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

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D5.5
Guideline for implementing an agro-industry logistic centre into an agro-industry

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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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1. Introduction

SUCELLOG project aims to trigger the involvement of the agrarian sector in the sustainable supply of new solid biomass, focusing on the opportunities that agro-industries have to become biomass logistic centres. In that sense, the project promotes that agro-industries diversify their regular activity and take advantage of two facts:

- Some agro-industries have equipment compatible with the production of solid biomass (driers, pelletisers, chippers, storage silos, etc.)
- Agro-industries are used to deal with agrarian products and to fulfil consumers' quality requirements.

For that purpose, within SUCELLOG project, some agro-industries have been supported with an evaluation of their opportunities to become logistic centres of biomass through different type of activities. Furthermore, the project has supported those agro-industries during the start-up process of the logistic centres.

Before jumping into a new business activity (and moreover when it implies a big investment), to conduct first a feasibility study and business model is highly recommended. It may sound tedious and could take away the excitement. However it can save not only time but also one's lifetime savings from being thrown away. How successful a business can be, could also rely on these two studies, as it is taking in consideration the factors/indicators (such as economical, legal, technical and time factors) that could affect the flow of the business. These kinds of studies are elaborated to detect possible positive and negative outcomes that could occur during the project and so that one could know what or how to act in a manner. A feasibility study and business model should therefore provide all the possible problems along with all the possible solutions. To make it simple, the more thorough these studies are, the more successful the business project could be.

Detailed information about techno-economic feasibility studies for agro-industries that want to become logistic centres can be found in the Handbook on how to carry out a feasibility study. Several studies and business models performed by SUCELLOG from real cases can also be consulted here.

The present guideline is built on this knowledge and complements it by providing the agro-industries with counsel, on the next steps to be taken (once the feasibility study and business model has been done) before the commercial operation and during the first moments of it. Those steps were applied by some agro-industries supported by the SUCELLOG project. Experiences gathered from those real cases also served as input for this guideline.

Figure 1 shows the inputs obtained from the feasibility study, the decisions to be made regarding the business model definition and, once that is solved, the steps to be addressed until reaching commercial operation, which are the subject of this guide.

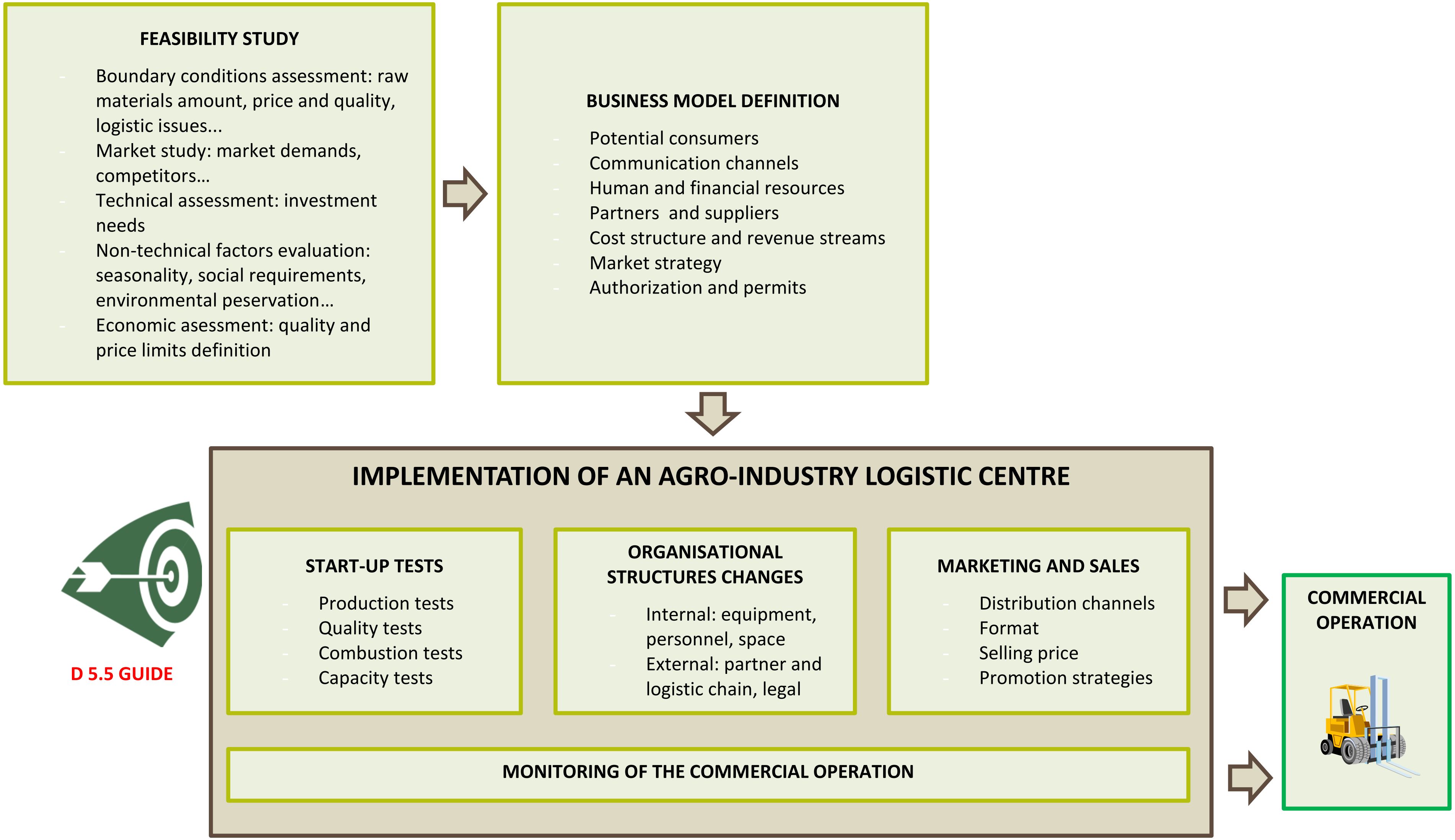

Figure 1. Logistic center implementation process

2. Start-up tests

During the start-up process of a logistic centre within an agro-industry, it is necessary to make several fuel production and combustion tests. This step is necessary to evaluate, if a solid biofuel of high quality can be produced under real conditions with the existing machinery and if the combustion equipment of potential customers can handle these fuels. Furthermore **quality tests of the produced fuel are necessary as the properties of the agro-fuel produced can differ from the properties found for the feasibility study in literature.**

These tests should be done before starting as a logistic centre since the success of the agro-industry logistic centre depends on the ability to produce solid agro-fuels of the quality demanded by the market.These step is important to satisfy customers in a long run.

2.1. First production test

The goal of the first production test is to make first samples of the solid biofuels the agro-industry wants to produce in their logistic centre . The SUCELLOG project recommends to **make those production tests, with each agro-fuel** which needs any kind of pretreatment, before selling it into the market. Therefore, this test should be done when one of the following steps are necessary to produce the fuel:

- particle size reduction
- drying
- pelletising

This guide will focus on pelletising tests as they are the most complex ones. Furthermore, pellets can be made out of a lot of different residues. The following steps are necessary for performing the tests:

1. find experts for making/supporting the tests
2. prepare the inventory
3. prepare the raw material
4. heat up the pelletiser
5. pelletising and cooling
6. measurements

Those necessary steps for the pelletising test are described in detail in the following paragraphs.

Find experts for making/supporting the tests

It is a key aspect for making the pelletising test to have experts who can make this test. Although this guide provides basic knowledge about how to make the test, but not the whole knowledge since this is gained through experience. Therefore, the project strongly recommends inviting, besides the person in charge for the pelletiser of the agro-industy, one technician from the pelletiser manufacturer.

If this is not possible, ask the pelletiser manufacturer for information about pelletising of the raw materials that are used in the test in order to get some guidance. In this case, a person from the agro-industry or another external expert who has done tests with different raw materials is needed.

Prepare the inventory

In a first preparation for the test, an inventory list of measurement devices has to be created. The following devices are needed for making a first quality check after the pelletising process and should be organised before the tests:

Figure 2: Durabilimeter

- device for meassuring the moisture content (e.g. thermobalance)
- device for meassuring the bulk density
- durabilimeter (device to check the durability of the pellet)
- balance (to measure how much of the product has been disgregated from the pellet itself during the test in the durabilimeter)

In a next step, it is necessary to make an inventory of the dies of the pelletiser. For each die the compression ratio has to be identified. The compression ratio is a key element of the granulation process to obtain, firstly, sufficiently hard pellets to guarantee the good performance of the product (handling, drying processes, transport) and secondly, to obtain the physical requirements of the quality standards. The higher the compression rate is, the denser the pellets are but more energy is used in the process. The compression ratio is calculated by the following formula: length of the compression channel (e) divided by diameter (d). An ideal compression rate would be between 4 and 7. It should be noted that the length of the compression channel (e) is not the same as the length of the holes (l) of the die. This fact is illustrated by the following graphic (as can be seen in the following picture).

Figure 3: Die and pelletiser of Tschiggerl Agrar (Austria)

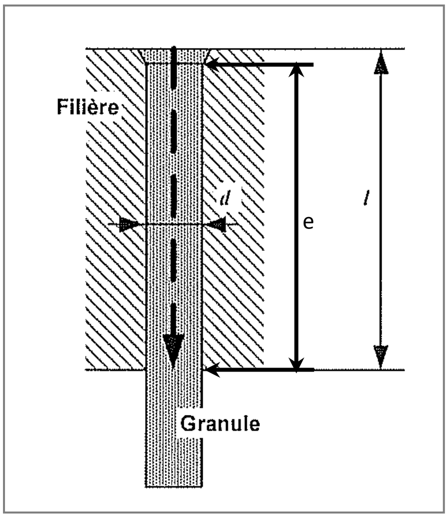

Figure 4: Structure of a die

Prepare the raw material

For a first pelletising test, the project suggests to prepare the raw material before making the pellets. This means that the pretreatment of the raw material should not be done in one flow directly with the pelletising, but it should be done before. This is because this first test has the goal to test the pellet production in terms of the quality of the final product and pretreating the raw material directly before pelletising creates a new source of error. The primary pelletising test just focuses on the right settings of the pelletiser. The test of the whole production line is part of the capacity test (see chapter 2.4).

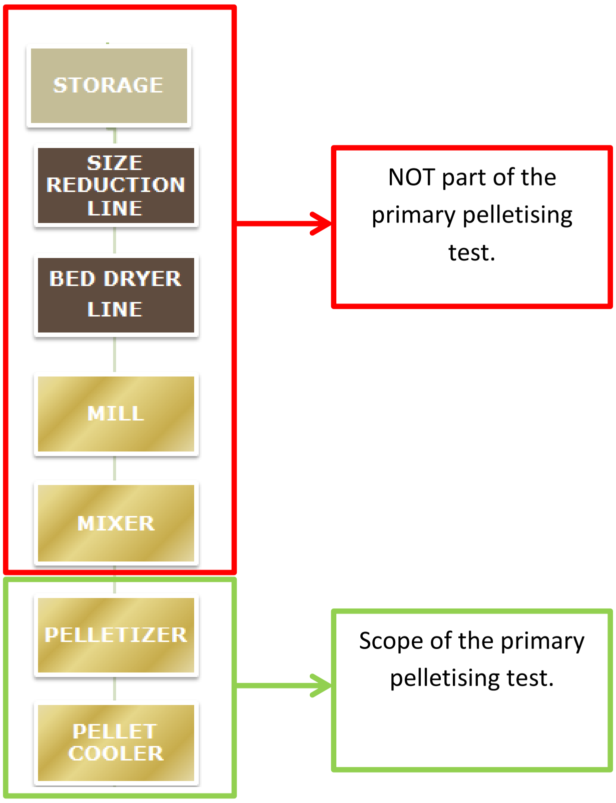

Figure 5: process first production test

This means that the input material for the pelletiser has to have the right format and the right moisture content, before starting with the test. **The recommended moisture content of the raw material before going into the pelletiser is 12-13 %.** Therefore, it is necessary to measure the moisture content before.

If more than one type of raw material is used as input, it is necessary to mix those residues. This can be done with a integrated mixer in the pelletising line if available, or manually with shovels.

Figure 6: Manual mixing of raw materials

If both materials have different moisture contents the mixture proportion has to be different than the planed mixture proportion of the final product.

Example of calculation of initial mixture:

An agro-industry plans to produce 100 t pellets (mixture of 70% straw and 30 % wood) with a moisture content of 8 % (wet basis). In a first step the amount with theoretical moisture content of 0 % has to be calculated:

$$total\ pellets_{0\ \%\ moisture} = total\ pellets_{8\ \%\ moisture} \times (1 - moisture) = 100\ t \times (1 - 0.08) = 92\ tons$$

$$share\ straw_{0\ \%\ moisture} = share\ straw_{8\ \%\ moisture} \times (1 - moisture) = 70\ t \times (1 - 0.08) = 64.4\ tons$$

$$share\ woood_{0\ \%\ moisture} = share\ wood_{8\ \%\ moisture} \times (1 - moisture) = 30\ t \times (1 - 0.08) = 27.6\ tons$$

For the calculation of the initial amounts needed, the moisture content of the raw material before pelletising must be measured. In this case, the straw has 10 % moisture content, the wood 15 %.

$$initial\ straw_{10\ \%\ moisture} = share\ straw_{0\ \%\ moisture} \div (1 - moisture) = 64.4\ t \div (1 - 0.10) = \mathbf{71.56\ tons}$$

$$initial\ wood_{15\ \%\ moisture} = share\ wood_{0\ \%\ moisture} \div (1 - moisture) = 27.6\ t \div (1 - 0.15) = \mathbf{32.47\ tons}$$

The total initial amount to produce 100 t of pellets is in this case 104.03 tons. The mixture of the initial raw materials is in this case, 68.78 % straw and 31.22 % wood. This example shows that the initial share of the raw material is different than the final share in the cases that the moisture content of the raw materials to be mixed is different.

Heat up pelletizer

Before making the test with the formula defined by the agro-industry, it is necessary to heat up the die of the pelletizer. Indeed, with the temperature, the compression ratio could be different due to the metal expansion. To heat up the die, use raw materials that are easy to pelletize like olive pomace or corn. After this, the first lot produced with the real raw material should be discarded to avoid contamination.

All the tests should be done at the current production temperature of the die in order to be representative of what will happen in a regular operation.

Production

During the production, it is necessary to record all the production parameters: moisture of the raw material and of the mixture before pelletising (%); production output (kg/min); amount of fines (%). It is recommended to make different benches of tests with different dies (if available), to see which die leads to the best results. Furthermore for each bench different lots should be produced. One with the standard formula, a second lot with some water added inside the pelletiser. Sometimes it is required to add water to the material so that the pellets don't break.

If the compression of the pellets is too low and no other die is available, the input material can be reduced. Thus the raw materials stays longer in the die and the pellets will be harder and will have a better durability.

Measurements

After the production, it is necessary to make some analysis of the produced pellets. Each bench and lot should be analysed by its own to figure out which one has the best quality and market potential. The following measurements should be done:

- visual analysis of the produced pellet and a comparison to a commercial wood pellet (see Figure 7)
- mechanical durability with a durabilimeter (if not available you can send to a lab)

Figure 7: Visual analysis of pellets

- determination of quantity of fines with a sieve with a diameter of 3,15 mm
- bulk density
- moisture content
- production rate in kilograms per minute

2.2. Quality tests

Quality of the solid biofuel is derived from the physical/chemical characteristics of the raw material and of the conditioning process undertaken. **Knowing the quality of the solid biomass being produced is relevant in making the operation efficient and effective not only for the biomass logistic centre but also for the customers.** The following sub-sections provide a recommendation on the basic parameters that should be determined and on how to proceed when sending the samples to a lab for their analyses.

2.2.1. Basic quality parameters

The basic parameters that should be evaluated are listed below together with their influence in the different process associated to the production and consumption of solid biomass:

Table 1: Basic quality parameters

Quality parameters	Affects:
Moisture content: (w-% ar; kg water/kg wet biomass)	Calorific value Transport costs Consumption in the chipping/milling Degradation & Auto-ignition in storage
Ash content: (w-% db; kg ash/kg dry biomass)	**Comes from the material itself but also from harvesting operation (stones, earth).** Ash content affects**:** Fouling/ Slagging / Corrosion Emissions of particles Maintenance cost
Calorific value: (MJ/kg ar; MJ of energy /kg wet biomass)	Fuel consumption
Particle size distribution: in case of non-pelletised fuels	Combustion time Emissions of particles Transport costs Storage
Durability: in case of pelletised process	Storage and transport Feeding process
Ash softening temperature: (°C)	The temperature of which a deposit of ash start melting decreasing heat exchange efficiency mainly. Combustion system should work at lower temperatures.
N and Cl composition: (w-% db; kg ash/kg dry biomass)	Nitrogen is linked with NOx emissions during production. For these emissions, there are national legal limits, which have to be complied. Chlorine is linked with corrosion problems in boilers and increases abrasion and maintenance costs.

More information about quality can be also found in the Handbook on basic demand of information and the Handbook on how to carry out a feasibility study.

2.2.2. How to determine quality properties

Quality properties are being determined by a series of tests. These tests require specific equipment, conditions, and quantity and are performed according to the standard. **It is usual to find certain equipment in the agro-industries to measure quality parameters, mainly moisture content. However, for the rest of characteristics, samples are normally sent to an accredited lab. In these cases, it should be beard in mind**:

- The sample should be representative of the material, meaning that every particle has the same probability to be included (for example, if the product is stored in big-bags, samples should be taken randomly from different parts to avoid the effect of stratification). When possible, perform the sampling when the material is in movement.
- When willing to make the moisture content analysis, ensure that the analysis is made within 24 h after sampling.
- Send a sufficient amount of sample (defined by the lab but normally between 1 and 2 kg).
- Ensure that you keep the sample in a sealed container and with the corresponding label.
- Specify the standard for the analysis (see table
- **Table 2**, it is recommended to use the new ISO series but some labs may have not implemented them yet).

Table 2: Standards for quality self-determination (*not published yet)

Property / Characteristic	EN	ISO
Sampling method	EN 14778	
Sample preparation	EN 14780	
Moisture content	EN 14774	ISO 18134
Ash content	EN 14775	ISO 18122
Volatile content	EN 15148	ISO 18123
Content of C, H, N	EN 15104	ISO 16948
Content of S, Cl	EN 15289	ISO 16994
Ash major elements (Al, Si, K, Na, Ca, Mg, Fe, P, Ti)	EN 15290	ISO 16967
Ash minor elements (As, Ba, Cd, Co, Cr, Hg, Cu,...)	EN 15297	ISO 16968
Heating value	EN 14918	
Bulk density	EN 15103	ISO 17282*
Particle density	EN 15150	
Particle size distribution	EN 15149	ISO 17827
Mechanical durability of pellets and briquettes	EN 15210	ISO 17831*

Ash melting behaviour	CEN/TS 15370	
Conversion of analytical results from one basis to another	EN 15296	ISO 16993

2.3. Combustion tests

Figure 8: Combustion of agro-fuels

First combustion tests are crucial for a successful implementation of the agro-fuel into the market. **Existing equipment which can handle the produced agro-fuel are a key for the start-up of the agro-industry logistic centre.** Therefore, it is necessary to make combustion tests with the agro-fuel generated in the first production test. The tests should be done with each agro-fuel the agro-industry has planned to produce.

Combustion tests are complex and expensive measurement devices are needed, so this guide provides only basic information about what these tests should include, but it is essential to have assistance of an experienced third party. The following steps are necessary for a combustion test:

1. find a boiler to make the test
2. contact boiler manufacturer
3. organize measurement devices
4. preparation of boiler and fuel
5. combustion and measurement
6. ash characterisation
7. evaluation of results

Find a boiler to make the tests

The first step is to search for possible equipment where to make the combustion tests. **It is important to look for the type of equipment of the potential consumers detected during the feasibility study.** It also makes sense to perform the test with different boilers in terms of age and brand, since the behaviour of the fuel is highly dependent on the type of technology and on its regulation parameters (feeding system, air input, etc.).

In this step also information about the equipment and normally used fuel in the boiler should be gathered:

- About the fuel normally used:
  - Which type of fuel is normally used?
  - Is a fuel analysis available? (see chapter **Error! Reference source not found.**)
- About the equipment:
  - Brand, model and full load output (kW)
  - Technology (moving grate, fixed grate, underfeed burner, pulverised, …)
  - Does the equipment have 1 fan for the primary and 1 fan for the secondary air? Or just 1 fan in total?
  - Does it have an automatic ash removal system? If yes, give details about how it works. If not, how often the equipment has to be cleaned?

- Does the equipment have a heat exchanger tubes cleaning system? If yes, which type (blowers or scrappers)?

Contact equipment manufacturer

Contact the equipment manufacturer in order to invite one technical person to the tests. The best choice would be a technical person from the equipment manufacturer laboratory, not a commercial person since it is necessary that this person knows well the combustion process.

If the technical person cannot come to the tests, just ask the equipment manufacturer for information about the combustion of the raw materials that are used in the formula: ask, if they have used this type of resource, what has been the problems associated and how to reduce them.

If the equipment manufacturer is not interested in performing the combustion tests, look for an external testing laboratory or expert with the skill and equipment needed.

Organize measurement devices

To make a good test, a combustion analyser is needed to optimise the settings. If the person from the equipment manufacturer company comes to the tests, they can bring this type of equipment. This analyser allows measuring the emissions during the combustion. Also, devices to measure heat output and efficiency are needed.

Preparation of equipment and fuel

Before making the combustion test it is necessary to clean the equipment before using the agro-pellets or agro-fuels, otherwise no reliable results can be derived from the test. This is because possible residues in the equipment from the normally used fuel would manipulate the results. Also the ash has to be removed before starting the test.

In a next step also the quantity of the agro-fuel, which will be used in the test, has to be prepared. For an estimation of the needed quantity the following formula can be used:

$$Quantity\ (t) = \frac{0{,}5 * \text{power of the boiler (kW)} * hours\ of\ the\ test}{heating\ value\ of\ the\ fuel\ \left({}^{kWh}/_{t}\right)}$$

Combustion and measurement

After the above mentioned preparations, the test can be started. The tests duration depends on the output power of the equipment:

<100 kW: at least 10 hours

100 – 500 kW: at least 24 hours

> 500 kW: at least 48 hours

On starting the test, a measurement of the time needed for the ignition of the equipment should be done. This measurement can be done via looking through the peephole of the equipment and stopping the time needed to fire on the equipment. Also the ignition time with the normally used biofuel should be measured.

Figure 9: dust measurement

Furthermore **a permanent measurement of the gas emissions (O_2, CO, NO_x, SO_x) should be done** during the whole combustion process with a combustion analyser. Also the measurement of dust emissions is recommended.

Ash characterisation

At the end of the test, **all the bottom ash should be removed from the equipment and separated according to the size (by means of sieves with different mesh sizes) into 3 fractions: bigger than 8 mm, between 3 and 8 mm and smaller than 3 mm.** All three fractions have to be weighted afterwards and the share of total weight has to be calculated for each fraction. The share bigger than 8 mm generally represents the slagging processes, so if the percentage corresponding to this size is high, maintenance and operation problems are likely to appear. In a fixed-bed equipment, the maximum mass percentage recommended for this ash category is 20 %, whereas in moving grate equipment, is in the range between 5 and 10 %. The fraction smaller than 3 mm might be drawn by the flue gases outside the chimney, causing dust emissions. A high share of this fraction thus might lead to higher particulate emissions.

Figure 10: three ash fractions

After the combustion, **the ash could be deployed on agricultural fields and used as fertiliser.** Therefore, the whole nutrients circle from the cultivation, the harvesting, the combustion to the deployment on fields can be closed. However, the national laws have to be considered in each case, as ash in some countries is classified as trash, which has to be disposed.

Evaluation of results

During the test

While the test is being carried out, there are some signs indicating that something is going wrong, for example:

- Impossible to reach the nominal heat output
- Water or hot gas temperature does not reach the setting value
- Blockage of the feeding system
- Blockage or malfunction of the ash removal system or the cleaning system.
- Highly dense flue gases, black flue gases or flue gases with too high temperature (e.g. > 200 °C)

After the test

After performing the test, the measured results have to be analysed. The ignition time should be compared with the fire on time of the equipment using the normal fuel. If both ignition times are similar, it is good. If the time is much longer with the agro-fuel, it can be a sign for problems.

Furthermore the measured emissions have to be compared with the allowed emissions according to the national law. It is very crucial that the agro-fuel complies with this law. Also the comparison with the emission caused by the normal fuel is recommended. Equipment efficiency (at same heat output) must also be compared with the one normally obtained with usual fuel.

In a final step the ash fractions have to be analysed. If there is a high share with more than 8 mm size, or if there are hard agglomerates there is a problem. Either with quality of the agro-fuel, with the setting of the equipment or with both.

2.4. Capacity tests

The feasibility study should provide the agro-industry with production targets (final product characteristics, quantities needed per year, investments in new equipment, etc.) to answer the clients demand and achieve competitiveness. Once carried out the first production tests, the quality analysis and the combustion tests, the capacity tests are the final tests to be performed before starting the regular operation as logistic centre. **The goal of these tests is to screen the whole process for the generation of the planned agro-fuel, not only the production (pelletising) process** (see Figure 11).

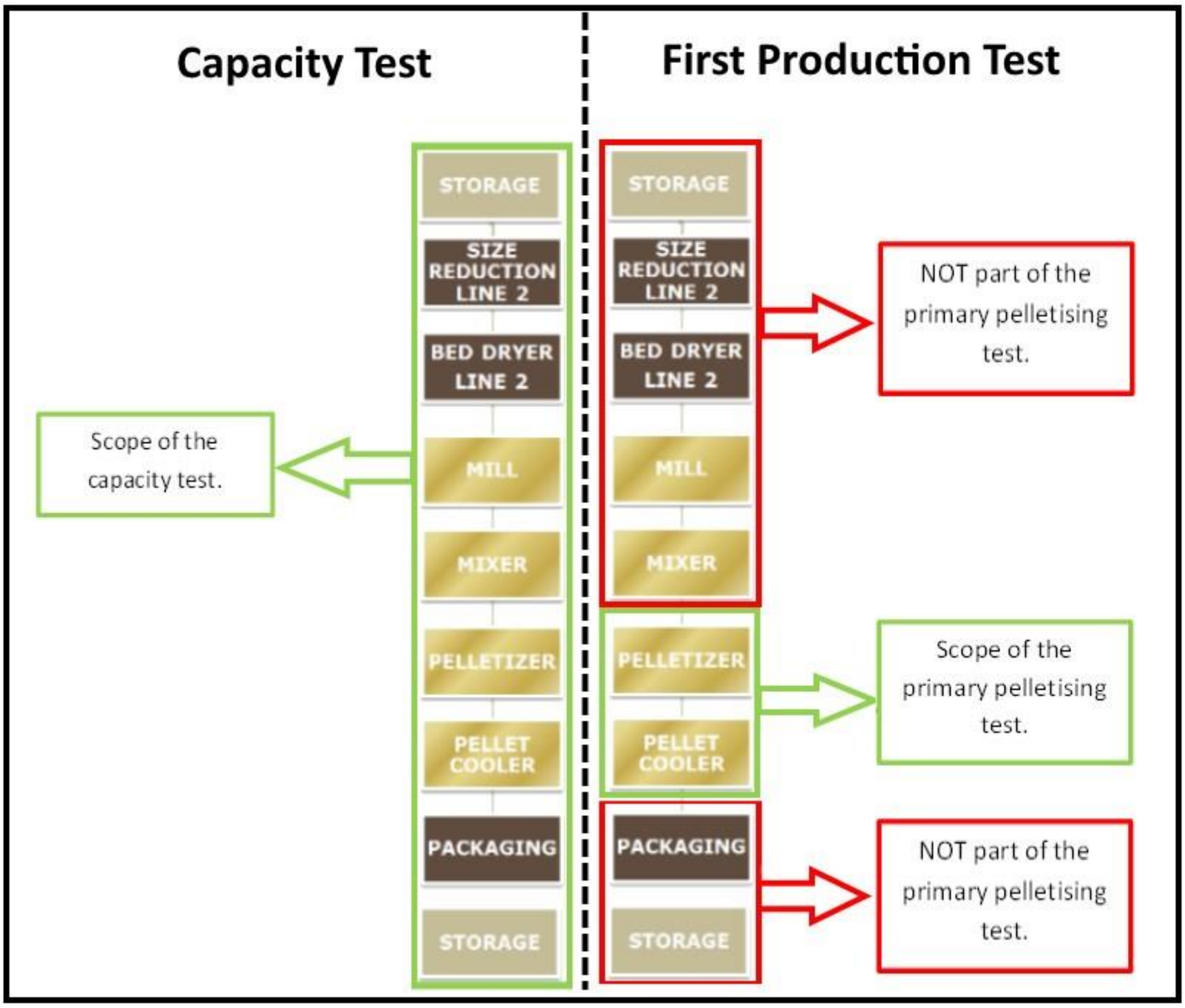

Figure 11: Comparison capacity test vs. first production test

Therefore, the whole supply chain, the storage both of the raw material and the final product, the pre-treatment and a possible packaging have to be tested. These capacity tests should be done at least once before starting the logistic centre. Moreover, **it is recommended to repeat the test until all steps match with each other so that the whole production process is harmonized**. One bottle neck or bad adjusted production step could decrease the production efficiency in a significant way, leading to an infeasible project.

A critical part of this capacity test is the assessment of the supply chain performance. As a new activity, agro-fuel production will impact the agro-industry organisation and it is quite important to identify which changes it will bring. **The capacity tests will make the project developer aware about which are the weak points and define the indicators that will help to monitor the correct operation of the process.** For example: if the project developer realises during the capacity tests that the space for the truck to unload is limited, an indicator to monitor it can be defined like the time that trucks are waiting for the previous truck to unload. The following list shows some indicators, which might be relevant for some agro-industries.

Indicator	Main parameters	Recommendations
Global process productivity	Equipment productivity Technicians efficiency Quality of raw material and suppliers efficiency Organization	The agro-industries experience is a key element to lead the capacity tests
Theoretical production capacity (e.g. for one day)	Theoretical hours of operation of equipment Theoretical working hours of technicians Theoretical maintenance duration Theoretical quantity of raw material used and final product produced	The feasibility study should provide this data
Real production capacity (e.g. for one day)	Duration of equipment starting up + real hours of operation and capacity Real working hours of technicians Quantity of raw material used Quantity of final product produced	Consider breakdowns, stock problems as well as maintenance and cleaning duration Technicians work duration inventory dedicated to production process/maintenance interventions Weighing of raw material Quantity of final product inventory
Theoretical supply management	Theoretical customer demand Raw material availability depending on production needs (seasonality, geographical distribution, etc.) Theoretical storage capacity Supply rhythm (by month, during one particular period, through the year)	The feasibility study should provide with this data
Supply and stock management	Quantity of raw material needed to insure a regular production process Real storage capacity needs Number of trucks to respond to production needs	A strategy can be developed with suppliers (e.g.: anticipate problems of stocks by collecting all the raw material through a special agreement with a cooperative) Evaluate volumes and space needed for raw materials (storage, space needed for handling and trucks moves, etc.) Monitoring of loading duration, transport duration, unloading duration

Thanks to this kind of indicators, the agro-industry will be able to see the positive or negative gap between feasibility study and real conditions.
It is also important to mention that agro-industries have their own experience, their own knowledge of logistic and capacity issues and the new activity should rely on it.

A representation of the supply chain key points to bear in mind is shown in the following figure.

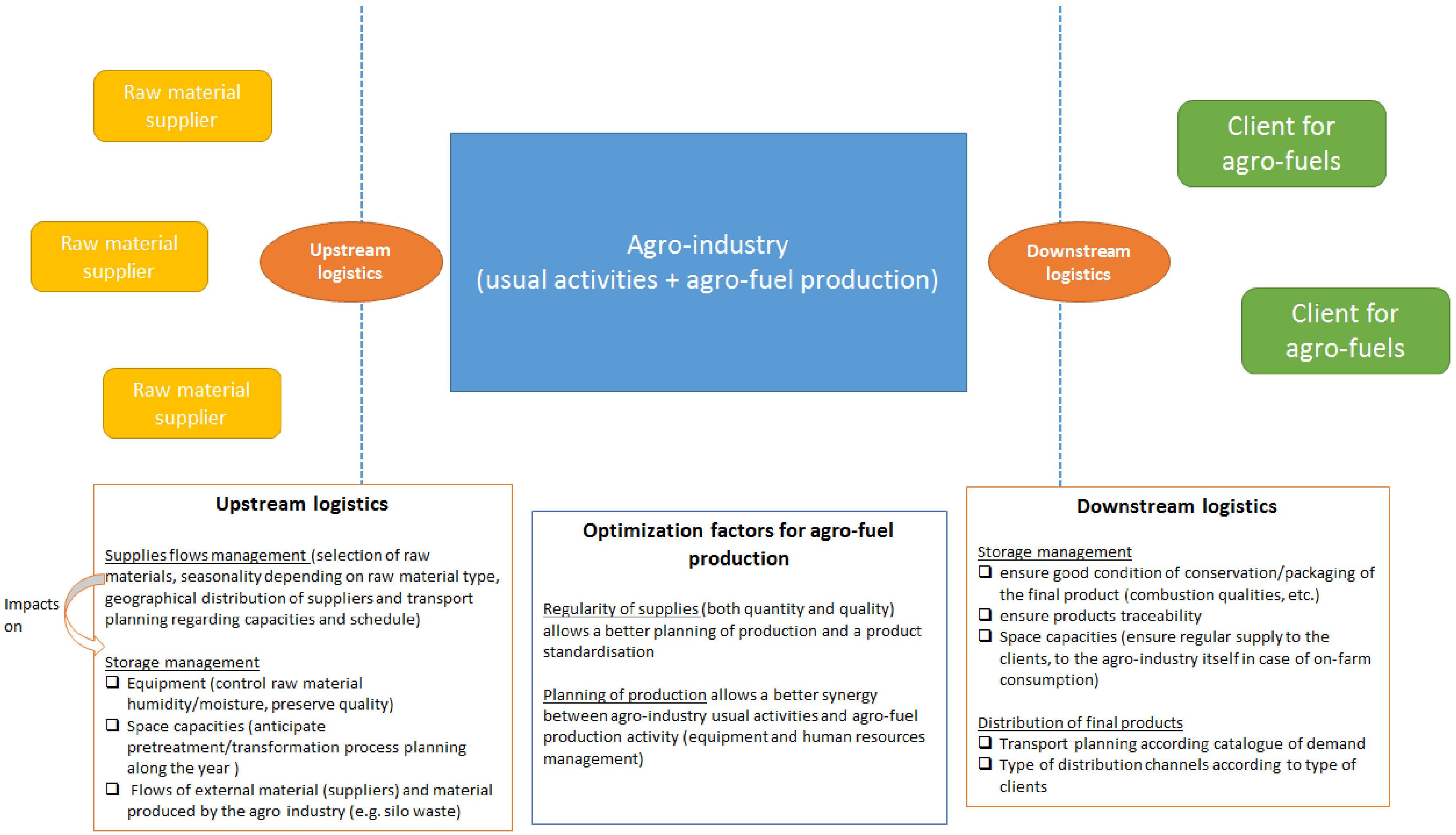

Figure 12. Supply chain representation

3. Change in organisational structures

A logistic centre's organizational structure forms the base upon which operational policies and actions are formed. Structure plays a large role in shaping organizational culture as well. **In the case of agro-industry, which is starting up a new business line as biomass logistic centre, it is essential to change its organizational structure.** This is a crucial point for a successful implementation of the logistic centre and helps to be adapted to the company's changes and to increase the competitiveness on the market.

3.1. Internal changes

The concept of the SUCELLOG project is to build biomass logistic centres within agro-industries. The reason why the project focuses on agro-industries is because they have existing infrastructure, which can be used for the new business line as logistic centre. The goal is that just little or even no investment should be necessary for starting up the new activity. Through the new business, the degree of utilization of the facility should increase as well as the business success.

Nevertheless, the goal of using just existing infrastructure is not possible in all cases. **Even if there is no need for new equipment, it is necessary to adapt the existing infrastructure, the space means to the new business and their new products. Furthermore, personnel should be trained or new persons have to be hired**. The following section provides information about the most important parts for internal changes. Additional information to this can be found in detail in the Handbook on how to carry out a feasibility study.

Equipment[1] 	The equipment used for the agro-industry's regular activity has to be adapted to the new raw material and the agro-fuel production. Different properties of the residues like surface structure or moisture content, strongly influences the adjustments needed for the machinery. For example, in the pelletizing process different compression rates in the die are necessary depending on the raw material. **For the adaption of different equipment and machinery, the SUCELLOG project strongly suggests to work with manufacturers.** In most cases, they know how to adjust the machinery and even for residues without any experience so far, they can provide support. For completely unused residues, where no experiences were made so far, enough time for adapting and testing the machinery should be budgeted.

Production[2] 	For starting a logistic centre within an agro-industry, it is necessary to coordinate the different production steps of both, the production during the regular activity and the production of agro-fuels. These adaptions are very individual for each agro-industry and depend on the business model as well as on the existing capacities of the company. Therefore, no general advice can be given.

[1] Pelletizer - Progeo Masone - Italy

[2] Pellet production - Tschiggerl - Austria

Maintenance	
	Different properties of the raw materials cause different erosion in the equipment and machinery. Therefore, the costs for maintenance can strongly increase, depending on the residues. It is crucial to be aware of those costs.

Contamination	
	Cleaning of the production line is a big issue during the operation as a logistic centre. The cleaning process has to be done if the production from the regular activity changes to the production of agro-fuels and vice versa. **It is very crucial that there are no leftovers in the line which can contaminate the regular product and the agro-fuels.** This can reduce the quality of the products and can cause legal troubles especially if foods are produced regularly.

Space[3]	
	The adaption of space, while creating a logistic centre within an agro-industry is a crucial and often underestimated step during the start-up phase. Through the expansion of the regular activity it is necessary to think about space. The space topic is relevant for nearly every process of the new logistic centre. From the supply to the delivery. The buildings have to fit for the new business from the construction point of view. Furthermore enough space has to be guaranteed at any time, during the regular and the new business activities. Another crucial point is the optimization of path lengths within the agro-industry. Finally, it is important to bear in mind that **storage facilities have to preserve raw material quality before the pretreatment** (being moisture content a critical parameter to be monitor)

Personnel	
	It is necessary to train the personnel for the new activities. All persons operating in the new business field should know what they have to do and how they have to do it. Additionally, hiring new persons can be necessary. It is also advisable to include the personnel in the whole process of the development of the new business line and the organisational changes. A regular communication reduces possible barriers and strengthens the relationship of the personnel to the company.

3.2. External changes

To design a structure, which best promotes the company's goals and protects from threats, it is necessary to look at both: the internal and external conditions the new business line faces. **In the external structure the most important areas, where changes could be necessary, are the legal area and the partner/logistic area**.

[3] Storage place - Agricola Latianese olive oil extraction - Italy

3.2.1. Partner & Logistic chain supply

As it has been mentioned previously, a very important part which has to be organised on the creation of logistic centres is the partner network and the logistic chain supply. This logistic chain has to do with the availability of the raw material for the agro-industry, the existence of a harvesting technology, the harvesting itself, the transport to the agro-industry and the acceptance at the facility. Furthermore, all external companies providing one of those steps are part of the logistic chain. **For the development of the new business line, it is necessary that first there is an already existing logistic chain and second that the supply is properly organized and adapted to the needs of the logistic centre.**

Depending on the raw materials used there are either existing logistic chains or not. Herbaceous resources like straw do have a well-developed logistic chain since the straw has a market from long time ago. Residues, which occur as a by-product of the regular activity of the agro-industry like olive pomace, normally do not have logistics problems, as they are already available at the facility of the logistic centre. On the contrary, there are other currently unexploited solid biomass resources (like wood prunings) which do not usually have an existing logistic chain developed. In this case, the logistic chain has to be set up first in order to ensure the supply of the raw materials to be treated in the logistic centre.

A scheme of main things to bear in mind when organising the logistics has been presented in Figure 12. Regarding the organization of supply to the logistic centre, for a certain amount of material, two points are crucial: (1) time, meaning not only the period of the year for supplying due to the seasonality of agriculture resources but also the schedule of trucks delivery (their time for unloading-transport-loading); and (2) place for storage, as mentioned several times in this document.

It's very important for a logistic centre to have the right amount of the solid biomass at the right time at the right place. One strategy to ensure this would be to build an inventory of the raw materials at the facility. This has the advantage that there are enough amounts of resources at the logistic centre at any time. The disadvantage is that the logistic centre needs a big storage place for the raw materials. A possible solution for this would be a just-in-time delivery of the raw materials. Such a strategy allows the logistic centre to receive the resources only as they are needed in the production process, thereby reducing inventory costs. This method requires logistic centre not only to forecast their demand precisely but also reliable suppliers. Although in practise both strategies are often mixed, it can be a good strategy for a logistic centre with a small storage-possibility. The best strategy for a logistic centre strongly depends on their logistic chain and on their facility.

3.2.2. Legal changes

The start-up of the logistic centre within an agro-industry can require new permissions and approvals. The need of those changes is very dependent on two things. First, it depends on the national legislation. Second, it depends on which technical changes are necessary at the logistic centre. Especially if new equipment and machinery is needed for the new business, legal approvals are very likely. But also if there are no technical changes in the facility new permissions could be necessary. Therefore, **the SUCELLOG project recommends having a look for the needed permissions before starting the logistic centre**. During the start-up, it is necessary to get this permissions and approvals. It has to be mentioned that receiving these permissions can be very time and cost intensive. A logistic centre operator has to consider this resource intensive process.

The following list shows possible needed permissions for starting a logistic centre:

- commercial law approval
- building approval
- approval of the local electricity authorities
- permission on fire protection

- permission on labour protection
- permission for noise emissions
- permission for dust emissions
- permission for explosion protection
- certificate for transport volume

Please consider that this is not a full list of needed permissions. Depending on national laws, the list can be different.

4. Marketing & sales

For a successful implementation of a biomass logistic centre in an agro-industry, it is necessary to generate income from selling solid biomass. **To address the target customer segments with active marketing activities is important when looking for customers**.

Marketing and sales are two very different entities but will always complement each other. **Marketing is the procedure of distinguishing, prospecting and providing the customer's needs and wants**. This is done by putting the product at the right place, with the right price, at the right time. Therefore, it is necessary for an agro-industry to know who target customers are, to concretely address those in their marketing activities. Those target customers should be defined in a business model before starting marketing activities. **On the other hand, sales or selling is providing the customers with the product that they are looking for**. Selling a standardised product guarantees the customer a certain quality as it is explained in this section.

The first steps during the marketing activities are the product development and the identification of potential customers. Selling a product to customers involves advertising and promotion to display its benefits, standards and quality. It will also involve a complex strategy like which distribution channels are used to sell the product. After selling, the feedback from the customers should be considered to improve the product and the distribution channels. Therefore, marketing and sales go hand in hand with each other.

In order to make use of an effective marketing, a special tool called 'Marketing Mix' is used. This tool helps to understand and demonstrate a product's purpose and potential and how to plan for a successful sales strategy. **The marketing mix is implemented through the execution of the 4 Ps of marketing: Product, Price, Place and Promotion**.

Figure 13: 4P Marketing mix

Source: https://saylordotorg.github.io/text_exploring-business-v2.0/s13-02-the-marketing-mix.html

The following sub-sections will describe the main points of the 4 P marketing mix, which are relevant for starting an agro-industry logistic centre. The first section "distribution channels" refers to the **place**. The main topic here is the location where the products are sold. Customer's convenience of buying the product is one of the main priorities on starting a logistic centre. Furthermore, the section "lot sizes & packaging" is a part of **product**, as different lot sizes offered influence the attractiveness of the product for the product. The "selling **price**" section refers to the value of the product. Various pricing strategies and discounting is another way of attracting customers. The "**promotion**" sub-section refers to all the activities undertaken to make the product known to the market.

The benefits of producing biomass products according to international or national standards or quality classes as an efficient way to build confidence in the final consumer are shown at the end of the chapter. Moreover, that last part refers to several points of the marketing mix as the production of standardized products affect the product. Moreover, having a standardized product can change the promotion strategy, as well as the prices can be affected by having a standardized product.

4.1. Distribution channels

A distribution channel is a series of middleman or intermediaries where the product/good is being passed or hand over through until it reaches the customer. These channels are differentiated in two types, the 'direct' and 'indirect' channels. 'Direct' channels allow customer to buy directly from the logistics centre while the 'indirect' channels only allow the customer to buy from an intermediary. In relation to the marketing mix, distribution channel acts as the 'Place' in the 4 Ps of marketing.

Below are the possible distribution channels of a logistic centre:

Direct selling from logistic centre – The logistic centre also acts as the shop/store of the solid biomass.

Wholesaler/agent - Acts as a middleman from the logistic centre and the customer. The wholesaler/agent is probably in a different area or location.

Online shop - Orders online may also be accepted but shipping fee may not be free for customers which are too far from the logistic centre.

Delivery through logistic centre - The logistic centre can be the one to deliver the agro-fuel directly to the customer. This is another way of reaching customers who have no trucks for picking up the product. Fees and charges may apply.

Self-pick-up through customers - The customer is the one who picks up the product from the logistic centre.

In finding the right distribution channel, the logistic centre can also use the distribution channels from their regular activities. In some cases, those channels may fit well to the new products, in some they will not. In general, it can be said that if the target customers are the same, also the distribution channels can be same.

4.2. Lot sizes & packaging

Packaging is the process of enclosing and keeping the product in a safe and suitable wrapping before it is delivered to the customer. It also preserves the quality of the agro-fuel and avoids security issues during transport. Packaging also refers to the procedure of evaluating, designing, and making appropriate packages for solid agro-fuels. Lot sizes of the fuels also affect the packaging. In the four Ps of marketing, lot sizes and packaging stands for the 'Product'.

Different customers would mean different requests, different requests would mean different products, and different products would mean different lot sizes and packaging. There are private customers that would buy solid biomass fuel for their own use and would not need so much of it. But there are also industrial customers who will buy big amounts. The private and industrial customers are two different kinds of customers. Each of them buys solid biomass with different lot sizes with different purpose of using it.

Non-packed fuels in a loose form are quite common and frequently transported in a trailer. Another commonly used packaging for solid biomass is bagged cargo and the big bags. For the bagged cargo, a machine for sealing of the bag is necessary. For the big bags machines for loading and unloading are necessary. The difference between those three methods is the size. Most bagged cargos are as big as a regular sack of rice while the big bags are mostly some cubic meter in volume. Selling the agro-fuel loose on trailers allows selling the biggest amount at once. Those packaging sizes have to be adjusted to the target customer groups and their needs.

Figure 14: Big bags for corn cob grits in Austria

Figure 15: Sealing machine for bags

4.3. Selling price

Selling price is basically the value of the good being sold and commonly the basis of any transactions. Prices may differ by product. Not only by products but may also be by customers. Back to the earlier stated example regarding customers: both buy solid biomass but in very different amounts. One big customer means less operational work for the logistic centre, than a lot of small customers. Therefore, different prices for different types of customers are advised.

The selling price of the agro-fuel can be in Euro per ton or in Euro per kilowatt-hour (energy unit). Euro per ton prices are the most common prices, while Euro per kilowatt-hour prices make it easier to compare different fuels and qualities. Below are listed the main things to be considered for the solid biomass pricing:

Selling price from feasibility study - Solid biomass prices from the logistic centres' feasibility study may also be implemented as a price basis or minimum pricing. In this way, the company will stay on track with its feasibility study.

Selling prices from competitors - Selling prices equal or lower versus the competitor would make a great deal attracting more customers. If the prices are higher, there has to be a better quality of the product and/or a better service.

Selling price from similar products – Similar products and competitors are very alike. These are also called indirect competitors. Compromising the products' price against similar products will also boost an advantage.

4.4. Promotion

Promotion is the act of making a product or benefits of the product widely known to everyone. **The purpose of promotion is basically to increase sales**. There are several types of promotion and the most common one is the advertising. Advertising from local radio station to local newspapers is a great way of promoting a logistic centre. But there are also other types of promotion which are less expensive and each type may depend on the type of customer.

The following list shows possible promotion ways for a logistic centre:

- local newspaper
- radio advertisement
- flyer
- online advertisement
- own webpage
- by word of mouth

Agro-industries should also use their promotion channels from regular business to promote the new business activity and their products.

4.5. Benefits of standardized biomass products

All agro-industries develop their activity to generate a product that accomplishes a certain regulation or quality in order to provide a guarantee to the consumer. In the same way, producing solid biomass products which quality values satisfy the limits stablished by the international standards can bring different types of benefits to the logistics centre:

- **Market competitiveness –** Producing solid biomass according to the European standard would make a great edge for the product's competitiveness in the market worldwide.
- **Quality Indicator -** It is necessary for a transparent market to have quality indicator as a reference for the buyer's needs.
- **Customer Transparency –** Transparency in the market is important especially for the product's quality. Consumers must know if the product is made under consideration of quality criteria.
- **International Trading –** It would make it easier for both: buyer and seller to find their way in meeting each other locally or internationally.

4.5.1. Which are the standards to take into account when producing solid biomass?

The Committee for European Standardization (CEN) started to work in the late nineties on the elaboration of European standards for solid biomass products. This work was an assignment from the EC during the development of energy policies where the promotion of renewable energies was an important goal. Nowadays, the work performed by the CEN has been used as the base to elaborate the International standards on solid biomass which are now in force, replacing the European ones.

For a logistic centre on biomass, it can be distinguished 3 main types of different type standards on solid biomass:

- **Standards that detail how to do the analysis of the different properties** (quantity and characteristics of sample, type of equipment, conditions -like temperature or atmosphere- and duration of the tests) and how to express the results. These are the standards that should be followed, by the agro-industry or by the external laboratory, when evaluating moisture or ash content for example. The majority of them have been included in

- **Table 2** in section 2.2.2 of this document.
- **Standards defining the specifications and classes of solid biomass** (ISO 17225; composed currently by 6 parts). This standard is the base of all the rest. It provides the recommended values of quality properties like moisture content in order not to create problems in the user.
  Some reference values are provided inside SUCELLOG guide D2.2 Guide on technical, commercial, legal and sustainability issues for the assessment of feasibility when creating new agro-industry logistic centres in agro-food industries (section 2.1.3). Here below are shown some quality values for wood chips and mixed pellets recommended according to the standard.

Table 3. Properties of non-woody pellets (mixed pellets included) according to ISO 17225-6

Property	Class A	Class B
Moisture content (w-% ar)	≤ 12	≤ 15
Ash content (w-% db)	≤ 6	≤ 10
Net calorific value (kWh/kg ar)	≥ 4,0	≥ 4,0
Cl (w-% db)	≤ 0,10	≤ 0,30

Table 4. Properties of wood chips according to ISO 17225-4

Property	Class A	Class B
Moisture content (w-% ar)	≤ 35	Maximum value to be declared
Ash content (w-% db)	≤ 1,5	≤ 3,0
Net calorific value (kWh/kg ar)	Minimum value to be declared	Minimum value to be declared
Cl (w-% db)	-	≤ 0,05

- **Standards that stablish the protocol for the quality assurance in the production process** (explained in section 5.2 of this document).

4.5.2. Where can the standards be purchased?

All EU countries have a National Standardization Body (NSB) that is either a member or an affiliate of CEN. **Standards can be purchased in the website of the NSB in the national language**. See below the NSB for SUCELLOG participating countries and the nomenclature used in the standards:

- AENOR in Spain (UNE-EN or UNE-EN ISO)
- AFNOR in France (NF EN or NF EN ISO)
- UNI in Italy (UNI EN or UNI EN ISO)
- ASI in Austria (ÖNORM EN or ÖNORM EN ISO)

4.5.3. What is the difference between a standardised product and a certified product?

A standardised product is that one accomplishing with the limits of a standard. The corresponding producer can show the results of quality analysis to the potential consumers. But none will certify that the characteristics presented in the document are the ones of the product.

On the other hand, the producer can certify this quality with the corresponding NSB, which will take samples to check it. The certificate issued can be provided to the potential consumer as a way to build trust on the product offered. In this case, it is a certified product.

In the last years, several commercial labels have been created to certify the solid biomass quality. The most common labels existing currently in the market and the type of products that are certified are:

- ENplus label: wood pellets.
- DINplus label: wood pellets and briquettes.
- BiomaSud label: wood pellets, wood chips, olive stones, pine nut shells, almond shells, chopped pine cones, hazelnut shells and blends of the cited biomasses (producer must specify the %).

Figure 16. Labels certifying solid biomass quality

At the time of publishing this guide, no certification systems have been developed yet for mixed pellets or briquettes produced partly by herbaceous resources considered in the international standard ISO 17225-6 “Solid biofuels – Fuel specifications and classes – Part 6: non-woody pellets” and ISO 17225-7 “Solid biofuels – Fuel specifications and classes – Part 7: non-woody briquettes”.

However, it should be clear that any company has the possibility to certify the quality of their product outside any commercial labels. For that, the corresponding NSB or accredited laboratory will take representative samples of the product and issue a certificate according to the results of the characterisation analyses.

5. Monitoring of commercial operation

Once the business is in operation, it is necessary to monitor it and compare the outcome with the planned results according to the feasibility study and business model. This is necessary in order to know if the business is aligned with the expected outcome from the previous idea. Furthermore control and quality assurance of the solid biomass products is must for logistic centres to assure the customers high quality.

The following chapter provides information about how an agro-industry logistic centre can handle these issues.

5.1. Determine indicators

New logistic centres that are producing biofuels out of agrarian residues should monitor their operation, especially the first operation period. **The purpose of this monitoring is to ensure all activities are executed properly, determine if the process and procedures are well utilised, identify errors and providing solutions**. In other words, monitoring is essential to determine if the project went as planned in the most appropriate way and detect possibilities for future improvements.

But how do we classify the data gathered from the monitoring as acceptable or unsatisfactory? Should we have something to compare these data with? These data from the monitoring should be compared to the data from the feasibility study which should have been developed beforehand.

There are two types of indicators which should be monitored throughout a period: the quantitative and the qualitative indicators. Quantitative indicators are the factors that are measurable, from its root word quantity which answers the question of "how much" or "how many". The quantitative part of the feasibility study should be compared to the actual business outcome to see if the biomass logistic centre is on its targeted direction. Qualitative indicators are the underlying reasons, opinions, market availability and other factors which are not measurable. Qualitative indicators should also be compared from the feasibility study with the actual business output. If there are differences, quantitatively or qualitatively, then the next question should be "why". Why is there a difference, what could have possibly been the factor behind the difference, and what to do in the situation?

Below the most important qualitative and quantitative indicators are shown. Those indicators should be measured regularly. The project suggests a measurement rhythm of once every 3 months, but at least once a year is necessary. Beside those indicators, additional ones could be relevant depending on the business model.

Quantitative Indicators:

- **Average price per ton** – The average price per ton of the raw material bought.
- **Purchasing amount in ton** – Amount of the raw material being purchased in tons.
- **Production amount in ton –** The amount of solid biofuel to be produced per ton.
- **Production cost per ton –** Cost of producing solid biofuel per ton.
- **Sold amount in ton –** The amount of the solid biofuel sold per ton.
- **Selling price per ton –** The price of the solid biofuel being sold per ton.

Quantitative factors should be compared from the feasibility study by measuring and contrasting their amount. Once a sufficient difference occurs, it should then be figured out what caused it even if it is desirable or not.

Qualitative Indicators:

- **Customers** – The buyer/consumer of the biofuel. Who are the customers? Are those the same as expected in the feasibility study? Customer's location and purpose of buying should also be gathered. Also feedbacks from the customers should be gathered for future improvements.
- **Suppliers** – From who are the raw materials bought? Compare if they provide the expected amount/quality of raw materials. Also their location and if where their stocks came from.
- **Personnel** – The workers of the logistic centre. How much additional personnel effort is necessary through the new business line? Was the adaption a problem for the workers? Are they well trained for the new business operations? Feedbacks from the personnel are very important.
- **Equipment** – Tools and machineries used in producing biomass. Expected efficiency of the equipment will be compared to the actual efficiency. Maintenance cost should be calculated and compared. The number of equipment to be used versus the actual is also of concern. Furthermore, problems in the adjustment of the equipment should be monitored.

Most qualitative indicators may not be measured by amount but can be described. One example is the customer's feedback. These "soft" indicators are also very necessary for the logistic centre and its success and further improvements. It is crucial to consider these indicators as well.

5.2. Quality control and assurance:

The control and quality assurance is a must in an industrial process like the production of solid biomass in logistics centres. In order to provide some guidance on these two issues, the European Standardisation Body elaborated the EN 15234 Standard.

The control procedures that are performed by the institutions related to certification systems (like for example ENplus) are based on this standard. Therefore, any wood pellet producer that wants to be certified under ENplus label should follow these procedures.

In this section, some important points about quality control and assurance to bear in mind are highlighted. They are based on the standard and on the ENplus manual. For more detail, please consult the standard (section 4.5.2 includes the different National Standardization Bodies where the standard can be acquired in the national language).

Examine the raw material:

- The examination of the raw material in terms of quality characteristics is the first step previous to the solid biomass production since it will determine the pre-treatment needed to reach the quality agreed with the consumer.
- Special attention should be placed to contamination by soil/stones. This contamination can be the result of the lack of cleanness in the transport trucks or in the storage area. Visual inspection is always the first step before any type of analysis.

Figure 17. Moisture checking in raw material

Identify the critical points from the facility and the product properties that are influenced in each point:

It is essential that the solid biomass producer identifies the critical points that can be found in a facility producing solid biomass pellets and how each process can influence the different properties of the final product. With this procedure, if there is any deviation in an expected quality value, the producer can act in the corresponding process/es.

Here it is the example of critical points in the production of pellets:

Table 5. Points to identify during monitoring and their influence in fuel properties

Process steps - Critical point	Property influenced
Storage of raw material	Moisture content, ash content because of contamination
Grinder	Particle size
Dryer	Moisture content
Mill	Particle size
Pelletiser & Cooler	Length and diameter, durability, amount of fines, bulk density
Storage of products	Moisture content, amount of fines
Sieving system	Amount of fines

Self-inspections:

In order to ensure quality according to consumers' requirements, the producer should carry out checks every day. The advisable frequency of these tests is determined by the volume of production according to the following formula:

$$Number\ of\ samples\ in\ 24\ hours = \frac{10}{annual\ working\ days} \times \frac{\sqrt{annual\ tons\ of\ pellet\ produced}}{10}$$

The minimum advisable frequency of checking quality is once per shift (8 hours). All samples taken should be representative of the production in the shift.

Importance of taking reference samples:

- Taking product samples is the only way to answer to complaints from end customers or traders.
- Samples should be taken per lot or shift according to the volume of production.
- The samples should be stored for at least 9 months in sealed containers and under proper conditions so as not to change their properties.
- Having 1 kg sample is advisable and the label should include the date and lot of production.

Declaration of the product:

All product supplied should be accompanied with a declaration (together with the bill or in the delivery note) containing the following points:

- Name of the producer
- Quantity delivered to the consumer
- Origin and source of the raw material (as a traceability method and to provide some information to the consumer about the environmental sustainability of the product consumed)
- Product format (pellets, chips, briquettes, bales, bulk pits, etc.)
- Indicate if the product comes from a raw material chemically treated (like, for example, boards with coatings)
- Quality properties (the ones that have been evaluated by the producer; the more the best)
- Indicate if the product can be categorized inside a defined class according to ISO 17225 – quality (see section 4.5.1)