Triggering the creation of biomass logistic centres by the agro-industry

Handbook for agro-industries interested in starting a new activity as biomass logistic centre: the basic demand of information

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SUCELLOG Project

The SUCELLOG project - Triggering the creation of biomass logistic centres by the agro-industry - aims to widespread the participation of the agrarian sector in the sustainable supply of solid biomass in Europe. SUCELLOG action focuses in an almost unexploited logistic concept: the implementation of agro-industry logistic centres in the agro-industry as a complement to their usual activity evidencing the large synergy existing between the agro-economy and the bio-economy. Further information about the project and the partners involved are available under www.sucellog.eu.

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Introduction

Bioenergy production, in Europe, currently accounts for more than 60 % of renewable energy sources and is expected to grow in terms of quantity by 2020 (European Commission, 2015). Knowing that the biomass resources from forest are limited, agricultural residues have a non-negligible potential to help fulfilling this growth. Moreover, the European policies, through the Agricultural Fund for Rural Development and national policies encourage Member States' institutions and support agro-industries in using agricultural residues for bioenergy as a way to diversify business activities of farmers and increase the added value.

Agro-industries equipped with agricultural goods processing facilities offer a great opportunity to become an agro-industry logistic centre providing quality solid biomass from raw feedstock. Using non-valorised biomass sources in agro-industries working with idle periods would further contribute to the EU-28 development, initiating new activities in rural areas, reducing greenhouse emissions, increasing the part of renewable energy in the EU consumption, participating in energy independency and creating new markets.

SUCELLOG (SUCcEssfuL LOGistic) is a three-year project funded by the Intelligent Energy for Europe programme carried out in Austria, France, Italy and Spain, which aims to implement new logistics chains in agro-industries for the production of solid biomass. Four logistic centres will be initiated in these four countries, forty feasibility studies will be conducted and agrarian associations will create competences to support new logistic centres.

As part of the SUCELLOG project and taking into account that the awareness and knowledge about the project concept is limited, three handbooks will be developed. The handbooks content will be addressed to three different categories of target groups based on their degree of awareness in the field. The progressive structure of the handbooks aims to raise awareness about the project concept and to foster entrepreneurial mind-sets of agro-industries towards starting new economic activities as agro-industry biomass logistic centres by providing guidance and showing good practice examples.

This first handbook gives the basic key information to be taken into account when interested in starting this new activity. It will address the following topics: the development of biomass consumption in the European Union, the agricultural biomass used in energy, the concept of agro-industry logistic centre through the prism of supply chain, the need of sustainable schemes in the procurement of biomass and examples of the facility types in European participating countries.

1. Biomass supply for bioenergy production

1.1. The use of biomass for energy

Biomass used for energy, in the European legislation, means “biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste” (Directive 2009/28/EC of the European Parliament and of the Council).

Biomass can be converted into energy through different pathways as it is illustrated in Figure 1. Depending on the biomass sources and the conversion processes, different types of biofuels and bioenergy carriers are produced and used for different purposes. The most widespread uses are:

- Heat and power by combustion of dry biomass (wood, straw, energy crops);
- Biogas obtained by anaerobic digestion of high moisture content organic matter (manure, vegetable by-products, grass etc.);
- Biofuels by transesterification of oil rich biomass (production of biodiesel) or fermentation of sugar or starchy biomass (production of ethanol).

> Biomass was the first energy used by Humans: 400 000 years ago, early humans tamed fire to cook, to light, to protect themselves from wild animals and for heating.
>
> Nowadays, biomass, to be an alternative to fossil fuels, requires to be economic, to be utilised with high automatized technology and to contribute to sustainable development.

There are many different pathways to transform biomass into energy, either directly or by producing intermediate energy carriers like bio-oils, torrefied biomass, syn-gas, among others. As well, solid biomass can be transformed into liquid biofuels, through thermochemical or enzymatic processes. In case of organic matter with high moisture content, apart from biogas production or the utilization for composting or as soil organic amendment, several emerging paths are in development: hydro-thermal conversion or micro-biological fuel cells.

For further information of most relevant processes, refer to Appendix I.

In the SUCELLOG project, the biomass resources used for the production of bioenergy is dry biomass which will be combusted either directly or after pre-treatment for heat and power production.

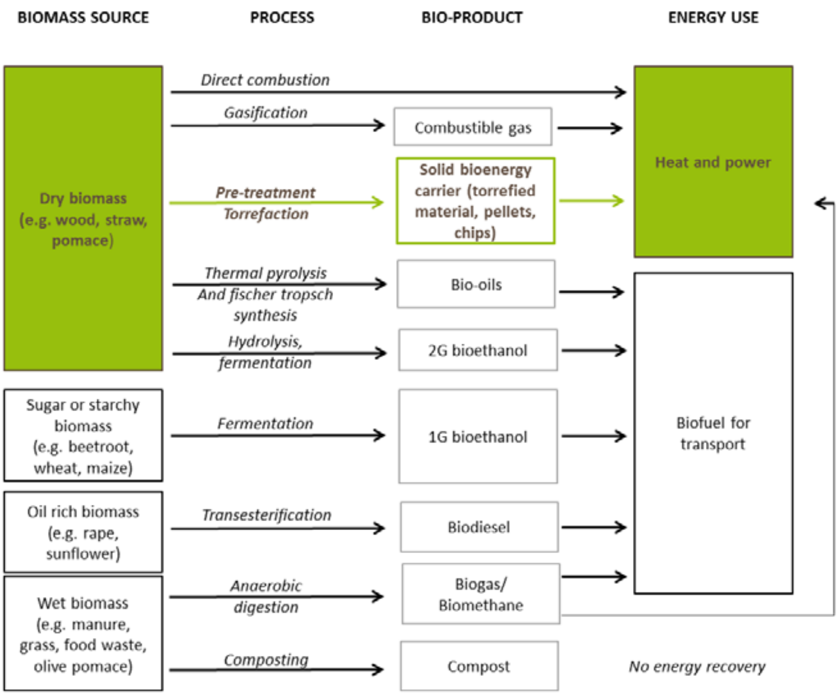

Figure 1: Major types of biomass energy processes and uses

1.2. Biomass, the main used source of renewable energy in the EU

Europe 2020 is the European Union's ten-year growth and jobs strategy, launched in 2010 to create the conditions for a smart, sustainable and inclusive growth (European Commission, 2015). Five headline targets have been decided to achieve a sustainable future, covering the employment, the research and development, the social inclusion, the poverty reduction and the climate and energy. For the Energy and Climate Package, the targets are known as the "20-20-20" targets, setting three key objectives for 2020:

- A 20 % reduction in EU greenhouse gas emissions as compared to 1990 levels;
- Raising the share of EU energy consumption produced from renewable resources to 20 %;
- A 20 % improvement in the EU's energy efficiency as compared to 1990.

In 2012, 14.1 % of the European gross final energy consumption was from renewable sources (Eurostat, June 2014).

Associated with the second objective, under the Renewable Energy Directive 2009/28/EC, Member States have taken on binding national targets for raising the share of renewable energy in their energy mix by 2020.

In the EU-28, the primary production of renewable energy almost doubled in 10 years, representing, in 2012, 177 Mtoe. The biomass is the best contributor of renewable energies in the energy mix, representing more than 67 % of the share of renewables in gross inland energy consumption (Figure 2). Biomass used for bioheat production represents 74.7 Mtoe followed by biofuels for transport at 14.6 Mtoe and bioelectricity at 12.8 Mtoe. Biomass accounts for 88.9% of the renewable heat (European Commission, 2015).

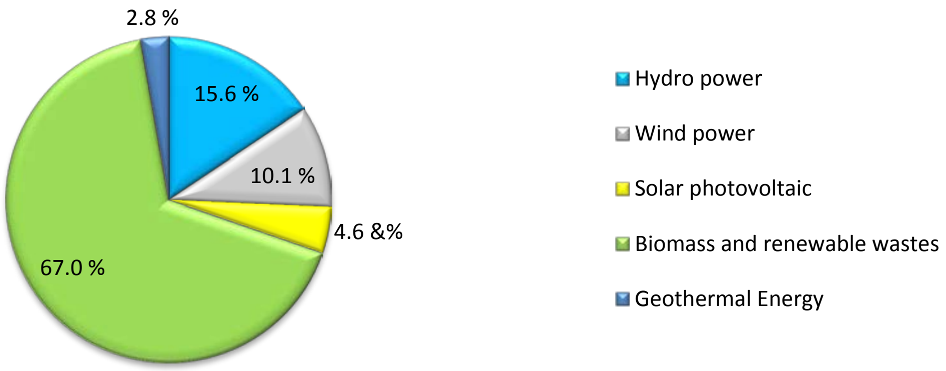

Figure 2 : Share of renewables in gross inland energy consumption in In the EU-28 (European Commission, 2015)

According to EurOberserv'ER 2013, biomass as energy represents a turnover of 50 billion of euros in the EU-27, including 28 billion for solid biomass. More than 500,000 jobs directly depend on bioenergy, including 282,000 in the solid biomass sector (Observ'ER, 2013).

Due to the "20-20-20 targets" and the European directives, numerous European countries propose national aid systems to promote renewable energy and to help innovative projects for biomass development or solid biomass consumption. This financial support, increasing the profitability of biomass production or consumption, depends on each country or region.

In France, the *Heat Fund*, implemented by the French Environment and Energy Management Agency (ADEME), supported 2,911 installations between 2009 and 2014, including more than 500 biomass projects in the industry, agriculture and services sectors for an annual production of 1,362,501 toe (sept. 2014). This program lead to the creation of 5,000 jobs.

1.3. Agricultural residues have a high potential to achieve the 2020 target

Forest biomass resources are the main contributor to reach the 2020 targets of renewable energies in the EU. They experienced a significant growth in the last 10 years but now tend to stabilize. It is therefore needed to promote the diversification of other available biomass resources like agricultural residues, which present a huge potential, are barely exploited and can easily grow in the next few years (Michael Carus, nova-Institut, August 2012).

Many studies investigated the potential availability of biomass from agricultural residues for bioenergy production (EEA, Scarlat & al etc) but no comprehensive national statistics are available on its current uses and markets. Nevertheless, it can be agreed that agricultural residues can be the key for a genuine expansion of biomass supply for bioenergy production once biomass from forestry and waste are stable over time.

The estimates show that the total average amount of crop residues left that would be available for bioenergy production in EU-27 reaches 425,000 GWh (1,530 PJ; after considering competitive uses). This represents 15 % of the electricity consumption by the industry, transport activities and households/services in the EU-28 (Scarlat N, 2010) (European Commission, 2015).

A new market, based on solid biomass from agricultural residues, should be developed in the short term in Europe. Agro-industries have an interesting opportunity in this field playing a strategic role between farmers and markets.

2. Agro-industry biomass logistic centres

Agro-industries use modern equipment for the processing of agricultural products for intermediary or final consumption. The products can be used for feed and food or for non-food purposes (textiles fibres, chemical extracts, etc.).

Some agro-industries like alfalfa dehydration, grain drying or seed oil extraction industries among others, are equipped with pelletisers, drying systems, silos and conveyors, working in most of the cases under seasonal regime. These facilities can be utilised during the idle periods to handle and pre-treat biomass feedstock obtained from different sources existing in the area and, therefore, offer a great opportunity to become a solid biomass logistic centre

A successful example of such an agro-industry is illustrated in Figure 3. The industry was initially producing feed for cattle breeding. It used corn, forage and other nutritive additives to produce animal feed pellets. Figure 3 shows the processes, the flows of food and non-food materials and the corresponding transformations of biomass feedstock carried out, once the agro-industry integrates the new activity of biomass production. The industry takes advantage of the commercial relations with corn grain producers, and purchases both, corn grain and corn cobs. Corn cobs are utilised during the idle periods of feed production as raw material to produce biomass pellets in the original feed pelletiser.

The sequence details of Figure 3 are as next:

1. Corn is produced as usual by farmers. So, farmers do not have to modify their activity.
2. During the harvest of corn grain, corn cobs are simultaneously obtained in an adapted corn harvester. Both grain and corn are discharged (separately) to trailers to be transported later on to the agro-industry facilities.
3. Corn grain is dried and combined with forage and other nutritional additives to produce animal feed pellets, as usual.
4. Corn cobs are partially utilised as source of energy for the heating process in the feed production line.
5. After the season of feed production, an idle period in winter and early spring starts.

The agro-industry process corn cobs with other local biomass complements to produce mixed biomass pellets in the original feed pelletiser. Corn cobs and corn cob pieces (grits) are treated in the drying unit.

6 Biomass is delivered to final consumers with the format of pellets, full corn cob and loose grit material. The facilities are then cleaned and prepared for the new session of feed production. The distribution of the biomass processed can continue afterwards, since the accumulated dry material is stable, and can be stored.

7 Ashes from combustion facilities can be recycled into nutrients for the corn fields, which would allow to close the cycle of nutrients and reducing the needs of fertilisers.

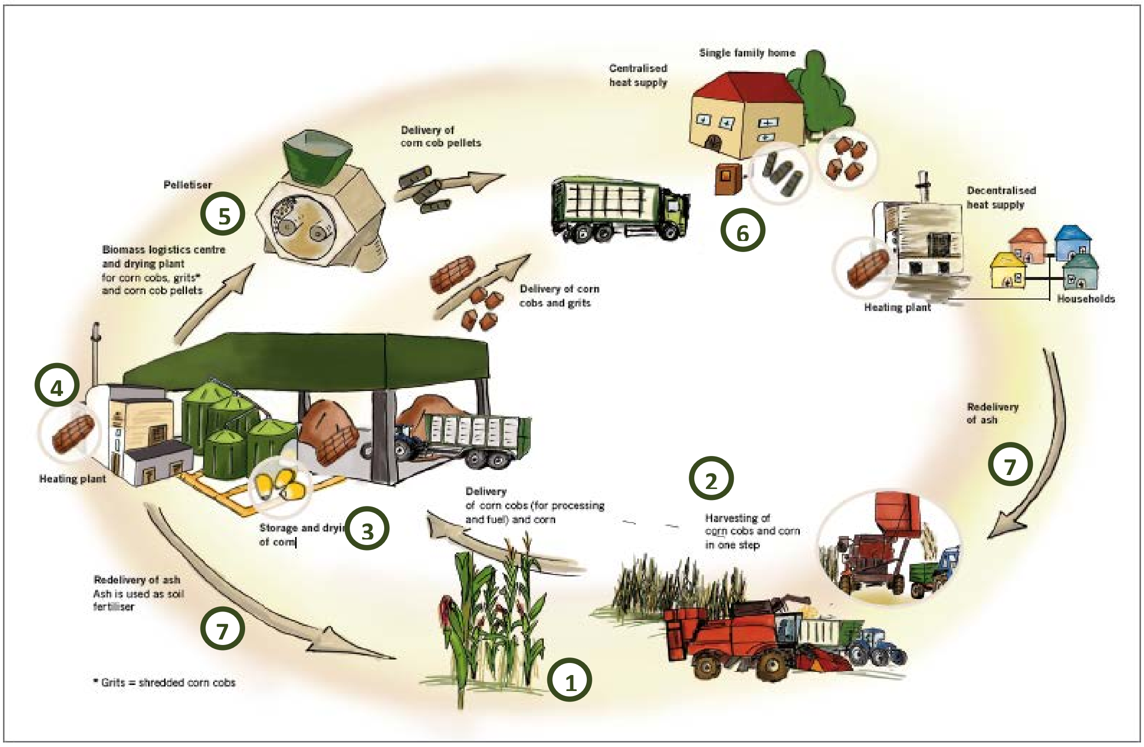

Figure 3: Concept of agro-industry biomass logistic centre

2.1. Advantages for an agro-industry to become a biomass logistic centre

Agro-industry facilities work under seasonal regime due to crop cycles; they can make some biomass pre-treatments compatible with their own process

In order to start a new logistic centre in the existing facilities of an agro-industry, it is necessary to have biomass resources available during the time the facility is not in operation. In this way, the idle period of the year can be utilised to compile, treat and distribute the biomass.

Dryers in forage dehydration, sugar industries, distilleries and oil pomace industries own usually horizontal dryers able to process a greater variety of raw material formats. Cereal dryers are equipped with vertical dryers (also called tower dryers), which are compatible with granulated biomass like olive and grape pits and crushed almond shell.

The agro-industries having drying equipment may use it directly or adapt it to treat biomass and produce solid biomass with higher quality

Agro-industries can become new suppliers of biomass mixed pellets

Feed industries and forage dehydration are usually designed to produce densified goods in pellet format. Other industries, like wine or sugar extraction industries, may be equipped with pelletisers for treating their residues, and produce dry, compact and stable pellets, which are later commercialised as dietary complement for cattle. Idle periods of such production lines can be utilised for the production of biomass pellets.

Both food-products and solid biomass are organic materials which need to be stored and treated to avoid deterioration. Agro-industries work on agricultural feedstock, usually received as bulk material. They hence already own handling machinery and facilities that could be utilised to handle biomass feedstock, as for example: shovels, cranes, storage bays, belt conveyor stackers, hoppers or silos. Therefore agro-industries, even not having compatible equipment for moisture reduction and for grinding or pelletising biomass, have an advantage as they have expertise and means for establishing a new activity as biomass provider.

Agro-industries have experience in handling food products, which are organic materials with similarities to biomass

Agro-industries are usually involved in commercialisation of bulk materials

Agro-industries have commercial networks for the distribution of their goods. Some agro-industries even have own control of their logistics. The goods they produce already have organised logistic chains. Both the existing networks and the own capacities are a competitive advantage for agro-industries to start new business in the distribution of biomass.

Agro-industries produce by-products which can be used to produce solid biomass. This is a competitive advantage since it offers more independence with respect to usual biomass centres, which have to deal with external providers.

The agro-industries already produce biomass residues

Agro-industries have strong commercial relations with their providers and clients, which may become providers of biomass residues

The agrarian residues up-stream and down-stream the agro-industry facilities are great opportunities for starting new business in biomass treatment and/or distribution. Agro-industries have already commercial relations with both farmers providing agricultural feedstock and clients of their transformed agricultural goods. Agro-industries are in a unique and a strategic position with respect to a regular biomass dealer. Therefore they have a competitive advantage to purchase agricultural residues from their usual providers and clients with favourable synergised contracts.

As an additional advantage to own biomass residues and contracts with usual providers and clients, agro-industries may find additional biomass resources to broaden their offer and increase the quality of their mixed products when necessary.

Agro-industries are surrounded by crop-fields, forests, other agro-industries or activities which can be a source for broadening their offer

Sustainability can be promoted by the agro-industry biomass logistic centres if they bet on local agrarian unused resources

Agricultural residues from harvesting and from agro-industry processing do not always find a market locally. It is not unusual that olive oil extraction cake becomes object of international trade, especially from Spain. Local consumers may make use of wood pellets, which may be imported from other regions in the country, other EU member states or even from other continents. Agro-industries can play a role to purchase, transform and combine multiple local agrarian residues to produce bulk or pelletised mixtures with balanced properties. This can be an opportunity to further promote local markets.

Adapting to handle and transform biomass to bring to market a product of quality is in line with their current work. Agro-industries are already concerned about product quality requirements. They must adapt to the specific requirements of the biomass quality regulations, quality labels or market demands, which is a translation of their usual work into a new parallel supply activity.

The agro-industries and farmers are already quite concerned about the importance of product quality due to CAP regulations, feed and food law, and the demands and requirements of the market

2.2. Synergies by agro-industry sector

Agro-industries dedicated to preservation of food/feed (dehydration, drying and roasting industries) and to elaboration of processed agricultural goods (flour, wine, sugar, olive oil, animal fed, etc.) offer, by far, the largest synergy with the biomass sector. SUCELLOG analysis of the European agro-industry framework has revealed specific synergies of several agro-industry sectors. Table 1 presents the synergies between the idle period of the facilities and the availability of agricultural residues, knowing that the conditions in the different European countries, as well as the idle period, are quite variable. Specific analysis by country for Spain, Italy, France and Austria can be found on the SUCELLOG website (in the section of publications and reports, D3.2, both in English as well as in native languages).

Table 1 : Synergies between idle period of agro-industries (green) and crops seasonal availability (brown)

IDLE PERIOD	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Forage dehydration												
Feedstuff producer												
Cereal dryer												
Rice dryer												
Tobacco dryer												
Distillery												
Sugar industry												
Olive oil pomace industry												
Dried fruits												
CROPS AVAILABILITY												
Feedstuff residues												
Cereal straw												
Soya Straw												
Rape stalks												
Corn stalks												
Corn cobs												
Husks and silo dust from cereal dryers												
Rice husks												
Husks and residues from oil seeds												
Tobacco residues												
Distillery residues												
Beet pulp												
Vineyard prunings												
Olive prunings												
Seed fruit pruning												
Stone fruit pruning												
Dry fruit pruning												
Citrus pruning												
Grapevine oilseed cake												
Grape marc and stems												
Grape pits												
Olive pits												
Olive oil pomace												
Nut shells												

Periods where facilities equipment used to be idle (green)

Periods when the biomass is produced by harvest or processing activities (brown)

Differences between countries are represented in striped box

Forage dehydration:

Figure 4 : Horizontal dryer – Luzéal - France

Forage dehydration sector has an important idle period of 6 months (from November to April approximately) and owns compatible equipment for the production of solid biomass (horizontal dryers, pelletisers and silos). In France, usually installations are used all the year because industries dry other material different from forage in order to diversify their activity (sugar beet, wine residues) or even are utilized to produce wood pellets. Additionally, in some cases the agro-industries are consumers of biomass, which is used as fuel to cover partially or totally the heat demand of the dryer (mainly in France and Spain).

The forage dehydration facilities do not produce any important biomass residues, either in the agrarian or processing phase, meaning that the raw material for the production of solid biomass should be purchased. However, since this activity is in many cases integrated with cereal dryers, particularly in Spain, they have easy access to the residues produced during the agrarian and processing phases of these cereals (like corn stalks, wheat and barley straw or grain dust).

Feedstuff producers

They usually do not have large seasonal idle periods, but have many proper equipment that might be used for the new activity such as: pelletisers, silos for storage, screening and machinery for particle size reduction.

Figure 5 : Animal feedstuff peletizer - Progeo Masone - Italy

Cereal dryers (winter cereals and corn):

Figure 6 : Cereal dryer - SAT el Cierzo - Spain

This sector shows an interesting potential to become a solid biomass logistic centre from a technical point of view, offering a long idle period of around 8 months, depending on the country, crop and crop specific variety (from February to October in Spain, January to July in France, October to May in Italy or January to September in Austria). These facilities are usually equipped with dryers (generally vertical), screening equipment and silos for storage. However, the drying equipment of these facilities cannot, in many cases, be used for drying other types of raw materials, being only compatible with granulated elements like olive pits. So, for the creation of a logistic centre in this sector, investments in a drier shall be needed. These industries are usually familiarised with the use of biomass as fuel during their process.

Regarding the raw material available for a possible logistic centre, cereal dryers are located in areas where there are important cereal extensions. Farmers supplying the grain to be dried in the facilities produce important quantities of straw which main market is the livestock feeding, bedding and mushroom substrate. Depending on the year, a considerable amount of straw is not able to enter the market, being left on the soil and therefore available to be used as a raw material for a logistic centre. The agro-industry itself does not produce important amounts of residues, just the broken grains and grain dust, which is normally given to the stockbreeder as animal feeding material without costs.

Figure 7 : Corn Cobs handling - Tschiggerl Agrar Gmbh - Austria

Corn cobs, usually left on the soil, are starting to be considered as a biomass resource for combustion in Austria and some machinery has been developed to collect them. A conventional corn harvester allows farmers to collect simultaneously the corn and the corn cob. Even though some models may be found in the market, most harvesters require small retrofitting for implementing this combined function.

Rice dryers:

The rice dryer industry has an idle period of around 9 months (from December to August approximately) in Spain and Italy and counts usually with vertical dryers. Similarly to cereal drying facilities, they present an interesting synergy to become a logistic centre.

In what concerns the residues associated to this type of agro-industry, the straw is not harvested in most cases due to the technical difficulty of working in waterlogged areas in which rice is produced. Other reasons are the limited nutritional interest as feed (due to low digestibility and composition, it must be enriched or pretreated). Even though the integration of rice straw in waterlogged fields may cause anaerobic organic degradation (leading to CH4 emissions release) and pests' proliferation, currently the main driving force is technical and economic and thus rice straw is not usually harvested.

Tobacco dryers:

The agro-industry of the tobacco remains open the whole year but their dryers have an idle period of 7 months in Italy (January to August), 8 months in Spain (December to August) and 9 months per year in France (from October to July). The agrarian practice of the tobacco generates residues (stalks) that are left on the soil after harvest's end and which could be available as a possible biomass source. In some countries like Spain, the sector is highly familiar with biomass issues since most of the tobacco facilities use this fuel during their drying process.

The synergy of these industries can be limited by some technical and non-technical constraints. On the one hand, the used dryers may be not compatible with biomass drying. On the other hands, legal restrictions or direct requests from international buyers of tobacco (cigarette and cigar producers) may not allow the tobacco industries to use dryers for different purpose.

Wine sector (cellar and distilleries):

Figure 8 : Santa Maria La Palma wine cellar - Italy

The distilleries own equipment (horizontal dryers) compatible with the production of solid biomass. The idle period of these dryers in the distilleries is from May to September/October in France, April to December in Italy (8 months) or June to October in Spain (4 months).

They have easy access to the agrarian residues such as the pruning or to the agro-industry residues obtained during the wine and distillate elaboration. Prunings are most commonly burnt or left on the soil, although some new initiatives are starting to use it as biomass source. Regarding the residues from the distillation process, they are sold for animal feedstock and biogas production. In Spain, residues are mainly used as fertilisers or are available to be used as solid biomass.

Sugar industry

The sugar industry presents an important idle period which goes from January to October (9 months) in Spain, 7 months in Austria and France (February to September and January to August), 8 months in Italy (November to July). This industry usually incorporates compatible equipment for the production of solid biomass, such as horizontal dryers and pelletisers. This equipment is generally dedicated to treat the industry by-products (beet pulp) to produce stable nutritive materials sold for the animal feeding industry. Therefore, in most cases, these facilities would have to out-source most of the biomass resource.

Oil extraction industries:

The oil extraction industries are dedicated to rape and pumpkin seeds in Austria, mainly working all the year, and to rape and sunflower seeds in France. The facilities count with pressers and silos in Austria and France, adding driers in France. In the production of oil from oil seeds, oil scrap and press cake are produced as residues. These residues are very rich in protein and are sold usually as animal feed. Regarding the residues obtained in the field, the straw from rape and soya is normally dedicated to animal feed or left on the soil, leaving some available straw that could be harvested and used for the production of solid biomass.

The olive oil sector includes oil mills and oil pomace extraction industries. Regarding the residues produced in the oil mill: the olive pits are currently being sold as solid biomass and the olive pomace is used for multiple purposes, like biogas production, as animal feedstuff or as energy feedstock. For such purpose, oil cake must undergo previously drying. During the agrarian phase, the olive orchards produce important amounts of prunings, which are usually an almost un-exploited energy resource.

Figure 9 : Storage place - Agricola Latianese olive oil extraction - Italy

Oil pomace extraction industries own horizontal dryers and pelletisers. Dryers are dedicated to reduce the moisture of the fresh olive cake to allow a subsequent process of oil extraction through solvents. The pelletiser is usually dedicated to granulate residues. In Italy or in Spain, these facilities are capable of using its own residues. As regard of the long idle period of 8 months approximately (from April to November), they are well positioned as potential biomass logistic centres.

Nut industry:

In Spain, the sector of the nut industry performs their activity during the whole year but their dryers are not working from December to August approximately (9 months idle period). Dryers are the main equipment compatible with the production of solid biomass they usually own, apart from silos and handling systems. Nut industry produces nut shells during the months of September to June, a valuable residue that can be used as solid biomass and is, nowadays, really appreciated for that purpose.

2.3. Feasibility keys and challenges

An agro-industry to become a biomass logistic centre, as promoted by SUCELLOG project, requires three conditions:

1. The capacity of these agro-industries equipment to handle and process biomass: if the existing equipment is not compatible with biomass feedstock, the agro-industry may have to incur relevant costs for purchasing new equipment, and to set-up new process lines. This causes the synergy to be not so evident and the costs and risks for the investment to rise. Financial capacity can, then, be a main trouble.
2. The possibility to use the same facilities without risk of contamination when turning to regular activity. This is a concern for products derived for animal feeding or for human consumption like tobacco. In case of feed, 2002/32/CE establishes regulations for undesirable substances in animal feed. The regulation and the procedural instruments to be followed, according to EC/219/2009, have to be accomplished. Beyond these requirements, there is currently no EU limitation. In some regions or EU member states, some constraining rules may apply, although for the moment, there is no regulation setting a general banning.
3. The compatibility of the seasonality with other biomass resources existing around the facility: availability of biomass in sufficient amount and at competitive prices is a must for the feasibility of biomass logistic centres integrated into agro-industry facilities. Therefore, a good matching of the seasonal production of biomass with the idle periods of the agro-industry is quite recommended.

2.4. Cases of success

There are some pioneering agro-industries which already have taken initiative to adapt their facilities for the treatment and marketing of solid biomass. A brief description for some experiences is found in next tables. SUCELLOG will build a more comprehensive description of success cases in the third handbook.

Daniel Espuny S.A.U.

Location
Linares (Spain)

Years in operation
12 years

Processing capacity
60 kt/yr olive oil pomace

Idle period
July-November

Investment
1 M€ (12 years, note that investment is for the usual activity and the biomass logistic centre)

Olive oil pomace industry

The activity of the logistic centre has supported the industry to keep the full-time work of their 20 employees.
Along last 12 years, the dryer and the pelletiser have been renewed. A mill for producing micronised biomass and a screen have been acquired. Part of the investment has also been dedicated to civil work for adapting truck reception and storage site.
The activity with biomass specially takes place during the idle period, even though biomass distribution takes place along the whole year.
The facility produces olive pomace and pulp pellets, micronised exhaust olive pomace and olive pits. Part of the biomass fuel produced is consumed by the agro-industry, whereas the rest is marketed mainly for large consumers, lime industry and retail biomass dealers.

Corn dryer

Adapting SAT nº 5 El Cierzo facilities for biomass distribution was quite simple and straight forward. Most of the investment was applied for civil works. The cereal drier required simple and inexpensive retrofitting to be able to dry the fresh olive pit particles. The facility rapidly started the commercialisation of high quality olive pits. Most of the solid biomass is currently being distributed to local farmers although the target is also to reach the market of residential heating in order to diversify their customers.

SAT nº 5 El Cierzo

Location
Zaragoza (Spain)

Years in operation
2 years

Processing capacity
4 kt/yr corn

Idle period
September-January

Investment
0.15 M€ mostly in civil works, retrofitting of the dryer, moisture measurement devices and automatic bagging

Ile-de-France Sud

Location
Etampes (France)

Years in operation
6 years

Processing capacity
500 tons of silos dust (potential of 1,500 tons)

Idle period
November - May

Investment
400,000€ for the pelletizing line

Cereal drier

This cooperative used to dry cereal grains for its associates. In 2009, the cooperative was forced to find new markets for its silos residues and decided to produce agropellets, working with RAGT energy for their formulation. It built a partnership with Etampes, the neighbour municipality, which was planning to install biomass boiler. They are now using annually 500 tons of agricultural residues to heat the municipal facilities (swimming pool, schools and buildings) and sell the other part of the production directly on the cooperative facilities for individual consumers. They invested only in a pelletising line and optimised the other installations and the storage places for the logistic centre.

3. Agricultural residues used for solid biomass production

3.1. Agricultural residues: relevance of their properties

Agricultural residues correspond to the fractions of crops discarded during:

- Primary agricultural operations such as harvesting, pruning - *primary residues* (e.g. stalks, straw, leaves, pruning, corn cobs) ;
- Food and materials processing, also called *secondary residues* (e.g. olives pits, silo waste, grape marc) (S2biom, Cosette Khawaja, Rainer Janssen, 2014).

It is ideal for agro-industries who would like to become a biomass logistic centre to integrate their own biomass residues (secondary residues) obtained during the processing of the agrarian feedstock. They can also include in their facilities the treatment of primary residues from usual providers (e.g. corn stalks in the case of providers of a corn drying industry) or secondary residues from their customers (e.g. rejects and manufacturing by-products of their clients).

In order to penetrate the market, a biomass logistic centre needs both fulfilling the expectations of the biomass consumers with respect to the biomass quality and being competitive in price with respect to other biomass resources. Biomass logistic centres are designed normally to obtain products of sufficient quality for the final consumers.

The main properties which influence solid biomass quality are:

- Moisture content;
- Ash content;
- Content in Nitrogen, Chlorine and Sulphur;
- Net calorific value;
- Ash softening temperature;
- Particle size distribution;
- Bulk density;

Moisture content:
The moisture content or water content in the living tissues of plants is variable along their life and usually decrease in periods of vegetative stops (e.g. during winter) or during senescence (like in annual crops, after the grain is formed). A plant in active growth can have moisture content over 60 %, whereas plants in senescence can have easily much lower moisture content (wheat straw in Mediterranean areas can, for example, reach less than 20 % moisture).

Under the scope of obtaining energy from biomass residues, they can be classified into two categories according to their moisture content: wet residues with moisture higher than 60 % (wet base) which are suitable for biogas production through anaerobic digestion and dry residues with moisture lower than 60% which are more appropriate for combustion.

It must be noted that the moisture content is one key quality criterion. It is crucial for the calorific value. Fresh residues with high moisture content are not suitable for energetic use in small and medium sized heating systems like the ones in households or small farms. As there is no water-free biomass in nature, always a certain degree of water has to be vaporized during combustion. The energy (heat) needed for this process reduces the net calorific value. A residue with low moisture content has therefore a higher net calorific value than the same residue with higher moisture content.

High moisture content is also a drawback for long-term storage since it can lead to fire risks and matter loss due to biological activity.

Ash content:
Ash is a non-burnable residue which emerges through the combustion of biomass. It consists of high mineral content which can be used as a fertilizer on fields. Depending on the residue, the ash content can strongly vary from under 1 % to over 10 %. High ash content decreases the calorific value, increases dust emissions and the operational maintenance. Additionally, the ash is a residue that has to be disposed.

Ash contents, in the parts of plants considered as a residue, can be, in primary biomass, as low as 1 or 2 % of the total dry matter. This ash content is usually found to be higher by final consumers since during the harvest, handling and transport of the residue, soil and dust particles are incorporated in the bulk material.

Ash softening temperature:
At a certain combustion temperature, the ash of biomass begins to slag and this causes the formation of clinker[1]. This temperature is strongly dependent on the fuel. The lower the temperature, the earlier starts the ash to slag. Agrarian residues have, in comparison to wood fuels, a lower ash softening temperature. This is the reason why there is a need for special boilers with either a cooled or moveable grate or an automatic ash disposal.

Content of Nitrogen, Chlorine and Sulphur:
Despite the dust emissions, other emissions emerge during the combustion process of biomass. The amounts of these emissions depend on the type of biomass as well as on the boiler design and the operating mode (full or partial load). Some of these are related to the content of Nitrogen, Chlorine and Sulphur of the biomass. Therefore, biomass types with high contents of these components could have problems with the emission legislation. Chlorine content, higher in herbaceous than in woody resources, can lead to corrosion problems.

Net calorific value:
The net calorific value describes how much heat will be released upon complete combustion of the fuel. It depends, as already mentioned, strongly from the moisture content and from the ash content. As the moisture content has a huge impact on the net calorific value, when comparing different biomass types, it is necessary to evaluate the energy content on dry basis. In general, fossil fuels have a higher net calorific value than biomass. Furthermore, woody biomass has in general a slightly higher value (in dry basis) than biomass from agrarian residues.

Bulk density:
The bulk density describes how much kilograms of a solid biomass type can be stored in a room of one cubic metre. Solid biomass has, in general, a quite low bulk density in comparison to fossil fuels. Especially loose stored agrarian residues as straw and hay have a very low bulk density, which can be increased enormously through pelletising these residues. The bulk density has strong impacts on the necessary storage size as well as on the transport costs. Solid biomass types with high density are cheaper in transport and less storage is needed, which is an important criterion especially in households.

Particle size distribution:
The particle dimension describes the shape, volume and the dimensions (length, width, height) as well as the surface texture of a fuel. The particle size distribution describes the differences of the single fuel pieces. It shows if there are an important amount of fine or big particles. The particle dimension and particle size distribution determines the appropriate fuel-feeding system and the combustion technology. To this respect, fuels where the size and shape of single pieces strongly differ from each other can cause major problems.

Summary of biomass properties:
Agricultural residues have different properties and therefore cannot always be adequate for pelletising or being used in boilers. However, biomass properties can be substantially modified by mean of the harvesting, handling, storage and pre-treatment processes. Table 2 shows the general properties of several primary and secondary agricultural residues.

[1] *The clinker consists of block of Silica and compact minerals which form during the fusion of ash. The melting point of ashes plays an important role in the evaluation of the risk of formation of clinker and also the mineral contents (Si, K, Ca, Mg…).*

Table 2 : General properties of several primary and secondary agricultural residues

(Réseau Mixte Technologique Biomasse et Territoires, 2015) (ADEME, Avril 2013) (Kristöfel Christa, 2014)[2]

	Cereal straw	Sunflower stalks	Rape straw	Wheat chaff	Corn stalks	Corn cobs	Vine pruning	Grape marc	Silo waste	Olive pits	Olive pomace	Rape press cake	Almond shells
Net calorific value (kWh/kg db)	4.1 – 5.3	5.0	3.9	5.0	4.6 – 5.3	4.1 – 4.6	4.1 – 5.0	3.8 – 5.7	4 – 4.6	4.4	4.9 – 5.1	5.8	4.9 – 5.1
Ash content (w-% db)	3 – 8	9 - 12	7 - 8	3,4	10 - 17	1 – 3	2.1 – 4.5	3.5 – 11	4 – 10	<1	9 - 12	6.5	9 - 12
Water content (w-% ar)	9-15	35 - 45	13 - 14	15 - 25	15 - 18	6 – 30	15	50 – 60	10 – 12	12 – 13	35 - 45	9	35-45
Ash softening temperature (°C)	800-1,000	1,395	1,425	1,300	1,250	900 – 1,300	800 – 1,500	1,300	1,050	-----	1,310	860 – 1,115	1,395

In this document, only dry agricultural residues (moisture content less than 60 w-% ar) used for solid biomass production will be described. Forestry residues will not be considered.

3.2. Agricultural residues: potentials and recommendations of use

3.2.1. Primary residues from annual crops

Annual crops are those which complete their life cycle within one year. The potential amount of biomass residues after harvesting the crops is very variable. Harvesting method and local preferences of farmers directly affect the amount and mode of production of biomass residues (loose on the soil, in bales, etc.) and so, its format, density and the potential incorporation of inorganics (soil particles, dust).

Regarding the availability of dry agrarian residues from annual crops, a crucial issue is the incorporation into the soil, which might be the best practice in soils with a poor content of organic matter, limiting the amount that can be removed without compromising the fertility and properties of the soil. Still on soils conservation, the integration of the agrarian residues into the soil is one of the CAP conditions for annual crops and therefore even though it is not a competitive use, farmers may choose it as the way to accomplish CAP agro-environmental measures.

Around 120 million tons of crop residues are estimated to be accessible for bioenergy in the European Union, once considered unavailable the biomass for competitive uses and soil quality requirements (Chris Malins, October 2013).

Corn cob is the central core of corn, a residue of the corn production.

It can be left on the field or harvested in the case of corn for seeding purpose.

Recommendations

Corn cobs have a lower energy density than wood fuels. This property has to be considered in transport and storage, fuel feeding systems and combustion system. For logistical issues it should be regarded as a fuel for local energy.

Corn cob is abrasive in contact with mechanic elements and can damage equipment of particle size reduction or pelletisers. In case of burning in non-adapted equipment, an unfavourable ash melting behaviour can happen. In that case, dust and particles can block the flue gas cleaning systems.

[2] The table shows very different moisture contents. In case of the primary residues they do not represent the moisture of the plant at harvest time but in ulterior stages of the chain.

Straw is an agricultural by-product from different cereal plants (wheat, oats, barley, rice, etc.) composed by dry lignocellulosic materials (the dry stalks of cereal plants and leaves) after the grain has been harvested.

Straw is stored in different sized bales (generally from 100 to 250 kg/m³). The harvest and logistic technologies are well established since it is one of the crop residues which traditionally have been utilised for centuries for multiple purposes like animal feeding and bedding. Currently, other competitive uses can be found like industry feedstock or energy. Around 3-5 t of straw can be produced per hectare.

Recommendations

Weather strongly influences straw quality. When straw is harvested in form of bales, moisture should not exceed 20 w-% to avoid mould growth and fermentation, leading to temperature rise and so, to a potential risk of fire during storage. Outdoor storage is cheaper but can lower the quality by weathering.

The presence of Chlorine and Alkali in straw is an important drawback. These elements can lead to the development of corrosive molecules for boilers and pipes.

Conversion into energy may require specific equipment because of the low ash softening temperature (leading to production of clinker).

Many other crop residues can be produced from annual crops depending on the region and crop type. The high majority can be used as solid biomass for energy, considering their properties such as sunflower stalks, rape straw, wheat chaff or corn stalks. Other primary residues can also be used for bioenergy production such as permanent grassland, hedges from boscages, rice husk, lavender, etc.

3.2.2. Primary residues from permanent crop prunings

The pruning residues come from permanent crops such as vineyard, olives trees, stone fruit trees, nuts trees etc. This woody material represents a large but unexploited biomass resource, particularly present in the Mediterranean countries: permanent crops represent a total of 10.6 Mha in Europe (Europruning, 2015), mainly olive and vineyard in Spain, Italy, France, Greece and Portugal. Prunings from the different tree types vary in wood composition and in incorporation of leaves in some of them like olive or citrus. There properties also depend on the tree form and agronomic aspects. Their behaviour as a fuel is close to the behaviour of forest wood.

Vine pruning is a residue from viticulture. Vine shoots are cut every year during winter. The production of prunings depends on the climatic and soil conditions, agronomics, vine variety and density of the vineyard (stock/ha). Vine pruning usually can provide from 1 to 2 tons of biomass (dry matter) per hectare. They can be collected, even though the common practice is to shred them and leave them on the soil as organic amendment.

Recommendations

Vine prunings have higher ash content than wood, due to the high quantity of bark and the incorporation of soil particles when it is compiled. Some heavy metals, from the soil or from chemicals applied to the soil, may accompany the wood pruning, being released to the fumes or trapped into ashes. Some of them are zinc, copper and arsenic. For this reason, ash obtained during combustion should be analysed before spreading back on vineyards soils.

Because of the high water content, storage without drying is not recommended, since it can lead to problems of fermentation. It can be dried loose on the vineyard area until April and then be treated and stored easily. The boilers must be ready to cope with this material which may include, depending on the collection techniques, not negligible amounts of soil and small stones.

Other permanent crops like olive, dry fruits and fruit crops also produce biomass prunings. Biomass production per hectare varies depending on crop type, intensification, climate and type of pruning work executed. The figures of production per hectare are quite varying, even though, with the regular annual prunings, the potential is usually between 0.5 and 2 t/ha.

3.2.3. Secondary residues from industrial processes

Secondary agricultural residues are by-products from industrial processes. Their physicochemical properties and their availability (quantity and seasonality) depend not only on the raw materials (primary product) but also on the industrial process itself. They are easier to collect than primary residues because they are concentrated at the processing site.

The wet **grape marc** comes from the grape processing and contains mainly skins, grape stalks and seeds. The yield is 18 – 23 kg per 100 litres of wine.

Recommendations

The high content of nitrogen can lead to the emission of NOx and particles. The ash content is quite high and the combustion can produce clinker as well as emissions of particles, including some inorganic compounds of copper, chromium and sulphur.

After some months, the material tends to degrade by fermentation, reducing its energy content.

Silo waste consists of a by-product from distribution and processing of grain, damaged grains and seeds, cereal dust, etc. They can be easily collected during all the processes of cereal supplying, drying and storing.

They are generally used for animal feeding (not loose powder but in form of granulated material) or can be burned in the industry to dry the seeds. The amount produced can be estimated as 0.5 – 2 t/ha.

Recommendations

This biomass has high ash content and an important amount of Nitrogen, Sulphur and Chlorine leading to emission of NOx, SOx and fine particles.

Silo waste has a very low bulk density, a property which should be considered regarding logistic issues.

Olive pits, the stones of the olive, are solid residues from the olive oil processing with properties similar to wood pellets. Spain is the main producer in Europe. It is estimated that pits represent about 20 % of the weight of the olive fruit.

Recommendations

Before using olive pits as fuel, they have to be cleaned and dried to limit the quantity of Chlorine and Sulphur naturally present in the pomace. Because of their shape and high bulk density, they can be easily stored into a silo.

Other secondary residues are olive pomace, grape seeds, beet pulp, other dry-fruit shells, fibre rejects, etc. In general, the majority of the numerous residues produced by the agro-industries have already a market: animal feeding, composting, industrial and chemical processes but also to produce heat, electricity or biogas.

3.3. The process of solid biomass production from agricultural residues

The aim of biomass supply chains is to produce a final biomass commodity of adequate quality for final consumers. Therefore, the configuration of biomass supply chains starts with the identification of feedstock and final consumer needs (specifications of the solid biomass, section 4). The final chains to be implemented by a company will depend on its own investment capacity, on its own existing means or facilities or on the capacities of external companies able to provide services. Multiple options are, a priori, feasible (Office of Energy Efficiency and Renewable Energy, 2015).

Because of the diversity of the biomass feedstock, of the impact of logistics on final price and of the variable types of final consumers' facilities, each supply chain has to be studied case-by-case. The limited availability of the biomass has also to be taken into account: the supply chain has to be considered within seasonality aspect of each biomass and possibility to be stored. The handling and treatment methods integrated in the value chain determine the final properties of the biomass. The main steps in the logistics chain are:

1) ***Harvesting:*** it is the first stage in the logistics chain. Depending on the harvesting method (e.g. for straw multi-pass, single-pass, whole crop harvesting), the agrarian residue is found in different format and its quality may significantly vary, due to soil particle incorporation or to weathering.

2) ***Transport:*** transport of biomass occurs at two stages: a first transport from the field to an intermediate storage or treatment plant, and a second transport, from the intermediate site to the final consumer. The first stage is mainly done by road transport, over short distances, offering a great flexibility. For the second stage, distances can be larger and transport is carried out with large trucks. The choice of technology for transport (and loading) systems depends on the biomass format (e.g. loose material, bales), density after processing, distance of delivery and existing transport infrastructure. The loading methods of solid biomass can also cause contamination with soil particles (Biomass Energy Center, 2015).

3) ***Pre-treatment:*** for conventional final consumers, pellets and chips are usually the most demanded formats. Therefore, the more widespread pre-treatment processes are particle size reduction, drying and pelletising. The aim of pre-treatments is to improve the characteristics of the biomass so that the subsequent handling, storage, transport or combustion are facilitated (Foday Robert Kargbo, 2009) (Biomass, 2013).

   - **Particle size reduction:** chipping and milling are necessary stages to transform some bulk materials like straw or tree branches, into a format compatible with usual boilers. Milling is a necessary stage before pelletising, except for very fine or powdered materials.
   - **Drying:** moisture reduction is convenient for improving the heating value of the biomass and also contributes to reduce the risks of degradation during storage. Drying can be carried out in piles placed on paved soils or into bays, usually known as natural drying. The process requires several weeks and usually cannot reach moistures under 20 %, except in areas with very dry climate. For reducing the moisture more rapidly, industrial equipment can be utilised. Driers are, as a matter of fact, quite usual equipment in agro-industries.
   - **Pelletising:** is the process of compressing raw materials into pellets which become up to 10 times denser than the material loose. The pelletising behaviour of biomass depends on several factors, including the nature of the material (and its structure), the particle size, moisture content and the mineral content. Not all biomass types can be easily pelletised and, in those cases, an additive is required. In other occasions, for creating a pellet of sufficient quality according to standards, mixtures of various materials may be necessary.

4) ***Storage:*** sufficient storage for biomass is necessary to accommodate seasonality of production and ensure regular supply to the biomass consumer (Biomass Energy Center, 2015). Storage must be adapted to the type of biomass (form, moisture content), adding cost to the system. Solid biomass has a relatively low energy density and, hence, requires a large volume to be stored (The Energy Crops Company, September 2007). Storage has to be done in a convenient place for subsequent handling, further treatment (if needed) and transferring to a final consumer or to other intermediary (BioEnergy Consult, 2015).

4. Quality requirements for solid biomass market

4.1. Solid biomass market

Solid biomass in Europe is used for heating, cooling or electricity production. Households, municipalities, industries and farms are potential biomass consumers.

Biomass consumers usually set specifications for the biomass; they purchase according to the features of their energy systems. The quality is usually based on the properties defined in section 3: it may request, for example, a certain format (size, particle distribution), a specific maximum moisture and ash content, or a threshold for chemical components (sulphur, chlorine, etc.).

Quality and willingness to pay go hand in hand. The higher the quality and the higher the reliability of the biomass, the higher the price can be obtained in the sale and the chances to strength the commercial relations and the position in the market. It must be noted that only very specialised energy plants can cope with complicated and low quality biomass. High and intermediate quality biomass is the feedstock consumed by households, tertiary sector and by non-energy intensive industries. Therefore, quality is an issue to be regarded when starting a business activity in biomass distribution.

Importance of social acceptance

In Italy, dark pellets are considered as a bad quality product and cannot find a market. Pellets must be white (light colours).

4.2. Quality standards and certification systems

Producing high quality fuels from primary and secondary agricultural residues is a challenge since, in most cases, the residues has a relevant content of inorganic compounds coming from the plant structure (nutrients and salts inherent to the organic matter and bio-minerals involved in the structure of the plant, like calcium oxalate and phytolith), in contrast to forest stem wood. Production of solid biomass from agricultural residues is quite rare (except for olives pits, almond shells, olive pomace and grape pits in Mediterranean countries). The strategy to address a good share of potential biomass consumers may rely in some cases on the utilisation of mixtures and additives to produce good quality solid biomass fuels.

Certified pellets consumption can be compulsory in some countries. For example, in Spain, the new air quality programme foresees incoming regulations limiting the use of non-certified biomass into households, in order to prevent emissions of noxious fine particle matter and emission into populated areas.

In order to improve the quality of solid biomass fuels, the Standardisation Committee CEN TC 335 “Solid Biofuels”, mandated by the European Commission, developed a set of standards for the definition of fuel classes, test and sampling methods as well as quality assurance schemes for supply chains. Many of the European standards have been brought forward to be 'upgraded' to international standards by the ISO TC 238 "Solid biofuels" incorporated in 2014. Some of the European standards in solid biomass fuels are not any more in force, being substituted by the ISO ones. The European standards focused on non-industrial uses whereas the international standards also include industrial use of the solid biofuels. In addition, in a near future, the international standards will include aquatic biomass as a raw material and classification of thermally treated biomass (e.g. torrefied biomass).

Standards establish a series of requirements, protocols and technical specifications related to the fuel quality. The standards can be divided along the topics in:

Table 3 : Examples of biomass standards

Topic	European (EN) standards	International (ISO) standards
Terminology	EN 14588*	ISO 16559
Fuel specifications and classes	EN 14961 series (6 parts)*	ISO 17225 series (8 parts)
Fuel quality assurance	EN 15234 series (6 parts)	ISO/CD 17588
Sample and sample preparation	EN 14778 and EN 14780	**ISO/NP 18135 and ISO/NP 14780
Physical and mechanical properties	15 standards published	12 standards under development
Chemical analysis	6 standards published	6 standards under development

(*) Not anymore in force (**) In preparation

The **ISO 17225:2014, *Solid biofuels – Fuel specifications and classes*** can be considered as the most important standard when starting a business activity on this field. The first part of the standard aims to provide unambiguous and clear nomenclature for solid biomass properties (diameter, ash content, moisture content, additive etc.), enabling good understanding between seller and buyer as well as a tool for communication with equipment manufacturers for an efficient trading.

ISO 17225 parts 2-7 establishes classes according to the properties values of different products (wood pellets, wood briquettes, wood chips, firewood, non-woody pellets and non-woody briquettes) which can serve as recommendations for quality specification for residential, small commercial and public buildings as well as for industrial use (the latter only in the case of wood pellets).

Several European countries such as Austria (ÖNORM M 7135), Sweden (SS 187120), France (NF Granulés), Italy (CTI - R 04/5) and Germany (DIN 51731 and DINPLUS) have introduced pellet certification systems. It is a way to provide confidence to consumers since an external entity is certifying that the product quality goes according to established specifications. At the EU level, the certification ENplus is the common certification which indicates a guarantee of high quality wood pellets. The other types of solid biomass have no certification systems for the moment.

Finally, it is important to highlight that, when an external service is contracted for carrying out quality analysis of a product, it is fundamental to ensure that the analysis is performed according to existent ISO standards. A list of them is given in Appendix 2.

4.3. Sustainable processes

As with any growing market, there are inevitably issues to overcome to truly let thrive bioenergy. A biomass initiative, to be sustainable in time, should accomplish three main sustainability factors: the economic, the social and the environmental dimensions. A sustainable product can justify a higher price than fossil fuel and be a powerfuel selling factor in favor of the solid biomass market (Europen Commission - Directorate General for Research and Innovation - SCAR, 2014).

ENVIRONMENTAL BENEFITS

Reduce greenhouse gas emission (biomass is considered as carbon neutral)	Use of renewable energy and energy mix[3]	Natural and local fuel

In terms of environmental concerns, the legal framework may set limits in air-emissions for facilities using biomass for energy. Therefore, it is necessary that the biomass produced is compliant with some standards

[3] Biomass is considered a renewable energy source due to it short term regeneration. When annual crops are burned, the amount of carbon generated can be taken up quickly by the growing of new plants, biomass is hence considered “carbon neutral”. The important difference is that fossil fuels like coal contain carbon that was sequestered thousands or millions of years earlier and when this resource is burned, it cannot be replenished. Moreover, whether biomass is burned or whether they decompose naturally, they release the same amount of carbon dioxide into the atmosphere.

and regulations, to ensure it will be marketable.

ECONOMIC BENEFITS

Self-sufficiency in energy supply	Reduce fossil fuel dependence	Stable prices not indexed on the price of oil

In terms of economics, sustainability is achieved when the agro-industry logistic centre gets a stable share of the market. For that purpose, the solid biomass marketed must be economically competitive whilst satisfying the final users' quality demand. Quality, processing costs and market prices are quite interlinked, and they are a crucial item for designing the marketing strategies successfully.

SOCIAL AND RURAL DEVELOPMENT BENEFITS

New activity with added value in all the logistics chain	Improving industrial infrastructure	Create new jobs (process, logistic)	Local supply chain and energy

Social barriers can be a main concern for soundness of the centre operation for which it is recommended that the handling methods and the industry activity do not cause local visual impacts, noise, or smells. Therefore, current customers should be kept aware of the new activities of the agro-industry

Sustainability criteria for biomass in the EU (European Commission, 2015)

The Renewable Energy directive 2009/28/EC sets binding sustainability criteria for biofuels and bioliquids, but not for solid and gaseous biomass. In 2011, the EC issued non-binding recommendations on sustainability criteria for solid and gaseous biomass (to apply to energy installations of at least 1MW thermal heat or electrical power). As summary, the still non-binding declaration of the EC suggests (European Commission, 2010):

- Forbid the use of biomass from land converted from forest and other high carbon stock areas, as well as highly biodiverse areas;
- Ensure that biofuels emit at least 35 % less greenhouse gases over their lifecycle (cultivation, processing, transport, etc.) when compared to fossil fuels. For new installations this amount rises to 50 % in 2017 and 60 % in 2018;
- Favour national biomass support schemes for highly efficient installations;
- Encourage the monitoring of the origin of all biomass consumed in the EU to ensure their sustainability;

In 2014, the European Commission published a report on the sustainability of solid and gaseous biomass for heat and electricity generation. The report includes information on current and planned EU actions to maximise the benefits of using biomass while avoiding negative impacts on the environment. Again sustainability criteria are not binding.

Current trends suggest that future could bring a gradual interest from the EC to promote sustainability within the field of biomass, which may be accompanied by more restrictive regulations for solid biomass. These potential commitments may be complete with official instruments, rules and procedures to be followed by biomass producers and marketers to prove the sustainability conformity of their products. Those non-compliant with the criteria might be excluded from support programs (renewable energy feed-in tariffs, support for investment in new energy plants) and disadvantaged in this competitive market.

Key messages for the reader

This handbook has been elaborated for agro-industries interested in starting a new activity as biomass logistic centre. It presents the basic demand of information that SUCELLOG considers as crucial for agro-industries inexperienced in the professional field of solid biomass for energy handling, treatment and commercialisation.

- The demand for sustainable solid biomass is growing in the EU-28 and agricultural residues represent a huge untapped potential for diversifying the current supply.

- Agro-industries have a strategic position to start a new business as biomass producers, since they:
    - already work with organic solid bulk materials,
    - their equipment for handling, drying or pelletising can, in some cases, be utilised to treat raw biomass materials,
    - can use also their usual facilities and permits for the storage and distribution,
    - have existing commercial networks and channels that can support them for initiating the biomass marketing,
    - can operate seasonally as biomass logistic centre during periods of reduced or no activity.

- Several successful cases in Europe of pioneering agro-industry logistic centres demonstrate the feasibility of such an approach.

- Agrarian residues have usually a lower quality than forest resources, which are currently used to produce the main solid biomass consumed in Europe. Achieving an equivalent quality based on agrarian residues is fairly difficult and agrarian fuels may not be fully compatible with conventional energy systems of the final consumers.

- The strategy of agro-industries to penetrate the market shall go in the direction of producing solid biomass not only with competitive prices but also with sufficient quality. Addressing the expected quality requested by target consumers is a must and a market study is therefore strongly recommended. Quality and standards conformity is crucial in building sustainable relationship with consumers.

- The biomass supply chain is a key component to obtain a feedstock with lower moisture and ash contents and consequently a better quality product. It therefore has to be carefully developed.

- There are already existing ISO standards with recommendations of quality specifications for different final user profiles. Standards already set the nomenclatures to be utilised and the procedures for determining the biomass properties.

- Non-binding sustainability criteria for solid biomass have already been communicated by the European Commission.

Appendices:

Appendix 1: biomass process

Combustion: act of burning biomass (or fossil fuels such as coal or oil), producing a high-temperature exothermic chemical reaction between a fuel and an oxidant (usually oxygen). Wood is the most commonly biomass used feedstock but agricultural by-products (straw, pits), forestry residues (prunings, bark, sawdust) or energy crops can also be burned. The thermal energy produced from combustion is used for diverse uses such as cooking, lighting, producing electricity or industrial and domestic heating.

Anaerobic digestion (Gasification Technologies Council, 2015): series of biological processes in which microorganisms break down biodegradable material in the absence of oxygen. It can be used for industrial or domestic purpose to produce biogas, managing waste (manure, vegetable by-products) or dedicated energy crops (corn). The biogas, one of the products of the anaerobic digestion of wastes, is mainly composed by methane and carbon dioxide and therefore can be burned to generate heat and electricity or used to produce transportation fuels (European Biofuels, 2015).

Biofuel production for transport (European Biofuels, 2015) (Biofuel.org.uk, 2015): Biofuels correspond to any hydrocarbon fuel produced from organic matter in a short period time (days to months, in contrast with fossils fuels which take millions years to be formed). They are divided into “first generation” biofuel, made from plant tissues rich in sugars, starch or vegetable oil and “second generation” manufactured from lignocellulose feedstock (straw, wood, etc.). Biofuel from algae are named “third generation”. The next two processes are used to produce biofuel:

- Transesterification**:** For the biodiesel production, vegetable oils are extracted and esterified through the addition of alcohols with a catalyser (sodium or potassium hydroxide).
- Fermentation: During the bioethanol production, the lignocellulosic biomass is hydrolysed, fermented and distilled, a well-known process based on enzymatic conversion of starchy biomass into sugar (IEA, International Energy Agency, 2015) (Biofuel.org.uk, 2015).

Some other processes can be cited such as **pyrolysis** (high-temperature chemical decomposition in absence of oxygen), **torrefaction** (thermal process in which biomass properties are changed to obtain a much better fuel quality for combustion and gasification applications) or **gasification** (manufacturing process converting any material containing carbon into synthesis gas) (Gasification Technologies Council, 2015).

Appendix 2: ISO standards

- ISO 16559, Solid biofuels — Terminology, definitions and descriptions
- ISO 16948, Solid biofuels — Determination of total content of carbon, hydrogen and nitrogen
- ISO 16968, Solid biofuels — Determination of minor elements
- ISO 16994, Solid biofuels — Determination of total content of sulphur and chlorine
- ISO 17225-1, Solid biofuels — Fuel specifications and classes — Part 1: General requirements
- ISO 17828, Solid biofuels — Determination of bulk density
- ISO 17829, Solid Biofuels — Determination of length and diameter of pellets
- ISO 17831-1, Solid biofuels — Determination of mechanical durability of pellets and briquettes — Part 1: Pellets
- ISO 18122, Solid biofuels — Determination of ash content
- ISO 18134-1, Solid biofuels — Determination of moisture content — Oven dry method — Part 1: Total moisture — Reference method
- ISO 18134-2, Solid biofuels — Determination of moisture content — Oven dry method — Part 2: Total moisture — Simplified method

Abbreviations

%: percent

°C: degree Celsius

ADEME: the French Agency for the Environment and Energy Management

Apr: April

ar: as received, meaning water base

Aug.: August

CAP: Common Agricultural Policy

db: dry base

Dec.: December

EC: European Commission

EU: European Union

EU-27: European Union with 27 members states (Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden and the United Kingdom).

EU-28: EU-27 + Croatia (from 1st July 2013)

Feb.: February

ha: hectare

Jan.: January

Jul: July

Jun: June

kg / 100 litres of wine : kilograms of raw materials contained in 100 litres of wine.

kg: kilogram

kt/yr: 1000 tons per year

kWh : kilowatt hour

Mar: March

Nov: November

NOx: Nitrogen oxides

Oct.: October

Sep: September

SOx: Sulfur oxide

Toe: tons of oil equivalent

w-%: percent by weight

w: weight

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Figure 3: Styrian Chamber of Agriculture and Forestry
Figure 4 : Pilar Fuente Tomai, Union de la Coopération Forestière Française
Figure 5: DREAM - Dimensione Ricerca Ecologia Ambiente
Figure 6: CIRCE
Figure7: Styrian Chamber of Agriculture and Forestry
Figure 8: DREAM - Dimensione Ricerca Ecologia Ambiente
Figure 9: DREAM - Dimensione Ricerca Ecologia Ambiente
Section 3.2 - Corn cobs: Cosette Khawaja, WIP - Renewable Energies
Section 3.2 - Straw: RAGT Energie SAS
Section 3.2 - Vine pruning: RAGT Energie SAS
Section 3.2 - Grape marc: RAGT Energie SAS
Section 3.2 - Silo waste: RAGT Energie SAS
Section 3.2 - Olive pits: CIRCE

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