



Harvesting / Transportation No. 27

© 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.



- | | |
|--|--|
| <p>Conifer sites</p> <ol style="list-style-type: none"> 1. Abbeyfeale, Co Limerick 2. Ballybofey, Co Donegal 3. Bweeng, Co Cork 4. Croaghrimcarra, Co Mayo 5. Foilaghig, Co Cork 6. Frenchpark, Co Roscommon 7. Kilbrin, Co Cork 8. Swan, Co Laois 9. Woodberry, Co Galway | <p>Broadleaf sites</p> <ol style="list-style-type: none"> 10. Dovea, Co Tipperary 11. Manseragh, Co Tipperary 12. Mullinavat, Co Kilkenny 13. Portlaw, Co Waterford 14. Stradbally, Co Laois |
| | <p>Cutaway peat site</p> <ol style="list-style-type: none"> 15. Boora, Co Offaly |
| | <p>Long-term storage trial site</p> <ol style="list-style-type: none"> 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

A synthesis and comparison of forest energy harvesting methods in broadleaves

Pieter D. Kofman¹

Background

Harvesting wood for energy is at an early stage of development in Ireland. To jumpstart the process, the ForestEnergy programme aimed to show that methods and machines developed on the continent could be used (and perhaps should be adapted) for Irish forestry.

Over a three year period (2006-2008), Waterford Institute of Technology, Danish Forestry Extension, Teagasc, the Forest Service and a host of forest owners, and contractors from Ireland and abroad cooperated in demonstrating many different harvesting systems for wood for energy in conifer and broadleaf plantations. The focus of ForestEnergy was harvesting wood from first thinnings from private forests, which represents the single largest ownership of young plantations, and the one with the largest knowledge gap.

Most of the trials were aimed at producing a wood fuel in the form of chips for large scale users, like electricity plants, but also chips for smaller installations in the commercial and domestic scale were shown, albeit on a smaller scale.

The programme included both broadleaf and conifer plantations. This COFORD Connects notes deals with an overview of all the systems tried in broadleaves.

Thinning broadleaves is not as straightforward as carrying out the operation in conifers. There is more variation in stem form and tree size in broadleaf plantations. It is therefore recommended that an expert marks the potential crop trees (PCTs) in the stand. Thinning is then aimed at creating favourable growing conditions around the PCTs. Even where thinning is used to remove, say, every 7th line, to provide access to machines, efforts should be made to save PCTs by slightly changing the orientation of the row. This needs to be well planned and executed, and of necessity must avoid a sudden change in line direction, as this will only lead to damage to the PCT during the operation itself and in subsequent thinnings.

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

Demonstrated systems

Two main systems were experimented with in broadleaves:

- Whole-tree harvesting with a combined line and selection thinning. The trees were chipped in the stand with terrain going chippers.
- The assortment method, where usually 3 m logs were produced, but other lengths were experimented with. Logs were mostly produced by a chainsaw gang, but on one occasion a harvester was used to produce the logs. Logs were either forwarded or skidded to the roadside, using a variety of methods. At the roadside many logs were converted to firewood using small firewood processors.

Three assortments were produced:

- Whole-tree chips, which were sold to boiler plants;
- Logs, which were sold to firewood producers;
- Firewood, which was sold after the storage trials were completed.

All systems and the overall results have been published in a series of COFORD Connects notes; this note compares the results. More detailed results can be found in reports on the trials. The results of the harvesting trials will also be combined with those from the storage trials (see relevant COFORD Connects notes), so that an overview is provided of the costs and performance of the systems as compared with each other.

Results

In Table 1 the delivered-in costs of the systems are compared, and the corresponding chip sizes and the obtainable moisture contents are presented. For all methods €5 per m³ solid biomass (€0.55/GJ) has been included as stumpage payment to the forest owner. Another €1.50/GJ has been included for transport to the end user over 50 km. Results should be treated with caution, as they are sometimes based on a small number of observations in a few stands.

From Table 1 it is clear that the large scale whole-tree harvesting methods are always far cheaper compared with systems where roundwood is harvested for subsequent conversion to firewood. The high cost of firewood methods is caused by the small tree size and the very high costs of converting stem wood into firewood; processing amounts to almost 70% of the total cost.

It is assumed that all of the work is carried out at market rates. The comparison between wood chips and firewood is not fully valid since products with a different sales prices are being compared. Seasoned firewood is sold at a price of €165 per m³ solid, or about €18 per GJ. This means that there is a considerable shortfall between production cost and sales price.

For wood chip the market is at a relatively early stage of development, so a comparison between the sales price and the productions cost is not really possible. However, the price difference would not be as large as for firewood.

Table 1: Delivered-in cost of wood fuel harvested by different method, with corresponding chip sizes and obtainable moisture contents.

Method	Delivered-in cost €/GJ	Obtainable moisture content %
Whole-tree system Silvatec, chainsaw felling, large chip	7.02	35
Whole-tree system Silvatec, feller-buncher, large chip	5.32	35
Whole-tree ,TP280, tractor, medium chip	4.87	35
Firewood, chainsaw harvest, quad extraction, firewood processing	28.78	25
Firewood, chainsaw harvest, forwarder, firewood processor	25.87	25
Firewood, harvester, forwarder, firewood processing	26.43	25



Forwarder taking thinning logs out of a ash stand. Note the brash mat.

Because of the lower initial moisture content of the hardwoods, it is possible to produce a wood chip of low moisture content for commercial boilers.

When the assortment method is used, the machines operate on a brash mat, which helps to keep the machines on the surface and reduce the amount of rutting. However, results from trials show that if the Silvatec chipper and chip forwarder are equipped with band tracks, soil damage is much reduced, because the tracks provide better flotation and grip.

The Silvatec terrain chipper produces a large chip, which is best suited for large-scale boilers. The tractor chipper produced a medium chip, which could be used for commercial boilers.

Whole-tree systems produce a large amount of large chip, so that means that a substantial customer base must be found to accept large volumes of chip year-around, as it is too expensive to have such expensive machines parked-up.

Capital investment

The investment in a Silvatec terrain chipping system, consisting of a terrain chipper, a chip forwarder and the necessary trucking capacity, might well be in excess of €1 million. A truck chipper can be had for €150,000-300,000, depending on the size and required production capacity. A medium-sized chipper on a tractor, with a high-tipping trailer, would cost in the region of €150,000-200,000. A small chipper to produce chips for private use can be had for as little as €6,000-10,000. A chainsaw, quad and firewood processor would cost around €15,000-20,000.

Conclusions

For large scale wood fuel production for large customers, whole-tree harvesting is the cheapest solution. The chips will never be dry enough and are too coarse for commercial boilers. The investment in equipment will be very high, so these systems have to run around the year, requiring customers that can accept large volumes of chips year-round.

Roundwood systems have the advantage that standard forest harvesting equipment can be used, and the wood can be moved to a yard for intermediate storage and chipping into a shed before delivery. It is however, the most expensive way to produce wood chip for fuel. These machines could also be used to produce chips for other purposes, such as for the board industry or for cattle out-wintering pads.

If the work is done by the forest owner, producing small chips for home consumption, or firewood, may be a good option as well. The chipper could be shared with other forest owners to reduce the investment costs.

Roundwood methods also have the advantage that the machines can operate on a brash mat, but the chipping trials of 2008 have shown that if the Silvatec chipper and chip forwarder are equipped with band tracks, then soil damage is minimized and that the machines have better flotation and traction.

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