© COFORD 2010

ForestEnergy Programme 2006-08

The COFORD ForestEnergy programme has the objective of securing marketable wood fuel of acceptable moisture content for sale as wood chip, firewood and other wood fuels, to support the development of the renewable wood energy sector in Ireland. The programme achieved this through commercial scale demonstrations of forest harvesting supply chains for wood energy on 15 forest sites (Figure 1). At each site the supply chain productivity, fuel quality and delivered energy cost of each system was assessed. Different storage options and seasoning schedules over one and two summer seasons were investigated. Public demonstrations of machinery and methods were held each year of the programme.

Conifer sites
1. Abbeyfeale, Co Limerick
2. Ballybofey, Co Donegal
3. Bweeng, Co Cork
4. Croaghrimcarra, Co Mayo
5. Foilagohig, Co Cork
6. Frenchpark, Co Roscommon
7. Kilbrin, Co Cork
8. Swan, Co Laois
9. Woodberry, Co Galway

Broadleaf sites
10. Dovea, Co Tipperary
11. Manseragh, Co Tipperary
12. Mullinavat, Co Kilkenny
13. Portlaw, Co Waterford
14. Stradbally, Co Laois

Cutaway peat site
15. Boora, Co Offaly

Long-term storage trial site
16. Rochfortbridge, Co Westmeath

Figure 1: Location of the ForestEnergy programme trial sites.

COFORD - Dept. Agriculture, Fisheries & Food
Kildare Street, Dublin 2, Ireland
Telephone: +353 1 607 2487
Email: info@coford.ie
http://www.coford.ie

FORESTENERGY PROGRAMME

Harvesting birch woodland on cutaway peat for wood chip production

Pieter D. Kofman[1]

Introduction

Many areas of cutaway peatland have been colonised by birch over a period of time. Where mineral soil is exposed colonisation proceeds more rapidly.

In co-operation with Bord na Móna several stands of birch were harvested for energy:

1. a narrow strip of 8 rows of birch planted in the middle of a species trial,
2. a Sitka spruce plantation that had been colonised and overgrown by birch and
3. a naturally regenerated stand of pure birch.

In all three stands, trees were felled in a clearfell type harvest, creating a wide open space, and optimal conditions for summer drying of felled stems. The trees were felled when leafless (in February, when moisture content was naturally low).

In all three cases, felling was carried out with a feller-buncher, which left the trees in a long row to one side of the machine, ready for terrain chipping after summer drying, using either the Silvatec self-propelled terrain chipper, or a front-fed TP280 tractor-mounted chipper towing a large trailer.

Whole-tree harvesting is successfully used elsewhere for woodfuel production. It has advantages over standard harvesting, since it ensures that the maximum volume of wood fuel is produced as tops, branches and small trees are also chipped. A disadvantage is that there is no brash mat provided for machines to operate on; however, some felled trees may be sacrificed and put under the wheels where required.

[1] *Danish Forestry Extension, Senior Consultant Wood for Energy. Email: woodenergy@gmail.com.*

Machines

The machines chosen for the work were not available in Ireland at the time of the trials, so they were transported from Denmark, with experienced crews who performed all operations. At the time of writing, one terrain going tractor-mounted chipper is now operating in Ireland.

In all stands the line trees were felled by feller-buncher. Trees were felled so that they were lying along the line in the same direction. The machine used was a three-axled Silvatec base machine, equipped with a parallelogram crane and a Silvatec felling head. The felling head has a stabilizing cylinder, which enables it to handle trees in a standing position. It has no feed rollers or delimbing knives, but has instead a set of accumulating arms, so that more than one tree in a cycle can be felled and lifted out to the rack.

The Silvatec chipper is a self-propelled machine, developed for chipping trees inside the confined space of forest stand. In Denmark, 500 mm tyres are used, but for operations in Ireland these were replaced by 600 mm tyres to increase flotation. The machine would have benifited from bandtracks on the wheels, but these were not available at the time. The chipper is front-mounted, and can handle trees up to 35 cm in diameter. Chips are blown to the rear of the machine into a 15-17 m^3 storage tank, which can be lifted to unload chips into a chip forwarder. The chip forwarders were also equipped with wider tyres. They transported the material from inside the stand to the roadside. Wood chips were tipped onto the ground for reloading into walking-floor trailers.

A tractor-mounted terrain chipper was also included in the trials. This was a TP280 disk chipper, mounted on a large Valmet tractor, which was permanently reversed. A hitch was attached to the tractor nose, so the machine could tow a high tipping trailer. Unlike the Silvatec chipper, this machine must travel to and from the stand to unload at the roadside.

Feller-buncher in lines of planted birch.

Silvatec unloading chips into a forwarder.

Tractor-mounted chipper working on clearfell of naturally-regenerated birch.

Results

Time studies

All operations were followed with time studies and the net productive time recorded. The time excludes all disturbances. In order to come to a more normal working

day, allowances are added to the productive time to get work place time. Allowances include rest breaks, small repairs and other normal things, but exclude major events like major breakdowns, getting stuck etc. By adding 30% allowances for machine work and 70% for chainsaw felling work, productive machine hours (pmh) are obtained.

Production units

In all cases the volume of loose chips ($m^{3\ lv}$) from the chippers is converted to m^3 solid biomass ($m^{3\ sb}$) by using a factor of 0.33. This is a standard ratio for converting loose biomass to solid and means that 1 $m^{3\ lv}$ = 0.33 $^{m3\ sb}$. All production figures and costs are expressed in $m^{3\ sb}$/hr or €/$m^{3\ sb}$. Along with the actually measured moisture content of the chips at the time of chipping, the energy content of the chips is calculated in GJ/$m^{3\ sb}$ and the final cost is expressed in €/GJ.

Only the average figures for the three stands are referred to (Table 1). Further details are available in the report of the ForestEnergy 2006 programme, which is on www.coford.ie.

The average total production cost of woodchip to roadside ranged from €37.08/$m^{3\ sb}$ to €39.73/$m^{3\ sb}$. When the moisture content is factored in, the production cost per unit of wood energy ranged from €3.74/GJ to €3.97/GJ.

As can be seen from Table 1 there was a high cost of felling. Naturally-regenerated and even planted birch have a lot of butt sweep and sometimes grows with multiple stems, which slows down the feller-buncher. The saw chain was whipped off the bar on many occasions by one of the multiple stems grasped by the head. There was also a large variation in tree diameter, from very small to 20 cm or more. Clumps of willow, growing along the drains, were also a big problem for the feller-buncher. Perhaps a chainsaw operator should have worked in front of the machine, clearing out the small trees and the willow clumps.

Another option would be to use a felling head with a circular saw, instead of the chainsaw bar and chain. These machines are much less susceptible to strain compared with a chainsaw chain.

The operators had to be aware that deep pockets of peat remained here and there, which were avoided or bridged by putting some trees under the wheels. Band tracks would have been a help to increase flotation and reduce rutting.

Birch, which had been cut in February 2006, resprouted vigorously; and a dense covering of shoots up to a metre high had emerged by the time of chipping. Unfortunately the natural regeneration was destroyed during the chipping process. Had the chipping been organised with regeneraton in mind, much of the regeneration between the lines could have been saved, to provide a further crop in 8 to 10 years time.

Table 1: Variation in productivity and costs of whole-tree harvesting and terrain chipping of birch for different stands and machine configurations.

Number of sites	1	1	1
Stand type	Planted birch	Naturally-regenerated birch	Birch in Sitka spruce plantation
Harvesting type	Clearfell	Clearfell	Clearfell
Felling method	Feller-buncher	Feller-buncher	Feller-buncher
Felling productivity (m^3/pmh)	5.24	4.54	4.6
Chipping machine	TP280 tractor	TP280 Tractor	Silvatec
Chipping productivity (m^3/pmh)	5.5	5.6	21.7
Feller-buncher cost @ €100/pmh (€/$m^{3\ sb}$)	19.03	22.02	21.7
Silvatec chipper cost @ €300/pmh (€/$m^{3\ sb}$)			16.03
TP tractor chipper cost @ €100/pmh (€/$m^{3\ sb}$)	18.05	17.71	
Total cost (€/$m^{3\ sb}$)	37.08	39.73	37.73
Average energy content (GJ/m^3) at harvested MC	9.8	9.9	9.8
Average energy cost to roadside (€/GJ)	3.74	3.86	3.97

Costs

An estimate of the delivered-in cost of wood energy to the end-user can be made by including some assumptions on the whole chain costs. If the forest owner gets €5 per m^3 solid biomass as payment for the right to harvest the wood (stumpage), then the total cost at the roadside, in containers, would be in the order of €2.75 to €5 per GJ. Adding the cost of road transport, depending on the distance travelled, would add another €1.50/GJ, giving a total delivered-in cost of €4.25 to €6.50 per GJ. A 3% management fee for the woodfuel trader has been included.

Stumpage (€5/$m^{3\ sb}$) €/GJ	€0.70
Chipping operation €/GJ	€3.74 - €3.97
Road transportation 50 km €/GJ	€1.50
Traders allowance 10% €/GJ	€0.59 - €0.61
Total delivered cost €/GJ	€6.53 - €6.78

Conclusions

The total delivered-in cost of birch from a cutway peat bog at a major consumer that can handle relatively wet fuel would be in the order of €6.53-€6.78 per GJ or roughly €60-65 per tonne at 45 % moisture content. Many midland peat bogs are situated close-by major consumers, and the haulage costs could be less than in the example provided.

If better care were taken of the birch regrowth, a harvest shoud be possible every 8-10 years from similar birch stands.

Large tracks of land are potentially available for birch colonisation or planting, so they could in future play an important role in the supply of biomass.

Felling and harvesting machines should be equipped with bandtracks to increase flotation and reduce rutting. Patches of deep peat will occur on cutaways, and these have to be avoided, using bandtracks.

The feller-buncher is a suitable machine to carry out the this type of felling, as trees are presented in the same direction for the chipper. The machine can accumulate two or more trees, before they are lifted out of the area next to the rack and laid down in the rack in a roof tile fashion.

For information and a free on-line advisory service on the wood energy supply chain, the quality of wood fuels and internal handling visit ***www.woodenergy.ie***

Note: The use of trade, firm or corporation names in this publication is for the information of the reader. Such use does not constitute an official endorsement, or approval by COFORD of any product or service to the exclusion of others that may be suitable. Every effort is made to provide accurate and useful information. However, COFORD assumes no legal liability for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed herein or for any loss or damage howsoever arising as a result of use, or reliance, on this information.