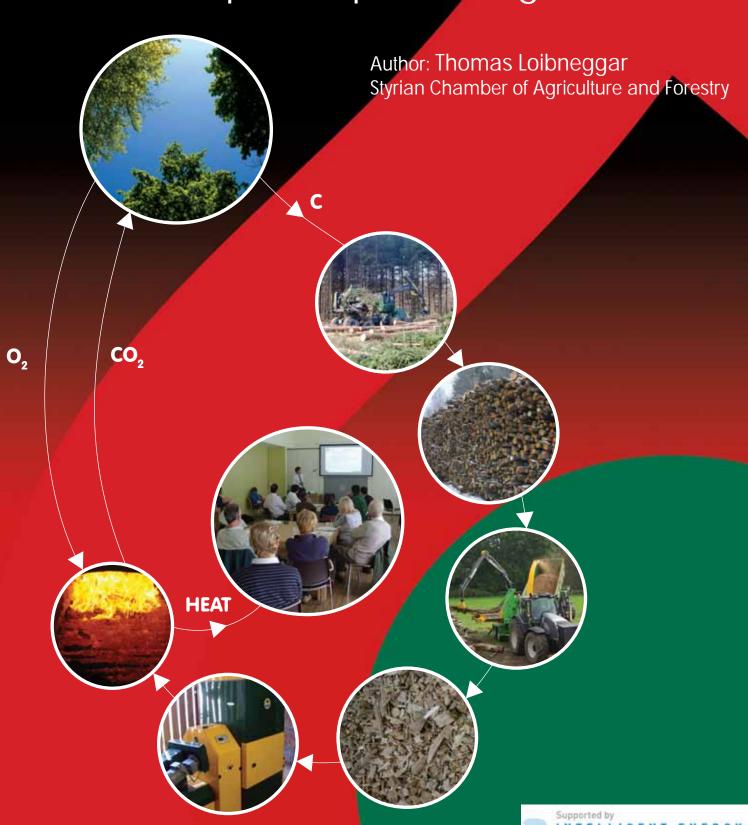


www.woodheatsolutions.eu

# Roadmap for Implementing Standards



# With the support of

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#### Wood – The Return of a Forgotten Energy Source

For thousands of years, wood has been the most obvious source of energy on earth. However, for some time it has been pushed further and further aside by fossil fuels such as coal, gas and heating oil. In these times of rising natural gas and oil prices, wood as a fuel source is experiencing a comeback and is once again the focus of increasing public attention. Heating with wood has become respectable again. The prices for wood fuels are relatively stable and largely independent of the strongly fluctuating world market prices for oil and gas. Thanks to the rapid technical progress in the field of biomass combustion, today's modern biomass heating systems create the same level of comfort for consumers as oil and gas based heating systems. In recent decades, the heating market has developed enormously and today offers a broad range of efficient and environmentally-friendly heating systems. Prejudices against wood heaters, for example that they have a propensity to break down and need considerable effort to keep them going, have been dispelled by today's sophisticated heat generation systems.

The market for firewood is experiencing considerable growth across Europe. However, at the same time, emission limits are being tightened, meaning that the demands placed on fuels are higher than ever. High quality fuels decrease the amount of energy materials and resources consumed, reduce the incidence of system failure and lower the emissions generated by biomass heating systems. Wood fuels are, in contrast to oil and gas, extremely diverse and reflect a wide range of characteristics. To clarify these different characteristics, a new European standard has been developed for solid biofuels. Its objective is to facilitate the national and international fuel trade and to enhance consumer confidence in wood as a fuel.

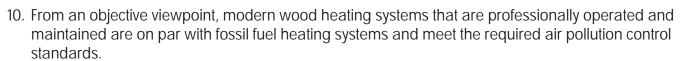
Buying high quality fuels protects both people's budget and the environment. The supply of quality fuels requires relevant know how and an appropriate quality assurance system along the entire production chain. When planning a heating system, fuel quality demands must be taken into account. For example, state of the art split log boilers may only be fuelled with air dried split logs, which means that the fuel must be stored for two years.

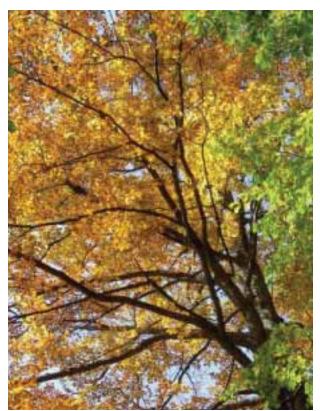
The rapidly increasing demand for wood fuels is presenting producers with the challenge of being able to provide high quality fuel materials. The object of this roadmap is to provide assistance in this respect. It offers useful tips on heating with wood, explains the fundamental wood fuel quality criteria and the steps that must be taken to meet them. Furthermore, there are also valuable tips for consumers about what matters when it comes to fuel wood, in order to ensure that they do not end up buying the proverbial "pig in a poke".



## Ten Arguments for Heating with Wood

- 1. Heating with wood means consuming energy within nature's CO<sub>2</sub> cycle. The carbon dioxide released through combustion is used in combination with the sun's energy to produce new biomass.
- 2. Provided that forests are managed sustainably, wood is a CO<sub>2</sub> neutral source of energy that constantly renews itself.
- From its very origin in the forest, wood is a raw material that is part of an ecosystem which provides us with protection from a number hazards and a multiplicity of environmental benefits.
- 4. The use of wood for fuel claims only those species from the forest that would not be put to any other use. The amount of wood being used for energy purposes today could be significantly increased, provided the appropriate framework conditions exist, without putting the sustainability of forestry at risk
- 5. The harvesting and preparation of wood is simple and does not consume large quantities of energy.
- 6. Transport routes are short and do not endanger the environment.
- 7. The storage of wood for fuel is unproblematic.
- 8. The processing and use of wood fuel contributes to the creation of added value for the region and thus secures jobs.
- 9. Using wood for energy purposes improves the consumers' understanding of and relationship to their local natural environment.





# **Wood as an Energy Source**

**Wood** a CO<sub>2</sub> neutral energy source

Over millions of years, carbon has been extracted from the cycle of nature in the form of crude oil, natural gas and coal. Since the onset of industrialisation, burning fossil fuels has contributed to the carbon that had been locked away over millions of years being rapidly released back into nature in the form of the greenhouse gas carbon dioxide ( $\rm CO_2$ ).  $\rm CO_2$  provides a protective shield that is important for life on earth, as it prevents the energy from the sun that reaches the earth's surface from being lost into outer space through heat radiation. Without this, the average temperature on earth would be -18 °C, and life here would be unthinkable. The increase in greenhouse gases brought about by mankind as a result of burning fossil fuels has resulted in a detrimental amplification of this effect, known as global warming. One litre of heating oil releases 2.7 kg of climate heating carbon dioxide ( $\rm CO_2$ ), thus adding to the strain on the environment. In contrast, wood is a  $\rm CO_2$  neutral energy source, as, when burned, it only releases as much  $\rm CO_2$  as it absorbed when growing. By sustainably managing our forests, we are able to create a cycle that does not result in any additional  $\rm CO_2$  being released. Over the course of its life, a 100 year old spruce absorbs up to 1.8 tonnes of carbon dioxide; in other words, a 100 year old spruce stores the same amount of  $\rm CO_2$  as is released by burning 660 litres of heating oil.



# **Clarification of terminology**

In many cases, fuel wood is a by-product of timber production. Some types of fuel wood are produced by the forestry sector, e.g. forest wood chips and split logs, while other wood fuels are produced in the wood working and processing industries, such as industrial wood chips, off cuts and splinters, sawdust and wood shavings or wood pellets and briquettes. The usual units of measurement in the forestry and timber industries are solid cubic metres (sm³) for logs and stacked cubic metres (stm³) for stacked wood up to 2 metres long. For small, loose pieces of wood (e.g. wood chips) the term bulk cubic metres (bm³) is used.

1 solid cubic metre (sm³) is the unit of measurement for a cubic metre of solid wood without air gaps.

1 stacked cubic metre (stm³) is the unit of measurement for stacked wood that attains a total volume of one cubic metre including air gaps.

**1 bulk cubic metre (bm³)** is the unit of measurement for small pieces of loose wood (e.g. wood chips, sawdust, wood pieces) that attain a total volume of one cubic metre including air gaps.

**1 oven dry ton (odt)** of completely dry wood is the unit of measurement for the (arithmetically calculated) mass where the water content is 0%.

The final stage of natural drying is the "air dried" stage. Here, the water content is between 15% and 20%.

In practice, the terms "water content" and "wood humidity" are often confused or even equated with one another. However, this is inaccurate. Quick measuring devices for determining the water content of fuel often measure the wood humidity.

The **water content (w)** of wood is the amount of water in percentage terms relative to the total weight (conventionally, this is known as the wet weight).

**The wood humidity (u)** is the amount of water in percentage terms relative to the moisture free weight (completely dry matter – pure wood weight excluding water).

| Measure     | Water content (Wet basis) |  | Wood humidity (Dry basis) |       |
|-------------|---------------------------|--|---------------------------|-------|
| Diagram     | 100 kg 80 kg 20 kg        |  | 100 kg 80 kg 30 kg        |       |
| Calculation | (20/100) X 100 = 20% W    |  | (20/80) X 100 = 25        | 5 % U |

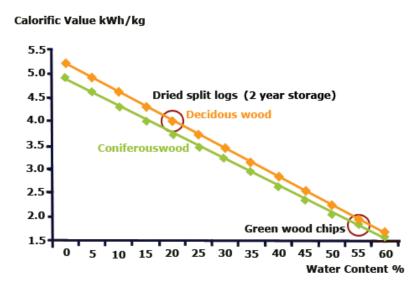
## Conversion factors for common types of fuel wood

The conversions shown in the table below are reference values which may vary depending on the stacking, particle size and compaction during transport.

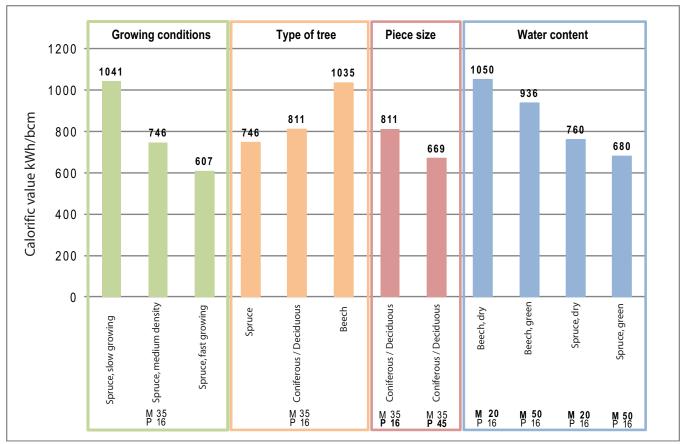
| Cubic metre ratios                     |                                     |                                     |
|----------------------------------------|-------------------------------------|-------------------------------------|
| Solid Wood in solid cubic metres (sm³) | Logs in stacked cubic metres (stm³) | Woodchip in bulk cubic metres (bm³) |
| 1 sm³                                  | 1.4 stm <sup>3</sup>                | 2.5 bm <sup>3</sup>                 |
| 0.7 sm <sup>3</sup>                    | 1 stm <sup>3</sup>                  | 1.8 bm³                             |
| 0.4 sm <sup>3</sup>                    | 0.6 stm <sup>3</sup>                | 1 bm³                               |

# **Energy value of wood**

Not all wood is equal when it comes to energy content. Critical factors for a high energy yield are primarily the water content followed by the type of wood and the size of the pieces of wood used. For traditional use in detached houses and apartment blocks, fuel wood may not contain more than 25% water. Otherwise, the water contained in the wood does precisely what it always does when it comes into contact with fire: it quenches it. The fire does not actually go out, but the temperatures fall below the optimum range, which leads to increasing amounts of smoke, higher emissions and damage to the chimney. If wood that is too wet is burned, the energy yield (calorific value) drops dramatically. The calorific value of wood that is stored until it is dry is approximately twice that of green wood, as part of the energy that is released through vaporisation of the water contained in the wood is lost (0.68 kWh per kilogram of water). The water that it contains escapes as steam from the system without being used for heating along with the hot flue gas, i.e. it does not contribute anything to the generation of heat.



Calorific value relative to water content



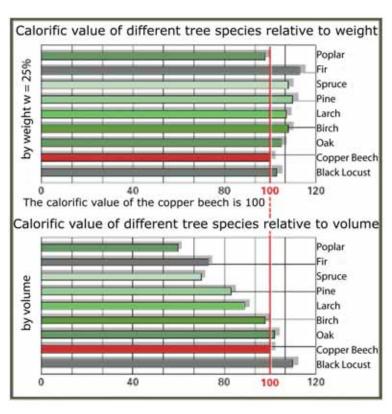
Energy content of wood chips subject to location, tree type, piece size and water content

#### Note:

"M" designations relate to the moisture content of the wood e.g. M35 = 35% MC

"P" designations relate to the woodchip size

# Types of wood



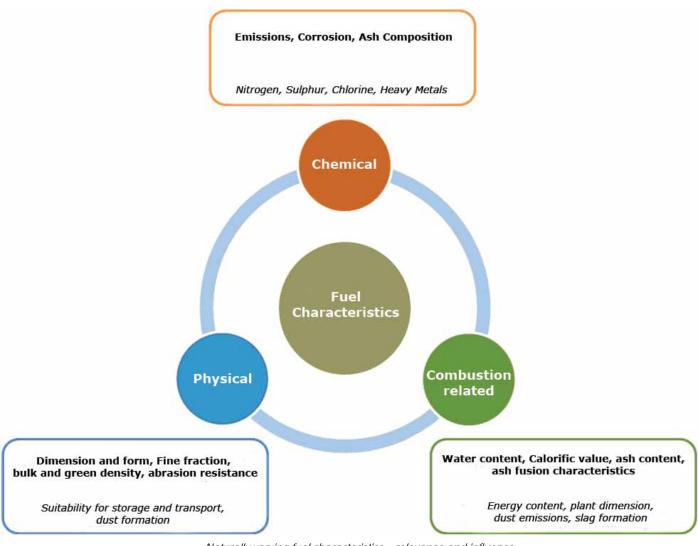
Relative to its weight, every type of wood with the same water content has an almost comparable calorific value. Due to its greater proportion of lignin, coniferous wood has a slightly higher calorific value per kilogram than deciduous wood. Completely dry wood has a calorific value of 5 kWh per kilogram. Put simply, the differences by volume in calorific values between deciduous wood and coniferous wood arise as a consequence of the fact that coniferous wood types contain more air in their cells. The greater air content makes hardly any contribution to the weight, but instead increases the volume of the pieces of wood. For this reason, 1 stacked cubic metre of beech (hardwood), for example, has a calorific value around 40% greater than 1 stacked cubic metre of spruce (softwood). This is why softwood is cheaper than hardwood: more wood is needed to obtain the same amount of heat. As far as the production of wood pellets is concerned, the type of wood used is not

#### Note:

- The term water content denotes the proportion of water contained in a fuel.
- The calorific value (kWh/kg) denotes the maximum usable heat quantity released during total combustion of a certain quantity of fuel.

#### **European Standard for Solid Biofuels**

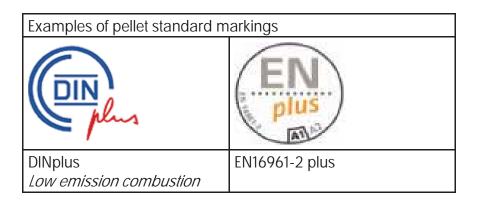
Wood fuels are inherently disparate in terms of composition, subject to the type of wood and prevailing growth conditions, and can never achieve a level of homogeneity comparable with oil or gas. Characteristics such as water content, ash content, calorific value and the quantity of certain elements (e.g. chlorine, nitrogen and sulphur) play an important role in the quality of the fuel, which is ultimately responsible for biomass incineration plants operating efficiently and with low emissions. In addition to the high-quality fuel wood products such as round wood and forest residues, branch and crown wood, landscaping residues, industrial and used wood may also be used as fuel. Chemical residues from previous production processes and impurities such as stones, soil and metals also have an influence on the quality.



Naturally varying fuel characteristics – relevance and influence

To enable different wood fuels to be categorised based on their quality characteristics, various national fuel standards have been developed in recent years. Standards make it possible to describe a fuel more accurately and are useful to both producers and consumers as a means of navigating the fuel market. Until recently, there were only individual national standards for certain types of fuel products such as pellets, wood chips and wood briguettes.

The quality of wood chips in Europe, for example, is generally expressed in accordance with the categories and specifications of the Austrian ÖNORM M 7133. Here, the most important parameters are requirements regarding the size of the wood chips, their water content, bulk density and ash content. For pellets there are the Austrian ÖNORM M 7135, the German DIN 51731 and the Italian and French quality marks "PelletGold" and "ITEBE".



With a view to encouraging the establishment of a biofuels market and to dismantling trade barriers between member states, a fuel standard has been developed that is applicable across Europe. Taking the existing national standards into account, the Technical Committee CEN/TC 335 "Solid Biofuels" at the European Committee for Standardisation (CEN) has compiled the EN 14961 "Solid Biofuels – Fuel Specifications and Classes" series of standards. For the first time, this series of standards offers a uniform, Europe-wide tool for the standardisation of every biomass fuel that may be used for energy generation purposes. The standard relates to solid biofuels originating from the following sources: agricultural and forestry products, plant wastes from the agriculture and forestry sectors and the food and animal feed industries, as well as wood and cork wastes. As far as heat generation is concerned, the most significant group is still ligneous biomass, which is why separate product standards are dedicated to the classification and specification of marketable wood fuels. The EN 14961 series of standards is subdivided into a general part (Part 1) and five short and easy-to-understand product standards specifically for the domestic consumer, and is also supported by a series of further EN standards. These govern the taking and processing of samples, testing and analysis procedures and the quality assurance of biofuels (e.g. testing the ash content of wood chips in accordance with EN 14775).

EN 14961-1: General requirements

EN 14961-2: Wood pellets for non-industrial use

EN 14961-3: Wood briquettes for non-industrial use

EN 14961-4: Wood chips for non-industrial use

EN 14961-5: Firewood for non-industrial use

EN 14961-6: Non-woody pellets for non-industrial use

Part 1 of the standard came into force in January 2010. Parts 2 to 6 are currently draft standards and will be converted into one standard in the near future. The national standards will be absorbed into the new European standards when they come into effect. With the introduction of EN 14961-5 a standard for split logs will be introduced for the first time.



Various basic raw materials for fuel wood production



Checking the quality of wood chips

# The importance of the EN 14961 standard

While at present woody biomass is still not used in many European countries, it is a limited resource, which in future with increasing demand will become ever more important and valuable. The European standard for solid biofuels serves as an important means of opening up the domestic and international fuel trade market. In addition to a sufficiently large number of participants in the market, clear information on the attributes and quality characteristics of wood fuels are necessary for the biofuels market to develop. After all, it isn't necessary to have to think about the quality of the fossil fuels that we buy. We simply buy heating oil or gas, for example. The objective of the European fuel standard is to strengthen trust in wood as a fuel and to facilitate trade between consumers and producers.

The standard will also improve the operating environment of boiler manufacturers, as they will be able to link their biomass boiler guarantees (product liability claims) to the use of standardised biomass fuels. Using poor-quality fuel is currently the most common cause of system faults. Furthermore, with a prescribed quality of fuel, it will be possible for biomass furnaces to comply more easily with statutory emission limits.

#### **Quality Management**

For a biomass furnace to work efficiently and in an environmentally friendly manner, it must incorporate the latest technology and be operated correctly, which depends on the choice of fuel, the day to day conditions, the settings and regular system maintenance. The quality of the fuel must meet the boiler requirements. Household furnaces place correspondingly higher demands on the fuel than industrial boilers for local and district heating plants. Fuel that does not meet the required standards and improper use of biomass systems leads not only to increased emissions, but also to significantly higher fuel consumption.

The introduction of a comprehensive quality management system makes it transparent and understandable for every party involved (i.e. forest owners, producers, consumers, heating system manufacturers) which quality criteria/requirements apply at which point within the supply chain. Quality must be assured throughout the entire value creation chain, from the supply of raw materials to the provision of energy services. Quality management is a continuous process which requires constant development (e.g. chipping, processing and logistics procedures, combustion technologies and consumer information). The quality of the biofuels must be monitored by a certified, independent body.



Quality assurance of wood fuels along the entire value creation chain

# An active quality management system for fulfilling quality standards ensures:

- the low cost production of high quality fuels,
- plants and systems that can be operated without problems in the same way as fossil fuel technologies (e.g. gas/oil),
- the reduction of harmful emissions (e.g. dust pollution) to a minimum, and
- the gaining of consumer trust in this environmentally friendly fuel.



Active quality management requires the participation of all parties involved in the production of fuel

| Consumer group (boiler output)                      | Fuel category | Quality requirements                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Small household furnaces  Split logs and wood chips | Quality fuels | <ul> <li>very homogeneous fuel (dimensions and shape, water content)</li> <li>wood types: full trees, round wood, forest residues</li> <li>foreign bodies excluded, air-dried and consistent level of dryness</li> <li>low proportion of fine fraction, low ash content</li> <li>wood chip standard: prEN 14961-4 (class A1)</li> <li>split log standard: prEN 14961-5 (class A1/A2)</li> </ul> |

| Consumer group (boiler output)                                                                                     | Fuel category  | Quality requirements                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------------------------------------------------------------------------------------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Commercial and communal local heating plants  Wood chips                                                           | Medium quality | <ul> <li>predominantly homogeneous fuel, fuel characteristics such as water content and dimensions do not exceed a set range,</li> <li>wood types: full trees, round wood, forest residues, short rotation wood, branch wood,</li> <li>almost uniform condition</li> <li>low level of impurities possible (e.g. soil, sand)</li> <li>increased proportion of fine fraction possible</li> <li>storable wood chips, variable level of dryness</li> <li>wood chip standard: prEN 14961-4 (class A2/B1):</li> </ul>                                                                                                                                          |
| Industrial furnaces for commercial purposes and district heating plants/combined heat and power plants  Wood chips | Low quality    | <ul> <li>fuel characteristics predominantly dependent upon boiler requirements</li> <li>wood types: forest residues, green waste and prunings, short rotation wood, branch wood, logging debris, industrial residues, used wood</li> <li>high proportion of fine fraction, high ash content</li> <li>very disparate fuel</li> <li>high level of impurities (e.g. soil, sand, stones)</li> <li>damp and green wood chips with variable levels of dryness</li> <li>often mixtures from different sources</li> <li>wood chip standard: prEN 14961-4 (class B2) or special definition of wood chips in accordance with the criteria of EN 14961-1</li> </ul> |

# Checklist for the implementation of quality standards

#### Phase 1: Supply of fuel wood

#### 1. Are the fuel wood types used suitable for the production of quality wood chips?

- Round wood? (e.g. thinning)
- Branch and crown material?
- Green waste and prunings?
- Proportion of lumber and industrial wood?
- Used wood? (e.g. from recycling of materials)

#### 2. Has the proportion of impurities been reduced to a minimum?

- Sand and soil?
- Stones?
- Metal and other impurities?

#### 3. Are the conditions of use adapted to the location?

 Withdrawal of nutrients through the removal of the branch and crown material? (e.g. soil biodiversity)

#### 4. Has the harvesting time been correctly selected?

- Time for natural drying? (e.g. March to June: optimum drying period)
- Is there any risk to forest protection from the planned utilisation? (e.g. bark beetle)

# Phase 2: Fuel wood processing (wood chips, split logs)

#### 5. Has the right kind of cutting and shredding machinery been selected?

- Shredder, drum chipper, disc chipper, cutter splitter?
- Screen size?

#### 6. Are the cutting and shredding machinery maintenance intervals adhered to?

Sharp blades?

#### 7. Is the machine suited to the type of fuel wood to be processed?

- Splitting wedge settings?
- Splitting wheel diameter?
- Number and position of blades?
- Inlet size?

# Phase 3: Fuel wood and fuel logistics (storage and transport)

#### 8. Do the storage conditions meet the necessary quality requirements?

- Short storage periods? (as short as possible, as long as necessary)
- Sunny and wind-exposed storage area?
- Firm, clean storage area base?
- Cover necessary? (e.g. snow, rain)

#### 9. Have transport routes been optimised?

Optimised logistics chain (high bulk density of wood fuels, depletion)?

#### 10. Is it necessary to dry the fuel?

- Natural drying? (e.g. sunny and wind-exposed locations, indoor storage)
- Artificial drying? (e.g. waste heat from biogas plant, drum dryer)

#### 11. Has the right kind of transport system been selected?

- Pusher truck? (e.g. dust pollution)
- Blower truck? (e.g. increased proportion of fine fraction through blowing)

#### 12. Has the customer been adequately informed about the proper way to store fuel?

• Fuel storage space? (e.g. dry storeroom, short storage time in cellar)

#### 13. Is it possible to adequately check the quality of the fuel purchased?

- Weighbridge? (e.g. measurement of weight and water content)
- Humidity meter? (e.g. drying cupboard, mobile humidity meter)
- Certification? (e.g. independent testing body)
- Quality assurance measures? (e.g. implementation of EN 14961)

#### Phase 4: Fuel wood utilisation (fuel use)

#### 15. Are the fuels suitable for the boiler?

- Water content, proportion of fine fraction, fuel wood types, granularity, piece size and shape, ash content?
- Suitable infeed system?

#### 16. Is the boiler the right size?

- · Suitable for the sale of heat?
- Optimisation of the pipe systems?

#### 17. Are the boiler maintenance intervals adhered to?

- Combustion settings? (e.g. air inlet, residual oxygen)
- Adherence to maintenance intervals?
- Qualified operating personnel?
- Service contract with boiler supplier?

#### 18. Has the question of ash disposal been dealt with?

- Ash quality and quantity? (e.g. dependent on the choice of fuel)
- Ash use? (e.g. use as soil improver in fields, ash disposal)

#### 19. Has the user been properly informed about the way the heating system works?

- Settings? (e.g. heat transfer station, boiler, heating elements, valves, pumps)
- User training? (e.g. qualified advice)

## **Wood chips**

For fuel wood that has been reduced by machine to pieces that are just a few centimetres in size, the term wood chips or wood scraps is used. The weak and poor quality wood types such as the crown and branch material are primarily used to make wood chips. Wood chips that are produced as a by product in lumber mills are known as industrial wood chips. These small pieces of wood are burned in fully automated incinerators



and offer the same comfort and convenience as their fossil fuel competitors, gas and oil. A disadvantage is their low energy density. Stored loose in bulk, they need twice as much room as split logs. Wood chip heating systems are ideally used by consumers with an average annual heating oil use of 4,000 litres. Typical areas of use for wood chip plants are agricultural and wood processing businesses, industrial units, apartment blocks, public buildings and micro and local heating plants. A not insignificant quantity of forest and industrial wood chips is currently used in heat and power plants for generating electricity and heat.

| Comparative storage space requirements |                        |                       |                  |  |  |  |
|----------------------------------------|------------------------|-----------------------|------------------|--|--|--|
| 2000 litres Oil                        | Split logs             | Wood chips            | Pellets          |  |  |  |
|                                        |                        |                       |                  |  |  |  |
| 2-3 m <sup>3</sup>                     | 12 m³                  | 24 m³                 | 6 m <sup>3</sup> |  |  |  |
| Sı                                     | pace required for 20,0 | 00kWh of stored energ | Эу               |  |  |  |



Wood chip production

#### Weight and calorific value relative to volume and water content

| Water                     | er Volume weight in kg/bulk m³ |     |      | Calorific value in kWh/bulk m <sup>3</sup> |       |      |      |        |
|---------------------------|--------------------------------|-----|------|--------------------------------------------|-------|------|------|--------|
| content<br>(wet<br>basis) | Beech                          | Oak | Pine | Spruce                                     | Beech | Oak  | Pine | Spruce |
| 20%                       | 277                            | 280 | 216  | 188                                        | 1048  | 1062 | 867  | 759    |
| 30%                       | 316                            | 320 | 246  | 216                                        | 1022  | 1034 | 846  | 740    |
| 40%                       | 369                            | 374 | 287  | 251                                        | 986   | 998  | 818  | 716    |
| 50%                       | 443                            | 449 | 345  | 302                                        | 936   | 948  | 780  | 682    |

<sup>1</sup> bulk m<sup>3</sup> of spruce wood chips (water content 30%) has the calorific value of 74 litres of heating oil, while beech, at 102 litres, has a considerably higher calorific value.

#### Average values for quantity calculations

|                          | Type of wood | Water<br>content (wet<br>basis) (%) | Volume:<br>bulk m <sup>3</sup> | Weight:<br>tonnes | Weight in<br>oven dry<br>tonnes (odt) | Energy Value<br>in Kilowat hrs<br>(kWh) |
|--------------------------|--------------|-------------------------------------|--------------------------------|-------------------|---------------------------------------|-----------------------------------------|
| 1 bulk m <sup>3</sup> of | Spruce       | 15                                  | 1.0                            | 0.20              | 0.17                                  | 876                                     |
| woodchips                |              | 30                                  | 1.0                            | 0.25              | 0.17                                  | 847                                     |
|                          |              | 45                                  | 1.0                            | 0.31              | 0.17                                  | 819                                     |
|                          | Beech        | 15                                  | 1.0                            | 0.32              | 0.27                                  | 1298                                    |
|                          |              | 30                                  | 1.0                            | 0.39              | 0.27                                  | 1252                                    |
|                          |              | 45                                  | 1.0                            | 0.49              | 0.27                                  | 1180                                    |
| 1 tonne                  | Spruce       | 15                                  | 5.0                            | 1.00              | 0.85                                  | 4380                                    |
| woodchips                |              | 30                                  | 4.0                            | 1.00              | 0.68                                  | 3388                                    |
|                          |              | 45                                  | 3.2                            | 1.00              | 0.55                                  | 2621                                    |
|                          | Beech        | 15                                  | 3.1                            | 1.00              | 0.85                                  | 4024                                    |
|                          |              | 30                                  | 2.6                            | 1.00              | 0.69                                  | 3255                                    |
|                          |              | 45                                  | 2.1                            | 1.00              | 0.55                                  | 2478                                    |

# **Purchasing wood chips**

Wood chips are traded loose in bulk on the fuel market. A bulk cubic metre corresponds, depending on the type of wood, size and water content, to a weight of between 250 and 450 kg. The heat content per bulk cubic meter varies between 630 and 1,100 kWh. Wood chips are mainly supplied loose by regional suppliers. Of late, it has also been possible for wood chips, like wood pellets, to be easily blown into storage. Due to the mixture of different types of wood, the size of the wood chips and the consolidation of loose material during transport, invoicing in bulk cubic metres is relatively imprecise. Single variety batches of wood chips are very rare. For this reason, wood chips should be bought by weight and water content. The exact delivered weight is easily established by weighing on a weighbridge, and the water content can be quickly determined using readily available meters.

# **Quality requirements**

In contrast to split logs, which are almost exclusively used in an air dried condition in small stoves and boilers

up to 60 kW, forest wood chips generally supply larger biomass heating systems. While in large biomass heating plants it is also possible to use "inferior" wood chips for energy production, small and medium sized heating system can only run on dry, high quality wood chips. Rotten, dirty and mouldy wood, as well as demolition wood or shrubbery with thin branches is not suitable as a raw material for high-quality wood chips. These raw materials are processed into low quality wood chips. Larger plants with output in excess of 1 MW are able to cope with damp wood chips containing relatively high proportions of green wood and bark. They can therefore be supplied directly from the forest. In the case of smaller plants, the water content of the wood must be reduced to less than 30%, otherwise the system may become blocked and soot may form. As a consequence, wood for small plants must driedprior to delivery (usually logs are seasoned in the open air and then converted to woodchips for delivery to customers). For a more accurate specification of the fuel, the criteria of size and water content are used.



In the case of larger boilers, the fuel quality is determined by the boiler requirements. Wood chips with a water content of less than 30% can often present a problem

In the case of household furnaces, only quality fuels may be used



# The most important characteristics of wood chips:

#### Water content

The water content is the most important quality criterion in wood chips, as it is decisive for the energy content and storability of the fuel. The higher the water content, the greater the risk of the wood chips being infested with mould. Green wood chips have a water content of over 50% and are therefore not suitable for longer term storage or for burning in small and medium sized biomass heating systems. However, in larger district heating plants and industrial furnaces, for economic reasons, the use of very wet wood chips is both expedient and common. Low emissions and efficient burning are ensured by these plants' technical facilities (e.g. flue gas treatment and flue gas condensation). Indirectly the water content also determines the logistical costs associated with raw material procurement

| Woodchip                                   | Water content (wet basis) |
|--------------------------------------------|---------------------------|
| Air dried woodchips                        | M < 20%                   |
| Woodchips suitable for storage             | 20% < M < 30%             |
| Woodchips, limited suitability for storage | 30% < M < 35 %            |
|                                            |                           |
| Damp woodchips                             | 35 % < M < 40 %           |
| Green woodchips                            | 40 % < M < 50%            |

| Oil                                        | Woodchips                                        |
|--------------------------------------------|--------------------------------------------------|
|                                            |                                                  |
| 1000 litre                                 | 10-15 bulk m <sup>3</sup>                        |
| 1000 litre of heating oil corresponds to a | pproximately 10-15 bulk m <sup>3</sup> woodchips |

# **Dimensions and shape**

The dimensions and shape of the wood chips, the amount of fine fraction and proportion of oversized pieces are of great importance, due to the risk of blocking the storage infeed and outfeed systems. Wood chips are available in different sizes on the market. A distinction is made between fine wood chips (CEN P16), which are especially suitable for small systems, medium sized wood chips (CEN P45), which correspond to the industrial wood chips from lumber mills and are mainly used in larger plants, and coarse wood chips (CEN P63-100), which are used in large and industrial plants.

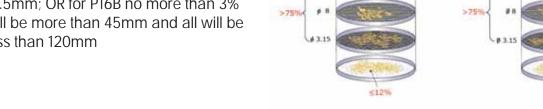


Sharp blades are a must for the production of sharp-edged quality wood chips

Under the CEN standards wood chips are specified in terms of the range of sizes of 75% of the volume of woodchips in a sample, measured using simple calibrated sieves.

For instance a common specification is likely to be P16 and this will comprise:

- 75% of the total volume of woodchips being between 3.15mm and 16mm;
- Less than 12% of the total volume of woodchips will be less than 3.15mm in size; and
- For P16A no more than 3% will be more than 16mm and all will be less than 31.5mm; OR for P16B no more than 3% will be more than 45mm and all will be less than 120mm



**Similarly** P31.5 woodchips will have:

- 75% between 8mm and 31.5mm
- Less than 8% smaller than 3.15mm
- Less than 6% more than 45mm and
- none greater than 120mm

#### **AND** P45A woodchips will have:

Proposed distribution of

Woodchip size for

< 31.5 mm

P16A

- 75% between 8mm and 45mm
- Less than 8% smaller than 3.15mm

Proposed distribution of

Woodchip size for

all < 120 mm

P16B

- Less than 6% more than 63mm
- Less than 3.5% more than 100mm and
- none greater than 120mm.

# **Bulk density**

The bulk density determines the energy density and enables conclusions to be drawn about the necessary storage capacity and the amount of space needed during transport, which ultimately determines the handling costs. Due to the differing green densities of the wood from different types of tree, the energy content per unit of volume may vary significantly (in spite of the fact that the energy content per kilogram of wood is comparable) and therefore the amount of space needed for the transport or storage of a certain energy quantity may vary as well. This in turn has an impact on the amount of wood that needs to be conveyed into the combustion chamber per unit of time and that has to be burned in the combustion chamber in order to achieve the same heat output. While oak and beech wood chips (with a water content of 20%) have a calorific value of around 1,100 kWh per bulk cubic metre, poplar wood chips have a significantly lower value of approx. 680 kWh per bulk cubic metre. Correspondingly, in order to meet the annual 44 MWh requirement of an apartment block, either 40 bulk cubic metres of oak or beech wood chips, or 65 bulk cubic metres of poplar wood chips must be supplied.

#### Ash content

The ash content can be used to determine the proportion of adherent materials (soil, dust, etc.) and the proportion of bark (the higher the bark content, the higher the ash content). The ash content of coniferous wood without bark is, like that of the wood pellets made from the same material, less than 0.5%. On average, wood chips made from deciduous and coniferous wood with bark have an ash content of less than 1%, depending on the bark content. However, values of up to 3% may be recorded. In the case of willow and poplar wood chips from agricultural short rotation coppices the ash content increases to almost 2%, as a consequence of the comparatively high bark content. The largest fluctuations in ash content, at approx. 2.5 to 10%, are found in wood chips made from landscaping residues. On average, an ash content of 5% is to be anticipated here. A higher ash content results in higher disposal and recycling costs for the ash. In extreme cases, boiler malfunctions may be caused when the ash fuses.

## **Impurities**

When producing quality wood chips, the proportion of foreign matter must be very low and no large sized contaminants such as soil, sand and stones or other foreign bodies and combustible impurities are permitted.



Stones in wood chips

# Standardisation of wood chips in accordance with prEN 14961-4

EN 14961-4 sets out specifications and classes for the non-industrial use of wood chips, according to their origin and type. Wood chips are differentiated into classes A1, A2, B1 and B2. Class A includes wood from full trees (excluding short rotation plantation wood), round wood, forest residues and chemically untreated wood residues. Class B1 also includes wood from landscaping and short rotation wood and class B2 includes industrial residues and used wood. EN 14961-4 provides normative specifications on particle size and particle size distribution, water content, ash content, calorific value and bulk density as well as the amounts of certain elements such as, nitrogen, sulphur and chlorine as well as various heavy metals. A pre standard of EN 14961-4 is expected to be published in February 2011.

To a certain extent, trade in wood chips in Europe is partially based on the ÖNORM M 7133 standard, but often takes place without reference to any standard at all and without a clear description of the characteristics that determine quality and value. The observance and application of wood chip standards on a broad scale will make a significant contribution to the development of a functioning wood chip fuel market in Europe.

# Summary of CEN terminology for describing woodchips:

The following key information should be provided:

#### 1. Origin:

The origin works on a hierarchical basis based on four main groups:

- 1. Woody biomass
- 2. Herbaceous biomass
- Fruit biomass
- 4. Blends and mixtures.

Each of these groups is then further divided into 2 to 4 sub-groups, and each of these is further divided and divided again down to four levels of detail. For example:

| 1. Woody | 1.1 Forest, plantation | 1.1.1 Whole trees                                                                  | 1.1.1.1 Broadleaf              |
|----------|------------------------|------------------------------------------------------------------------------------|--------------------------------|
| Biomass  | wood                   | without roots                                                                      | 1.1.1.2 Conifer                |
|          |                        |                                                                                    | 1.1.1.3 Short Rotation Coppice |
|          |                        |                                                                                    | 1.1.1.4 Bushes                 |
|          |                        |                                                                                    | 1.1.1.5 Blends and mixture     |
|          |                        | 1.1.3 Stemwood                                                                     | 1.1.3.1 Broadleaf              |
|          |                        |                                                                                    | 1.1.3.2 Conifer                |
|          |                        |                                                                                    | 1.1.3.3 Blends and mixtures    |
|          |                        | 1.1.7 Segregated wood from gardens, parks, roadside maintenance and fruit orchards |                                |

Refer to BS EN 14961-1:2010 for full details

There is no requirement to give a more detailed description of origin than you want, however certain classes of fuel will require biomass from one of a limited number of categories of origin.

#### 2. Particle size:

For instance P16A, P16B, P31.5 or P45 as outlined on page 18.

#### 3. Moisture content:

Specified in terms of the maximum moisture content (by proportion of overall weight)
Hence an M35 woodchip would have an average of no more that 35% water and an M25 woodchip would have an average of no more than 25% water,

#### 4. Ash content:

Specified in terms of a proportion of the dry weight of the wood.

Hence an A0.7 woodchip would produce no more than 0.7% of its' dry weight as ash if burnt efficiently and an A1.5 woodchip would produce no more than 1.5% of its' dry weight as ash.

The following information may be appreciated:

Net calorific value as received 'Q' in kWh/kg

Bulk Density as received 'BD' in kg/loose m3

The amount of Nitrogen, Sulphur or Chlorine in terms of % of dry weight So for example

**N 1.0** describes a nitrogen content of less than or equal to 1.0% of the dry weight of the woodchips **S 0.1** describes a sulphur content of less than or equal to 0.1% of the dry weight of the woodchips **CI 0.05** describes a chlorine content of less than or equal to 0.05% of the dry weight of the woodchips Quantities of other chemicals such as Arsenic (Ar), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni) and Zinc (Zn) can also be provided in terms of mg/kg dry

# Tips for the proper storage of quality wood chips

Storing wood chips presents three fundamental risks:

- 1. the growth of mould, which poses a health hazard;
- 2. losses in mass through decomposition; and
- 3. spontaneous combustion of the wood chips.



The causes for this are mainly that the wood chips are stored in an overly wet condition or the drying process happens too slowly. For the production of quality wood chips, it is important to ensure that the fuel wood that is chipped is as dry as possible and the chipper is in a good condition, so that sharp edged chips are produced that fall loosely and form ventilated cavities. Wood chips are best dried naturally by the effects of sun and wind. Technical drying is, in most cases, a difficult process from an economic viewpoint and is generally only worthwhile if cheap waste heat from energy generation or process heat (e.g. from a biogas plant) is available.

- Store round wood that is intended for chipping for at least one summer in a well-ventilated, sunny location (natural drying)
- Wood for chipping that is stored over the summer should have a water content of 25% to 30% at the time of chipping in late summer
- Plan storage locations in sunny spots that are exposed to the wind
- Store pre-dry wood in unchipped form wherever possible
- If the summer months are especially rainy, covering the wood is recommended
- Avoid storing wood chips with a high green waste content (mould and fungal infestation)
- Keep the storage duration of the wood chips as short as possible (natural decomposition process)
- Cold air drying, cold ventilation and storage in well ventilated, covered warehouses have all been proven to work well in practice
- Keep the proportion of fine fraction as low as possible (means better ventilation)
- Ensure that the wood chips are stored in an orderly fashion and stipulate the order by which the different batches must be used ("first in, first out" principle)
- When storing the fuel, take care to avoid compaction (heavy machinery)
- Never store wet fuel in storage rooms



#### **Good quality wood chips**

Homogeneous wood chip size, average calorific value of 1,000 kWh/bulk m<sup>3</sup>

#### High calorific value through appropriate drying

Outcome: lower fuel requirement, greater system efficiency, efficient operation, good controllability of biomass heating system, cleaner combustion

#### Equal dimensions and shape and low proportion of fine fraction

Outcome: low cleaning costs for heating system, optimum transportability (no blockages in the fuel feed), high storage stability

#### Poor quality wood chips

Increased proportion of fine fraction and impurities, average calorific value of 600 kWh/bulk m<sup>3</sup>

#### Low calorific value through increased water content

Result: high fuel requirement, higher fuel costs

#### High proportion of fine fraction with large quantities of green materials

Result: high ash content, higher manual cleaning costs, higher maintenance costs, lower system life expectancy



Wood chip production



Correct storage of logs



Correct storage of quality wood chips in covered storage buildings

#### **Split logs**



Split logs are the traditional form of fuel wood. The sawn and split residual wood pieces are mainly the result of forest management activities. The vast majority of split logs are supplied by small agricultural and forestry businesses. In the case of split logs, a distinction is made between deciduous wood and coniferous wood on the one hand and the size of the logs on the other hand. Chopped, stove ready fuel wood, which is suitable for immediate use, is also known as firewood. Rising expectations of comfort and convenience in the household sector are driving the labour intensive

firewood heaters out of cellars, where they are increasingly being replaced by modern, fully automatic wood chip and pellet boilers. Nevertheless, as a result of the current trend for wood burning tiled stoves, the demand for firewood is experiencing a boom. For tiled stove heating, the primary woods used are beech, maple, oak, ash and birch. Beech wood produces strong embers and as a consequence emits an even, long lasting heat. In addition to the attractive flames, it burns almost without sparks and is therefore ideally suited to all types of tiled stoves, and especially for those with a viewing window.

# Purchasing split logs

Split logs are usually purchased in stacked cubic metres. However, one must always bear in mind that the individual logs do not lie flush against one another, which means that in fact what is actually supplied is 70% wood and 30% air. In addition to the care taken in stacking, the amount of wood in a stacked cubic metre depends on the shape of the wood and the quality of delimbing, plus the diameter and length of the split wood pieces. Recently split logs have more frequently been marketed in bulk (loose or by weight), as highly mechanised fuel wood machines are increasingly being used in production. In just a single step, the smallwood is processed into stove ready pieces. Loose bulk wood contains even more air, which means

that accurately monitoring the quantity is even more difficult. Sale by weight is also possible, but this, too, is associated with uncertainties regarding the water content. Here it is important to buy dry wood, otherwise it is possible to find oneself paying for the water content, and for a poor energy yield into the bargain (low calorific value). Many fuel wood producers supply wet split logs, as this means that they receive a faster financial return. With a little experience, it is possible to identify how dry the split logs are from their weight. The dryer the log, the lighter it is, and the higher the sound if two pieces of wood are banged together.



Single-variety quality split logs for tiled stove heating

# **Quality requirements**

Supplying high quality fuel wood requires appropriate storage facilities. Stove ready prepared fuel wood reaches the necessary air dried condition, depending on the type of wood and the storage conditions, only after one or two years of storage. The fuel wood must be dried in as short a time as possible to achieve the optimum water content for combustion of a maximum of 20%, in order to keep the natural decomposition of the material to a minimum. Basically, every type of wood can be processed into split logs. Only very rotten, dirty or chemically treated wood is not suitable, as it would quickly clog up or cause soot deposits in the heating system and chimney and would generate toxic emissions upon burning.

With the development of the European standard for solid biofuels, a standard for split logs (quality classes A1, A2 and B) has been introduced for the first time. Not only has the demand for split logs grown strongly in recent years, but so have the emissions from incomplete combustion. The new split log standard will enable fuel producers to stand out from the crowd with quality split logs. At the same time they will also be able to realise a higher price on the market. The quality labelling system will enhance the customer's trust in the product and its origin.

#### Five good reasons for drying split logs



475 ml of water needs to be extracted from a regular-sized split log with a 50% initial moisture content before it can be considered to be air-dried (source: http://ibt-kraemer.de)

- 1. Dry wood has a higher calorific value
- 2. No sooting of stove and chimney
- 3. Longer furnace life cycle
- 4. Less smoke and other harmful emissions
- 5. Long storage without mould and decay



Fully-automated split log production at the Waldstein biomass centre



Natural drying of split logs in mesh pallet boxes. Depending on the type of wood and weather conditions, the duration of storage is 1–2 years



Producing quality split logs pays. Wood that is too wet contaminates the heating system and chimney, causes soot deposits and releases toxic emissions

#### Summary of CEN terminology for describing stove ready split logs:

CEN standards describe firewood in terms of:

**Origin:** Woody biomass from specified species (for instance oak, ash); the same 'codes' as outlined for the origin of woodchips are used;

**Length:** Sometimes a narrow range of lengths is specified, for instance **L25** logs would all be between 23 and 27cm, however, more pragmatically the maximum length in cm is provided;

Width: D20 logs would all be between 10 and 20cm wide;

**Moisture content:** so a delivery of **M25** logs would have a moisture content of no more than 25% by weight;

**Volume or weight:** deliveries should specify the volume in stacked or loose m3 OR the weight in kg.

Additionally suppliers can specify:

- the energy density (**E**) in kwh/kg or kWh/m3 loose or stacked;
- the proportion of split volume: No split (i.e. roundwood), split (>85% split) or mixed;
- the cut-off surface: (smooth or uneven ends of logs); and
- the proportion of mould or decay (if >10% it should be stated).

#### Tips for the proper storage of your split logs

- Properly storing and drying fuel wood is fundamental to environmentally conscious and cost efficient heating.
- The wood must be split to ensure that it dries efficiently. The smaller the pieces into which it is split, the larger the surface area, and the faster the drying process.
- Unsplit wood needs up to 2 years to dry to the same extent.
- The wood should preferably be stored in sunny areas exposed to the wind and on a dry base (pallets or logs).
- Maintain a gap of at least 20 cm to the ground so that the fuel wood cannot absorb moisture from the ground.
- Do not store freshly split wood in enclosed spaces (e.g. cellars) and under no circumstances completely wrap it in plastic sheeting, as this prevents it from drying out and causes it to harden.
- Immediately after the summer drying period cover the stack of fuel wood to protect it from the rain.
- Even with wood that is stored dry, the calorific value can fall by up to 3% per annum (natural decomposition processes).
- Wet wood burns with considerably less energy yield, causes higher emissions and leads to aggressive deposits in furnaces and stoves.







Correct storage of split logs – there must be a gap to the natural ground



Providing the customer with information about the proper way to handle fuel wood is crucial. In the wrong hands, even split logs of the highest quality cannot realise their full energy potential

# **Energy Content of split logs**

| Oil                | Softwood                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Hardwood                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                    | TANES TANES TO SERVICE | THE PARTY OF THE P |
| 1000 litres of oil | 8 stacked cubic metres                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 6 stacked cubic metres                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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1000 litres of heating oil corresponds to approx 7-8 stm³ softwood (spruce) or 5-6 stm³ hardwood (beech)

# Energy Content of split logs by species

| Species                                                                | Calorific value in kWh/kg | Calorific value in kWh/stm <sup>3</sup> | 1 stm³ of this species replaces litres of heating oil | 1 stm <sup>3</sup> beech is replaced by |  |
|------------------------------------------------------------------------|---------------------------|-----------------------------------------|-------------------------------------------------------|-----------------------------------------|--|
| Beech                                                                  | 3.8                       | 1900                                    | 190                                                   | 1 stm <sup>3</sup> Beech                |  |
| Oak                                                                    | 3.8                       | 1900                                    | 190                                                   | 1 stm <sup>3</sup> Oak                  |  |
| Birch                                                                  | 4.0                       | 1800                                    | 180                                                   | 1.1 stm <sup>3</sup> Birch              |  |
| Poplar                                                                 | 3.8                       | 1200                                    | 120                                                   | 1.6 stm <sup>3</sup> Poplar             |  |
| Spruce                                                                 | 4.1                       | 1350                                    | 135                                                   | 1.4 stm <sup>3</sup> Spruce             |  |
| Pine                                                                   | 4.0                       | 1500                                    | 150                                                   | 1.2 stm <sup>3</sup> Pine               |  |
| Douglas fir                                                            | 4.0                       | 1500                                    | 150                                                   | 1.2 stm³ Douglas Fir                    |  |
| These typical values apply for woodfuel with a moisture content of 20% |                           |                                         |                                                       |                                         |  |

#### Note:

- The split logs should be examined carefully to ensure they are stacked correctly. Depending on how
  carefully the merchant measures the stack, the customer frequently receives more or less wood
  than he actually ordered. Purchasing fuel wood is always a matter of trust.
- Only use untreated, air dried wood with a water content of maximum of 20% for heating purposes.
   Under the correct storage conditions, this water content will be achieved in both beech and spruce within a year.
- One stacked cubic metre of wood can replace up to 200 litres of heating oil and just a single split log of a metre in length can provide as much heat as 4 litres of oil.
- An average well insulated detached home requires around 15 stacked cubic metres of split logs per year.

#### **Wood Chip and Fuel Wood Supply Contracts and Accounting Modalities**

Norms and standards are used for drawing up wood chip and fuel wood supply contracts. The supplier guarantees to the customer in writing that the products supplied will correspond to the agreed quality criteria. If there is a suspicion that the fuel quality is inadequate, the customer may have the delivery tested by an independent body using the designated standard testing procedures. Supply contracts provide all parties concerned with planning reliability and help to prevent subsequent conflicts. The constituent parts of the fuel supply contract are set out in agreement between the supplier of the fuel and the consumer (e.g. heating plant operator).

#### Basic aspects of the contract include:

| Subject of the contract | Obligation of the supplier to deliver a certain quantity of an appropriate type of fuel wood and the obligation of the customer to accept it.                                                                                                                                                                                                                                                                               |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wood chip quality       | <ul> <li>Proportion of uncombusted foreign matter. (e.g. stones, sand, soil, road salt, etc.)</li> <li>Specification of the fuel in accordance with available standards. (e.g. prEN 14961-4, class A2)</li> <li>Specification of the wood chips in accordance with freely agreed quality criteria, which may refer to the classes in the standards. (e.g. max. water content, max. piece size, max. ash content)</li> </ul> |
| Origin of wood chips    | <ul> <li>% share of forest wood, sawmill by-products, landscaping wood,<br/>etc.</li> </ul>                                                                                                                                                                                                                                                                                                                                 |
| Quality control         | <ul> <li>Number of retained samples.</li> <li>Storage conditions of the retained samples.</li> <li>Entitlement to rectification and compensation if the contractually specified quality standards are not met.</li> </ul>                                                                                                                                                                                                   |
| Remuneration            | <ul> <li>Invoicing and payment terms. (e.g. volumes, energy supplied)</li> <li>Price</li> <li>Terms of credit</li> <li>Measuring equipment (e.g. scales, heat meter)</li> </ul>                                                                                                                                                                                                                                             |
| Indexation              | Indices for value adjustment (e.g. oil price, wood, mixed indices)                                                                                                                                                                                                                                                                                                                                                          |
| Take-back of ashes      | <ul><li>Disposal costs and conditions</li><li>Proof of disposal</li></ul>                                                                                                                                                                                                                                                                                                                                                   |

| Duration of contract and notice periods | <ul> <li>Entry into effect and termination of the contract</li> <li>Automatic contract extension</li> <li>Notice periods</li> </ul> |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Liability                               | <ul><li>Damage to the system due to poor quality fuel</li><li>Compensation in the event of an interruption to supply</li></ul>      |

#### Accounting for wood chip deliveries

When drawing up supply contracts, the measurement, valuation and verification of price determining attributes is of particular importance. Ultimately, they regulate the price of the wood fuel. The cost of the fuel can be invoiced by weight, energy content or volume. In practice, invoicing by volume (e.g. bulk cubic metre) is very easy to do, but tends to be rather inaccurate in terms of the amount of energy actually supplied. If wood chips of different origins and different species of tree and widely varying bulk densities are sold, it is also possible to invoice by weight. To do this, the water content and weight must be determined as accurately as possible. However, this requires some organisational and logistical effort. The water content must be measured for every delivery, since this determines not only the weight but also the combustion behaviour and the calorific value of the fuel. In addition, a weighbridge must be available in the immediate vicinity of the unloading point, so that the delivered weight of the wood chips can be established. For invoicing by calorific value, a basic price in euros per tonne at a specific water content is agreed and the price is determined using correction factors for wood chips with a different water content. The customer only pays for the amount of energy actually received. For the supplier, this method provides an incentive to supply high quality wood chips, as this will help to achieve the highest possible return. Heating plant operators often prefer to be invoiced in accordance with the energy yielded by the fuel, using a heat quantity meter (per boiler). However, since the energy output of the fuel is influenced by the efficiency and level of maintenance of the heating plant, the fuel supplier carries all of the technical and financial risk. To avoid conflicts in the supply of wood chips, the energy quantity should be determined in accordance with the weight and water content. The qualities can be established in accordance with the available standards.



Not all bulk cubic metres are the same. Taking delivery by volume can lead to great uncertainty regarding the amount of energy actually received

| Delivery method               | Advantages                                                            | Disadvantages                                                          |
|-------------------------------|-----------------------------------------------------------------------|------------------------------------------------------------------------|
| By volume                     | Volume is easily determined                                           |                                                                        |
|                               | Possibility of accounting for part quantities by individual suppliers |                                                                        |
|                               |                                                                       | Large degree of uncertainty regarding the energy content supplied      |
|                               |                                                                       | No incentive for optimising the energy content of the delivery         |
|                               |                                                                       | Numerous conflicts due to different delivered qualities                |
| By weight and water content   | Not dependent on type of wood and bulk density                        |                                                                        |
|                               | High degree of accuracy in terms of energy content                    |                                                                        |
|                               | Fewer conflicts due to fair accounting for delivered quality          |                                                                        |
|                               |                                                                       | Measurement of weight and water content technically complex            |
|                               |                                                                       | Relatively high time and cost expenditure                              |
|                               |                                                                       | Necessity of calculating the dry weight                                |
| By amount of energy generated | Not dependent on weight and type of wood                              |                                                                        |
|                               | Not dependent on water content                                        |                                                                        |
|                               | Cost-effective                                                        |                                                                        |
|                               |                                                                       | Dependent on efficiency and thus the level of maintenance of the plant |
|                               |                                                                       | Differentiated accounting of different suppliers is difficult          |

# The Hartberg Biomass Centre – Case Study



The Hartberg biomass centre in Styria

Fuel wood and forest wood chips are predominantly marketed on an informal level. Even today, a large proportion of fuel wood and forest wood chips are still collected by individuals. Despite enormous resources, the supply of fuel wood and wood chips is subject to uncertainty. Wood as a fuel is not visible in the market, and this makes the procurement of fuel more difficult for those operators of wood-based heating systems who themselves have no woodland and no direct access to forest owners or wood fuel and wood chip suppliers. There is a lack of an appropriate supply infrastructure with local interim storage and marketing facilities that would make it possible to supply customers quickly and easily. The central marketing idea of the "Styrian Biomass Centres" concept consists of the construction of a collective rural marketing channel for biomass fuels and energy services in Styria. Regional biomass centres market all kinds of biomass fuels supplied by farmers. The main product ranges are fuel wood, split logs and wood chips.

The protected "Biomassehof – Steiermark" (Styrian biomass centre) trademark provides all biomass centres in Styria with a uniform, coordinated appearance. This collective identifying mark guarantees the customer a secure fuel supply of regional origin and the highest quality. Each biomass centre is committed to complying with strict quality criteria, and this is checked on an ongoing basis.



The central advantages for the customer are the combined availability of different biofuels at the biomass centre, the guaranteed quality of the fuels on offer and the provision of a wide variety of services such as fuel delivery. Through a comprehensive network of biomass centres, customers can be certain that supplies for their heating systems are guaranteed over the long term. For this reason, private households and businesses can choose this cost effective and environmentally friendly method of heating in good conscience.

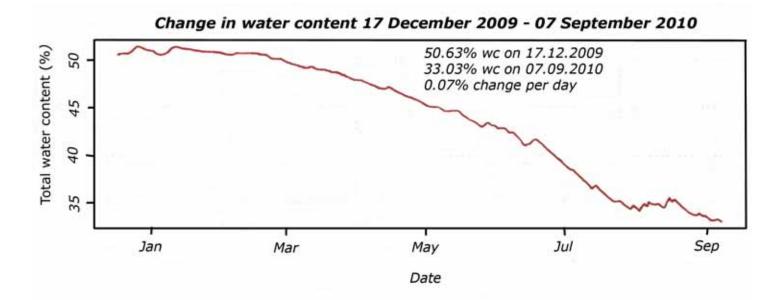
# Quality assurance at the Hartberg biomass centre

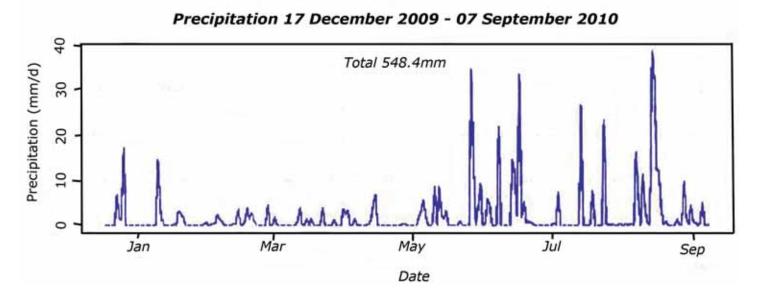
The Hartberg biomass centre has introduced a comprehensive quality management system that enables it to produce high quality fuels. The fuel wood that is bought in is purchased by quantity and water content and then stored on a sunny and well ventilated storage area for natural drying. The wood types supplied,

such as round wood, forest residues and branch material, are sorted according to quality and origin. The wood is primarily sourced from the surrounding forests.

Fuel wood for split log production is split when still wet, as on the one hand it is easier to split in this condition, and on the other hand drying takes place more quickly due to the larger surface area. The wood is dried in mesh pallet boxes, and progress is continually monitored. Split logs generally only go on sale when their water content is less than 20%.

Fuel wood for wood chip production is stored over the summer months and chipped at the beginning of the heating season. The drying process of fuel wood has been investigated in practical tests. Freshly harvested fuel wood that is cut in January reaches a storable condition (M < 30%) by September through natural drying. The wood chips are chipped in September and then stored in covered storage buildings for ongoing use. Quality wood chips for small household systems (M < 20%–25%) are artificially dried if necessary. Artificial drying is, however, always associated with high costs and is generally only worthwhile if cheap heat is available (e.g. waste process heat or a biogas plant). As far as the supply to heating plants is concerned, the delivered wood chip quality is tailored to the respective boiler requirements. The quality demands on the wood chips are considerably lower in this case.





Drying process for logs at the Hartberg biomass centre (analysis by the University of Natural Resources and Life Sciences in Vienna)

#### **Fuel sales**

At the biomass centre, the split logs and wood chips are sold by weight and water content, i.e. according to the energy actually contained. As far as purchasing the raw materials and selling the wood chips and split logs are concerned, the delivered quantity is weighed on a calibrated weighbridge and the water content is determined using an appropriate meter. The measurement of the water content is combined with quality control upon receipt of the wood.

When buying split logs, the customers have the opportunity to select their own logs and to have the water content measured. This type of accounting strengthens the customer's trust in wood as a fuel and enables an easy comparison of the price with that of other energy sources. One litre of heating oil has an energy content of 10 kWh and currently costs 75 cents (price basis November 2010), meaning that one kWh costs 7.5 cents. The price for 1 kWh of beech fuel wood in 33 cm split logs is currently 4.0 cents and equates to approximately half of the cost of heating oil.

#### Calculation method of the Fürstenfeld biomass centre:

The energy content of a fuel is calculated according to the following formula:

| Sample calculation for the calorific value of 1 kg of fuel wood with a water content of 20%          |       |                               |        |                 |  |
|------------------------------------------------------------------------------------------------------|-------|-------------------------------|--------|-----------------|--|
| 5.2 kWh * 80%                                                                                        | -     | 0.63 kWh * 20%                | =      | 4.03 kWh        |  |
| Calorific value of<br>the completely dry<br>matter                                                   | minus | Evaporation heat of the water | equals | Calorific value |  |
| Calorific value of 1 kg of fuel wood (dry matter): 5.2 kWh  Energy to evaporate 1 kg water: 0.63 kWh |       |                               |        |                 |  |

The sample invoices shown on the next page illustrate the charges for two fuel sales with different water contents. The price calculation for 1,270 kg of beech fuel wood with a water content of 15% is based on the actual energy content and is calculated as follows:

Price per kg = 
$$[(5.2 * 85\%) - (0.63 * 15\%)] * [0.04]$$
  
Price per kg =  $[energy content per kg in kWh] * [price per kWh of energy in cents]$ 

Accordingly, split beech logs with a water content of 15% cost 17 cents per kg and are 2 cents per kg more expensive than those with a water content of 25%. The biomass centre achieves a higher return by selling higher quality fuel, which provides an incentive to continue quality improvement efforts. On the other hand, the customer only pays for the energy actually taken home.





#### Waldverband Steiermark GmbH, ATU 57073856

Biomassehof Hartbergerland, Gewerbepark Greinbach 273, 8230 Hartberg

Mr. N E Body Anywhere Street 11 Anytown

Hartberg,

22.09.2009

Invoice No. 4550-2010

For the supply of 3.18 stacked cubic metres of beech wood, 33 cm split logs

Total gross price

Calculation basis: kg of beech fuel wood, 33 cm 1,270.00 Water content % 15.00 Price per kWh 0.04

Price per kym
Price per kg
0.17
Total net price
VAT 10%
219.74
21.97

241.71

By volume, this equates to... 76€ per stm³

The wood quantity purchased equates to ... 521 litres of heating oil

Savings over the cost of heating oil... 391€ CO2 emissions avoided... 1,406 kg

Please transfer the amount due without any deductions within 30 days to account no. 21-00.048.736, sort code 38 000.

The delivered goods remain our property until full payment is received.

With kindest regards,

The team of the Hartberg biomass centre

Fuel purchase, 33 cm split beech logs with a water content of 15%





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Biomassehof Hartbergerland, Gewerbepark Greinbach 273, 8230 Hartberg

Mr. N E Body Anywhere Street 11 Anytown

22.09.2009

Hartberg,

Invoice No. 4550-2010

For the supply of 2.80 stacked cubic metres of beech wood, 33 cm split logs

Calculation basis: kg of beech fuel wood, 33 cm 1,270.00 Water content % 25.00

Price per kWh 0.04
Price per kg 0.15
Total net price 190.12
VAT 10% 19.01
Total gross price 209.13

By volume, this equates to... 75€ per stm<sup>3</sup>

The wood quantity purchased equates to ... 445 litres of heating oil

Savings over the cost of heating oil... 333€ CO2 emissions avoided... 1200 kg

Please transfer the amount due without any deductions within 30 days to account no. 21-00.048.736, sort code 38 000.

The delivered goods remain our property until full payment is received.

With kindest regards,

The team of the Hartberg biomass centre

Fuel purchase, 33 cm split beech logs with a water content of 25%

#### Comparison of energy sources for woodchips at the Hartberg biomass centre

The customer only pays for the energy actually taken home.

| Comparison of energy source                      |                 |                  |                   |  |  |  |
|--------------------------------------------------|-----------------|------------------|-------------------|--|--|--|
| Price basis 20 Euros per MWh or 2 cents per kWh. |                 |                  |                   |  |  |  |
| Туре                                             | Pine woodchip   | Spruce woodchip  | Beech woodchip    |  |  |  |
| Water content                                    | 20%             | 50%              | 20%               |  |  |  |
| Energy content per kg                            | 4.09 kWh        | 2.3kWh           | 3.86kWh           |  |  |  |
| Weight per sm <sup>3</sup>                       | 227kg           | 265kg            | 285kg             |  |  |  |
| Energy content per sm <sup>3</sup>               | 929             | 610              | 1100              |  |  |  |
| Energy x Price                                   | 929 x 0.02Euros | 610 x 0.02 Euros | 1100 x 0.02 Euros |  |  |  |
| Price per bm <sup>3</sup>                        | 18.58 Euros     | 12.20 Euros      | 22 Euros          |  |  |  |
| Price incl. VAT                                  | 20.80 Euros     | 13.66 Euros      | 24.64 Euros       |  |  |  |

The biomass centre produces its fuels in accordance with the available standards (e.g. ÖNORM M 7133). In the near future, it will produce them in accordance with the new European biofuel standard EN 14961. At present, intensive efforts are underway to have the biomass centres certified. Once certification has been achieved, the quality produced must be tested several times per year by an independent certification body. This will continue to strengthen consumer trust.



Rapid determination of the water content of split logs at the Hartbergerland biomass centre

Rapid determination of the water content of wood chips



# Example: Cost accounting on the basis of weight

A bucket with 50 litres of wood chips is placed on a scale. The scale indicates a figure of 10.08 kg. For 1 bm³ (1,000 litres) this corresponds to a weight of (20 x 10.08 =) 210.6 kg. This means that to obtain 1 ton, (1,000/210.6 kg =) 4.96 bm³ of wood chips are needed.

The water content of a delivery is measured with a hygrometer. This measurement shows a water content of 20%, i.e. 4 kWh per kg. The energy content of 1 bm³ amounts to  $(210.6 \times 4) 842 \times 100.6 \times 100.80 \times 100.8$ 

# 'Using quality woodfuel helps you use the wood resource efficiently, and

- reduces the amount you use
- reduces the wear on your boiler
- minimises ash and other emissions
- helps combat climate change by using a renewable fuel'

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