INTERNAL PROJECT INFORMATION NOTE 14/07

Title:	**Energy value assessment of woodchips from trees of different ages**
Number:	**500S/37/07 & FR07049**
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Energy Value Assessment of Woodchips from Trees of Different Ages

SUMMARY

Assessments of the calorific value of woodchips produced from Corsican pine and birch of five, eleven and fourteen years of age were carried out. The calorific values ranged from 20.03 to 20.10 MJ/dry kg for birch and 20.68 to 20.79 MJ/dry kg for Corsican Pine, showing no obvious difference between the calorific values for different ages of these particular species.

BACKGROUND

A wide range of partners, including the Forestry Commission England (FCE), Forest Research (FR), Technical Development (TD), Natural England (NE), Marches Wood Fuel Ltd (MWF), and Abbey Forestry are working together to develop a woodfuel pathfinder project centred on the Wyre Forest area in the West Midlands. This project aims to develop a woodfuel demonstration forest, assessing methods and outputs and monitoring change and progress as part of normal management objectives.

Early and pre-commercial thinnings for fuel wood production have been developed in the past twenty years in Scandinavia, and especially in Finland. A central assumption is that the energy value of woodchips produced from such operations is highest when coming from younger and smaller diameter material (Hall, pers. comm.). As part of the wider Wyre forest project, it was decided to investigate this and to see if recommendations could subsequently be made for woodfuel production.

OBJECTIVES

The objective of the project was to select, fell and chip tree species of different ages, test the woodchips for calorific value and analyse the findings.

TEST CONDITIONS

Age and species

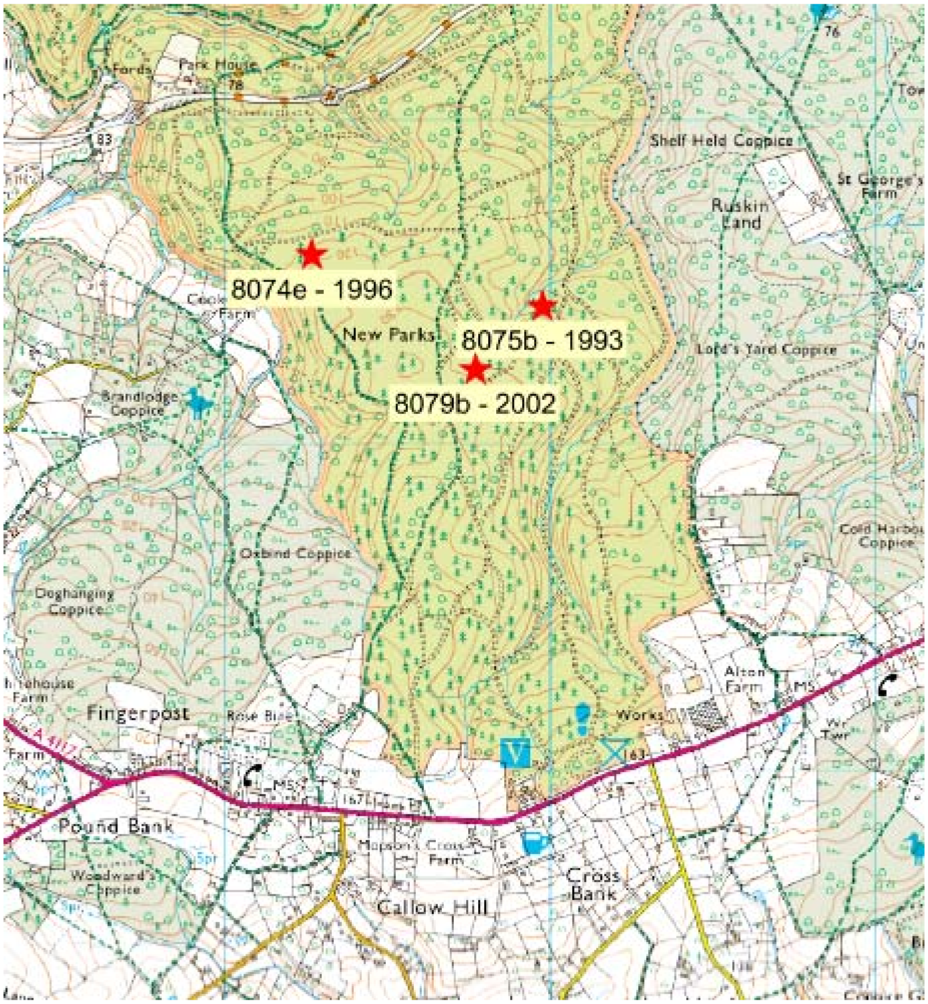
It was decided to carry out the tests for two species, birch (*Betula pendula* – Bi) and Corsican pine (*Pinus nigra* spp. *laricio* – CP), for trees of 5, 10 and 15 years of age.

The West Midlands Forest District identified areas felled and restocked 5, 11 and 14 years ago in the Wyre Forest (Plate 1):

- sub-compartment 8079b, planted 2002
- sub-compartment 8074e, planted 1996
- sub-compartment 8075b, planted 1993.

Natural regenerated birch in the plantations was used to provided material of similar age.

Plate 1 Location of sampling areas – scale: 1:20 000



Sampling of trees

Discussions with Biometrics Division (FR) indicated that a sample of ten trees should be felled and chipped for each combination of age/species.

The selection of the trees was based on:

- prescriptions from the Forest District regarding the pattern of sampling (visual impact, quality of the trees)
- the identification, as far as possible, of trees representative of the stand.

To identify representative trees, a first assessment was carried out in the stand to evaluate the mean dbh and 95% confidence interval [1]; the sample trees were then selected with a dbh within these limits (Table 1). It was not possible to obtain reliable values for the 5 year old birch, so the trees were selected randomly within the stand.

[1] This indicates that if any tree is sampled within the stand, there is a 95% probability that its dbh will be within this interval

Table 1 Dbh class of sample trees

Combination age-species	dbh class of sample trees
Bi – 5 years	-
Bi – 11 years	4 - 5
Bi – 14 years	5 - 6
CP – 5 years	4
CP – 11 years	7
CP– 14 years	11

THE TRIAL

Felling and chipping

The field sampling took place on 19 September 2007 at the Wyre Forest. The trees were felled with a chainsaw, sned, and chipped on site. All the branches were removed to avoid the presence of leaves or needles in the chips that could have biased the analysis of the calorific value of the timber itself (Plate 2). The stems were then fed into the chipper, a Timberwolf 150/35 (see specifications in Appendix 1), and the chips were blown onto a plastic sheet to avoid soil contamination (Plate 3).

Plate 2 Preparation of stems before chipping (CP 5 years)

Plate 3 Chips blown onto a plastic sheet

Between every operation, a leaf blower was used to clear any remaining chips and particles from the chipper in-feed (Plate 4), and the warm-down time (*c.* 2 minutes) allowed expulsion of the remaining material in the chipper, thus limiting the contamination between operations. The plastic sheet was also shaken and brushed between each sample chipping.

Plate 4 Cleaning of chipper between operations

Sampling of chips

The standard for the sampling of chips is described in CEN/TS 14778-1:2005, and is based on the top nominal size (size of a sieve used through which at least 95 % by mass of the material would pass) of the chips produced by the chipper.

In the case of this trial, the small quantity and small diameter of the material to chip dictated the use of a small arboricultural chipper. A sample provided prior to the trial showed a great variation in chip size and an important top nominal size[2].
This top nominal size is the main element used in the standard CEN/TS 14778-1:2005 to determine the number and the volume of elementary increments to sample to obtain a representative sample. In the case studied sampling of the woodchips would have required:

- a substantial volume of the elementary increments to sample (determined by the standard) which was impractical to implement
- in some cases, an overall volume of chips required according to the standard greater than the quantity produced.

It was therefore decided to collect and send all the chipped material for analysis (Plate 5).

Plate 5 Bags of chips ready to be sent for analysis

Testing of chips

The testing of the sample was carried out by TES Bretby[3], an accredited testing laboratory, and assessed the moisture content[4] (MC) and calorific value (CV) of the samples.

[2] Top nominal size: aperture size of the sieve used in the CEN/TS 15149 method for determining the particle size distribution of solid biofuels through which at least 95 % by mass of the material passed.

[3] TES Bretby, Bretby Business Park, Ashby Road, Burton-upon-Trent, Staffs, DE15 0XD, 01283 554 451.

[4] Moisture content wet basis = weight of water/ (weight of water + weight of dry wood).

RESULTS

The results are presented in Table 2 below. For ease of interpretation, the equivalent calorific value dry weight basis has been calculated in the last column of the table.

This calculation has been carried out using the equations used in “Woodfuel supply strategies” – University of Aberdeen:

● Conifers: net CV = CV dry – (0.2021 x %MC).
● Hardwood: net CV = CV dry – (0.2064 x %MC).

Table 2 Results of the MC and CV

Samples tested	Moisture content in %	Gross calorific value in MJ/kg	Net calorific value in MJ/kg	Net calorific value in MJ/dry kg
Bi 5 years	45.9	10.803	9.682	**18.96**
Bi 11 years	43.7	11.197	10.130	**18.96**
Bi 14 years	46.9	10.620	9.475	**18.95**
CP 5 years	60.6	8.286	6.806	**19.05**
CP 11 years	59.5	8.467	7.014	**19.04**
CP 14 years	58.9	8.526	7.088	**18.99**

CONCLUSIONS AND RECOMMENDATIONS

These results are consistent with other values found in literature for net calorific values:

- 17.72 GJ/dry tonne of hardwood and 18.15 GJ/dry tonne of softwood in *Wood fuel supply strategies*- volume 1- Aberdeen University.

- Betula ssp, 19.2 MJ/dry T and Pine ssp 19.3 MJ/dry T in Nurmi 1993 (respectively in *Bioenergy from Sustainable Forestry: Guiding Principles and Practice,* 2002 and *Wood Fuels Basic Information Pack*, 2000).

They show no obvious difference between the calorific values obtained from a given species at different ages.

In the light of these findings it is recommended that further trials should be carried out with a wider range of species and ages (up to *c.* 25 years) to confirm or not the absence of link between timber age and calorific value.

If any differences are identified in further research, they will need to be considered in conjunction with other factors, such as technical issues and market conditions, to issue relevant recommendation and guidance for woodfuel production.

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Appendix 1

Timberwolf 150/35 specifications

Engine	35 hp water cooled Kubota 4 cylinder diesel
Fuel	Diesel
Tank Capacity	18 litres (4 gallons)
Weight (FTR)	1155 kg
Weight (VTR)	1080 kg
Length	Working 2775 mm
Width (FTR)	1300mm
Width (VTR)	700-1100 mm
Height	2300 mm
Max dia. infeed	150 mm (6")
Throughput (DH)	Up to 4 tonnes per hour
Feed Method	Twin hydraulic feed rollers c/w No Stress
Blades	2 x 101 mm (4") fully hardened