


SolidStandards


Enhancing the implementation of quality and sustainability standards and certification schemes for solid biofuels (EIE/11/218)

D2.1d:
Wood chip module

Co-funded by the Intelligent Energy Europe
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The SolidStandards project

The SolidStandards project addresses ongoing and recent developments related to solid biofuel quality and sustainability issues, in particular the development of related standards and certification systems. In the SolidStandards project, solid biofuel industry players will be informed and trained in the field of standards and certification and their feedback will be collected and provided to the related standardization committees and policy makers.

SolidStandards is coordinated by:

WIP Renewable Energies
Sylvensteinstrasse 2
81369 Munich, Germany
Cosette Khawaja & Rainer Janssen
Cosette,khawaja@wip-munich.de
rainer.janssen@wip-munich.de
Tel. +49 (0)89 72012 740

About this document

This document is part of **Deliverable 2.1** of the SolidStandards project. It is the training guidebook for the wood chip module and provides background information to the corresponding presentation slides. This document was prepared in **December 2011 and updated in February 2013** by:

Holzforschung Austria
Franz Grill-Strasse 7
1030 Wien, Austria
Monika Steiner
m.steiner@holzforschung.at
Tel. +43 1 798 2623 912

VTT
Koivurannantie 1
40400 Jyväskylä, Finland
Eija Alakangas
eija.alakangas@vtt.fi
Tel. +358 20 722 2550

Intelligent Energy Europe

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1. Introduction

1.1. Normative references

This document serves as a guideline to facilitate the implementation of quality standards in the production and the transportation of wood chips according to the respective standards of the EN 14961 / EN 15234 series. Greyed text is quoted directly from the standards. Still, for the application of this system the acquisition of in this document mentioned standards is indispensable. For further information please contact the national standardization institutes.

Update: Most European standards mentioned in this document will be superseded within the next years by EN ISO standards. A list, which shows the relationship between the numbers of now valid EN standards with future EN ISO standards, can be found in the Annex.

1.2. Wood chips supply chain

Several different harvesting methods are in use in energy wood harvesting, depending on different harvesting stands, properties of the harvested energy wood and different users. The woody biomasses to be harvested are delimbed and whole trees, logging residues and tree stumps.

Harvesting delimbed energy stems often is similar to the thinning of pulpwood stands, in which a harvester both fells and delimbs trees and a forwarder takes stems to the roadside. The typical length of the stems is 2.7 – 5.0 m and the top diameter 4 – 5.5 cm. This working method suits well for thinning stands in which the average tree size is big enough (e.g. 60 dm^3). The advantages of delimbed stems are good storability and transport efficiency in long-distance transport. Chips made from delimbed stems are suitable for different users from small buildings up to the large power plants. The yield of delimbed stems is about 20 – 30% lower than for undelimbed stems. Harvesting often requires clearing in advance.

Harvesting of undelimbed stems, whole trees of very small stems, is often done by a harvester or felling buncher with a special energy wood grab. Harvesting can also be carried out with a normal harvested equipped with a multi-stem handling grab. The method suits best in young forests, in which the seedling stand management has been neglected. The typical length of harvested stems is 6 – 7 m. Whole trees are transported with a forwarder to a roadside storage, where they usually are seasoned and chipped before long-distance transport. In whole tree harvesting integrated harvesting machines can be also used, with which trees can be both felled and transported to the roadside.

Energy wood bundling is a new method in energy wood harvesting. In this method, the felling machine is equipped with a bundler which bundles harvested wood directly into bundles. Forest transport takes place with normal forwarder, which collects the bundles and transports them to a roadside storage. This method enables efficient forest and long-distance transport

Logging residues are typically collected from spruce dominated final felling stands. The harvester delimbes branches and cuts tops to a pile. The forwarder collects residues and transports them to a roadside storage. To improve the transport efficiency, logging residues are often chipped at a roadside storage before long-distance transport.

Harvesting and chipping can be done by the same person or company, but just as well it can be done as a chain of different operations by different actors (Figure 1 and Figure 2). The energy wood can be chipped in the terrain, at the roadside landing (roadside storage) or at the plant or a terminal. Chipping at the roadside landing is the most common form of chipping in small scale applications. When the chipping is carried out by the heat entrepreneur or a member of the cooperative (in some cases also the contractor), the chipping is normally done with a tractor mounted chipper. This is feasible in especially small sites, where the amount of energy wood is small. Bigger sites, with large amounts of energy wood use the heavier machinery for comminution (Figure 3). There are also enterprises which are specialized in bioenergy procurement and chipping and they usually have heavier machinery, which allows larger amounts of chips to be produced and transported at a time.

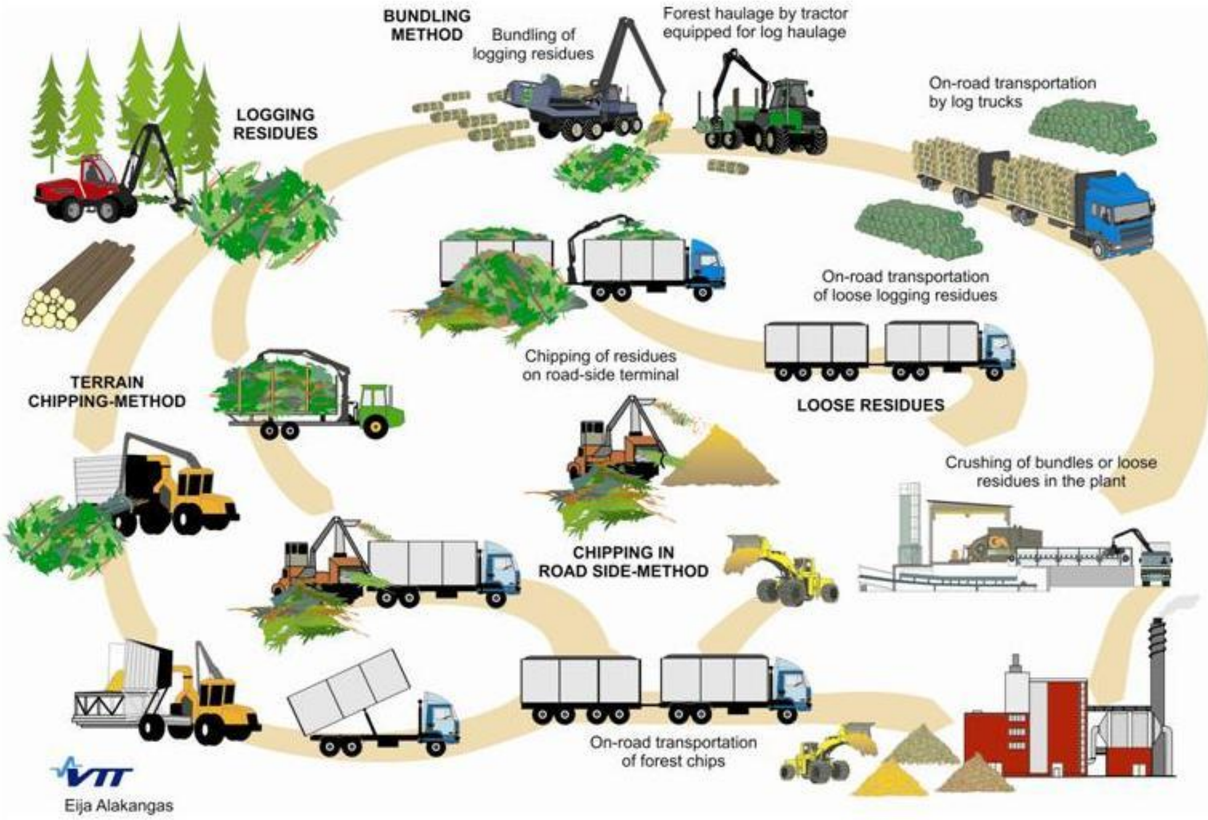

Figure 1: Chipping chain options 1 – logging residues (Source: VTT)

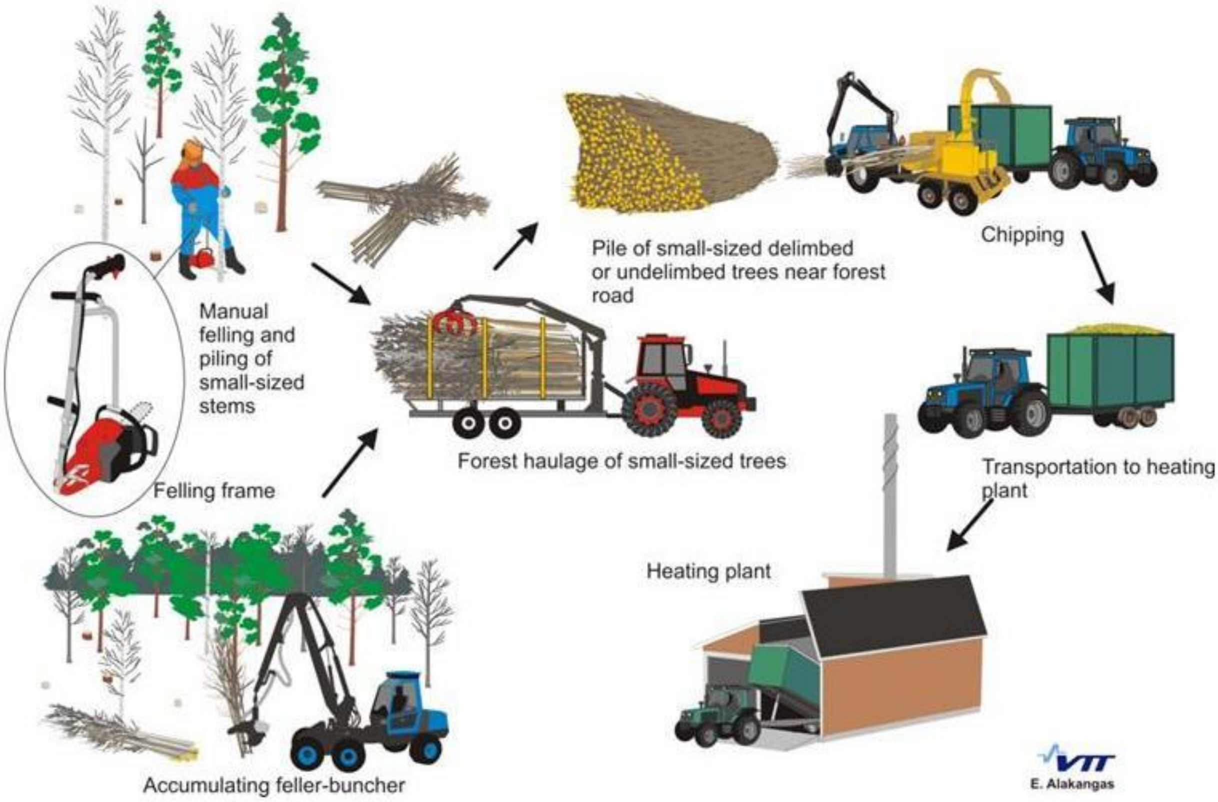

Figure 2: Chipping chain options 2 – delimbed stems or whole trees (Source: VTT)

Figure 3: Whole tree piles covered by Kraft paper to protect them from rain and snow during storage; wood chipper (Source: VTT)

2. How to specify wood chips

2.1. Relevant standards

EN 14961-1:2010 Solid biofuels – Fuel specification and classes.
Part 1: General requirements

Classification is flexible and hence the producer or the consumer may select from each property class. This classification does not bind different characteristics with each other. Some properties are normative (mandatory) some are informative (voluntary).

EN 14961-4:2011 Solid biofuels – Fuel specification and classes.
Part 4: Wood chips for non-industrial use

This product standard targets wood chips for non-industrial use in small-scale appliances ≤ 500 kW (households, small commercial and public sector buildings). Properties are bound together to form a class and all properties are normative.

2.2. Definition (EN 14588)

Wood chips are chipped woody biomass in the form of pieces with a defined particle size produced by mechanical treatment with sharp tools such as knives[1].

Hog fuel is crushed/shredded wood in the form of pieces of varying size and shape and produced by crushing with blunt tools such as rollers, hammers or flails[2].

2.3. Specification

2.3.1. Origin and source (EN 14961-1, Table 1)

Standard EN 14961-1 contains a system for the classification of origin and source of raw material for the production of solid biofuels. On the first level four solid biofuel types are defined: woody, herbaceous, and fruit biomass, furthermore mixtures and blends. On the second level the solid biofuel origin is specified, levels three and four give more detailed information. All in all 115 level-four-descriptions enable a detailed description of origin and source.

While in EN 14961-1 the whole assortment of “woody biomass” can be utilized for the production of wood chips and hog fuel, EN 14961-4 only allows the use of specific raw material classes for the production of a certain wood chip quality class.

[1] EN 14588:2010, paragraph 4.183
[2] EN 14588:2010, paragraph 4.94

2.3.2. Specification of properties (EN 14961-1 or EN 14961-4)

Property classes according to EN 14961-1

In Table 5 of EN 14961-1 wood chips for **general use** (mainly targeted for larger plants) are defined by the following properties:

Normative properties (mandatory, always to be specified)

Particle size (Dimensions) - Analysis according to EN 15149-1

Classes: **see EN 14961-1, Table 5**

Figure 4: Sieves according to method EN 15149-1 (Source: HFA)

Moisture, M (w-% as received) - Analysis according to EN 14774-1, EN 14774-2

Classes: **see EN 14961-1, Table 5**

Ash, A (w-% of dry basis) - Analysis according to EN 14775

Classes: **see EN 14961-1, Table 5**

Typical values for the ash content of pure wood without bark should range below 0.7 %.

Reasons for higher values can be:[3]

- Contamination with soil/sand
- Higher content of bark
- Inorganic additives
- Chemical treatment such as paint/preservation

Problems with ash: Disposal; risk of slagging

Figure 5: High temperature laboratory furnace according to method EN 14775 (Source: VTT)

Normative properties (mandatory only for chemically treated biomass (1.2.2; 1.3.2) or **Informative** properties (for all other biomass)

Nitrogen, N (w-% of dry basis) - Analysis according to EN 15104

Classes: **see EN 14961-1, Table 5**

Typical values for Nitrogen N in pure wood without bark should range around 0.1 %.

Reasons for higher values can be:[4]

- High content of bark/needles (about 0,5 % for logging residues)
- Adhesives (e.g. aminoplaste polymeres UF)
- Plastic (laminates)

Problems with N: Transition in nitrous gases during combustion.

Figure 6: CHN-analyzer according to method EN 15104 (Source: VTT)

[3] EN 14961-1:2010, Annex C1
[4] EN 14961-1:2010, Annex C1

Chlorine, Cl (w-% of dry basis) - Analysis according to EN 15289

Classes: **see EN 14961-1, Table 5**

Typical values for Chlorine Cl in pure wood without bark should range below 0.02 %.

Reasons for higher values can be:[5]

- High content of bark or needles
- Origin of wood from coast near locations (seawater exposed),
- Contamination during storage/transportation by road salting
- Preservation chemicals

Problems with Cl: Clorides (e.g. alkalines, K and Na), Transition in HCl (hydrochloride acid), dioxines and furan emissions during combustion. Condensation of the flue gases can lead to corrosion; enables the formation of aerosols which leads to higher particle emissions

Figure 7: Analyzer for Cl according to method EN 15289 (Source: ENAS Oy)

Informative properties (voluntary, but recommended to be stated)

Net calorific value, Q (MJ/kg or kWh/kg as received) - Analysis according to EN 14918

see EN 14961-1, Table 5

Typical values for the net calorific value of wood without bark (dry basis) should be around19.1 MJ/kg. Net calorific value as received for stem wood chips is about 11.3 MJ/kg if the moisture content is 35 w-%.

Reasons for lower values can be:[6]

- High moisture content
- High ash content
- Content of combustible material with lower calorific value (e.g. adhesives)

Reasons for high values can be:[7]

- Content of combustible material with higher calorific value than wood (e.g. resin, plastic, vegetable or mineral oils)

Figure 8: Bomb calorimeter according to method EN 14918 (Source: HFA)

Bulk density, BD (kg/m³ as received) - Analysis according to EN 15103

Classes: **see EN 14961-1, Table 5** (separate description of the test in the Annex)

Ash melting behavior (°C) - Analysis according to CEN/TS 15370-1

Ash melting behavior is an important property for combustion. If ash melts at low temperatures it can cause deposit formation, slagging and fouling and even shut down of boiler.

Table 6 of EN 14961-1 defines property classes for hog fuel. There are differences to wood chips in the specification of particle size and fine fraction and the net calorific value as received is normative (minimum value to be stated). For hog fuels no product standard exists.

Update: In the future EN ISO 17225-1 there will be only one table for both wood chips and hog fuel specification.

[5] EN 14961-1:2010, Annex C1
[6] EN 14961-1:2010, Annex C1
[7] EN 14961-1:2010, Annex C1

Quality classes according to EN 14961-4

Wood chips for **non-industrial use** can be specified as quality class A1, A2 or B1, B2 if they comply with the respective property classes according to Table 2 of EN 14961-4. Class A1 represents the best quality for wood chips with low ash and moisture content. Although the standard allows the use of a number of raw material classes for the production of wood chips with quality class A1, this high quality usually can only be produced with already dried industrial wood residues. For quality class A2 also stemwood might be taken into account.

Fuel analysis and specification

When specifying a class within a property, the average numerical value from the whole lot (e.g. shipload, truckload, bag) shall determine which class is to be used. If the properties being specified are sufficiently known through information about the origin and handling then physical/chemical analyses may not be needed.[8]

For specification one of the measures in the following order is recommended:

a) using typical values [9]
   - e.g. laid down in annex B of EN 14961-1 or obtained by experience
   - For ash, gross/net calorific value, CHN, S, Cl, metals, ... typical values are stated on dry basis.
   - Moisture content, bulk density and particle size depend on many different factors (not only on the raw material) and therefore there are no typical values stated. Nevertheless the fact that e.g. stemwood, which was stored for two years in a dry place in Central Europe has a moisture content of below 20 w-% can be seen as a typical value.

b) calculation of properties [10]
   - e.g. for mixtures/blends properties can be calculated out of typical values or analyzed values of the respective unmixed/-blended raw materials

stemwood, deciduous	logging residue, coniferous, green
typical value for ash acc. to Annex B.1 = 0.3 w-% dry basis	typical value for ash acc. to Annex B.3 = 3.0 w-% dry basis
calculated value for ash for the blend 50/50 = 1.65 w-% dry basis (A2.0)	

c) carrying out of analysis (with simplified methods if available or with reference methods)[11]

The responsibility of the producer or supplier to provide correct and accurate information is exactly the same whether laboratory analysis is performed or not![12]

[8] EN 14961-1:2010, paragraph 7.2
[9] EN 14961-1:2010, paragraph 7.2
[10] EN 14961-1:2010, paragraph 7.2
[11] EN 14961-1:2010, paragraph 7.2
[12] EN 14961-1:2010, paragraph 7.2

3. How to guarantee a specific quality of wood chips

3.1. Relevant standards

EN 15234-1:2011:	Solid biofuels – Fuel quality assurance. Part 1: General requirements
EN 15234-4:2011:	Solid biofuels – Fuel quality assurance. Part 4: Wood chips for non-industrial use

3.2. How to implement EN 15234-1 and/or EN 15234-4

3.2.1. General

According to EN 15234-1 quality assurance and control aims at providing confidence that a stable quality (not necessarily a high quality) is continually achieved in accordance with the customer requirements.[13]

Quality control = controlling the quality of a product or process [14]

- on the basis of company requirements, standards, agreements, ...
- with the aim to enable the delivery of the product within agreed parameters in the most efficient and cost effective way
- by means of analyses, calculations, checklists, ...

Quality assurance = reviewing the products and processes [15]

- on the basis of data provided from the quality control records
- using this data to provide confidence that products are produced within the required specification and processes are operated as they should be, and to assure that over a longer term either consistency is being maintained or that quality improvements are making the intended impact
- by means of exception reporting

As part of the implementation of this quality management system all measures taken to assure the fuel quality have to be documented and kept up-to-date. The documentation shall include at least:

- Allocation of responsibilities
- Training of the staff (concerning the required quality demands)
- Quality control in the production process
  - Raw material reception (e.g. documentation on the delivery note or the invoice)
  - Results of wood chips analyses (if necessary)
  - Outgoing wood chips (e.g. delivery agreement with the customer or documentation on the delivery note).
  - Non-conforming raw material or wood chips
- Complaint management system

[13] EN 15234-1: 2011, paragraph 6.1
[14] EN 15234-1: 2011, paragraph 6.2
[15] EN 15234-1: 2011, paragraph 6.2

Depending on the position of a market actor in the wood chips supply chain, there are different responsibilities for implementing fuel quality assurance.

A **raw material supplier** is the first operator in the supply chain for solid biofuels and is responsible for preparing the documents of 'origin and source' of the raw material the first time. The documents shall be available and provided on justified request throughout the entire supply chain [16]and thus guarantee the traceability of the wood chips.

The wood chip producer has to check whether the properties of the received raw material are in compliance with the declaration of 'origin and source' given by the raw material supplier. The wood chip producer has to follow 6 consecutive steps to guarantee quality assurance and quality control throughout the whole production process (supply chain).

The **wood chip trader** has to check whether the properties of the received wood chips are in compliance with the product declaration given by the wood chip producer. The wood chip trader has to follow 6 consecutive steps to guarantee quality assurance and quality control throughout the whole production process (supply chain).

The **wood chip consumer** should be able to judge whether the properties of the received wood chips are in compliance with the product declaration given by the wood chip producer/trader.

3.2.2. Implementation process

In the following the fuel quality implementation processes for raw material supplier and wood chip producer/trader are described on the basis of an example.

The example described in the following represents wood chips for industrial use according to EN 14961-1 and EN 15234-1 (the same method is applicable for wood chips for non-industrial use according to EN 14961-4 and EN 15234-4).

[16] EN 15234-1:2011, paragraph 6.3

Raw material supplier

Start	Biomass first time traded as biofuel
Process	Classification of origin according Table 1 in EN 14961-1:2010
Result	Declaration according to EN 15234-1:2011

Raw material 1

Start

Figure 9: Logging residues, coniferous, green (Source: HFA)

Process

Derivation of the source in Table 1 in EN 14961-1:2010

1 Woody biomass
- 1.1 Forest, plantation and other virgin wood
  - 1.1.4 Logging residues
    - **1.1.4.2** Fresh/Green, Coniferous (including needles)

Result

mandatory documentation !

Product declaration based on EN 14961-1	
Supplier:	---
Origin:	**1.1.4.2**
Country:	Austria (or more detailed location if needed)

e.g. on the invoice, delivery note, receiving slip, etc.

Raw material 2

Start

Figure 10: Logging residues, deciduous, stored (Source: HFA)

Process

Derivation of the source in Table 1 in EN 14961-1:2010

1 Woody biomass
- 1.1 Forest, plantation and other virgin wood
  - 1.1.1 Whole trees without roots
    - **1.1.1.1** Deciduous

Result

mandatory documentation !

Product declaration based on EN 14961-1	
Supplier:	---
Origin:	**1.1.1.1**
Country:	Austria (or more detailed location if needed)

e.g. on the invoice, delivery note, receiving slip, etc.

Wood chip producer/trader

Start	Raw material specified by a 'declaration of origin and source'
Process	
Step 1	Define fuel requirements for the final product
Step 2	Document the steps in the process chain (process description)
Step 3	Identify factors influencing the fuel quality and company performance
Step 4	Identify and document Critical Control Points (CCP)
Step 5	Select appropriate measures to ensure the quality of the product (at CCP)
Step 6	Establish and document routines for separate handling of nonconforming materials and solid biofuels
Result	Product declaration according to EN 15234-1:2011

Production / Trade

Start

mandatory documentation !

The wood chip producer has to check whether the properties of the received raw material are in compliance with the declaration of 'origin and source' given by the raw material supplier. If there doesn´t exist a 'declaration of origin and source' the producer is responsible for preparing this declaration for the first time.

The raw material supplier (e.g. forestry) contacts the wood chip producer to inform him that two types of raw material are available at one forest site ready to be chipped. The producer gets the oral information that the two types are logging residues (coniferous/green) and whole trees without roots (deciduous). Usually there doesn't exist a written declaration of origin and source and the wood chip producer has to prepare the declaration and include it on e.g. the delivery note or the invoice after the transaction only.

Figure 11: Raw material ready to be chipped (Source: FHP, HFA)

Process

Step 1

The fuel quality is described by the appropriate part of EN 14961 and should be the result of an agreement between the producer and his customer. The wood chip producer shall determine key properties of the wood chips in accordance with the end-user needs. [17] *Usually the fuel quality requirements are written in sales contracts.*

The wood chip producer has a delivery contract with a heating plant, which can only use wood chips with a size of P45B or smaller (the limiting factor is the max. cross sectional area of 5 cm²) and an ash content of below 3 %. The producer defines 'dimension' and 'ash' as key properties, which need to be checked continually during the production process. The specification '**Wood chips P45B-A3.0**' defines the maximum values of the required properties.

[17] EN 15234-1:2011, paragraph 6.4 a)

Process Step 2

mandatory documentation !

To document the steps in the process chain the wood chip producer can elaborate a flow chart, in which he defined – based on the influencing factors (step 3) - Critical Control Points CCP (step 4).

Step 2, 3 and 4 should be part of a 'company-manual', which has to be elaborated independently of a specific commission for the usual processes of the company. A flow chart for wood chip production and transport including critical control points is attached below.

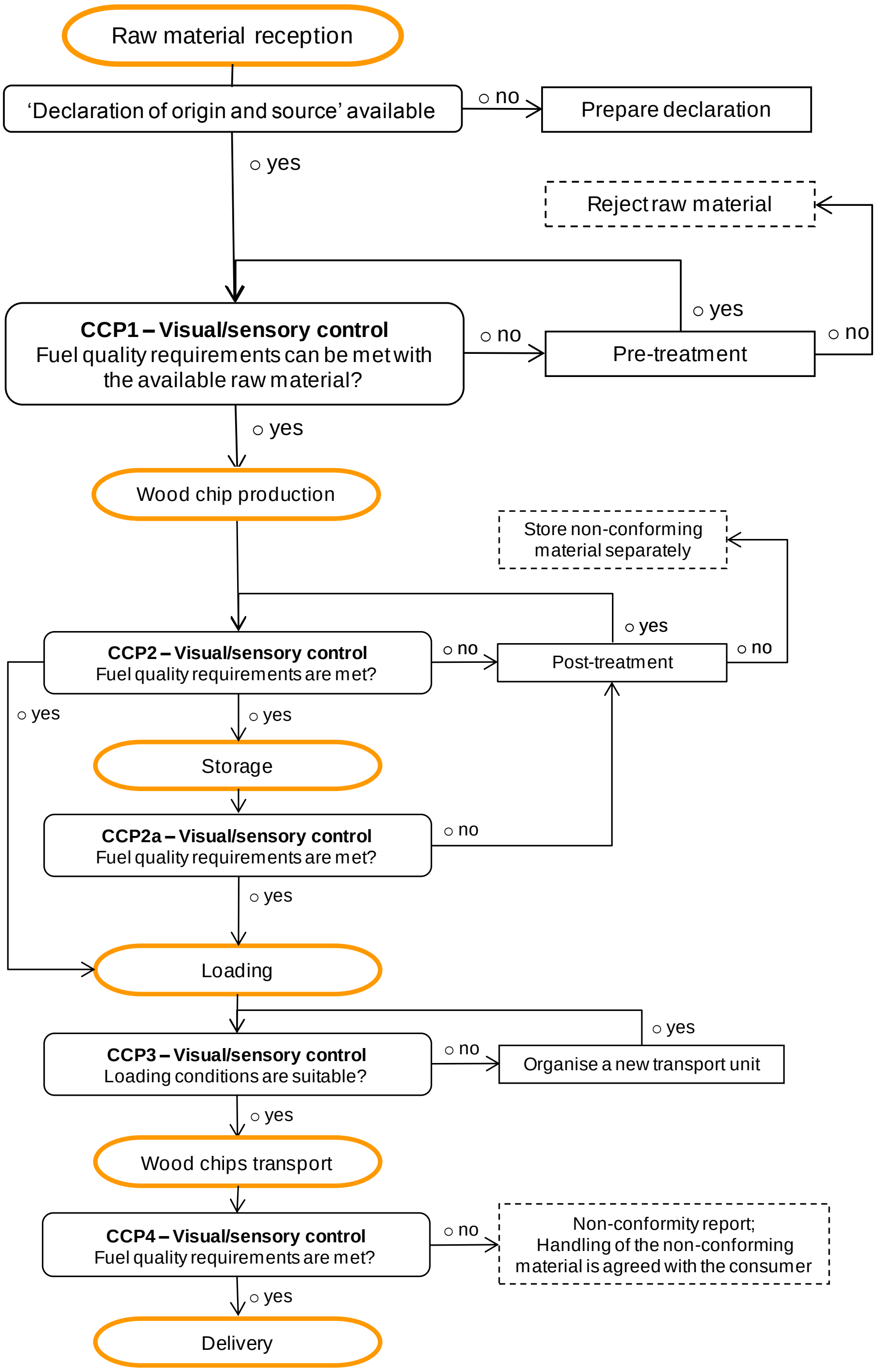

Figure 12: Flow chart with CCP

Process Step 3

All activities referring to both technical processes and management issues should be examined. The following factors determine the quality of the wood chips and its performance.

- *The effectiveness of preliminary inspection of fuel sources and checking of incoming raw material.*
- *The care with which the material is stored and processed.*
- *The knowledge, competence and qualification of the staff.* [18]

The producer has to assess all influencing factors in the production process, beginning with the raw material reception and - in case of own delivery - including the transport to the heat plant. If he hires a forwarder for delivery and not a specialized trading company, the producer has to include transport in his evaluation process as well (to make sure, that the transport is handled in an appropriate way; e.g. control of the transport unit.

Influencing factors	Influenced fuel property
raw material • wood species • part of the tree (source) – needles/leaves, bark • weather conditions	• ash content • net calorific value • particle size (fines) • moisture content
storage conditions • covering (weather conditions) • storage time (e.g. long storage can lead to dry material or to wet and even partially decayed material – depending on the place of storage and the weather conditions) • storage place (impurities of raw material - e.g. soil and stones depending whether the material was stored on a paved road or on forest ground)	• moisture content • net calorific value • ash content
chipping • chipper (sieves)	• particle size (fines and course fraction)
transport unit • contamination (e.g. impurities of the wood chips due to soiled transport units) • covering (weather conditions; e.g. increasing moisture content due to precipitation) • effects of transportation on the biofuels	• ash content • moisture content • particle size (fines)
possible contamination with other products/fuels	• all
knowledge, competence and qualification of the staff	• all

[18] EN 15234-1:2011, paragraph 6.4 c)

Process Step 4 **mandatory documentation** !	*Critical Control Points are points within or between processes at which properties can be most readily assessed and that offer the greatest potential for quality improvement.* [19] See Figure 12.
Process Step 5 **mandatory documentation** !	*Appropriate measures to give confidence to the customer, that the specifications are being realized, include besides product control the following management issues:* • *Allocation of responsibilities* • *Training of staff* • *Work instructions* • *Establishment of quality control measures* • *Proper documentation of processes and test results* • *System of procedures for complaints* [20] In the 'company-manual' it is defined that the manager of the production company is quality manager at the same time and is responsible for the training of the staff and the allocation of responsibilities. Work instructions exist for each Critical Control Point (CCP). Based on the flow chart of the production process a shift protocol was elaborated to assure that quality issues are taken into consideration and documented at all times. Step 5 - **CCP1 (raw material reception):** *As part of the raw material reception it must be ensured by the wood chip producer that the declaration of origin and source is in order.* • *Visual or other sensory inspections of the delivered raw material* [21] *(general evidence of suitability can be obtained from knowledge of the type of wood, amount of needles/leaves, storage place/time, contamination with impurities, weather conditions during harvest, …).* Out of two types of raw material the producer selects the 'whole trees without roots' because with the 'green' logging residues he wouldn´t be able to fulfill the requirement of an ash content below 3 %. He has to be careful picking up the material to avoid excessive contamination with soil and stones, which would increase the ash content.  **Figure 13: Raw material (Source: FHP, HFA)**

[19] EN 15234-1:2011, paragraph 6.4 d)
[20] EN 15234-1:2011, paragraph 6.4 e)
[21] EN 15234-4:2012, paragraph 5.6.1

Step 5 - **CCP2 (production):**

- *Visual or other sensory inspections are carried out across the whole production process.*
- *Control of key properties after the raw material basis has changed; at a frequency appropriate to the process requirements.*
- *Equipment is maintained or changed when necessary; some parts will require changing regularly.*[22]

During the chipping process raw material which is not complying with the agreed on requirements is put aside and not chipped (e.g. highly soil contaminated wood).

The operator changes or edges the knives as soon as he notices a negative impact on the wood chip quality. To reduce the max. cross sectional area of the wood chips, it might be necessary to use a sieve with the chipping unit.

Figure 14: Wood chip production (Source: FHP, HFA)

Step 5 - **CCP3 (storing / transport):**

- *Storage and transport equipment is checked regularly (suitability and cleanliness).*
- *Stored/delivered chips should be covered or otherwise protected from precipitation.* [23]

Before loading the wood chip producer checks whether the transport unit is clean. In case of severe contamination he gives order to clean the vehicle or if that is not possible he orders a new transport unit. If the wood chips are loaded directly on the transport vehicle in the course of chipping, the inspection of the vehicle has to be done before chipping already. The wood chip producer documents whether the wood chips are covered during transport or not.

Figure 15: Container loading (Source: FHP, HFA)

Figure 16: Shipment (Source: FHP, HFA)

[22] EN 15234-4:2012, paragraph 5.6.2
[23] EN 15234-4:2012, paragraph 5.6.2

	Step 5 - **CCP4 (delivery/reception):** At the heating plant the wood chips are visually and sensory inspected by the heating plant staff and the included checklist is controlled. A sample is taken of the delivered wood chips and the water content is analyzed to fix the price of the lot.
Process Step 6 **mandatory documentation** !	• *If raw materials or the produced wood chips are not fulfilling the requirements (due to e.g. high moisture content), these batches have to be stored separately from conforming ones.* • *Re-screening processes could be applied to achieve compliance with the required fuel properties (e.g. sieving, drying,..).* • *All necessary information has to be documented.* • *If nonconformity of the product is discovered at the premises of the consumer in connection with delivery, a nonconformity report is generated and handling of the nonconforming lot is agreed with the consumer.* [24] During raw material reception the producer realizes that the raw material includes a pile of bushes as well. He decides to chip it nevertheless but fills a separate container with this material and delivers it to a company, which takes wood chips with higher ash content. The checklist for the production process is filled in accordingly to document the whereabouts of the material.

[24] EN 15234-4:2012, paragraph 5.7

Result	

mandatory documentation !	*The quality of the produced chips corresponds to that defined in step 1 of the process. If the producer/trader delivers wood chips to end-consumers the product declaration/labelling shall as a minimum include:*
	• *Supplier (body or enterprise) including contact information;*
	• *Traded form (according to EN 14961-1:2010, Table 2);*
	• *Origin and source (according to the EN 14961-1:2010, Table 1);*
	• *Country/countries (locations) of origin;*
	• *Specification of properties (according to the relevant part of EN 14961):*
	  ○ *Normative properties;*
	  ○ *Informative properties;*
	• *Chemically treated material (yes/no);*
	• *Signature, date.*
	The product declaration can be approved electronically. Signature and date can be approved by signing of the waybill or stamping of the packages in accordance with the appropriate part of EN 14961.
	With the product declaration the supplier (producer) confirms, that the properties of the end product are in accordance with the requirements of the respective part of EN 14961 according to EN 15234-1. The supplier shall date the declaration and keep the record for a minimum of one year after the delivery. [25]

Product declaration – wood chips	
Supplier:	---
Quality assurance standard	EN 15234-1
Origin:	1.1.1.1
Country:	Austria 7540 Güssing
Traded Form:	Wood chips
Chemically treated material	**No x** Yes □
Normative properties – EN 14961-1	
Particle size	**P45B**
Moisture (w-%)	**M50**
Ash content (w-%)	**A2.0**

[25] EN 15234-1:2012, paragraph 7

Annex

Storage and handling of wood chips

CEN standards do not cover solid biofuel storage and handling issues. The below cited storage and handling guidelines for solid biofuel are published as a Nordtest method (source: NT ENVIR 010:2008-10: "Guidelines for storing and handling of solid biofuels", Nordic innovation centre).

Problems and risks

Deterioration of the wood chip quality

Reduction in the calorific value of the fuel, inhomogeneous fuel due to increased and uneven moisture content, increased ash content as a result of the loss of organic matter or contamination with soil and an increase in the percentage of fine particles. The effect of storage on fuel quality is decided by many factors related to the properties of stored material and storage method.

The composition of the material, e.g. wood, foliage, bark, etc. affects the rate of biological degradation since it determines the availability of easily usable nutrients in the stored chips. Needles and bark, for example, have more soluble nutrients and higher nitrogen content than stem wood thus providing a better substrate for the rapid establishment of fungal and bacterial growth.

Moisture content of the fuel is another major property which affects microbial activity and subsequently heat development and dry matter losses. Moisture/humidity is essential for the metabolic activities of fungi and bacteria.

Particle size of the chips influences on many processes directly and indirectly. Chipping the fuel leads to an enormous increase in the exposed surface areas available for microbial colonization. It also reduces air passages inside the pile thus reducing the possibility for heat diffusion. Storage of larger particles, e.g. chunk wood and small trees in bundles, is known to cause fewer problems than chips.

Improper handling of the raw material for wood chip production can lead to a significant increase of soil-contaminated material.

Improvement of storage:

— Outdoor storage should be placed preferably on dry, level ground close to the transport road. The ground should be free of stumps, stones and large residues, higher than the roads to avoid percolation of rain water from the road to the storage.

— At factory and terminal storage bituminous ground surface covering is advisable.

— To prevent uptake of moisture from the ground, a dry bottom surface layer for a pile is preferable and to avoid penetration of precipitation from the top, the storage can be covered with hydrophobic shield, impregnated paper or similar covering material.

— Indoor storages shall be protective against exposure to rain and other water sources to prevent moisture uptake. In storage with low ventilation, a CO-sensing system is recommended to be installed for occupational health concerns.

— Indoor storages should be well ventilated. In storages with low ventilation, a CO-sensing system is recommended to be installed for occupational health concerns.

Improvement of handling:

— Handling and transport shall be conducted with a minimum of wear and damage to the solid biofuel.

Spontaneous ignition

Fire through self-heating can occur in piles of wood chips, bark and other solid biofuels, which are porous, often moist materials, which are prone to self-heating caused by microbiological activity, chemical oxidation and physical processes.

Microbial growth results in a temperature increase in the stored fuel. As the heat producing processes proceed, heat is transported from the interior of the bulk towards the surface. The centre of the bulk is drying and water is transported out from the centre and condensing on the outside layers. Height of pile and ambient temperature are factors which influence average moisture content and temperature during storage of wood chips. In particular, the shape of a chip pile effects the temperature rise more than the height of the pile as the shape will determine the ventilating chimney effect in the pile. The ventilation provides the oxygen needed by metabolic activity as well as it cools the pile interior by convection.

The main factors influencing the temperature in the stack are: moisture content, moisture gradients, the size of the bulk and density. Mixing fuels with different moisture content should be avoided as the moisture gradient may lead to increased risk of self ignition. Spontaneous ignition starts as pyrolysis in the interior of the stack in cases when the heat production exceeds the heat dissipation in bulk material. The spontaneous ignition results in flaming combustion in cases when the pyrolysis spreads to the surface of the stack.

Prevention of spontaneous ignition:

- Fuels of different qualities (e.g. different raw materials, particle sizes, moisture content) should never be mixed when stored;
- Store preferably in small piles and during a short time;
- If possible, store dry fuels to avoid microbial growth (< 20 % moisture content);
- It is important to utilize fuel or raw material piles according to age; the oldest first (FIFO-principle: First-in – First-out). Reduce storage time as much as possible;
- Avoid compaction of the material;
- Raise piles in elongated stacks with a base-width of twice the height of the stack;
- Examples of recommended maximum open pile storage heights:
  wood chips from pure wood without bark – 15 m, forest residue chips – 7 m, bark – 7 m.
- Avoid metal objects in the pile;
- Follow the development of temperature in a pile or storage;
- In the case of high self-heating phenomena (> 60°C), take sufficient measures to prohibit open fire;
- Never deliver fuel having high temperature or fire pockets.

Extinction of fire in freely located heaps and stacks:

- Locate hot-spots and dig out and remove warm/active material from the stack;
- Spread out the material at a safe place and let it cool off;
- Use water spray/jets to cool/extinguish pyrolysing material during the extinguishing operation. Water shall also be used to control any open fire. Water additives, e.g. fire fighting foams and wetting agents might improve the extinguishing efficiency.

Health risks

Emissions from piles stored outdoor are normally diluted by surrounding air and have, therefore, limited effect. A greater risk for exposure to harmful emissions from stored biofuel comes from storage in enclosed spaces. Examples of such storages are cargo spaces in ships and storage in silos and other confined storages.

Storage of wet solid biofuel, especially freshly chipped material, in a pile provides a favourable environment for the growth of many species of bacteria and fungi. Handling mouldy chips can lead to the release of high concentration of spores to the air. Due to their small size, the spores are easily inhalable and they can penetrate the respiratory system and cause allergic reactions. Using a protective mask is therefore highly recommended.

There is always some dust present when handling especially dry fuels produced from biomass. The harmfulness of dust depends on chemical (and mineralogical) composition, dust concentration and particle size and shape. Air-borne small particles (≤ 5 µm) are able to penetrate deep into lungs and may cause occupational respiratory diseases.

Prevention of health risks:

- Good ventilation; use of a CO-sensing device
- The use of personal protection equipment as masks (P3 filter) is only a solution which can be used if the air pollution cannot be removed with technical measures.
- Technical measures available to reduce the exposure to dust are: ventilation, exhaust ventilation and negative pressure, curtain, walls, fine water sprays, closed sections and remote control.
- Spreading of airborne spores from the solid biofuel storage to other parts of an energy plant can be reduced by installing double doors between the storage and the other part of the energy plant.
- The control of loading and unloading under variable wind and air stream and circulation conditions is important for reducing dust problems at factory and handling sites.

Overview of European standards and international standards on solid biofuels

As of January 2014

Below table provides an overview of European and international standards on solid biofuels. The European Standards are developed in CEN/TC 335 "Solid biofuels". Most of the standards on the work programme of CEN/TC 335 have been formally published as European (EN) standards. The international standards are developed in ISO/TC 238 "Solid biofuels". The standards on the work programme of ISO/TC 238 are either still under development or the process should formally be initiated. The list of (future) international standards is based on the information available at the so-called ISO Project Portal (31 January 2013); the work programme may extend in future. The work programme of ISO/TC 238 shows much overlap with the work programme of CEN/TC 335, noting that differences exist. For example, where the European standards on fuel specifications and classes (EN 14961 series) focus on non-industrial use, the international standards on this topic (future ISO 17225 series) enlarge the scope to industrial use as well.

European standards (EN)		International standards (ISO)	
If dated, the (draft) standard is published and publicly available		*If dated, the (draft) standard is published and publicly available*	
Terminology		**Terminology**	
EN 14588:2010	Solid biofuels – Terminology, definitions and descriptions	ISO/DIS 16559: 2013 01 31	Solid biofuels -- Terminology, definitions and descriptions
Fuel specifications and classes		**Fuel specifications and classes**	
EN 14961-1:2010	Solid biofuels – Fuel specifications and classes – Part 1: General requirements	ISO/FDIS 17225-1: 2013 11 28	Solid biofuels -- Fuel specifications and classes -- Part 1: General requirements
EN 14961-2:2011	Solid biofuels – Fuel specifications and classes – Part 2: Wood pellets for non-industrial use	ISO/FDIS 17225-2: 2013 11 28	Solid biofuels -- Fuel specifications and classes -- Part 2: Graded wood pellets
EN 14961-3:2011	Solid biofuels – Fuel specifications and classes – Part 3: Wood briquettes for non-industrial use	ISO/FDIS 17225-3: 2013 11 28	Solid biofuels -- Fuel specifications and classes -- Part 3: Graded wood briquettes
EN 14961-4:2011	Solid biofuels – Fuel specifications and classes – Part 4: Wood chips for non-industrial use	ISO/FDIS 17225-4: 2013 11 28	Solid biofuels -- Fuel specifications and classes -- Part 4: Graded wood chips
EN 14961-5:2011	Solid biofuels – Fuel specifications and classes – Part 5: Firewood for non-industrial use	ISO/FDIS 17225-5: 2013 11 28	Solid biofuels -- Fuel specifications and classes -- Part 5: Graded firewood
EN 14961-6:2012	Solid biofuels – Fuel specifications and classes – Part 6: Non-woody pellets for non-industrial use	ISO/FDIS 17225-6: 2013 11 28	Solid biofuels -- Fuel specifications and classes -- Part 6: Graded non-woody pellets

European standards (EN)

If dated, the (draft) standard is published and publicly available

Fuel quality assurance

EN 15234-1:2011	Solid biofuels – Fuel quality assurance – Part 1: General requirements
EN 15234-2:2012	Solid biofuels – Fuel quality assurance – Part 2: Wood pellets for non-industrial use
EN 15234-3:2012	Solid biofuels – Fuel quality assurance – Part 3: Wood briquettes for non-industrial use
EN 15234-4:2012	Solid biofuels – Fuel quality assurance – Part 4: Wood chips for non-industrial use
EN 15234-5:2012	Solid biofuels – Fuel quality assurance – Part 5: Firewood for non-industrial use
EN 15234-6:2012	Solid biofuels – Fuel quality assurance – Part 6: Non-woody pellets for non-industrial use

Sample and sample preparation

EN 14778:2011	Solid biofuels – Sampling
EN 14780:2011	Solid biofuels – Sample preparation

Physical and mechanical properties

EN 14774-1:2009	Solid biofuels – Determination of moisture content – Oven dry method – Part 1: Total moisture – Reference method
EN 14774-2:2009	Solid biofuels – Determination of moisture content – Oven dry method – Part 2: Total moisture – Simplified method
EN 14774-3:2009	Solid biofuels – Determination of moisture content – Oven dry method – Part 3: Moisture in general analysis sample

International standards (ISO)

If dated, the (draft) standard is published and publicly available

ISO/FDIS 17225-7: 2013 11 28	Solid biofuels -- Fuel specifications and classes -- Part 7: Graded non-woody briquettes

Fuel quality assurance

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Sample and sample preparation

ISO/NP 18135	Solid biofuels -- Sampling
ISO/NP 14780	Solid biofuels -- Sample preparation

Physical and mechanical properties

ISO/DIS 18134-1: 2013 09 19	Solid biofuels -- Determination of moisture content -- Oven dry method -- Part 1: Total moisture -- Reference method
ISO/DIS 18134-2: 2013 09 19	Solid biofuels -- Determination of moisture content -- Oven dry method -- Part 2: Total moisture - Simplified method
ISO/DIS 18134-3: 2013 09 19	Solid biofuels -- Determination of moisture content -- Oven dry method -- Part 3: Moisture in general analysis sample

European standards (EN)		International standards (ISO)	
If dated, the (draft) standard is published and publicly available		*If dated, the (draft) standard is published and publicly available*	
EN 14775:2009	Solid biofuels – Determination of ash content	ISO/DIS 18122: 2013 09 19	Solid biofuels -- Determination of ash content
EN 14918:2009	Solid biofuels – Determination of calorific value	ISO/NP 18125	Solid biofuels -- Determination of calorific value
EN 15103:2009	Solid biofuels – Determination of bulk density	ISO/DIS 17828: 2013 11 01	Solid biofuels -- Determination of bulk density
EN 15148:2009	Solid biofuels – Determination of the content of volatile matter	ISO/DIS 18123: 2013 11 01	Solid biofuels -- Determination of the content of volatile matter
EN 15149-1:2010	Solid biofuels – Determination of particle size distribution – Part 1: Oscillating screen method using sieve apertures of 1 mm and above	ISO/CD 17827-1	Solid biofuels -- Determination of particle size distribution for uncompressed fuels -- Part 1: Horizontally oscillating screen using sieve for classification of samples with a top aperture of 3.15 mm and above
EN 15149-2:2010	Solid biofuels – Determination of particle size distribution – Part 2: Vibrating screen method using sieve apertures of 3,15 mm and below	ISO/CD 17827-2	Solid biofuels -- Determination of particle size distribution for uncompressed fuels -- Part 2: Vertically vibrating screen using sieve for classification of samples
CEN/TS 15149-3: 2006	Solid Biofuels – Methods for the determination of particle size distribution – Part 3: Rotary screen method		
EN 15150:2011	Solid biofuels – Determination of particle density	ISO/DIS 18847: 2013-06-19	Solid biofuels -- Determination of particle density
EN 15210-1:2009	Solid biofuels – Determination of mechanical durability of pellets and briquettes – Part 1: Pellets	ISO/DIS 17831-1: 2013 11 01	Solid biofuels -- Methods for the determination of mechanical durability of pellets and briquettes -- Part 1: Pellets
EN 15210-2:2010	Solid biofuels – Determination of mechanical durability of pellets and briquettes – Part 2: Briquettes	ISO/DIS 17831-2: 2013 11 01	Solid biofuels -- Methods for the determination of mechanical durability of pellets and briquettes -- Part 2: Briquettes
EN 16126:2012	Solid biofuels – Determination of particle size distribution of disintegrated pellets	ISO/CD 17830	Solid biofuels -- Determination of particle size distribution of disintegrated pellets
EN 16127:2012	Solid biofuels – Determination of length and diameter for pellets and cylindrical briquettes	ISO/DIS 17829: 2012-11-22	Solid biofuels -- Determination of length and diameter of pellets
		ISO/CD 18846	Solid biofuels -- Determination of fines content in quantities of pellets -- Manual sieve method using 3,15 mm sieve aperture

European standards (EN)

If dated, the (draft) standard is published and publicly available

Chemical analysis

EN 15104:2011	Solid biofuels – Determination of total content of carbon, hydrogen and nitrogen – Instrumental methods
EN 15105:2011	Solid biofuels – Determination of the water soluble chloride, sodium and potassium content
EN 15289:2011	Solid biofuels – Determination of total content of sulfur and chlorine
EN 15290:2011	Solid biofuels – Determination of major elements – Al, Ca, Fe, Mg, P, K, Si, Na and Ti
EN 15296:2011	Solid biofuels – Conversion of analytical results from one basis to another
EN 15297:2011	Solid biofuels – Determination of minor elements – As, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Sb, V and Zn

International standards (ISO)

If dated, the (draft) standard is published and publicly available

Chemical analysis

ISO/DIS 16948: 2013 04 15	Solid biofuels -- Determination of total content of carbon, hydrogen and nitrogen
ISO/DIS 16995: 2013 04 15	Solid biofuels -- Determination of the water soluble content of chloride, sodium and potassium
ISO/DIS 16994: 2013 04 15	Solid biofuels -- Determination of total content of sulphur and chlorine
ISO/DIS 16967: 2013 04 01	Solid biofuels -- Determination of major elements
ISO/DIS 16993: 2013 04 15	Solid biofuels -- Conversion of analytical results from one basis to another
ISO/DIS 16968: 2013 04 01	Solid biofuels -- Determination of minor elements
ISO/CD 16996	Solid biofuels -- Determination of elemental composition by X-ray fluorescence

ISO/CD	Committee Draft developed by ISO (draft available for members only)
ISO/DIS	Draft International Standard (draft available for public enquiry)
ISO/FDIS	Final Draft International Standard (draft available for public enquiry)
ISO/NP	New Project by ISO, but standard development to be initiated