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: Lessons learned and good practice examples

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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 biofuels 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

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 supports agro-industries in the diversification of their regular activity and taking advantage of two facts:

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

During SUCELLOG project, several agro-industries have been supported by an evaluation of their opportunities to become logistic centres of biomass. The support has been provided through different types of activities – audits, feasibility studies and trainings – and through the development of practical guidelines and handbooks. Four agro-industries were directly supported to become biomass logistic centres and more than 40 agro-industries were assessed regarding their opportunities by the development of auditing studies. During all these activities, several good practice examples and experiences regarding issues to be faced when developing biomass logistic centres within existing agro-industries have been detected.

This third SUCELLOG project handbook, titled "*Lessons learned and good practice examples",* is a guide to be used by a project developer (the agro-industry itself or any other entity) when setting up a biomass logistic centre based on agriculture products. It is targeted to users which are already aware about basic concepts on agricultural biomass production and use, and who have considered the possibility to develop biomass logistic centre within their agro-industries.

This handbook is therefore summarising lessons learned and good practices from SUCELLOG experience and other existing projects. It aims to make the reader paying attention on critical points which need to be properly addressed while preparing the technical and the economic assessment of the concept. It provides good practice examples as an answer to concern which might rise during the biomass logistics centre development process. These critical points are illustrated by examples from the project target countries - Austria, France, Italy and Spain.

This document contains 4 sections, following the same structure as the second SUCELLOG handbook, Handbook 2 - Carrying out a feasibility study:

- **What determines the success of the overall business concept?:** when designing a business model, the project developer should consider the overall business concept, including the identification of all involved parties and the assessment of how the concept corresponds to the interests of each party. This section presents important points to be kept in mind when building the business model as a whole.
- **What are the critical points regarding the biomass supply?:** Biomass resources and their availability is the starting point of the business concept and has significant influence on the overall structure of the concept. Knowledge about the properties, quantities and prices of biomass resources is needed to set-up the business model and to ensure the profitability of the project. Critical points to bear in mind when analysing the available biomass resources are presented in this section through real cases.
- **What are the critical points in organisation of biomass processing?:** Investment in biomass processing technologies is another crucial point affecting the profitability of the biomass logistics centre concept. Examples, where opportunities to reduce investment costs have been taken into practice, are presented in this section.
- **What are the critical points in addressing the bioenergy market demand?:** In general, the awareness of solid biomass end-users is low concerning agricultural biomass products and the market is not always well structured. This section gives useful tips about how to facilitate the demand for agricultural biomass and to develop the local bioenergy market.

1 What determines the success of the overall business concept?

When initiating a biomass logistic centre activity and developing a specific business model, in order to ensure the best economic performance, the project developer has to keep in mind several key points. The proposed business concept has to be analysed regarding its strengths and weaknesses, and opportunities related to the local community. Useful tips for appreciating the strengths of the business concept, creating successful partnerships and responding to societal challenges are further described in this chapter.

1.1 Acknowledge your strengths and turn them into opportunities

The concept of the biomass logistic centre within the agro-industry is based on the exploitation of the excellent opportunities that agro-industries have to become solid biomass producers with reduced need for investments. Agro-industries are used to work with agricultural biomass: they already collect, treat and sell products from agriculture. They transport products to the transformation site or to the final consumers and they are used to collaborate with farmers in the organisation of large scale logistics of agricultural commodities like grains, fruits, etc. Moreover, they are already aware about the importance of assuring a certain quality level of the end-products.

Complementary to their usual activities, **agro-industries have the untapped opportunity to benefit from their expertise in dealing with food/feed materials and to diversify their activities by adding value to their biomass residues**. Within SUCELLOG concept, **agricultural biomass logistics is drawn from the classical agrarian business model and, when possible, improved to respond to the demands of the local bioenergy market**.

Good practice example: integration of a biomass logistic centre activity as an opportunity to complement regular activities of the company Tschiggerl Agrar GmbH, Austria

***Tschiggerl Agrar GmbH** is an agro-industry located in the south-east of Styria (Austria). Their main activities are harvesting and processing of maize grains and cereal straw for animal feeding.*

Maize grains drying is the most energy intensive processing operation of Tschiggerl Agrar GmbH. To produce energy for drying operations, usually oil or gas was used as fuel in drying facilities. In 2007, when oil prices were very high, the owner of the company, Mr. Tschiggerl, started to look for an alternative cheaper fuel. He came to the idea of using corn cobs since the currently underutilised by-product has been used as fuel by farmers in the past, when harvesting of the corn was still done manually.

- **Fuel cost savings for own energy consumption:** 200,000 € /year
- **Pay-back period of the boiler:** 2 years
- **No additional investment** for development of biomass logistic centre
- **Produced fuels** (2015): 1,200 t
- **Corn cob grits are 40 % cheaper than wood pellets**
- **Only 1.3 % of the total energy content** of the fuel is consumed in their production (harvesting+chipping)

Following up this idea, Tschiggerl Agrar GmbH started to investigate on how to carry out this project. The logistic chain was the first critical point to be solved. Mobilization of sufficient amount of raw materials was not a problem, since Mr. Tschiggerl provides the service of corn harvesting as well for other farmers. However, regarding the corn harvesting technology, the regular corn harvester had to be modified to be able to collect grains and corn cobs at the same time in separate containers (for more information see example in section 2.2). Once logistics issues were solved, he decided to face the consumption by investing in 2012 in a boiler able to burn corn cobs and to use it to cover the energy demand of the company.

As more corn cobs were generated every year, the company decided to use the surplus biomass for production of solid fuel and to sell it in the market. In 2015 and thanks to the support from SUCELLOG project, Tschiggerl Agrar GmbH started working as biomass logistic centre. The new business concept has been developed based on the existing infrastructure and idle period of the equipment already available on site (dryer and chipper), and therefore it did not impose significant initial investment. The company is selling corn cobs in different formats (pellets, grits and loose corn cobs) directly to the consumers. Pellets are produced in another facility, which is owned by an association dealing with animal feed. Mr. Tschiggerl is a member of this association. For more information, see SUCELLOG project report - Summary of the current situation of Tschiggerl Agrar GmbH and feasibility study.

Take advantage of the opportunity to use existing structures and biomass resources!

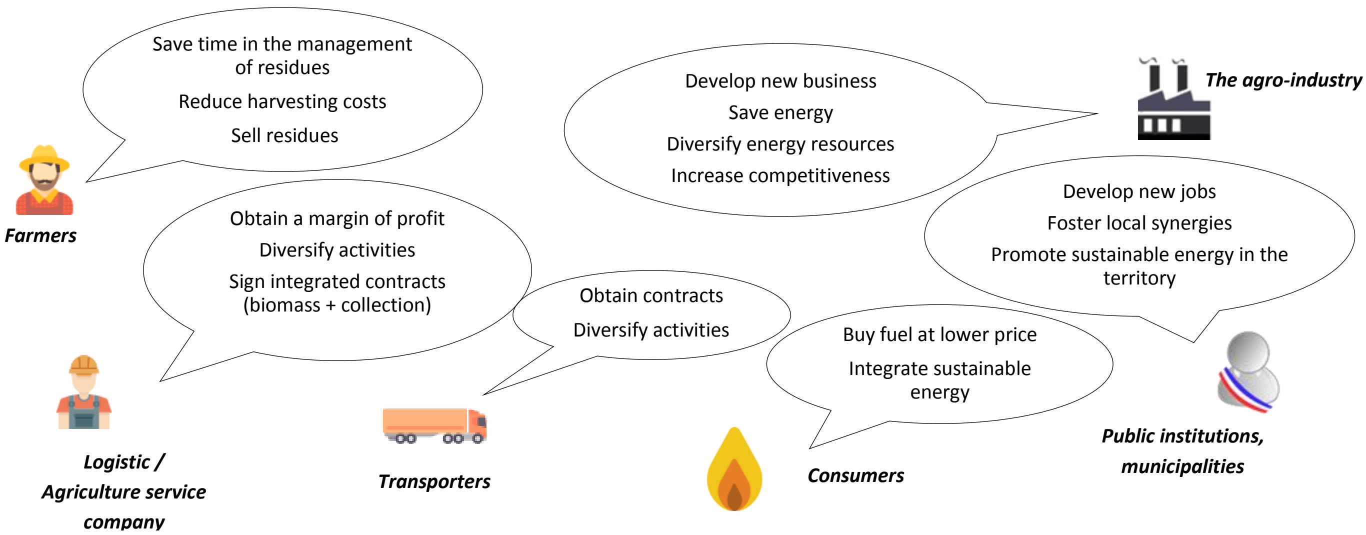
Tschiggerl Agrar is a company specialised in working with grain. The company took the opportunity to use their experiences and knowledge to develop new business activity based on existing structures and biomass resources. They decided to treat biomass in a similar way as they used to treat grains by replicating the classic treatment model of cereals to the new products. Tschiggerl Agrar produces solid fuels in the idle periods of the regular activity and sells them directly from the facility to farmers, energy service companies and households.

1.2 Select your "team members" and understand their motivation

The development of a biomass logistic centre is affected by the synergies between various kinds of stakeholders: biomass producers, energy suppliers, boiler manufacturers, national energy agencies, etc. Their needs and objectives are different. For this reason, **the project developer should identify which parties are crucial for the new biomass logistics centre and should understand how they could be motivated to support the intended activity. The success of the project will depend on the ability to set up a "win-win" partnership where all involved "team members" are benefiting from the project and thus are highly motivated**.

Examples of potential "team members" and their expectations are provided in Figure 1. As said, if the project can satisfy the expectations and needs of stakeholders, they will be motivated to support the intended activity. However, it is important to understand that stakeholders can be motivated not only by monetary benefits, but also when saving their time or improving their corporate image.

Examples of stakeholders and their expectations



Good practice example: successful partnership of stakeholders initiated by the company Boortmalt, France

The Boortmalt company is a subsidiary of Axereal group and owns ten malthouses in Europe. The company produces 1.1 million tons of malt per year. This activity involves energy intensive barley drying stage. Until 2011, the required energy consumption for the Boortmalt plant in Issoudun, France, was around 160,000 MWh of natural gas and 15,500 MWh of electricity per year. Energy costs represented 25 % of the turnover of

- **Total cost of the project:** 2.8 M€
- **Payback time:** 4 years
- **Energy costs saved:** 500,000 €/year
- **Energy share covered by biomass:** 13 %
- **Energy saving:** 18,000 toe / year
- **CO_2 savings:** 4,312 t / year.

Figure 1 : Expectation of biomass stakeholders when developing a solid biomass project

the plant or 28 % of the total production costs.

In 2011, the company initiated a study to assess the possibility of using large amounts of available residues (silos wastes) of barley and other cereal for energy production to cover the own heat demand. The evaluation of this opportunity was supported by Vyncke (a boiler manufacturer) and by Dalkia France (an experienced energy service company[1]).

The positive results of the study, converted the project in a reality in 2013. The company was looking for a boiler manufacturer providing a combustion equipment able to work with silo wastes. Boortmalt thus decided to cooperate with Vyncke, who adapted one of its commercial 4 MW wood boiler to operate with agricultural biomass. Vyncke worked together with the agro-industry to optimise performance of the equipment. Dalkia France has been involved to take care of operation and maintenance of the new facility.

To develop this project, Boortmalt received funding from the Heating Fund administrated by ADEME - the French National Agency of the environment and energy management. In total, 714,000 € of public funding, complemented by co-financing from own resources was necessary to build this facility.

Figure 2 : Vyncke boiler in Boortmalt site (Issoudun, France)

Understand the motivation and Develop “win— win” partnerships

For the Axereal group this project was an opportunity to valorise a part of its residues (4,000 t/year) and to decrease its energy costs. The energy independence of the company has been improved.

For Dalkia this project was a chance to obtain new consumers and to develop references on projects using agricultural biomass.

For the ADEME a new significant sustainable project has been implemented and new jobs created, thus contributing to a national fund promoting renewable heat performance targets.

For Vyncke it was an opportunity to develop an experimental boiler adapted to agricultural residues and to test its operation for future references.

1.3 Look for synergies with public sector and respond to societal challenges

Agro-industries can develop a win-win partnership together with municipalities and other public stakeholders to for the establishment of biomass logistics centres. **The development of this new activity may not only provide economic benefits, but also address several societal challenges like regional and social development, sustainability, safety aspects and environmental protection. When addressing societal challenges, the project developer might get access to additional financial and/or political support to develop the project.** Also in cases, when the intended business model is not economically highly profitable, the public institution may decide to support the project if it provides public services, which are beneficial for the local community. Public services may include support to agriculture, limiting the burning of crop residues, creating new jobs, reducing greenhouse gas emissions, etc. More examples of positive externalities are provided in Figure 3 below.

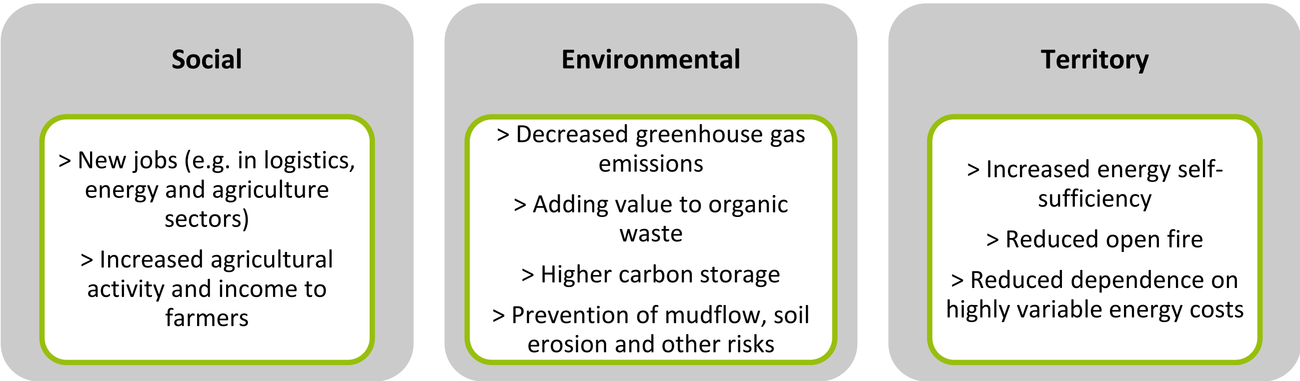


Figure 3 : Examples of positives externalities

Good practice example: Planting Miscanthus against erosion in the Caux area, France

The Caux area in France is often affected by mud flows caused by erosion. In order to limit the impacts of erosion, the local agriculture network is working together with municipalities on a new project. They are planting miscanthus strips to minimize the erosion impacts, to reduce pollution of rivers and to stabilise the soil of agricultural areas. Planting miscanthus is more efficient than the usually weed strips. Besides the primary intention of the project, the above ground part of miscanthus is thought to be further valorised. Plants are planned to be harvested and sold as solid fuel for energy production, thus providing additional income to farmers in addition to environmental benefits. The project is highly supported by several local stakeholders because of the positive externalities it brings to the local community.

Good practice example: Collection of biomass to reduce fire risks in Serra Council, Spain

Serra is a municipality of 3,000 inhabitants in the Valencian community in Spain. In 2011, the municipality decided to start collecting the available-around-wood and converting it into pellets. They bought the necessary equipment and organised the final transfer of pellets to the boilers in public buildings.

The implementation of this biomass initiative in Serra municipality started with an ambitious project lead by its Town Hall. In order to limit the fires developed due to the scarce forest cleaning operations carried out in the abundant forest, the municipality decided to use the forest resources as fuel in their own facilities. Not only fire risks, but also greenhouse gas emissions and air contamination were thus reduced.

Additionally, annual costs for handling green residues in Serra were significant. So, as a complement to forest resource, it was decided to convert the residues from gardening works and for agriculture into solid fuels. The first step was to convert the local administration in a consumer, replacing the traditional electrical heaters by biomass systems. Little by little, with the purchasing of biomass pre-treatment equipment (chipper and pelletising system), they are extending the project for biomass heating to other public buildings. They are even planning to sell the surplus of the production to the neighbourhood, which would represent a new income opportunity for the municipality.

Around 350 t of biomass per year are processed to produce pellets: 10 % coming from agricultural prunings from small farms around the municipality, 55 % coming from the gardening residues and 35 % coming from the forest residues.

Valorise positive externalities

The project of Serra municipality allowed not only reducing waste management and energy costs, but also provided positive effects on the protection of the natural environment, reducing the risk of fires and pollution. It also contributed to the development of local economy by creating new jobs in the area.

Moreover, to further boost the biomass consumption, to develop agricultural sector and to reduce open fire, the municipality also intends to change the management practices of agricultural biomass. They invited farmers to bring their prunings to the plant and exchange their biomass for a certain amount of pellets free of charge.

During the first four years of the project, Serra municipality has experienced considerable annual savings in waste management (more than 24,000 €) and electricity bills (around 16,000 €), has reduced CO_2 fossil fuel emissions by over 100 t/year and created 10 new jobs.

1.4 Extend your project to optimise your material, energy and residue flows

The development of a biomass logistics centre involves not only establishing a value chain between the biomass producer and the fuel consumer. A good project has to be sustainable in a long run and thus, it should be embedded in the local environment. What are the companies nearby my production site? What are the expectations and needs of my stakeholders? Do they need heating? Can they use ash as fertiliser or maybe they have residues which I could use as raw material? **Biomass logistics centre should be considered not only as an energy activity, but as a part of circular economy concept.**

Good practice example: Biomass logistics centre based on circular economy principles in Leo Verde, Italy

Leo Verde Società Agricola, located in Roccastrada, Grosseto (Italy), is a farm cultivating olives and ryegrass. The farm also operates 1 MW_e biogas cogeneration plant, producing heat and electricity. They are currently solid biomass producers.

Among other raw materials, Leo Verde is using olive pomace for biogas production. Leo Verde is purchasing the olive pomace at 25 €/t from the several local oil mills in the area to which they provide also the olives from their own cultivation. This cooperation allows using olive oil processing residues as raw material for biogas production and brings economic benefits for both sides. Olive mills are able to sell their residues that would otherwise impose costs for the authorisation and disposal. Leo Verde benefits from the access to a cheap raw material with high further valorisation potential.

Moreover, before using olive pomace in the biogas plant, Leo Verde extracts olive pits in order to improve their quality. The resulting olive pits, with a moisture content between 20 and 30 %, are used in regular wood pellets boilers to cover their own heat demands (swimming pool) and the rest is sold in the local market at a price of

150-170 €/t. The main part of the pits is sold to the oil mills which are providing olive pomace to the company. Leo Verde is currently assessing the possibility to upgrade the quality of olive pits by drying them with the combustion gases coming from the cogeneration plant.

This example shows the project in a perspective of circular economy, where all residual flows are taken into account.

Extend the scope of your project joining separate value chains to reach higher profitability

The development of a new market for olive pits, using olive pomace for biogas production, saving energy costs, building up relationships with nearby mills, etc. are several small projects which, considered separately, may not be profitable or would require a lot of time. With extending the scope of the project beyond separate stand-alone value chains, Leo Verde succeeded in creating a successful biomass logistics centre project.

2 What are the critical points regarding biomass supply?

Well-developed biomass supply concept is a cornerstone of a successful biomass logistic centre. Availability of biomass resources and their quality have influence on the entire value chain. Agricultural biomass includes a broad range of feedstocks which can be completely different in terms of quality, quantity and their availability. This chapter discusses the most critical points to be taken into account when developing biomass supply concept for the biomass logistic centre based on agricultural residues.

2.1 Look for residues without competitive uses

Usually the purchase of biomass represents a high share on the total costs within the overall business concept of the biomass logistics centre. Residues (e.g. straw, silo dust, olive pomace) are often used for feeding animals, bedding, biogas production, composting, etc. If there is a demand in competing markets, prices of biomass residues can increase significantly. **Therefore, in the first step, it is important to look for residues which are currently not used in any other markets**.

These residues are often available free of charge and only related logistics costs shall be covered by biomass logistics centre. However, sometimes, the exploitation of unused biomass requires development of new logistic chains and application of innovative approaches to harvesting and residue collection. To this respect, new technologies emerge in the market to enable the access to new biomass sources which have not been used before.

Good practice example: Taking advantage of unused chaff, France

Chaff is a residual stream produced during harvesting of cereals. It consists of fine straw, dust and weed seeds. During harvesting operations, the chaff is usually left on the soil as organic matter. In 2015, the company ETS Thierart has developed new windrower which allows collecting and baling chaff directly on the field with continuous pressing. This equipment can also be adapted for harvesting of other types of biomass.

During last years, several companies have been working on the development of chaff collection technologies. Collection of chaff brings both agronomic and economic benefits. By removing the chaff from the field, the seeds of weeds are collected and thus the need for application of agro-chemical products is reduced and at the same time, the chaff can be used as raw material for solid fuel production. Chaff is thus available and can be collected at low price. Indeed, the purchasing cost should cover the logistic work (equipment needed to collect chaff and personal) and additional organic amendment to compensate the organic matter withdrawing.

Figure 4 : Chaff collector from ETS Thierart

2.2. Look for opportunities to reduce biomass harvesting and collection costs

In order to make agricultural activities more cost efficient, much effort is made in the research and development activities on agricultural biomass harvesting and collection. **Various integrated technical solutions, which combine simultaneous harvesting of food products and biomass residues, are already available in the market. They can be used to develop new, more profitable biomass logistic chains**. The presented technical solutions include both completely new machinery and adaptation of already existing technologies. In the latter case, the improved harvesting of biomass can be achieved with less investment, being therefore interesting in particular for farmers and companies who already own the harvesting machinery. Some examples are presented below.

Good practice example: Integrated corn & cob harvester in Austria

***Tschiggerl Agrar GmbH** is an agro-industry located in the south-east of Styria (Austria). Their main activities are harvesting and processing of maize grains and cereal straw.*

In order to collect corn cobs, the owner of the Austrian company Tschiggerl Agrar has modified a regular CASE Axial-Flow 7088 corn harvester. The modification included an installation of a sieve which separates corn cobs from the stalk and the shucks. After separation, the cobs are collected in a container with a volume of 13 m³. The container is emptied by tipping it over an external trailer (see Figure 5). It takes about 4 minutes to unload the container. The additional fuel demand for harvesting the cobs is 4 litres per hectare compared to the regular activity for grain harvesting. Instead of a container, a big bag system could be implemented. In that case, the harvesting system would need just 2 litres more per hectare, but much more additional time effort.

Figure 5 : Tschiggerl Agrar corn cobs harvester

Good practice example: Integrated machinery for collection of vineyards prunings

Optimisation of vineyard pruning collection has been investigated in a project called VINEYARDS4HEAT. The project is funded by EU Life Programme and runs from June 2014 to April 2017. Its main objective is to make profit of vineyards prunings to cover the energy demand for heating and cooling of wineries.

As part of the overall feasibility assessment of the logistic chains, the project has evaluated costs of on-field harvesting and chipping of prunings by using one particular commercially available machine. Moreover, during the project, in order to improve the economic feasibility of the supply chain, an ad-on device for the tractor has been designed and developed, allowing the integration of pruning and chipping steps in a single phase. Due to this innovation, a sole machine is used for the two operations: the forefront system is able to cut the branch

from the plant and directly chip it, in the same operation, instead of throwing the branch on the field; finally, an aspiration system pushes chipped material to the backward container.
This is a significant improvement compared to the former logistics chains in which the farmer had to make manual pruning and then had to use a machine to collect prunings from the ground. Although further improvements need to be implemented, the new and prototype allows saving time and money and improves the purity of the collected material (less soil, stones, etc.).

Precise estimations of savings are not available yet; however, it is clear that this new system will reduce biomass costs significantly, allowing to produce cheaper renewable energy from prunings and making this agricultural by-product more competitive.

Figure 6 : VINEYARDS4HEAT prototype tests in vineyard

2.3. Agricultural biomass can be used for large scale supplies

Similar to wood biomass, large logistic chains can be set up based on agricultural biomass. Agricultural biomass sector can take advantage of using existing facilities of agro-industries, such as storage places and harvesting equipment, and thus be able to organise large scale biomass processing operations during the idle period, as a complement of their usual activities. **Logistic chains supplying thousands of tons of agricultural residues already exist in Europe. They are able to supply fuel for large scale facilities and to answer the consumers demand in terms of quality, quantity and the organisation of supply**.

Good practice example: Large biomass logistics at OLEÍCOLA EL TEJAR, S.C.A., Spain

OLEÍCOLA EL TEJAR NTRA. SRA DE ARACELI S.C.A. is an agro-industry located in Andalusian region in Spain. The objective of this cooperative, made of 248 associated companies, is the integral exploitation of the olive oil by-products from its members.

Initially, the company was collecting only the wet olive pomace from the olive oil industry and using the residues from their own extraction of olive pomace oil for electricity production in power plants belonging to OLEÍCOLA EL TEJAR. In 2008, they started to think about adding value also to the olive tree prunings and the leaves (other by-products from the same sector). In order to fulfil this goal, the company started to develop a new logistics line for the production of electricity also from this type of resources generated on the field.

Around 100,000 tons of olive tree prunings and leaves are annually collected and used as fuel in the four power plants distributed in Andalusia. The total capacity of power plants exceeds 45 MWe. The raw material is collected from around 100,000 farmers cultivating more than 300,000 hectares. One of the members (BIOMASA DE LA SUBBÉTICA, S.L.), is in charge of all activities related to pre-treatment, supply, pre-chipping and chipping of prunings and to the delivery of chipped material to the power plants. Besides, the agro-industry acquired two additional sites where chipping and screening of olive tree prunings and leaves can be done.

Agricultural biomass can be used in large biomass supply chains

OLEÍCOLA EL TEJAR has created logistic chain dealing with hundreds thousands of tonnes of agricultural biomass annually, taking advantage of the company's experiences in the integral exploitation of the olive oil by-products. The inclusion of olive tree prunings reinforced its business activity as electricity producers.

This biomass supply chain has been working for 8 years. It is a good example which shows that collection of agricultural biomass from large areas can be organised and the demand for thousands of tons of fuel based on agricultural residues can be satisfied.

Three main success factors of this large supply chain are: the short distance from the fields to the power plants, the storage and management capacity of the OLEÍCOLA EL TEJAR and the establishment of clear rules for its members by clear definition of quality, reception conditions, reception centres and

2.4. Base your business concept on the real tested properties of your biomass

In a new business activity, when considering a particular resource as the feedstock for solid biomass production, it is essential to analyse the properties of these resources on the early stage of planning. Properties and quality of the raw material will define the market of the final product and its price. The quality of agricultural biomass is very variable and theoretical ranges of the parameters are very large. They depend on intrinsic properties of the crops as well as on external conditions. Theoretical data from literature can hence only be used for a pre-feasibility study. In further development of the business concept, instead of theoretical data, actual values obtained from laboratory tests of raw materials have to be used.

As explained in Handbook 1—the basic demand of information and in Handbook 2—Carrying out a feasibility study, agrarian resources usually contain more ash than forestry biomass with a different composition (mineral content). Ash content and composition affects the operation and maintenance of the combustion equipment. Chlorine content is another critical parameter to pay attention to, especially for herbaceous biomass, since it increases the risk of corrosion.

Ash content largely depends on the amount of exogenous material (e.g., soil particles) in the biomass. The composition of ash and the content of chlorine also depend on the part of the plant which is collected (e.g. leaves, bark, stem or husks) and on the properties of soil, use of fertilisers and agricultural practices in general.

Lesson learned: Evaluation of biomass resources properties at initial stage of the feasibility study at San Miguel de Tauste, Spain

San Miguel de Tauste is a cooperative producing fodder pellets and bales from alfalfa and working also as cereal dryer. It is located in Zaragoza, in Spain.

During SUCELLOG project, the Cooperative San Miguel de Tauste was selected to be supported by the project because of their high interest and potential to become a biomass logistic centre. The resource assessment concluded that the most interesting material to be used in the area was wheat straw produced by the cooperative members in large quantities, therefore limiting possible supply risks. When evaluating the possibility to produce pellets from straw or in mixture with wood, no specific analyses of the available raw material has been carried out. The study considered the typical quality characteristics for cereal straw stated by the standard ISO 17225-1 (Solid biofuels -- Fuel specifications and classes -- Part 1: General requirements). With those reference values, it was concluded that, to comply with the quality requirements for class B of the standard ISO 17225-6 (Solid biofuels -- Fuel specifications and classes -- Part 6: Graded non-woody pellets) a mixture of 70 % straw and 30 % wood was required. The whole economic feasibility study of the logistic centre was performed taking into account that specific mixture based on theoretical data.

Before testing the pellets in the combustion facilities of potential consumers of the area, representative samples were sent to a specialised laboratory to carry out chemical characterisation analyses. Results were not as expected: the chlorine content was 3 times higher than the standard limits and considerably higher than the typical value stated for straw in the standard.

Although the straw has usually higher content of chlorine compared to wood (as any other herbaceous product), it is still able to comply with the standards for fuels of class B. For example, cooperative Luzeal which has been supported by SUCELLOG project in France, has produced pellets from 100 % of wheat straw and still was able to fulfil the requirements of the standard.

In case of San Miguel de Tauste, the high salinity of the soil in the area seems to be the reason of much higher chlorine content in the straw. A proper sampling and analysis of the potential resources identified at the beginning of the study could have provided a better overview of the case. Due to this constrain, the cooperative is currently looking for areas nearby with different types of soils and evaluating the feasibility to produce pellets from straw coming from these territories.

Knowledge about the actual chemical composition of the biomass is essential

Without performing chemical analysis, San Miguel de Tauste would not have been able to realise the unusually high chlorine content in their pellets. In a worst case, if this product went in the market, the company would have lost the credibility from their consumers. This case highlights the large variability of biomass properties and confirms the necessity of performing quality analysis of the actual biomass resources and combustion tests already at an early stage of the project planning.

3 What are the critical points in organisation of biomass processing?

Investment in new equipment may present the most important expenditure for a new biomass logistic centre. It certainly affects the profitability of the project in a competitive bioenergy market. Agro-industries already own some equipment for carrying out their usual activities. Therefore, they have a strategic position to develop a biomass logistic centre. Nevertheless, even when the agro-industry does not possess all the necessary equipment, there are still other opportunities to reduce the initial investment costs.

3.1 If possible, use your existing processing equipment and storage facilities

Investment in new equipment and facilities to start production of solid fuels can be high and thus, can represent an obstacle for the feasibility of the biomass logistics centre project. Agro-industries have generally an advantage – they already own equipment which is often compatible with biomass production or can be slightly adapted, reducing the overall investment costs. **Adaptation of existing equipment and facilities will require less investment than a completely new one. Moreover, sharing the use of equipment and facilities between two activities (the agro-industrial activity itself and the biomass logistic centre) can mean an important reduction in its pay-back period**.

Good practice example: the adaptation of already existing equipment by the company El Cierzo, Spain

SAT El Cierzo has been working as cereal dryer since 1981. In 2012, the company decided to diversify their original activity and became a biomass logistic centre, offering high quality olive pits to the biomass market. Their customers are located in a radius of 150-200 km.

Figure 7 : El Cierzo facility working as biomass logistic centre

El Cierzo is purchasing raw olive pits from oil mills in different regions. The pits come with a moisture content of 22-24 % (wet basis). Operation of the biomass logistics centre includes drying (reducing the moisture content of pits to 14-15 %), cleaning of pits from fines/pulp, and supplying produced solid fuel to the consumers.

Cereal dryer, storage facilities and other equipment (like sieves) that the agro-industry owned is used in the biomass logistic centre. However, little modifications have been performed in order to adapt them to the new raw material. The investment cost in total did not exceed 150,000 € (adaptation of the cereal dryer and acquisition of hoppers and conveyors). With this adaptation of already existing facilities, the company developed a new business line that nowadays represents around 50 % of their total income. Starting with 600 tonnes a year, the company has increased their production rate, processing currently around 5,000 tonnes of olive pits. Making both activities (cereal drying and solid biomass production) compatible in seasonal terms and taking the advantage of the use of existing equipment, have been essential for the success of the business concept developed by El Cierzo.

- **Initial investment:** 150,000 €
- **Payback period:** 7.5 years
- **Amount of olive pits sold in the market:** 5,000 t/year

Figure 8 : Raw materials and biomass product offered by from El Cierzo

Take advantage of reduced investment costs by adapting your existing equipment and facilities

In 2012, when El Cierzo started the biomass processing activity, they understood that the success of their product in the market would be determined by the quality and the price they can offer. At that time, there was a lack of high quality solid fuel providers in the market. Investment in new equipment would have increased the overall production costs and make the price of the product not competitive in the market.

Because of reduced investment costs, El Cierzo has been able to offer the best quality-price relation, keeping their initial customers. They are the perfect example of a business born taking advantage of the synergies of the agricultural and biomass sector.

3.2 Look for the companies owning the equipment you need and make them your partners

Solid biomass from agricultural resources is available in various formats and degrees of quality. Moreover, the availability of the resources is often seasonal (read more about the challenges in the Handbook 2 - Carrying out a feasibility study of the SUCELLOG project). Therefore, it is not always possible to use the own equipment for all kinds of resource processing. Often, it means that, to build up the biomass logistics centre, the project developer will have to invest in new facilities and equipment. Investment costs can be relatively high, being challenging to ensure the feasibility of the project, in particular when machinery is operated only over a short period of time. More information about the estimated investment costs is given in the Guide on technical, commercial, legal and sustainability issues for the assessment of feasibility when creating new agro-industry logistic centres in agro-food industries from the SUCELLOG project.

Before deciding to invest in new machinery, the project developer could still explore the surrounding companies in order to identify the one which owns the needed equipment. If interested, partnership can be built between the companies. For example, a company who owns large amount of residues and knows someone who would use the solid biomass for energy production, can make partnership with another agro-industry who possesses the needed equipment for biomass processing. The partnership can be built in several ways. For example, as service contract (the first company pays for the service of processing the resources), as equal partnership (both companies are sharing the profit) or as purchaser and provider (the first company sells the resource or the processed biomass to the second one).

Good practice example: cooperation with a neighbouring company to reduce the investment cost for La Cavale, France

Located in Limoux in Occitanie (France), La Cavale is a cooperative working as a distillery, oil industry and cereals collector. The company is continuously improving the efficiency of their use of energy and materials. Within the last years, the company have implemented several projects for efficient use of its grape residues and established local composting platform for the grape marc.

Currently, a feasibility study for the development of a gasification plant on the production site is being carried out. Within SUCELLOG project, La Cavale was supported to analyse the opportunity to develop a biomass logistic centre activity. The purpose of the study is to find out which parts and how much of the agricultural biomass could be used for the gasification process and which part can be sold in the bioenergy market.

The cooperative owns storage facilities and a rotary dryer which can be used during the idle periods of their regular activities to produce solid biomass from agricultural residues. However, the company does not have a pelletiser, which is necessary to produce the required format for the gasification process. Investment in a new pelletizer is significant and may reduce the profitability of the project. On the other hand, there is a neighbouring company of La Cavale which just started to produce wood pellets with an annual capacity of around 1,000 tons. The company owns a pelletising system that is able to process 800 kg of pellets per hour, thus they have capacity to process more raw material for other purposes and make the use of the equipment more profitable.

La Cavale contacted the neighbouring company and made a contract of service for pelletising. Before signing the contract, complementary tests have to be made to make sure that intended wood pelletiser is able to work properly with grape marc.

Cooperation with another industry to reduce investment costs

The given case is an example of a ‘win-win’ partnership in biomass processing: the cooperative was able to strengthen their gasification project with less investment costs, while the new pelletising company was able to increase the operation time of their pelletiser, to diversify their activities and to shorten the pay-back time of the investment in the equipment.

This project is also an example of territorial collaboration, enabling the use of agricultural biomass while maintaining local employment and activities.

4 What are the critical points in addressing the bioenergy market demand?

There are several unjustified preconceptions concerning solid biomass produced from agricultural resources. Some of them are questioning the ability of agricultural biomass in responding to the market demand. The most common preconceptions are the following:

- Efficient combustion technologies to use agricultural biomass are not available: it is not true. **Specifically designed agricultural biomass burners exist for both – small and large scale applications.** More information can be found in the Guide on technical, commercial, legal and sustainability issues for the assessment of feasibility when creating new agro-industry logistic centres in agro-food industries of SUCELLOG project.
- Existing agricultural biomass resources are not enough to satisfy the demand for bioenergy: as stated in the Handbook 1—the basic demand of information, the estimations show that the total amount of crop residues that are available for bioenergy production in EU-27, after considering competitive uses, reaches 425,000 GWh (1,530 PJ). Many residues (e.g. corn cobs, prunings, and silos dust) do not have any alternative market and are therefore entirely available for energy production purposes. **Agricultural residues from the cultivation of crops and from agro-industrial activities represent a significant pool of resources** for bioenergy production. The vast variety of biomass resources and their different properties, allow addressing the different customer segments in the most efficient and flexible way.
- Agricultural biomass is too expensive and is not competitive with other fuels: agricultural biomass is produced locally and thus transportation and logistics costs are reduced. Many types of agricultural residues do not have alternative markets and may even represent additional costs for specific treatment or disposal of residues. Costs of shredded and pelletized agricultural biomass depend on the organisation of logistics operations and on the overall investment. However, **in general, agricultural biomass products can compete in quality-price with forest products and fossil fuels.** The following chapter provides an example of the competitiveness of agricultural biomass.

4.1 Be assured that agricultural biomass is competitive and can be mobilized on a large scale

Agricultural biomass suffers from a poor reputation while it can be an opportunity for a biomass project: this resource is locally available and thus contributes to the territory's development, it is produced every year, the price is relatively stable and can therefore compensate a regional lack of forest biomass. That is why, even if its use is more common in the agrarian sector, other stakeholders decided to use agricultural biomass. For instance, the Troyes municipality and the Atomic Energy Commission of Valduc in France both installed boilers using straw bales as fuel.

Good practice example: Highly competitive pellets from vineyard prunings produced by Pélet, combustible de la Mancha, Spain

Pelets, combustible de la Mancha is a company producing solid biomass from vineyard prunings and is located in the region of Castilla la Mancha (Spain). With a maximum *capacity of 20,000 tons per year, they represent the only industrial facility in Europe working with this type of residues. They supply pellets and chips to industries and the tertiary sector in a radius of up to 300 km*.

The plant is placed inside an area of high density of vineyard plantations. The resource is gathered from a surface of 30,000 hectares (mostly small fields) around 30 km maximum. Before the pellet facility was settled, the common practice followed by the farmers was to store the pruning branches at the side of each field to be burnt in the open-air. Currently, the company offers them to pick-up the material once stored, so that farmers save time from the burning process and from all the administrative permits that they had to request. The perception of saving time from the farmer has been crucial for the development of this business model.

Pellets and chips from vineyard prunings present a competitive price in the biomass market in the area compared to the forestry resources. This advantage is not because the resource is obtained for free from the farmers, since the material coming from agricultural practices usually requires to be cleaned from exogenous matter while the forest resource do not normally need such an intense conditioning. The fact that the resource is produced every year, available in the same quantities and at the same distance from the pellet plant is the condition that makes it competitive with forest wood products.

Agricultural biomass can be competitive

The above given example is a project which promotes positive externalities by using local biomass resources. The company has developed sophisticated supply chains and took advantage of the constant production of prunings over the years and the defined location of the production sites. Under these conditions, the company is able to make the production and use of a competitive agricultural biomass.

4.2 Take advantage of the versatility of agricultural biomass

Usually, the biomass market proposes a wide range of products with different qualities and formats to be able to satisfy the needs of various types of consumers. For instance, households would look for high quality biomass whereas, in general, industries are able to cope with lower quality biomass and therefor prefers cheaper biomass resources.

The agricultural sector can provide a large diversity of biomass resources (e.g., silos dust, corn cobs, straw and prunings) which are able to fulfil the demand of one or another consumer. These materials can be sold loose, shredded/chipped, as pellets or as briquettes. Quality of the raw materials can be very different (see part 2.4), but it can be adjusted by mixing with higher quality biomass (e.g., mixing straw with wood) depending on the needs of the biomass end users.

The needs of the consumers therefore have to be carefully evaluated to be able to answer the specific demand in terms of format, quality and organisation of supply.

Good practice example: Addressing the needs of various consumers by versatile biomass products in Daniel Espuny, Spain

Daniel Espuny is an oil pomace extraction agro-industry located in Jaén, Spain. With an intention to diversify their activities, the company started to produce solid biomass from their own by-products. Their agro-industrial facility, with a large capacity, a wide variety of equipment and long idle period, allowed them to reach a position in the market with a reduced need of investment.

Daniel Espuny has been working for more than 12 years in the solid biomass business. One of the keys of their success is the flexibility they offer to the biomass consumers in terms of the quality of the product. From low to high quality biomass, they adjust the product characteristics to the needs of their customers. For example, the olive pits can be provided just as extracted from the olive pomace (with 20-25 % moisture content and with pulp), dried or both dried and cleaned. In terms of format, as they do with the olive pomace, they offer both – pulverised or in pellet format. Trying to explore other resources, different from the regular working line inside the olive oil sector, they have even worked with woody biomass from prunings, almond shells and maize husks.

The market has made them being flexible also in terms of their business model. They can act as biomass producer, as a company providing solely the service of pre-treatment (reduction of particle size, drying, pelletising) or as a product distributor.

Figure 9 : Different formats of biomass provided by the company Daniel Espuny (from left to right: pulverized olive pomace – pruning wood chips – pelletized olive pomace)

Take advantage of the diversity of biomass properties

Daniel Espuny adapted its production to the needs of the market, developing a trusting relationship with its customers and getting the best of its raw materials to answer its market demand. The large diversity of agricultural resources is an opportunity to develop a large range of products and to answer the demand of customers in terms of quality and quantity.

4.3 Consider the option of becoming an energy service provider

Solid biomass market is currently dominated by wood fuels and consequently mostly wood fired equipment, which is not appropriate for agricultural biomass, is installed at consumer sites. **In order to be able to use agricultural biomass, a modification of existing equipment or the installation of a new one could be required. This means investment, which consumers are often not willing to make. One option that prevents this problem to the consumers is contracting the heat service from a so called ESCO (energy service company).** ESCO installs specialized boiler or stove (e.g. multi-fuel boiler) which is able to work with the agricultural biomass, takes care of the maintenance of the boilers and about the supply of the fuel.

A possible business opportunity for an agro-industry is to become the ESCO. Alternatively, the agro industry can make a partnership with some already existing ESCO.

Good practice example: Development of an energy service company by the farmer's cooperative Nahwärme Oberspitz, Austria

The Nahwärme Oberspitz is a cooperative of two farmers from south-east Styria (Austria). The company is currently working as an energy service company. Together the farmers built up a district heating network working with agriculture biomass and now provide heating for 5 farms.

Initially, the intention behind the establishment of the Nahwärme Oberspitz was to cover the energy demand of the two pig farms belonging to the cooperative members. Farm owners wanted to replace the fossil fuel with regional biomass and residues from their own cultivation activities. To be more cost efficient in the operation, they decided to offer heating also to other farmers in the neighbourhood, thus acting as an energy service company. The district heating network of the Nahwärme Oberspitz started its operation in October 2014.

The company is using around 50 % wood chips and 50 % corn cobs as a fuel. Biomass is only partly supplied by the cooperative members. The remaining part is purchased from other farmers in the region. Since the area of Oberspitz is not rich in forests, the opportunities of using agrarian residues in local energy systems are much appreciated.

The heat is produced in a moving grate boiler KWB which is designed for using different types of biomass, including corn cobs. The capacity of the boiler is 100 kW. For covering heat demand peaks, 3,000 litre buffer storage tank has been installed. Heat is supplied using 300 metres district heating grid that connects the facility and 5 small farms.

Thanks to this initiative, 20,000 litres of heating oil are saved every year. This shows that even small projects can be economically feasible and provide environmental benefits, while using agrarian residues from the region.

- **Total cost of the project:** 100 k€
- **Energy covered by biomass:** 100 %
- **Share of corn cobs:** 50 %
- **Energy savings:** 17 toe/year

Extend your services to obtain the market

Extending your services beyond solid fuel production by providing energy services (i.e. becoming an ESCO) might be a good approach to obtain higher market share from consumers which do not own the equipment able to use agricultural biomass fuels. ESCO concept is attractive for fuel consumers since they do not have to invest in a new equipment (investment and operation is made by the ESCO). For the ESCO, stable demand for the solid biomass fuel and for their services is guaranteed in a long term.

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 lessons learned in SUCELLOG project and good practice examples from several European countries. The main points to be analysed while performing the feasibility study have been highlighted.

- The project has to be evaluated as a whole. It is important to not focus on one specific point, but to keep a general overview in order to evaluate the interaction between all elements;

- When evaluating the assets of the agro-industry, different business models may be analysed before choosing the best one for the company.
    - Agro-industries have several advantages for becoming biomass logistic centres – they produce residues on their site, they have equipment for biomass processing, they know the local market and possess the necessary personal skills. All these strengths should be acknowledged and integrated in the success of the overall concept.
    - Creation of partnerships in the territory should be sought to improve the economic performance of the biomass logistic centre. As the production of solid biomass from agrarian resources is not developed, local support is essential to start a new solid biomass business.
    - Interactions with other activities of the agro-industry or neighbouring companies should be analysed to find new opportunities and to improve the profitability of the project. Principles of circular economy and positive externalities may be analysed in order to convince local partners.
    - Considering the difficulties in making agro-pellets competitive to wood chips, an alternative scenario can be assessed: the agro-industry may become a heat supplier for final consumers. It installs the energy equipment (multi-fuel), takes care of their performance and also of the supply the solid biomass – namely, operates as ESCO.

- To find a market, the price of agricultural solid biomass has to be competitive with fossil fuels. That is why production cost should be reduced. Several solutions exist:
    - Agricultural residues are rarely available for free. They are generally already used in different markets such as biogas production, animal feeding of bio-based materials. To reduce production costs, currently unused residues can be mobilised (chaff, wood prunings, plantation removal, corn cobs, etc.). New logistic chains to mobilise and collect this biomass may need thus to be created.
    - To reduce investment, the use of already existing equipment may be necessary. The agro-industry can adapt its own facilities with specific modifications. Another solution is finding another company on the territory already owning the needed equipment and to organise a partnership.

- Development of agricultural biomass market is still hindered by several unjustified preconceptions. Project developers should be prepared to explain the feasibility of their project:
    - Agricultural solid biomass can be mobilised on a large scale and can sufficiently address the demand of large consumers. Examples of large agricultural biomass supply chains in Europe already exist.
    - Agricultural solid biomass is not always expensive. It can be competitive with fossil fuels and with other biomass.
    - The impact of the quality of agricultural biomass is manageable with the new technology that is already available in the market. Once the quality tests are performed and the properties of particular biomass are known, existing multifuel boilers can be adapted and regulated to ensure appropriate combustion process.

Abbreviations

%: percent

€: euros

CO_2: carbon dioxide

ESCO: Energy service company - this type of company installs specialized boiler or stove (e.g. multi-fuel boiler) which is able to work with the agricultural biomass, takes care of the maintenance of the boilers and about the supply of the solid fuel. A service contract is usually made for a certain time period. Consumer continues paying for heat the fixed amount (as agreed in the contract) and ESCO benefits from the margin between energy production costs and income from sales.

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).

ha: hectare

J: Joule

kg: kilogram

kWh: kilowatt hour

m^3: cubic meter

M€: million euros

MWe: electric Megawatt

t: tons

toe: ton of oil equivalent (1 toe = 11,630 kWh)

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Further Reading

The following documents are available on the SUCELLOG website.

Handbooks and guidelines

- SUCELLOG project. (2015). Handbook for agro-industries interested in starting a new activity as biomass logistic centre: the basic demand of information
- SUCELLOG project. (2016). Handbook for agro-industries interested in starting a new activity as biomass logistic centre: carrying out a feasibility study
- SUCELLOG project. (2016). Guide on technical, commercial, legal and sustainability issues for the assessment of feasibility when creating new agro-industry logistic centres in agro-food industries
- SUCELLOG project. (2016). Auditors Guide

Case study reports

- SUCELLOG project. (2015). D4.3a Current situation and feasibility study of Austrian case study
- SUCELLOG project. (2015). D4.3b Current situation and feasibility study of Spanish case study
- SUCELLOG project. (2015). D4.3c Current situation and feasibility study of Italian case study
- SUCELLOG project. (2015). D4.3d Current situation and feasibility study of French case study
- SUCELLOG project. (2015). D4.4a Business Model of Austrian case study
- SUCELLOG project. (2015). D4.4b Business Model of Spanish case study
- SUCELLOG project. (2015). D4.4c Business Model of Italian case study
- SUCELLOG project. (2015). D4.4d Business Model of French case study
- SUCELLOG project. (2016). D6.5b Report on individual auditing studies and diagnosis in France
- SUCELLOG project. (2016). D6.5a Report on individual auditing studies and diagnosis in Spain
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- SUCELLOG project. (2016). D6.5c Report on individual auditing studies and diagnosis in Austria