Solid Biofuel Classification Guidelines

Bioenergy Association Technical Guide 01

Version 8

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About this Guide:

1. The compilation of this Technical Guide has been facilitated by contributions and oversight of the relevant expert members of the Bioenergy Association.
2. Bioenergy Association is an observing member of the ISO (International Organization for Standardization) Technical Committee ISO/TC238, Solid biofuels and information from the workings of that committee have been incorporated into this guide.
3. The Guide is to assist anyone buying and selling solid biofuels to know which technical standards are applicable to New Zealand and Australia and to provide guidance on when and how the standards should be used. There are a large number of standards and only part of any of those is applicable to buying and selling solid biofuels. The full standard should be consulted on specific matters.
4. The aim of the Bioenergy Association's Technical Guides is to encourage delivery of high quality and consistent best practice bioenergy solutions. These Guidelines are voluntary but essentially provide a regulatory framework for the New Zealand bioenergy and biofuels sector.
5. The guide is an outcome of industry discussion and collaboration. It captures the collective technical knowledge of a range of relevant leading bioenergy sector personnel. In addition, it benefits from the collective review and use by relevant asset owners, guide users, policy makers and regulators.
6. This guide is provided in good faith as an addition to the ongoing body of knowledge relating to the bioenergy and biofuels sector in New Zealand and Australia. However, as the guide is general and not specific to any application the Association and none of those involved with its preparation accept any liability either for the information contained herein, or its application.
7. As with all Bioenergy Association technical guidance documents, this guide is a 'living document' and will be revised from time to time and reissued, as new information comes to our attention. If you have suggested additions to this guide please contact admin@bioenergy.org.nz.
8. Any enquiries regarding these guidelines should be referred to:

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CAVEAT

Bioenergy Association recommends that any party undertaking a project to upgrade or replace a bioenergy facility should undertake a full evaluation of all possible options prior to fixing on a specific new project solution.

As a decision maker, it's important to understand the pro's and cons of each option and have them set out by an appropriate expert in a way that ensures they are easily comparable. Too often a client rushes into a solution without properly evaluating all the options.

These Technical Guides are only a guide and users should ensure that they have engaged appropriate expert to consider their specific application. The Guides are also not a substitute for the full technical standard but provides guidance on which ones should be consulted for specific purposes.

EXECUTIVE SUMMARY

This guide sets out the information necessary for those involved with solid biofuels in the new Zealand and Australian markets to be able to consistently describe each type of fuel for the preparation, sale and purchase of biomass as a solid biofuel. The guide draws on the very detailed information in the technical standard ISO 17225, and its parts, and provides guidance on which parts apply to the preparation, sale and purchase of solid biofuels. Most of the detailed information in those standards are not necessary for the more simple purposes of preparation, sale and purchase of solid biofuels.

The full suite of standards covered by ISO 17225 are most relevant for diagnostic purposes or addressing specific issues related to the combustion of solid biofuels.

Anyone dealing in the sale and purchase of solid biofuels should refer to the full standard and for legal protection should hold a copy. This document provides guidance on which standard is applicable to specific applications.

This document is an extensive revision of the Wood Fuel Classification Guidelines originally published by the Bioenergy Association[1] (BANZ) in July 2010. This is the eighth revision and has updated the various specifications of fuels so that these align with ISO 17225. Earlier revisions brought the guide into alignment with EN 14961 which has now been superseded by ISO 17225. The main revisions in this document have included the following:

- Broadening these guidelines so that they are applicable to all solid biofuels including herbaceous biofuels rather than just “Wood Fuel”;
- The terminology for some of the fuel property descriptions have been updated for example “S” for particle size is now “P” through where “S” has been used previously for the contracted specification, then this can continue to be used as the fuel property description. This change is to bring the terminology into alignment with ISO 17225.
- Construction and demolition waste timber has been replaced by Urban Solid Biofuels and there are two separate grades for this material.
- Herbaceous wood fuels and torrefied wood and chip were added to version 6.
- The verification methods in the original version of this document have been removed from this document and placed in a new separate guide “Standard Methods for Verifying the Quality of Solid Biofuel for the New Zealand Energy Market: BANZ Technical Guide 5.
- This version incorporates terminology that also makes it suitable for the Australian solid biofuels market.

This document should be read in conjunction with ISO17225 and its parts, however if this is not available, then there should be sufficient information in this guide to effectively define the characteristics of a solid biofuel for general use.

[1] Bioenergy Association of New Zealand

Some quality certification systems such as DIN Plus and EnPlus for wood pellets used by solid biofuel suppliers may be based on variations of ISO 17225 and its parts but ISO 17225 is the underlying technical standard relevant to New Zealand and Australia.

This document will be revised when new solid biofuels are identified and become traded fuels.

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1. INTRODUCTION

The solid biofuel supply market has since 2010 matured into a mainstream fuel source. It has transformed from having an emphasis on the disposal of wood wastes to being a well established sector that supplies quality solid biofuel as an alternative to coal and gas for the production of heat. Increasingly, wood fuels and other solid biofuels have become recognised as a reliable quality energy source and a number of fuel supply operators are either in the market or considering entering. In this version of the Solid Biofuel Classification Guidelines the use of the term wood fuels has been replaced by solid biofuels to broaden the overall range of fuels covered by this document. However because the term 'wood fuel' is often used in the market, and wood fuel is the dominant solid biofuel in New Zealand, the term 'wood fuel' should be considered synonymous with the term 'solid biofuel.'

For there to be confidence in this market there is a continuous need for sellers and buyers of solid biofuels to be consistent with respect to the description and quality of the fuel sought or supplied. Confidence in terms of the fuel characteristics will increase the value to both buyers and sellers.

Increasingly, it is important that standard terminology of solid biofuels is used by all participants in the market so that there are no misunderstandings between parties. This will result in fuel being prepared and supplied that meets contract specifications and is appropriate for the specific design of boilers and heat plant. Having defined, consistent fuel classifications will assist to de-risk projects and provide the limits for specifying boiler fuel.

These guidelines for classification of solid biofuel s have been prepared to provide a common terminology and methodology for classifying, specifying and declaring the quality and properties of traded solid biofuel in New Zealand. In most cases it is expected that the traded fuel will be a wood fuel. The guide also advises on the relevant technical standards that should be used by both buyers and sellers of solid biofuels.

Additional benefits of the standardised terminology and classification of these fuels include:

- An increase in use of the full range of solid biofuels;
- Improving consumer and user confidence in the availability and use of solid biofuel;
- Building the confidence within Regional Councils in the use of wood fuels with regard to emissions to air;
- Provide fuel quality assurance to heat plant manufacturers and wood fuel users;
- Promote solid biofuels as a sustainable and main-stream energy source;
- Minimise adverse environmental effects by using biofuels 'fit-for-purpose' and ensuring that any air emissions are minimal; and
- Assist have buyers and sellers of solid biofuels refer to the same technical standards and use the same terminology so there is minimal chances of confusion lading to a bad experience is using solid biofuels..

These Classification Guidelines were produced as a voluntary industry regulatory tool and have been prepared to meet specific New Zealand and Australian requirements, but most importantly they provide an effective tool to facilitate solid biofuel trading. The parameters set out are based on formal international standards (principally ISO 17225 and its parts) but these have been simplified to meet New

Zealand and Australian trading needs. The guidelines are not a replacement for the formal technical standards but provide a guide to the appropriate elements of the standards, or parts of a standard, to use in the context of the preparation, sale and purchase of solid biofuels in New Zealand and Australia. For more information on the details of the formal technical standards fuel that may be applicable to solid biofuel use owners of heat plant should refer to the full standard – a list of these is provided in section 2.

The Guidelines have been prepared on the basis of having a working document that the solid biofuels sector can use when trading in solid biofuel. The Guidelines are intended to be flexible and allow a framework for defining the different kinds of solid fuels. As experience with the Guidelines is developed they will be reviewed and edited from time to time to best meet market requirements.

This guide covers solid biofuels purchased for households, small commercial and public sector buildings or industrial applications, which demand the use of fuels with specified quality (properties). Commercial applications have similar fuel requirements as residential appliances whereas industrial applications may utilise a much wider array of materials and have vastly different fuel requirements.

Additional information on the Guidelines and their application is available on www.usewoodfuel.org.nz and set out in "BANZ Technical Guide 6 – "Contracting To Deliver Quality Solid Biofuels To Customers[2]."

The Guidelines are a best practice guide developed and maintained by the Bioenergy Association. Comments on the current version of the Guidelines are welcome and should be provided to the:

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2. OVERVIEW OF SOLID BIOFUEL CLASSIFICATIONS

2.1 Technical standards

New Zealand and Australian best practice fuel specifications and classes for all solid biofuels follow the ISO standards. Current standards are set out in Solid biofuel standards

The standards relevant to the sale and purchase of solid biofuels are covered by the ISO 17225 series. The ISO 17225 series has been prepared 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.

ISO 17225 has nine parts. Part 1 provides an overview of the standard and Parts 2-9 cover specific graded solid biofuels.

ISO 17225-1:2021 Solid biofuels -- Fuel specifications and classes -- Part 1: General requirements

ISO 17225-2:2021 Solid biofuels -- Fuel specifications and classes -- Part 2: Graded wood pellets

ISO 17225-3:2021 Solid biofuels -- Fuel specifications and classes -- Part 3: Graded wood briquettes

[2] https://www.usewoodfuel.org.nz/resource/tg06-contracting-deliver-quality-wood-fuel-customers

ISO 17225-4:2021 Solid biofuels -- Fuel specifications and classes -- Part 4: Graded wood chips

ISO 17225-5:2021 Solid biofuels -- Fuel specifications and classes -- Part 5: Graded firewood

ISO 17225-6:2021 Solid biofuels -- Fuel specifications and classes -- Part 6: Graded non-woody pellets

ISO 17225-7:2021 Solid biofuels -- Fuel specifications and classes -- Part 7: Graded non-woody briquettes

ISO 17225-8:2016 Solid biofuels -- Fuel specifications and classes -- Part 8: Graded thermally treated and densified biomass fuels

ISO 17225-9:2021 Solid biofuels -- Fuel specifications and classes -- Part 9: Graded hog fuel and wood chip for industrial use.

The information in this guide refers to the relevant parts of the ISO 17225 series relevant to trading in solid biofuels for the purpose of guidance only. For legal protection fuel suppliers and large customers are recommended to purchase a copy of the full standard and relevant parts.

2.2 Types of solid biofuels

Solid biomass covers organic, non-fossil material of biological origin which may be used as fuel for heat and electrical generation.

Solid biofuel can be classified by major types or sources of materials for example wood chips, hog fuel, densified wood fuels, urban derived wood fuels, or firewood and by their specific characteristics such as particle size, moisture content, ash content, and energy content.

Furthermore, solid biofuels can come from a range of sources, the ones relevant to this classification guideline are:

- Products and wastes from forestry and arboriculture;
- Fibrous residues from agriculture and horticulture;
- Wood residues from processing;
- Other woody related materials (e.g. used wood, demolition and construction wood waste);
- Selected processed wood fuels (e.g. torrefied wood, wood pellets and briquettes).

These classification guidelines do not include materials from aquatic plants or municipal food wastes.

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.

If a solid biofuel contains chemically treated material it shall be stated. Chemically treated material may not include halogenated organic compounds or heavy metals at levels higher than those in typical virgin material values

For the purposes of this Classification Guideline the main principal is that fuels can be classified by:

- The main type and tradable form (chips, hog fuel etc);
- Specific descriptions that are based on the properties of the solid biofuels.

The main types of fuel included in these classification guidelines are shown in Table 1. For information on other solid biofuels reference should be made to ISO 17225

Table 1: Types of solid biofuel.

Fuel Type	Features	Example
Wood Chips	Chipped woody biomass in the form of pieces, with a defined particle size produced by mechanical treatment with sharp tools such as knives.	
Hog Fuel	Fuel wood in pieces of varying size and shape produced by crushing with blunt tools such as rollers, hammers or flails. These fuels are typically of a lower quality compared to wood chip.	
Wood Pellets	Wood that has been pulverised and densified (pelletised) under heat and high pressure to produce a cylindrical wood derived fuel of consistent size.	
Urban Wood Fuels	Wood residues derived from the urban activities including packaging materials, off-cuts from manufacturing, construction and demolition wood residues, yard trimmings, urban tree residues and from land clearing	
Densified Firelogs and Briquettes	A briquette or fire log is a block of densified flammable matter used as fuel to start and sustain a fire. Common types of briquettes are fuel logs, charcoal briquettes and biomass briquettes.	
Torrefied Wood	"Torrefied wood is thermally modified wood and completely desiccated, with devolatilised hemicellulose, which has not yet reached the point of “char”. These fuels may be compressed, fine or chunky.	
Herbaceous biofuels	These are fibrous derived fuels sourced from Miscanthus, Switchgrass, other grasses and straw and may be in the form of chip, hogged, pelletised, or baled fuels.	
Firewood	Larger piece sizes of wood used for kindling or for sustaining combustion in domestic solid wood fire appliances.	

2.3 Classification by origin

Woody biomass	Forest plantation and other virgin wood	Whole trees without roots
		Whole trees with roots
		Stemwood
		Logging residues
		Stumps/roots
		Bark
		Segregated wood from gardens, parks, roadside maintenance, vineyards, fruit orchards and driftwood from freshwater
	By-products and residues from wood processing industry	Chemically untreated wood by-products and residues
		Chemically treated wood byproducts, residues, fibres and wood constituents
	Used wood	Chemically untreated used wood
		Chemically treated used wood
Herbaceous biomass	Herbaceous biomass from agriculture and horticulture	Cereal crops
		Grasses
		Segregated herbaceous biomass from gardens, parks, roadside maintenance, vineyards and fruit orchards
	By-products and residues from food and herbaceous processing industry	Chemically untreated herbaceous residues
		Chemically treated herbaceous residues

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.

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 (eg PVC, Methyle bromide etc) as a result of treatment with wood preservatives or coating.

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 more than in virgin wood, or halogenated organic compounds as a result of treatment with wood preservatives or coating.

Herbaceous biomass from agriculture and horticulture

Material, which comes directly from the field, perhaps after a storage period, and may only have been subject to size reduction and drying.

3. DESCRIPTION PROPERTIES

Traded solid biofuels are typically described by size, moisture content, ash, bulk density and energy density.

The classification of wood fuels is based on the following properties:

- **Size (P)**[3] – Particle size is an important parameter for many boilers and stove heaters as their fuel feed and distribution systems are typically designed to suite specific fuel sizes. Size distribution also has an effect on the boiler/stove performance. Too many fine particles or too long a piece size will reduce the boiler/stove performance considerably. It is desirable to have as consistent fuel size as possible. This may be influenced by the use of different size reduction technologies such as chippers, hoggers, hammer mills and grinders.
- **Moisture (M)** – Boilers and stoves are generally specified to be used with wood of certain moisture content. Furthermore, in some regions of New Zealand only dry wood is permitted to be used in wood fired heat plant.
- **Ash** (**A**) – Some boilers and stoves specify certain ash level limits in the fuel. Some Regional Plans also specify ash content limits on solid fuels. Excessive ash reduces fuel heating value and increases maintenance and ash disposal costs.
- **Bulk density (BD)** – By combining moisture content figures with those stated for bulk density, wood fuels can be sold on an energy basis by simply measuring a certain volume of wood chips. This has cost advantages as in many applications it is more practical to measure a volume of wood fuel for sale rather than by weight.
- **Energy density (ED)** – It is important for consumer confidence that fuels being sold with a specific classification has consistent energy content rather than one that varies by weight or volume due to high moisture or ash contents.

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 ISO 16993.

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.

[3] Note: previously the size property was denoted by a "S".

4. SOLID BIOFUEL PROPERTY DESCRIPTIONS

Wood fuel will be described by its grouped properties e.g. A specific wood chip could be described as a Woodchip P16 M35 A1 BD200 ED15.

Example – Wood chip for a specific small wood chip boiler could be specified in a contract as P16 M35 A1 BD200 ED15 .
This would be a 16 mm sized chip (3.15≤P16≤16mm) with a moisture content of 35% (M35≤ 35%), ash content of 1% (A1≤ 1%), bulk density of 200 kg/m^3 (BD 200+/-10%), and an energy density of 15 MJ/kg (ED15+/-10%).

5. VERIFICATION METHODS

The standard methods for verifying wood fuels are provided in a separate technical guide "*Bioenergy Association Technical Guide 5 - Standard Methods for Verifying the Quality of Solid Biofuels*[4]".

6. BLENDS AND MIXTURES

In some circumstances solid biofuels may be supplied as either blends or mixtures. Blends are intentionally mixed biofuels whereas mixtures are unintentionally mixed biofuels. The origin of a blend or mixture should be described.

A solid biofuel sold ungraded would be sold with no size or quality description.

7. MOST COMMON FORMS OF TRADED SOLID BIOFUELS

Solid biofuels are traded in many different forms, sizes and shapes often referred to as grades. The size and shape (grade) influence the handling of the fuel as well as its combustion properties. Solid biofuels may be delivered in the following forms:

Table 2. Most common forms of traded solid biofuel.

Fuel Type	Delivered Form	Typical Particle size	Preparation Method
Wood chips		5 mm to 100 mm	Cut with sharp tools
Hog fuels		Varying	Crushed with blunt tools
Pellets		Diameter < 25 mm	Mechanical compression
Urban solid fuels		10mm – 200mm	Chopped during collection
Firelogs and briquettes		25mm	Mechanical compression
Torrefied wood		<100 mm	Heat treatment
Herbaceous biofuels		10 mm to 200 mm	Chopped
	Small square bales	0.1m^3	Compressed and bound to squares
	Big square bales	3.7m^3	Compressed and bound to squares
	Round bales	2.1 m^3	Compressed and bound to squares
Firewood	Trailer or truck load	50 mm to1000mm	Cutting to size with sharp tools

[4] https://www.usewoodfuel.org.nz/resource/tg05-verifying-solid-biofuel

8. WOOD CHIPS

Wood chips are a common form of solid biofuel used for small and larger scale heat plant and are produced from stem wood, process residues, billet or binwood (collected forest derived residues). Chips are produced by sharp cutting tools to which mostly give a consistent particle size. For a full description of wood chip grading refer to Table 5 ISO 17225-1.

Wood may be chipped either wet or dry. Key aspects of wood chip quality are:

- Moisture content;
- Particle size distribution; and
- Ash

Table 3 – Specification of properties for wood chips.

Size specification	**Main fraction (minimum, 60 w-%) mm P = particle size W= weight**	**Fines fraction w-% (< the specified minimum mm)**	**Coarse fraction, (w-%), max length of particle, mm**	**Max length of particles , mm**
P16s	3.15≤P≤16mm	≤15%	≤ 6%.> 31.5 mm	< 45 mm
P16	3.15≤P≤16mm	To be stated from F classes below	≤6%.>31.5 mm	Value to be stated
P45s	3.15≤P≤45mm	≤ 10%	≤ 10%.> 63 mm	≤ 200 mm
P45	3.158≤P≤45mm	To be stated from F classes below	≤10% >63mm	Value to be stated
P63	3.15≤P≤63mm		≤10% > 100mm	
Fine fraction (3.15 mm w-%) ISO 17827-1				
F02	≤ 2%			
F05	≤ 5%			
F10	≤ 10%			
F20	≤ 20%			
F30	≤ 30%			
F40	≤ 40%			
Moisture (w- % by weight as received)- ISO18134-1, ISO18134-2				
M20	≤ 20%			
M30	≤ 30%			
M35	≤ 35%			
M40	≤ 40%			
M55	≤ 55%			
M55+	≤ 55+%			
Ash (w-% by weight of dry basis) ISO18122				
A.0.5	≤ 0.5%			
A1	≤ 1%			
A3	≤ 3%			
A5	≤ 5%			
A6+	> 6% - Actual Value to be stated			
Bulk Density (Kg/m^3 as received) ISO 17828				
	Actual value stated if traded on a volume basis			
Energy Density MJ/kg ISO 18125				
	Actual Value Stated – If sold by weight			

Note 1: Refer to BANZ Technical Guide 5. Standard Methods for Verifying the Quality of Solid BioFuels for a description on measuring particle size and the other parameters.

Note 2: The description of particle size has been changed in this guideline compared to the earlier version to become consistent with ISO 17225. In the previous version of the Wood Fuel Classification Guidelines, particle size was referred to an "S" (i.e. S30, S50, S100). These particle descriptions had different cut-off size limits for fine and coarse particles and different allowable percentages.

Note 3: The particle size is based on particles passing through specific screen diameters. For instance, to remove over-sized particles, P63 fuel should be passed through a screen with holes with a diameter of 63mm, the P45 screen should have holes with a diameter of 45mm etc. A separate screen should be used to ensure fines are removed to comply with the maximum fines percentage. The main fraction of the wood chips is to have a minimum of 60% of the weight is to within the specified particle size range.

Contamination

The level of contamination is also important as this will affect the ash content and potential impact on deposition on boiler surfaces.

- Classified wood fuels must be free from non wood contaminants.
- Where contaminants may arise such as silica for wood fuels derived from the Central North Island then these will need to be considered separately and specified so that the fuel is appropriate of the selected heat plant or application. Silica in the fuel can cause fusing on the boiler grate.

9. HOG FUEL

Hog fuel is solid biofuel in the form of pieces of varying size and shape produced by crushing or shredding with blunt tools such as rollers, hammers, or flails and can be sourced from a wide range of woody feedstocks such as wood processing residues, urban clean woody waste or other forest or woodlot derived materials. Hog fuel is often a mixture of different sources and materials.

The specification of properties of hog fuel are the same as for chip fuel. (refer ISO 17225 and Section 8 above).

10. BIOMASS FUEL PELLETS

Biomass fuel pellets are produced by densification of wood or herbaceous residues and their production is standardised to specific standards according to the feedstock used.

Pellets are typically used in three different scales of heat plant, namely:

- Small – generally for residential home heating;
- Medium – generally for small to medium sized commercial/institutional/industrial heat plant; and
- Large – generally for large industrial process heat plant and for substitution for coal, or for cofiring with coal or low grade hog fuel such as bark.

Biomass fuel pellets are able to be consistently produced to specified standards because they are an engineered product. In small scale heating applications such as for residential home heating the electronic control of the heater operation and the consistency of the quality of the wood pellet fuel provides a means of control of the emissions from combustion[5]. As a controlled heat source this ensures that emissions are within Air Plan rules and avoids the need for monitoring emission outputs as they are controlled by the technology and fuel inputs. In larger heat plant where air emission resource consent conditions require external monitoring and reporting the amount of monitoring can be reduced significantly because of the consistent quality of the fuel input. Control of the quality of fuel ensures that combustion plants will operate within the consent conditions.

Internationally standards relating to the classification of pelletised biomass fuels are set out in parts of the ISO 17225 series. ISO 17225-2 (graded pellets from wood for household and commercial[6] applications and for industrial us), ISO 17225-6 (non-woody graded pellets for household and commercial applications, and ISO 17225-7 (Graded non-woody briquettes.)

ISO 17225-2 supports the use of graded wood pellets for residential, small commercial and public buildings as well as industrial energy generation applications, which require classified pellet quality. The residential, small and commercial and public building applications require higher quality fuel for the following reasons:

- Small-scale equipment does not usually have advanced controls and flue gas cleaning.
- Appliances are not generally managed by professional heating engineers.
- Appliances are often located in residential and populated districts.

Pellets produced according to ISO 17225-2 may be used in pellet stoves, which are tested according to European Standard EN 14785[1], pellet burners tested according to EN 15270[2] and pellet boilers or integrated-pellet burner systems tested according to EN 303–5[3].

There are four categories of wood pellet standard based on the quality classes of ISO 17225-2 and are named as follows:

- Grade A1 - premium pellets - for use in any residential heater or commercial boiler;
- Grade A2 – large premium pellets - for use in selected boilers;
- Grade B – commercial grade pellets for use in selected boilers subject to resource and boiler manufacturer consents.
- Grade I – industrial grade

There are also grades of pellet produced from non-woody biomass to the standard ISO 17225-6

- Grade NWP – pellets produced from non-woody biomass.

Torrefied pellets are excluded from the scope of ISO 17225-2 and are instead included in ISO 17225-1 and ISO 17225-8.

[5] Consent process – When a resource consent is applied for, the boiler supplier must clearly state what category of pellets are to be used in the appliance. This must also be stated in the warranty conditions of the boiler. This requirement will give confidence to the consent issuer that the appropriate technology and fuel are being used. Testing of both the fuel and boiler technology in advance is likely to lead to a more efficient consenting process.

[6] Commercial applications means a facility that utilise solid biofuel burning appliances or equipment that have the similar fuel requirements as residential appliances.

10.1 Quality Assurance

This guide has been produced for the purpose of assisting the sale and purchase of biomass fuel and the pellets component is based on the International Standard ISO 17225-2 (graded pellets for household and commercial applications and for industrial use) and outlines the main elements required to demonstrate compliance for retail and contract based sale. For diagnostic activities reference should be made to the full standard.

Compliance for sale in New Zealand, Australia and the Pacific

Retailed pellets should be certified by an authorised independent certification body as being produced to the standard claimed. In Europe, the two main certifications of quality for pellets are DIN Plus (German) or EN Plus (EU). In New Zealand and Australia the Bioenergy Association also offers a Wood Fuel Supplier Accreditation Scheme (WFSAS). Each of these certification schemes are based on the production of pellets to ISO 17225-2. The WFSAS accepts the certification from the two European schemes within its own scheme.

Wood pellets certified by DIN-Plus, EN Plus or WFSAS are considered compliant for sale in New Zealand, Australia and the South Pacific. A pellet certified as being compliant to DIN-plus or EN Plus is considered to be equivalent as being produced to ISO 17225-2.

10.2 Graded wood pellets – ISO 17225-2

Wood pellets for household and commercial application can be stated in three different classes A1, A2 and B. The property class A1 for wood pellets represents virgin woods and chemically untreated wood residues low in ash and nitrogen content. Fuels with slightly higher ash content and nitrogen content fall within A2. In property class B, forest residues, bark, chemically untreated industrial wood by-products and residues, and chemically untreated used wood is also allowed.

Wood pellets for use in residential wood pellet heaters may only be produced from untreated wood. The following wood A1 class is permitted according to ISO 17225-2, table 1:

- Stem wood
- Chemically untreated wood residue

The types of wood indicated in *Table 2* can be used according to the standard ISO 17225-2 as raw material for the production of wood pellets. The raw material assortments are defined in ISO 17225-1.

***Table 2:** Wood types that are permitted to be used for wood pellet production*

A1	A2	B
- Stem wood[a] - Chemically untreated by-products and residues from the wood processing industry[b]	- Stem wood[a] - Chemically untreated by-products and residues from the wood processing industry[b] - Whole trees without roots[a] - Logging residues[a]	- Forest, plantation and other virgin wood[a] - Chemically untreated by-products and residues from the wood processing industry[b] - Chemically untreated used wood[c]

a) Wood which was externally treated with wood preservatives against insect attack (e.g. lineatus), is not considered as chemically treated wood. If all chemical parameters of the pellets comply with the limits and/or concentrations are too small to be concerned with.

b) Negligible levels of glue, grease and other timber production additives used in sawmills during production of timber and timber product from virgin wood are acceptable, if all chemical parameters of the pellets are clearly within the limits and/or concentrations are too small to be concerned with.

c) Demolition wood is excluded. Demolition wood is used wood coming from the demolition of buildings or civil engineering installations.

Manufacturers of wood pellets must keep records on the origin of their wood including a list of the suppliers of raw wood recognized by the manufacturer and their confirmation to delivery exclusively chemical untreated wood for the wood pellet production.

Contamination, foreign substances

Foreign substances are not permitted except negligible levels of glue, grease and other timber production additives used in sawmills during production of timber and timber product from virgin wood, if all chemical parameters of the pellets are clearly within the limits and/or concentrations are too small to be concerned with.

Requirements on additives

An additive is a material which is intentionally introduced into pellet production, or is added after production, to improve the quality of fuel, reduce its emissions, make production more efficient or mark the pellets. Additives are allowed to a maximum of 2% of the total mass of the pellets. The amount of additives in production shall be limited to 1.8 w-%, while the amount of post-production additives (e.g. coating oils) shall be limited to 0.2 w-% of the pellets. The type (material or trade name) and quantity (in w-%, as received) of all additives shall be documented. Water, steam and heat are not additives.

Chemically treated wood (e.g. glued, lacquered, painted) shall not include halogenated organic compounds or heavy metals at levels higher than those in typical virgin material values. If the raw material includes chemically treated biomass, then also nitrogen, sulphur and chlorine content have to be stated. It also has additional properties like fixed carbon and volatile matter, which are specified only for thermally treated biomass such as torrefied pellets.

Additives, such as starch, corn flour, potato flour, vegetable oil, lignin from sulphate kraft process etc., shall originate from processed or unaltered farming and forestry products.

Identifying marking

The packaging and/or the accompanying papers (with unpacked consignments) must be durably indicated by the following data:

- Name or registered trademark of the manufacturer or the supplier/distributor
- Source of raw biomass from which the pellets have been produced eg A1 or A2
- Designation of the product with indication of the diameter e. g. wood pellets – diameter 6 mm
- Nominal weight and/or mass of the packaging content
- Ash melting temperature (optional)
- Notice
    - that during transport and storage the pellets are to be protected from moisture.
    - The pellets must only be combusted in heat-producing appliances that are suitable and permissible for this type of fuel (e.g.refer to operating instructions).
- Packaged pellets must be marked with a traceability identification on the package. For clear identification of the delivery, every product or its packaging/insert/accompanying documents must be labelled with the date of manufacture and, in the case of several monitored production sites, the production site. This can take the form of an identification code and/or a serial number providing information on the year of manufacture and the production site. For reasons of traceability the marking with the actual date is recommended.
- Reference to relevant external certification process.eg WFSAS, EN Plus

Sampling testing and certification

Guidelines for sampling testing and certification are set out in Bioenergy Association Technical Guide 5 – Standard methods for verifying the quality of solid biofuels.

10.1 Grade 1 - Premium pellets

Application – for use in any residential heater or commercial boiler.

This grade represents the highest level of quality. 'Grade A1' pellets can be used in any residential wood pellet heater or wood boiler. Grade A1 pellets are only manufactured from virgin wood fibre, untreated and free from contamination. Their ash levels are extremely low as are the subsequent levels of emissions. The fuel and the resulting ash should be able to be certified as organic under 'BioGro' (which is driven by both the feedstock and the operating practices in the manufacturing process). This fuel is suited to small commercial boilers and for boilers that require high quality fuels. 'Grade A1' pellets are suitable also for use in controlled air sheds and often allow residential wood pellet heaters to be a permitted use.

Grade A1 Premium wood pellets align with the international wood pellet standard ISO 17225-2. A1 wood pellets may only be produced from untreated wood with the addition of pressing aids according to table 2.

Table 5- Specification parameters for Grade A1 Premium wood pellets.

Specification	Measurement	Comment	Testing standard
Diameter	6±1 mm		ISO 17829
Length	3.15 ≤ L ≤ 40 mm	Max of 1% of the pellets may be greater than 40mm, no pellets > 45mm allowed	ISO 17829
Ash	≤ 0.7 %	By weight	ISO 18122
Additives	≤ 2.0 %	By weight. Type of additives to be defined. Examples are slagging inhibitors or any other additives like starch, corn flour, vegetable oil, or lignin.	-
Moisture	≤10 %	By weight	ISO 18134
Bulk density	600 ≤ BD ≥ 750 kg/m^3	As received basis. It is recommended actual value of bulk density to be stated on packaging.	ISO 17828
Net calorific value	≥ 16.5MJ/kg	As received basis	ISO 18125
Mechanical Durability	≥97.5 %	As received. By weight.	ISO 17831-1
Fines	≤1.0% truck load delivery ≤0.5% Large sacks and bulk ware	By weight, ex gate. Particles of size less than 3.15mm	ISO 18846
Ash deformation temperature	≥ 1200 °C		CEN/TC 15370-1
Chlorine	<20ppm		ISO 16994
Sulphur	<0.04%	By weight	ISO 16994

Grade A2 – Large premium pellets

Application – for use in selected residential and commercial boilers

This grade also represents high quality pellets but is for larger scale applications, such as for school boilers. This grade can also be used in controlled air shed areas. Grade A2 pellets are suited to use in large boilers (depending on design). Grade A2 pellets differ from Grade A1 pellets only in terms of their physical qualities (likely to be larger diameter compared to Grade A1 pellets); the pellet quality remains largely unchanged compared to Grade A1 pellets.

Table 6 - Specification parameters for Grade A2 wood pellets

Specification	Measurement	Comment	Testing standard
Diameter	8 ±1 mm		ISO 17829
Length	3.15 ≤ L ≤ 40 mm	Max of 1% of the pellets may be greater than 40mm, no pellets > 45mm allowed	ISO 17829
Ash	≤ 1.2 %	By weight	ISO 18122
Additives	≤ 2.0 %	By weight. Type of additives to be defined. Examples are slagging inhibitors or any other additives like starch, corn flour, vegetable oil, or lignin.	-
Moisture	≤10 %	By weight	ISO 18134
Bulk density	600 ≤ BD ≥ 750 kg/m^3	As received basis. It is recommended actual value of bulk density to be stated on packaging.	ISO 17828
Net calorific value	≥ 16.5MJ/kg	As received basis	ISO 18125
Mechanical Durability	≥97.5 %	As received. By weight.	ISO 17831-1
Fines	≤1.0% truck load delivery ≤0.5% Large sacks and bulk ware	By weight, ex gate. Particles of size less than 3.15mm	ISO 18846
Ash deformation temperature	≥1100^{o}C		CEN/TC 15370-1
Chlorine	<20ppm		ISO 16994
Sulphur	<0.05%	By weight	ISO 16994

10.2 Grade B – Commercial grade pellets (wood)

Application – for use in selected boilers (subject to resource consents and boiler manufacturer approval)

This grade of wood pellets is for larger scale applications which are installed outside controlled air shed areas or where air emission consents are required. Large boilers (dependent on design) can utilise a variety of wood fuels. Grade B pellets offer the benefits of a pelletised fuel (easy handling) but does not necessarily offer some of the advantages associated with Grade A1 and A2 pellets (i.e., low ash and low emission levels). Where this grade of pellets is to be used, it would be necessary to confirm that the fuel is compatible with the boiler and any consent conditions. Furthermore, it may be necessary to add further specifications to those outlined below to adequately define the fuel for a proposed industrial application.

Table 7 - Specification parameters for Grade B wood pellets.

Specification	Measurement	Comment	Testing standard
Diameter	8±1 mm		ISO 17829
Length	3.15 ≤ L ≤ 40 mm	Max of 1% of the pellets may be greater than 40mm, no pellets > 45mm allowed	ISO 17829
Ash	≤ 2.0 %	By weight	ISO 18122
Additives	≤ 2.0 %	By weight. Type of additives to be defined. Examples are slagging inhibitors or any other additives like starch, corn flour, vegetable oil, or lignin.	-
Moisture	≤10 %	By weight	ISO 18134
Bulk density	600 ≤ BD ≥ 750 kg/m^3	As received basis. It is recommended actual value of bulk density to be stated on packaging.	ISO 17828
Net calorific value	≥ 16.5MJ/kg	As received basis	ISO 18125
Mechanical Durability	≥96.5 %	As received. By weight.	ISO 17831-1
Fines	≤1.0% truck load delivery ≤0.5% Large sacks and bulk ware	By weight, ex gate. Particles of size less than 3.15mm	ISO 18846
Ash deformation temperature	≥1100 ^{o}C		CEN/TC 15370-1
Chlorine	<30ppm		ISO 16994
Sulphur	<0.05%	By weight	ISO 16994

10.3 Grade I1 – Industrial grade pellets (wood)

Application – for use in selected boilers (subject to resource consents and boiler manufacturer approval)

This grade of wood pellets is for larger scale applications which are installed outside controlled air shed areas or where air emission consents are required. Large boilers (dependent on design) can utilise a variety of wood fuels. Grade I1 pellets offer the benefits of a pelletised fuel (easy handling) but does not necessarily offer the advantages associated with Grade A and B pellets (i.e., low ash and low emission levels). Where this grade of pellets is to be used, it would be necessary to confirm that the fuel is compatible with the boiler and any consent conditions. Furthermore, it may be necessary to add further specifications to those outlined below to adequately define the fuel for a proposed industrial application.

There are three industrial grades of pellet made from woodI1, I2 and I3. Only the I1 grade is provided as an example here. If there is a need for the I2 and I3 grades refer to ISO 17225-2.

Table 8 - Specification parameters for Grade I1 industrial grade wood pellets.

Specification	Measurement	Comment	Testing standard
Diameter	8mm		ISO 17829
Length	3.15 ≤ L ≤ 40 mm	Max of 1% of the pellets may be greater than 40mm, no pellets > 45mm allowed	ISO 17829
Ash	≤ 1.0 %	By weight	ISO 18122
Additives	≤ 2.0 %	By weight. Type of additives to be defined. Examples are slagging inhibitors or any other additives like starch, corn flour, vegetable oil, or lignin.	-
Moisture	≤10 %	By weight	ISO 18134
Bulk density	600 ≤ BD ≥ 750 kg/m^3	As received basis. It is recommended actual value of bulk density to be stated on packaging.	ISO 17828
Net calorific value	≥ 16.5MJ/kg	As received basis	ISO 18125
Mechanical Durability	≥97.5 %	As received. By weight.	ISO 17831-1
Fines	≤1.0% truck load delivery ≤0.5% Large sacks and bulk ware	By weight, ex gate. Particles of size less than 3.15mm	ISO 18846
Chlorine	<30ppm		ISO 16994
Sulphur	<0.05%		ISO 16994

10.4 Grade NWP – Non-woody biomass pellets

Application – for use in selected boilers (subject to resource consents and boiler manufacturer approval)

Graded non-woody pellets – ISO 17225-6

Non-woody pellets include those made from blends and mixtures, including herbaceous, fruit or aquatic biomass. Blends and mixtures can also include woody biomass. ISO 17225-6 includes two classification tables:

1. A and B class pellets produced from herbaceous and fruit biomass and blends and mixtures
2. Those made from straw, miscanthus and reed canary grass pellets.

Non-woody pellets have high ash, chlorine, nitrogen and sulphur contents, as well as major element contents, so non-woody pellets are recommended to be used in appliances which are specially designed or adjusted for this kind of pellets.

When using non-woody materials for combustion, special attention should be paid to the risk of corrosion in small- and medium-scale boilers and flue gas systems. Herbaceous or fruit biomass may influence the fuel ash composition differently depending on growth and soil conditions. The content of chlorine, phosphate and potassium in the material may form chlorides and phosphates and other chemical compounds resulting in high hydrochloric emissions and chemically active ash with low melting temperature, causing corrosion.

In general, non-woody biomass materials have higher content of ash-forming elements and produce ashes with lower melting temperature compared to most woody biomass. This may result in fouling,

slagging and corrosion inside boilers. These problems are especially related to materials that contain high contents of potassium and silicate and low levels of calcium.

This grade of wood pellets is for large scale industrial applications which are installed outside controlled air shed areas or where air emission consents are required. Large boilers (dependent on design) can utilise a variety of non-woody fuels. Where this grade of pellets is to be used, it would be necessary to confirm that the fuel is compatible with the boiler and any consent conditions. Furthermore, it may be necessary to add further specifications to those outlined below to adequately define the fuel for a proposed application.

Pellets made from non-woody biomass such as herbaceous plant material, fruit biomass, aquatic biomass and blends and mixtures are covered by Class B of ISO 17225-6. Pelletising specific energy crop such as miscanthus or other grass species improves their handling characteristics and improves bulk density. A number of agricultural crop residues such as straw and stover can be pelletised to turn them from being a waste into an easy useable fuel.

The specification parameters below should be taken as a guide for the production of non-woody pellets. The actual pellet characteristics may depend on the feedstock and pelletising equipment. If there are other grades required of pellet based on non-woody feedstock contact the Bioenergy Association Administrator who will discuss requirements or refer to ISO 17225-6.

Table 9 - Specification parameters for pellets produced from non-woody biomass.

Specification	Measurement	Comment	Testing standard
Diameter	10 – 20 mm		ISO 17829
Length	3.15 ≤ L ≤ 40 mm	Max of 1% of the pellets may be greater than 40mm, no pellets > 45mm allowed	ISO 17829
Ash	≤ 10.0 %	By weight	ISO 18122
Additives	≤ 2.0 %	By weight. Type of additives to be defined. Examples are slagging inhibitors or any other additives like starch, corn flour, vegetable oil, or lignin.	-
Moisture	≤15 %	By weight	ISO 18134
Bulk density	600 ≤ BD ≥ 750 kg/m^3	As received basis. It is recommended actual value of bulk density to be stated on packaging.	ISO 17828
Net calorific value	≥ 14.5MJ/kg	As received basis	ISO 18125
Mechanical Durability	≥96 %	As received. By weight.	ISO 17831-1
Fines	≤3.0 % truck load delivery ≤3.0 % Large sacks and bulk ware	By weight, ex gate. Particles of size less than 3.15mm	ISO 18846
Chlorine	<30ppm		ISO 16994
Sulphur	<0.3%		ISO 16994

11. URBAN SOLID BIOFUELS

The term 'urban' is used to describe solid biofuels which are derived from largely urban sources as outlined below:

- Logistics and freight forwarding companies;
- Storage, warehousing and distribution centres;
- Manufacturing including furniture, home wear, pallets and board producers;
- Construction which covers new builds, residential, industrial and commercial properties;
- Demolition works, mainly residential and commercial units;
- Building refurbishments;
- Household Waste Recycling Centres where local residents dispose of unwanted wood and timber products;
- Commercial activities, for instance companies who receive significant quantities of palletised products or packaging cases.

Although these sources are not mutually exclusive to urban areas, the volumes necessary to make processing economically viable usually means that this type of solid fuel production is situated close to urban areas.

In developing the urban solid biofuel market, two main grades are considered, which not only simplify processing, but make it easier for potential urban fuel users to decide what type of fuel is best suited to them.
General chip dimensions and specification fall within the ISO17225-1 specification.

Urban Clean Biofuel

Urban clean solid biofuel is untreated wood usually sourced from packaging material, pallets and wood processing off-cuts. This type of material is ideal for home and commercial boilers and heaters. Moisture content can typically be around 14% and because this fuel has relatively low moisture content it has a high (as supplied) calorific value.

Provided the material is appropriately monitored to ensure that it is not contaminated with treatment chemicals, then there is unlikely to be any constraints on its use. Given the boiler and burner technology that is prevalent across New Zealand, then untreated wood chip can be used in a wide variety of systems without particular regulatory considerations.

Mixed Grade Urban Chip

Urban wood waste can come contaminated with wood preservatives, binders, paints, glues, chlorine bleach, plastic laminating materials, chlorinated adhesives, phenol and urea formaldehyde resins, nails/staples, or other non-wood materials. It may be mixed with other types of demolition waste, such as rubble, reinforcing bars, tiling or dry wall plasterboard.

Contaminated demolition wood should only be used in high temperature combustion facilities that are specifically designed to effectively combust such materials and which account for any potential

hazardous emissions. Any such installations are likely to require specific resource consents which will allow the use of treated wood.

Shavings and wood dust can also be included in the mixture and would be typically less than 10% of the total mix. This grade can include a small percentage of treated timber. The moisture content is slightly higher than the Urban Clean Biofuel as some of the materials for this grade have greater capacities to absorb moisture, such as hogged MDF. Typically the moisture content is between 18-25%. The chip is also less dense compared to Urban Clean Biofuel and therefore has lower energy density.

Although this type of fuel can be derived from any of the sources detailed in the introduction to this section, there are four main sources:

- **Manufacturing** – treated and untreated wood consisting of off cuts from furniture making, homeware items, board making, MDF & plywood manufacturing.
- ***Construction*** – off cuts from structural timbers, timber packaging, scaffolding, wooden hoardings, concrete form work and building refurbishments.
- ***Demolition*** – used structural timbers, e.g. floorboards, joists, beams staircases and doors.
- ***Building refurbishments*** – this will be a mixture of construction and demolition materials.
- **Treated and contaminated wood**

A large proportion of the waste wood arising in each of the waste streams is treated in some form to increase its durability. Treatments commonly used now or in the recent past include surface coatings such as paints, varnishes and impregnated preservatives such as chromate copper arsenate (CCA), ammoniacal copper quat (ACQ), creosote, boric and pentachlorophenol. Treatments with lesser environmental impacts have been, and are being, developed and are likely to lead to more acceptable use of the 'end of life' wood as fuel. Different preservatives require different considerations when they are reprocessed, recovered or disposed of.

The handling of any treated or coated material as a solid biofuel should be undertaken in a safe manner and be approved by the Regional Council. Further expert technical advice may be required to process or use this fuel type.

Verification methods for these solid biofuels are the same as those described in the Verification Technical Guide (refer section 5).

12. COMPRESSED FIRELOGS AND BRIQUETTES

Biofuel firelogs and briquettes are densified biofuel made either with or without additives in a range of different shapes and are produced by compressing pulverized biomass. The raw material for briquettes can be woody biomass, herbaceous feedstocks, fruit derived material or blends and mixtures. Biomass briquettes are typically made in a piston press. The total moisture of briquettes is usually less than 15%. The properties used to describe these fuels are shown in Table 10.

Table 10 – Specification of the properties for firelogs and briquettes[7].

Diameter (mm) (Firelogs)	
D40	≤ 40mm
D50	≤ 50mm
D60	≤ 60mm
D80	≤ 80mm
D100	≤ 100mm
D125	≤ 125mm
D125+	> 125+
Length (mm)	
L50	≤ 50mm
L100	≤ 100mm
L200	≤ 200mm
L300	≤ 300mm
L400	≤ 400mm
L400+	> 400mm
Moisture (by weight, wet basis)	
M10	≤ 10% Moisture
M15	≤ 15% Moisture
M20	≤ 20% Moisture
Ash (by weight, dry basis)	
A0.5	≤0.5%
A1	≤ 1%
A3	≤ 3%
A6	≤ 6%
A10	≤ 10%
Energy Density	
MJ/Kg	Actual Value Stated – If sold by weight
MJ/m^3	Actual Value Stated – If sold by volume

Contamination

- All firelogs and briquettes must be made from untreated timber;
- Wood fuels must be free from non wood contaminants.

The description of these fuels is based on the same properties as used for other solid biofuels considered in this guide (refer section 3).

Verification methods for these solid biofuels are the same as those described in the Verification Technical Guide (refer section 5).

13. THERMALLY TREATED BIOMASS

Torrefied wood is relatively new type of upgraded wood fuel produced by heating wood to 240 -320 °C in a low oxygen atmosphere. The chemical composition of the biomass has been changed by the heat. This thermal treatment includes processes such as torrefaction, steam explosion, hydrothermal carbonization and charring, all of which represent different exposure to heat, oxygen, steam or water. Thermally treated and densified biomass fuels should only be used in plants with manufacturer approval.

[7] Briquettes have a range of dimensions. Diameters above should be approximated for briquettes.

Drying is not considered thermal treatment in this definition.

Fuel pellets briquettes which are produced by applying the thermal treatment after compaction are also included in this definition.

Biochar produced by pyrolysis to be used in an industrial and not an agricultural application is commonly referred to as biocarbon.

The advantages of torrefaction are:

- Torrefaction (+ densification) enables energy-efficient (>90%) upgrading of biomass into commodity solid biofuels with favourable properties in view of logistics and end-use;
- Favourable properties include high energy density, better water resistance, slower biodegradation, good grindability, good "flowability", homogenised material properties;
- These characteristics give cost savings in handling and transport, advanced trading schemes (futures) possible, capex savings at end-user (e.g. outside storage, direct co-milling and co-feeding), higher co-firing percentages and enabling technology for gasification based biofuels and biochemicals production; and
- Applicable to a wide range of lignocellulosic biomass feedstock, even mixed waste streams.

Table 11. Typical characteristics of torrefied wood:

Characteristic	
Moisture content (%wt)	1-5
Calorific value (LHV MJ/kg)	18-24
Volatile matter (wt dry basis)	55-65
Fixed carbon (wt dry basis)	22-35
Bulk density (kg/L)	0.65-0.8
Energy density (GJ/m^3)	12-19
Hydroscopic properties	Moderately hydrophobic
Biological degradation	low
Milling requirement	Standard
Product consistency	High

For detailed specification information reference should be made to ISO 17225-8 Solid biofuels — Fuel specifications and classes — Part 8: Graded thermally treated and densified biomass fuels for commercial and industrial use.
Products which are marketed as charcoal or as charcoal products are covered by, ISO 17225-1, Table 14
The ISO standards committee ISO/TC238 is investigating the need for a standard for biocarbon for metallurgical applications. The evaluation is assessing whether any standard should be based on existing coal testing or solid biofuel testing. The aim is to identify properties relevant to biocarbon use in metallurgical applications and ensure that test methods are available to measure them reliably

- Behaves differently from coal due to different physical and chemical properties (i.e. lower density, different reactivity etc.)
- Raw biomass is not suitable because of relatively low carbon content/calorific value
- Need thermally-treated, and in some cases also densified biomass to enhance material properties.

14. HERBACEOUS WOODY FUELS

Herbaceous biomass is from plants that have a non-woody stem and which die back at the end of the growing season. Herbaceous biofuels are typically sourced from agricultural activities and will include grasses, and residues from cereal crops, root and legume crops and flowers. For each of these sources, materials may consist of whole plants, straws, grains or seeds, husks and roots.

Herbaceous biomass from agricultural and horticultural fields, and gardens and parks comes directly from the field, perhaps after a storage period, and may only have been subject to size reduction and drying.

Herbaceous biomass may also be by-products and residues from food and herbaceous processing. Examples are fibrous residues from the production of sugar from sugar beets, barley malt residues from beer production and raw vegetable residues from food processing industry.

The use of herbaceous fuels in heat plant must take into account the chemical composition of the material as typically these types of solid biofuels will have high concentrations of inorganic constituents which can contribute to fouling of boiler surfaces and corrosion issues. It is important to have good knowledge of the chemical composition of these materials before using them in heat plants. Herbaceous fuel sources such as straws, cereals and grasses can have low concentrations of calcium and high concentrations of potassium which contributes to lower sintering temperature compared to other wood fuels. The use of these types of fuel requires consideration of appropriate technology to control combustion conditions and the use of effective air emission control equipment.

The description of these fuels is based on the same properties as used for other solid biofuels considered in this guide (refer section 3).

For detailed specification for:

- non-woody pellets refer to 10.4 above or for more detail ISO17225-6
- Non-woody briquettes to ISO17225-7

15. FIREWOOD

Firewood is generally large piece sizes of wood used for domestic fire appliances. These fuels may be supplied as either kindling or larger pieces to sustain a fire. These fuels are typically supplied by a firewood supplier. Many jurisdictions specify moisture content for these types of fuel to minimize emissions.

Table 12 – Specification of the properties for Firewood

Origin	Species of wood should be stated
Diameter (cm) Maximum diameter of a single piece	
D2 ignition wood (kindling) D5 D15 D20 D35+	≤ 2 cm 2 cm≤ D ≤ 5cm 10 cm≤ D ≤ 15cm 15 cm≤ D ≤ 20 cm > 35 cm (maximum value to be stated)
Length (cm) maximum length of single piece	
L20- L20 L30 L40 L50 L100+	<20 cm 20 cm ± 2cm 30 cm ± 2cm 40 cm ± 2cm 50 cm ± 4cm > 35 cm (maximum value to be stated)
Moisture (w-% as received) ISO 18134-1, ISO18134-2)	
M10 M15 M20 M30 M40 M55 M55+	≤ 10% ≤ 15% ≤ 20% ≤ 30% ≤ 40% ≤ 55% > 55 cm (maximum value to be stated)
Volume m^3 stacked or loose **or weight**, kg as received	To be stated which unit is used when retailed(m^3 stacked or m^3 loose, kg) and/or packaged log woods weight.
Energy Density	
Net calorific value, Q MJ/Kg as received	Actual Value Stated – If sold by weight
Energy Density,E MJ/m^3 stacked or loose	Actual Value Stated – If sold by volume
Decay and mould	No visible decay or mould ≤ 5% of pieces
Proportion of split volume	No split (= mainly round wood) ≥ 90 % ≥ 50 %

85% of firewood should be in specified diameter class.
15% firewood shorter than requested length including the limit value

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