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# Report on the labelling concept

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# 1 Background

According to the worldwide rising energy demand and the increased ambitious climate protection targets, the use of biomass for energetic utilization will gain even more importance than it already has. At the moment, especially in Europe, small-scale combustion units (20 to 200 kW, 20 to 500 kW in the future) are used almost only with high quality wood fuels. Since nowadays wood is getting more scarce caused by the growing demand in material and energetic use, alternative and mixed solid biofuels, like low quality wood for example prunings from vineyards, straw or olive press cake, are experiencing growing interest. In most of the European countries first activities have been started to integrate these alternative biomass fuels. Furthermore, for small and medium scale combustion systems (400 kW – several MW), pelletized fuels seem to have the best chances due to their advantages like high energy density, similar physical characteristics, easy handling and efficient transportation. However, the market integration of alternative and mixed biopellets is still hindered by various constraints. Therefore the target of the MixBioPells project is to identify the constraints and drivers in detail and to find promising market introduction concepts for enhancing the market relevance of alternative pellets in Europe. Difficulties due to combustion of alternative and mixed biopellets, especially in small scale, amplifies the need for quality systems and quality assurance of both fuel and combustion technologies. The heterogeneity of pellets from certain primary products results in that they only can be applied in certain combustion units or combustion units of a certain size. In addition to that, certain fuel characteristics demand special combustion components for example, the low ash-melting temperature of many alternative pellets requires combustion units with moving and water cooled grids. A well-designed labelling system for both pellets and combustion technologies allocates alternative and mixed biopellets to the appropriate combustion appliance thus helping reducing hazardous emission and avoiding operational disturbances and high maintenance cost. Thus, the project criterions for such a labelling system were identified and summarized based on the project results and discussion with key actors during the advisory board meetings and the international side workshop.

Based on this, the partners of the MixBioPells project has developed a handbook for alternative and mixed biopellets certification in close cooperation with the European Pellet Council. The system is based on the ENplus handbook and standard EN 14961-6 (see Part I). The product standard EN14961-6 was published in April 2012. Deviating from the planned activities according to annex 1, a certification scheme for the production of alternative and mixed biomass pellets is still necessary to enhance the market implementation.

Technical information was gathered in WP3 and WP4 and studied in order to propose criterions for a labelling system including boiler requirements as well as required standards for solid biofuels (see Part II). Test procedures according to EN303-5 and the harmonization, e.g. of emission thresholds on European level within the ECO Design directive are still ongoing. Consequently, important requirements for the use of these fuels in small and medium combustion plants are not clear yet. Thus, only a draft of criterions for the labeling systems could be included in this report.

## 1.1 Normative References used in the labelling concept

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 procedure

EN 14775:2009, Solid biofuels – Determination of ash content

EN 14778:2011, Solid biofuels – Sampling

EN 14780:2011, Solid biofuels – Sample preparation

EN 14918:2010, Solid biofuels – Determination of calorific value

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

EN 14961-6:2012, Solid biofuels – Fuel specification and classes – Part 6: Non-woody pellets for non-industrial use

EN 15103:2010, Solid biofuels – Determination of bulk density

EN15104:2011, Solid biofuels – Determination of total content of carbon, hydrogen and nitrogen – Instrumental method

EN 15210-1:2010, Solid biofuels – Determination of mechanical durability of pellets and briquettes – Part 1: Pellets

EN 15289:2011, Solid Biofuels - Determination of total content of sulphur and chlorine

EN 15297:2011, Solid Biofuels - Determination of minor elements - As, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Sb, V and Zn

CEN/TS 15370-1:2007, Solid biofuels - Method for the determination of ash melting behaviour - Part 1: Characteristic temperatures method

EN 15234-1:2011, Solid biofuels – Fuel quality assurance – Part 1: General requirements

EN 15234-6:2012, Solid biofuels – Fuel quality assurance – Part 6: Non-woody pellets for non-industrial use

EN 16127:2012, Solid biofuels – Determination of length and diameter for pellets and cylindrical briquettes

ISO/IEC 17025 (2005), General requirements for Test- and Calibration Laboratories

EN ISO 9001 (2008), Quality Management Systems – Requirements

EN 14588:2010[1], Solid biofuels – Terminology, definitions and description

EN ISO/IEC 17025:2005/AC:2007, general criteria for the operation of various types of auditing organisations

ISO 3310 (2001), Test sieves — Technical requirements and testing

EN 45011 (1998), General requirements for organisations that operate product certification systems

# 2 Part I Handbook for the certification of alternative and mixed biopellets based on EN 14961-6

## 2.1 Background and goal

The goal of the following draft of certification system for non-woody pellets is to secure the supply of non-woody pellets with clearly defined and consistent quality.

In the scope of this system consistently constant quality of the delivered alternative and mixed biopellets are guaranteed. Not only the manufactured pellets, but also the processes that are necessary for their production and logistics will be certified. As a result, aspects of a product certification will be combined with those of a system certification.

The classes of ENagro pellet qualities that are defined are based on the specifications of the European standard EN 14961-6, "Solid biofuels – Fuel Specifications and Classes – Part 6: Non-woody pellets for non-industrial use"[1].

The certification system contains the following essential points:

- Requirements for pellet production and quality assurance (EN 15234-6)
- Requirements for the product (EN 14961-6)
- Requirements for labelling, logistics and intermediate storage
- Requirements for the delivery to end customers

Specifications for internal quality management guarantee that the set product requirements are maintained. Requirements for technical facilities, operation procedures and documentation are defined, which make the operation processes transparent and should lead to a rapid tracking down and solving of problems. The formulation of these specifications was carried out on the basis of either the ISO 9001 or EN 15234-6.

The independence of the certification system will be guaranteed through the involvement of accredited certification organizations according to EN 45011. It is also possible to organize the ENagro certification as group certification that is monitored by an accredited certification body.

### 2.2 Normative References

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 procedure

EN 14775:2009, Solid biofuels – Determination of ash content

EN 14778:2011, Solid biofuels – Sampling

[1] Non-industrial use means fuel intended to be used in smaller applications, such as in households and small commercial and public buildings.

EN 14780:2011, Solid biofuels – Sample preparation

EN 14918:2010, Solid biofuels – Determination of calorific value

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

EN 14961-6:2012, Solid biofuels – Fuel specification and classes – Part 6: Non-woody pellets for non-industrial use

EN 15103:2010, Solid biofuels – Determination of bulk density

EN15104:2011, Solid biofuels – Determination of total content of carbon, hydrogen and nitrogen – Instrumental method

EN 15210-1:2010, Solid biofuels – Determination of mechanical durability of pellets and briquettes – Part 1: Pellets

EN 15289:2011, Solid Biofuels - Determination of total content of sulphur and chlorine

EN 15297:2011, Solid Biofuels - Determination of minor elements - As, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Sb, V and Zn

CEN/TS 15370-1:2007, Solid biofuels - Method for the determination of ash melting behaviour - Part 1: Characteristic temperatures method

EN 15234-1:2011, Solid biofuels – Fuel quality assurance – Part 1: General requirements

EN 15234-6:2012, Solid biofuels – Fuel quality assurance – Part 6: Non-woody pellets for non-industrial use

EN 16127:2012, Solid biofuels – Determination of length and diameter for pellets and cylindrical briquettes

ISO/IEC 17025 (2005), General requirements for Test- and Calibration Laboratories

EN ISO 9001 (2008), Quality Management Systems – Requirements

EN 14588:2010[1], Solid biofuels – Terminology, definitions and description

EN ISO/IEC 17025:2005/AC:2007, general criteria for the operation of various types of auditing organisations

ISO 3310 (2001), Test sieves — Technical requirements and testing

EN 45011 (1998), General requirements for organisations that operate product certification systems

### 2.3 Definitions of terms

Other terms and descriptions related to pellets are listed in EN 14588.

In standard EN 14588 *non-woody pellet* is densified biofuel made from pulverised (e.g. ground) biomass with or without additives usually with a cylindrical form diameter < 25 mm, random length and typically

3,15 mm to 40 mm with broken ends, obtained by mechanical compression. NOTE: The raw material for non-woody pellets can be herbaceous biomass, fruit biomass, or biomass blends and mixtures including also woody biomass. They are usually manufactured in a die with a total moisture content usually less than 15% of their mass.

In this manual a term *Alternative and mixed biopellets* are used to clarify that mixed or blended pellets can include also woody biomass.

## 2.4 Certification System

### 2.4.1 Overview

The essential components of the certification programme are:

- Inspection and verfication of the compliance of the agro and mixed biopellets with the European standards, as well as the logistics system (up to the end customer's store), both according to the requirements written in this manual (see 7.1.4 and 7.2.3)
- Specifications for the in-house quality management (certificate holder facilities and processes, employee qualifications, documentation duties, internal quality control) (see 7.1.4 and 7.2.3).
- The execution of certification and external controls, license issuing and revoking, handling of complaints.

### 2.4.2 Certification of Production

The interested party files an application for certification. The certification body is responsible in the country where (the headquarters of) the applicant is located. The respective organization has to take a decision on the application within 2 months.

To be submitted are:

- Approval application from national association
- Inspection contract with a listed inspection body
- Inspection and testing report of the initial inspection

The report of an initial inspection in accordance with this certification programme has to be presented to the certification body.

#### *2.4.2.1 Mandate for Production Control*

The interested party enters into an inspection contract with an inspection body listed by the supplier of the licence and commissions it with the initial inspection of its production facilities.

#### 2.4.2.2 *Initial Inspection of Production*

The inspection body conducts an initial inspection of the production site(s) of the interested party, where the following points are to be examined, and, to be verified by the interested party respectively:

- Raw material: Classification of the origin and sources of solid biofuels in accordance with EN 14961-6 (detailed description of raw material classification in Table 1, EN 14961-1).
- Type, exact description and quantity of additives[2] (e.g. pressing aids, slagging inhibitors), if they are used.
- Type and suitability of the raw material storage.
- Production plant: Suitability of the technical facilities in order to be able to produce alternative and mixed biopellets; especially facilities used for separating fines and extraneous material. Cleanliness of the plants.
- Type and suitability of the product storage.
- Quality management system (in accordance with Chapter 2.9): in-house manual and/or operating instructions, training records (external and internal), handling of claims and complaints, etc.
- Self-monitoring of production, suitability and condition of the testing devices, reference sample management.
- Product declaration (see chapter 4.9), according to standard EN 15234-6 (a product declaration)

At the initial inspection, the following tasks are to be carried out by the site auditor(s):

- Sampling from production/storage, description, and photo documentation of the sampling points respectively; the sampling has to be carried out in accordance with EN 14778.
- Inspection of the plant's own sampling for internal quality testing; if necessary, training in representative sampling, including suggestions for improvement. The suitable test procedure for self-monitoring is to be determined.
- Examination of the production process and quality management documentation; these documents are to be treated confidentially by the inspection body and are not allowed to be passed on to third parties (exceptions are justified inquiries of the certification body).
- The auditor is to be given access to all parts of the plant and all relevant documentation.

[2] Additive is a material, which improves the quality of the fuel (e.g. combustion properties), reduces emissions or makes production more efficient.

Moreover, the auditor has to pack and seal the drawn samples and manage their delivery to the testing laboratory.

The initial inspection report (including the laboratory results) is to be forwarded to the applicant and, in copy form, to the certification body.

If minor non-conformities are found during the inspection or laboratory test, the inspection body sets a reasonable deadline for corrective measures; the applicant has to prove that adequate corrective measures have been taken within the deadline.

When major non-conformities have occurred, a completely new audit has to be conducted after the defects have been corrected. Major non-conformities that can influence the production quality on a sustained basis are e.g. inappropriate raw material or defective production and storage facilities. Major non-conformities can have a direct or indirect influence on the operating performance of equipment using the produced pellets.

#### *2.4.2.3 Issuing of the Certificate*

The certification body tests the compliance with the ENagro certification guidelines based on the information

- in the approval application
- in the inspection report of the inspection body (including the results of the laboratory test of pellets)

If the application is approved, the applicant is informed and receives a license contract and a request for submitting a down-payment of the license fee. When proof of the down payment of the license fee has been received and the signed contract has been returned, certification is carried out by sending the certification document with the identification number and the validity period of the certificate.

The company will be entered into a register with all other certificate holders, which is to be published on the websites of the supplier of the licence.

#### *2.4.2.4 Surveillance inspections*

Each production facility is to be inspected annually by the inspection body in accordance with the requirements stated in this manual. The monitoring inspection can be carried out unannounced. Improvements and changes in the certification system (for standards, quality management, etc.) are to be reported to the person responsible for quality management in the pelletizing plant. This will be carried out by the supplier of the license.

When defects in or deviations from the ENagro regulations are found in the plant or in the laboratory test during the periodic inspection, the accredited testing centre has to immediately inform the certificate holder. When minor deviations occur, the accredited testing centre can set a reasonable period of time (a

maximum, however, of 10 weeks), in which the certificate holder has to verify that corrective measures have been taken. The certification body does not need to be informed.

When major defects have occurred, the certification body has to be immediately informed by the testing centre. The certification body is entitled to order a completely new monitoring inspection after the defects have been corrected. Major defects that can influence the production quality on a sustained basis are especially considered to be inappropriate raw material or defective production and storage facilities.

#### *2.4.2.5 Application Procedure*

The interested party submits an application to the supplier of the license for certification and declares himself/herself willing to observe the regulations of the certification system. The certification body makes a decision on the application within 2 months.

When a positive decision about the application is made, the applicant completes a contract with the certification body, which enables it, if necessary, to mandate an inspection by a listed testing centre.

#### *2.4.2.6 Issuing of the Certificate*

On the basis of the information in the approval application the certification body examines the conformance to the certification guidelines. If the application is approved, the applicant is informed. As soon as the proof of the down payment of the license fee to the national association or supplier of the licence has been received and the signed license contract has been returned, certification is carried out by sending the certification document with the identification number and the validity period of the certificate. In addition, the certificate holder will be entered into a register with all the other certificate holders, which will be published on the Internet site of supplier of the licence and the national association (if applicable).

### 2.4.3 Objection Proceedings

Applicants and certificate holders can file a written objection to the certification body against the following decisions:

- Refusal of the requested certification
- Ordering of new monitoring inspections
- Ordering of extraordinary inspections (see 2.5.6)
- Ordering of more frequent inspections in the scope of internal controls
- Suspension and cancellation of the certificate / the license (see 2.5)
- Public mentioning of grievances (see 2.5).

The objection is only permissible when the applicant or certificate holder proves that the affected decision violates his/her own rights. A written decision on the objection will be made within two weeks by an objection committee to be set up by the national association . No party who have definitively been affected by the objection decision can participate in the decision-making process.

### 2.5 Validity of the Certificate

The national association and the responsible certification body determine the duration of the validity of the certificate. Recommended duration is 3 years including an annual inspection.

When conscious violations of the regulations of this certification system occur or when noticed non-conformities continue despite repeated demands to remedy these, the national association have to suspend the license to use the ENagro trademark for a limited period or terminate the seal usage contract and request the certification body to revoke the certificate. If the certificate holder has several locations, the license can be suspended for the location where the defects have been assessed until they have been corrected. Alternative and mixed biopellets from other locations of the certificate holder can still be marketed as certified goods.

In the case that the license and the certificate are revoked, the former license holder can re-apply for certification and license after being verified by the certification body to be adequate and sufficient.

In addition, the national association is authorized to publicize the grievances on the Internet in an appropriate manner and to name the affected certificate holder.

#### 2.5.1 Major Changes

The certificate holder has to immediately report major changes to the certification body. Major changes are all changes of the technical equipment as well as the operation processes or the company structure and rules that have to be reported during the ENagro application process.

#### 2.5.2 Use of the Certificate Seal

When the certificate is issued, the certificate holder acquires the right to use the certification seal for the corresponding quality class to label his/her products and to use for advertising purposes. The seal may be exclusively used in direct connection with the certified product, and the certified service (transport, storage) respectively. Certificate holders, who manufacture certified and non-certified goods, have to avoid that the complete production quantities are certified. The certification seal may only appear on invoices when these invoices are issued for ENagro certified goods.

The certification seal will be linked to the identification number of the certificate holder. Use of the seal without the combination with the identification number is only possible with the permission of the national association.

Trading with ENagro-labelled bagged pellets, however, is permissible without certification. In combination with the identification number of an ENagro certified pre-supplier can declare the goods as ENagro on account and by delivery in written form.

#### 2.5.3 Labelling

Each sales unit of agro and mixed biopellets certified according to this system has to be labelled with the following specifications:

- “Agro and mixed biopellets,” with the corresponding quality class (ENagro including cereal straw pellets, miscanthus pellets, reed canary grass pellets and mixed or blended pellets class A and B)
- Certification seal (for packed material)
- Certificate identification number (see 2.5.5.1; for bagged alternative and mixed biopellets, the number of the producer or, optionally, the general number of a dealer has to be indicated)
- Mass (in kg or ton)
- Diameter (from 6 mm to 25 mm)
- Note: Store in dry conditions
- Note: Use only in approved and appropriate firing units according to manufacturer´s information and national regulations.
- For bulk pellets, the license plate number of the delivery vehicle has to be documented.

### 2.5.4 Interfaces

Every actor in the production and supply chain guarantees the certified alternative and mixed biopellet quality in his/her area of responsibility. When service providers are engaged, the contracting entity is responsible for adhering to the regulations of this certification scheme. The interface to the end consumer is the blow-in nozzle or delivery of bagged pellets at the customer’s storage.

### 2.5.5 Traceability

The tracking system serves as a self-control and quality assurance aid to find out where the failures in the supply chain occurred and to identify, which batches are out of specification. Through the identification number and the analysis of the internal documentation of the involved actors, possible sources of quality defects can be traced through the supply chain. If necessary, the archived reference samples from the producer/supplier are to be analysed by a testing body and, where appropriate, are to be compared with a sample taken at the complainant’s.

#### *2.5.5.1 Identification Number*

Through a system of unique identification numbers, each delivery should be able to be traced back from the end customer, through the various links in the logistics chain to the producer. When applying for certification, the certificate holder agrees to the participation in this system. If a manufacturer operates several production facilities or if a dealer purchases pellets from multiple dealers or producers, the respective company can request a general number. This means that certified pellets from different sources can be mixed. However the internal documentation system should allow traceability of deliveries with quality problems and to identify the source of a problem by archived reference samples.

Dealers without their own storage capacities and transport vehicles have to work together with service

providers certified according to this system.

If a wood pellet producer does contract pelletizing, he/she uses the individual identification number of each certified customer. The owner of the identification number has to register the contracted pellet producer as if he was his own production facility. In the case of bagged pellets, the identification number of the producer or the general number of the trader has to be indicated on the packaging.

For bagged pellets, the number of the producer (or, alternatively, the general number of the dealer) will be printed on the packaging. In the case of complaints, the end consumer can turn to the national association.

If a delivery is made, the identification number of the companies active in the supply chain of this delivery is set together to a delivery identification number. This number will be indicated on the delivery note to retrace the route of the delivery if necessary. If a batch-pure storage of consignments from different origins is not possible, the complete identification number of the batch begins with the number of the dealer who mixed the pellets (general number).

Each identification number has five characters, which specify whether the respective certificate holder is a dealer or a producer, and which country he/she comes from. The first two spaces indicate the country in which the pellets are produced or in which the headquarters of the pellet producer or trader are. Country codes as specified by ISO 3166-1-alpha-2 are to be used.

The interlinked five-digit specifies will be separated from each other by a blank space.

The three numbers after the country code provide the number of the respective certificate holder in the country. The numbers 001 to 300 will be respectively assigned to producers, the numbers 301 to 999 to dealers.

The following example of a delivery identification number indicates that pellets were produced by the Austrian producer 012 and delivered by the German dealer 344.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A | T | 0 | 1 | 2 | D | E | 3 | 4 | 4 |

#### 2.5.5.2 *Reference Samples*

With each delivery of alternative and mixed biopellets to the end consumer, the certificate holder has to take a reference sample during the loading of the transport vehicle at the last possible location for an eventual later inspection of the mechanical durability. At least 1.2 kg per day of the delivered quantity must be archived. Provided that more than 3 vehicles deliver pellets per day, the sample quantities can be reduced to at least 0.5 kg per vehicle and 1.5 kg per day (at least 3 vehicles have to be sampled throughout the day). The date, pellet quality, size of the batch and license plate number of the delivery vehicle are to be documented. The samples have to be archived for at least 6 months under proper conditions.

### 2.5.6 Regular and extraordinary audits

For pellet producers one annual audit is mandatory. In addition to that extraordinary audits can be carried out upon demand by the certification organization, the national association e.g. if significant numbers of complaints are received.

If major non-conformities have occurred, the inspection body has to immediately inform the certificate holder and the certification body. In this case, the certification body is authorized to mandate a new inspection after the defects have been corrected. Major defects that can influence the production quality on a sustained basis are in particular inappropriate raw material or defective production and storage facilities.

When conscious violations occur, the regulations stated in 4.5 are applicable.

### 2.5.7 Complaint Procedure

When customers or subordinate actors make complaints, the certification body or the national association will pursue these on the basis of the supply chain documented by the identification number. The complaints will be handled by national rules and the in-house documentation of the involved actors will be inspected by certification body.

Complaints will be acknowledged, if pellet storage rooms are designed properly to avoid damage to pellets during filling. Normative references for pellet storage rooms are to be considered if available. National requirements for pellet storage rooms are to be specified by national associations that receive an ENagro license.

Furthermore, at least one of the following preconditions must be fulfilled:

- One sample, which was drawn in the presence of all involved parties (customer/ wood pellet dealer/ installer/ service technician), was examined by a listed testing body[3] and does not conform to the chemical and physical characteristic values.
- The average fine material quantity[4] (all particles below 3.15 mm) in the storage area exceeds 10% and the boiler combustion shows clear signs of malfunction due to this. There must only have been used 20% of the silo load since the last silo filling. A sample is drawn in presence of the involved parties and examined by a testing body as mentioned beforehand. If possible a representative sample must be taken in a falling stream between silo and boiler, and must consist of 3 individual samples which are mixed afterwards.

### 2.5.8 Schedule of Fees

The fees for using the ENagro brand is determined by the national associations and it is recommended that fees are same in all countries.

The fees may consist of: enlisting fee, fee per produced/traded amount of pellets, marketing fee or other justification.

In addition there will be costs for auditing and testing of pellets, which are settled directly between the inspection/testing body and the certificate holder.

3 Contrary to the regulations in other parts of this manual, the accredited testing centre does not have to be registered with the certification body in this case.
4 All particles < 3.15 mm.

## 2.6 Product Quality

In the scope of this system, five pellet qualities with different demands on the used raw material, as well as the pellet characteristics, will be certified.

These essentially correspond to the classes of the EN 14961-6.

- ENagro-cereal straw pellets (Table 2)
- ENagro-miscanthus pellets (Table 2)
- ENagro-reed canary grass pellets (Table 2)
- ENagro-mixed pellets class A [5] (Table 3)
- ENagro-mixed pellet class B (Table 3)

The relevant quality parameters, the corresponding threshold values, as well as the specifications for the raw materials to be used, are listed in chapter 2.11.

## 2.7 Sustainability Requirements

Certified producers have to document the origin of the raw material and inform the inspection body at the yearly audit regarding the share of raw material for mixed or blended pellets. If the raw material also includes woody biomass it is recommended to state, if it is coming from certified sources (FSC, PEFC or equivalent systems). The inspection body integrates this information in the audit report.

Common agricultural policy (CAP) promotes sustainable agriculture and sustainable farming and rules for cross compliance to be followed.

In view of the importance of greenhouse gas mitigation pellet producers must be able to state the amount of greenhouse gases emitted as a consequence of pellet production. An own analysis can be made based on the energy consumed by the pellet production plant or one may use default values published by European Commission[6]. In this case the annual inspection will include the verification of the stated $CO_2$ emissions per ton of produced pellets, if annual production is bigger than 5 000 tons.

## 2.8 Quality Management

In this chapter, the guidelines for internal quality management are established. How these guidelines are implemented is mainly left up to the certificate holders. EN 15234-6 requirements will be the basis of ENagro system. Alternatively, a quality management system according to ISO 9001 can be set up.

[5] Composition of blend or mixture should defined according Table 1 in EN 14961-1. For example 75w-% of cereal straw (2.1.1.2), 25w-% of reed canary grass (2.1.2.1). In case of mixture the main fraction is mentioned first. For Example Cereal straw (2.1.1.2) and bark (1.2.1.5). See chapter 9.

[6] Report from the Commission to the Council and the European Parliament on sustainability requirements fort he use of solid and gaseous biomass sources in electricity, heating and cooling, SEC (2010) 65 and 66. 20 p.

### 2.8.1 Production

#### *2.8.1.1 Technical Operating Equipment and Operation Processes*

The production facilities must fulfil the following requirements:

- The certificate holder must have adequate technical equipment for the production, loading and possible packaging of pellets at its disposal. The functions and condition of this equipment must be regularly checked.
- When raw materials are received from new suppliers, their adequacy is to be checked (incoming goods inspection), e.g., through certification of the manufacturer or by an individual inspection (e.g., checking the ash, chlorine and nitrogen content, the ash melting behaviour).
- Contaminations of the raw materials before pelletizing by substances such as soil, stones and grain, as well as contaminations of the manufactured pellets, must also be excluded. Pre-treatment areas, silos and conveyor equipment must be regularly checked for soiling and, if necessary, cleaned. This also applies to each loading of external vehicles, as far as it does not involve special vehicles for the exclusive transport of pellets.
- Before loading of alternative and mixed biopellets for delivery to the user, a fully functional and regularly maintained facility for the separation of fine material has to be available. Pellets have to be sieved to a maximum of 1 or 2 w-% of fine material (other agreements with retailers can be bilaterally stipulated).
- The pellets must not absorb any water, e.g., through contact with condensed water, rain or snow. Condensate formation is to be excluded as far as possible.
- The blending of alternative and mixed biopellets of different quality must be precluded through the conscientious planning of operation procedures and the possibility of spatially divided storage.
- In the case of malfunctions in the production process, it must be checked which quantities of defective pellets were produced until the malfunction was noticed. These pellets are not allowed to be sold as certified pellets.
- After repair and maintenance work has been completed, the manufactured pellets must undergo an in-house quality inspection.
- All involved employees must receive training from the quality assurance representative concerning the required quality demands.
- The certificate holder must have the appropriate testing instruments and testing means, as well as the commensurate knowledge to inspect the manufactured pellets.

#### *2.8.1.2 Quality Assurance Representative*

Certificate holder management must appoint an experienced employee as a quality assurance

representative. This person must ensure the orderly internal documentation and is responsible for archiving reference samples, as well as carrying out self-inspections, if necessary. The appointed employee must know the effects of different operating processes on the quality of the manufactured pellets and appropriately train the other employees for their areas. Moreover, he/she is the contact partner for his/her colleagues in the case of malfunctions in the production process. The quality assurance representative can delegate individual monitoring and documentation tasks to other employees. In this case, he/she has to brief the responsible employee and monitor the orderly execution of these tasks.

#### *2.8.1.3 Internal Documentation*

The quality assurance representative must ensure the orderly documentation and evaluation of operating processes that have an effect on the quality of the manufactured pellets. In detail, the documentation must encompass the following points:

- Raw materials and additives receiving (date, quantity and name of the supplier; for pressing aids: the type of material, internal storage location identity)
- Outgoing goods (date, quality category, quantity and name of the customer), the used vehicles or external forwarders, and the freight which was last transported by the vehicle – in as much as no special vehicle will be used for the exclusive transportation of the pellets - as well as a description of the respective reference samples
- The addition of pressing aids or other additives (type: data sheet with the chemical composition, as well as dosage)
- Manufacturing of certified and non-certified pellets (period, quality, quantity)
- Malfunctions of the production process (date, type of malfunction, measures taken to remedy the problem, quantity and disposition of the pellets that cannot be certified)
- More extensive repair and maintenance work that could lead to a change in the pellet quality (date, type of work performed)
- Employee training regarding the effect of the various production factors on the pellet quality (date, participants, contents)
- Areas of responsibility of the individual employees
- Self-inspection (documentation and evaluation of the results)
- Customer complaints (date, results of the findings, measures taken to remedy the defects, if necessary).

The documentation is always to be kept up-to-date and regularly presented to management. For this purpose, it is recommended to maintain a shift book. Discovered defects are to be immediately disclosed to the responsible employees and to be remedied.

### 2.8.1.4 Self-Inspections

The producer must regularly inspect the quality of the manufactured pellets to verify the fulfilment of the product requirements and to avoid the production of larger defective batches. When reasonable doubts concerning the pellet quality exist, the accredited testing centre can stipulate more frequent internal inspections in the scope of monitoring or extraordinary inspections.

The frequency of the checks can be calculated by the following formula (EN 15234-6):

$$N = \frac{10}{days} * \sqrt{\frac{ton}{10}}$$

| | |
|---|---|
| N | number of sample in 24h |
| days | annual working days |
| ton | annual quantity of pellets in tons |

Example N=10/220*√50 000/10 = 3 times per 24h

Parameters that must be inspected in the scope of internal quality inspections are listed below. For smaller producers (less than 5 000 tons/year) parameters should be inspected once a day.

| **Parameter** | **Point of the Test** | **frequency** |
|---|---|---|
| Bulk density (BD) | Production line before storage | at least once per shift |
| Moisture (M) | After production, before storage | at least once per shift |
| Mechanical durability (DU) | After production, before storage | at least once per shift |
| Fines (F) | At the last possible point before delivery | at least once per shift |
| Length (L) | After production before storage | at least once a day or when visual inspections shows that pellets are too long or short. |

The tests must be conducted according to the standards listed in EN 14961-6. As an alternative, equivalent procedures can also be applied which are referable to EN standards.

### 2.8.2 Handling, storage and delivery of pellets

#### *2.8.2.1 Technical Operating Equipment and Operation Processes*

The following requirements must be fulfilled during storage and delivery to end customers:

- The certificate holder must have adequate technical equipment for the storage and/or transport of pellets at its disposal. The functions and condition of this equipment must be regularly checked.
- Manipulation areas, silos and conveyor equipment must be regularly checked for soiling and, if necessary, cleaned. This also applies to the loading of external vehicles, as far as it does not involve special vehicles for the exclusive transport of premium pellets. Responsibility for the inspection lies with the certificate holder that delivers the pellets. However, this can also be contractually regulated in a different manner.
- The pellets must not absorb any moisture, e.g., through contact with condensed water, rain or snow. Condensate formation is to be excluded as far as possible.
- The mixing of pellets of different quality (ENagro certified, non-certified pellets) must be precluded through the conscientious planning of operation procedures and/or the possibility of spatially divided storage, respectively, of spatially divided transport.

- If pellets from the respective storage facility shall be delivered to end customers, the storage facility must be equipped with a facility to separate the fine material before filling the transport vehicle. After the separation process, the fine material must amount to a maximum of 1 w-% or 2 w-%. Reloading from delivery truck or trailers without sieving is forbidden.
- The temperature of the loaded pellets must not exceed 40°C (EN 15234-6).
    - During the loading process, the driver of the delivery vehicle must assure himself of the quality of the pellets by doing a visual inspection.
- Reference samples are to be taken when bulk pellets are delivered to the end customer.
- Silo vehicles for the transport to private customers should be equipped with a gauged on-board weighing system. Individual exemptions from this rule can be agreed between the national association and certificate holders for a maximum of 3 years. Such exemptions must be reported to supplier of the licence however and can be lifted, if repeated complaints from customers are received.
- The transport vehicle must be equipped with a low-abrasion blowing/suction feeding system – this means the delivery pipe should be coated to reduce friction and the connection between pipes should not contain sharp edges looking into the pellet flow.
- Silo vehicles must have a device to extract the supply air from the storage during delivery. National associations can accept other solutions that prevent dust from being blown into the building of the customer. The supplier of the licence must be informed which other solutions will be accepted.
- When a delivery to end customers is made, the transport mechanisms and the store should be checked for irregularities (e.g., missing impact mats or unfavourable pipe angles). The filling level of the store must be estimated before the filling process. Obvious defects of the storage area or existing dust build-up are to be documented on the delivery note and are to be confirmed by the customer if present.
- When a delivery to end customers is made, a checklist stating all relevant details for the quality of delivery (as proposed by the national association) has to be filled out.
- Drivers with contact to end customers must have an internal training course.
- Instructions for healthy and safety issues for delivery and storage must be provided. Especially, instructions of ventilation in order to avoid any harmful CO-level in transport or storage rooms shall be given.

#### *2.8.2.2 Quality Assurance Representative*

Certificate holder management must appoint an experienced employee as a quality assurance representative. This person must ensure the orderly internal documentation and is responsible for carrying out self-inspections, as well as for archiving reference samples. The appointed employee must know the effects of different operating processes on the quality of the traded pellets and train the other employees accordingly. Drivers who deliver pellets to end customers are furthermore responsible for customer contact and must be correspondingly instructed. The quality assurance representative can delegate individual

monitoring and documentation tasks to other employees. In this case, he/she has to brief the responsible employee and monitor the orderly execution of these tasks. Additionally, the quality assurance representative has to participate in an external training course for quality assurance at least once a year.

#### *2.8.2.3 Internal Documentation*

The quality assurance representative must ensure the orderly documentation and evaluation of operating processes that have an effect on the quality of the traded pellets.

In detail, the documentation must encompass the following points:

- Materials received (date, pellet quality, quantity and name of the supplier)
- Outgoing goods (date, pellet quality, quantity, name of the customer, the store which the batch originates from, the used vehicles or external forwarders and the freight which was last transported by the vehicle, as well as a confirmation of the carried out cleaning of the vehicle - inasmuch as no special vehicle will be used for the exclusive transportation of the pellets
- Problems during storage and transport (date, type of problem, effect on the pellet quality, measures taken to remedy the defects, quantity and disposition of the substandard pellets)
- Repair and maintenance work that can lead to a change in the pellet quality (date, type of work performed, either a confirmation that no irregularities could be determined during the visual inspection or of measures taken to remedy the defects, as well as the quantity and disposition of the substandard pellets)
- Self-inspections (documentation and evaluation of the results.
- Delivery to the end customer (quality of the pellets at loading, irregularities as well as the estimated remainder of the stock; when a delivery is made with a silo vehicle, the blowing-in pressure and the hose lengths) are to be documented
- Areas of responsibility of the individual employees (organisation flowchart and description of work)
- Employee training regarding the effect of the various operating processes on the pellet quality (date, participants, contents)
- Customer complaints (date, measures taken to remedy the defects).

#### *2.8.2.4 Self-Inspections*

The quality assurance representative is responsible for regularly inspecting the quality of the traded pellets to verify the fulfilment of the product requirements. The extent and type of the inspections are left up to him/her. However, the minimum requirement is a weekly visual inspection of the stored pellets, including the storage facilities. This can also be done based on reference samples.

The tests have to be carried out according to a previously determined inspection plan; the execution and the results are to be documented.

### 2.9 Listed Inspection and Testing Bodies

The supplier of the licence lists inspection bodies that are qualified organizations that audit the technical facilities and the internal quality management of pellet producers or traders. The supplier of the licence lists testing bodies that are qualified laboratories that analyse pellet quality.

#### 2.9.1 Registration Requirements

A listed inspection body must be accredited according to EN ISO 17020 and for EN 14961-6. Auditors must be listed by name and must have at least 2 years of experience of auditing pellet production plants. Experienced inspection experts in similar field's e.g. wood processing industry or agriculture are accepted if they are accompanied by a person who is experienced in pellet production. Auditors that do not fulfil these requirements need to pass a training acknowledged as adequate by the supplier of the license. Listed auditors must participate at least every second year in annual international auditors workshops organized by the supplier of the licence.

Testing bodies must be accredited according to EN ISO 17025 and for the standards stated in EN 14961-6. They must proof, that they have participated successfully in at least 1 round robin test for pellets (Z-score <2). The accreditation and the proof for the round robin test have to be handed in within twelve months from the time of registration.

#### 2.9.2 Application Procedure

Inspection bodies that intend to be listed make a formal application to the supplier of the licence that includes their accreditation. In the application, the proposed auditors for pellet plants and pellet traders and their qualification have to be listed. There is an annual fee of €1,000 for being listed as inspection body.

Testing bodies that intend to be listed make a formal application to the supplier of the licence that includes the necessary accreditations or specifies, by when these accreditations and the documentation of participation in a round robin test will be supplied. There is an annual fee of €500 for being listed as testing body.

### 2.10 Requirements for Raw Materials

The types of raw material indicated in Table 1 and culled from the EN 14961-1 standard are permitted to be used as raw material for the production of alternative and mixed biopellets. If also woody biomass is used in blends and mixtures chemically treated wood may not include heavy metals or organic halogenated compounds as a result of treatment with wood preservatives or coating. Wood which was externally treated with wood preservatives against insect attack (e.g., lineatus) does not classify as chemically treated wood[7], as long as the threshold values listed in Table 3 can be met. Minimum levels of glue, grease and other timber production additives used in saw mills 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

[7] National Regulation for waste materials shall be followed.

concentrations are too small to be concerned with. National legal requirements for raw material must be respected.

*Table 1: Raw material types that are permitted to be used for alternative and mixed biopellet production.*

| ENagro-straw pellets | ENagro-Miscanthus pellets | ENagro-reed canary grass pellets | ENagro-blended pellets (A and B class) |
|---|---|---|---|
| 2.1.1.2 Straw parts | 2.1.2.1 Grasses, whole plant | 2.1.2.1 Grasses, whole plant | 2 Herbaceous biomass |
| | | | 3 Fruit biomass |
| | | | 4 Blends and mixtures[8] |

To be stated the 4-digit classification number of the source for 1 Woody biomass, 2 Herbaceous and 3 Fruit biomass (See Table 1 of EN 14961-1).

If composition of blend is known, the w-% can be used to specifying blends.
Example 1: 80 w-% 2.1.1.2 Straw, 20 w-% 2.1.2.2 Grasses, straw plant.

In the case of mixture, the main component should be stated first.
Example 2: 2.1.1.2 Straw, 2.1.2.2 Grasses, straw plant, 1.2.1.5 bark.

If raw material composition is changed, then quality requirements according to Table 3 have to checked and different qualities to be kept separately.

### 2.10.1 Requirements for additives

Additives (e.g. pressing aids or slagging inhibitors) that are used to improve fuel quality, to decrease emissions or to boost burning efficiency are allowed. The type (material and trade name) and quantity (in max.-%) of the pressing additives used have to be documented. Also additives, which are used after production, before delivery to end-user storages, must be documented. Water, heat and steam are not additives in terms of this regulation.

### 2.10.2 Requirements for pellets

Table 2 and 3 list the normative parameters that are important in the scope of this certification system for assessing the alternative and mixed biopellet quality. Table 2 is used for straw, miscanthus and reed canary grass pellets and Table 2 for other and especially mixed or blended pellets. The testing procedures described in the listed standards are to be used during external inspections. In standard EN 14961:6 the ash melting behaviour, chemical composition of arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc is informative. It is recommended that the producer detect them at least, when raw material is changing or there is doubt of a contamination.

[8] Note: Blends and mixtures can also include woody biomass.

*Table 2: Quality requirements for cereal straw, Miscanthus and reed canary grass pellets.*

| Property | Unit | Cereal straw pellets | Miscanthus pellets | Reed canary grass pellets | Analysis method |
|---|---|---|---|---|---|
| Diameter class (D) | mm | 6 (±1) to 25 (±1)[2)] | | | EN 16127 |
| Length (L) | mm | 3.15 ≤ L ≤ 40 [3)]<br>3.15 ≤ L ≤ 50 [3)] | | | EN 16127 |
| Moisture (M) | as received, w-% wet basis | ≤ 10 | | ≤ 12 | EN 14774-1 or 2 |
| Ash (A) | w-% dry [1)] | ≤ 6.0 | ≤ 4.0 | ≤ 8.0 | EN 14775 (550 °C) |
| Mechanical durability (DU) | w-% ar [4)] | ≥ 97.5 [4)] | | ≥ 96,5 [4)] | EN 15210-1 |
| Fines, F (< 3.15 mm) | w-% ar [1)] | <1 | | | EN 15210-1 |
| Additives | w-% dry | type and amount to be stated | | | |
| Net calorific value (Q) | MJ/kg ar [1)] | minimum value to be stated | | ≥14.5 | EN 14918 |
| Bulk density (BD) | kg/m$^3$ | ≥ 600 | ≥ 580 | ≥ 580 | EN 15103 |
| Nitrogen (N) | w-% dry [1)] | ≤ 0.7 | ≤ 0.5 | ≤ 2.0 | EN 15104 |
| Sulphur (S) | w-% dry [1)] | ≤ 0.1 | ≤ 0.05 | ≤ 0.2 | EN 15289 |
| Chlorine (Cl) | w-% dry [1)] | ≤ 0.1 | ≤ 0.08 | ≤ 0.1 | EN 15289 |
| Ash melting behaviour[5)] | °C | Characteristic temperatures should be stated (voluntary) | | | EN 15370 |

[1)] ar= as received, on wet basis (determinations from moist fuel (max. 10 w-% or 12 w-%), dry =on dry basis (in water-free condition).

[2)] Diameter class (D06 to D25) must be indicated.

[3)] Maximum 1% of the pellets longer than 40 mm and max. length 45 mm (D06 to D10), Maximum length 50 mm (D12 to D25)

[4)] If measured by the Ligno-Tester, the threshold value is ≥ 97.7 Max.-%.

[5)] Ash melting behaviour at oxidizing conditions is informative (voluntary). When analysed all characteristic temperatures (shrinkage starting temperature (SST), deformation temperature (DT), hemisphere temperature (HT) and flow temperature (FT) to be informed.

*Table 3. Quality requirements for pellets produced from herbaceous, fruit and blends and mixtures including also woody biomass.*

| Property | Unit | A | B | Analysis method |
|---|---|---|---|---|
| Diameter class (D) | mm | 6 (±1) to 25 (±1)[2)] | | EN 16127 |
| Length (L) | mm | 3.15 ≤ L ≤ 40 [3)]<br>3.15 ≤ L ≤ 50 [3)] | | EN 16127 |
| Moisture (M) | as received, w-% wet basis | ≤ 12 | ≤ 15 | EN 14774-1 or 2 |
| Ash (A) | w-% dry [1)] | ≤ 5.0 | ≤ 10.0 | EN 14775 (550 °C) |
| Mechanical durability (DU) | w-% ar [4)] | ≥ 97.5 [4)] | ≥ 96,0 [4)] | EN 15210-1 |
| Fines, F (< 3.15 mm) | w-% ar [1)] | ≤2 | ≤3 | EN 15210-1 |
| Additives | w-% dry | type and amount to be stated | | |
| Net calorific value (Q) | MJ/kg ar [1)] | ≥ 14.1[6)] | ≥ 13.2[6)] | EN 14918 |
| Bulk density (BD) | kg/m$^3$ | ≥ 600 | | EN 15103 |
| Nitrogen (N) | w-% dry [1)] | ≤ 1.5 | ≤ 2.0 | EN 15104 |
| Sulphur (S) | w-% dry [1)] | ≤ 0.2 | | EN 15289 |
| Chlorine (Cl) | w-% dry [1)] | ≤ 0.2 | ≤ 0.3 | EN 15289 |
| Ash melting behaviour [5)] | °C | Characteristic temperatures should be stated (voluntary) | | EN 15370 |
| [1)] ar= as received, on wet basis (determinations from moist fuel (max. 10 w-% or 12 w-%), dry =on dry basis (in water-free condition). | | | | |
| [2)] Diameter class (D06 to D25) must be indicated. | | | | |
| [3)] Maximum 1% of the pellets longer than 40 mm and max. length 45 mm (D06 to D10), Maximum length 50 mm (D12 to D25) | | | | |
| [4)] If measured by the Ligno-Tester, the threshold value is ≥ 97.7 Max.-%. | | | | |
| [5)] Ash melting behaviour at oxidizing conditions is informative (voluntary) in EN 14961-6. All characteristic temperatures (shrinkage starting temperature (SST), deformation temperature (DT), hemisphere temperature (HT) and flow temperature (FT) to be informed. | | | | |

### 2.11 Certification Seal and Examples of the Production Declaration

Firstly, the seal has to feature a minimum height of 15 mm. The identification number of the certificate holder is an essential component of the certification seal and must be displayed close to the seal. Furthermore, the height of the identification number may not be any smaller than ten percent of the seal's height, but a minimum height of 1.5 mm (Arial font size of 10). The seal must be displayed in one of the colour variations or in monochrome specified here. The certification seal has to be used only in addition

with the identification number of the certificate holder. Using the seal without the identification number is possible only with written authorization of the certification body.


Figure 1: General certification seal for alternative and mixed biopellets.

The type of alternative and mixed biopellets can be marked in right bottom corner of the seal as follows:

- Cereal straw pellets
- Miscanthus pellets
- Reed canary grass pellets
- Class A
- Class B


Figure 2: Example of certification seal for straw, Miscanthus and reed canary grass pellets.


Figure 3: Example of certification seal for A and B class alternative and mixed biopellets.

*Table 4.* Example of a product declaration based on EN 15234-6

| | | | |
|---|---|---|---|
| | **PRODUCT DECLARATION BASED ON EN 14961-6** | | |
| | **Supplier** | EAA agropellets Ltd. Ketunleipä 10, FI-40520 Jyväskylä, Finland | |
| | **Amount of delivery** | 6 tons | |
| | **Origin**: | 2.1.2.1 Spring harvested reed canary grass (Phalaris arundinacea L.) | |
| | **Country** | Finland/Jyväskylä | |
| | **Chemically treated raw material** | No | |
| | **Traded Form** | Reed canary grass pellets | |
| | **Class or raw material type** | Reed canary grass | |
| **Normative** | **Specifications of properties according to EN 14961-6** | Unit | Average value |
| | Diameter class, EN 16127 | mm | ≤15 |
| | Moisture, M, EN 14774-1, EN 14774-2 | as received, w-% | ≤12 |
| | Ash, A, EN 14775 | w-% dry | ≤8 |
| | Mechanical durability, DU EN 15210-1 | as received, w-% | ≥97.0 |
| | Fines, F, EN 15210-1 | w-% as received | ≤1.0 |
| | Additives, type | w-% dry | kaolin, ≤ 1 w-% |
| | Net calorific value, Q EN 14918 | as received, MJ/kg or kWh/kg | ≥14.5 |
| | Bulk density, BD, EN 15103 | kg/m$^3$ | ≥ 550 |
| | Nitrogen, N, EN 15104 | w-% dry | ≤1.5 |
| | Sulphur , S, EN 15289 | w-% dry | ≤0.15 |
| | Chlorine, Cl, EN 15289 | w-% dry | ≤0.09 |
| **Informative** | Arsenic, As, EN 15297 | mg/kg dry | ≤1 |
| | Cadmium, Cd, EN 15297 | mg/kg dry | ≤0.5 |
| | Chromium, Cr, EN 15297 | mg/kg dry | ≤40 |
| | Copper, Cu, EN 15297 | mg/kg dry | ≤20 |
| | Lead, Pb, EN 15297 | mg/kg dry | ≤10 |
| | Mercury, Hg, EN 15297 | mg/kg dry | ≤0.1 |
| | Nickel, Ni, EN 15297 | mg/kg dry | ≤10 |
| | Zinc, Zn, EN 15297 | mg/kg dry | ≤100 |

*Example of simplified product declaration based on EN 15234-6 and EN 14961-6*

Agropellet

| | |
|---|---|
| **Producer** | EAA Agropellets<br>Ketunleipä 10<br>FI-40520 Jyväskylä<br>Tel. +358 20 722 2550<br>E-mail: info@eaa-agropellets.com |
| **Origin and source** | 2.1.2.1 Grasses, reed canary grass |
| **Traded form** | Pellet |
| **Country and location** | Jyväskylä, Finland |
| **Specification according to EN 14961-6** | |
| **Dimensions** (mm)<br>Diameter (D) and length (L) | D12 (12 mm ± 1mm, ja 3,15 ≤ L ≤50 , |
| **Moisture**<br>(w-% as received) | M12 (≤ 12 w-%) |
| **Ash** (w-% dry basis) | A8.0 (≤ 8.0 w-%) |
| **Mechanical durability**<br>(w-% pellets after testing) | DU96.5 |
| **Fines**(w-%, < 3.15 mm) | F1.0 (1 w-% at factory gate when loading) |
| **Additives**<br>(w-% of pressing mass) | ≤ 1 w-% (kaolin) |
| **Bulk density** (kg/m$^3$) | DB550 (≥ 550 kg/m$^3$) |
| **Net calorific value as received** | Q4.0 [kWh/kg] |
| **Nitrogen** (mg/kg dry) | ≤1.5 mg/kg dry |
| **Sulphur** (mg/kg dry) | ≤0.15 mg/kg dry |
| **Chlorine** (mg/kg dry) | ≤0.09 mg/kg dry |

Example include only normative properties requested by ENagro and EN 14961-6.

*Example about a blended pellets according to EN 15234-6 and EN 14961-6 Table 2.*

Agropellet

| | |
|---|---|
| **Producer** | EAA Agropellets<br>Ketunleipä 10<br>FI-40520 Jyväskylä<br>Tel. +358 20 722 2550<br>E-mail: info@eaa-agropellets.com |
| **Origin and source** | 50% Straw, 50% Reed canary grass (2.1) |
| **Traded form and class** | Blended pellet, Class A |
| **Country and location** | Jyväskylä, Finland |
| **Specification according to EN 14961-6** | |
| **Dimensions** (mm)<br>Diameter (D) and length (L) | D12 (12 mm ± 1mm, ja 3,15 ≤ L ≤50 , |
| **Moisture**<br>(w-% as received) | M12 (≤ 12 w-%) |
| **Ash** (w-% dry basis) | A5.0 (≤ 5.0 w-%) |
| **Mechanical durability**<br>(w-% pellets after testing) | DU97.5 |
| **Fines**(w-%, < 3.15 mm) | F2.0 (2w-% at factory gate when loading) |
| **Additives**<br>(w-% of pressing mass) | ≤ 2 w-% (kaolin) |
| **Bulk density** (kg/m$^3$) | DB600 (≥ 600 kg/m$^3$) |
| **Net calorific value as received** | Q3.9 [kWh/kg] |
| **Nitrogen** (mg/kg dry) | ≤1.5 mg/kg dry |
| **Sulphur** (mg/kg dry) | ≤0.20 mg/kg dry |
| **Chlorine** (mg/kg dry) | ≤0.20 mg/kg dry |

Example include only normative properties requested by ENagro and EN 14961-6.

Boiler manufacturers could use also classification of agro and mixed biopellets in their boiler sign.

*Example for labelling a boiler for use of alternative and mixed biopellets.*

**App. 1. Check list for a producer**

| Phase | Action |
|---|---|
| Quality management system development | EN 15234-6 or ISO 9001 |
| Internal documentation | • Raw materials including sustainability certification<br>• Additives<br>• Outgoing goods<br>• Manufacturing of certified and non-certified pellets<br>• Malfunctions in production, storage and transport<br>• Repair and maintenance work<br>• Employee training records<br>• Areas of responsibilities of the employees<br>• Self-inspections, sampling and sample storage<br>• Product declarations<br>• Delivery to customer<br>• Customer complaints |
| Application for a certification | Letter to national pellet association |
| Selection of inspection body and testing organisation | See the website of the supplier of the licence |
| Labelling | Labelling of certified pellets |

**App. 2. Checklist for an inspection body**

| Phase | Action |
|---|---|
| Contract with producer | Inform visit with short notice and ask documents in advance. Be equipped with appropriate clothing and safety equipment (helmets and CO meter) and camera. |
| General comments | • Lists of deviation and deadline for proof of conformity<br>• List standards and certification system applied<br>• Look general cleanness of the plant |
| Staff | • Contact person<br>• Quality representative<br>• Responsible person for self-inspection<br>• Other staff present during the audit |
| Products | • Products of different classes and product declarations |
| Quality management system | • Which system applied<br>• Work instructions<br>o Inspection of in and outgoing goods<br>o Inspection and calibration of measuring and test equipment<br>o Execution of self-inspection (asks to carry out inspection during your audit)<br>• Customer complaint management system<br>• Education of staff |
| Raw material | • Origin of raw materials and sustainability<br>• Source and species of raw material<br>• Raw material storage (type, visual control) |
| Quality assurance – Raw materials | • Documentation of raw materials (list of suppliers, impurities)<br>• Documentation of additives (amount, type) |
| Sustainability | • Raw material origin (CAP rules followed or certified forests)<br>• $CO_2$ emission calculation (own calculation, default values) |
| Production process | • Visit each step (grinding, drying, removal of contaminants and impurities, milling, blending, conditioning, pressing, cooling, removal of fines) and document type of equipment<br>• Separation of low quality batches (manual/automatic)<br>• General recommendations |
| Quality assurance – pellet production | • Documentation of certified and non-certified pellets (e.g. inspect a shift book)<br>• Documentation of malfunctions and maintenance |
| Quality assurance – self inspection | • Internal sampling<br>• Instructions for representative sampling<br>• Equipment folder (maintenance, service, calibration)<br>• Documentation of test results<br>• List those properties which are checked regularly |

| Phase | Action |
|---|---|
| Quality assurance – pellet storages | • Type and capacity<br>• Storage of different qualities<br>• Protection of moisture and impurities<br>• Screening of fines before loading or packaging |
| Quality assurance – outgoing goods/complaints | • Documentation of outgoing goods<br>• Retain sampling (frequency, amount, retaining period)<br>• Sample labelling<br>• Storage of retain samples<br>• Documentation of customer complaints |
| Sampling for laboratory analysis | • Sampling point, amount and sizes (bags and bulk) (during auditing) |
| Delivery sample to laboratory | • Carry out sampling and deliver samples to laboratory agreed by a producer |
| Reporting | • Report of evaluation results to company and certification body. |

# 3 Part II: Criterions for the labelling of combustion systems for alternative and mixed solid biofuels pellets and briquettes based on EN 14961-6, EN 303-5, EN 14785:2006, EN 15270:2007

## 3.1 Labeling of combustion systems suitable for alternative biomass pellets

A labeling system suitable for combustion of alternative biomass pellets should as a minimum include the following:

- A clear statement of what fuels, or range of fuels can be used in the boiler. The fuel is preferably defined according to EN 14961-6.
- A clear statement of what efficiencies are reached and what emission levels (or classes) of CO and particles are reached with the specified fuel, or range of fuel.
- A criterion for long term performance should be included.

## 3.2 Existing standards and certifications for combustion systems:

### 3.2.1 Existing EN standards

The measurement methods for boiler testing when using alternative pellets are another important fact, and have to be compared for all partner countries. Since the permission for boilers and alternative fuels depends on the legal conditions as well as on their emissions, the methods for emission measurements and boiler testing are of great relevance to compare national conditions. There are three European standards dealing with boilers and stoves for pellets:

- EN 303-5 Heating boilers: Heating boilers for solid fuels, hand and automatically stoked, nominal heat output of up to 300 kW. Testing fuels are wood logs, wood briquettes, wood pellets and a number of fossil fuels.
- EN 14785:2006 Residential space heating appliances (< 50 kW). Testing fuel is wood pellets.
- EN 15270:2007 Pellet burners for small heating boilers (< 70 kW). Testing fuel is high quality pellets. Other fuels will be considered in future amendments.

The most important guideline for boiler testing is the EN 303-5 which is valid for small and medium scale wood combustion systems up to 300 kW. This guideline is used both for wood and non-wood boilers although it is not applicable to the latter. It applies to different solid fuels that are specified according to Table 5. The boiler can be either manually or automatically stoked, which includes pellet boilers. The standard includes different aspect such as[9]:

- Production documentation such as drawings including material used and welding process and quality manual.
- Safety and design requirements such as material used (steel/cast iron), wall thickness, water side resistance, temperature control and limiting devices for open and closed vented system, cleaning of heating surfaces, insulation, electrical safety (according to EN 60335-1), etc.
- Boiler performance requirements such as boiler efficiency, emission (CO, OGC and dust; $NO_x$ is optional) and heat output and combustion period (2h, 4h, 6h)

[9] EN303-5

The standard 303-5 is under revision and will be published in June 2012. Some of the suggested changes are: it will include boilers up to 500 kW, there will be additional safety requirements for automatically stoked boilers, risk analyses shall be done by the manufacturer and the emission- and efficiency requirements will increase[10]. Most important for the use of mixed biomass pellets is that it is suggested that non-woody biomass such as straw, Miscanthus, reeds, kernels and grains will be included. The suggestion is that the EN303-5 will be extended with the following fuel specification: "Non-woody biomass according to the range specification of the manufacturer or EN 14961". It has to be remembered that this is still a suggestion.

Table 5: Test fuels in the EN 303-5:1999

| | **Bituminous coal** | | **Brown coal (incl. briquetts)** | | **Coke** | | **Anthracite** | **Log wood** | | **Chipped wood** | | **Compressed wood** | **Sawdust** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Softwood | Hardwood | | | | |
| | **a1** | **a2** | **b1** | **b2** | **c1** | **c2** | **d** | **A1** | **A2** | **B1** | **B2** | **C** | **D** |
| Moisture content in % (as fired basis) | ≤ 11 | | ≤ 20 | | ≤ 5 | | ≤ 5 | 12 to 20 | | 20 to 30 | 40 to 50 | ≤ 12 | 35 to 50 |
| Ash content in % (as fired basis) | 2 to 7 | | 5 to 20 | | 5 to 15 | | 5 ±3 | ≤ 0.4 | | ≤ 0.4 | | ≤ 0.5 | ≤ 0.5 |
| Volatile matter (as fired basis) | 15 to 30 | > 30 | 40 to 50 | 50 to 60 | < 6 | 8 ± 2 | < 10 | | | | | | |
| Net (lower) calorific value in MJ/kg (wf) | > 28 | | > 12.5 | | > 28 | | > 28 | 19 ± 5% | 18 ± 5% | 18 ± 5% | | 18 ± 5% | 18 ± 5% |
| Size/length | according to manufacturer's instruction | | | | | | | | | | | | |

wf…water free

The standard EN 14785:2006 is used for residential space heating appliances < 50 kW and the testing fuel is wood pellets[11]. It is not likely that this standard will be extended to non-woody fuels. The standard EN 15270:2007 is used for pellet burners for small heating boilers < 70 kW[12]. It is used for burners that are installed as exchange for an oil burner in an existing oil boiler. This kind of technique has been common in Scandinavia, especially in Sweden. Testing fuel today is high quality pellets. Other fuels will be considered in future amendments.

[10] EN303-5, draft
[11] EN14785
[12] EN15270

### 3.2.2 Existing voluntary certification systems

There are several existing voluntary labels for pellet appliances in Europe. The most well-known are:

- P-marking of pellet burners, pellet boilers and pellet stoves (Sweden). Includes emissions, safety, function and surveillance inspections
- Nordic Ecolabelling of Solid biofuel boilers (Scandinavia). Includes emissions, efficiency and environmentally responsible product design.
- Der Blaue Engel (Germany). Includes emissions, efficiency, safety, auxiliary power demand and environmentally responsible product design.
- Din Plus for pellet stoves (Germany). Includes emissions and efficiency.
- Umweltzeichen 37 (Austria). Includes emissions, efficiency and auxiliary power demand.

Labels often play an important role in grant schemes in different countries. The demands on emissions and efficiency vary quite a lot between the labels and also between the emission level demands issued by authorities in different countries, see Table 6.

Table 6: Emission thresholds according to voluntary labels and existing standards (nominal load / partial load)[13]

| | Particles | | Organic Gaseous Compounds (OGC) | | Carbon monoxide (CO) | |
|---|---|---|---|---|---|---|
| | mg/Nm$^3$ at 13% $O_2$ | mg/Nm$^3$ at 10% $O_2$ | mg/Nm$^3$ at 13% $O_2$ | mg/Nm$^3$ at 10% $O_2$ | mg/Nm$^3$ at 13% $O_2$ | mg/Nm$^3$ at 10% $O_2$ |
| EN303-5 | | | | | | |
| Manually stocked (class 3) | | 150 | | 150 | | 5,000 |
| Automatically stoked (class 3) | | 150 | | 100 | | 3,000 |
| Revision proposal: | | | | | | |
| Automatically stoked <500 kW | | | | | | |
| Class 4 | | 60 | | 30 | | 1,000 |
| Class 5 | | 40 | | 20 | | 500 |
| EN 15270 Pellet burner | | | | | | |
| Class 1 | | 200 | | 1,750 | | 15,000 |
| Class 2 | | 180 | | 200 | | 5,000 |
| Class 3 | | 150 | | 100 | | 3,000 |
| Class 4 | | 75 | | 75 | | 1,000 |
| Class 5 | | 30 | | 50 | | 500 |
| EN 14785 Residential heaters[1] | | | | | 500/750 | |
| P-mark | | | | | | |
| - Pellet stoves | | 100 | | | | |
| - Pellet burners | | | | 75 | | 2,000 |
| - Pellet boiler | | | | 75 | | 2,000 |
| The Swan: | | | | | | |
| - Boilers, automat. stoked | | 40 | | 25 | | 400 |
| - Stoves, automat. stoked | | | 50 | | 1,000 | |
| DIN-plus - voluntary | | | | | | |
| - Pellet boilers[1] | 35 | | 10 | | 200 | |
| Blauer Engel | | | | | | |
| -Pellet boilers (50-500 kW)[1] | 20/40 | | 5 | | 70/150 | |
| -Pellet stoves[1] | 25/55 | | 8/13 | | 160/350 | |
| Austria Umweltzeichen 37 | | | | | | |
| - Boilers for solid fuels (<400kW)[1, 2] | ≈ 24 / - | | ≈ 5 / - | | ≈ 95/ ≈ 212 | |

1 Efficiency > 90 %, 2 Converted from mg/MJ

[13] Federal Ministry for the Environment (ed.): Renewable Energy Sources Act (revised version), (2011), Miljo- og Energiministeriet (ed.), Bekendtgorelse om biomasseaffald Nr. 638, (1997), EN 303-5, Central-heating boilers – Part 5: Heating boilers for solid fuels, hand and automatically stoked, nominal heat output up to 300 kW, (1999), EN 303-5 (draft), Central-heating boilers – Part 5: Heating boilers for solid fuels, hand and automatically stoked, nominal heat output up to 500 kW, (2010). EN 14785, Residential space heating appliances fired by wood pellets. Requirements and test methods, (2006), EN 15270, Pellet burners for small heating boilers. Definitions, requirements, testing, marking, (2007), Richtlinie UZ 37, Holzheizungen, (2012), RAL-UZ 112, Vergabegrundlage fur Umweltzeichen: Holzpellet- und Holzhackschnitzelheizkessel,(2011), RAL-UZ 111, Vergabegrundlage fur Umweltzeichen: Holzpelletofen, (2011), DINplus Zertifizierungsprogramm, Raumheizer zur Verfeuerung von Holzpellets mit schadstoffarmer Verbrennung (Pelletofen), (2008), Nordic Ecolabelling of Solid biofuel boilers, version 2.1, 21 June 2010, Oravainen, Heikki: Testing methods and emission requirements for small boilers in Europe. Motiva's Publication B 3/2000, Helsinki, 2000.

### 3.2.3 Classification of existing emission thresholds

Within the partner countries the threshold values vary significantly in the range from non-existing till highly regulated with low thresholds. In Figure 4 the threshold values of each country are classified as strict, loose and no regulation of threshold values. According to Figure 4 there are significant differences of the legal conditions for different thermal ranges and different countries. Emissions of carbon monoxide (CO), nitrogen oxides ($NO_x$) and particles are commonly limited in medium and industrial scale combustion plants. Emission threshold values for small scale combustion plants up to 100 kW mainly exist in Germany and Austria. In contrast, emission threshold values of hydrogen chloride and dioxins/furanes exist only in Germany. If there are no regulations in the respective thermal range existing, legal authorities will set the permission and the threshold values at their sole discretion. Finland and Sweden have relatively low emission thresholds particularly for small and medium scale. However, based on the experience with alternative raw material combustion, only selected raw materials are actually used in these countries. Restrictions are rather set at the bottom end (raw material quality) than at the top end (flue gas emission thresholds). The classification of the threshold values indicates whether the use of alternative biomass pellets can be problematic ("strict thresholds") or in some cases problematic ("loose thresholds"). However, the realisation strongly depends on available combustion and flue gas cleaning systems and the properties of the used fuel. Clearly, emission thresholds are more easily complied with for industrial scale applications for which appropriated flue gas cleaning system are commonly available. However, for small and medium scale applications the situation is different. Though there are a few systems available an adaption for specific fuels is often required and the additional investments are more severe drawback for small and medium scale systems. For that reason the following classification of the legal conditions can be established for **small and medium scale applications**. In case there are thresholds for several emissions that have to be complied with *and* the thresholds are strict then legal conditions are classified as "highly restricted". In contrast, if thresholds apply only for few of the possible emissions and the thresholds are loose then the legal conditions are classified as "low restricted". Consequently, the legal conditions influence the range of alternative fuels that can be used:

- Highly restricted legal conditions: A small range of fuels can be used due to strict emission threshold values and due to few technical possibilities to keep the threshold values, e.g. restrictions for small and medium scale combustion plants in Germany and Austria and medium scale applications in Italy (150-400 kW).
- Low restricted legal conditions: A wide range of alternative fuels could be used for combustion purposes due to loose restricted emission threshold values, e.g. restrictions for medium scale systems in Denmark as well as small scale systems in Italy and Sweden.
- No regulations: Due to a lack of emissions thresholds and/or alternative fuels not being specifically indicated as allowed fuels the utilisation of alternative fuels has to be individually approved by local authorities based on experiences, e.g. in Spain, Finland (below 1 MW) or non-industrial use in Austria (except for boilers below 400 kW in the province of "Lower Austria").

| Country | Capacity | CO | OGC | $NO_x$ | $SO_2$ | HCl | Particles | Dioxine/ Furanes |
|---|---|---|---|---|---|---|---|---|
| Austria[1)] | < 100kW | | | | | | | |
| private sector | 100kW - 1MW | | | | | | | |
| Austria | < 100kW[2)] | | | | | | | |
| public and industrial sector | 100kW - 1MW[3)] | | | | | | | |
| Denmark | < 100kW | | | | | | | |
| | 100kW - 1MW | | | | | | | |
| Finland | < 100kW | | | | | | | |
| | 100kW - 1MW | | | | | | | |
| Germany | < 100kW | | | | | | | |
| | 100kW - 1MW | | | | | | | |
| Italy | < 100kW[4)] | | | | | | | |
| | 100kW - 1MW[5)] | | | | | | | |
| Sweden | < 100kW[6)] | | | | | | | |
| | 100kW - 1MW[7)] | | | | | | | |
| Spain | < 100kW | | | | | | | |
| | 100kW - 1MW | | | | | | | |
| | | mg/Nm³ | mg/Nm³ | mg/Nm³ | mg/Nm³ | mg/Nm³ | mg/Nm³ | ng/Nm³ |
| | strict | <500 | <30 | <300 | <250 | <50 | <50 | <0.1 |
| | loose | <1000 | <125 | <600 | <400 | <100 | <300 | <0.5 |
| | none | - | - | - | - | - | - | - |

[1)] Threshold values valid in Lower Austria up to 400 kW
[2)] Threshold values valid for <400 kW
[3)] Threshold values valid for 0.4-1 MW
[4)] Threshold values valid for 35-150 kW
[5)] Threshold values valid for 0.15-3 MW
[6)] Threshold values valid up to 300 kW
[7)] Threshold values valid for 0.3-1 MW

Figure 4: Classification of existing emission threshold values for the use of non woody biomass up to 50 MW in different European countries (based on 13 Vol.-% $O_2$)

## 3.3 Requirements for combustion of alternative and mixed solid biofuels

Combustion processes depend on both fuel characteristics and combustion technologies. Typical fuel characteristics of biomass are elemental composition (e.g. porosity, fibrousness, intact vs. destroyed cell wall structure) or molecular. The term "fuel composition related parameters" is used for such characteristics of the fuel. In contrast, there are adjustable combustion process parameters (e.g. particle size, temperature, residence time) which can be set individually – although not always independently from other parameters – according to the requirements of a technical process. Nevertheless, these process related parameters are not always independently from each other. Thus, special focus should be taken on the influence of fuel composition related and especially process related parameters on thermo-chemical conversion processes. Compared to the combustion of woody biomass, the main fields of problems for the combustion of alternative and mixed biomass fuels are:

- Slagging tendencies in the bottom ash
- Increased emissions on dust, NOx, HCl, $SO_2$
- Increased risks of corrosion and fouling

These problems can be decreased by primary and secondary measures. Reduction of harmful emissions through flue gases and effluents can be obtained by either avoiding creation of such substances (primary measures) or removing the substances from the flue gas (secondary measures). Primary measures are based on a modification of the combustion process and a secondary measure takes places after the combustion process.

### 3.3.1 Primary emission reduction measures

Primary emission reduction measures aim to prevent or reduce the formation of emission related slagging tendencies and corrosion within the combustion chamber. Several possible measures exist as for example the modification of the fuel composition or the selection of the right combustion system. Both parameters must fit each other to achieve a reliable and stable combustion operation with low emissions. The main influences of the fuel properties on the combustion process are displayed in Figure 5.

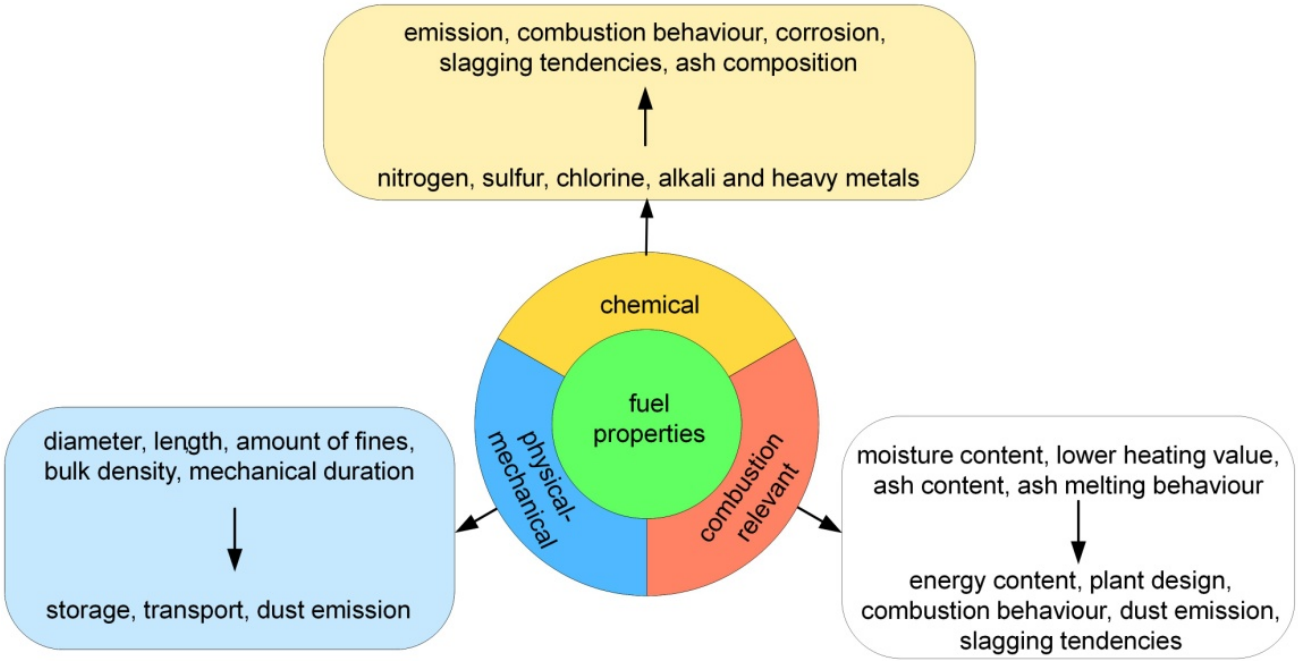


Figure 5: Impact of fuel properties on the combustion process[14]

Decreasing the amount of critical elements in the fuel that contribute to harmful emissions or operational problems can be carried out to some extent. By choosing the fuel specification, one can influence the fuel composition and hence the emissions. K, Na, S, Cl, Zn and Pb concentrations in the fuel determine the mass of aerosol emissions as well as their chemical composition. Washing of straw can be used to reduce the amount of chlorine and potassium in the fuel significantly. Washing can either be performed by leaving the straw on the field for some time after the harvest, exposing it to rain or by controlled washing. Table 9

[14] Source of picture MixbioPells D 3.1

gives an overview about guiding values and guiding ranges for elements in biomass fuels and biomass ashes for unproblematic thermal utilization that can be used as a basis for adjusting the right fuel mixtures. Biomass fuels within the given guiding concentration ranges can be used in modern combustion plants without problems. For fuels with compositions outside the given ranges, additional technological requirements should be considered. In addition, the limiting factors are highly dependent on the type of combustion plant, operational conditions, emission limit values, steam parameters, national rules for ash recycling etc.

So far, only a few fuels are used as "pure" fuels, e.g.wood pellets/briquettes and straw in special boilers. Most of the other fuels are generally co-fired in industrial CHP plant in varying fuel proportions. An important reason for mixing fuels is to achieve required fuel properties, e.g. of existing product standards such as EN 14961. The mixing ratio often depends on the availability and price of the raw materials. Important parameters are[15]:

- Good mixing of the component fuels is very important in order to ensure, for example:
  - stable combustion
  - avoidance of local sintering
  - that the favourable properties of various fuels are put to use
  - utilization of the effect of fuels that have high sulphur contents, in order to avoid/reduce corrosion and deposits.
- Fuels that differ widely in particle size/form may require special treatment, such as extra fuel preparation in the form of mills or separate fuel feed systems.
- Wide differences in moisture content between the fuels may require special fuel feed arrangements.
- The dry solids content of the fuel mixture should be >45 % to ensure beneficial energy utilization in boilers without flue gas condensation.

Furthermore, the chemical composition of the used raw materials is of great relevance. As a general rule /Värmeforsk 2006/:

- Fuels with high sulphur content, such as peat can improve the properties of fuels with high alkali contents.
- Fuels with high ash melting points can improve the properties of agricultural fuels such as straw and grain with low ash melting points.

A very low proportion (< 2–3 %) of a "difficult" fuel added to a fuel mix that performs well does not normally cause problems. However, an exception is grain chaff at high combustion temperatures, which may cause sintering problems even in very small quantities

[15] Värmeforsk 2006

Table 9: Guiding values and guiding ranges for elements in biomass fuels and ashes for unproblematic thermal utilization[16]

| Element | Guiding concentration in the fuel wt% (d.b.) | Limiting parameter | Fuels affected outside guiding ranges | Technological methods for reducing to guiding ranges |
|---|---|---|---|---|
| **N** | < 0.6 | $NO_x$ emissions | Straw, cereals, grass, olive residues | Primary measures (air staging, reduction zone) |
| | < 2.5 | $NO_x$ emissions | Waste wood, fibre boards | Secondary measures (SNCR or SCR process) |
| **Cl** | < 0.1 | Corrosion | Straw, cereals, grass, waste wood, olive residues | – fuel leaching<br>– automatic heat exchanger cleaning<br>– coating of boiler tubes<br>– appropriate material selection |
| | <0.1 | HCl emissions | Straw, cereals, grass, waste wood, olive residues | – dry sorption<br>– scrubbers<br>– fuel leaching |
| | < 0.3 | PCDD/F emissions | Straw, cereals, waste wood | – sorption with activated carbon |
| **S** | < 0.1 | Corrosion | Straw, cereals, grass, olive residues | See Cl |
| | < 0.2 | $SO_2$ emissions | Grass, hay, waste wood | See HCl emissions |
| **Ca** | 15–35 [1)] | Ash-melting point | Straw, cereals, grass, olive residues | Temperature control on the grate and in the furnace |
| **K** | < 7.0[1)] | Ash-melting point, depositions, corrosion | Straw, cereals, grass, olive residues | Against corrosion: see Cl |
| | – | Aerosol formation | Straw, cereals, grass, olive residues | Efficient dust precipitation, fuel leaching |
| **Zn** | < 0.08 | Ash recycling, ash utilization | Bark, woodchips, sawdust, waste wood | Fractioned heavy metal separation, ash treatment |
| | – | Particulate emissions | Bark, woodchips, sawdust, waste wood | Efficient dust precipitation, treatment of condensates |
| **Cd** | < 0.0005 | Ash recycling, ash utilization | Bark, woodchips, sawdust, waste wood | See Zn |
| | – | Particulate emissions | Bark, woodchips, sawdust, waste wood | See Zn |

[1)] wt.-% in the ash of the fuel

[16] van Loo 2008

Table 10: Commonly available and appropriate combustion systems for the combustion of alternative and mixed biomass pellets[17]

| Description of combustion system | Thermal range | Picture |
|---|---|---|
| **Horizontal stoker burner**<br><br>The burner consists of a cast iron, refractory-lined or water-cooled horizontal cylinder. The burner is mounted partially inside the furnace, and partially outside it, so the whole firebox of the boiler effectively takes part in radiative heat transfer. The basic idea in horizontal stoker burners is that fuel is fed precisely according to the heat demand. | 20 kW – 1 MW |  |
| **Moving grate combustion system**<br><br>Grate firing is the complete conversion of coarse solid biofuels into completely oxidised products. Air is usually supplied from the bottom and passes through the fuel bed. | 30 kW – 10 MW |  |
| **Water cooled combustion chamber with ash stoker**<br><br>Complete conversion of coarse solid biofuels into completely oxidised products. Air is usually supplied from the side of the water cooled combustion chamber and passes through the fuel bed. | 50 – 800 kW |  |

[17] van Loo 2008, Kaltschmitt 2009

### 3.3.2 Process and technology measures

Parameters defined by the technical realisation of the thermo-chemical conversion such as residence time of the flue gas, temperature and mixing of the available oxygen with the flue gas usually not independent from each other. However, in cases where oxygen is available in sufficient quantities, temperature is the most important variable due to its exponential influence on the reaction rates. An optimization of these variables will in general contribute to reduced emission levels of all emissions from incomplete combustion. Hence, by optimizing any combustion process by adjusting the mixing of fuel and oxidant, temperature and residence time, emissions from incomplete combustion can be minimized. Thus, the selection of an appropriate combustion system is essential. Commonly available and appropriate combustion systems for the combustion of alternative and mixed biomass pellets are listed in Table 10 according to their thermal range. The combustion technology must be suitable to the problematic fuel properties. The technical requirements should apply to higher dust and $NO_x$-emissions, possible slagging tendencies and higher ash amounts. A powerful ash removal system combined with the possibility to control or limit of the combustion temperatures should avoid problems caused by slagging tendencies in the bottom ash. The reduction of dust emissions could also be realised by precipitators which are gaining more importance since more strict emission thresholds are coming into effect. Besides, the high investment and operation costs prevent a widespread usage of this technology in small and middle scale combustion systems so far. The operation with a suitable combustion system has to be achieved in any case. The following requirements could be necessary:

General technical requirements for the combustion systems:

- automatic ignition and fuel feed
- adequate possibilities to control the operation of the combustion system (power and combustion control), e.g. with staged combustion
- appliances for automatic (mechanically or pneumatically) cleaning of heat exchanger
- integration of the combustion system into peripheral systems (buffer storage etc.)
- operator convenience and maintainability

Technical requirements due to problematic fuel properties, when using fuels according to the ENagro label:

- reduction of dust emissions:
  - precipitators
- prevention or reduction of slagging tendencies in the bottom ash:
  - limitation of combustion temperatures in the fire bed due to air or water cooled combustion systems or control of temperatures in the combustion chamber
  - combustion systems with a powerful ash removal system suitable for the removal of ash agglomerates
- removal of higher ash amounts in the bottom ash:
  - combustion systems with a powerful ash removal system

## 3.4 Possible classifications

Currently, high quality wood fuels are mainly used in small scale heating systems. This fuel combines convient supply, easy handling and compliance with regulations even for small scale and with varying loads. Small scale heating-systems are mostly optimised for high quality wood pellets but there are innovations to use alternative pellets as well. For example in Austrian, burner and boiler manufacturers are working on solutions for mixed biomass combustion on small scale. For some Scandinavian the capability to burn pellets with high ash content is claimed. Heating systems, like Guntamatic, REKA, Ökotherm or Hargassner, with capacities > 30 kW have been developed for the combustion of more problematic fuels than wood pellets and are gaining importance. Some woodchip boilers might be partly operated with alternative pellets. The combustion of alternative pellets is possible if the boilers are equipped with appropriate grate technology and operated with optimised parameters. Not all of these systems can handle all types of alternative pellets. Therefore, the standardisation and the adaption of the fuel and the boilers are of great relevance. Hence, the exact fuel specification of different boilers systems need to be known and communicated with pellet manufacturers and raw material suppliers. Especially, small scale combustion systems need to comply with higher dust emissions and have to cope with slagging and higher ash content when alternative and mixed biopellets are used. Several technologies for controlling and limiting of the combustion temperature to reduce slagging tendencies in the bottom ash are available on the market e. g. air cooled grate systems with moving grates or water cooled combustion chambers with ash stoker. A powerful ash removal system combined with the possibility to control the combustion temperatures should limit problems caused by slagging hazards. According to Table 11 about 34 % of the boiler manufacturers are producing combustion systems within a range up to 100 kW. Apparently, in Scandinavian countries the combustion of alternative and mixed biomass pellets is favoured in medium and industrial plants. In other countries e.g. in Germany and Austria the energetic utilisation in a range up to 1 MW is promoted due to economic or political constraints. Further information is included in the MixBioPells report “Critical review on pelletizing and combustion technologies”.

Table 11: Number of boiler and combustion plant manufacturers identified in the project selling combustion technologies for non-woody biomass; listing in accordance to the different thermal input ranges

| | small scale < 100 kW | medium scale 100 kW - several MW |
|---|---|---|
| Austria | 3 | 7 |
| Denmark | 1 | 5 |
| Finland | 4 | 8 |
| Germany | 2 | 5 |
| Italy | 5 | 4 |
| Spain | 4 | 12 |
| Sweden | 4 | 4 |
| Total | 23 | 45 |

Pellets according to EU-standards will probably be more expensive due to certification procedures and possibly higher pre-treatment efforts as well as a more demanding pelletizing process to ensure constant quality and fulfilment of the requirements of the standard. However, these pellets are then applicable for certified combustion appliances that do not require special adaption to the fuel requirements. Thus, overall economics could be still favourable despite the higher fuel costs. In contrast, regional available alternative and mixed biomass pellets could be produced without fulfilling EU-standards. These pellets would be less expensive. However, available combustion technology would have to be adapted to the requirements of the local fuels. This strategy would be particularly suitable on regional level with local contracts for a local fuel. Thus, fuel characteristic would be though critical fairly constant. Thus, the additional costs for adapting the combustion technology could still pay off. Finally, the availability of raw materials for different capacity ranges has been evaluated. This has been realised according to the EN 14961-6. Thus, for small and medium scale utilisation only those raw materials that fulfil the requirements of EN 14961-6: Miscanthus, EN 14961-6: straw and EN 14961-6: reed canary grass well as EN 14961-6: class A should be used (see Table 1). Raw materials that fulfil the requirements of EN 14961-6: class B can be used for medium scale. For industrial scale applications those raw materials with even more critical characteristics should be applied.

Table 1: Comparison of the fuel characteristics of the most relevant raw materials with the thresholds given in EN14961-6 (A – requirements for ash content according to EN14961-6: Miscanthus A < 4 wt.-% d.b.; Straw A < 6 wt.-% d.b.; RCG A < 8 wt.-% d.b.)

| Raw material | EN14961-6: Miscanthus | | | | EN14961-6: Straw | | | | EN14961-6: RCG | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | N | S | Cl | A | N | S | Cl | A | N | S | Cl |
| Miscanthus | | | | | | | | | | | | |
| Reed canary grass | | | | | | | | | | | | |
| Hemp | | | | | | | | | | | | |
| Straw | | | | | | | | | | | | |
| Vine pruning | | | | | | | | | | | | |
| Corn cobs | | | | | | | | | | | | |
| Corn stalks | | | | | | | | | | | | |
| Cereal spilling | | | | | | | | | | | | |
| Hay | | | | | | | | | | | | |
| Rape press cake | | | | | | | | | | | | |
| Grape marc | | | | | | | | | | | | |
| Olive residue | | | | | | | | | | | | |
| Almond shells | | | | | | | | | | | | |
| Shea waste | | | | | | | | | | | | |
| Carragenan waste | | | | | | | | | | | | |
| Mash from breweries | | | | | | | | | | | | |
| Digestate | | | | | | | | | | | | |
| Peat | | | | | | | | | | | | |

requirements of the EN14961-6 can be fulfilled

requirements of the EN14961-6 can be fulfilled in some cases

requirements of the EN14961-6 can be not fulfilled

Table 1: (continued) Comparison of the fuel characteristics of the most relevant raw materials with the thresholds given in EN14961-6 (A – requirement for ash content according to EN14961-6: class A - A < 5 wt.-% d.b.; class B - A < 10 wt.-% d.b.)

| Raw material | EN14961-6: class A | | | | EN14961-6: class B | | | |
|---|---|---|---|---|---|---|---|---|
| | A | N | S | Cl | A | N | S | Cl |
| Miscanthus | | | | | | | | |
| Reed canary grass | | | | | | | | |
| Hemp | | | | | | | | |
| Straw | | | | | | | | |
| Vine pruning | | | | | | | | |
| Corn cobs | | | | | | | | |
| Corn stalks | | | | | | | | |
| Cereal spilling | | | | | | | | |
| Hay | | | | | | | | |
| Rape press cake | | | | | | | | |
| Grape marc | | | | | | | | |
| Olive residue | | | | | | | | |
| Almond shells | | | | | | | | |
| Shea waste | | | | | | | | |
| Carragenan waste | | | | | | | | |
| Mash from breweries | | | | | | | | |
| Digestate | | | | | | | | |
| Peat | | | | | | | | |

requirements of the EN14961-6 can be fulfilled
requirements of the EN14961-6 can be fulfilled in some cases
requirements of the EN14961-6 can be not fulfilled

## 3.5 Identification of criterions for labeling of heating systems suitable for alternative pellets

Today's existing voluntary certification systems for pellets take combustion related criterions into account such as emissions and efficiency. In addition to this, the labels address to varying degrees other things such as function and surveillance inspections, environmentally responsible product design or auxiliary power demand. Below only combustion related aspects are discussed, since regarding other aspects, alternative and mixed biopellets do not differ from wood pellets.

The following combustion related parameters were identified by the project consortium to be considered in a labeling system for mixed pellets:

1. Low emissions (CO, $NO_x$, Particles)
2. Fine dust particles (PM 10 or PM 2.5)
3. Efficiency
4. Measuring methods
5. Ash amount and behavior
6. Ash melting behavior
7. Long term performance

Low emissions, especially CO and soot, and high efficiency are reached only if the boiler is performing with complete combustion and a well-adjusted air excess. To attain this, the boiler must be adjusted to the characteristics of the fuel. This can be done in two ways:

- By design and adjustment of the boiler to a well-defined fuel. In this case the combustion will be of high standard as long as the characteristics of the fuel do not vary. To handle different fuels, the boiler can have several fixed adjustment schemes, and when the user changes fuel quality, he/she also changes to appropriate adjustment scheme.
- By equipping the boiler with a smart control system that can adjust the combustion conditions to a fuel with varying characteristics. In this case the characteristics of the fuel can be allowed to vary to a certain degree. With a smart control system the boiler can also adapt itself to different fuels.

The characteristics of mixed biomass pellets are likely to vary quite a lot depending on what raw materials are used. Therefore, even a boiler with a smart control system will probably be able to handle a certain range of fuels, which has to be specified.

Particle emissions can be formed by incomplete combustion or by entrainment of bottom ash in the gas flow. Neither of this should be allowed in a well designed boiler. But particles are also formed by volatilization of inorganic species in the fuel. These particles are found as fine particles, most of them smaller than PM2.5. The amount of these particles can be reduced by primary measures such as reduced temperature in the bed by well-designed air staging, cooled grate or flue gas recirculation. They can also be reduced by secondary measures, i.e. flue gas cleaning. A third way of reducing fine particles is to design the fuel, e.g. mixing it with an additive that reacts with the volatile species in the fuel and prevents it from leaving the bottom ash. Additives can be mixed during fuel production or by adding it into the boiler.

Fine particles will be found in the emitted gas, but are also likely to foul the heat exchange surfaces. Therefore, cleaning of these surfaces, manually or automatically, will be necessary.

Particle emissions are today measured by different methods, giving different results depending on the elemental composition of the formed particles and the particle size distribution. There are today a lot of works going on by researchers and business stake-holders, some in connection to the standardization community, to define a measuring method that can be accepted and used in Europe. Therefore, it is not possible for the project consortium to define what methods should be used for

mixed bio pellets, until guidelines are agreed on a European level. It is nevertheless important to press that fine particles should be measured.

During biomass small-scale combustion nitrogen oxides are formed mainly from the nitrogen content in the fuel. The amount of $NO_x$ in the flue gas can be reduced by proper air staging. Today, $NO_x$ -emissions from small-scale combustion is normally not regulated (exception: Austria and Germany). The content of nitrogen is often higher in mixed bio pellets compared to stem wood pellets, and therefore, $NO_x$ should be monitored, but not regulated.

The fuel ash amount and behavior during combustion must be considered, since piling up of ash may hinder oxygen diffusion to the burning fuel. Some fuels, especially the silica rich fuels, have a tendency to form “ash skeletons” that must be removed by mechanical means or high air pressure. The boiler must be designed to handle ash rich fuels; to hinder ash from piling up and cover fresh fuel pieces and to remove the formed ash from the grate. As mixed bio pellets will demonstrate different ash content and behavior, the boiler will probably be designed to handle a certain range of fuels.

The ash melting behavior of the fuel will be one of the most important characteristics of mixed bio pellet to be handled. A low melting temperature may cause severe slagging and cause shut-down of the boilers. Therefore, formation of slag should be minimized by reducing the temperature in the fuel bed by the same means as explained for fine particle formation. Additives that react chemically with the fuel can be used to increase the melting temperature.

It is important that formed slag is transported away from the grate. Formed slag is not necessarily a problem – it is the removal of the slag that is crucial.

To handle ash amount, behavior and ash melting characteristics of the fuel, the boiler must be designed accordingly and equipped with the proper means to do this. For example, forward burning design facilitates mixing of fuel and oxygen and prevents ash to cover the fuel, mechanical means can be useful to remove any gathered ash or slag or high pressurized air can fulfill the same purpose. For a boiler designed for mixed bio pellets the long term performance is particularly important to ensure because of the often increased risk of slagging, fouling and ash gathering of these fuels.

# 4 Conclusions

According to the previous chapters, boilers should be tested with the ENagro fuels in a sufficient way. Thus, a two-step type test scheme is suggested:

**Step 1: Type tests according to the EN 303-5**

At first a type test with the ENagro labeled fuel will be done. Since the product standard of the EN14961-6 includes only upper limits for normative fuel properties the type test should be done with the worst fuel of each product class. According to the EN303-5 the boiler and safety requirements as well as the production documentation are proofed.

**Step 2: Additional test procedure**

Additionally, a long term test following the EN303-5 test criteria, e.g. 48 hours must be carried out with the ENagro labeled fuel to evaluate slagging, ash removal and corrosion. Since the product standard of the EN14961-6 includes only upper limits for normative fuel properties the type test should be done with the worst fuel of each product class.

The harmonization of requirements within ECO Design Directive (LOT 15), e.g. for emission thresholds and efficiency is still under development. Until now, the requirements of the ECO Design Directive (LOT 15) are orientated on the EN305:2012. If the European Unions Framework Directive on Eco-Design of Energy-Using Products (Directive 2009/125/EC) is coming into force most national frameworks will be adjusted and will therefore replace existing national regulations. Thus, European wide uniform requirements will result in a validity of the type test according to the EN303-5 in all EU member countries.