



Harvesting / Transportation No. 19

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### 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. Foilaghig, 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  
 Arena House, Arena Road,  
 Sandyford, Dublin 18, Ireland  
 Telephone: +353 1 2130725  
 Email: info@coford.ie  
 http://www.coford.ie

## FORESTENERGY PROGRAMME

# Storage and seasoning of conifer and broadleaf firewood

Pieter D. Kofman<sup>1</sup> and Tom Kent<sup>2</sup>

## Introduction

Firewood should be well seasoned and dried to less than 25% moisture content before it is used. If it is too wet, there is a risk of poor combustion, leading to the emission of smoke and fine particles, and the formation of soot in the chimney, which in turn may lead to a chimney fire. The energy content of firewood is directly related to the moisture content. Natural drying is the simplest and cheapest method.

Natural drying can achieve a moisture content of about 18-20%. At this moisture content, the moisture between and within the cells has evaporated, only the water chemically bound to the cell wall remains. It is not possible to dry wood below this level in the Irish climate. Artificial drying can reduce moisture content to 8-10%, for example in sawn timber that is dried in a kiln. If wood is dried below 8% it will reabsorb moisture from the air.

Long pieces of roundwood take a long time to dry. Most evaporation takes place from the exposed ends of the logs; bark traps moisture in the wood. To speed up the drying process, firewood is usually cross cut into the required short lengths and split as soon as possible after harvesting. This increases the surface from which the water can evaporate and thus reduces drying time.

In the ForestEnergy trials, firewood was produced as part of the harvesting programme (described in other COFORD Connects notes). Firewood was presented in two ways: in 1 m<sup>3</sup> large net bags stored on pallets, and in small net bags of 30 or 50 litres. The bags were then used for storage trials under different conditions (Table 1).

The purpose of the trial was to determine how long firewood should be stored to reduce it to an acceptable moisture content and what circumstances are required to achieve this.

The large net bags on pallets were stored as follows (Table 1):

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

<sup>2</sup> Waterford Institute of Technology. Email: tkent@wit.ie.

Table 1: Conifer and broadleaf firewood storage trials.

Site	Species	Assortment	Packaging	Storage
Abbeyfeale	Sitka spruce	25 cm split firewood	1 m <sup>3</sup> net bag on pallet	Outside (uncovered)
Ballybofey	Sitka spruce	25 cm split firewood	1 m <sup>3</sup> net bag on pallet	Outside (covered)
Bweeng	Sitka spruce	25 cm split firewood	1 m <sup>3</sup> net bag on pallet	Inside
Toormakeady	Sitka spruce	25 cm split firewood	1 m <sup>3</sup> net bag on pallet	Inside
Dovea	Ash	25 cm round firewood	Small net bags	Inside
Manseragh	Ash	25 cm split firewood	1 m <sup>3</sup> net bag on pallet	Outside (covered)
Manseragh	Ash	25 cm round firewood	1 m <sup>3</sup> net bag on pallet	Outside (covered)
Manseragh	Ash	3 m whole logs	None	Outside (uncovered)
Stradbally	Ash	25 cm split firewood	1 m <sup>3</sup> net bag on pallet	Outside (covered)
Stradbally	Ash	25 cm round firewood	Small net bags	Inside

- Outdoors in the forest where they were produced, without a cover (Abbeyfeale);
- Outdoors in the forest, but covered with a sheet of plastic to protect from rain. The pallets were in two rows at the bottom with one row on top and exposed to the wind (Balleybofey);
- The large net bags produced at Bweeng were transported to Waterford and stored under a lean-to in a sheltered location;
- The large net bags produced at Toormakeady were stored in an enclosed shed in the forest;
- The large net bags produced at Stradbally were stored at a nearby farm in a well ventilated lean-to, open on three sides;
- The ash from Manseragh Estate was stored as three assortments: split and round firewood in separate 1 m<sup>3</sup> net bags, and as whole 3 m logs for comparison. The net bags were placed outside on pallets and covered with plastic. The logs were stored outside uncovered.
- The small net bags of wood that were produced at Dovea and Stradbally were stored in an enclosed shed.

The trials were started in 2007, with the exception of Manseragh estate, where work began in February 2008. All storage trials were completed by late 2008. The initial moisture content of the logs were determined during the preparation of the bags. All the bags were sampled at different intervals and when the trials were concluded.

## Results

The results of the 2007-2008 storage trials are shown in Table 2, by location, sample date, tree species, assortment and type of cover.

The reduction in moisture content in Sitka spruce firewood is also shown in Figure 2. Pallets that were left in the open without cover initially dried very well, but reabsorbed moisture during the wet summer of 2008. Pallets that were stored inside dried better than those stored outside under a sheet of plastic.

The final result was that firewood stored indoors was of a good quality in terms of moisture content (20%), whereas

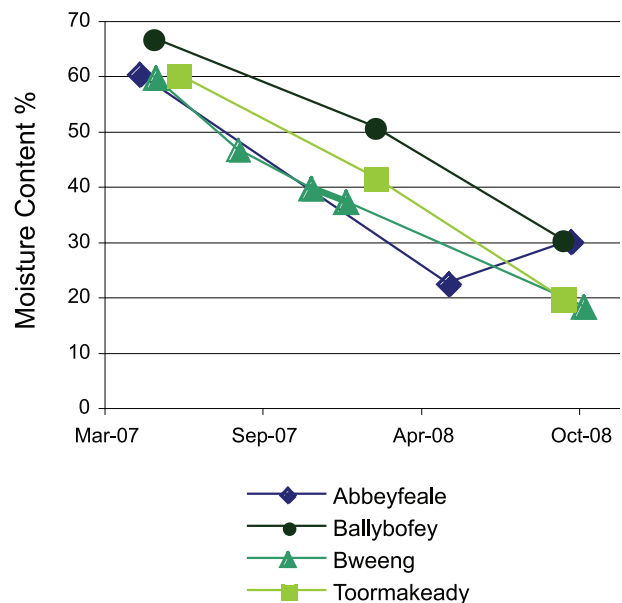


Figure 2: Change in moisture content of split Sitka spruce stored in 1 m<sup>3</sup> net bags on pallets.

Table 2: Moisture content (MC) over the storage period for each method.

Location	Sample date	Species	Storage	Package type	MC %
Abbeyfeale	April 2007	Sitka spruce	Outdoors uncovered	1 m <sup>3</sup> net bag	60
Abbeyfeale	May 2008	Sitka spruce	Outdoors uncovered	1 m <sup>3</sup> net bag	22
Abbeyfeale	October 2008	Sitka spruce	Outdoors uncovered	1 m <sup>3</sup> net bag	30
Ballybofey	May 2007	Sitka spruce	Outdoors covered	1 m <sup>3</sup> net bag	67
Ballybofey	February 2008	Sitka spruce	Outdoors covered	1 m <sup>3</sup> net bag	51
Ballybofey	October 2008	Sitka spruce	Outdoors covered	1 m <sup>3</sup> net bag	30
Bweeng	May 2007	Sitka spruce	Inside	1 m <sup>3</sup> net bag	60
Bweeng	August 2007	Sitka spruce	Inside	1 m <sup>3</sup> net bag	47
Bweeng	November 2007	Sitka spruce	Inside	1 m <sup>3</sup> net bag	39
Bweeng	January 2008	Sitka spruce	Inside	1 m <sup>3</sup> net bag	37
Bweeng	November 2008	Sitka spruce	Inside	1 m <sup>3</sup> net bag	18
Toormakeady	June 2007	Sitka spruce	Inside	1 m <sup>3</sup> net bag	60
Toormakeady	February 2008	Sitka spruce	Inside	1 m <sup>3</sup> net bag	41
Toormakeady	October 2008	Sitka spruce	Inside	1 m <sup>3</sup> net bag	20
Stradbally	June 2007	Ash	Outdoors covered	1 m <sup>3</sup> net bag	40
Stradbally	October 2007	Ash	Outdoors covered	1 m <sup>3</sup> net bag	29
Stradbally	April 2008	Ash	Outdoors covered	1 m <sup>3</sup> net bag	22
Stradbally	September 2008	Ash	Outdoors covered	1 m <sup>3</sup> net bag	21
Manseragh	February 2008	Ash (split)	Outdoors covered	1 m <sup>3</sup> net bag	37
Manseragh	February 2008	Ash (round)	Outdoors covered	1 m <sup>3</sup> net bag	37
Manseragh	June 2008	Ash (split)	Outdoors covered	1 m <sup>3</sup> net bag	23
Manseragh	June 2008	Ash (round)	Outdoors covered	1 m <sup>3</sup> net bag	22
Manseragh	December 2008	Ash (split)	Outdoors covered	1 m <sup>3</sup> net bag	24
Manseragh	December 2008	Ash (round)	Outdoors covered	1 m <sup>3</sup> net bag	25
Manseragh	November 2008	Ash	Outdoors uncovered	3 m logs	31
Dovea	July 2007	Ash	Inside	0.05 m <sup>3</sup> net bag	45
Dovea	August 2007	Ash	Inside	0.05 m <sup>3</sup> net bag	35
Dovea	December 2007	Ash	Inside	0.05 m <sup>3</sup> net bag	29
Dovea	May 2008	Ash	Inside	0.05 m <sup>3</sup> net bag	19
Dovea	August 2008	Ash	Inside	0.05 m <sup>3</sup> net bag	22
Dovea	November 2008	Ash	Inside	0.05 m <sup>3</sup> net bag	20
Stradbally	June 2007	Ash	Inside	0.03 m <sup>3</sup> net bag	40
Stradbally	December 2007	Ash	Inside	0.03 m <sup>3</sup> net bag	27
Stradbally	August 2008	Ash	Inside	0.03 m <sup>3</sup> net bag	20
Stradbally	November 2008	Ash	Inside	0.03 m <sup>3</sup> net bag	19

the other storage options achieved a moisture content of 30%.

Figure 3 shows the change in moisture content of the hardwood firewood over the storage period. Ash achieved a usable level of moisture content faster than Sitka spruce. This is mainly because the initial moisture content of freshly harvested ash was around 40-45%, compared with 60-65% for Sitka spruce. However, the final moisture content of the ash was comparable to the conifer assortment, at 20-25%. The drying time for ash was shorter, only 8 months, while the large net bags of Sitka spruce firewood took 16 months to fully dry.

For the small diameter logs in this study, there was little difference between the drying rates achieved by splitting the firewood or leaving it in the round, apart from ash logs left as 3 m lengths that did not dry to the same extent. Similarly, there was little difference between storage in large or small net bags. The Manseragh Estate firewood was stored over 2008 only, so it did not achieve the same moisture content reduction as at other locations.

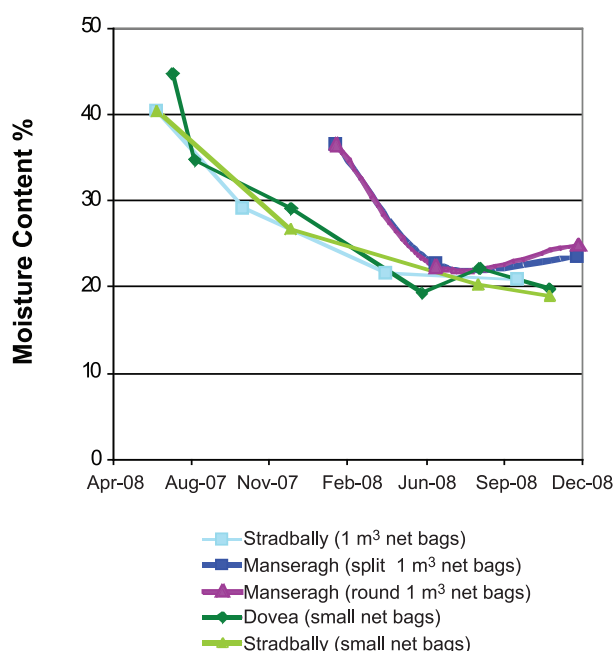


Figure 3: Change in moisture content of ash firewood stored in 1 m³ net bags and small net bags.

## Conclusions

Both hardwood and softwood firewood must be seasoned before it can be used in order to promote good combustion, avoid excessive smoke, the emission of fine particles and the formation of tar or soot in the chimney.

The studies have shown that short logs with a diameter less than 10 cm, dry as well whether split or unsplit, so there is no need to split small diameter firewood logs.

Storage under roof or other cover is needed. Pallets with firewood that were left uncovered in the open dried well initially, but then reabsorbed moisture during the wet summer of 2008. If that firewood had been left open during the winter, then the final moisture content would have been even higher.

Ash assortments dried similarly to Sitka spruce, even though the ash had a much lower initial moisture. However, Sitka spruce needed twice as long (16 months) to dry as ash (8 months).

At the trial at Manseragh Estate the firewood (both split and unsplit) dried better than logs left to season in 3 m stacks.

There was little difference in the drying of the wood in small net bags as compared with large bags on pallets. Both storage systems ended with a moisture content of around 20%, for those that were indoors. Firewood stored outdoors under plastic sheeting did not dry as well as that placed indoors.

*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](http://www.woodenergy.ie)*

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