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- *Firewood needs to be dry (less than 25% moisture content) to burn well without giving off excess pollutants*
- *Natural drying is the cheapest way to produce quality firewood, but it takes time over the summer*
- *Artificial drying speeds up the drying process but costs more money*
- *Kiln drying produces the best quality firewood, but is expensive in equipment and input of energy*

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Getting the most out of your firewood

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Introduction

Firewood is one of the oldest fuels known to man. Global use remains at a high level: recent data from the Food and Agriculture Organisation of the UN show that 40-80% of wood harvest in developing countries is used as fuel (FAO 2009). Wood fuel use in the developed world has also been on the rise - sales of wood fuels, and firewood in particular, have increased rapidly in Ireland in recent years, due mainly to rising fossil fuel prices, and the availability of modern and efficient stoves and boilers. Wood fuel quality is important for the consumer, so that the fuel's moisture content and size make it burn efficiently. When buying wood fuel it is a good idea to look for the Wood Fuel Quality Assurance logo on the bag or consignment note, as this means the fuel meets a number of quality demands, including moisture content.



Harvesting and use of firewood from sustainably managed forests provides a number of benefits, not only providing a competitive fuel, but also an early market for small-sized forest thinnings, which allows the remaining trees in the plantation to more rapidly reach a size where they are suitable for processing into a wide range of solid wood products. Production, processing and sale of firewood provide income and jobs in local economies and reduces the use of fossil fuels.

The use of firewood is good for the environment too, provided it is sourced from sustainably managed forests. Where firewood replaces fossil fuels such as oil, gas, coal and peat it will, over a period of time, result in a decline in carbon dioxide in the atmosphere, one of the main contributors to global warming.

The remainder of this note deals with how to achieve low firewood moisture content. It is intended as a brief outline of the main points and issues and is aimed at both producers and users of firewood. Suggestions for additions or changes to this note or further enquires are welcome at www.woodenergy.ie, where all queries will be dealt with.

Drying of firewood

Drying of firewood is essential for effective heating and to get a better energy return from the wood resource. While open fireplaces are an attractive feature, wood is better used in an efficient wood stove or boiler, as they are more economic in the long run, and better for the environment. For example: an open fire place might have an energy efficiency of 25%, while modern stoves and boilers have an efficiency in excess of 80%, meaning that with one third of the fuel, the same amount of heat can be had.

Firewood should ideally have a moisture content of below 25% of total weight by the time it is used. As a quick guide, when wood is dry it will give of a crisp sound when two pieces are struck together,; they will give off a dull sound if the wood is not dry enough.

The best way to sell firewood is by the tonne with assured moisture content, so in effect the customer pays for the energy content of the fuel. This also makes it easier to sell coniferous firewood because the buyer is getting the same energy but from a larger volume of wood. Hardwoods are denser than softwoods, so the same energy can be obtained from a smaller volume.

In a trial in the Forestenergy project, large 1 cubic metre netbags of loosely stacked Sitka spruce and ash firewood were produced. The weight of the bags at the same moisture content of 20%, was 245 kg for Sitka spruce, and 407 kg for ash. This means that one would need 407/245 or 1.66 cubic metres of loose Sitka spruce firewood to obtain the same amount of energy as of one cubic metre of loose ash firewood.

Natural drying

The cheapest way to dry firewood is by natural drying. Here the log is cross cut and then split into firewood as soon as possible after harvesting, and stored in an open place where sun and wind can dry the fuel. Firewood needs to be covered on top or preferably stored under a roof to keep out rain, and should be lifted out of direct ground contact, for example by storing it in an open perforated bag or netting on a pallet. This will improve the air flow through the wood. Alternatively one can store unprocessed logs, stacked well off the ground in a sunny and windy place, again covered on top, and then process the logs into firewood, after which some additional drying will be necessary.

In addition, drying as roundwood will take much longer than drying as processed firewood, because most of the evaporation of logs is through the end of the logs because the bark around the logs acts as insulation and prevents evaporation because that is the natural function of the bark. When the firewood is processed the surface area of the pieces is increased several fold and evaporation will be much faster. Also the moisture has a shorter way to travel to the surface of the pieces.

Artificial drying

Artificial drying is normally by:

- Forced ventilation by cold or heated air or
- Kiln drying with hot air.

Drying by forced ventilation

Drying by forced ventilation can be done either in the open or under roof. The firewood is ventilated through channels under the wood. Air travelling through the firewood will increase the evaporation and transport moist air out of the stack. The firewood can be placed either loose or in netbags on pallets.

Forced air drying requires extra handling because the firewood has to be placed on the ventilation channels and removed again to make place for the next batch.

Ventilation will not take place when the outside air has a relative humidity higher than 75%, as the drying effect is very limited and in some cases ventilation may even result in rewetting the firewood. A simple sensor on the ventilator that checks relative humidity should be enough. In reality this means that ventilation is often switched off during the night and during foggy or rainy weather.

One can improve forced air drying by making sure that the air moisture content is below the 75% threshold by adding heat to the ventilation air. The amount of heat is not the most important factor, but rather that the relative air moisture content is well below 75%. In order to control costs and reduce the energy input to firewood production, the addition of heat should be kept to a minimum.

When heat is added one can choose to ventilate continuously. This will shorten the drying period, but will of course increase the cost of the operation.

Kiln drying

Kiln drying of firewood is a process where high temperature air is used to dry the firewood in as short a time as possible. Kiln drying can only be carried out in specially constructed kilns, where temperature and air flow can be regulated. This means an extra investment in equipment.

Kiln drying requires extra handling in placing firewood in the kiln and removing it when it has reached the desired moisture content. Depending on the starting moisture content one can calculate how much energy is required to evaporate the water from the fuel, assuming a starting moisture content of 55% for conifer wood and 45% for hardwood, with a goal to achieve 15% moisture after drying.

Firewood	Energy content start	Energy content at 15% final MC	Energy consumption evaporation	Effective Energy consumption including boiler efficiency etc.
	GJ/ton			
Conifer start 55%	7.29	15.95	8.66	10.82
Hardwood start 45%	9.35	15.78	6.43	8.04

The numbers in the effective energy consumption column include energy losses in the system and the fact that the boiler will not be 100% efficient. For the example shown, efficiency is estimated at 80%, which results in an energy consumption of over 10 GJ per tonne for conifer wood and just over 8 GJ for hardwood. If we place a value of €6 on each GJ, then the energy cost of artificial drying in a kiln is between €65 per tonne for conifer and €48 for hardwood. To this extra handling and the investment cost need to be added to the sale price.

Conclusions

Natural drying is the cheapest way of drying firewood, but it will take several months over a summer period, or much longer at other times of the year. Firewood is thus best harvested at the beginning of the year (especially hardwoods which tend to have a lower natural moisture content during the winter months when they are bare of foliage and before the sap begins to rise in the spring) and left to dry over the summer period for use in the following winter. Firewood should always be stored under cover in a well ventilated place.

Forced air drying will reduce the drying time to 4-6 weeks depending on the time of year. It should be done when the ambient air has a relative humidity of less than 75%. To speed up the drying, heat can be added to the ventilation air to lower the relative humidity and thus to increase the evaporation (the intention is not to heat the wood but to improve the evaporation and transport of the moisture).

Kiln drying reduces the drying time further again, but it requires a controlled kiln and significant amounts of energy to heat the wood to remove the moisture. If fresh wood after harvesting is used, then the cost of the energy to heat the wood is considerable. Consideration should thus be given to some form of natural pre-drying.

Firewood with the WFQA seal of approval should be bought, because then one has an assurance of the quality including the all important moisture content.

