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Manual for firewood production

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Contents

Preface

This publication is part of the BioHousing Project (BioHousing – Sustainable, comfortable and competitive biomass-based heating of private houses EIE/05/067/SI2.420197, www.biohousing.eu.com) funded by the European Union's Intelligent Energy Programme. The BioHousing is coordinated by Jyväskylä Innovation Ltd and other partners are VTT, Jyväskylä University of Applied Sciences, ofi, ETA Renewable Energies, Biomass Normandie and Escan SA.

This manual includes information on firewood production, drying and storage. The manual is intended for single-family house builders and owners, equipment manufacturers and firewood producers.

The sources and other literature used for this publication are listed only in the bibliography and are not referenced in the text. Sources are only listed in the text for the photos and tables.

Jyväskylä, December 2008

Authors

1. Sourcing fuel for fireplaces

Woody biomass contributed 1 334 PJ (370 TWh) in households in the EU-27 in 2006, of which more than half is traditional firewood. The biggest consumption of wood fuels in domestic sector was in France (319 PJ), Germany (222 PJ), Poland (105 PJ) and Romania (108 PJ).

Table 1. Use of wood fuels in households in participating countries and the EU 27 (TJ). Source: Eurostat.

	Finland	Austria	France	Italy	Spain	EU27
2000	39,200	59,663	336,316	50,998	83,528	1,194,095
2001	40,800	66,304	324,866	53,078	83,529	1,175,590
2002	41,400	63,534	297,988	48,223	83,534	1,265,259
2003	41,290	64,674	323,714	50,414	83,537	1,291,319
2004	40,980	64,262	328,047	49,557	84,540	1,306,194
2005	40,620	65,423	327,614	54,000	84,706	1,306,194
2006	41,240	63,861	318,829	68,400	85,034	1,334,338

1 TJ equals 277,778 kWh

These days fireplaces are seldom the only source of heating in private houses in the Nordic countries, but they often satisfy the entire heat demand in Central and Southern Europe. However, their importance as auxiliary heat sources is all the more important in Nordic countries. Logs or pellets are the primary source of heat if a system based on a boiler or integrated boiler-burner combination is used. Since the 1990s the use of wood pellets in heat production has increased. In Italy approximately 700,000 pellet stoves are used for heating. In Finland around 2.9 million stoves are used mainly for auxiliary heat production in private houses. Approximately half of them are heat retaining stoves.

There are almost 24 million one-family houses altogether in Finland, Austria, France and Spain. Unfortunately data from Italy is not available. If owners of private houses increased their use of solid biomass fuels, the greenhouse gas emissions caused by private houses could be reduced considerably.

Energy consumption of private houses

The energy requirements of private houses vary considerably according to the season and the country. This variation can be described using a load curve, which illustrates the amount of energy used over the course of time. The area of the curve corresponds to the annual amount of energy. Peak output is seldom used. Typically 80 to 90 percent of the energy consumed in private houses is satisfied with an output of 50 percent.

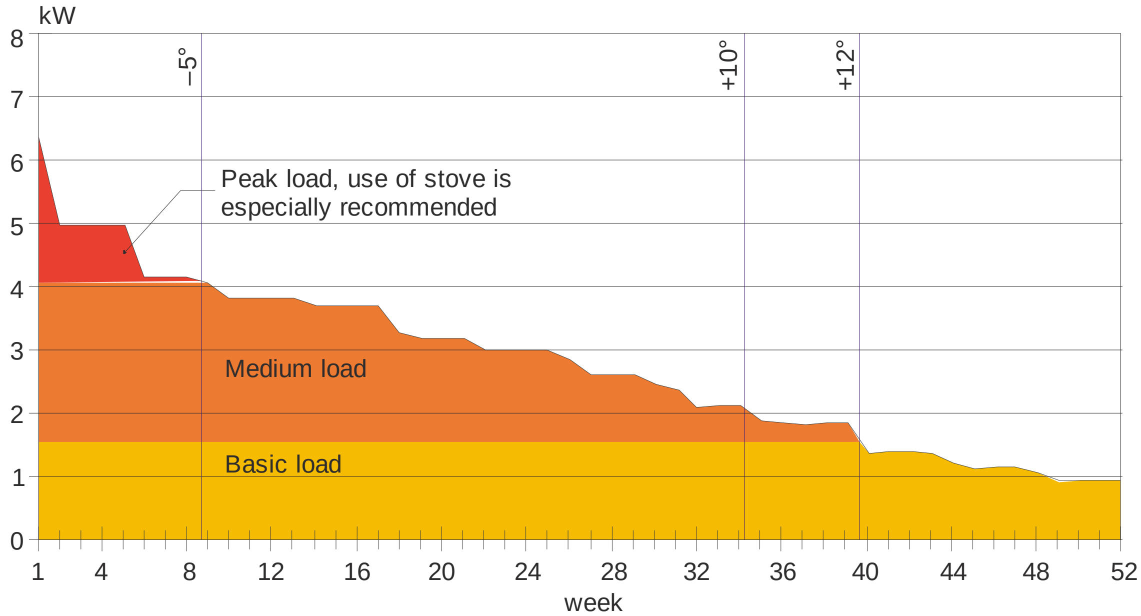


Figure 1. Example of a load curve showing the energy consumption of a private house heated by electricity in Helsinki, Finland. Source: Tampere University of Technology.

Energy consumption varies according to how the house was built and how it is equipped. Household electricity consumption varies from 3,500 kWh to 7,000 kWh for private houses in Europe. In Finland consumption is higher from 7,000 kWh to 10,000 kWh annually. Most of the household electricity in Finland is consumed for lighting. Approximately 1,000 kWh is consumed each year to heat saunas in Finland. Another 1,000 kWh per person per year is consumed to hot water (approximately 50 litres of hot water per person per day).

An ordinary private house conforming to building regulations consumes an average of 90 to 140 kWh/m^2 heating energy per year in Europe. A low-energy house consumes 40 to 65 kWh/m^2 and a passive house just 15 to 30 kWh/m^2 per year for heating and cooling. A passive energy house consumes just 15 to 20 percent of the energy of an ordinary house. Passive energy houses are situated optimally to utilise as much sunlight as possible. Solar and waste energy are also used for heating. Building an energy-efficient house requires sufficient insulation in the roof, walls and floor combined with energy-efficient ventilation. Energy-efficient windows and doors help minimise energy consumption for heating.

The energy regulations for buildings will be tightened in 2010, and the goal is reduce the energy consumption of new houses from the beginning of 2008.

Table 2. Energy consumption of typical private houses in Finland, Austria, France, Italy and Spain.

Country	Energy consumption	Annual heat consumption
Finland	Single family house (heating only) - Electrically heated	9,600 – 14,400 kWh
	Average house size	110 m^2
	Average energy consumption	Old houses (pre-1970) 160 – 200 kWh/m^2 New buildings (2000s) 80 – 120 kWh/m^2 New houses (2003 standard) 60 – 70 kWh/m^2 Low energy houses 40 – 60 kWh/m^2 Passive houses 15 – 30 kWh/m^2
	Hot water (heating)	4,000 kWh (1,000 kWh/person)
	Household electricity (not for heating)	7,000 kWh (10,000 kWh for well-equipped houses) Sauna stoves approx. 1,000 kWh
Austria	Single family house (heating only)[gas]	Common houses (old) 150 – 250 kWh/m^2 New buildings (1999 standard) 75 – 90 kWh/m^2 New buildings (energy-saving) 50 – 65 kWh/m^2 Low energy houses 20 – 50 kWh/m^2 Passive houses < 15 kWh/m^2
	Average house size	97 m^2
	Hot water (heating)	10,000 kWh
	Household electricity (not for heating)	3,500 kWh (family) 7,000 kWh (family including hot water production, not for heating)
France	Single family house (heating only) typical heating source gas (37% - natural gas or LPG)	Old houses (pre-1975) 16,700 kWh Newer houses (post-1975) 14,000 kWh (Source: ADEME and CEREN – 2-006)
	Average house size	108 m^2 (2002) 115 m^2 (current, source: INSEE).
	Hot water (heating)	2,500 – 3,000 kWh
	Household electricity (not for heating)	3,000 kWh
Italy	Single family house (heating only)	10,000 – 40,000 kWh
	Average house size (for new houses)	78 m^2
	Hot water (heating)	3,000 kWh (Thermal energy)
	Household electricity (not for heating)	3,000 kWh (Electric energy)
Spain	Single family house (heating only) natural gas heated	14,000 kWh
	Average house size Average energy consumption	150 m^2 Average 130 – 140 kWh/m^2 New houses 60 – 80 kWh/m^2
	Hot water (heating)	2,800 kWh
	Household electricity (not for heating)	4,000 kWh

Amount of firewood needed

The amount of firewood needed each year depends on how it is used. In private houses firewood is typically burnt in fireplaces for comfort and heat, as well as to heat saunas. The amount of firewood thus depends on how frequently it is burnt. If firewood provides the only source of heating, the amount of firewood needed each year depends on several factors, such as the amount of space being heated, weather conditions and the level of heat insulation. The efficiency of the fireplace also affects the amount of firewood needed. The efficiency ratio of the newest heat retaining fireplaces is as high as 80 to 85 percent.

If firewood provides the only source of heating, the annual consumption of heating energy is 20,000 kWh and the efficiency of the heat retaining fireplace is 80 percent, 25 unstacked cubic metres or 15 stacked cubic metres of dried birch logs will be needed to produce the required heating energy. If the fireplace is used as an additional source of heat, or if the sauna stove is heated on average twice a week around the year, and the efficiency ratio is 75 percent, around 7 loose cubic metres or 4 stacked cubic metres of dried birch logs are required. If alder is burnt instead of birch, then the demand for firewood is 1.4 times greater.

Fireplace or stove manufacturer specify in their heating instructions the right amount of firewood to be used. The right amount of firewood for each heating is generally one kilo per hundred fireplace kilos. A typical fireplace weighs 1,500 kg, so the right amount of firewood is approximately 15 kg. The amount of firewood required is divided into several loads (3 to 5 kg/load).

In Italy a typical house uses about 12 stacked cubic metres of wood (18,800 kWh). In Spain weekend houses need annually about 3.2 stacked cubic metres (5,000 kWh). In Finland consumption varies a lot. The holiday homes in Finland use annually 2.7 stacked cubic metres per house. Private houses use on average 5.7 stacked cubic metres per house (9,700 kWh), and farmhouses use annually 21.6 stacked cubic metres per house (29,900 kWh) in Finland. In France a typical house uses about 5.3 stacked cubic metres per house (12,250 kWh) annually.

Example

The net calorific value of firewood as received (the moist fuel) can be calculated by the net calorific value of the dry basis according to the equation (EN 14961-1) (4).

$$q_{p,\mathrm{net,ar}} = q_{p,\mathrm{net,d}} \times \left(\frac{100 - M_{\mathrm{ar}}}{100}\right) - 0{,}02443 \times M_{\mathrm{ar}} \qquad (4)$$

where

$q_{p,\mathrm{net,ar}}$	is the net calorific value (at constant pressure) as received (MJ/kg);
$q_{p,\mathrm{net,d}}$	is the net calorific value (at constant pressure) in dry matter (MJ/kg);
M_{ar}	is the moisture content as received [w-%];
0,02443	is the correction factor of the enthalpy of vaporization (constant pressure) for water (moisture) at 25 °C [MJ/kg per 1 w-% of moisture].

In this example net calorific value in dry basis $q_{net, d}$ is 19 MJ/kg.

The net calorific value for moist fuel (20 w-%) is

$$q_{net, ar}=19 \text{ x } (100–20/100)–0,02443 \text{ x } 20 = 14.71 \text{ MJ/kg}$$

$$=1 \text{ kg x } 14.71 \text{ MJ/kg}/3.6 = 4.09 \text{ kWh/kg}$$

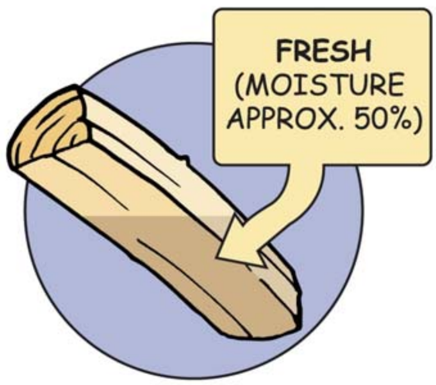
If the efficiency of the stove is 80%, the net energy stored in the stove is = 0.8 x 4.09 kWh = 2.6 kWh.

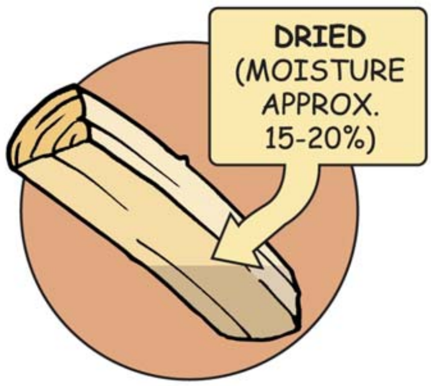
Note: 1 MJ/kg = 1/3.6 kWh/kg = 0.2778 kWh/kg

2. Firewood quality

All tree species can be used as firewood. Naturally, however, different tree species have different properties. It is useful to note the differences in terms of quality. Softwood (coniferous) trees, such as spruce, fir and pine, can spark a lot when burnt, so they are not ideal for use in open fireplaces. Of course, this does not prevent them from being used in enclosed fireplaces or continuously heated sauna stoves. Robinia, beech and oak in Central Europe and birch in the Nordic countries have high energy content thanks to the density of the wood. Robinia, oak, beech and birch are therefore ideal for heating ovens, heat retaining fireplaces and open fireplaces. Alder is particularly suitable for continuously heated saunas and smoke saunas.

The most important factor affecting the quality of firewood is moisture content, which determines how much of the energy content can be utilised. The ideal moisture content for firewood is less than 20 percent. The moisture content of fresh wood is generally 45 to 55 percent. After 1 to 2 years of storage time it is in an “air dried” condition with moisture content of 15 to 20 percent. Hardwood dries more slowly than softwood, and the drying time for oak is especially long. Ideally firewood should be stored for at least two years in a sunny, well aerated place. The combustion of fresh cut or moist wood in a stove provides little energy and can harm the furnace.





Dry wood that has been split into suitable sizes is easier to ignite than moist wood. Dry wood also burns more efficiently, produces less emissions and provides more heat than moist wood. The drier the wood, the greater its energy content (=net calorific value). If you burn 10 kilos of birch with a moisture content of 20 percent, two kilos of water has to be effectively evaporated, compared to four kilos if the moisture content is 40 percent. The energy content of 10 kilos of moist wood is 31 kWh, whereas that of dry wood is 41 kWh.

There is not much difference in the energy content of different tree species on a similar weight basis. In terms of volume, robinia, beech and birch have the highest energy content due to its density. All wood species contain approximately equal amounts of energy – 4 kWh/kg with a moisture content of 20 percent.

Table 4. Typical properties of firewood (moisture < 20 w-%).

Wood species	Net calorific for fuel in typical moisture content, kWh/stacked m^3
Poplar	1,110
Spruce	1,300 – 1,320
Aspen	1,330
Fir	1,350 – 1,370
Pine	1,360 – 1,570
Alder	1,230 – 1,400
Willow	1,440
Larch	1,780
Maple	1,675 – 1,780
Birch	1,700 – 1,810
Ash	1,870
Beech	1,850 – 1,930
Oak	1,890 – 2,030
Robinia	2,040 – 2,200

Firewood amounts are given in cubic metres. A cubic metre of stacked wood means a stack of wood that occupies a space of one cubic metre. A cubic metre of loose wood is equal to a box one cubic metre in size into which the split logs are “thrown”. This is also referred to as an “unstacked cubic metre”. Naturally, the conversion rates between the volumes in the table below will be affected by the size of the logs and how they are arranged. Firewood is usually sold in by either loose cubic metre or stacked cubic metre.

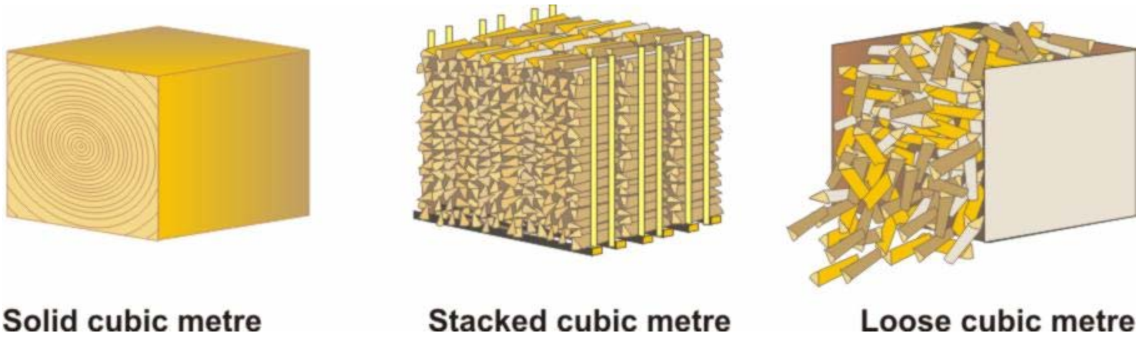


Figure 2. Comparison of volumes. Drawing: VTT.

Table 3. Comparison of volumes of firewood in Finland. Conversion rates according to the TTS Institute.

Measuring unit	Loose m^3	Stacked m^3	Solid m^3
Loose m^3, 33-cm split logs	1	0.6	0.4
Stacked m^3, 33-cm split logs	1.68	1	0.67
Stacked m^3, 100-cm unsplit logs	1.55	1	0.62
Solid m^3	2.5	1.5	1

In Austria one stacked cubic is equivalent to 0.7 solid cubic meters and 1.4 loose cubic meters. One stacked cubic meter of air-dried hardwood weights 410 to 550 kg, depending on the type of wood. The weight of air-dried softwood ranges from 350 to 450 kg. An important quality characteristic in addition to size and type of wood is the moisture. Fresh cut wood is usually stacked and dried in pieces of one meter with good aeration.

3. Harvesting firewood yourself

There are many different ways to source firewood, starting from harvesting the firewood yourself to having dried birch logs delivered to your home. Harvesting firewood yourself can combine forest maintenance, exercise and sourcing fuel. If you are interested in harvesting firewood yourself but you do not own forest, you can enquire about suitable wood harvesting locations from your local forest management association. Various tools and equipment are needed for harvesting, chopping, drying and transporting firewood. If you are primarily interested in inexpensive heating energy, you should calculate whether harvesting firewood yourself is in fact less expensive than having dried logs delivered to your home considering equipment and transportation costs. Many firewood sellers also offer fresh wood that you can chop and dry yourself.

3.1 Harvesting trees

The moisture content of growing trees varies according to the season (Figure 3). The moisture content of deciduous trees peaks in April and May. Since the best weather for drying logs is from April to July, trees are harvested and cut into long and straight logs during the winter months and chopped for drying in the early spring. The appearance of the firewood also benefits from this, especially if the drying logs are protected from the rain.

In a good summer and in a good drying place, wood that has been harvested during the winter can be dried for use as firewood in a single summer. However, the wood must then be chopped by the end of May at the latest. If it is not possible to chop the wood in the same spring, the bark of the felled and lopped stem should be broken or peeled in strips. The bark can be broken with a chainsaw already during the harvesting process. With the bark thus broken or removed, the logs will begin to dry well during the spring.

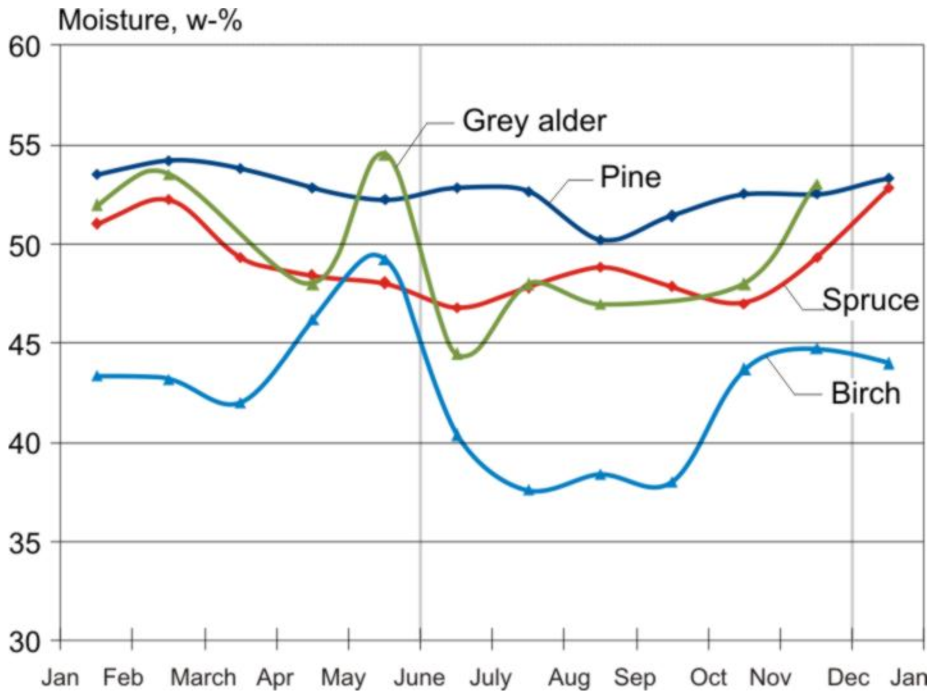


Figure 3. The moisture content of growing trees at different times of the year. Source: Hillebrand & Frilander 2005.

Firewood is sometimes also harvested by leaf seasoning which means leaving the trees where they fall in a cleared forest. The trees then release moisture through their live treetops. The moisture content of the trees is reduced to the saturation point of the cells when the trees or needles dry and fall off. The saturation point of the cells of Finnish tree species equals moisture content of 27 to 30 percent. If it is possible to harvest the trees in the late winter and chop them immediately into logs, it is not worth to wait the leaf seasoning time. Trees dry faster when chopped into logs. The leaf seasoning can be used if the intention is to make dry firewood for the following year.

A chainsaw is generally used when harvesting trees yourself, whereas forest harvesters are used for larger amounts. During mechanical harvesting the trees are partially debarked, which improves drying and helps prevent the wood from rotting. Trees with their bark intact deteriorate rapidly already during the second summer. If the trees are left for the entire year or more, the bark should be broken. Logs that are protected from the rain and those where bark has been broken dry well. Figure 4 presents the results of research into trees dried in a pile in poor drying conditions in summer 2007. The evaporation amount was 410 millimetres and the rain amount was 423 millimetres. The research compared the drying of partially debarked trees (Figure 5) and split logs to that of trees that were left unhandled.

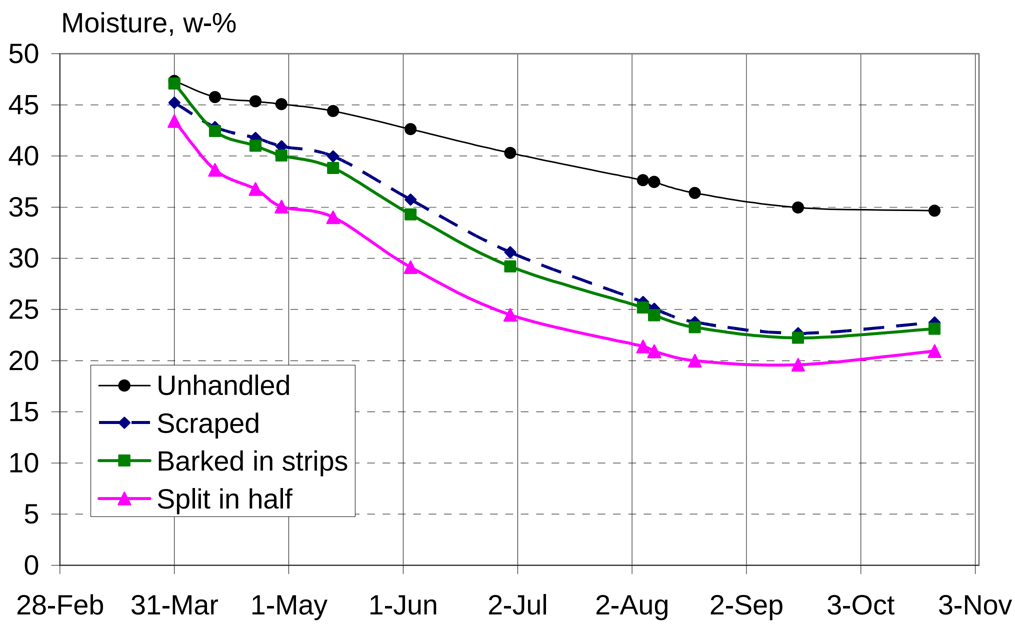


Figure 4. The effect of breaking the bark on drying birch logs in a covered pile. Source: Sikanen et al 2008.

Figure 5. Specimens of partially debarked birch logs: split in half, barked in strips and scraped wood. Photo: Pekka Rötkönen, Tähtikuva.

Figure 6. Walki®Wrap Energy covering paper protects a pile of wood. Photo: Ari Erkkilä, VTT.

The trees are transported out of the forest by tractor, ATV or snowmobile pulling a trailer or sledge. The tree trunks are then stored on top of supporting logs to prevent moisture from the ground from rising up and reaching the wood. If the pile is left for the entire year or more, it should be covered to protect it from rain. Plenty of space should be left between the cover and the top of the pile. If there is no space for the air to circulate, the wood will become mouldy.

3.2 Chopping the wood

Cutting and splitting the trunks is referred to as chopping. Chopping the wood accelerates the drying process. Splitting the wood and breaking the bark increases the surface area from which water can evaporate. Bark restricts water from passing through it and slows the drying process. Thin trunks do not need to be split, but the bark should still be broken.

In addition to facilitating the drying process, chopping the wood reduces its size for burning. The length of the logs depends on the intended fireplace. Birch bark, chippings and splinters left over from the chopping process can be used to help light the fire. Small logs (for example 8 to 10 cm) should be used for the first load, as these light easily and heat the stove fast. Larger logs can then be used for successive loads to control the burning speed. Cooking stoves should always be heated using small logs in order to control the heat.

Several tools can be used for chopping, from saws and splitting axes to professional automatic chopping machines. When considering the appropriate level of equipment investments, you should consider how you source and use firewood, how much time you have available and the overall cost of the investment.

Chainsaws are generally used to cut the tree trunks into logs. Chainsaws create noise and vibration, as well as considerable safety risks. The injuries caused by chainsaws are mainly to the extremities. Caution must be taken against kickback from the steel chain. The chain can kick backwards in situations where the upper part of the chain catches against the tree being cut or where the chain hits a nail or other hard object in the tree. Pay attention to the tip of the chain at all times. The cutting should be performed at full power right from the start. The trunks should be supported in a sawhorse to ensure that they do not move when being cut. The person operating the chainsaw should use all the appropriate safety gear. Chainsaw chaps, made of a material that jams the moving parts of a chainsaw with fibres, are effective at preventing some leg injuries. Gloves with similar material help prevent hand injuries. The last piece of safety equipment you should consider is steel-toed boots which can prevent chainsaw injuries and crush-type injuries.

Once cut using a chainsaw, the logs must be split into appropriate sizes. The traditional tool for this is an axe. Tools that rely on human muscle power eliminate the need for environmentally unfriendly energy production and are ideal for chopping small amounts of wood. Special splitting axes are available for splitting logs, and a number of other products can also be used, such as the Smart Splitter, the Logmatic Wedge Axe and the Vipukirves Lever Axe. These products are designed to safer, more ergonomic and more effective than traditional axes.

The Smart Splitter employs a wedge that moves up and down a rod, so it cannot slip and hit your leg (Figure 7). The splitting force is generated by accelerating a weight down the rod, releasing both hands before it strikes the top of the wedge, which splits the wood.

The Wedge Axe operates according to the hammer and wedge principle (Figure 8). The wedge is extended by a shaft in which a metre-high hammer is raised and slammed down. Each time the hammer hits the wedge safely, and the wood splits as a result of the weight of the hammer, muscle power and the law of continuity.

The Lever Axe separates wedges from logs by using the twisting force of a lever (Figure 9). Upon striking the log, it automatically turns to the right and detaches the chopped portion from the log. The Lever Axe functions like a conventional axe with the exception that the user must loosen his or her grip on the handle when the blade strikes the log. Chopped sections are removed with a single strike. The blade does not become lodged in the log, but remains in the same place and ready for the next strike.

Figure 7. The Smart Splitter controls the force of impact against the wedge. Photo: Oscar trade.

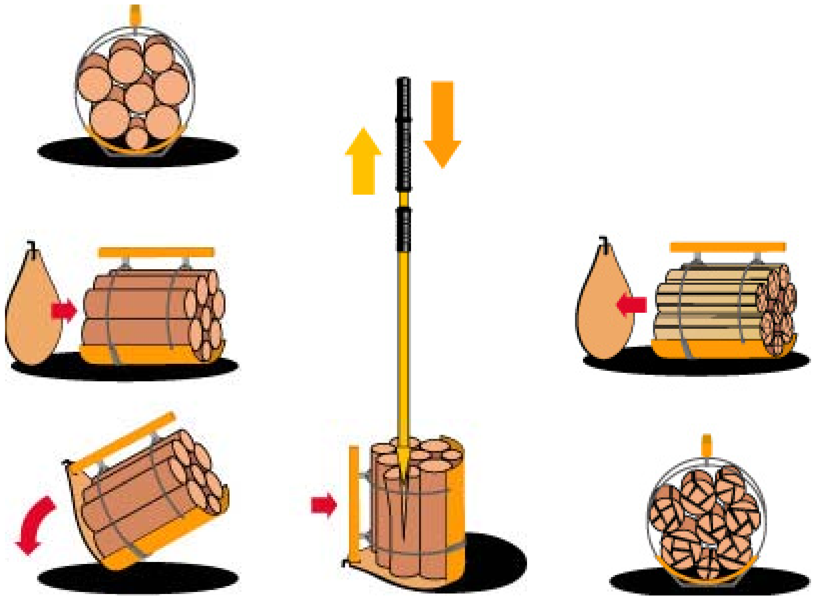


Figure 8. The Logmatic LM-250 Wedge Axe. Photo: Logmatic.

Figure 9. The Vipukirves Lever Axe. Photo: Vipukirves Heikki Oy.

Hydraulic splitters are the simplest mechanical splitting tools. The force is usually generated by an electrical hydraulic pump, which transfers pressure to a hydraulic cylinder. The cylinder then pushes the log against a blade, which splits the wood. Many different types of hydraulic splitter are available. Tractor-driven hydraulic splitters use the tractor's own hydraulics to generate the force (Figure 10).

Two-stage chopping machines both saw and split the wood (Figure 11). The trunk is cut with either a chainsaw or buzz saw, and the log is then split hydraulically in the same manner as a hydraulic splitter. Advanced chopping machines increase productivity by accelerating the return action of the hydraulic cylinder or by utilising double alternating hydraulic cylinders. The least expensive chopping machines split the wood using a cone screw.

Some chopping machines use a cutting blade that splits and cuts the log at the same time. These machines are suitable for trunks with a diameter of less than 15 cm.

Figure 10. Tractor-driven hydraulic splitter. Photo: Terästakomo Oy.

Figure 11. A two-stage chopping machine that saws and splits the wood. Photo: Ari Erkkilä, VTT.

3.3 Drying logs

Several factors affect the drying of firewood, such as the species of tree, the diameter of the tree, the drying method, the conditions where the wood is being dried, the arrangement of the wood and the weather. The place where the wood is dried should be open and sunny. A storage place that is higher than its surroundings will remain dry from flowing water.

Logs can be dried either stacked or unstacked. Drying unstacked logs requires less work than stacking the wood. Supporting logs, pallets and various frames can be used to elevate the logs off the ground and into an ideal arrangement for drying (Figure 12 and Figure 13). It is essential to prevent ground moisture from rising up into the woodpile, to ensure the flow of air around the logs, and to prevent rainwater from soaking the pile. The woodpile can be protected against the rain using a canopy already from the start of summer. Space should be left between the canopy and the logs to allow air to flow. Covering the woodpile will not slow down the drying process, but it will prevent rainwater from getting inside the pile. The logs will also maintain their colour better without getting mouldy. Ideal canopy materials include paper based cover material, agricultural plastic, a light tarpaulin or even leftover roofing material. The canopy should be secured so that the wind does not remove it.

Figure 12. These chopped logs are being stored in breathable sacks where they will dry. Machine power is needed to deposit the logs. Photo: Isto Mäkelä.

Figure 13. Around 15 unstacked cubic metres of chopped logs drying on pallets and supported by metal netting. Photo: Isto Mäkelä.

Drying logs in a stack reduces the amount of space required. Supporting logs are needed under the stack to prevent ground moisture from reaching the wood and to facilitate airflow also beneath the pile. Sturdy trunks, pallets or other similar items should be used for the supporting structure. The lowest logs should be at least 10 cm above the ground. The supporting logs can be raised and prevented from sinking into the ground by placing logs every 50 to 100 cm under them in the direction of the drying logs. Any grass should be mowed from around the stack.

The ends of the stack should be supported by pairs of stakes driven into the ground. Debarking these stakes will help them to dry and prevent them from rotting. To prevent the stakes from bending or falling over, adjacent stakes should be supported by cross braces and attaching opposite stakes together with a beam or rope.

The end stakes can be replaced by constructing a so-called lattice from the firewood. Place evenly sized chopped logs lengthways and crossways into latticed layers. The structure should lean slightly into the stack. Stacks should not be supported against live trees, which can sway and cause the stack to collapse.

Stacks should not touch each other, as air must flow around them. To help keep the stacks upright, they can be made in pairs leaving around a metre of space around each pair of stacks and around twenty centimetres of space between the adjacent stacks. The pair of stacks can then be supported against each other with thin connecting logs reaching into both stacks. These connecting logs should be placed every two metres. Stacks of firewood are protected from the rain the same way as unstacked woodpiles.

In good conditions logs that have been chopped by the end of May will dry into firewood over the summer. Birch dries slower than other Finnish tree species due to its tight bark. If the bark is broken sufficiently, birch logs will also dry over the spring and summer. Before the arrival of the autumn rains woodpiles and stacks should be protected also from the sides, leaving enough space between the cover and the logs to ensure ventilation. Ideally the logs should be moved closer to where they will be burnt into a spacious storage area, where the logs will remain dry from the rain and can even continue to dry until September.

Figure 14 and Figure 15 show how logs dry in a well-ventilated woodshed in which the logs are protected from the rain and direct sunlight.

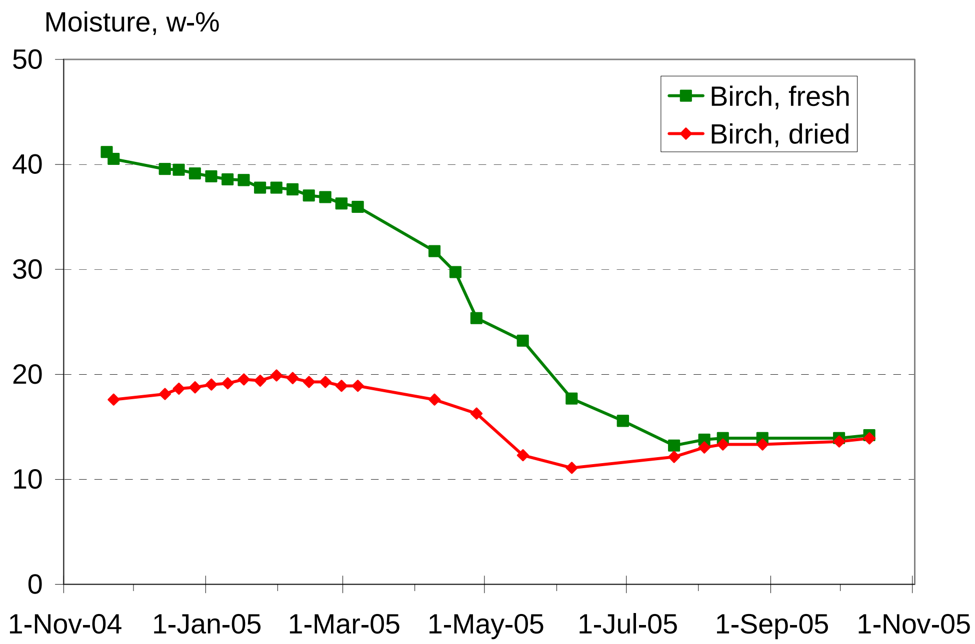


Figure 14. The moisture content of fresh and dried birch logs stacked under a shelter in Central Finland. Source: Hillebrand & Kouki 2006.

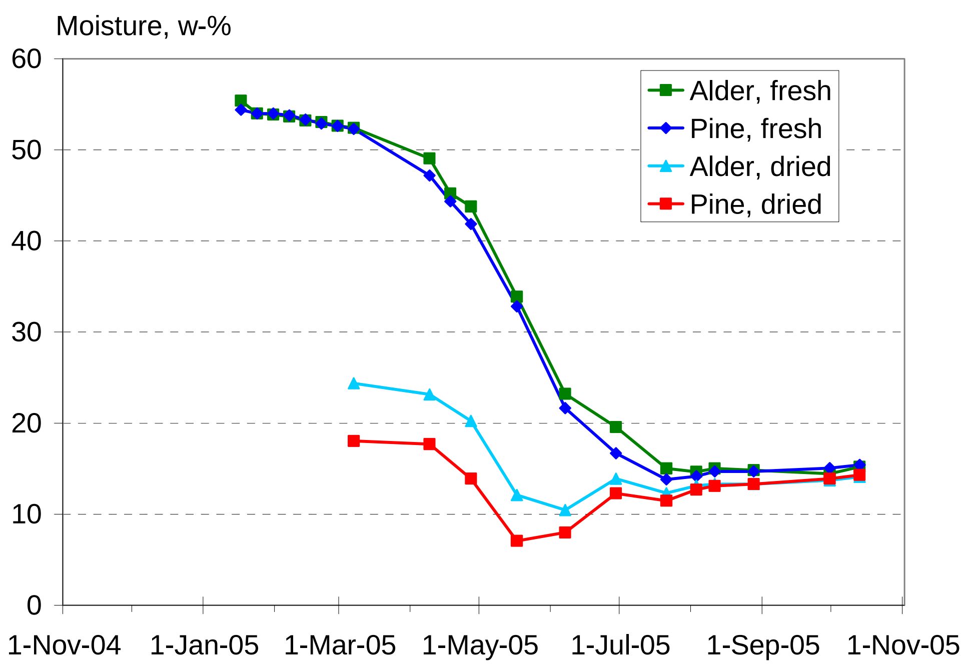


Figure 15. The moisture content of fresh and dried alder and pine logs stacked under a shelter in Central Finland. Source: Hillebrand & Kouki 2006.

3.4 Storage

The moisture content of even dry wood varies according to the temperature and humidity of the surrounding air. The equilibrium moisture content of wood in a covered outdoor woodshed can vary between 15 and 25 percent depending on the season in Finland. Storing firewood correctly helps prevent the accumulation of rot and funguses. For this reason it is important to keep dried wood dry. The changes in the moisture content of dried and stacked logs in the type of wire fence illustrated in Figure 16 over a period of three years are presented in Figure 17.

Figure 16. A 3.5 loose cubic metre of firewood supported on top of pallets and surrounded by wire fencing. Photo: Kari Hillebrand, VTT.

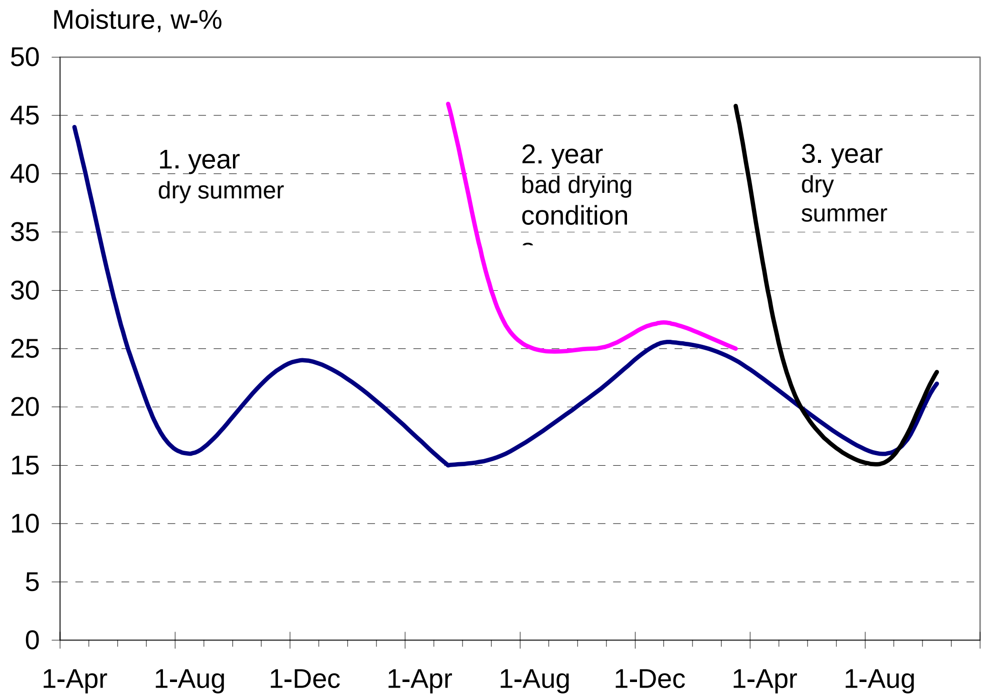


Figure 17. The moisture content of logs varies according to the season. The logs in the photo above are protected from the rain and supported by wire fencing. The drying conditions in 2004 were poor in Finland. Source: Hillebrand & Kouki 2006.

Drying and storing semi-dried logs

The ideal woodshed is spacious, well ventilated and protected from dampness and rain. If you plan to continue drying the logs in an outdoor woodshed, the storage area should be ventilated from the walls and floor. The less air and open space there is within the woodshed, the drier the logs should be before storing them there. Air should flow freely under, around and between the logs. The flow of air beneath the woodpile can also be ensured with the appropriate floor structures or supporting logs. On flat concrete floors less space is required beneath the logs, and thin trunks or empty brick pallets can be used to support them. If the wall surface is flat, the flow of air can be ensured by placing thin trunks or planks between the wall and the stack. In outdoor shelters without floors, the airflow should be ensured in the same way as with outdoor stacks.

Space should be left between the stacks whenever possible. The more even the sides of the stacks are, the better the airflow. There should be sufficient ventilation between the woodshed and open air to prevent mould.

The woodshed should be large enough to store enough firewood for one year or half a year at a time. In small houses an average of around 6 cubic metres of stacked firewood is consumed a year. This amount of firewood will fill an area of approximately five square metres. The storage area should be made big enough to allow sufficient space around the woodpiles for safe and unimpeded access to the wood.

A good woodshed will have large door openings and low thresholds to facilitate access. Low thresholds make it easier to fill the woodshed. Ideally the door opening should be wide enough to allow logs to be brought in on a pallet. The door of the woodshed should face the building into which the logs will be carried (Figure 18).

The correct location of the woodshed will help make it convenient to use. The woodshed should be situated as close to a road or path as possible, and there should be sufficient space around the woodshed for the logs to be unloaded before being stacked. There must be sufficient room to operate a truck, loader or trailer, and the road or path must be able to carry the weight. The distance between the woodshed and the building in which the logs will be burnt should be as short as possible. Firewood is often needed most in the dark wintertime. The woodshed and paths should be sufficiently well lit to ensure safe passage.

Figure 18. An ideal woodshed for storing one year's consumption of firewood. About 1.5-meter wide doorway allows firewood to be transported directly to the woodshed from the lorry. The minimum volume for Nordic conditions is 5 m^3 and in Southern Europe a few cubic metres. The floor has good ventilation when 50 x 100 mm sawn timber and 1 cm space between the floor planks are used. The front door is facing the building into which the logs will be carried. Photo: Lauri Sikanen.

Storing dry logs

Dried logs can also be stored indoors. Close attention must be paid to fire safety regulations, occupational safety aspects and convenience when planning the storage of firewood.

To make using your fireplace as convenient and easy as possible, firewood should be brought inside into the warmth one day before it is burned. Humidity in the room will condense on the surface of cold wood, making it harder to light. Firewood should be stored near the fireplace in such a way that any risk of accidentally combusting is eliminated. Different safety distances are recommended for different fireplaces, and these must be adhered to.

It is recommended that a maximum of 0.5 cubic metres of firewood is stored inside unless stored in a separate compartmentalised storage area.

Compartmentalised storage areas inside houses include boiler rooms, car garages and fuel storage areas. Even if a car garage or other motor vehicle shelter is compartmentalised, motor vehicles and firewood must not be stored together in the same area at the same time.

In Finland there is a regulation that fuel storage areas must be compartmentalised into a separate fire compartment. The fire resistance rating for compartmentalised areas in houses usually must be able to resist fire for 30 or 60 minutes before spreading. The surface materials of inner walls and ceilings have their own requirements that must be adhered to. Floor materials do not have their own fire safety requirements. If a fuel storage area is situated in the basement of the building, the building material requirements are more stringent.

In Italy, Spain, France and Austria there are no special regulations on the storage of fuel for heating systems with an output less than 35 kW. The only recommendation is to keep the fuel in a dry place so as not to affect its quality. In Italy heating systems with an output of more than 35 kW have to abide by the ministerial decree of 28 April 2005.

Outdoor woodsheds also have their own fire safety requirements. These vary according to the distance from the woodshed to other buildings. If the distance between the structures is more than eight metres, no additional fire protection is needed to protect one from the other according to Finnish fire safety regulations. If the distance is less than eight metres, structural protection is required to limit the spread of any fire as much as possible, usually by compartmentalising. There are also restrictions based on the distance from the woodshed to the border of the property on which it stands. These restrictions may vary according to municipality and address.

Attention must be paid to fire safety risks also when temporarily storing firewood. Firewood should not be stacked against the outer walls of buildings (Figure 19). If the woodpile catches fire or is lit on fire, the entire building could burn down. Woodpiles can also cause structural damage if stacked against outer walls.

Local fire and building inspection officials can provide advice about fire safety, including how to compartmentalise and where to locate woodsheds.

Figure 19. Firewood should not be stacked against the outer walls of buildings. Photo: Matti Alakangas.

4. Purchasing firewood

4.1 Products, characteristics, quality and packaging

In addition to harvesting firewood yourself, it is also possible to purchase ready-to-use wood-based fuels. The most common of these include firewood, wood pellets and briquettes.

Firewood is sold in the form of chopped wood in various quantities and made from different wood species. Professional suppliers of chopped wood prepare their products in accordance with quality guidelines, as a result of which the quality of the chopped wood is generally better than firewood that has been harvested yourself. The common lengths of firewood in Europe are 25 cm, 33 cm and 50 cm and diameters 8 to 15 cm. The CEN standard EN 14961 for firewood quality is currently being developed and will be published in 2009.

In Austria logwood is defined by the standards ÖNORM M 7104 and M 7132. Logwood is mainly supplied by small-scale agriculture and forestry or by self-supply. It can be differentiated between hardwood and softwood. Logwood is also classified according to the size. Logwood is ready to use firewood that has been cut into the appropriate length. The most common lengths are 25 cm, 33 cm, 50 cm and 100 cm.

When purchasing firewood, it is helpful to consider how it will be used. When used as a source of heat, the most important characteristic of logs is sufficient dryness. The right size of the logs for their intended use is also important. Possible funguses and mould on the logs will not affect how they burn, but they may cause various symptoms, especially to the eyes and respiratory systems, to the user when handling the logs. The evenness of the cut ends of the logs and other esthetical qualities do not play a major role in how the wood burns, but they can affect how easy they are to handle.

Logs are sold either loose or in packages. Loose logs are usually delivered to the customer in a trailer (Figure 20). After the logs have been unloaded, it is then up to the customer to move them into storage so they do not get wet.

Figure 20. Loose logs are usually delivered to the customer in a trailer. Photo: Ari Erkkilä, VTT.

Figure 21. Package of wood logs. Photo: Iiris Lappalainen, Motiva Oy

Logs are also sold in various forms of packaging, the most common of which include mesh sacks, mesh bags, plastic bags with ventilation holes, plastic wrapping and cardboard boxes (Figure 21). The most common packaging size is one cubic metre packed on a pallet or in a mesh sack. The size of mesh bags, plastics bags with ventilation holes, plastic wrapping and cardboard boxes is usually 30 or 40 litres, which holds 10 to 15 kg of chopped wood. The most convenient packages contain enough firewood and kindling for a single burning. Packaged firewood is often sold at gas stations and at hardware and farm shops, as well as directly from suppliers.

In some places a firewood service is available in which the supplier carries the ready-to-use logs into the customer's house, for example on a castor pallet. This service is ideal if you do not have your own storage areas for dry wood, but it requires that the delivery truck is able to get close to the house.

Wood pellets are a dry, compressed and uniform biomass fuel that is made from the residues and by-products of the mechanical wood-processing industry. The raw material is mostly dry sawdust, grinding dust and cutter shavings. Pellets are cylindrical in shape and usually have a diameter of 6 or 8 mm. Their length can vary from 5 to 40 mm. The energy content of wood pellets is 4.8 kWh/kg and the moisture content less than 10 percent. Wood pellets are used in special pellet boilers equipped with a pellet burner, as well as in pellet fireplaces. A specially designed pellet holder must be used for burning pellets in ordinary fireplaces.

Figure 22. Wood pellets are sold in small and large packages. Photo: Vapo Oy.

Wood pellets are sold either as bulk goods in 500 to 1,000 kg large sacks or in small 15 to 20 kg sacks (Figure 22). Loose pellets can be ordered directly from the manufacturer. Sacks can also be purchased from hardware and farm shops.

Wood briquettes are also made from the residues and by-products of the mechanical wood processing industry. The size of briquettes is larger than that of pellets, the smallest generally having a diameter of 50 to 75 mm. Briquettes are compressed into cylinders or bricks. The energy content of briquettes by weight is the same as for wood pellets. Briquettes are also supplied in bulk and packaged (Figure 23). When used for heating it is important to note that briquettes contain more than two times the energy per volume of chopped logs.

Figure 23. Packages of wood briquettes. Photo: Karelia Upo-Floor Oy.

4.2 E-trading

Buying and selling over the internet is increasingly popular, also in terms of firewood, pellets and briquettes. Websites for both individual firewood suppliers and firewood services in general can be found on the internet. Several services are available in Europe (see www.eufirewood.info).

These websites offer search engines that make it possible to find the details of firewood suppliers by location and product. The prices and quality of firewood can be easily compared and orders made by filling in the order form or by e-mail, letter or phone. Online retailers have delivery and sale conditions that suppliers must adhere to. The seller must ensure that his wood meets the quality criteria set out in the terms and conditions. Payment takes place directly between the buyer and seller. Home delivery, delivery times and other related services are also agreed directly between the parties involved.

References

Alakangas, E. 2005, Properties of wood fuels used in Finland, Technical Research Centre of Finland, VTT Processes, Project report PRO2/P2030/05 (Project C5SU00800), Jyväskylä 2005, 90 p. + app. 10 p.

Alhojärvi, P. 1981. Polttopuiden rasikuivatus [Leaf-seasoning of fuelwood]. TTS Forestry Bulletin. 4 p. in Finnish,

Erkkilä, A.. & Alakangas, E. 2008, Fill up the woodshed, BioHousing flyer, 3 pages (www.biohousing.eu.com).

*Hillebrand, K. & Frilander, P.*2005. Pilkkeen kuivaus ja laadun hallinta [Drying and quality control of firewood], VTT Processess, Project report PRO2/P2068/05, Jyväskylä 2005, 41 p. + app. 6 p. in Finnish.

Hillebrand, K. & Kouki, J. 2006. Pilkkeen kuivaus – luonnonkuivaus, keinokuivaus ja laadun hallinta [Drying of chopped firewood – natural and artificial drying and quality control]. TTS Publication 398. 62 p. in Finnish.

http://www.ttl.fi/Internet/Suomi/Aihesivut/Rakennusterveys/Turvapakki/Moottorisaha.htm, 23.1.2008

http://www.agma.com/

http://www.oscartrade.fi/splitter.php

http://www.logmatic.com/index_fin.php

http://www.vipukirves.fi/etusivu.htm

http://www.mottinetti.fi/http://www.halkoliiteri.com

http://www.walki.com/internet/waw_internet.nsf/sp?open&cid=ContentD7E8A&leftnavinf=Navi%5CMedia+relations&leftnavinfa=o, 4.12.2008

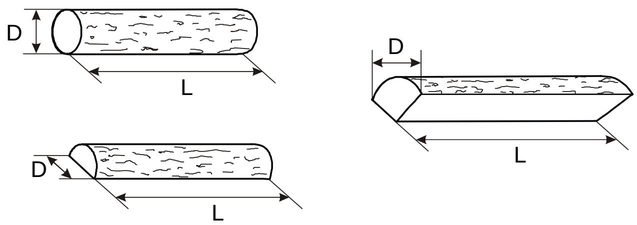
Pirinen, H.1997. Pilkeopas omakotitaloille [Firewood guide for single-family houses]. TTS Publication 357. in Finnish.

Sikanen L. 2005. Kehittyvä pilkebisnes. Joensuu. Ympäristöteknologian teemapäivä. 1.12.2005, Joensuun Tiedepuisto. Power Point sheets 33 p.

Sikanen, L., Röser, D., Prinz, R., Nuutinen, Y., Emer, B., Asikainen, A., Erkkilä, A., Heikkinen, A., Hillebrand, K., Kaipainen, H. & Oravainen, H. 2008. Runkopuun osittainen kuorinta ja luonnonkuivaus metsähakkeen ja pilkkeiden tuotantoketjussa [Partial debarking of energy wood stems in production of high quality fuel chips and fuel logs] Metla Working Papers draft, will be published in 2008.

Tuomi, S. & Peltola, A. 2002. Polttopuun käytön nykytila pientaloissa [The present state of fuelwood use in detached houses in Finland]. TTS Forestry Bulletin 15/2002. 4 p. in Finnish

App.1 — Specification of properties for log wood, firewood – EN 14961-1

	Master table		
	Origin: According to Table 1 in EN 14961-1.		Woody biomass (1.1) Wood species to be stated
	Traded Form		Log wood, firewood
Normative	**Dimensions** (cm)		
	Length (L) (maximum length of a single chop), cm		
	L20-	< 20 cm	 Examples
	L20	20 cm ± 2 cm	
	L25	25 cm ± 2 cm	
	L30	30 cm ± 2 cm	
	L33	33 cm ± 2 cm	
	L40	40 cm ± 2 cm	
	L50	50 cm ± 4 cm	
	L100	100 cm ± 5 cm	
	L100+	maximum value has to be stated	
	Diameter (D) (maximum diameter of a single chop), cm		
	D2-	D < 2 cm ignition wood (kindling)	
	D10	2 cm ≤ D ≤ 10 cm	
	D12	4 cm ≤ D ≤ 12 cm	
	D15	10 cm ≤ D ≤ 15 cm	
	D20	10 cm ≤ D ≤ 20 cm	
	D25	10 cm ≤ D ≤ 25 cm	
	D35	20 cm ≤ D ≤ 35 cm	
	D35+	D > 35 cm, maximum value to be stated	
	Moisture, M (w-% as received)		
	M10	≤ 10 %	
	M15	≤ 15 %	
	M20	≤ 20 %	
	M25	≤ 25 %	
	M30	≤ 30 %	
	M35	≤ 35 %	
	M40	≤ 40 %	
	M45	≤ 45 %	
	M55	≤ 55 %	
	M55+	> 55 % (maximum value to be stated)	
	Volume or weight, m^3 stacked or loose or kg as received		To be stated which volume is used when retailed (m^3 stacked or m^3 loose, kg) and/or packaged log woods weight.
Informative	**Energy density, E** [b] (kWh/kg or kWh/m^3 loose or stacked)		Recommended to be specified when retailed.
	Proportion of split volume		No split (=mainly round wood) Split: more than 85 % of volume is split Mixture: split and round wood as a mixture
	The cut-off surface		To be stated if the cut-off surface of log woods are even [a] and smooth [a] or ends of log woods are uneven
	Mould and decay		If significant amount (more than 10 % of weight) of mould and decay exists it should be stated. In case of doubt particle density or net calorific value could be used as indicator.

[a] Use of chainsaw is considered to be smooth and even.

[b] Energy density of log wood is depending on moisture content and net calorific value of dry fuel (see annex D). For example if moisture content of birch wood log is 15 w-%, energy density is 4,43 kWh/kg and if moisture content is 25 w-% energy density is 3,83 kWh/kg.