states that 5.75% of all petrol and diesel must be replaced by biofuels by 2010. This estimate should be reduced by a factor of three if existing markets are considered.
- 30 Woodfuel would not be delivered (or used) in an oven-dried condition. The above estimates do not account for the energy required to evaporate the moisture contained in woodfuel because it can be very variable from one form of material to another and from one season to another. Ideally woodfuel will be dried using passive drying or waste heat to maximise efficiency of the overall process.

Limitations and uncertainties

- 31 We are confident in the base data for this study but there are uncertainties and limitations. Three of the main issues are:
- our estimate of constraints on brush harvesting in the private sector should be verified
 - deadwood has not been included but could be a significant additional resource in areas where it is too windy to thin stands regularly.
 - in view of the large resource identified in the branchwood of broadleaved woodlands, this estimate should be further validated and refined.
- 32 Forecasts of biologically available resource are subject to changes in silvicultural system - generally expected to reduce woodfuel yields - and to a lesser extent climate change, which is expected to increase overall tree growth.
- 33 Forecasts of the operationally available resource are subject to technological developments; some are likely to have positive effects on woodfuel availability but others are likely to reduce availability. A particular uncertainty is the response of the forestry sector, both the growing and the processing sectors, to the opportunities presented by a developing woodfuel market.
- 34 Though predictions of commercially available resource are not part of this study, we

have tried to estimate the quantity of woodfuel that could be made available without significantly affecting existing industries. The assumptions behind these estimates are open to question.

- 35 If the data presented in this study are extended to estimate commercial availability of woodfuel to energy markets, a further layer of uncertainty must be taken into consideration. The effects of competing and inter-related markets are difficult to predict especially as most wood products are traded internationally. Commercially available woodfuel will also be highly influenced by regulation, incentives and support mechanisms affecting not only energy markets but also waste recovery and recycling.