BRITISH STANDARD

BS EN
14961-1:2010

Solid biofuels — Fuel specifications and classes

Part 1: General requirements

ICS 75.160.10

BSI
British Standards

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National foreword

This British Standard is the UK implementation of EN 14961-1:2010. It supersedes DD CEN/TS 14961:2005 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PTI/17, Solid biofuels.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Feste Biobrennstoffe - Brennstoffspezifikationen und -klassen - Teil 1: Allgemeine Anforderungen

This European Standard was approved by CEN on 1 November 2009.

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Foreword

This document (EN 14961-1:2010) has been prepared by Technical Committee CEN/TC 335 “Solid biofuels”, the secretariat of which is held by SIS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2010, and conflicting national standards shall be withdrawn at the latest by July 2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes CEN/TS 14961:2005.

The series EN 14961, *Solid biofuels — Fuel specifications and classes* is provided as a general requirement and additional product standards. Additional product standards may extend this series over time.

EN 14961, *Solid biofuel — Fuel specification and classes*, consists of the following parts:

— *Part 1: General requirements*

— *Part 2: Wood pellets for non-industrial use* (under development)

— *Part 3: Wood briquettes for non-industrial use* (under development)

— *Part 4: Wood chips for non-industrial use* (under development)

— *Part 5: Firewood for non-industrial use* (under development)

— *Part 6: Non woody pellets for non-industrial use* (under development)

Although these product standards may be obtained separately, they require a general understanding of the standards based on and supporting EN 14961-1. It is recommended to obtain and use EN 14961-1 in conjunction with these standards.

In these product standards, "non-industrial" use means use in smaller scale appliances, such as in households and small commercial and public sector buildings.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

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Introduction

This European Standard, *Fuel Specifications and Classes — Part 1: General requirements*, has been produced by TC 335 Solid Biofuels Working Group "Fuel Specifications, Classes and Quality Assurance".

The objective of this European Standard is to provide unambiguous and clear classification principles for solid biofuels and to serve as a tool to enable efficient trading of biofuels and to enable good understanding between seller and buyer as well as a tool for communication with equipment manufacturers. It will also facilitate authority permission procedures and reporting.

This European Standard is made for all user groups.

Figure 1 describes the bioenergy utilisation chain from sources of biomass, to biofuel production to final use of bioenergy. Although biomass can be used for energy generation it has many other primary uses (non-fuels) as a raw material for construction, furniture, packaging, paper products, etc. The classifications given in this European Standard are provided with the objective of using biomass as a biofuel, and therefore do not deal with all other uses. The biofuels covered by this European Standard are identical to the fuels exempted from the Directive 2000/76/EC (Article 2.2 a) from i) to v)) on incineration of waste.

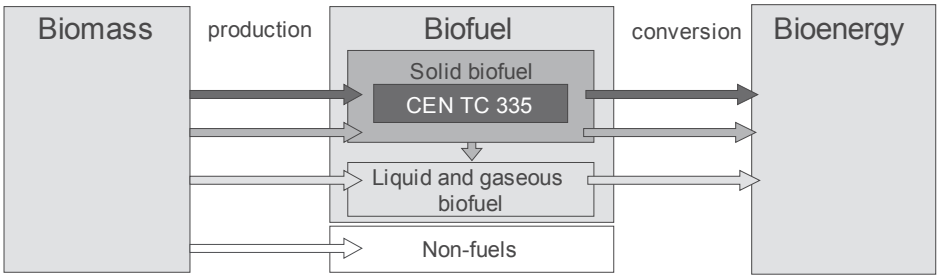

Figure 1 — CEN TC 335 within the biomass – Biofuel – Bioenergy field

1 Scope

This European Standard determines the fuel quality classes and specifications for solid biofuels. According to the mandate given for the standardisation work, the scope of the CEN/TC 335 only includes solid biofuels originating from the following sources:

a) products from agriculture and forestry;

b) vegetable waste from agriculture and forestry;

c) vegetable waste from the food processing industry;

d) wood waste, with the exception of wood waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coating, and which includes in particular such wood waste originated from construction and demolition waste;

e) fibrous vegetable waste from virgin pulp production and from production of paper from pulp, if it is co-incinerated at the place of production and heat generated is recovered;

f) cork waste.

NOTE 1 For the avoidance of doubt, demolition wood is not included in the scope of this European Standard. Demolition wood is “used wood arising from demolition of buildings or civil engineering installations” (prEN 14588).

NOTE 2 Aquatic biomass is not included in the scope of this European Standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

prEN 14588:2009, *Solid biofuels — Terminology, definitions and descriptions*

EN 14774-1, *Solid biofuels — Determination of moisture content — Oven dry method – Part 1: Total moisture — Reference method*

EN 14774-2, *Solid biofuels — Determination of moisture content — Oven dry method – Part 2: Total moisture — Simplified method*

EN 14775, *Solid biofuels — Determination of ash content*

CEN/TS 14778 (all parts), *Solid biofuels — Sampling*

CEN/TS 14780, *Solid biofuels — Methods for sample preparation*

EN 14918, *Solid Biofuels — Determination of calorific value*

EN 15103, *Solid Biofuels — Determination of bulk density*

CEN/TS 15104, *Solid biofuels — Determination of total content of carbon, hydrogen and nitrogen — Instrumental methods*

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CEN/TS 15149-1, *Solid biofuels — Methods for the determination of particle size distribution — Part 1: Oscillating screen method using sieve apertures of 3,15 mm and above*

CEN/TS 15149-2, *Solid biofuels — Methods for the determination of particle size distribution — Part 2: Vibrating screen method using sieve apertures of 3,15 mm and below*

CEN/TS 15150, *Solid biofuels — Methods for the determination of particle density*

EN 15210-1, *Solid Biofuels — Determination of mechanical durability of pellets and briquettes — Part 1: Pellets*

CEN/TS 15210-2, *Solid biofuels — Methods for the determination of mechanical durability of pellets and briquettes — Part 2: Briquettes*

CEN/TS 15234, *Solid biofuels — Fuel quality assurance*

CEN/TS 15289, *Solid Biofuels — Determination of total content of sulphur and chlorine*

CEN/TS 15290, *Solid Biofuels — Determination of major elements*

CEN/TS 15296, *Solid Biofuels — Calculation of analyses to different bases*

CEN/TS 15297, *Solid Biofuels — Determination of minor elements*

CEN/TS 15370-1, *Solid biofuels — Method for the determination of ash melting behaviour — Part 1: Characteristic temperatures method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in prEN 14588:2009 and the following apply.

3.1
chemical treatment
any treatment with chemicals other than air, water or heat (e.g. glue and paint)

NOTE Examples of chemical treatments are listed in informative Annex C.

4 Symbols and abbreviations

The symbols and abbreviations used in this European Standard comply with the SI system of units as far as possible.

d dry (dry basis)

daf dry, ash-free

ar as received

w-% weight-percentage

A Designation for ash content [w-%, dry basis][1)]

BD Designation for bulk density as received [kg/m^3][1)]

D Designation for diameter as received [mm][1)]

D Diameter as received [mm]

DE Designation for particle density as received [g/cm^3][1)]

DT Designation for deformation temperature [°C]

DU Designation for mechanical durability as received [w-%][1)]

E_{ar} Energy density as received [GJ/m^3 or MWh/m^3 loose or stacked volume] (amount of energy/volume unit)

E Designation for energy density [GJ/m^3 or MWh/m^3 loose or stacked volume][1)]

F Designation for amount of fines [w-%, as received]

L Length as received [mm]

L Designation for length as received [mm][1)]

M_{ar} Total moisture content as received [w-%] on wet basis

M Designation for moisture content as received [w-%][1)]

P Designation for particle size distribution as received [mm][1)]

$q_{V,gr,\,d}$ Gross calorific value at constant volume on dry basis [MJ/kg]

$q_{p,\mathrm{net,d}}$ Net calorific value at constant pressure on dry basis [MJ/kg]

Q Designation for net calorific value as received, $q_{p,\mathrm{net,ar}}$ [MJ/kg or kWh/kg or MWh/t] at constant pressure[1)]

NOTE 1 MJ/kg equals 0,2778 kWh/kg (1 kWh/kg equals 1 MWh/t and 1 MWh/t is 3,6 MJ/kg). 1 g/cm^3 equals 1 kg/dm^3.

5 Principle

Solid biofuels are specified by:

a) origin and source, Clause 6;

b) major traded forms and properties, Clause 7.

For specification of origin and source, see Table 1. For major traded forms, see Table 2.

For specification of properties see Tables 3 to 15. The major traded forms of solid biofuels are covered by Tables 3 to 14. Table 15 is a general master table to be used for solid biofuels not covered by Tables 3 to 14.

1) Designation symbols are used in combination with a number to specify property levels in Tables 3 to 15. For designation of chemical properties chemical symbols like S (sulphur), Cl (chlorine), N (nitrogen) are used and the value is added at the end of the symbol.

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If solid biofuels fall outside the specifications of the major traded fuels given in Tables 3 to 14 then Table 15 should be used for specification purposes.

Tables 3 to 15 list the normative properties, which shall be specified and informative properties, which are voluntary. Normative properties vary depending on both origin and traded form.

EXAMPLE OF SPECIFICATION

Origin: Logging residues (1.1.4)

Traded form: Wood chips

Properties: Particle size distribution P45, Moisture M40, Ash A1.5

In the case of wood chips (Table 5) the properties of dimensions, moisture and ash are normative in the specification. Other properties are informative.

Specifications for high quality classes of solid biofuels are recommended for smaller scale appliances, such as in households and small commercial and public sector buildings. Product standards for such biofuels are given in other parts of EN 14961.

6 Classification of origin and sources of solid biofuels

6.1 General

The classification is based on the biofuel origin and source. In the hierarchical classification system (Table 1) the main origin-based solid biofuel groups are:

a) woody biomass;

b) herbaceous biomass;

c) fruit biomass; and

d) blends and mixtures.

Woody biomass is biomass from trees, bushes and shrubs.

Herbaceous biomass is from plants that have a non-woody stem and which die back at the end of the growing season. It includes grains and their by-products such as cereals.

Fruit biomass is the biomass from the parts of a plant which are from or hold seeds.

If appropriate, also the actual species (e.g. spruce, wheat) of biomass should be stated.

The term “Blends and mixtures” in Table 1 refers to material of various origin within the given box in the classification table and appears on four levels. Blends are intentionally mixed biofuels, whereas mixtures are unintentionally mixed biofuels. The origin of the blend and mixture shall be described using Table 1.

If solid biofuel blend or mixture may contain chemically treated material it shall be stated.

The second level of classification in Table 1 describes fuels from different sources within the main groups, primarily stating whether the biomass is a virgin material, a by-product or a residue from the industry.

Groups in Table 1 are further divided into third and fourth level sub-groups. The purpose of Table 1 is to allow the possibility to differentiate and specify biofuel material based on origin with as much detail as needed. With the help of typical values from informative Annex B information on physical and chemical properties can be deduced.

Examples for classification according to Table 1:

a) Whole trees without roots from birch (1.1.1.1);

b) Logging residues (1.1.4);

c) Logging residues from spruce stands (1.1.4.2);

d) Sawdust from broad-leaf (1.2.1.1);

e) Ply from coniferous(1.2.1.2);

f) Plywood residues (1.2.2.1);

g) Grinding dust from furniture industry (1.2.2.1);

h) Lignin (1.2.2.4);

i) Construction wood (1.3.1.1);

j) Pallets (1.3.2.1);

k) Reed canary grass (2.1.2.1);

l) Straw from wheat, barley, oat, rye (2.1.1.2);

m) Rice husk (2.1.1.4);

n) Grains or seeds crops from food processing industry (2.2.1.1);

o) Olive residues from olive pressing (3.2.2.4).

Table 1 — Classification of origin and sources of solid biofuels

1. Woody biomass	1.1 Forest, plantation and other virgin wood	1.1.1 Whole trees without roots	1.1.1.1 Broad-leaf
			1.1.1.2 Coniferous
			1.1.1.3 Short rotation coppice
			1.1.1.4 Bushes
			1.1.1.5 Blends and mixtures
		1.1.2 Whole trees with roots	1.1.2.1 Broad-leaf
			1.1.2.2 Coniferous
			1.1.2.3 Short rotation coppice
			1.1.2.4 Bushes
			1.1.2.5 Blends and mixtures
		1.1.3 Stemwood	1.1.3.1 Broad-leaf
			1.1.3.2 Coniferous
			1.1.3.3 Blends and mixtures
		1.1.4 Logging residues	1.1.4.1 Fresh/Green, Broad-leaf (including leaves)
			1.1.4.2 Fresh/Green, Coniferous (including needles)
			1.1.4.3 Stored, Broad-leaf
			1.1.4.4 Stored, Coniferous
			1.1.4.5 Blends and mixtures
		1.1.5 Stumps/roots	1.1.5.1 Broad-leaf
			1.1.5.2 Coniferous
			1.1.5.3 Short rotation coppice
			1.1.5.4 Bushes
			1.1.5.5 Blends and mixtures
		1.1.6 Bark (from forestry operations) [a]	
		1.1.7 Segregated wood from gardens, parks, roadside maintenance, vineyards and fruit orchards	
		1.1.8 Blends and mixtures	
	1.2 By-products and residues from wood processing industry	1.2.1 Chemically untreated wood residues	1.2.1.1 Without bark, Broad-leaf
			1.2.1.2 Without bark, Coniferous
			1.2.1.3 With bark, Broad-leaf
			1.2.1.4 With bark, Coniferous
			1.2.1.5 Bark (from industry operations) [a]
		1.2.2 Chemically treated wood residues, fibres and wood constituents	1.2.2.1 Without bark
			1.2.2.2 With bark
			1.2.2.3 Bark (from industry operations) [a]
			1.2.2.4 Fibres and wood constituents
		1.2.3 Blends and mixtures	
	1.3 Used wood	1.3.1 Chemically untreated wood	1.3.1.1 Without bark
			1.3.1.2 With bark
			1.3.1.3 Bark [a]
		1.3.2 Chemically treated wood	1.3.2.1 Without bark
			1.3.2.2 With bark
			1.3.2.3 Bark [a]
		1.3.3 Blends and mixtures	
	1.4 Blends and mixtures		

[a] Cork waste is included in bark sub-groups.

NOTE 1 For the avoidance of doubt, demolition wood is not included in the scope of this European Standard. Demolition wood is “used wood arising from demolition of buildings or civil engineering installations” (see prEN 14588).

NOTE 2 If appropriate, also the actual species (e.g. spruce, wheat) of biomass may be stated. Wood species may be stated e.g. according to EN 13556, *Round and sawn timber — Nomenclature of timbers used in Europe*[1].

NOTE 3 Chemical treatment before harvesting of biomass does not need to be stated. Where any operator in the fuel supply chain has reason to suspects serious contamination of land (e.g. coal slag heaps) or if planting has been used specifically for the sequestration of chemicals or biomass is fertilized by sewage sludge (issued from waste water treatment or chemical process), fuel analysis should be carried out to identify chemical impurities such as halogenated organic compounds or heavy metals.

Table 1 (*continued*)

2. Herbaceous biomass	2.1 Herbaceous biomass from agriculture and horticulture	2.1.1 Cereal crops	2.1.1.1 Whole plant
			2.1.1.2 Straw parts
			2.1.1.3 Grains or seeds
			2.1.1.4 Husks or shells
			2.1.1.5 Blends and mixtures
		2.1.2 Grasses	2.1.2.1 Whole plant
			2.1.2.2 Straw parts
			2.1.2.3 Seeds
			2.1.2.4 Shells
			2.1.2.5 Blends and mixtures
		2.1.3 Oil seed crops	2.1.3.1 Whole plant
			2.1.3.2 Stalks and leaves
			2.1.3.3 Seeds
			2.1.3.4 Husks or shells
			2.1.3.5 Blends and mixtures
		2.1.4 Root crops	2.1.4.1 Whole plant
			2.1.4.2 Stalks and leaves
			2.1.4.3 Root
			2.1.4.4 Blends and mixtures
		2.1.5 Legume crops	2.1.5.1 Whole plant
			2.1.5.2 Stalks and leaves
			2.1.5.3 Fruit
			2.1.5.4 Pods
			2.1.5.5 Blends and mixtures
		2.1.6 Flowers	2.1.6.1 Whole plant
			2.1.6.2 Stalks and leaves
			2.1.6.3 Seeds
			2.1.6.4 Blends and mixtures
		2.1.7 Segregated herbaceous biomass from gardens, parks, roadside maintenance, vineyards, and fruit orchards	
		2.1.8 Blends and mixtures	
	2.2 By-products and residues from herbaceous processing industry [b]	2.2.1 Chemically untreated herbaceous residues	2.2.1.1 Cereal crops and grasses
			2.2.1.2 Oil seed crops
			2.2.1.3 Root crops
			2.2.1.4 Legume crops
			2.2.1.5 Flowers
			2.2.1.6 Blends and mixtures
		2.2.2 Chemically treated herbaceous residues	2.2.2.1 Cereal crops and grasses
			2.2.2.2 Oil seed crops
			2.2.2.3 Root crops
			2.2.2.4 Legume crops
			2.2.2.5 Flowers
			2.2.2.6 Blends and mixtures
		2.2.3 Blends and mixtures	
	2.3 Blends and mixtures		

[b] Group 2.2 also includes residues and by-products from the food processing industry.

Table 1 (*concluded*)

3. Fruit biomass	3.1 Orchard and horticulture fruit	3.1.1 Berries	3.1.1.1 Whole berries
			3.1.1.2 Flesh
			3.1.1.3 Seeds
			3.1.1.4 Blends and mixtures
		3.1.2 Stone/kernel fruits	3.1.2.1 Whole fruit
			3.1.2.2 Flesh
			3.1.2.3 Stone/kernel
			3.1.2.4 Blends and mixtures
		3.1.3 Nuts and acorns	3.1.3.1 Whole nuts
			3.1.3.2 Shells/husks
			3.1.3.3 Kernels
			3.1.3.4 Blends and mixtures
		3.1.4 Blends and mixtures	
	3.2 By-products and residues from fruit processing industry [c]	3.2.1 Chemically untreated fruit residues	3.2.1.1 Berries
			3.2.1.2 Stone/kernel fruits
			3.2.1.3 Nuts and acorns
			3.2.1.4 Crude olive cake
			3.2.1.5 Blends and mixtures
		3.2.2 Chemically treated fruit residues	3.2.2.1 Berries
			3.2.2.2 Stone/kernel fruits
			3.2.2.3 Nuts and acorns
			3.2.2.4 Exhausted olive cake
			3.2.2.5 Blends and mixtures
		3.2.3 Blends and mixtures	
	3.3 Blends and mixtures		
4 Blends and mixtures	4.1 Blends		
	4.2 Mixtures		

[c] Group 3.2 also includes residues and by-products from the food processing industry.

NOTE 4 Group 4 "Blends and mixtures" include blends and mixtures from the main origin-based solid biofuel groups 1 to 3.

6.2 Woody biomass

6.2.1 Forest, plantation and other virgin wood

Forest, plantation and other virgin wood in this group may only have been subjected to size reduction, debarking, drying or wetting. Forest, plantation and other virgin wood includes wood from forests, parks, gardens, plantations and from short rotation forests and coppice.

6.2.2 By-products and residues from wood processing industry

Wood by-products and wood residues from industrial production are classified in this group. These biofuels can be chemically untreated (for example residues from debarking, sawing or size reduction, shaping, pressing) or chemically treated wood residues from wood processing and the production of panels and furniture (glued, painted, coated, lacquered or otherwise treated wood), as long as they do not contain heavy metals or halogenated organic compounds as a result of treatment with wood preservatives or coating.

NOTE This classification is in accordance with the classification in the European Waste Catalogue[2] including the waste code No. 03 01 (Wastes from wood processing and the production of panels and furniture).

6.2.3 Used wood

This group includes post consumer/post society wood waste; natural or merely mechanically processed wood, contaminated only to an insignificant extent during use by substances that are not normally found in wood in its natural state (for example pallets, transport cases, boxes, wood packages, cable reels, construction wood). With respect to treatment the same criteria apply as with respect to "wood processing industry by-products and residues", i.e. the used wood shall not contain heavy metals or halogenated organic compounds as a result of treatment with wood preservatives or coating.

NOTE This classification is in accordance with the classification in the European Waste Catalogue[2] including the waste codes No. 15 01 03 (Wooden packaging), 17 02 01 (Construction and demolition wood wastes, but without the demolition wood wastes, which are excluded according the scope) and 20 01 38 (Municipal wood wastes including separately collected fractions).

6.2.4 Blends and mixtures

This refers to blends and mixtures of woody biomass in the groups 1.1 to 1.3 in Table 1. The mixing can be either intentional (blends) or unintentional (mixtures).

6.3 Herbaceous biomass

6.3.1 Agriculture and horticulture herbaceous biomass

Material, which comes directly from the field, perhaps after a storage period, and may only have been subject to size reduction and drying is included here. It covers herbaceous material from agricultural and horticultural fields and from gardens and parks.

6.3.2 By-products and residues from herbaceous processing industry

This refers to any herbaceous biomass material that is left over after industrial handling and treatment.

Examples are residues from the production of sugar from sugar beets, barley malt residues from beer production and raw vegetable residues from food processing industry.

6.3.3 Blends and mixtures

This refers to blends and mixtures of herbaceous biomass in the groups 2.1 to 2.2 in Table 1. The mixing can be either intentional (blends) or unintentional (mixtures).

6.4 Fruit biomass

6.4.1 Orchard and horticulture fruit

Fruit from trees, bushes and fruit from herbs (e.g. tomatoes and grapes) are classified in this group.

6.4.2 By-products and residues from fruit processing industry

This refers to a fruit biomass material that is left over after industrial handling and treatment.

Examples are pressing residues from olive oil or apple juice production and processed (e.g. heated, steamed, cooked, etc.) vegetable residues from food processing industry.

6.4.3 Blends and mixtures

This refers to blends and mixtures of fruit biomass in the groups 3.1 to 3.2 in Table 1. The mixing can be either intentional (blends) or unintentional (mixtures).

6.5 Biomass blends and mixtures

These include blends and mixtures of different biomasses mentioned above under 6.2 to 6.4. The mixing can be either intentional (blends) or unintentional (mixtures).

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7 Specification of solid biofuels based on traded forms and properties

7.1 Traded forms of solid biofuels

Solid biofuels are traded in many different sizes and shapes. The size and shape influence the handling of the fuel as well as its combustion properties. Biofuels may be delivered for example in the forms shown in Table 2.

Table 2 — Major traded forms of solid biofuels

Fuel name	Typical particle size	Common preparation method
Whole tree (Table 15)	> 500 mm	No preparation or delimbed
Wood chips (Table 5)	5 mm to 100 mm	Cutting with sharp tools
Hog fuel (Table 6)	Varying	Crushing with blunt tools
Log wood/firewood (Table 7)	100 mm to 1 000 mm	Cutting with sharp tools
Bark (Table 10)	Varying	Debarking residue from trees Can be shredded or unshredded
Bundle (Table 15)	Varying	Lengthways oriented & bound
Fuel powder (Table 15)	< 1 mm	Milling
Sawdust (Table 8)	1 mm to 5 mm	Cutting with sharp tools
Shavings (Table 9)	1 mm to 30mm	Planing with sharp tools
Briquettes (Table 3)	Ø ≥ 25 mm	Mechanical compression
Pellets (Table 4)	Ø < 25 mm	Mechanical compression
Bales (Table 11)		
Small square bales	0,1 m^3	Compressed and bound to squares
Big square bales	3,7 m^3	Compressed and bound to squares
Round bales	2,1 m^3	Compressed and bound to cylinders
Chopped straw or energy grass (Table 15)	10 mm to 200 mm	Chopped during harvesting or before combustion
Grain (Table 12, Table 13) or seed (Table 13, Table 14)	Varying	No preparation or drying except for process operations necessary for storage for cereal grain
Fruit stones or kernel (Table 13)	5 mm to 15 mm	No preparation or pressing and extraction by chemicals.
Fibre cake (Table 15)	Varying	Prepared from fibrous waste by dewatering

NOTE 1 Also other forms may be used.

NOTE 2 The definitions from different traded forms are in accordance with prEN 14588.

Figures in the informative Annex A describe the particle size differences between different wood fuels and also the difference between wood chips and hog fuel.

7.2 Specification of properties of solid biofuels

The European Standards listed in Clause 2 shall be used for the sampling and determination of properties of solid biofuels. The additional parts of 14961 (e.g. 14961-2, 14961-3, etc.) have been developed to describe non-industrial solid biofuel products. These Product Standards are recommended for smaller scale appliances, such as households and small commercial and public sector buildings. Wood pellets, wood briquettes, wood chips and firewood (log wood) are traded forms commonly used for small-scale applications.

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For a specification of a solid biofuel, the denominations given in Tables 3 to 15 are normative and informative properties. In Tables 3 to 14 solid biofuels are defined by property classes.

When specifying a class within a property, the average numerical value from the whole lot or defined portion from the lot (e.g. shipload, truckload or bag) shall determine which class shall be used. For an example in Table 6, the ash class A3.0 (≤ 3%) means that the average ash content shall be ≤ 3,0% to belong to this class.

A general master table (Table 15) shall be used for solid biofuels not covered by Tables 3 to 14.

If the properties being specified are sufficiently known through information about the origin and handling (or preparation method combined with experience) then physical/chemical analysis may not be needed.

To minimise resources needed, one of the measures in the following order is recommended:

a) using typical values, e.g. laid down in Annex B, or obtained by experience;

b) calculation of properties, e.g. by using typical values and considering documented specific values;

c) carrying out of analysis:

   1) with simplified methods if available;

   2) with reference methods.

The responsibility of the producer or supplier to provide correct and accurate information is exactly the same whether laboratory analysis is performed or not. Typical values do not negate the producer or supplier from providing accurate and reliable information.

NOTE 1 Typical values for some physical and chemical properties of biofuels are listed in Annex B. These can be used as an indication of the properties when needed, however, they may not be used for the limitation of the fuel parameters.

Conversion of a value on a dry basis (*d*) to a dry, ash free basis (*daf*) or to as received basis (*ar*) is given in CEN/TS 15296.

NOTE 2 For Tables 3 to 15: only chemically treated biomass that are included in the scope, should be considered, i.e. wood waste which can contain halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coating, are not included. Examples of chemical treatment are mentioned in Annex C.

NOTE 3 For Tables 3 to 15 is stated that the net calorific value should be specified on as received basis. The net calorific value will vary depending on the actual moisture content in the fuel. The value given in a specification is thus valid only for the actual connected moisture content. The net calorific value as received ($q_{p,\mathrm{net,ar}}$, designation Q) can be calculated using both the net calorific value on a dry basis ($q_{p,\mathrm{net,d}}$) and the moisture content (see Annex D).

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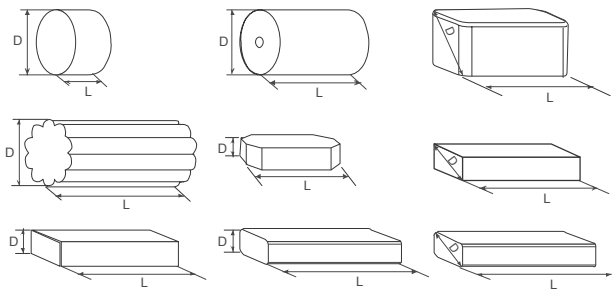
Table 3 — Specification of properties for briquettes

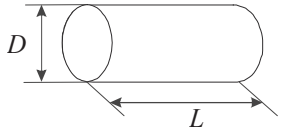
	Master table		
	Origin: According to 6.1 and Table 1		Woody biomass (1); Herbaceous biomass (2); Fruit biomass (3); Blends and mixtures (4).
	Traded Form (see Table 2)		Briquette
Normative	**Dimensions** (mm)		
	Diameter (D) or equivalent (diagonal or cross cut), mm		
	D 40	$25 \leq D \leq 40$	
	D 50	≤ 50	
	D 60	≤ 60	
	D 80	≤ 80	
	D 100	≤ 100	
	D 125	≤ 125	
	D 125+	> 125 (maximum value to be stated)	
	Length (L), mm		
	L 50	≤ 50	
	L 100	≤ 100	
	L 200	≤ 200	
	L 300	≤ 300	
	L 400	≤ 400	
	L 400+	> 400 (maximum value to be stated)	
			L Length D Diameter
			Figure 2 — Examples of briquettes
	Moisture, M (w-% as received) EN 14774-1, EN 14774-2		
	M10	≤ 10 %	
	M15	≤ 15 %	
	Ash, A (w-% of dry basis) EN 14775		
	A0.5	≤ 0,5 %	
	A0.7	≤ 0,7 %	
	A1.0	≤ 1,0 %	
	A1.5	≤ 1,5 %	
	A2.0	≤ 2,0 %	
	A3.0	≤ 3,0 %	
	A5.0	≤ 5,0 %	
	A7.0	≤ 7,0 %	
	A10.0	≤ 10,0 %	
	A10.0+	> 10,0 % (maximum value to be stated)	
	Particle density, DE (g/cm^3) CEN/TS 15150		
	DE0.8	≥ 0,8	
	DE0.9	≥ 0,9	
	DE1.0	≥ 1,0	
	DE1.1	≥ 1,1	
	DE1.2	≥ 1,2	
	DE1.2+	> 1,2 (maximum value to be stated)	
	Additives (w-% of pressing mass) [a]		Type and content of pressing aids, slagging inhibitors or any other additives have to be stated
	Net calorific value as received, Q (MJ/kg or kWh/kg) EN 14918		Minimum value to be stated

Normative / informative	**Mechanical durability, DU** (w-% of briquettes after testing) CEN/TS 15210-2		
	DU95.0	≥ 95,0 %	Informative: only if traded in bulk
	DU90.0	≥ 90,0 %	
	DU90.0-	< 90,0 % (minimum value to be stated)	
	Nitrogen, N (w-% of dry basis) CEN/TS 15104		
	N0.3	≤ 0,3 %	Normative: Chemically treated biomass (1.2.2; 1.3.2; 2.2.2; 3.2.2) Informative: All fuels that are not chemically treated (see the exceptions above)
	N0.5	≤ 0,5 %	
	N1.0	≤ 1,0 %	
	N2.0	≤ 2,0 %	
	N3.0	≤ 3,0 %	
	N3.0+	>3,0 % (maximum value to be stated)	
	Sulphur, S (w-% of dry basis) CEN/TS 15289		
	S0.02	≤ 0,02 %	Normative: Chemically treated biomass (1.2.2; 1.3.2; 2.2.2; 3.2.2) or if sulphur containing additives have been used. Informative: All fuels that are not chemically treated (see the exceptions above)
	S0.05	≤ 0,05 %	
	S0.08	≤ 0,08 %	
	S0.10	≤ 0,10 %	
	S0.20	≤ 0,20 %	
	S0.20+	> 0,20 % (maximum value to be stated)	
	Chlorine, Cl (w-% of dry basis) CEN/TS 15289		
	Cl0.02	≤ 0,02 %	Normative: Chemically treated biomass (1.2.2; 1.3.2; 2.2.2; 3.2.2) Informative: All fuels that are not chemically treated (see the exceptions above)
	Cl0.03	≤ 0,03 %	
	Cl0.07	≤ 0,07 %	
	Cl0.10	≤ 0,10 %	
	Cl0.10+	> 0,10 % (maximum value to be stated)	
Informative: Ash melting behaviour (°C) CEN/TS 15370-1			Deformation temperature, DT should be stated

[a] The maximum amount of additive is 20 w-% of pressing mass. Type stated as chemical substance (e.g. starch). If amount is greater, then raw material for briquette is blend.

NOTE 4 Special attention should be paid to the ash melting behaviour for some biomass fuels, for example eucalyptus, poplar, short rotation coppice, straw, miscanthus and olive stone.

Table 4 —Specification of properties for pellets

	Master table	
	Origin: According to 6.1 and Table 1	Woody biomass (1); Herbaceous biomass (2); Fruit biomass (3); Blends and mixtures (4).
	Traded Form (see Table 2)	Pellets
Normative	*L* Length *D* Diameter **Figure 3 — Dimensions (mm)** 	
	Dimensions (mm)	
	Diameter (*D*) and Length (*L*) [a]	
	D 06	6 mm ± 1,0 mm and 3,15 ≤ L ≤ 40 mm
	D 08	8 mm ± 1,0 mm, and 3,15 ≤ L ≤ 40 mm
	D 10	10 mm ± 1,0 mm, and 3,15 ≤ L ≤ 40 mm
	D 12	12 mm ± 1,0 mm, and 3,15 ≤ L ≤ 50 mm
	D 25	25 mm ± 1,0 mm, and 10 ≤ L ≤ 50 mm
	Moisture, M (w-% as received) EN 14774-1, EN 14774-2	
	M10	≤ 10 %
	M15	≤ 15 %
	Ash, A (w-% of dry basis) EN 14775	
	A0.5	≤ 0,5%
	A0.7	≤ 0,7%
	A1.0	≤ 1,0%
	A1.5	≤ 1,5 %
	A2.0	≤ 2,0 %
	A3.0	≤ 3,0 %
	A5.0	≤ 5,0 %
	A7.0	≤ 7,0 %
	A10.0	≤ 10,0 %
	A10.0+	> 10,0 %
	Mechanical durability, DU (w-% of pellets after testing) EN 15210-1	
	DU97.5	≥ 97,5 %
	DU96.5	≥ 96,5 %
	DU95.0	≥ 95,0 %
	DU95.0-	< 95,0 % (minimum value to be stated)
	Amount of fines, F (w-%, < 3,15 mm [b]) after production when loaded or packed, CEN/TS 15149-1	
	F1.0	≤ 1,0 %
	F2.0	≤ 2,0 %
	F3.0	≤ 3,0 %
	F5.0	≤ 5,0 %
	F5.0+	> 5,0 % (maximum value to be stated)
	Additives (w-% of pressing mass) [c]	Type and content of pressing aids, slagging inhibitors or any other additives have to be stated
	Bulk density (BD) as received (kg/m^3) EN 15103	
	BD550	≥ 550 kg/m^3
	BD600	≥ 600 kg/m^3
	BD650	≥ 650 kg/m^3
	BD700	≥ 700 kg/m^3
	BD700+	> 700 kg/m^3 (minimum value to be stated)
	Net calorific value as received, Q (MJ/kg or kWh/kg) EN 14918	Minimum value to be stated

Normative / informative	**Sulphur, S** (w-% of dry basis) CEN/TS 15289		
	S0.02	≤ 0,02 %	Normative: Chemically treated biomass (1.2.2; 1.3.2; 2.2.2; 3.2.2) or if sulphur containing additives have been used. Informative: All fuels that are not chemically treated (see the exceptions above)
	S0.05	≤ 0,05 %	
	S0.08	≤ 0,08 %	
	S0.10	≤ 0,10 %	
	S0.20	≤ 0,20 %	
	S0.20+	> 0,20 % (maximum value to be stated)	
	Nitrogen, N (w-% of dry basis) CEN/TS 15104		
	N0.3	≤ 0,3 %	Normative: Chemically treated biomass (1.2.2; 1.3.2; 2.2.2; 3.2.2) Informative: All fuels that are not chemically treated (see the exceptions above)
	N0.5	≤ 0,5 %	
	N1.0	≤ 1,0 %	
	N2.0	≤ 2,0 %	
	N3.0	≤ 3,0 %	
	N3.0+	> 3,0 % (maximum value to be stated)	
	Chlorine, Cl (w-% of dry basis) CEN/TS 15289		
	Cl0.02	≤ 0,02 %	Normative: Chemically treated biomass (1.2.2; 1.3.2; 2.2.2; 3.2.2) Informative: All fuels that are not chemically treated (see the exceptions above)
	Cl0.03	≤ 0,03 %	
	Cl0.07	≤ 0,07 %	
	Cl0.10	≤ 0,10 %	
	Cl0.10+	> 0,10 % (maximum value to be stated)	
Informative: Ash melting behaviour (°C) CEN/TS 15370-1			Deformation temperature, DT should be stated

[a] Amount of pellets longer than 40 mm (or 50 mm) can be 5 w-%. Maximum length for classes *D*06, *D*08 and *D*10 shall be < 45 mm.

[b] Fines shall be determined by using method CEN/TS 15149-1.

[c] The maximum amount of additive is 20 w-% of pressing mass. Type stated (e.g. starch). If amount is greater, then raw material for pellet is blend.

NOTE 5 Special attention should be paid to the ash melting behaviour for some biomass fuels, for example eucalyptus, poplar, short rotation coppice, straw, miscanthus and olive stone.

Table 5 —Specification of properties for wood chips

	Master table			
	Origin: According to 6.1 and Table 1.			Woody biomass (1)
	Traded Form			Wood chips
Normative	**Dimensions** (mm) CEN/TS 15149-1, CEN/TS 15149-2			
		Main fraction (minimum 75 w-%), mm [a]	Fines fraction, w-% (< 3,15 mm)	Coarse fraction, (w-%), max. length of particle, mm
	P16A [c]	3,15 ≤ P ≤ 16 mm	≤ 12 %	≤ 3 % > 16 mm and all < 31,5 mm
	P16B [c]	3,15 ≤ P ≤ 16 mm	≤ 12 %	≤ 3 % > 45 mm and all < 120 mm
	P45A [c]	8 ≤ P ≤ 45 mm	≤ 8 % [b]	≤ 6 % > 63 mm and maximum 3,5 % > 100 mm, all < 120 mm
	P45B [c]	8 ≤ P ≤ 45 mm [b]	≤ 8 % [b]	≤ 6 % > 63 mm and maximum 3,5 % > 100 mm, all < 350 mm
	P63 [c]	8 ≤ P ≤ 63 mm [b]	≤ 6 % [b]	≤ 6 % > 100 mm, all < 350 mm
	P100 [c]	16 ≤ P ≤ 100 mm [b]	≤ 4 % [b]	≤ 6 % > 200 mm, all < 350 mm
	Moisture, M (w-% as received) EN 14774-1, EN 14774-2			
	M10	≤ 10 %		
	M15	≤ 15 %		
	M20	≤ 20 %		
	M25	≤ 25 %		
	M30	≤ 30 %		
	M35	≤ 35 %		
	M40	≤ 40 %		
	M45	≤ 45 %		
	M50	≤ 50 %		
	M55	≤ 55 %		
	M55+	> 55 % (maximum value to be stated)		
	Ash, A (w-% of dry basis) EN 14775			
	A0.5	≤ 0,5 %		
	A0.7	≤ 0,7 %		
	A1.0	≤ 1,0 %		
	A1.5	≤ 1,5 %		
	A2.0	≤ 2,0 %		
	A3.0	≤ 3,0 %		
	A5.0	≤ 5,0 %		
	A7.0	≤ 7,0 %		
	A10.0	≤ 10,0 %		
	A10.0+	> 10,0 % (maximum value to be stated)		
Normative / informative	**Nitrogen, N** (w-% of dry basis) CEN/TS 15104			
	N0.3	≤ 0,3 %		Normative: Chemically treated biomass (1.2.2; 1.3.2) Informative: All fuels that are not chemically treated (see the exceptions above)
	N0.5	≤ 0,5 %		
	N1.0	≤ 1,0 %		
	N2.0	≤ 2,0 %		
	N3.0	≤ 3,0 %		
	N3.0+	> 3,0 % (maximum value to be stated)		
	Chlorine, Cl (w-% of dry basis) CEN/TS 15289			
	Cl0.02	≤ 0,02 %		Normative: Chemically treated biomass (1.2.2; 1.3.2) Informative: All fuels that are not chemically treated (see the exceptions above)
	Cl0.03	≤ 0,03 %		
	Cl0.07	≤ 0,07 %		
	Cl0.10	≤ 0,10 %		
	Cl0.10+	> 0,10 % (maximum value to be stated)		

Informative	**Net calorific value, Q** (MJ/kg or kWh/kg as received) or **energy density, E** (MJ/ m^3 loose or kWh/m^3 loose) EN 14918		
	Minimum value to be stated		
	Bulk density (BD) as received (kg/m^3) EN 15103		
	BD150	≥ 150	Recommended to be stated if traded by volume basis
	BD200	≥ 200	
	BD250	≥ 250	
	BD300	≥ 300	
	BD350	≥ 350	
	BD400	≥ 400	
	BD450	≥ 450	
	BD450+	> 450 (minimum value to be stated)	
	Ash melting behaviour (°C) CEN/TS 15370-1		Deformation temperature, DT should be stated

[a] The numerical values (P-class) for dimension refer to the particle sizes (at least 75 w-%) passing through the mentioned round hole sieve size (CEN/TS 15149-1). The cross sectional area of the oversized particles shall be P16 < 1 cm², for P45 < 5 cm², for P63 < 10 cm² and P100 < 18 cm².

[b] For logging residue chips, which include thin particles like needles, leaves and branches, the main fraction for P45B is 3,15 ≤ P ≤ 45 mm, for P63 is 3,15 ≤ P ≤ 63 mm and for P100 is 3,15 ≤ P ≤ 100 mm and amount of fines (< 3,15 mm) may be maximum 25 w-%.

[c] Property classes P16A, P16B and P45A are for non-industrial and property class P45B, P63 and P100 for industrial appliances. In industrial classes P45B, P63 and P100 the amount of fines may be stated from the following F04, F06, F08.

NOTE 6 Special attention should be paid to the ash melting behaviour for some biomass fuels, for example eucalyptus, poplar, short rotation coppice.

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Table 6 —Specification of properties for hog fuel

	Master table		
	Origin: According to 6.1 and Table 1.		Woody biomass (1)
	Traded Form		Hog fuel
Normative	**Dimensions** (mm) CEN/TS 15149-1, CEN/TS 15149-2		
	Main fraction (minimum 75 w-%), mm [a]		Coarse fraction, w-% (max. length of particle, mm) [b]
	P16	3,15≤ P ≤ 16 mm	≤ 6 % > 45 mm and all < 120 mm
	P45	3,15 ≤P ≤ 45 mm	≤ 10 % > 63 mm and all < 350 mm
	P63	3,15 ≤ P ≤ 63 mm	≤ 10 % > 100 mm and all < 350 mm
	P100	3,15 ≤ P ≤ 100 mm	≤ 10 % > 125 mm and all < 350 mm
	P125	3,15 ≤ P ≤ 125 mm	≤ 10 % > 150 mm and all < 350 mm
	P200	3,15 ≤ P ≤ 200 mm	to be specified
	P300	3,15 ≤ P ≤ 300 mm	to be specified
	Fine fraction (< 3,15 mm), % of weight, CEN/TS 15149-2		
	F06	≤ 6 %	
	F10	≤ 10 %	
	F12	≤ 12 %	
	F15	≤ 15 %	
	F20	≤ 20 %	
	F25	≤ 25 %	
	Moisture, M (w-% as received) EN 14774-1, EN 14774-2		
	M10	≤ 10 %	
	M15	≤ 15 %	
	M20	≤ 20 %	
	M25	≤ 25 %	
	M30	≤ 30 %	
	M35	≤ 35 %	
	M40	≤ 40 %	
	M45	≤ 45 %	
	M50	≤ 50 %	
	M55	≤ 55 %	
	M55+	> 55 % (maximum value to be stated)	
	Ash, A (w-% of dry basis) EN 14775		
	A0.5	≤ 0,5 %	
	A0.7	≤ 0,7 %	
	A1.0	≤ 1,0 %	
	A1.5	≤ 1,5 %	
	A2.0	≤ 2,0 %	
	A3.0	≤ 3,0 %	
	A5.0	≤ 5,0 %	
	A7.0	≤ 7,0 %	
	A10.0	≤ 10,0 %	
	A10.0+	> 10,0 % (maximum value to be stated)	
	Net calorific value, Q (MJ/kg as received) or **energy density, E** (kWh/m^3 loose) EN 14918		Minimum value to be stated
Normative / informative	**Nitrogen, N** (w-% of dry basis) CEN/TS 15104		
	N0.3	≤ 0,3 %	Normative: Chemically treated biomass (1.2.2, 1.3.2) Informative: All fuels that are not chemically treated (see the exceptions above)
	N0.5	≤ 0,5 %	
	N1.0	≤ 1,0 %	
	N2.0	≤ 2,0 %	
	N3.0	≤ 3,0 %	
	N3.0+	> 3,0 % (maximum value to be stated)	
	Chlorine, Cl (w-% of dry basis) CEN/TS 15289		
	Cl0.02	≤ 0,02 %	Normative: Chemically treated biomass (1.2.2; 1.3.2) Informative: All fuels that are not chemically treated (see the exceptions above)
	Cl0.03	≤ 0,03 %	
	Cl0.07	≤ 0,07 %	
	Cl0.10	≤ 0,10 %	
	Cl0.10+	> 0,10 % (maximum value to be stated)	

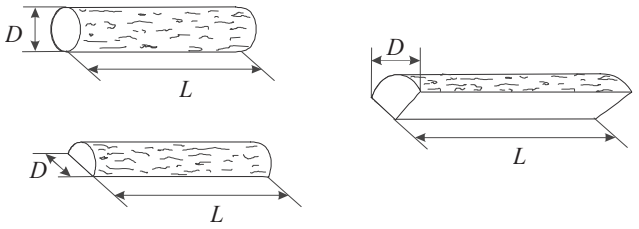
Informative	**Bulk density (BD)** as received (kg/m^3) EN 15103		
	BD150	≥ 150	Recommended to be stated if traded by volume basis
	BD200	≥ 200	
	BD250	≥ 250	
	BD300	≥ 300	
	BD350	≥ 350	
	BD400	≥ 400	
	BD450	≥ 450	
	BD450+	> 450 (minimum value to be stated)	
	Ash melting behaviour (°C) CEN/TS 15370-1		Deformation temperature, DT should be stated

[a] The numerical values (P-class) for dimension refer to the particle sizes (at least 75 w-%) passing through the mentioned round hole sieve size (CEN/TS 15149-1).

[b] The cross sectional area of the oversized particles shall be P16 < 1 cm², for P45 < 5 cm², for P63 < 10 cm² and P100 < 18 cm².

NOTE 7 Special attention should be paid to the ash melting behaviour for some biomass fuels, for example eucalyptus, poplar, short rotation coppice.

Table 7 — Specification of properties for log wood, firewood

	Master table		
	Origin: According to 6.1 and Table 1.		Woody biomass (1.1) Wood species to be stated
	Traded Form		Log wood, firewood
Normative	**Dimensions** (cm)		
	Length (L) (maximum length of a single chop), cm		
	L 20- L 20 L 25 L 30 L 33 L 40 L 50 L 100 L 100+	< 20 cm 20 cm ± 2 cm 25 cm ± 2 cm 30 cm ± 2 cm 33 cm ± 2 cm 40 cm ± 2 cm 50 cm ± 4 cm 100 cm ± 5 cm maximum value has to be stated	 L Length D Diameter **Figure 4 — Examples**
	Diameter (D) (maximum diameter of a single chop), cm		
	D 2- D 10 D 12 D 15 D 20 D 25 D 35 D 35+	D < 2 cm ignition wood (kindling) 2 cm ≤ D ≤ 10 cm 4 cm ≤ D ≤ 12 cm 10 cm ≤ D ≤ 15 cm 10 cm ≤ D ≤ 20 cm 10 cm ≤ D ≤ 25 cm 20 cm ≤ D ≤ 35 cm D > 35 cm, maximum value to be stated	
	Moisture, M (w-% as received) CEN/TS 15149-1, CEN/TS 15149-2		
	M10 M15 M20 M25 M30 M35 M40 M45 M55 M55+	≤ 10 % ≤ 15 % ≤ 20 % ≤ 25 % ≤ 30 % ≤ 35 % ≤ 40 % ≤ 45 % ≤ 55 % > 55 % (maximum value to be stated)	
	Volume or weight, m^3 stacked or loose or kg as received		To be stated which volume is used when retailed (m^3 stacked or m^3 loose, kg) and/or packaged log woods weight.
Informative	**Energy density, E** [b] (kWh/kg or kWh/m^3 loose or stacked)		Recommended to be specified when retailed.
	Proportion of split volume		No split (= mainly round wood) Split: more than 85 % of volume is split Mixture: split and round wood as a mixture
	The cut-off surface		To be stated if the cut-off surface of log woods are even [a] and smooth [a] or ends of log woods are uneven
	Mould and decay		If significant amount (more than 10 % of weight) of mould and decay exists it should be stated. In case of doubt particle density or net calorific value could be used as indicator.

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

[b] The energy density may be calculated according to Annex D on the basis of the bulk density and the net calorific value of the dry fuel. Example: For a firewood with a net calorific value on dry basis, E of 5,3 kWh/kg and an actual moisture content M_{ar} of 15 w-%, the net calorific value on as received basis E_{ar} is 4,43 kWh/kg. For a bulk density BD of 410 kg/stacked m^3, the energy density E_{ar} is 1 800 kWh/stacked m^3.

Table 8 —Specification of properties for sawdust

	Master table		
	Origin: According to 6.1 and Table 1.		Woody biomass (1)
	Traded Form		Sawdust
Normative	**Moisture, M** (w-% as received) EN 14774-1, EN 14774-2		
	M10	≤ 10 %	
	M15	≤ 15 %	
	M20	≤ 20 %	
	M25	≤ 25 %	
	M30	≤ 30 %	
	M35	≤ 35 %	
	M45	≤ 45 %	
	M50	≤ 50 %	
	M55	≤ 55 %	
	M60	≤ 60 %	
	M65	≤ 65 %	
	M65+	> 65 % (maximum value to be stated)	
	Ash, A (w-% of dry basis) EN 14775		
	A0.5	≤ 0,5 %	
	A0.7	≤ 0,7 %	
	A1.0	≤ 1,0 %	
	A1.5	≤ 1,5 %	
	A2.0	≤ 2,0 %	
	A3.0	≤ 3,0 %	
	A5.0	≤ 5,0 %	
	A7.0	≤ 7,0 %	
	A10.0	≤ 10,0 %	
	A10.0+	> 10,0 % (maximum value to be stated)	
	Net calorific value, Q (MJ/kg as received) or **energy density, E** (kWh/m^3 loose) EN 14918		Minimum value to be stated
Normative / informative	**Nitrogen, N** (w-% of dry basis)		
	N0.3	≤ 0,3 %	Normative: Chemically treated biomass (1.2.2; 1.3.2) Informative: All fuels that are not chemically treated (see the exceptions above)
	N0.5	≤ 0,5 %	
	N1.0	≤ 1,0 %	
	N2.0	≤ 2,0 %	
	N3.0	≤ 3,0 %	
	N3.0+	> 3,0 % (maximum value to be stated)	
	Chlorine, Cl (weight of dry basis, w-%) CEN/TS 15289		
	Cl0.02	≤ 0,02 %	Normative: Chemically treated biomass (1.2.2; 1.3.2) Informative: All fuels that are not chemically treated (see the exceptions above)
	Cl0.03	≤ 0,03 %	
	Cl0.07	≤ 0,07 %	
	Cl0.10	≤ 0,10 %	
	Cl0.10+	> 0,10 % (maximum value to be stated)	
Informative	**Bulk density (BD)** as received (kg/m^3) EN 15103		
	BD100	≥ 100 kg/m^3	Recommended to be stated if traded by volume basis
	BD150	≥ 150 kg/m^3	
	BD200	≥ 200 kg/m^3	
	BD250	≥ 250 kg/m^3	
	BD300	≥ 300 kg/m^3	
	BD350	≥ 350 kg/m^3	
	BD350+	≥ 350 kg/m^3 (minimum value to be stated)	
	Ash melting behaviour (°C) CEN/TS 15370-1		Deformation temperature, DT should be stated

NOTE 8 Particle size of sawdust is considered to be homogenous. Particle size distribution may be specified if requested.

Table 9 —Specification of properties for shavings

	Master table		
	Origin: According to 6.1 and Table 1.		Woody biomass (1)
	Traded Form		Shavings
Normative	**Moisture, M** (w-% as received) EN 14774-1, EN 14774-2		
	M10	≤ 10 %	
	M15	≤ 15 %	
	M20	≤ 20 %	
	M30	≤ 30 %	
	M30+	> 30 % (maximum value to be stated)	
	Ash, A (w-% of dry basis) EN 14775		
	A0.5	≤ 0,5 %	
	A0.7	≤ 0,7 %	
	A1.0	≤ 1,0 %	
	A1.5	≤ 1,5 %	
	A2.0	≤ 2,0 %	
	A3.0	≤ 3,0 %	
	A5.0	≤ 5,0 %	
	A7.0	≤ 7,0 %	
	A10.0	≤ 10,0 %	
	A10.0+	> 10,0 % (maximum value to be stated)	
	Net calorific value Q (MJ/kg as received) or **energy density, E** (kWh/m^3 loose) EN 14918		Minimum value to be stated
Normative / informative	**Nitrogen, N** (w-% of dry basis)		
	N0.3	≤ 0,3 %	Normative: Chemically treated biomass (1.2.2; 1.3.2) Informative: All fuels that are not chemically treated (see the exceptions above)
	N0.5	≤ 0,5 %	
	N1.0	≤ 1,0 %	
	N2.0	≤ 2,0 %	
	N3.0	≤ 3,0 %	
	N3.0+	> 3,0 % (maximum value to be stated)	
	Chlorine, Cl (weight of dry basis, w-%) CEN/TS 15289		
	Cl0.02	≤ 0,02 %	Normative: Chemically treated biomass (1.2.2; 1.3.2) Informative: All fuels that are not chemically treated (see the exceptions above)
	Cl0.03	≤ 0,03 %	
	Cl0.07	≤ 0,07 %	
	Cl0.10	≤ 0,10 %	
	Cl0.10+	> 0,10 % (maximum value to be stated)	
Informative	**Bulk density (BD)** as received (kg/m^3) EN 15103		
	BD100	≥ 100 kg/m^3	Recommended to be stated if traded by volume basis
	BD150	≥ 150 kg/m^3	
	BD200	≥ 200 kg/m^3	
	BD250	≥ 250 kg/m^3	
	BD300	≥ 300 kg/m^3	
	BD300+	> 300 kg/m^3 (minimum value to be stated)	
	Ash melting behaviour (°C) CEN/TS 15370-1		Deformation temperature, DT should be stated

NOTE 9 Particle sizes of shavings are considered to be homogenous. Particle size distribution may be specified if requested.

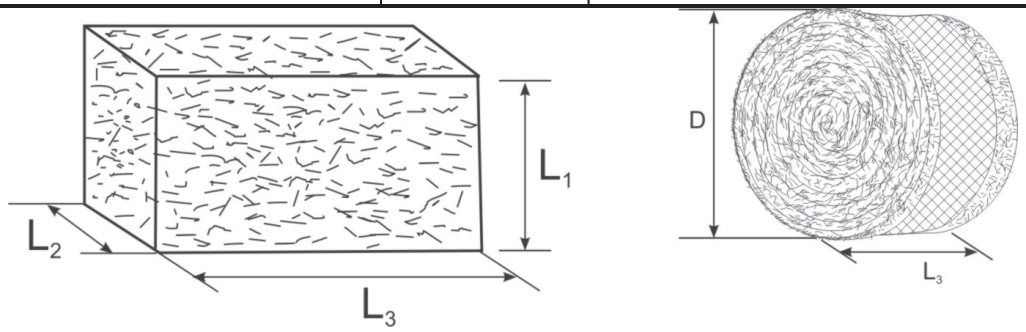
Table 10 —Specification of properties for bark [a]

	Master table		
	Origin: According to 6.1 and Table 1.		Woody biomass (1.1.6, 1.2.1.5, 1.2.2.3, 1.3.1.3, 1.3.2.3)
	Traded Form:		Bark
Normative	**Dimensions** (mm) CEN/TS 15149-1, CEN/TS 15149-2		
		Nominal top size, mm [b]	Coarse fraction, max. length of a particle, mm < 5 w-%
	P16	P < 16 mm	> 45 mm all < 90 mm
	P45	P < 45 mm	> 63 mm
	P63	P < 63 mm	> 100 mm
	P100	P < 100 mm	> 125 mm
	P200	P < 200 mm	> 250 mm
	Moisture, M (w-% as received) EN 14774-1, EN 14774-2		
	M20	≤ 20 %	
	M25	≤ 25 %	
	M30	≤ 30 %	
	M35	≤ 35 %	
	M40	≤ 40 %	
	M45	≤ 45 %	
	M50	≤ 50 %	
	M55	≤ 55 %	
	M60	≤ 60 %	
	M65	≤ 65 %	
	M65+	> 65 % (maximum value to be stated)	
	Ash, A (w-% of dry basis) EN 14775		
	A1.0	≤ 1,0 %	
	A1.5	≤ 1,5 %	
	A2.0	≤ 2,0 %	
	A3.0	≤ 3,0 %	
	A5.0	≤ 5,0 %	
	A7.0	≤ 7,0 %	
	A10.0	≤ 10,0 %	
	A10.0+	> 10,0 % (maximum value to be stated)	
	Shredding		To be stated if bark is shredded into pieces or unshredded
	Net calorific value, Q (MJ/kg as received) or **energy density, E** (kWh/m^3 loose or MWh/m^3 loose) EN 14918		Minimum value to be stated
Normative / informative	**Nitrogen, N** (w-% of dry basis) CEN/TS 15104		
	N0.5	≤ 0,5 %	Normative: Chemically treated biomass (1.2.2; 1.3.2) Informative: All fuels that are not chemically treated (see the exceptions above)
	N1.0	≤ 1,0 %	
	N2.0	≤ 2,0 %	
	N3.0	≤ 3,0 %	
	N3.0+	> 3,0 % (maximum value to be stated)	
	Chlorine, Cl (w-% of dry basis) CEN/TS 15289		
	Cl0.02	≤ 0,02 %	Normative: Chemically treated biomass (1.2.2; 1.3.2) Informative: All fuels that are not chemically treated (see the exceptions above)
	Cl0.03	≤ 0,03 %	
	Cl0.07	≤ 0,07 %	
	Cl0.10	≤ 0,10 %	
	Cl0.10+	> 0,10 % (maximum value to be stated)	
Informative	**Bulk density (BD)** as received (kg/m^3) EN 15103		
	BD250	≥ 250 kg/m^3	Recommended to be stated if traded by volume basis
	BD300	≥ 300 kg/m^3	
	BD350	≥ 350 kg/m^3	
	BD400	≥ 400 kg/m^3	
	BD450	≥ 450 kg/m^3	
	Ash melting behaviour (°C)		Deformation temperature, DT should be stated

[a] Also cork is included.

[b] The numerical values (P-class) for dimension refer to the particle sizes (at least 95 % by mass) passing through the mentioned round hole sieve size (CEN/TS 15149-1).

Table 11 — Specification of properties for straw bales, reed canary grass bales and Miscanthus bales

	Master table			
	Origin: According to 6.1 and Table 1.	2.1.1.2 Cereal crop straw, 2.1.2.1 Whole plant (Reed canary grass and Miscanthus, 2.1.2.2 Grass straw, 2.1.3.2 Oil seed crops stalks and leaves		
	Traded Form	Round bale and square bale		
Normative	 L_1 Height D Diameter L_2 Width L_3 Length **Figure 5 — Dimensions (m)**			
	Round bale	Diameter (D)	Length (L_3)	
	D 1	1,2 – 1,5	1,2	
	D 2	1,6 – 1,8	1,5	
	Square bale	Height (L_1)	Width (L_2)	Length (L_3)
	P1	≤ 0,35	≤ 0,4	≤ 0,5
	P2	≤ 0,9	≤ 1,2	1,5 – 2,8
	P3	≤ 1,3	≤ 1,2	1,0 - 3,0
	P3+	Maximum values to be stated		
	Bale density, BD (kg/m^3)			
	BD100	≥ 100		
	BD120	≥ 120		
	BD160	≥ 160		
	BD180	≥ 180		
	BD220	≥ 220		
	BD220+	> 220 (minimum value to be stated)		
	Moisture, M (w-% as received) EN 14774-1, EN 14774-2			
	M10	≤ 10 %		
	M15	≤ 15 %		
	M20	≤ 20 %		
	M25	≤ 25 %		
	M30	≤ 30 %		
	M30+	> 30 % (maximum value to be stated)		
	Ash, A (w-% of dry basis) EN 14775			
	A5.0	≤ 5 %		
	A7.0	≤ 7 %		
	A10.0	≤ 10 %		
	A10.0+	> 10 % (maximum value to be stated)		
	Species of biomass	Has to be stated (Example: spring harvested reed canary grass (*Phalaris arundinacea L.*) or Miscanthus (*Miscanthus Giganteus*))		
	Net calorific value, Q (MJ/kg as received) or **energy density, E** (kWh/m^3 loose or MWh/m^3 loose) EN 14918	Minimum value to be stated		

Informative	**Production method**	It is recommended to declare production methods that influence the size of the straw particles in the bale. That is for instance whether the crop has been trashed by rotation or oscillation or whether it has been chopped. Harvested as a whole plant for Reed canary grass and Miscanthus
	Chlorine, Cl (w-% of dry basis) CEN/TS 15289	
	Cl0.01	≤ 0,01 %
	Cl0.03	≤ 0,03 %
	Cl0.07	≤ 0,07 %
	Cl0.10	≤ 0,10 %
	Cl0.10+	> 0,10 % (maximum value to be stated)
	Binding type of bales	Tying material recommended to be specified (net binding, plastic line)
	Ash melting behaviour (°C) prEN 15370	Deformation temperature, DT should be stated

Table 12 — Specification of properties for energy grain

	Master table		
	Origin: According to 6.1 and Table 1		Herbaceous biomass (2.1.1.3)
	Traded Form		Grain
Normative	**Dimensions** (mm)		
	Diameter (D) (5 w-% may have diameter over the class) CEN/TS 15149-1, CEN/TS 15149-2		
	D 05	1 mm ≤ D ≤ 5 mm	
	D 10	3,15 mm ≤ D ≤ 10 mm	
	Moisture, M (w-% as received) EN 14774-1, EN 14774-2		
	M10	M ≤ 10 %	
	M15	M ≤ 15 %	
	Ash, A (w-% of dry basis) EN 14775		
	A2.0	≤ 2,0 %	
	A3.0	≤ 3,0 %	
	A5.0	≤ 5,0 %	
	A5.0+	> 5,0 % (maximum value to be stated)	
	Net calorific value as received, Q (MJ/kg) EN 14918		Minimum value to be stated
	Nitrogen, N (w-% of dry basis) CEN/TS 15104		
	N2.0	≤ 2,0 %	
	N2.0+	> 2,0 % (maximum value to be stated)	
	Sulphur, S (w-% of dry basis) CEN/TS 15289		
	S0.20	≤ 0,20 %	
	S0.20+	> 0,20 % (maximum value to be stated)	
Informative	**Amount of fines, F** (w-%, < 1 mm for D 05 and w-%, < 3,15 mm for D 10) CEN/TS 15149-2		
	F1.0	≤ 1,0 %	
	F1.0+	> 1,0 % (without additive)	
	Bulk density (BD) as received (kg/m^3) EN 15103		
	BD550	≥ 550 kg/m^3	
	BD550+	> 550 kg/m^3 (minimum value to be stated)	
	Chlorine, Cl (w-% of dry basis) CEN/TS 15289		
	Cl 0.10	≤ 0,10 %	
	Cl 0.15	≤ 0,15 %	
	Cl0.15+	> 0,15 % (maximum value to be stated)	
	Ash melting behaviour (°C) CEN/TS 15370-1		Deformation temperature, DT should be stated

NOTE When using cereal grain materials for combustion special attention should be paid to risk of corrosion in small- and medium-scale boilers and flue gas system. Be aware that different types and varieties of grains, grown under different conditions and soil type, may have a fuel ash composition, i.e. high content of P, K and Cl, that will capture chlorine (K will form K-phosphates instead of KCl) in the ash that will result in high hydrochloric emissions.

Table 13 — Specification of properties for olive residues

	Master table		
	Origin: According to 6.1 and Table 1		Fruit biomass (3.2.1.2, 3.2.1.4,3.2.2.2,3.2.2.4)
	Traded Form		Grain or seed, kernel
Normative	**Dimensions** (mm)		
	Diameter (D) [a], CEN/TS 15149-1, CEN/TS 15149-2		
	D 03	1 mm ≤ D ≤ 3,15 mm	
	D 05	1 mm ≤ D ≤ 5 mm	
	D 10	1 mm ≤ D ≤ 10 mm	
	D 10+	D > 10 mm (maximum value to be stated)	
	Moisture, M (w-% as received) EN 14774-1, EN 14774-2		
	M10	M ≤ 10 %	
	M15	M ≤ 15 %	
	Ash, A (w-% of dry basis) EN 14775		
	A1.5	≤ 1,5 %	
	A2.0	≤ 2,0	
	A3.0	≤ 3,0	
	A5.0	≤ 5,0 %	
	A7.0	≤ 7,0 %	
	A10.0	≤ 10,0 %	
	A10.0+	> 10,0 % (maximum value to be stated)	
	Additives (w-%)		Type and amount of additive have to be stated
	Net calorific value as received, Q (MJ/kg) [b], EN 14918		Minimum value to be stated
	Nitrogen, N (w-% of dry basis) CEN/TS 15104		
	N1.0	≤ 1,0 %	
	N1.5	≤ 1,5 %	
	N2.0	≤ 2,0 %	
	N3.0	≤ 3,0 %	
	N3.0+	> 3,0 % (maximum value to be stated)	
Informative	**Amount of fines, F** (w-%, < 1 mm) CEN/TS 15149-2		
	F1.0	≤ 1,0 %	
	F1.0+	> 1,0 % (without additive)	
	Bulk density (BD) as received (kg/m^3 loose) EN 15103		Recommended to be stated if traded by volume basis
	Chlorine, Cl (w-% of dry basis) CEN/TS 15289		
	Cl 0.10	≤ 0,10 %	
	Cl 0.15	≤ 0,15 %	
	Cl0.15+	> 0,15 % (maximum value to be stated)	
	Sulphur, S (w-% of dry basis) CEN/TS 15289		
	S0.15	≤ 0,15 %	
	S0.20	≤ 0,20 %	
	S0.20+	> 0,20 % (maximum value to be stated)	
	Ash melting behaviour (°C) CEN/TS 15370-1		Deformation temperature, DT should be stated

[a] 5 w-% may have diameter over the class.
[b] Additives can reduce net calorific value.

Table 14 — Specification of properties for fruit seeds

	Master table	
	Origin: According to 6.1 and Table 1	Fruit biomass (3.1.1.3, 3.1.3, 3.1.3.3, 3.2.1.2, 3.2.1.3, 3.2.2.2, 3.2.2.3)
	Traded Form	Fruit seed or kernel
Normative	**Dimensions** (mm) CEN/TS 15149-1, CEN/TS 15149-2	
	Diameter (D) (5 w-% may have diameter over the class)	
	D 03	1 mm ≤ D ≤ 3,15 mm
	D 05	1 mm ≤ D ≤ 5 mm
	D 10	1 mm ≤ D ≤ 10 mm
	D 10+	D > 10 mm (maximum value to be stated)
	Moisture, M (w-% as received) EN 14774-1, EN 14774-2	
	M10	M ≤ 10 %
	M15	M ≤ 15 %
	Ash, A (w-% of dry basis) EN 14775	
	A1.5	≤ 1,5 %
	A2.0	≤ 2,0
	A3.0	≤ 3,0
	A5.0	≤ 5,0 %
	A7.0	≤ 7,0 %
	A10.0	≤ 10,0 %
	A10.0+	> 10,0 % (maximum value to be stated)
	Additives (w-%)	Type and amount of additive have to be stated
	Net calorific value as received, Q (MJ/kg) [a], EN 14918	Minimum value to be stated
	Nitrogen, N (w-% of dry basis) CEN/TS 15104	
	N1.0	≤ 1,0 %
	N1.5	≤ 1,5 %
	N2.0	≤ 2,0 %
	N3.0	≤ 3,0 %
	N3.0+	> 3,0 % (maximum value to be stated)
Informative	**Amount of fines, F** (w-%, < 1 mm) CEN/TS 15149-2	
	F1.0	≤ 1,0 %
	F1.0+	> 1,0 % (without additive)
	Bulk density (BD) as received (kg/m^3) EN 15103	Recommended to be stated if traded by volume basis
	Chlorine, Cl (w-% of dry basis) CEN/TS 15289	
	Cl 0.10	≤ 0,10 %
	Cl 0.15	≤ 0,15 %
	Cl 0.15+	> 0,15 % (maximum value to be stated)
	Sulphur, S (w-% of dry basis) CEN/TS 15289	
	S0.15	≤ 0,15 %
	S0.20	≤ 0,20 %
	S0.20+	> 0,20 % (maximum value to be stated)
	Ash melting behaviour (°C) CEN/TS 15370-1	Deformation temperature, DT should be stated

[a] Additives can reduce net calorific value.

NOTE 10 Includes kernels, nuts and acorns.

Table 15 — General master table for specification of properties for other solid biofuels

	General Master Table		
	Origin		To be specified in accordance with to 6.1 and Table 1, as detailed as needed.
	Traded Form		A short description of the form of the biofuel (see Table 2 for guidelines).
Normative	**Dimensions** (mm)		If dimensions are not suitable to express as diameter and length other formats may be used, but shall then be clearly stated.
	D_x	x = Maximum diameter	
	L_y	y = Maximum length	
	Moisture, M (w-% as received) EN 14774-1, EN 14774-2		Recommended to be stated as a class: M10, M15, M20, M25, M30; M35, M40, M45, M50; M55, M60; M65, M65+ (maximum value to be stated)
	MXX	≤ XX %	
	Ash, A (w-% of dry basis) EN 14775		Recommended to be stated as a class: A0.5, A0.7, A1.0, A1.5, A2.0, A3.0, A5.0, A7.0, A10, A10+ (maximum value to be stated)
	AXX.X	≤ XX,X %	
Normative/informative	**Additives** (w-% of dry basis)		If any type of additive is added to the fuel, amount and type shall be stated. The maximum amount of additive is 20 w-% of in solid biofuels. If amount is greater, then solid biofuel is a blend.
	Type and content of additives to be stated		
	Nitrogen, N (w-% of dry basis) CEN/TS 15104		Nitrogen is normative only for chemically treated biomass. Recommended to be stated as a class N0.5, N1.0, N1.5, N2.0, N3.0, N3.0+ (maximum value to be stated)
	NX.X	≤ X,X %	
	Net calorific value, Q (MJ/kg as received) or **energy density, E** (kWh/ m^3 loose) EN 14918		Minimum value to be stated.
	Bulk density (BD) as received (kg/m^3) EN 15103		Recommended to be stated in the classes (minimum value): BD200, BD250, BD300, BD300, BD350, BD400, BD450, BD500, BD550, BD600, BD650, BD750.
	Chlorine, Cl (weight of dry basis, w-%) CEN/TS 15289		Chlorine is normative only for chemically treated biomass. Recommended to be state as a class: Cl 0.01, Cl 0.02, Cl 0.03, Cl 0.07, Cl 0.10 and Cl 0.10+ (if Cl > 0,10% maximum value to be stated)
	ClX.XX	≤ X,XX %	
	Sulphur, S (w-% of dry basis) CEN/TS 15289		Sulphur is normative only for chemically treated biomass or if sulphur containing additives have been used. Recommended to be stated as a class S0,03, S0,05, S0,1, S0,2 and S0,2+ (if S > 0,2 % maximum value to be stated)
	SX.XX	≤ X,XX %	
	Further specification of dimensions		It is recommended that maximum allowed amount of fine and coarse particles of the fuel should be stated.
	Others e.g. major (CEN/TS 15290) and minor elements (CEN/TS 15297)		Properties that are specific to the actual solid biofuel and considered as containing useful information.
Informative			
	Ash melting behaviour (°C) CEN/TS 15370-1		Deformation temperature, DT should be stated
NOTE Property classes from Table 3 to 14 can be used if also appropriate in this master table.			

Annex A
(informative)

Illustrations of typical forms of wood fuels

A.1 Visually classifying wood fuels based on a typical particle size (Source: Swedish University of Agricultural Sciences[2])

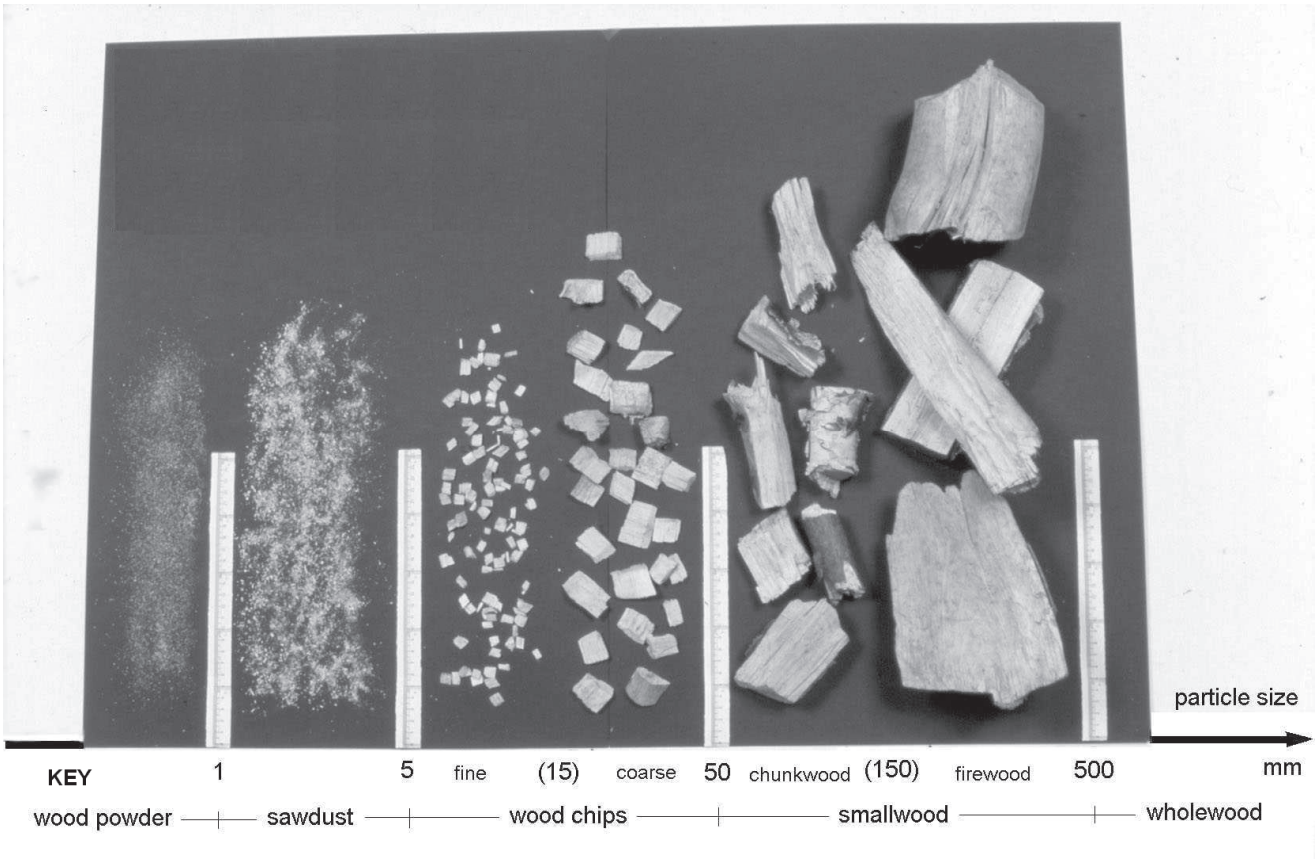


Figure A.1 — Classification of wood fuels based on fuel particle size

2) Jan Erik Mattsson, Swedish University of Agricultural Science, Department of Agricultural Engineering, PO Box 66, SE-23066, Alnarp, Sweden.

A.2 Differentiating between wood chips and hog fuel (Source: Swedish University of Agricultural Sciences[3])

a) Wood chips **b) Hog fuel**

Figure A.2 — Close examination of wood chips and hog fuel

3) Jan Erik Mattsson, Swedish University of Agricultural Science, Department of Agricultural Engineering, PO Box 66, SE-23066, Alnarp, Sweden.

Annex B
(informative)

Typical values of solid biomass fuels

B.1 — Typical values [a] for virgin wood materials, with or without insignificant amounts of bark, leaves and needles

Parameter	Unit	Coniferous wood (1.1.2.2 and 1.2.1.1)		Broad-leaf wood (1.1.2.1 and 1.2.1.1)	
		Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	0,3	0,1 to 1,0	0,3	0,2 to 1,0
Gross calorific value $q_{V,gr,d}$	MJ/kg d	20,5	20,0 to 20,8	20,1	19,4 to 20,4
Net calorific value $q_{p,net,d}$	MJ/kg d	19,1	18,5 to 19,8	18,9	18,4 to 19,2
Carbon, C	w-% d	51	47 to 54	49	48 to 52
Hydrogen, H	w-% d	6,3	5,6 to 7,0	6,2	5,9 to 6,5
Oxygen, O	w-% d	42	40 to 44	44	41 to 45
Nitrogen, N	w-% d	0,1	< 0,1 to 0,5	0,1	< 0,1 to 0,5
Sulphur, S	w-% d	< 0,02	< 0,01 to 0,02	0,02	< 0,01 to 0,05
Chlorine, Cl	w-% d	0,01	< 0,01 to 0,03	0,01	< 0,01 to 0,03
Fluorine, F	w-% d	< 0,000 5	< 0,000 5	< 0,000 5	< 0,000 5
Aluminium, Al	mg/kg d	100	30 to 400	20	< 10 to 50
Calcium, Ca	mg/kg d	900	500 to 1 000	1 200	800 to 20 000
Iron, Fe	mg/kg d	25	10 to 100	25	10 to 100
Potassium, K	mg/kg d	400	200 to 500	800	500 to 1 500
Magnesium, Mg	mg/kg d	150	100 to 200	200	100 to 400
Manganese, Mn	mg/kg d	100	40 to 200	83	
Sodium, Na	mg/kg d	20	10 to 50	50	10 to 200
Phosphorus, P	mg/kg d	60	50 to 100	100	50 to 200
Silicate, Si	mg/kg d	150	100 to 200	150	100 to 200
Titanium, Ti	mg/kg d	< 20	<20	<20	< 20
Arsenic, As	mg/kg d	< 0,1	< 0,1 to 1,0	< 0,1	< 0,1 to 1,0
Cadmium, Cd	mg/kg d	0,10	< 0,05 to 0,50	0,10	< 0,05 to 0,50
Chromium, Cr	mg/kg d	1,0	0,2 to 10,0	1,0	0,2 to 10,0
Copper, Cu	mg/kg d	2,0	0,5 to 10,0	2,0	0,5 to 10,0
Mercury, Hg	mg/kg d	0,02	< 0,02 to 0,05	0,02	< 0,02 to 0,05
Nickel, Ni	mg/kg d	0,5	< 0,1 to 10,0	0,5	< 0,1 to 10,0
Lead, Pb	mg/kg d	2,0	< 0,5 to 10,0	2,0	< 0,5 to 10,0
Vanadium, V	mg/kg d	< 2	< 2	< 2	< 2
Zinc, Zn	mg/kg d	10	5 to 50	10	5 to 100

[a] Data is obtained from a combination of mainly Swedish, Finnish, Danish, Dutch and German research. The values only aim to describe properties that can be expected in Europe in general. Formulas how to calculate different bases are given in prEN 15296.

B.2 — Typical values [a] for virgin bark materials

Parameter	Unit	Bark from coniferous wood (1.1.5 and 1.2.1.2)		Bark from broad-leaf wood (1.1.5 and 1.2.1.2)	
		Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	1,5	<1 to 5	1,5	0,8 to 3,0
Gross calorific value $q_{V,gr,d}$	MJ/kg d	20,4	18,0 to 21,4	20	18,0 to 22,7
Net calorific value $q_{p,net,d}$	MJ/kg d	19,2	17,5 to 20,5	19	17,1 to 21,3
Carbon, C	w-% d	52	48 to 55	52	47 to 55
Hydrogen, H	w-% d	5,9	5,5 to 6,4	5,8	5,3 to 6,4
Oxygen, O	w-% d	38	34 to 42	38	32 to 42
Nitrogen, N	w-% d	0,5	0,3 to 0,9	0,3	0,1 to 0,8
Sulphur, S	w-% d	0,03	< 0,02 to 0,05	0,03	< 0,02 to 0,20
Chlorine, Cl	w-% d	0,02	<0,01 to 0,05	0,02	< 0,01 to 0,05
Fluorine, F	w-% d	0,001	< 0,000 5 to 0,002		
Aluminium, Al	mg/kg d	800	400 to 1 200	50	30 to 100
Calcium, Ca	mg/kg d	5 000	1 000 to 15 000	15 000	10 000 to 20 000
Iron, Fe	mg/kg d	500	100 to 800	100	50 to 200
Potassium, K	mg/kg d	2 000	1 000 to 3 000	2 000	1 000 to 3 200
Magnesium, Mg	mg/kg d	1 000	400 to 1 500	500	400 to 1 000
Manganese, Mn	mg/kg d	500	9 to 840	190	
Sodium, Na	mg/kg d	300	70 to 2 000	100	20 to 1 000
Phosphorus, P	mg/kg d	400	20 to 600	400	300 to 700
Silicate, Si	mg/kg d	2 000	500 to 5 000	2 500	2 000 to 20 000
Arsenic, As	mg/kg d	1,0	0,1 to 4,0	0,4	0,1 to 4
Cadmium, Cd	mg/kg d	0,5	0,2 to 1,0	0,5	0,2 to 1,2
Chromium, Cr	mg/kg d	5	1 to 10	5	1 to 30
Copper, Cu	mg/kg d	5	3 to 30	5	2 to 20
Mercury, Hg	mg/kg d	0,05	0,01 to 0,1,	< 0,05	
Nickel, Ni	mg/kg d	10	2 to 20	10	2 to 10
Lead, Pb	mg/kg d	4	1 to 30	15	2 to 30
Vanadium, V	mg/kg d	1,0	0,7 to 2,0	2	1 to 4
Zinc, Zn	mg/kg d	100	70 to 200	50	7 to 200

[a] Data is obtained from a combination of mainly Swedish, Finnish, Danish, Dutch and German research. The values only aim to describe properties that can be expected in Europe in general. Formulas how to calculate different bases are given in CEN/TS 15296.

B.3 — Typical values [a] for virgin wood materials, logging residues

Parameter	Unit	Coniferous wood (1.1.3)		Broad-leaf wood (1.1.3)	
		Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	3,0	< 1 to 10	5,0	2 to 10
Gross calorific value $q_{V,gr,d}$	MJ/kg d	20,5	19,5 to 21,5	19,7	19,5 to 20,0
Net calorific value $q_{p,net,d}$	MJ/kg d	19,2	18,5 to 20,5	18,7	18,3 to 18,5
Carbon, C	w-% d	51	48 to 52	51	50 to 51
Hydrogen, H	w-% d	6,0	5,7 to 6,2	6,0	5,8 to 6,1
Oxygen, O	w-% d	40	38 to 44	40	40 to 43
Nitrogen, N	w-% d	0,5	0,3 to 0,8	0,5	0,3 to 0,8
Sulphur, S	w-% d	< 0,02	< 0,02 to 0,06	0,04	0,01 to 0,08
Chlorine, Cl	w-% d	0,01	< 0,01 to 0,04	0,01	< 0,01 to 0,02
Fluorine, F	w-% d	0,001		0,002	0,0 to 0,001
Aluminium, Al	mg/kg d			250	1 to 3000
Calcium, Ca	mg/kg d	5 000	2 000 to 8 000	4 000	3 000 to 5 000
Iron, Fe	mg/kg d	1500	500 to 2000	150	10 to 1500
Potassium, K	mg/kg d	2 000	1 000 to 4 000	1 500	1 000 to 4 000
Magnesium, Mg	mg/kg d	800	400 to 2 000	250	100 to 400
Manganese, Mn	mg/kg d	130	80 to 170	120	10 to 800
Sodium, Na	mg/kg d	200	75 to 300	100	20 to 200
Phosphorus, P	mg/kg d	500		300	30 to 1 000
Silicate, Si	mg/kg d	3 000	200 to 10 000	150	75 to 250
Titanium, Ti	mg/kg d			7	1 to 40
Arsenic, As	mg/kg d	0,6	0,2 to 1	1	0 to 2
Cadmium, Cd	mg/kg d	0,2	0,1 to 0,8	0,5	0 to 3
Chromium, Cr	mg/kg d	1	0,7 to 1,2	8	1 to 40
Copper, Cu	mg/kg d	10	10 to 200	10	1 to 100
Mercury, Hg	mg/kg d	0,03		0,02	0 to 2
Nickel, Ni	mg/kg d	1,6	0,4 to 3	10	1 to 80
Lead, Pb	mg/kg d	1,3	0,4 to 4	1,5	0,5 to 5
Vanadium, V	mg/kg d	0,6	0,1 to 1	0,5	0,1 to 3
Zinc, Zn	mg/kg d	20	8 to 30	50	2 to 100

[a] Data is obtained from a combination of mainly Swedish, Finnish, Danish, Dutch, Spanish and German research. The values only aim to describe properties that can be expected in Europe in general. Formulas how to calculate different bases are given in prEN 15296.

B.4 — Typical values [a] for virgin wood materials, short rotation coppice

Parameter	Unit	Willow (Salix) (1.1.1.3)		Poplar (1.1.1.3)	
		Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	2,0	1,1 to 4,0	2,0	1,5 to 3,4
Gross calorific value $q_{V,gr,d}$	MJ/kg d	19,9	19,2 to 20,4	19,8	19,5 to 20,1
Net calorific value $q_{p,net,d}$	MJ/kg d	18,4	17,7 to 19,0	18,4	18,1 to 18,8
Carbon, C	w-% d	48	46 to 49	48	46 to 50
Hydrogen, H	w-% d	6,1	5,7 to 6,4	6,2	5,7 to 6,5
Oxygen, O	w-% d	43	40 to 44	43	39 to 45
Nitrogen, N	w-% d	0,5	0,2 to 0,8	0,4	0,2 to 0,6
Sulphur, S	w-% d	0,05	0,02 to 0,10	0,03	0,02 to 0,10
Chlorine, Cl	w-% d	0,03	0,01 to 0,05	< 0,01	< 0,01 to 0,05
Fluorine, F	w-% d	0,003	0 to 0,01		
Aluminium, Al	mg/kg d	50	3 to 100	10	
Calcium, Ca	mg/kg d	5 000	2 000 to 9 000	5 000	4 000 to 6 000
Iron, Fe	mg/kg d	100	30 to 600	30	
Potassium, K	mg/kg d	2 500	1 700 to 4 000	2 500	2 000 to 4 000
Magnesium, Mg	mg/kg d	500	200 to 800	500	200 to 800
Manganese, Mn	mg/kg d	97	79 to 160	20	
Sodium, Na	mg/kg d	-	10 to 450	25	10 to 60
Phosphorus, P	mg/kg d	800	500 to 1 300	1 000	800 to 1 100
Silicate, Si	mg/kg d	500	2 to 2 000		
Titanium, Ti	mg/kg d	10	< 10 to 50		
Arsenic, As	mg/kg d	< 0,1	< 0,1	<0,1	< 0,1 to 0,2
Cadmium, Cd	mg/kg d	2	0,2 to 5	0,5	0,2 to 1
Chromium, Cr	mg/kg d	1	0,3 to 5	1	0,3 to 2
Copper, Cu	mg/kg d	3	2 to 4	3	2 to 4
Mercury, Hg	mg/kg d	< 0,03	< 0,03	< 0,03	< 0,03
Nickel, Ni	mg/kg d	0,5	0,2 to 2	0,5	0,2 to 1,0
Lead, Pb	mg/kg d	0,1	0,1 to 0,2	0,1	0,1 to 0,3
Vanadium, V	mg/kg d	0,3	0,2 to 0,6		
Zinc, Zn	mg/kg d	70	40 to 100	50	30 to 100

[a] Data is obtained from a combination of mainly Swedish, Finnish, Danish, Dutch, Spanish and German research. The values only aim to describe properties that can be expected in Europe in general. Formulas how to calculate different bases are given in CEN/TS 15296.

B.5 — Typical values [a] for virgin straw materials, with or without insignificant amounts of grains

Parameter	Unit	Straw from wheat, rye, barley (2.1.1.2)		Straw from oilseed rape (2.1.3.2)	
		Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	5	2 to 10	5	2 to 10
Gross calorific value $q_{V,gr,d}$	MJ/kg d	18,8	16,6 to 20,1	18,8	16,6 to 20,1
Net calorific value $q_{p,net,d}$	MJ/kg d	17,6	15,8 to 19,1	17,6	15,8 to 19,1
Carbon, C	w-% d	47	41 to 50	48	42 to 52
Hydrogen, H	w-% d	6,0	5,4 to 6,5	6,0	5,4 to 6,5
Oxygen, O	w-% d	41	36 to 45	41	36 to 45
Nitrogen, N	w-% d	0,5	0,2 to 1,5	0,8	0,3 to 1,6
Sulphur, S	w-% d	0,1	< 0,05 to 0,2	0,3	< 0,05 to 0,7
Chlorine, Cl	w-% d	0,4	< 0,1 to 1,2	0,5	< 0,1 to 1,1
Fluorine, F	w-% d	0,000 5			
Aluminium, Al	mg/kg d	50	Up to 700	50	Up to 700
Calcium, Ca	mg/kg d	4 000	2 000 to 7 000	15 000	8 000 to 20 000
Iron, Fe	mg/kg d	100	Up to 500	100	Up to 500
Potassium, K	mg/kg d	10 000	2 000 to 26 000	10 000	2 000 to 26 000
Magnesium, Mg	mg/kg d	700	400 to 1 300	700	300 to 2 200
Manganese, Mn	mg/kg d	40	20 to 100		
Sodium, Na	mg/kg d	500	Up to 3 000	500	Up to 3 000
Phosphorus, P	mg/kg d	1 000	300 to 2 900	1 000	300 to 2 700
Silicate, Si	mg/kg d	10 000	1 000 to 20 000	1 000	100 to 3 000
Titanium, Ti	mg/kg d	70	5 to 200		
Arsenic, As	mg/kg d	< 0,1	< 0,1 to 2,0	< 0,1	< 0,1 to 0,5
Cadmium, Cd	mg/kg d	0,10	< 0,05 to 0,30	0,10	< 0,05 to 0,30
Chromium, Cr	mg/kg d	10	1 to 60	10	1 to 60
Copper, Cu	mg/kg d	2	1 to 10	2	1 to 10
Mercury, Hg	mg/kg d	0,02	< 0,02 to 0,05	0,02	< 0,02 to 0,05
Nickel, Ni	mg/kg d	1,0	0,2 to 4,0	1,0	0,2 to 4,0
Lead, Pb	mg/kg d	0,5	0,1 to 3,0	2,0	1,0 to 13,0
Vanadium, V	mg/kg d	3	1 to 6		
Zinc, Zn	mg/kg d	10	3 to 60	10	5 to 20

[a] Data is obtained from a combination of mainly Swedish, Finnish, Danish, Dutch and German research. The values only aim to describe properties that can be expected in Europe in general. Formulas how to calculate different bases are given in prEN 15296.

B.6 — Typical values [a] for virgin cereal grain materials

Parameter	Unit	Grain from wheat, rye, barley (2.1.1.3)		Grains from rape (2.1.1.3)	
		Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	2	1,2 to 4	4,3	3,75 to 5,5
Gross calorific value $q_{V,gr,d}$	MJ/kg d	18, 0	16,5 -19, 6	28,1	27,5 to 29,0
Net calorific value $q_{p,net,d}$	MJ/kg d	16,5	15,0 - 18,1	26,6	
Carbon, C	w-% d	45	42 to 50	60	
Hydrogen, H	w-% d	6,5	5,5 to 6,5	7,1	
Oxygen, O	w-% d	44	43 to 50	23	
Nitrogen, N	w-% d	2		3,8	
Sulphur, S	w-% d	0,16	0,05 to 0,1	0,1	
Chlorine, Cl	w-% d	0,11	0,05 to 0,5	0,07	0,01 to 0,15
Aluminium, Al	mg/kg d		< 20		
Calcium, Ca	mg/kg d	600	100 to 1 200	5 000	3 200 to 6 400
Iron, Fe	mg/kg d	75	15 to 200	93	
Potassium, K	mg/kg d	5 000	3 700 to 6 500	8 400	
Magnesium, Mg	mg/kg d	1 400	1 000 to 2 100	2 600	
Manganese, Mn	mg/kg d	30	9 to 60	39	
Sodium, Na	mg/kg d	100	50 to 120	100	50 to 120
Phosphorus, P	mg/kg d	3 400	2 100 to 4 300	7 300	
Silicate, Si	mg/kg d	50	10 to 200		
Titanium, Ti	mg/kg d		< 50 to 100		
Arsenic, As	mg/kg d	≤ 0,5	0,0 to 0,7		
Cadmium, Cd	mg/kg d	0,01	0,0 to 0,7		
Chromium, Cr	mg/kg d	0,5	< 0,5 to 1,0		
Copper, Cu	mg/kg d	5	1,5 to 12	2,6	
Mercury, Hg	mg/kg d	< 0,02	< 0,02		
Nickel, Ni	mg/kg d	1,0	0,2 to 2,0		
Lead, Pb	mg/kg d	0,9	≤ 0,1 to 1		
Vanadium, V	mg/kg d				
Zinc, Zn	mg/kg d	22	17 to 34		

[a] Data is obtained from a combination of mainly Swedish, Finnish, Danish, Dutch, French (including rye) and German research. The values only aim to describe properties that can be expected in Europe in general. Formulas how to calculate different bases are given in CEN/TS 15296.

B.7 — Typical values [a] for virgin reed canary grass

Parameter	Unit	Summer harvest (July – Oct) (2.1.2.1)		Delayed harvest (March – May) (2.1.2.1)	
		Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	6,5	2,5 to 10	6,9	1,0 to 8,0
Gross calorific value $q_{V,gr,d}$	MJ/kg d	17,7		17,8	17,7 to 18,0
Net calorific value $q_{p,net,d}$	MJ/kg d	16,6		16,5	16,5 to 17,0
Carbon, C	w-% d	46		46	45 to 50
Hydrogen, H	w-% d	5,7		5,8	5,7 to 6,2
Oxygen, O	w-% d	40		42	40 to 43
Nitrogen, N	w-% d	1,3		0,9	0,4 to 2,0
Sulphur, S	w-% d	0,1	0,1 to 0,2	0,13	0,04 to 0,17
Chlorine, Cl	w-% d	0,5	0,2 to 0,6	0,025	0,01 to 0,09
Aluminium, Al	mg/kg d				20
Calcium, Ca	mg/kg d	3 500	1 300 to 5 700	2 000	800 to 3 200
Iron, Fe	mg/kg d			140	60 to 220
Potassium, K	mg/kg d	12 000	3 100 to 22 000	2 700	< 800 to 6 000
Magnesium, Mg	mg/kg d	1 300	300 to 2 300	500	100 to 900
Manganese, Mn	mg/kg d			160	< 200
Sodium, Na	mg/kg d	200	< 100 to 400	200	< 20 to 400
Phosphorus, P	mg/kg d	1 700	500 to 3 000	1 100	300 to 2 000
Silicate, Si	mg/kg d	12 000	< 1 000 to 25 000	18 000	2 300 to 30 000
Arsenic, As	mg/kg d	0,1	< 0,1 to 0,2	0,2	< 0,1 to 0,5
Cadmium, Cd	mg/kg d	0,04	< 0,04 to 0,10	0,06	< 0,04 to 0,20
Chromium, Cr	mg/kg d				
Copper, Cu	mg/kg d				
Mercury, Hg	mg/kg d	0,03	< 0,02 to 0,05	0,03	< 0,02 to 0,05
Nickel, Ni	mg/kg d				
Lead, Pb	mg/kg d	1,0	< 0,5 to 4,0	2,0	< 0,5 to 5,0

[a] Data is obtained from a combination of mainly Swedish, Finnish, Danish and German research. The values only aim to describe properties that can be expected in Europe in general. Formulas how to calculate different bases are given in CEN/TS 15296.

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B.8 — Typical values [a] for virgin grass in general (hay) and miscanthus

Parameter	Unit	Grass, in general (2.1.2.1)		Miscanthus (China reed) (2.1.2.1)	
		Typical value	Typical variation	Typical value	Typical variation
Ash	w-% d	7	4 to 10	4	1 to 6
Gross calorific value $q_{V,gr,d}$	MJ/kg d	18,0	18 to 20	19,0	17 to 20
Net calorific value $q_{p,net,d}$	MJ/kg d	17,1	16 to 19	17,7	16 to 19
Carbon, C	w-% d	46	45 to 50	47	46 to 52
Hydrogen, H	w-% d	5,9	5 to 7	6,1	5 to 6,5
Oxygen, O	w-% d	40	38 to 48	42	40 to 45
Nitrogen, N	w-% d	1,3	1 to 2	0,7	0,1 to 1,5
Sulphur, S	w-% d	0,2	0 to 0,5	0,2	0,02 to 0,6
Chlorine, Cl	w-% d	0,7	0,02 to 1,3	0,2	0,02 to 0,6
Fluorine, F	w-% d	0,001	0,001 to 0,003	0,002	0,001 to 0,003
Aluminium, Al	mg/kg d	200	20 to 300	100	50 to 200
Calcium, Ca	mg/kg d	3 500	2 500 to 5 500	2 000	900 to 3 000
Iron, Fe	mg/kg d	600	100 to 1 200	100	40 to 400
Potassium, K	mg/kg d	15 000	4 900 to 24 000	7 000	1 000 to 11 000
Magnesium, Mg	mg/kg d	1 700	800 to 2 300	600	300 to 900
Manganese, Mn	mg/kg d	1 000	200 to 2 600	20	10 to 100
Sodium, Na	mg/kg d	3 000	1 400 to 6 300	700	20 to 100
Phosphorus, P	mg/kg d	15 000	3 000 to 25 000	500	200 to 800
Silicate, Si	mg/kg d			8 000	2 000 to 10 000
Titanium, Ti	mg/kg d			5	3 to 10
Arsenic, As	mg/kg d	0,1	< 0,1 to 1,4	1	0,5 to 4
Cadmium, Cd	mg/kg d	0,20	0,03 to 0,60	1	0,4 to 8
Chromium, Cr	mg/kg d	1,0	0,2 to 3,0	2	1 to 10
Copper, Cu	mg/kg d	5	2 to 10	2	1 to 6
Mercury, Hg	mg/kg d	< 0,02	< 0,02 to 0,03	2	0,5 to 5
Nickel, Ni	mg/kg d	2,0	0,5 to 5,0	2	0,5 to 5
Lead, Pb	mg/kg d	1,0	< 0,5 to 2,0	2,0	1 to 20
Vanadium, V	mg/kg d	3	-	< 2	
Zinc, Zn	mg/kg d	25	10 to 60	5	3 to 30

[a] Data is obtained from a combination of mainly Swedish, Finnish, Danish, Dutch and German research. The values only aim to describe properties that can be expected in Europe in general. Formulas how to calculate different bases are given in prEN 15296.

B.9 — Typical values [a] for olive and grape cake

Parameter	Unit	Olive cake			Grape cake	
		Crude olive cake 3.2.1.4	Exhausted olive cake 3.2.2.4	Olive kernels 3.2.1.2	Crude grape cake 3.2.1.1	Exhausted grape cake 3.2.1.1, 3.2.2.1
Ash	w-% d	10	3,4 to 11,3	1,2 to 4,4	4,5 to 11,2	6 to 13
Gross calorific value $q_{V,gr,d}$	MJ/kg d	19,4 to 21,4	18,1 to 21,6	18,6 to 20,8	19,3 to 22,0	
Net calorific value $q_{p,net,d}$	MJ/kg d	18,1 to 20,7	13,9 to 19,2	17,3 to 19,3	16,7	19,0
Carbon, C	w-% d	50	48 to 52	45,7 to 52,3	54	46,0 to 54,4
Hydrogen, H	w-% d	6,9	4,6 to 6,3	6,1 to 6,8	6,8	5,8 to 7,5
Oxygen, O	w-% d	30	33	38,5 to 42,1		
Nitrogen, N	w-% d	1,5	1,4 to 2,7	0,8 to 1,6	1,5	1,9 to 2,4
Sulphur, S	w-% d	0,2	0,0 to 0,5	0,0 to 0,5	0,20	0,03 to 0,18
Chlorine, Cl	w-% d	0,2	0,1 to 0,4	0,1 to 0,4		< 0,05
Aluminium	mg/kg d	1250	2 700	559		
Calcium, Ca	mg/kg d	6 900	17 200	968		
Iron, Fe	mg/kg d	1 000	1 900	391		
Potassium, K	mg/kg d	6 000 to 16 000	17 500	6 950		12 500 to 35 700
Magnesium, Mg	mg/kg d	3 400	4 000	316		
Manganese, Mn	mg/kg d	< 26	17 to 44	12		14 to 36
Sodium, Na	mg/kg d	44 to 1 000	250 to 450	120		34 to 180
Phosphorus, P	mg/kg d	2 450	30 to 1 750	590		
Silicate, Si	mg/kg d	14 to 6 600	20 to 11 850	9 to 3 500		
Titanium,Ti	mg/kg d	53	145	39		
Arsenic, As	mg/kg d	0,4	4	0,8		
Cadmium, Cd	mg/kg d	< 0,1	< 0,5	0,2		0,05 to 0,18
Chromium, Cr	mg/kg d	3	3 to 13	3		0,73 to 1,54
Copper, Cu	mg/kg d	14	10 to 20	9		48 to 190
Mercury, Hg	mg/kg d		0,1			
Nickel, Ni	mg/kg d	2	2 to 17	0,05		0,66 to 1,64
Lead, Pb	mg/kg d	2	15	2,1		0,35 to 2,70
Vanadium, V	mg/kg d		5			
Zinc, Zn	mg/kg d	19	19	7		
Cobalt, Co	mg/kg d		1			
Silver, Ag	mg/kg d		4			
Tin, Sn	mg/kg d		4			

NOTE 1 Crude olive cake is a by-product of the first industrial olive oil extraction process. The chemical composition can vary according to the pressing method utilised.

NOTE 2 Exhausted olive cake is a by-product of the second industrial olive oil extraction process that remains after oil extraction (chemical treatment from the above mentioned crude olive cake).

NOTE 3 Olive kernels is a by-product of the first industrial olive oil extraction process, by which a certain quantity of the olive cake produced is separated, giving as a result this high quality biofuel.

NOTE 4 Crude grape cake is a by-product that remains after the grapes have been pressed.

NOTE 5 Exhausted grape cake is a residual material, which remains after water or chemical treatment from crude grape cake.

[a] Data is obtained from a combination of mainly Austrian, Dutch, Italian, Greek and Spanish research. The values only aim to describe properties that can be expected in Europe in general. Formulas how to calculate different bases are given in CEN/TS 15296.

B.10 — Typical values [a] for fruit stones and shells

Parameter	Unit	Fruit stones and shells	
		Apricot, peach, cherry fruit stone 3.2.1.2	Almond, hazelnut, pinenut shells 3.1.3.2
Ash	w-% d	0,2 to 1,0	0,95 to 3,00
Gross calorific value $q_{V,gr,d}$	MJ/kg d		19 to 20
Net calorific value $q_{p,net,d}$	MJ/kg d	19,5 to 22,9	17,5 to 19,0
Carbon, C	w-% d	51 to 55	44 to 50
Hydrogen, H	w-% d	5 to 7	5 to 6
Oxygen, O	w-% d	43	40 to 45
Nitrogen, N	w-% d	0,2 to 0,3	0,1 to 1,2
Sulphur, S	w-% d	0,05 to 0,50	0,04 to 0,22
Chlorine, Cl	w-% d	0,04	0,004 to 0,09
Aluminium	mg/kg d		65
Calcium, Ca	mg/kg d		300 to1200
Iron, Fe	mg/kg d		58 to 66
Potassium, K	mg/kg d		1 500 to 1 750
Magnesium, Mg	mg/kg d		175 to 300
Manganese, Mn	mg/kg d		3 to 12
Sodium, Na	mg/kg d		62 to 73
Phosphorus, P	mg/kg d		79 to 82
Silicate, Si	mg/kg d		580 to 4 200
Titanium,Ti	mg/kg d		1 to 6
Zinc, Zn	mg/kg d		2,3 to 5,3

[a] Data is obtained from a combination of mainly Austrian, Dutch, Italian, Greek and Spanish research. The values only aim to describe properties that can be expected in Europe in general. Formulas how to calculate different bases are given in CEN/TS 15296.

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B.11 — Typical values [a] for selected types of husks, stalks and trash

Parameter	Unit	Rice husk 2.1.1.4	Cotton stalks 2.1.1.2	Cotton gin trash 2.1.1.2	Sunflower husk 2.1.6.2	Pensylvanian malva 2.1.6.2
Ash	w-% d	13 to 23	6,0 to 6,7	1,6 to 9,4	1,9 to 7,6	2,8
Gross calorific value $q_{V,gr,d}$	MJ/kg d	14,7 to 6,6	15,8 to 18,3	16,4 to 17,5	18 to 23	19,0
Net calorific value $q_{p,net,d}$	MJ/kg d	14,5 to 16,2			17 to 22	17,7
Carbon, C	w-% d	38 to 43	39,5 to 47,0	39,6 to 43,7	51,5 to 52,9	
Hydrogen, H	w-% d	4,3 to 5,1	5,1 to 5,8	5,3 to 6,1	5,0 to 6,6	5,9
Oxygen, O	w-% d	35 to 47			36 to 43	
Nitrogen, N	w-% d	0,1 to 0,8	0,65 to 1,25	0,2 to 2,9	0,6 to 1,4	
Sulphur, S	w-% d	0,02 to 0,10	0,02 to 0,21		0	0,05
Chlorine, Cl	w-% d	0,03 to 0,3	0,08		0 to 0,1	0,02
Potassium, K	mg/kg d	2 800 to 4 300				
Sodium, Na	mg/kg d	33 to 38				

[a] Data is obtained from a combination of mainly Italian, Greek and Finnish research. The values aim to describe properties that can be expected in Europe in general. Formulas how to calculate different bases are given in prEN 15296.

Annex C
(informative)

Examples of possible causes for deviant levels for different properties and of consequences of handling and treatments for the properties of biomass

C.1 Examples of possible causes for deviant levels for different properties

Property	Deviation	Possible causes
Ash, d	High value	Contamination with soil/sand Higher content of bark than specified Inorganic additives Chemical treatments such as paint, preservation
Net calorific value $q_{p,net,d}$	Low value	High ash content Content of combustible material with lower calorific value as e.g. glues
Net calorific value $q_{p,net,d}$	High value	Content of combustible material with higher calorific value as e.g. resin, vegetable or mineral oils, plastic
N, daf	High value	Higher content of bark than specified Glue Plastic (laminate)
S, daf	High value	Higher content of bark than specified Organic additives as corn flour, potato flour Inorganic additives containing sulphur compounds Treatment with chemicals containing sulphur, as sulphuric acid
Cl, daf	High value	Higher content of bark than specified Origin of wood from coast near locations and exposed from sea water Contamination during storage/transportation by road salting Preservation chemicals
Si, d	High value	Contamination with soil/sand Higher content of bark/needles/leaves than specified
Ti, d	High value	Paint
As, d	High value	Preservation chemicals
Cr, d	High value	Preservation chemicals Contamination with soil/sand
Cu, d	High value	Preservation chemicals Contamination with soil/sand
Hg, d	High value	Contamination with soil/sand
Cd, d	High value	Paint Plastic Fertilizer (e.g. ash, sewage sludge (issued from waste water treatment or chemical process))
Ni, d	High value	Contamination from working up machinery Mineral oils
Pb, d	High value	Environmental contamination (e.g. traffic) Paint Plastic Fertilizer (e.g. ash, sewage sludge (issued from waste water treatment or chemical process))
NOTE 1 Chemically treated wood waste that may contain halogenated organic compounds or heavy metals, is not included in the scope of the standard. As the presence of such materials or the remains of other materials can occur accidentally, examples for these incidents are given also. NOTE 2 Chemical treatment before harvesting of biomass does not need to be stated.		

C.2 Examples of consequences of handling and treatments for the properties of biomass

Circumstance	**Possible consequences**
Handling, storage or transportation	— increased content of ash and Si due to contamination with soil/sand (may also lead to decrease of ash melting; DT, especially if alkali (Na, K) present) — increased content of Cl due to contamination with road salting
Mechanical contamination	— increased content of metals as Fe, Cr and Ni from the working tools/machinery
Environmental contamination	— increased content of Cl due to deposition from the sea spray/fog — increased content of heavy metals as Pb and Zn due to exposition to society activities as traffic — increased content of Cd, Pb due to fertilizer (e.g. sewage sludge)
Additives (pellets and briquettes)	**Possible consequences**
Inorganic additives: Limestone Kaolin	— increased content of ash and Ca — increased content of ash, Si and Al
Organic additives: Other solid biomass Vegetable oils	— changes, depending on type & quality of the particular material. Higher amounts of e.g. corn or potato flour may cause increased content of e.g. ash and S — increased calorific value
Chemical treatments	**Possible consequences**
Glue	— increased content of N — decreased calorific value
Lye	— increased content of Na
Paints [a]	— increased content of ash — increased content of metals as Pb, Ti and Zn depending of the actual pigments
Plastics (laminate) [a]	— increased calorific value — increased content of N (e.g. ABS or celluloid plastics) — increased content of Cl or F (e.g. PVC or teflon plastics) — increased contents of metals as Cd, Pb, Zn depending of the content of additives in the plastic
Preservations [a]	— increased content of ash — increased content of As, B, Cl, Cr, Cu, F, P or Zn depending of the used type of preservation chemical
Sulphur acids	— increased content of S

[a] Chemical treatments containing halogenated organic compounds (as Cl, F) or heavy metals (as As, Pb) is not included in the scope of the standard.

Annex D
(informative)

Calculation of the net calorific value at different bases and energy density as received

D.1 The net calorific value of dry basis

The net calorific value at a constant pressure for a dry sample (dry basis, in dry matter) is derived from the corresponding gross calorific value at a constant volume according to Equation (EN 14918) (1)

$$q_{p,\text{net, d}} = q_{V,\text{gr,d}} - 212{,}2 \times w(\text{H})_\text{d} - 0{,}8 \times [w(\text{O})_\text{d} + w(\text{N})_\text{d}] \quad (1)$$

where

$q_{p,\text{net, d}}$ is the net calorific value for dry matter at a constant pressure in joules per gram(J/g) or kilojoules per kilogram (kJ/kg);

$q_{V,\text{r, d}}$ is the gross calorific value for dry matter in joules per gram(J/g) or kilojoules per kilogram (kJ/kg);

$w(\text{H})_\text{d}$ is the hydrogen content, in percentage by mass, of the moisture-free (dry) biofuel (including the hydrogen from the water of hydration of the mineral matter as well as the hydrogen in the biofuel substance);

$w(\text{O})_\text{d}$ is the oxygen content, in percentage by mass, of the moisture-free biofuel;

$w(\text{N})_\text{d}$ is the nitrogen content, in percentage by mass, of the moisture-free biofuel.

For the calculation of the net calorific value as received using Equation (2) in D.2, the result from Equation (1) in in joules per gram(J/g) or kilojoules per kilogram (kJ/kg), shall be divided by 1 000 to get the result in megajoules per kilogram (MJ/kg).

NOTE $[w(\text{O})_\text{d} + w(\text{N})_\text{d}]$ can be derived by subtracting from 100 (w-%) the percentages of ash, carbon, hydrogen and sulphur.

D.2 The net calorific value as received

a) Calculation from dry basis

The net calorific value (at constant pressure) on as received (the moist biofuel) can be calculated on the net calorific value of the dry basis according to Equation (2).

$$q_{p,\text{net,ar}} = q_{p,\text{net,d}} \times \left(\frac{100 - M_\text{ar}}{100}\right) - 0{,}024\,43 \times M_\text{ar} \quad (2)$$

where

$q_{p,\text{net,ar}}$ is the net calorific value (at constant pressure) as received in megajoules per kilogram (MJ/kg);

$q_{p,\text{net,d}}$ is the net calorific value (at constant pressure) in dry matter in megajoules per kilogram (MJ/kg);

M_ar is the moisture content as received [w-%];

0,024 43 is the correction factor of the enthalpy of vaporization (constant pressure) for water (moisture) at 25 °C (in megajoules per kilogram (MJ/kg) per 1 w-% of moisture).

b) Calculation from dry and ash-free basis

The net calorific value (at constant pressure) on as received (the moist biofuel) can be calculated from a net calorific value of the dry and ash-free basis according to Equation (3).

$$q_{p,\text{net,ar}} = \left[\left(\frac{q_{p,\text{net,daf}} \times (100 - A_\text{d})}{100}\right) \times \left(\frac{100 - M_\text{ar}}{100}\right)\right] - 0{,}024\,43 \times M_\text{ar} \quad (3)$$

where

$q_{p,\text{net,ar}}$ is the net calorific value (at constant pressure) as received, in megajoules per kilogram (MJ/kg);

$q_{p,\text{net,daf}}$ is the net calorific value (at constant pressure) in dry and ash-free basis, in megajoules per kilogram (MJ/kg);

M_ar is the moisture content as received (w-%);

A_d is the ash content in dry basis (w-%);

0,024 43 is the correction factor of the enthalpy of vaporization (constant pressure) for water (moisture) at 25 °C (in megajoules per kilogram (MJ/kg) per 1 w-% of moisture).

In both the above cases a) and b), the calorific value can be either determined for that particular lot or a typical value can be used.

1) If the ash content of the fuel is low and rather constant, the calculation can be based on the dry basis equation with a typical value of $q_{p,\text{net, d}}$;
2) If the ash content varies quite a lot (or is high) for the specific biofuel then using the equation for dry and ash-free basis with a typical value of $q_{p,\text{net,daf}}$ is preferable.

The result shall be reported to the nearest 0,01 MJ/kg.

D.3 Energy density as received

The wood fuels for small-scale heating plants and households are traded usually on a volume basis and energy content (net calorific value) is informed often as megawatts hour (MWh) per bulk volume. Bulk density and moisture content is measured or estimated.

The energy density as received can be calculated according to Equation (4).

$$\text{E}_\text{ar} = \frac{1}{3\,600} \times q_{p,\text{net,ar}} \times \text{BD}_\text{ar} \quad (4)$$

where

E_ar is the energy density of the biofuel as received, in megawatts hour per cubic metre (MWh/m^3) of bulk volume;

$q_{\text{p,net,ar}}$ is the net calorific value (at constant pressure) as received, in megajoules per kilogram (MJ/kg);

BD_ar is the bulk density, i.e. volume weight of the biofuel as received, in kilograms per cubic metre (kg/m^3) of bulk volume;

$\frac{1}{3\,600}$ is the conversion factor for the energy units (megajoules (MJ) to megawatts hour (MWh)).

The result shall be reported to the nearest 0,01 MWh/m^3 of bulk volume.

The values of net calorific value and bulk density used in equations can be either measured or based on typical values of biofuels. The typical net calorific values of solid biofuels are reported in Annex B of this European Standard.

Bibliography

[1] EN 13556:2003, *Round and sawn timber — Nomenclature of timbers used in Europe*

[2] COMMISSION DECISION of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste (notified under document number C(2000) 1147) (Text with EEA relevance) (2000/532/EC); Official Journal of the European Union, 6.9.2000.

[3] EN 14774-3 *Solid biofuels — Determination of moisture content — Oven dry method — Part 3: Moisture in general analysis sample*

[4] CEN/TS 15105, *Solid biofuels — Methods for determination of the water soluble content of chloride, sodium and potassium*

[5] EN 15148, *Solid biofuels — Determination of the content of volatile matter*

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