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

SUCELLOG: IEE/13/638/SI2.675535

D6.5b
Report on individual auditing studies and diagnosis in France

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About 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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About this document

This report corresponds to a part of the D6.5 Report on individual auditing studies and diagnosis in Spain, France, Italy and Austria of the SUCELLOG project. Lead by SPANISH COOPERATIVES, this document has been prepared by:

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Table of contents

List of tables

List of figures

1. Introduction

SUCELLOG supports the creation of biomass logistic centres inside agro-industries covering the gap of knowledge faced when willing to start this new activity. Within WP6, SUCELLOG provides an auditing service facilitating the decision making to agro-industries interested in becoming a logistic centre. Beneficiaries have been object of a previous diagnosis in order to evaluate the degree of matureness to start-up the new activity, their potential and their knowledge gaps.

This document includes, in a first part, a collection of the individual reports of diagnosis carried out in France and, in the second part, the collection of the reports of the auditing services. Finally, a summary of the state of the country with respect to the implementation of the logistic centre in France is included.

2. Companies diagnosed in France

The diagnosis service included questions linked to available biomass, equipment, local biomass market, identifying the best candidates for the audit stage. 27 agricultural cooperatives or branches of agricultural cooperatives were contacted, in France, during the diagnosis (

This document proposes a global revue of the different information gathered during the diagnosis stage, as complement to WP3 analysis, presenting the most interesting sectors to implement the SUCELLOG concept.

It is important to underline the diversity of agro-industries interested by the SUCELLOG concept, in terms of sectors (cereals, distillery and vine, forage dehydration …) and size (few dozen members to tens thousands). This diversity in terms of sectors is presented in Figure 1.

It can be noted that cereal dryers sector is over represented, very concerned by residues uses: large quantity available and growing awareness of their value are key factors to develop the biomass logistic centre concept.

The diagnosis served to evaluate the potentialities of these agro-industries to become biomass logistic centres. After a fair and transparent process, some of them (marked with an asterisk * in the table below) were selected to be beneficiaries of a more detailed study inside an auditing service.

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Table 1. List of diagnosed agro-industries in France.

Region	Agro-industry name	Sector
Aquitaine	SOAL*	Animal feedstuff
Auvergne	Eurea	Cereal dryer
Bourgogne	Bourgogne du Sud	Cereal dryer
Bourgogne	Interval*	Forage dehydration; Cereal dryer, Animal feedstuff
Bourgogne	Lallemand*	Animal feedstuff
Bretagne	Cooperl	Animal feedstuff (and animal productions)
Centre	Axereal	Cereal dryer
Champagne	Acolyance	Cereal dryer
Champagne	Coop de la Mogne	Forage dehydration
Languedoc-Roussillon	Cavale*	Distillery and Cereal dryer
Midi-Pyrénées	Vinovalie	Winery
Nord	Coop Saint Hilaire	Cereal dryer
Normandie	Cap Seine	Cereal dryer
Normandie	Cerena	Cereal dryer
PACA	GPS	Cereal dryer
Picardie	Noriap*	Cereal dryer
Picardie	Tereos*	Sugar industry
Picardie	UCAC*	Cereal dryer
Poitou-Charentes	Durepaire*	Forage dehydration; Cereal dryer
Rhône-Alpes	Jalès	Winery
Rhône-Alpes	Jura Mont Blanc	Cereal dryer
Rhône-Alpes	Lorifruit	Fruits company
Rhône-Alpes	Natura Pro*	Cereal dryer
Rhône-Alpes	SICOLY	Fruits company
Rhône-Alpes	SOFRAGRAIN*	Animal feedstuff
Rhône-Alpes	Top Semence	Cereal dryer
Rhône-Alpes	Valgrain	Cereal dryer

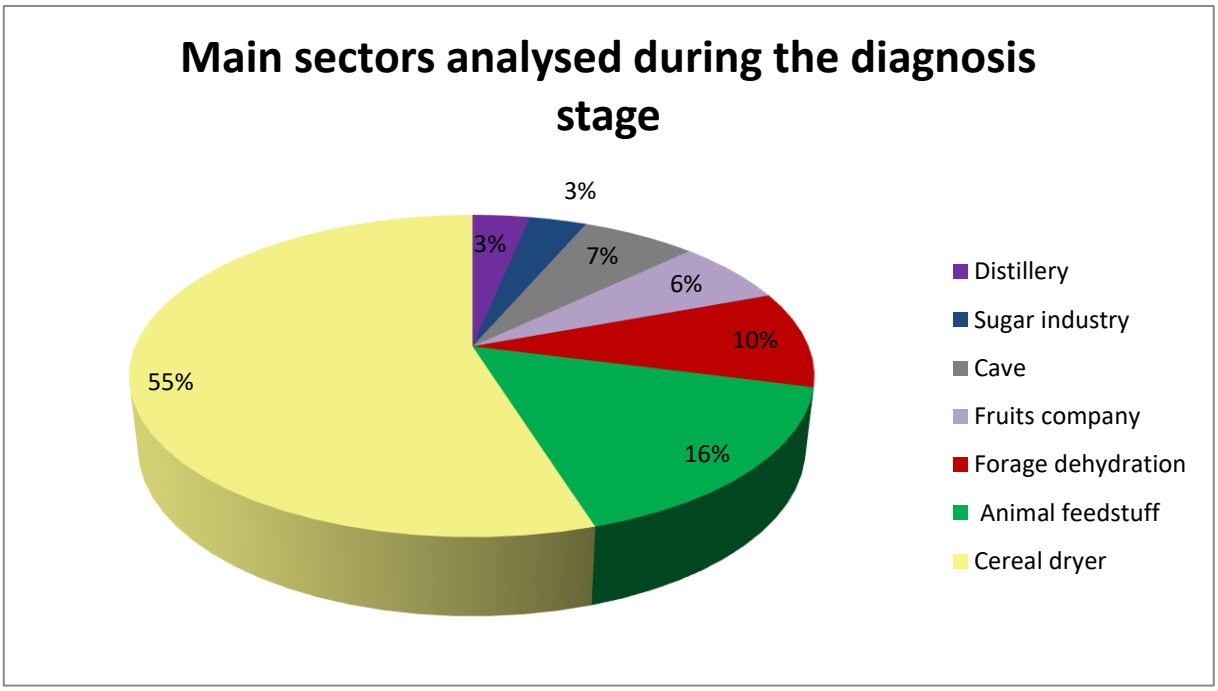


Figure 1 : Diversity of diagnosed cooperatives in France

2.1. General information about their regular activity as agro-industry

The high majority of diagnosed cooperatives belongs to WP3-identified sectors. Cereal dryers and vine producers were particularly targeted because of residues abundance. Sugar industries, distilleries and forage dehydration industries can have access to amortized equipment, in spite of the lake of residues, and can thus propose interesting production costs. Animal feedstuff units, even with no idle period of activities, own residues and equipment for the SUCELLOG concept.

WP3 analysis may be completed by the present analysis.

2.2. Types de ressources en biomasse disponibles

According to the diagnosis, it can be noticed that a large diversity of residues does not imply a large availability for energy. The high majority of residues cited by cooperatives already has uses:

- Use as organic matter on soils.
- Pruning, rape straw, corn cobs are let on the field: there is not logistic chains to harvest them. In the absence of structured market, these logistic chains will not be developed in the next few years.
- Silos dust are mainly used for animal feeding.
- Wet matters are used in animal feeding, methanation or compost.

Resources directly available on industrial sites (corn cobs, silos dust, marcs and pomace) are more interesting. Residues produced on the field are generally already used or cannot be collected because of the absence of structured logistic chains. Except for the straw collection in some area organized for animal breeding, these residues cannot be integrated in logistic chains for energetic uses. This observation is shared by all sectors.

Main availability periods are proposed in Table 2. Biomasses in red do not have structured logistic chains in France.

Table 2. Available residues during the year

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Sunflower stalks												
Rotten fruits (depending on the species												
Silos dust						cereals	cereals		Corn and sunflower	Corn and sunflower	corn	
Grape marc												
Chaff												
Fruits stones												
Olive pomace												
Cereal straw												
Rape straw												

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Seeds and skins												
Corn cobs												
Pruning (vine and fruits)												

Some residues are already used in high value markets (beet pulps for example), in animal feeding, cosmetic or pharmaceutics. They are not included in this study.

2.3. Existing equipment in the agro-industry and availability

Equipment availability is variable, depending on cooperatives, sectors of activity and activities during the year.

- Cereal dryers own silos and dryers available outside the harvesting period. Nevertheless, this expensive equipment is built to treat only cereal grains. Except for crushed biomass (such as almond, seeds, rare in France), they cannot be used to dry solid biomass. These cooperatives do not generally have pelletizing units but large storage places are available.
- Animal feeding industries theoretically work all the year. Nevertheless, this sector has activity pics: equipment is not fully used and may be employed a part of the year for solid biomass production. These units include complete pelletizing line but not always driers. Biomass thus has to be dried before.
- Forage dehydration sector is looking for new opportunities to use its equipment all the year. Units (included dryers, screening equipment, and pelletizing line) may thus be available for energy activities.
- Distilleries own the needed equipment to develop a biomass logistic center activity. On the contrary, caves and fruits activities generally only have storage places.

2.4. Knowledge on the bioenergy sector

Knowledge about the bioenergy sector is highly variable, depending on the cooperative:

- Some, mainly forage dehydration units, already work with wood pellets and know quite well this sector.
- Some own high biomass boilers (corn cobs, silos dust) and thus know the combustion bioenergy sectors and linked requirements.
- Methanation is more often cited (and known) when talking about the bioenergy sector.

2.5. Biomass market in the region

- The most important part of agricultural cooperatives has gardening shops, selling wood pellets for households. They thus generally know this customer segment.
- Beyond this point, only few of them studied the local bio-economy. They know some regional biomass projects but without any particular contacts.

- Only few cooperatives already thought about producing solid biomass for the international market but some studied this possibility.
- Some self-consumption projects are in progress in some cooperatives, completing external customers segments.

2.6. Conclusions of the diagnosis

Interest about the bioenergy sector showed by agricultural cooperative is highly variable and depends on each company: link with another internal bioenergy project (gasification or methanation), « clever diversification », search of new opportunities…

WP3 presented the most interesting sectors to be studied in order to develop the SUCELLOG concept. Using the diagnosis results, this analyse can be affined:

- Cereals dryers, caves and fruits industries own their residues but do not have any equipment. The needed investment for SUCELLOG concept establishment implies thus a structured market, not currently developed or new partnership for solid biomass production. These sectors are not the most interesting when implementing the SUCELLOG concept.
- Forage dehydration companies and sugar industries own equipment but do not have any available residues. They are able to produce solid biomass at an attractive price but have to buy raw material, incrementing the production costs.
- Distillery and animal feedstuff industry own residues and adapted equipment for the biomass logistic centre activity. These sectors are the most interesting ones for the SUCELLOG concept development.

Cooperatives maturity levels are very variable. Some already worked with energy stakeholders in the territory when other lead an active watch on residues uses.

3. Companies audited in France

The following **Table 3** presents a list of the agro-industries audited in France.

Table 3: list of agro-industries audited in France

Region	Name of the agro-industry	Activity
Bourgogne	Interval	Dehydration, cereal, feedstuff
Bourgogne	Lallemand	Feedstuff
Languedoc-Roussillon	Cavale	Distillery and cereal
Rhône-Alpes	Natura Pro	Cereal
Rhône-Alpes	SOFRAGRAIN	Feedstuff
Aquitaine	Sud Ouest Aliment (SOAL)	Cereal, animal feeding
Aquitaine	Durepaire	Feedstuff
Picardie	UCAC	Cereal
Picardie	Tereos	Beet sugar industry
Picardie - Normandie	Noriap	Cereal

3.1. Summary of the audit study to Interval

3.1.1. Company description

The Interval cooperative bought in the 1990s a forage dehydration unit able to pelletise alfalfa. This unit can treat 100 000 t of alfalfa per year, making work 80 to 100 people. This unit is composed of two production lines dedicated to:

- Straw bales production: straw is shredded and compressed in square bales.
- Production of straw, hay, silos dust, alfalfa, hemp and wood pellets.

The cooperative is interested in developing a logistic centre based on agrarian residues in order to develop new profitable markets to sell unused regional residues, complete its decreasing wood pellets production and optimise its equipment uses.

3.1.2. Synergies to become an agro-industry logistic centre

3.1.2.1. Biomass resources availability:

This unit treats the most important part of the Interval's silos dust production, which represents 2,500 t of residues on 40 sites, delivered during all the year at 13% moisture content. Currently, 90% of the resource is sold for animal feeding. Interval would like to work to find new markets for silos dust in case the current market become scarce and unprofitable. Additionally, the company thinks that increasing its production, buying new regional residues not used for animal feeding purposes, can be a good strategy for the future.

Other regional resources may be mobilised, such as hemp dust, cereal straw, hay, rape straw, miscanthus and sawdust. Alfalfa will not be taken into account, since it is already sold in a high added-value market.

Table 4. Available resources for the biomass logistic centre in 50 km radius

Type of residue	Volume (t)	Moisture content w-% ar
Silos dust (wheat, maize, barley)	2,500	13
Hemp dust	1,000	13
Cereal straw	3,500	13
Hay (natural grassland)	1,000	13
Rape straw	1,000	13
Sawdust (deciduous)	No information	50

Taken into consideration the available resources, the biomass to be produced by the logistic centre is proposed to be in a pellet format.

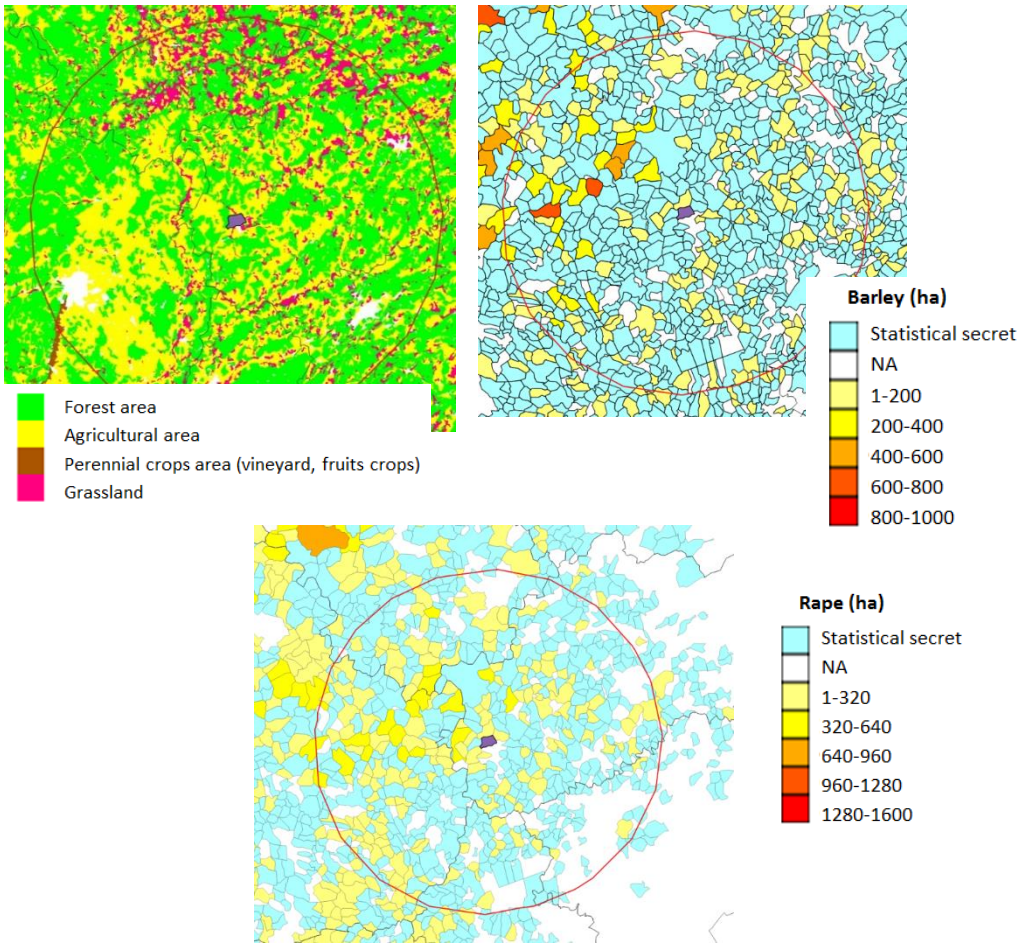


Figure 2 : Resources in the area - GIS maps (50 km radius)

3.1.2.2. Equipment and facilities available

INTERVAL would like to produce at least 2,000 t/yr of agro-pellets to initiate the new activity. Indeed, the cost of production would increase when producing small quantity,

due to the facilities characteristics. Depending on the market, a 10,000 t/yr production could be considered in a short-time.

Alfalfa production line could be used for this production including storage places, shredder, mixer and pelletizing equipment.

Equipment is used all the year with an important workload from May to September during the alfalfa season. Regarding the seasonality of the resources, silos dust is available all the year; straw and hay harvest takes place mainly during summer (June to August) but storage is a common practice The possible production period from October to February suits with the main market demand during winter. It would be possible to work on demand. Moreover, raw materials production period is only few months before, no long storage time would be necessary.

3.1.2.3. Bioenergy market potential

The regional biomass market is focused on wood pellets. Wood pellets are sold 190 €/t (transportation not included), respecting several standards: NF Biocombustibles solides, DIN, DIN +, EN or EN+.

Household consumers segment seems to not be relevant because of the rarity of multifuels boilers. Nevertheless, some municipalities labelled “positive energy territory for green growth” (TEPCV) represent an interesting market. Municipalities are, in general, the customer segment the most interesting to develop agro-pellets.

Table 5. Main regional competitors

Type of residue	Price		Ash content w-% db
	€/t	€/MWh	
Wood pellets NF standards	220	47	≤ 0.7
Wood chips	-	22	1.5

3.1.3. Feasibility of the new business line as agro-industry logistic centre

Four scenarios were identified for the agro-pellets production, theoretically respecting the ISO 17225-6 standards.

Table 6. Studied scenarios

Type of agrofuels	Quantity t/yr
Sawdust / hay Agro-pellets	2,000
Sawdust / hay / hemp Agro-pellets	2,000
Sawdust / hay / silos dust Agro-pellets	2,000
Saw dust / hay / silos dust / straw Agro-pellets	2,000

Cost productions are shared as follows:

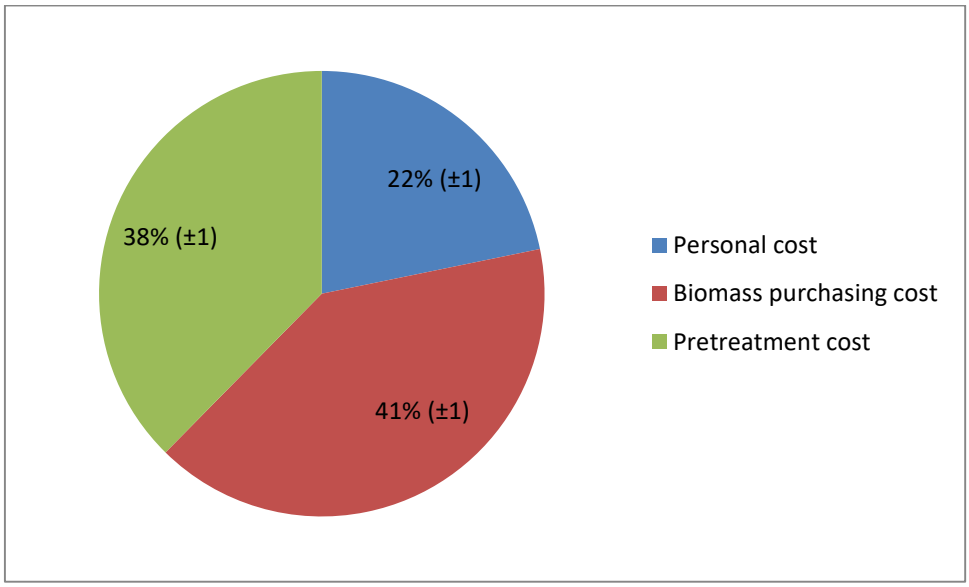


Figure 3 : Production costs allocation for pellets (mean of the four scenarios)

From all the scenarios considered, the sawdust/hemp/hay pellets has the most interesting LHV and the lower ash content. Nevertheless, according to the feasibility study, these pellets are more expensive than wood chips, which can limit the market development.

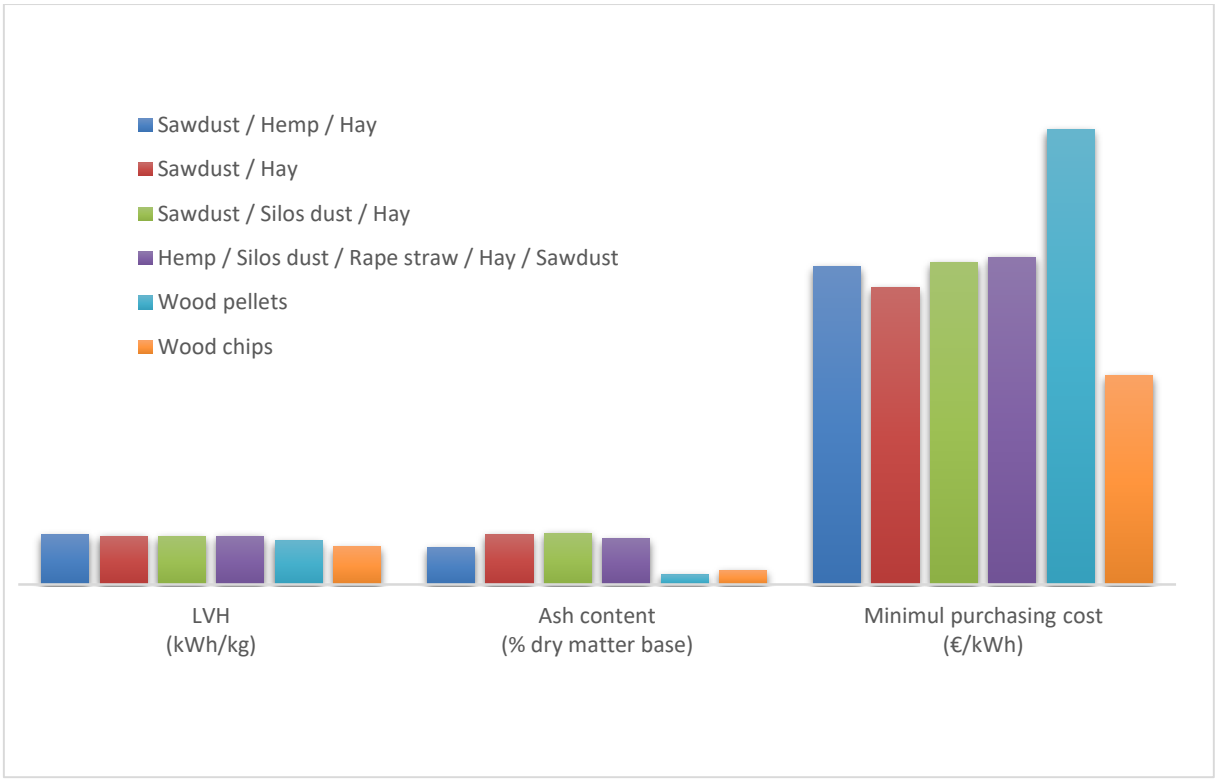


Figure 4 : Comparison between agro-pellets and competitors

However, as a marketing strategy, the cooperative should highlight on the saving space offer linked with agro-pellets when comparing with wood chips. A new costumer segment such as wood pellets consumers should also be targeted.

3.1.4. Conclusions

Due to the current context, Interval is looking for new strategies of development. According to SUCELLOG study, the cooperative can easily become a biomass logistic centre. The company already owns all the needed equipment to initiate a pellet production activity. Moreover, it has a good knowledge on the agricultural residues market and can thus buy additional resources, if needed, which are not in competition with the current uses.

Interval can produce different agro-pellets, the most interesting one (from an economic point of view) being the mix sawdust / hay, with a lower calorific value of more than 5 kWh/kg but high ash content (> 5 %). In order to include this kind of pellets from agrarian source in the market, partnership with local actors (industrial, municipalities) should be developed and combustion tests should be performed in order to check their combustion feasibility.

3.1.5. Extra support provided to the cooperative

The cooperative was interested in having an estimation of the feasibility of the project, knowing the available resources in its territory, the local bioenergy market and an estimation of the needed investments to adapt its equipment to become a biomass logistic center. This information is available in the audit carried out by French regional agrarian associations. Beyond the audit, the cooperative was also interested by a personalized extra-support, carried out by French SUCELLOG partners:

- **Interval was looking for new solutions to use its silo dusts residues as their quality is not always good enough for animal feeding, engaging agro-industries and promoting synergies to develop this project.**

> Because of expectations of several cooperatives involved in SUCELLOG, SCDF decided, with Coopenergie, to develop a “silo dust group” to develop new solutions to use this product, in partnership with Coop de France. This group was launched with the impulsion of SUCELLOG partners (cooperatives and agrarian association). The energy uses as solid biomass was obviously studied during this group meeting, as well as other solutions such as chemical uses. This group took place the 13.09.16 and Interval was attending. Another session will be done in June 2017.

> Interval was interested in having contacts to develop its own study of silo dust uses in energy or for other uses. SUCELLOG gave them contacts from several companies working on agricultural biomass: the Industrial Agro Biotechnology chair of AgroParistech working on agricultural biomass residues (mainly for chemical uses) but also the direct contact of Stolz company to have prices of equipment to treat agricultural biomass.

- **Interval was looking for solutions to reduce its investment costs.**

> Showing real experiences: Interval was really interested in developing an activity of biomass logistic center but wanted feedback from already existing logistic center to analyse the market opportunities. That is why, during a “SCDF-biomass club” to whom Interval attended, the Ile-de-France Sud cooperative was invited to present its experience as agricultural biomass logistic center.

3.2. Summary of the audit study to ETS Lallemand

3.2.1. Company description

ETS LALLEMAND is located in Val de Mercy (89 – Yonne). Branch of the AXEREAL group, it buys 30,000 tons of silos dust per year to produce pellets, used by animal feeders.

The company is interested in becoming a biomass logistic centre, in a general context because of the cereal price decline (which is directly linked to their final product price), but also to optimise the use of its equipment and to find new profitable market to sell a part of its unused production.

3.2.2. Synergies to become an agro-industry logistic centre

3.2.2.1. Biomass resources availability:

ETS LALLEMAND treats 30,000 tons of silos dust (from barley, wheat, corn, rape and sunflower), managing silos dust collection, producing the pellets and delivering to the final consumer.

For the development of a logistic centre, biomass resources available all the year are mainly silo dust but also others like cobs or pruning.

Table 7. Residues locally available in a 50 km radius

Type of residue	Volume (t/yr)	Moisture content (w-% ar)	Months of harvest
Silos dust	30,000	10 - 15	All the year
Corn cobs	500 – 1,000	13	September to November
Wine pruning	5 – 10,000	50	January to April
Hemp dust	No information	10 - 15	All the year, 40% in autumn

Although vineyard pruning seems to be an interesting resource for the new business line, it has been discarded by the cooperative in a fist stage because there is no current logistic chain created to gather this residue. Additionally, it is possible to find other biomasses in the territory, non-included in this study because of the competition with other uses:

- Rape straw: this biomass is left on the field as organic amendment.
- Cereal straw: use for animal breeding.

Taking into consideration the resources available, the solid biomass to be produced by the logistic centre is proposed to be in a pellet format.

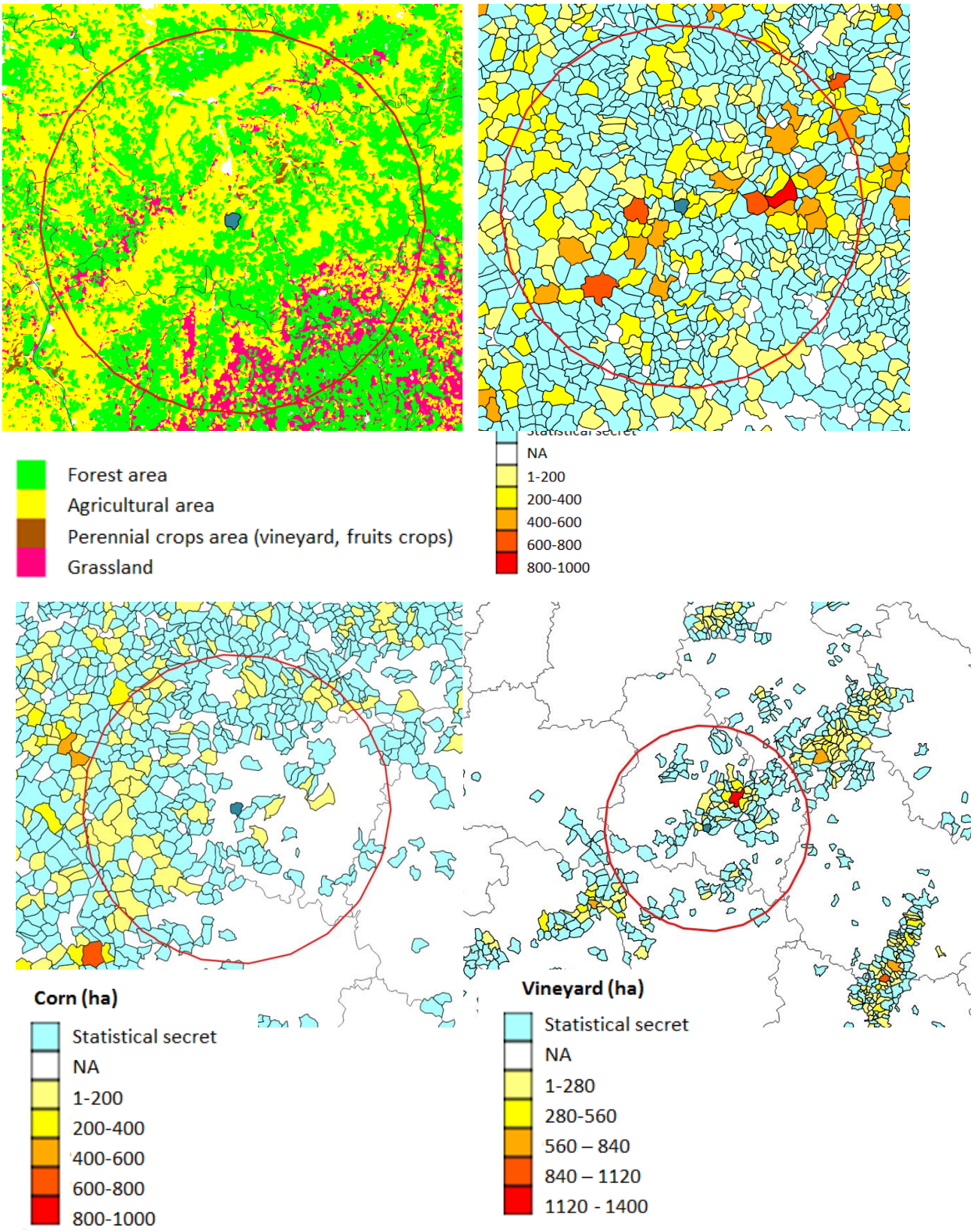


Figure 5 : Biomass resources in a 50 km radius - GIS maps

3.2.2.2. Equipment and facilities available

For the new pellet production activities destined to energy, ETS Lallemand is able to use its own equipment during low production periods along the year without any investment. More specifically, it would be used:

- Storage places for raw materials
- The pelletizing line (shredder, mixer, pelletizing press and cooling equipment).
- Silos as storage place for final product.

Silos dust is available all the year whereas corn cobs are produced from September to November. Since the most important period for heating demand is during winter, the most convenient period of activity for the logistic centre would be from October to February in order to reduce the storage time of silo dust and allowing to work on demand for the final product production. This period is a low production period for animal feeding production and would permit the implementation of another activity.

The current production line can generate 8 t/h and a total of 10,000 t/yr. Although it does not own a dryer, no investment has been forecasted to implement the SUCELLOG concept. For the biomass logistic centre, drying stage is proposed to be avoided by mixing biomasses with different moisture contents.

3.2.2.3. Bioenergy market potential

Households market is not relevant for agro-fuels since multifuels boilers or stoves are rare in the territory for this customers segment. The market analysis demonstrated that there is no agro-pellet market in the area even if a local company has been working on its development for years and that some biomass boilers may be compatible. However, some municipalities labelled “positive energy territory for green growth” (TEPCV) may represent an interesting market. Municipalities are, in general, the customer segment the most interesting to develop agro-pellets and alliances should be considered.

Table 8. Main competitors in the territory

Type of residue	Price		Ash content w-% db
	€/t	€/MWh	
Wood chips	-	22	1.5
Wood pellets	200	47.83	1.0

3.2.3. Feasibility of the new business line as agro-industry logistic centre

The cooperative is interested in initiating a new production line, producing and selling agro-pellets as presented hereafter:

Table 9. Studied scenarios

Type of agrofuels	Quantity t/yr
Mixed pellets (using its own residues)	5,000
100% corn cobs pellets	1,000
Corn cobs / hemp dust pellets	1,430

A percentage of mixture between the resources has been calculated to fulfil ISO 17225-6 requirements (starting from average values for each resource taken from bibliography). In the case of the mixed pellet, the study has shown that it is not possible to fulfil ISO 17225-6 quality requirements and for this reason it has been discarded. However, additional tests should be done in accredited labs to analyse the chemical and physical characteristics of the pellets.

Production costs allocation for the proposed pellets is shown in Figure 6.

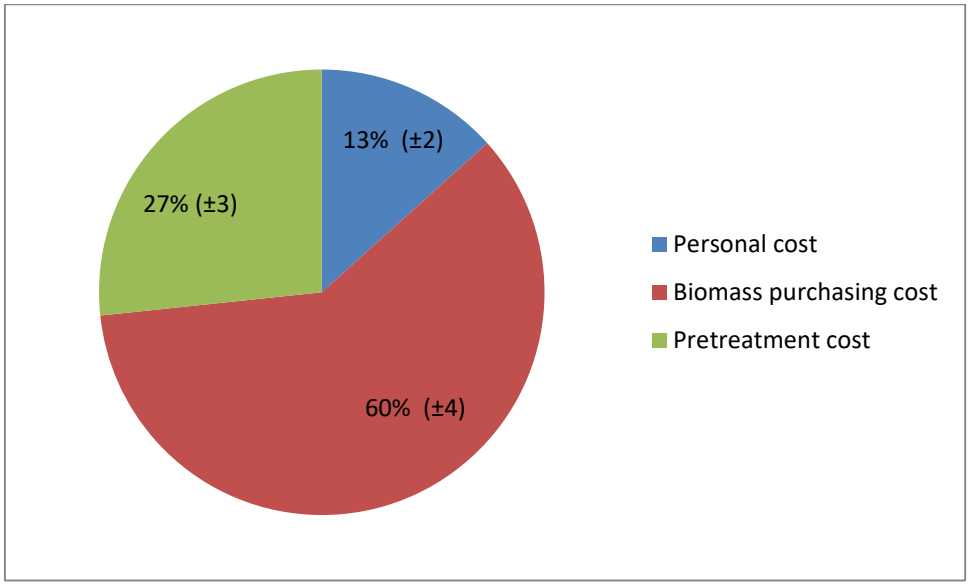


Figure 6 : Costs allocation for agro-pellet production (means of the 3 scenarios)

The price comparison of the different types of pellets proposed against the current solid biomass in the market can be observed in Figure 7.

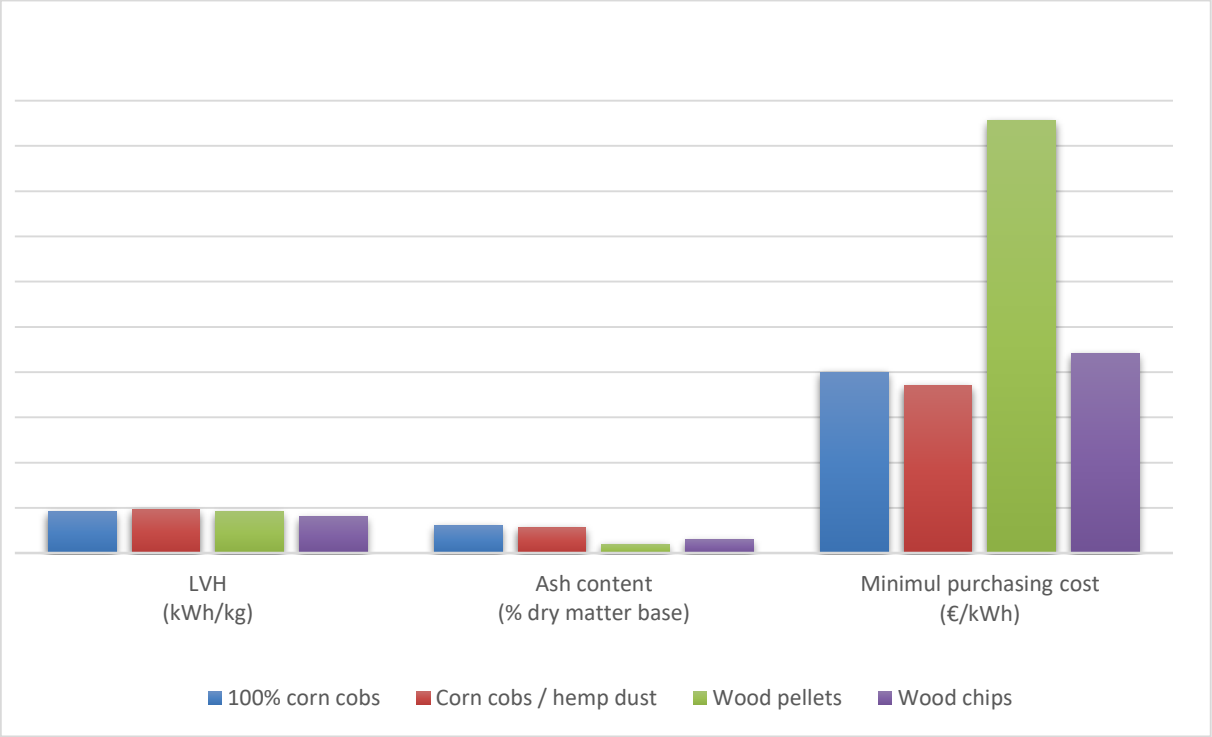


Figure 7 : Comparison between agro-pellets and competitors

When comparing the produced agro-pellets with their competitors on the territory, considering prices and properties, it can be noted that agro-pellets are fully competitive in terms of euro per energy both with wood pellets and wood chips. Nevertheless, the higher ash content should be taken in consideration when fixing the final price of the product.

3.2.4. Conclusions

ETS Lallemand acquires annually 30,000 t of agricultural residues (silos dust, corn dust and oleaginous products) and transforms them into pellets used for animal feeding. Because of the present context, the cooperative is evaluating other possible uses for these residues like the generation of biomass products.

The study performed within SUCELLOG has concluded that ETS Lallemand can easily become a biomass logistic centre, owning the equipment required to initiate an agro-pellet production. It has good experiences in agricultural markets and can thus easily acquire raw materials (corn cobs, hemp dust) complementing their own residues if needed.

Agro-pellets complying with the ISO 17225-6 standard can – theoretically – be produced, using available biomasses on the territory. Two types of pellets have been considered as the most feasible to be produced with a competitive price in the market (even with wood chips): an agro-pellet using corn cobs and a second one mixing corn cobs and hemp dust.

Strategic alliances with municipalities can be the way to promote the market of agro-pellets in the area, which is very scarce at the moment.

3.2.5. Extra support provided to the cooperative

The cooperative was interested in having an estimation of the feasibility of the project, knowing the available resources in its territory, the local bioenergy market and an estimation of the needed investments to adapt its equipment to become a biomass logistic center. This information is available in the audit carried out by French regional agrarian associations. Beyond the audit, the cooperative was also interested by a personalized extra-support, carried out by French SUCELLOG partners:

- **ETS Lallemand was looking for new solutions to use its silo dusts residues as their quality is not always good enough for animal feeding, engaging agro-industries and promoting synergies to find new solutions**

> Because of expectations of several cooperatives involved in SUCELLOG, SCDF decided, with Coopenergie, to develop a “silo dust group” to develop new solutions to use this product, in partnership with Coop de France. This group was launched with the impulsion of SUCELLOG partners (cooperatives and agrarian association). The energy uses as solid biomass was obviously studied during this group meeting, as well as other solutions such as chemical uses. This group took place the 13.09.1. Another session will be done in June. ETS Lallemand was interested but did not attend. Nevertheless, they ask for the detailed report of the meeting.

> ETS Lallemand was integrated, thanks to its participation in SUCELLOG, in a biomass logistic project organized by SCDF to optimize logistic issues.

- **ETS Lallemand was looking for more information about energy uses of agricultural biomass.**

> ETS Lallemand was attending a visit of biomass boilers organized by SCDF to promote the opportunities to use agricultural biomass for energy.

3.3. Summary of the audit study to La CAVALE

3.3.1. Company description

La Cavale is a 5-branches cooperative working as:

- **Supplier**: supply of phytosanitary products and fertilizers.
- **Distillery**: production of alcohol made with grape marc, use of seeds and fine pulps.
- **Cereal collection**: collection and sorting of cereals from its members.
- **Oil industry**: olive oil milling.
- **Distribution**: 5 gardening shops, including 4 Gamm Vert.

La Cavale is interested in initiating a new activity as biomass logistic centre, producing and selling agro-pellets. They are currently developing a strategic project to provide added-value to their usual residues (compost, pharmaceutic) and to use them as energy source for their own consumption (gasification project in progress).

3.3.2. Synergies to become an agro-industry logistic centre

3.3.2.1. Biomass resources availability:

The main biomass resources to be considered for the development of the logistic centre are the own residues produced by the usual activity. The three main activities (distillery, cereal sorting and oil production) producing residues are located on the same site and thus no transport cost is required.

Table 10 : Residues available in the cooperative site

Type of residue	Volume (t/yr)	Moisture content w-% ar	Months of availability	Current uses
Silos dust	7.5 - 30	13	June - August	Organic matter
Exhausted marc	5,000 – 6,000	60	September - January	Organic matter, compost
Olive pomace	40	45	November - December	Organic matter

In addition to the cooperative residues, some other biomass sources are:

- **Silos dust:** 20,000 to 25,000 t of cereals are produced within 20 km, representing 50 to 250 t of silos dust. A large quantity of straw is also available but, because of the breeding activity, this type of biomass will not be taken into account.
- **Exhausted marc:** apart from the residues from La Cavale distillery, another company (at 20 km from the cooperative) produces 5,000 t of marc (60 % moisture content).

- **Wood:** it is easy to find wood in the territory thanks to high forestry areas. Wood chips can be bought around 25 €/t and wet sawdust (30-35 % moisture content) 35 €/t ex-factory (transport cost not included).
- **Vineyard pruning:** 8,000 ha of vineyards are located in 20 km from the cooperative, including 4,000 to 5,000 ha belonging to cooperative members. 1,000 to 8,000 tons of pruning may be thus collected. Nevertheless, this resource has not been taken into account because of the absence of already existing logistic chain.

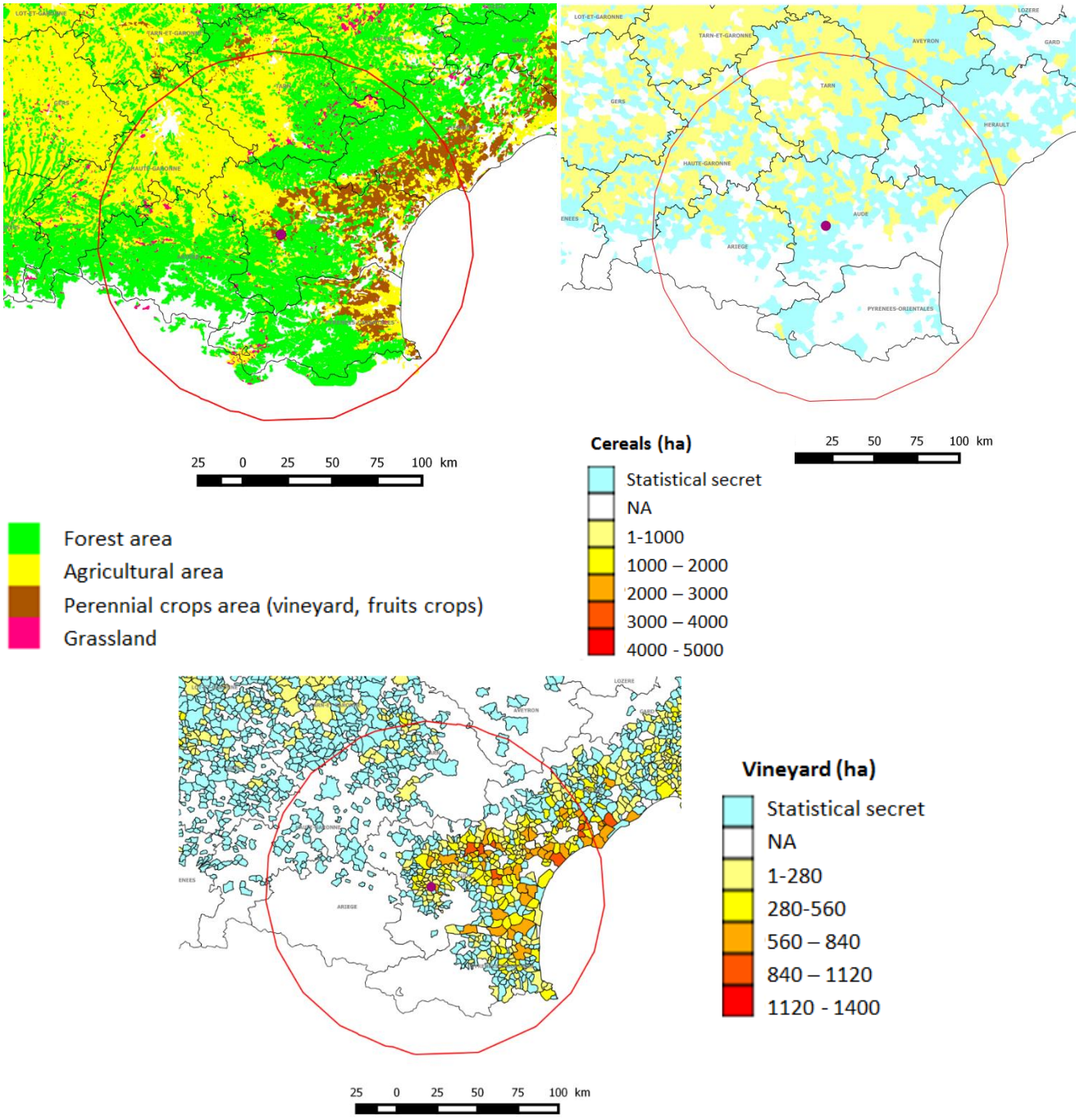


Figure 8 : Resources in the area (100 km radius) - GIS maps

Exhausted marc, which is the most important resource belonging to the cooperative and currently not used, should be the base of the possible biomass product to be generated in the logistic centre. Olive pomace and silo dust can be a complement of it, as well as other sources in the area like sawdust. All possible combinations with exhausted marc have been studied in SUCELLOG analysis according to ISO 17225 quality limits.

The cooperative is planning to sell a part of this solid biomass production (but also to consume a part of it in a gasification process.

Taking into consideration the type of resources available as raw materials and the fact that the gasification process consumes pellets, the proposed product for the new business line of la Cavale is an agro-pellet.

3.3.2.2. Equipment and facilities available

The cooperative owns a rotary drier, which is fully used from January to May. Since the company does not own a pelletising line, a local company, close to the cooperative, could be subcontracted to make the pelletising service. This company is currently producing wood pellets from wooden pallets (no purchasing cost) or naturally dried sawdust (acquired at 35 €/t – 35 % moisture content).

For their operation as a biomass logistic centre, the dryer is considered to be the own equipment to be used together with:

- Storage facilities for raw materials.
- Storage buildings for final product.

No further investments are forecasted.

Biomass is mainly available in summer for cereal residues and from September to January for wine residues. Equipment is available from summer to January. The cooperative can thus work on demand during that period reducing the storage time for raw materials as well as for final product.

3.3.2.3. Bioenergy market potential

Self-consumption: la Cavale is currently working with the Languedoc-Roussillon ADEME (the French Environmental and Energy Agency) to analyse the technical and economic feasibility of a gasification unit to cover the heating needs of the cooperative. This project would consume 1,500 t of dry marc in pellet format that could be produced by the logistic centre. If the cooperative decides to self-consume agro-pellets using the gasification unit under construction, it should be validated that the energy production is higher than the consumed energy used for the pellets production.

Local market: local market is similar to French market, focused on wood pellets and wood chips. Some multi-fuels boilers are installed on the territory and they can be

considered as the target segment to be focus by the logistic centre to be implemented. Some municipalities should also be engaged to develop the agro-pellet market.

Table 11 : Main competitors in the area

Type of residue	Price		Ash content w-% db
	€/t	€/MWh	
Wood pellets	280	61	1.00
Wood chips	110	28	1.50
Wood pallets chips	80	27	2.00

3.3.3. Feasibility of the new business line as agro-industry logistic centre

From all the possible available resources, only one scenario was chosen for the agro-pellets production, following the ISO 17225-6 standards requirements on quality characteristics and considering theoretical quality properties for the different resources available.

Table 12 : Studied scenario

Type of agro-fuels	Quantity t/yr
Grape marc / sawdust pellets	1,900

The theoretical properties (average values for each resource taken from bibliography) of produced pellets seem to be interesting with a high lower calorific value (> 5 kWh/kg) and low contents of K, Cl and N. Nevertheless, the high ash content could be a serious obstacle for the sale in the local market. In order to respect the ISO 17225 quality, less than 35% of marc has to be used.

Production costs allocation for the mixed pellet is shown in Figure 9.

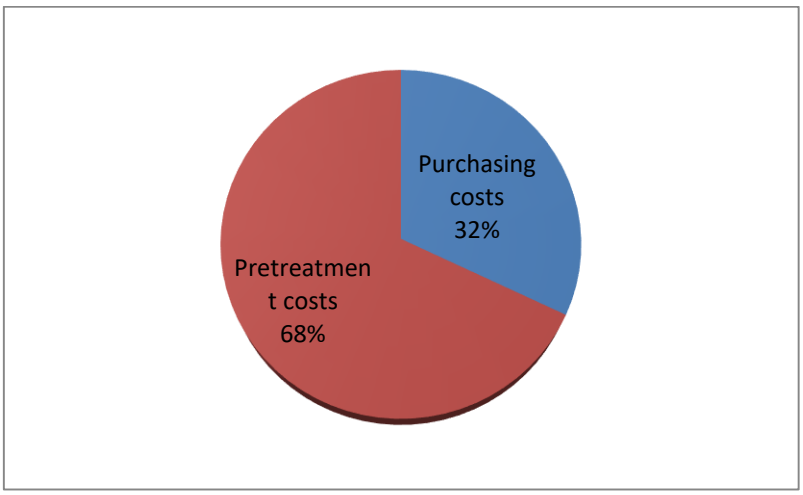


Figure 9 : Costs allocation for agro-pellet production

As it can be observed from Figure 10, when comparing La Cavale's agro-pellets and other local solid biomasses, it can be noted that la Cavale agro-pellet is highly competitive with

wood pellets but also with high-medium wood chips. This lower price is a pre-requisite to pellets development. However, higher ash content should be taken into account.

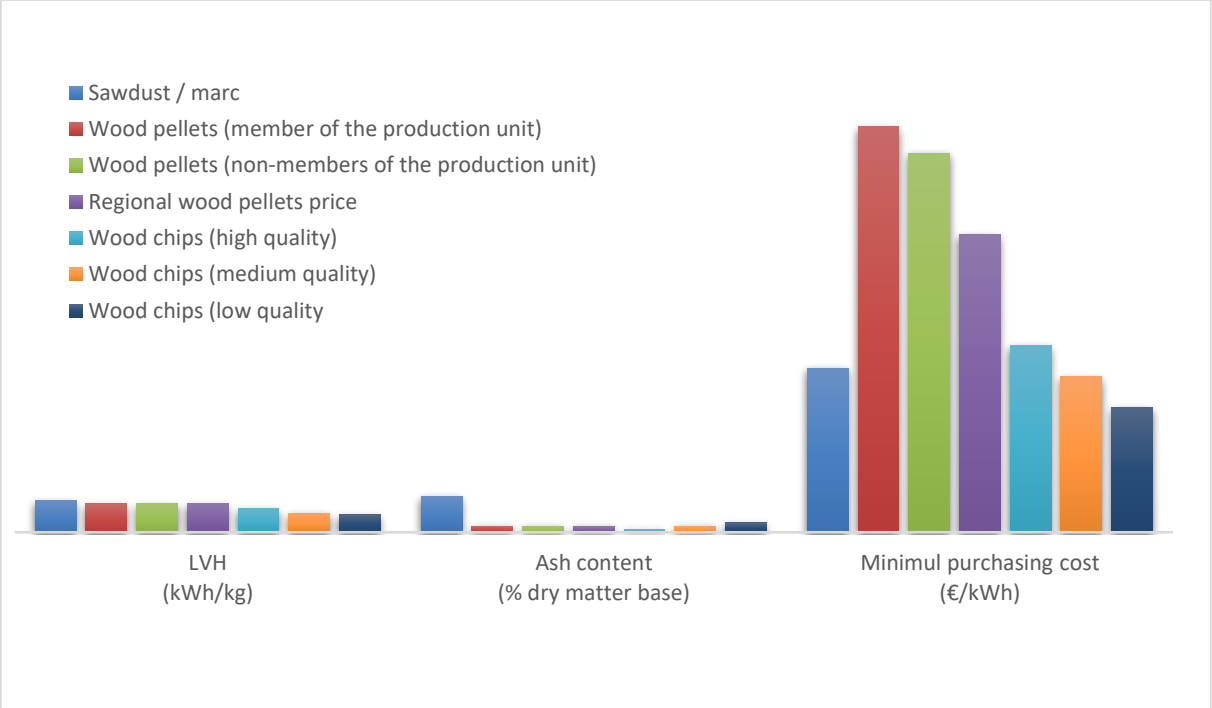


Figure 10 : Comparison of the agro-pellets and competitors in the area

Combustion tests in boilers are necessary to validate the results on the equipment performance in order to avoid consumers' dissatisfaction.

3.3.4. Conclusions

La Cavale is currently looking for new opportunities to use its residues. Composed by marc (without alcohol, seeds and pulps), mixed with silos dust and olive pomace, a part of this residue is used as compost and spread on fields (adding a cost for the cooperative). Within SUCELLOG project, la Cavale has been object of a study in order to evaluate the possibility to generate a logistic centre in their facilities which transform these residues into a pellet for energy production.

Regarding the equipment, the cooperative does not own a pelletising line. It recently invested in a new dryer and can, nevertheless, built a partnership with a local wood pellet producer to quickly develop this new production.

SUCELLOG results showed that it is possible to develop a competitive pellet out of sawdust and exhausted grape marc with high calorific value (> 5 kWh/kg) and low production costs. Nevertheless, a higher ash value compared to marketed products should be taken into account and therefore chemical analysis and combustion tests should be made to ensure the feasibility of this product before marketing.

3.3.1. Extra support provided to the cooperative

The cooperative was interested in having an estimation of the feasibility of the project, knowing the available resources in its territory, the local bioenergy market and an estimation of the needed investments to adapt its equipment to become a biomass logistic center. This information is available in the audit carried out by French regional agrarian associations. Beyond the audit, the cooperative was also interested by a personalized extra-support, carried out by French SUCELLOG partners:

- **Looking for a solution to use their biomass residues**

> SCDF worked with la Cavale to develop its gasification project in order to use its own residues to produce energy in auto consumption, studying the best technology (boiler or gasification unit) suitable with the cooperative 'needs, the available resources used as solid biomass and the needed power for the future unit.

- **How linking the SUCELLOG concept to their gasification project**

> La Cavale asked for support to SUCELLOG partner to gather its gasification project and the possibility to sell agricultural biomass for energy (as SUCELLOG concept). SCDF and CDF-RAA discussed with the cooperative to analyse the needed resources for gasification and the possibility to use the same ones as solid biomass to be sold in the bioenergy market. SCDF and CDF-RAA were thus working together with la Cavale to develop a global concept of gasification with integration of the SUCELLOG concept.

> La Cavale also worked with SCDF to develop energy efficiency through an energy audit, taking into account the biomass project.

- **Looking for partners to develop this project**

> SCDF and CDF-RAA presented to la Cavale the possible public aids to develop their project (mainly ADEME). La CAVALE did a call for applications to ask for support to develop its important energy project, taking into account our advices

> CDF-RAA organized a meeting with the possible partner defined in the feasibility study to share the equipment - PAN SAS - and the Pôle Energie 11 able to support la Cavale when developing its whole project. They discussed about the possible support of the energy project of the cooperative and an action plan to structure it.

All of that being integrated in an important energy strategy (energy saving, cost saving) and use of waste (a part of residues is already used as a specific compost).

La Cavale will begin a logistic center in the next few months. It already tested its raw materials with RAGT energy (met thanks to SUCELLOG project) and is negotiating to buy sawdust with an external company to produce its pellets. It is currently leading a large feasibility study for a circular economy project integrating the gasification project and the sale of projects. This is included in their 2020 strategy. They hire one person to lead the project and may invest 1.3 M€ in the next few years for the entire project (including the

biomass unit). The ADEME is already paying a part of the feasibility study and will probably support the gas unit investment.

3.4. Summary of the audit study to Natura Pro Company

3.4.1. description

Natura'Pro is a cooperative placed in Montelimar (Drôme). It works on 4 departments (Loire, Ardèche, Drôme, Gard and Vaucluse) on different activities:

- Cereal harvesting, sorting, drying, selling.
- Gardening shops.
- Supply shops for its members.

Natura'Pro is nowadays working on improving its waste uses in order to reduce the incurred costs. The cooperative is currently offering – for free – its silos dust to its members or is paying to have access to composting plant. For this reason, the cooperative would like to find new opportunities to develop a new profitable market for these residues.

3.4.2. Synergies to become an agro-industry logistic centre

3.4.2.1. Biomass resources availability:

As said before, the cooperative has access to silos dust from their own activity (from the different grain storage places belonging to the cooperative, at 150 km around the cooperative), which would be the base of the product to be generated by the biomass logistic centre.

Other different biomass resources are:

- **Wood:** wood residues are produced in the cooperative's gardening shops from non-usable pallets.
- **Green waste:** from non-sold products of gardening shops. However, they cannot be used as a biomass product for their large moisture content, being generally mixed with breeding ground and soil.
- **Straw:** non-used straw may be mobilised on the territory for biomass uses.

Table 13. Available resources for the biomass logistic centre

Type of residue	Available quantity (t/yr)	Moisture content (%)
Silos dust (wheat, barley, maize,…)	250	30 to 40
Cereal straw	NA	12 to 15

Although wood and straw resources are available, the cooperative would like to try first with the silo dust as a first approach for the construction of the logistic centre.

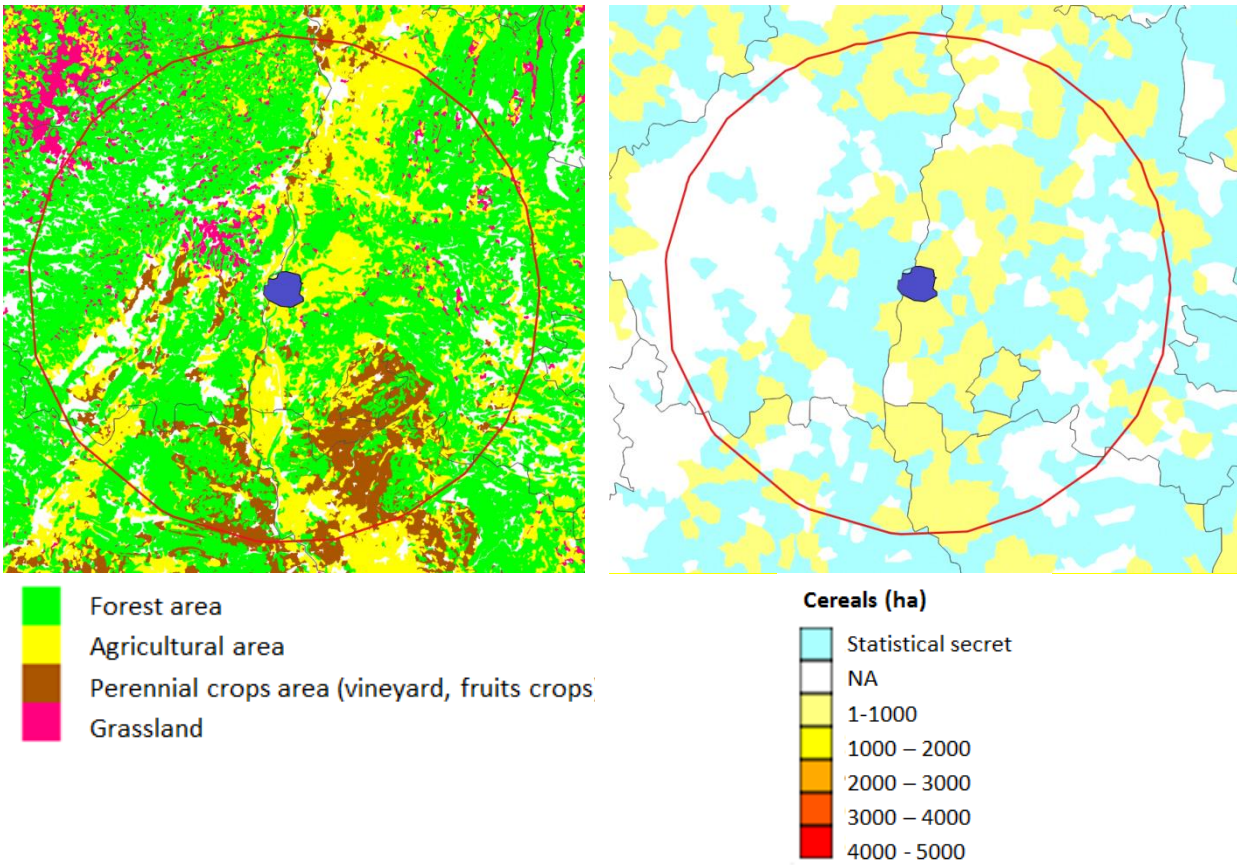


Figure 11 : Resources in the area - GIS maps

3.4.2.2. Equipment and facilities available

Taking into consideration the available resources (diversity and low quantity), only solid biomass in a pellet format can be produced to propose a homogeneous mixed product. However, Natura'Pro does not have pelletising line or shredder for its production. Neither, silos and driers, which are dedicated to cereals work all along the year, can be used for the biomass logistic centre. For this reason, SUCELLOG study has considered two possibilities: (1) the investment of a new production line (shredder, mixer, press, pelletizing equipment, cooler and conveying system); and (2) a partnership with a subcontractor to make the pelletising service from the residues of the cooperative.

3.4.2.3. Bioenergy market potential

In the area of the cooperative, households' market is not relevant for a product from agrarian sources since multifuel boilers or stoves are rare in the territory for this consumer segment.

However, some boilers using corn cobs have been identified on the territory, which could be the target consumers of the proposed logistic centre. Combustion tests should be performed in these boilers to confirm the compatibility of the generated product with the existing equipment.

Some municipalities labelled "positive energy territory for green growth" (TEPCV) may represent an interesting market. Municipalities are, in general, considered as the most relevant he custom

er segment to develop agro-pellets. Nevertheless, interviewed municipalities remain prudent, focused on wood sector developed in the same time than wood boilers, despite of the reduction of price that these alternative fuels present. An intense work (offering price-quality and good service) should be done in that sense to try to engage them as agro-pellet consumers in order to ensure the viability of the project.

Table 14. Main regional competitors

Type of residue	Price		Ash content w-% db
	€/t	€/MWh	
Wood pellets (NF, EN, EN+)	220 - 280	40 - 60	< 1
Wood chips (< 30% moisture)	120	30	1.50
Low quality wood chips (> 30 % moisture)	70	35	2

3.4.3. Feasibility of the new business line as agro-industry logistic centre

As mentioned previously, two scenarios have been considered for the development of a biomass logistic centre in Natura'Pro.

Scenario 1: Investment in new equipment

A new production line costs between 400,000 and 900,000 €, including drier, shredder, mixer, press, pelletizing equipment, cooler and conveying system. This price depends on the treatment capacity (0.3 t/h to 5 t/h).

Producing the silos dust / maize dust / oleaginous pellet and taking into account the volume, only 38 t to 95 t of agro-pellets may be produced annually (limited by oleaginous residues quantity).

Since the investment is important for the limited volume produced, this scenario is not possible: considering an investment of 400 000 € (the lowest possible) and the best production scenario of 95 t/yr, it results in a 10 year payback period, the incurred cost for the pellet production would be more than 400 € per ton, which is not competitive in the market.

Scenario 2: Work with a subcontractor

A regional company is able to produce agro-pellets as subcontractor. Natura'Pro can contract the pelletising service and sell the final product in its own sale channels.

Considering therefore the production according to scenario 2, the price comparison of the different types of pellets proposed with the current solid biomass in the market can be observed in Figure 12.

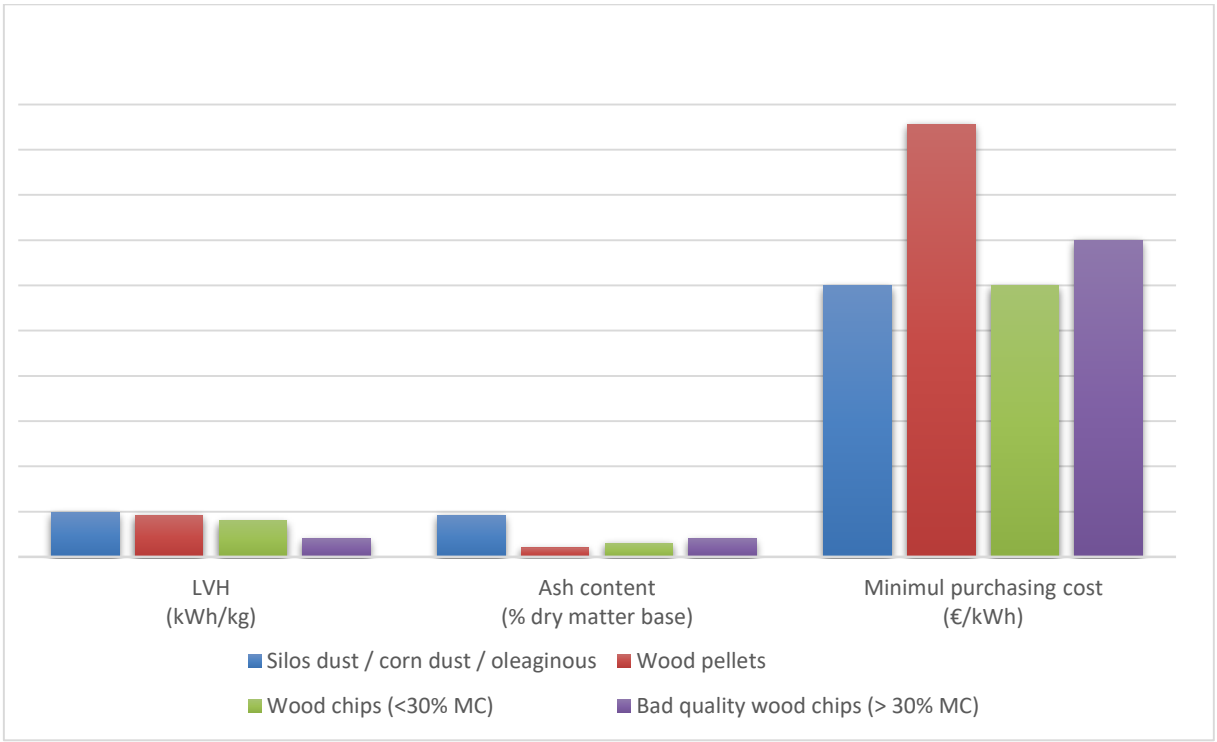


Figure 12 : Comparison between agro-pellets and competitors

When comparing the produced agro-pellets with their competitors on the territory, considering prices and properties, it can be noted that agro-pellets are competitive with

wood pellets and bad quality chips. Nevertheless, the ash content should be evaluated in order to avoid problems in consumers' equipment. The storage savings compared to wood chips should be highlighted as an advantage to consumers.

3.4.4. Conclusions

Natura'Pro is currently processing 20,400 t/yr of cereals, oleaginous and leguminous plants, which represents annually a residue of 644 t of silos dust that requires management. The cooperative is looking for new opportunities for this residue, considering that only 250 t/yr are available and stored in good conditions.

The cooperative does not have needed equipment to become a biomass logistic centre. It can either work with a sub-contractor to produce pellets or invest in a new production line. The production cost analysis has demonstrated that the investment in a new pelletizing line is not profitable and therefore this option is not economically possible. Partnership between to SUCELLOG company seems to be a relevant solution for Natura Pro.

According to SUCELLOG study, a mixed pellet from silos dust / maize dust / oleaginous residues, (theoretically respecting the ISO 17225-6 quality limits) can be produced being competitive with wood pellets and chips. Chemical analysis in lab as well as combustion tests in local combustion facilities should be considered before marketing the product in order to check their suitability and compliance with ISO 17225-6 quality requirements.

3.4.1. Extra support provided to the cooperative

The cooperative was interested in having an estimation of the feasibility of the project, knowing the available resources in its territory, the local bioenergy market and an estimation of the needed investments to adapt its equipment to become a biomass logistic center. This information is available in the audit carried out by French regional agrarian associations. Beyond the audit, the cooperative was also interested by a personalized extra-support, carried out by French SUCELLOG partners:

- **Natura Pro has residues but does not know how to use them. The company is looking for a profitable solution instead of paying to dispose them.**

> After the SUCELLOG feasibility study, it was stated that produce solid biomass is not profitable for the company (only 200 tons of products for hundreds of thousands euros of investment) and they were looking for a new solution. That is why, CDF-RAA proposed a partnership with the SOFRAGRAIN company. For this reason, SOFRAGRAIN was contacted and a possible solution was analysed: Natura Pro may supply SOFRAGRAIN with its residues, SOFRAGRAIN being the main regional biomass logistic center.

3.5. Summary of the audit study to SOFRAGRAIN

3.5.1. Company description

SOFRAGRAIN, branch of the Terre d'Alliance group, is an animal feedstuff company placed in Varambon (Ain).

SOFRAGRAIN produces 3 products:

- 20,000 t of pellets – mix of agricultural residues (silos dust, oleaginous crops) and raw materials (maize, barley, wheat, rape);
- 15,000 t of flakes maize and barley;
- 5,000 t of extruded pellets produced with high content omega 3 materials (linen, maize, wheat, sunflower).

SOFRAGRAIN is interested in diversify its activities taking advantage of the unused residues and thus in developing a biomass logistic centre. The company started the production of 200 t/yr of agro-pellets for the energy market 2 years ago and would like to enlarge this production.

3.5.2. Synergies to become an agro-industry logistic centre

3.5.2.1. Biomass resources availability:

During its usual activities, SOFRAGRAIN treats several materials (wheat, barley, linen) and its or residues (silos dust, oleaginous). Residues are available all the year although the main production periods are in summer and autumn. They are used for feedstuff production but the company would like to explore their use as solid biomass.

Other resources are available on the territory (corn cobs, grape seeds, pruning or chaff) and can be observed in the following Table 15. Nevertheless, there is no organised logistic chain to mobilise these resources and, for this reason, they have thus not been taken into account for this study. Additionally, the company does not want to work with non-food materials like wood to limit cross-contamination for the animal feedstuff activity.

Table 15 : Available resources for the biomass logistic centre in a 50 km radius

Type of residue	Volume t or ha	Moisture content w-% ar	Months of harvest
Silos dust (maize, cereal, oleaginous)	30,000 t	10 à 35	All the year
Pruning	16,000 ha	-	January to April
Grape seeds	16,000 ha	-	NA
Corn cobs	60,000 ha	-	October
Chaff	No information	-	July – August

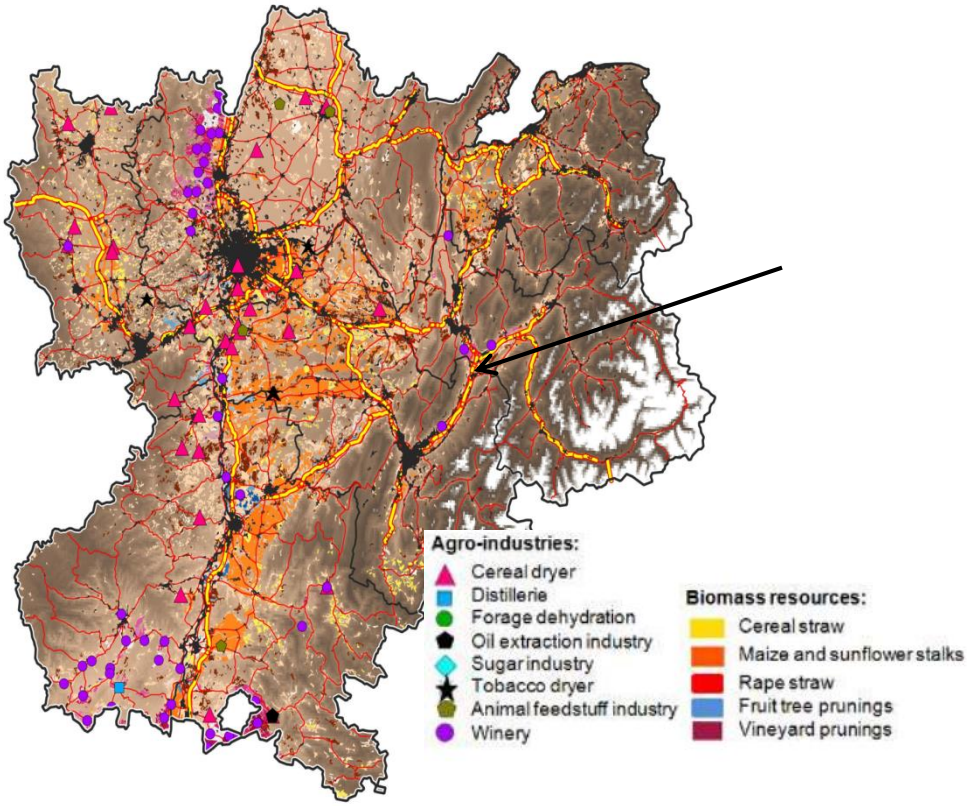


Figure 13 : Resources in the area - GIS maps

Taking into consideration the resources available, the solid biomass to be produced by the logistic centre is proposed to be in a pellet format.

3.5.2.2. Equipment and facilities available

In accordance with the new pellet production activities destined to energy, SOFRAGRAIN is able to use its own equipment during low production periods without any investment.

SOFRAGRAIN owns a complete pelletizing line. Residues are normally pressed, controlled and sorted before being processed. Depending on the moisture contents, residues are stabilised (dried by mixing) and stored. They can also be pelletised, cooled and stored before delivering.

SOFRAGRAIN does not own dryer since it normally works with dry biomasses. The production line capacity is 6 t/h.

Silos dust is available all the year. Since the most important period for energy demand is during winter, the most convenient period of activity for the new business line would be from October to February in order to reduce the storage time of cereal residues and allowing a work on demand for the final product generation. This period is also a low production period for animal feeding production and would permit the implementation of the new activity.

Even though it does not own a dryer, no investment has been forecasted in SUCELLOG study since the agro-industry is not willing to consider any investment. For the biomass

logistic centre, drying stage is proposed to be avoided by mixing biomasses with different moisture contents.

3.5.2.3. Bioenergy market potential

SOFRAGRAIN processes (pelletizing, extrusion, flakes) need a large volume of steam and thus high quantity of fossil fuels (propane and fuel) consumption. The company would like to reduce its fossil fuel consumption, buying a multi-fuel boilers able to consume the agrarian raw materials (1,500 t/yr) produced in their own facility. The purchasing of a new equipment to make self-consumption possible will be evaluated in a further stage but it has not been included in this study.

Market development: the cooperative already develops its market and is currently selling 200 t of agro-pellets per year. They sell their product to an ESCO (energy service company) for heating purposes. They would like to increase their production till 5,000 t/yr.

Households market is not relevant for agro-fuels since multi-fuels boilers or stoves are rare in the territory for this customers segment. Some municipalities labelled as “positive energy territory for green growth” (TEPCV) may represent an interesting market. Municipalities are, according to SUCELLOG, considered to be the most interesting customer segment to develop agro-pellets in France.

The type of solid biomass available in the region is shown in the following Table 16.

Table 16 : Main regional competitors

Type of residue	Price		Ash content w-% db
	€/t	€/MWh	
Wood pellets (NF, EN, EN+)	220 à 280	40 to 60	< 1
Wood chips (< 30% MH)	120	30	1.50
Low quality wood chips (> 30 %MH)	70	35	2

3.5.3. Feasibility of the new business line as agro-industry logistic centre

One scenario was studied for the agro-pellets production, respecting theoretically the ISO 17225-6 standard.

Table 17 : studied scenarios

Type of agro-fuels	Quantity t/yr
Silos dust / maize dust / oleaginous residues	500 – 5,000

A theoretical mixture among the silos dust / maize dust / oleaginous pellets has been done to respect the ISO 17225-6 standard in terms of quality. For that purpose, data about quality characteristics of the raw materials have been taken from bibliography and similar studies.

Production costs allocation is shown in Figure 14.

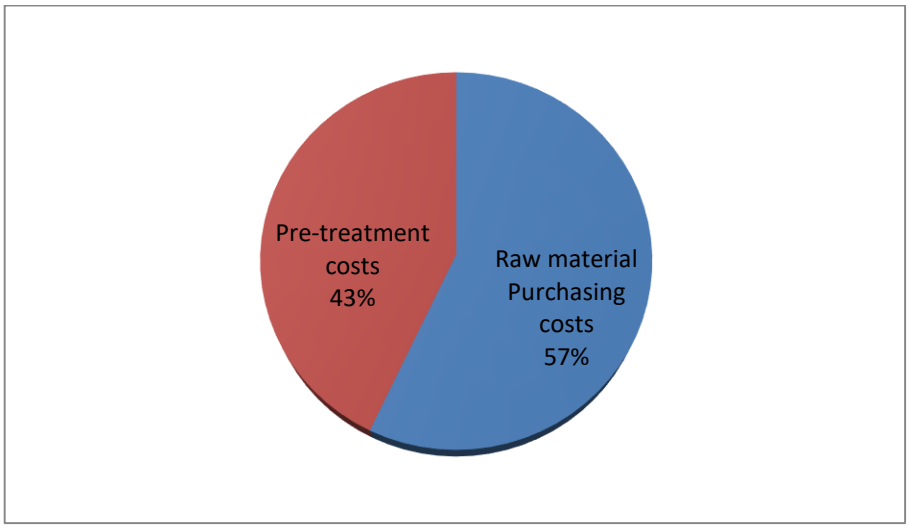


Figure 14 : Costs allocation for agro-pellet production

The price comparison of the different types of pellets proposed against the current solid biomass in the market can be observed in Figure 15.

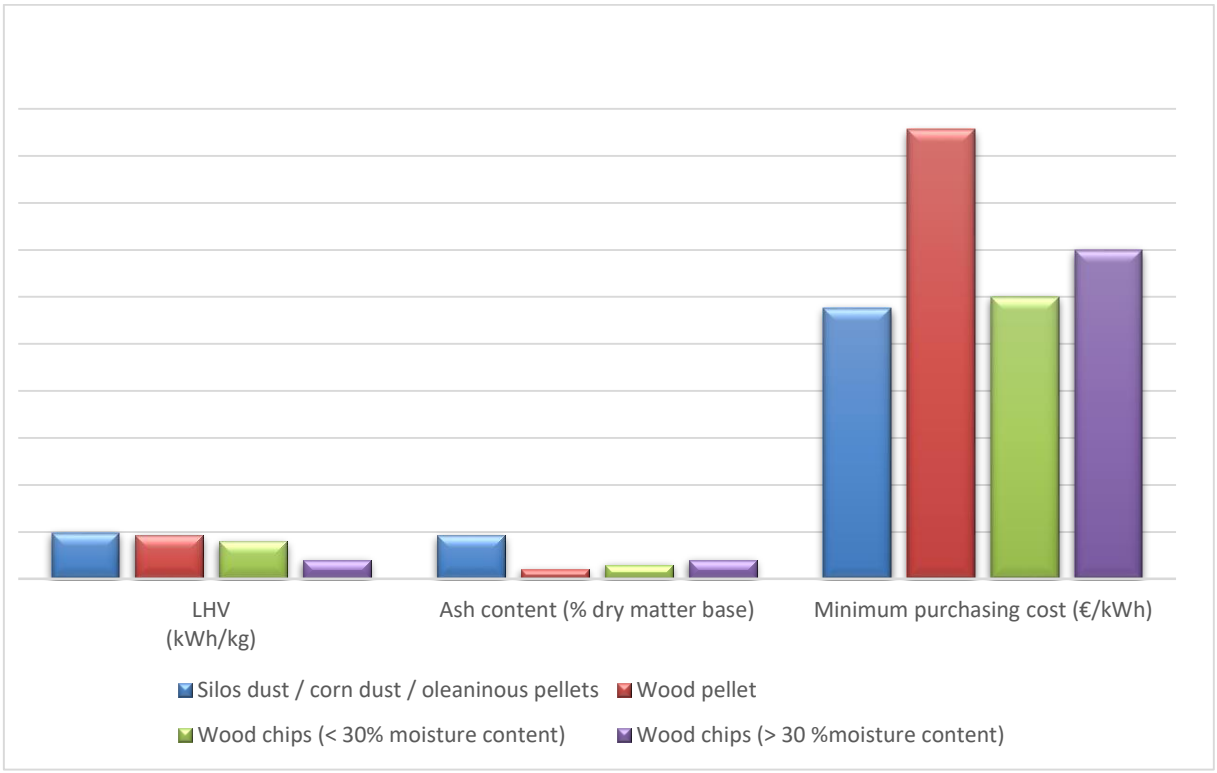


Figure 15 : Comparison between agro-pellets and competitors

When comparing the produced agro-pellets with their competitors on the territory, considering prices and properties, it can be noted that the agro-pellets proposed are fully competitive in terms of euro per energy even with chips.

In order to ensure this statement, further analysis on quality characteristics of the agro-pellet are highly recommended specially to ensure the ash and Chlorine content. The higher ash content compared to wood fuels should also be taken into consideration since

it will mean more maintenance operations for the consumer. Combustion tests in the facilities of the potential consumers are for this reason also recommended.

3.5.4. Conclusions

SOFRAGRAIN currently buys 20,000 t of agricultural residues (silos dust, maize dust and oleaginous) and transforms them in pellets for animal feeding. The company started some years ago, the production of pellets for the bioenergy market since they would like to develop new opportunities for its residues as biomass logistics centre. They currently would like to enlarge their production and look for new markets

SOFRAGRAIN can easily become a biomass logistic center, owning needed equipment, having knowledge about the residues market.

SOFRAGRAIN produces a silos dust, maize dust and oleaginous pellet sold to an ESCO. SUCELLOG study has checked that the product generated fulfils the quality requirements of the ISO 17 225-6 standard and that their final product is competitive in the market

3.5.1. Extra support provided to the cooperative

The cooperative was interested in having an estimation of the feasibility of the project, knowing the available resources in its territory, the local bioenergy market and an estimation of the needed investments to adapt its equipment to become a biomass logistic center. This information is available in the audit carried out by French regional agrarian associations. Beyond the audit, the cooperative was also interested by a personalized extra-support, carried out by French SUCELLOG partners:

First of all, SOFRAGRAIN, which is already a logistic center, developed the idea of agricultural logistic center thanks to SUCELLOG partners. The director attended the first SUCELLOG meeting and found the concept very appropriate for its company. SOFRAGRAIN met, at this meeting, the ESCO Agronergy and worked with them to develop a small logistic center, using 500 tons of silos dust to produce pellets. CDF-RAA followed the relationship between the cooperative and the ESCO. They are now working together to supply some biomass boilers and Agronergy is satisfied from the quality of the pellets.

- **Find partners to develop the SUCELLOG concept**

> CDF-RAA helped SOFRAGRAIN to contact the regional institution, thanks to their network, to find founds to develop the SUCELLOG concept and the self-consumption concept (mainly to the ADEME and regional state institution).

> CDF-RAA proposed to SOFRAGRAIN to attend a workshop organized by the ADEME, based on a circular economy concept, getting in contact several industries to develop local partnerships.

- **Find new residues to develop its production**

> Natura Pro is another cooperative involved in the SUCELLOG project. After a first analyse, it was shown that the concept is not profitable for them. Nevertheless, they are looking for solution to use their own residues. A partnership between Natura Pro and SOFRAGRAIN was proposed by SUCELLOG. Natura Pro would sell its residues to SOFRAGRAIN which would produce pellets from these raw materials.

- **Find new markets to develop its activities**

> Having contacting the ESCO Idex to have information about their point of view on biomass, SCDF transferred the contact of SOFRAGRAIN to this ESCO which was looking for new suppliers in Rhône-Alpes, explaining the production of the cooperative and the first feedbacks from its products.

- **Estimate the needed investment to develop its solid biomass activities**

> As complement to the audit and in order to analyse the needed investment, CDF-RAA contacted several equipment manufacturers to have precise ideas of prices.

- **Find new opportunities to develop its activities and new solutions to use its silo dust residues**

> Because of expectations of several cooperatives involved in SUCELLOG, SCDF decided, with Coopenergie, to develop a “silo dust group” to promote new solutions to use this product, in partnership with Coop de France. This group was launched with the impulsion of SUCELLOG partners (cooperatives and agrarian association). The energy uses as solid biomass was obviously studied during this group meeting, as well as other solutions such as chemical uses. This group took place the 13.09.16 and SOFRAGRAIN was attending. Another session will be done in June 2017.

> SOFRAGRAIN was interested in having contacts to develop its own analyse of silo dust uses in energy or as other uses. SUCELLOG gave them contacts from several company working on agricultural biomass: the Industrial Agro Biotechnology chair of AgroParistech working on agricultural biomass residues (mainly for chemical uses) but also Stolz contacts to have prices of equipment to treat agricultural biomass

- **Analyse the opportunity to develop self-consumption project from agricultural solid biomass**

SOFRAGRAIN demanded CDF-RAA solutions to use a part of its solid biomass product for self-consumption. CDF-RAA launched a program to help regional cooperatives interesting in developing this kind of concept and SOFRAGRAIN was integrated in this program. The SUCELLOG concept and the self-consumption project were thus gathered in the feasibility study.

3.6. Summary of the audit study to Tereos

3.6.1. Company description

The sugar refinery of Attin in Pas-de-Calais exercises during the campaign (from September till January) activities of production of sugar and drying of pulps. The site employs 79 permanent employees as well as 75 seasonal employees during the campaign.

Figure 16 : Location of the site TEREOS of Attin in Pas-de-Calais, region of Hauts de France

The sugar refinery transforms beets produced on 8,900 hectares cultivated by 850 cooperative farmers of Nord-Pas-de-Calais and the Somme. Its average beam of supply is 30 km.

The annual production of the site is:

- 82,000 tons of white sugar
- 53,000 tons of syrups of low purity
- 73,000 tons of pressed pulps
- 16,000 tons of dehydrated pulps*

* Dehydration and granulation plant have not worked for 3 campaigns. The farmers get back directly the pressed pulps.

A new activity of production of solid biofuels could allow to use this line, all or part of the year, and so to contribute to optimize the economic balance sheet of the site.

3.6.1.1. Biomass resource availability

Beet pulp is currently supplied to the local farmers mostly as pressed form for animal feeding. The cooperative is not planning to use the pulp to produce energy. The current use as animal feeding is an economically relevant market and mobilize all the resources.

Other territorial resources could be mobilized to formulate a solid quality fuel such as cereal straw, co-products of linen, ligneous refusals of composting and oilseed cakes (rapeseed, sunflower). Their available quantity and prices are shown in Table 18. Figure 17 to 18 show the situation of the agricultural resources.

In view of the diversity and in view of the format of the proposed resources, the granular format will be favoured.

Table 18: Biomass resources in a 30 km radius

Types of co-products	Available quantity t/y	Moisture content %	Average regional price (€/t)
Linen co-products	1,000 t à 2,000 t	13 %	60
Cereal straw	30,000 t	13 %	60-70
Sunflower cake	In development	9.5 à 11.5 %	190
Rapeseed cake	180 t / week	8-9 %	260-280
Ligneous refusal of composting	40,000 t of green waste handled per year	50 %	30-35

Considering the price of rapeseed cake and even if this resource is available in the area, it will not be considered as a relevant resource for the project and will not be integrated in this study.

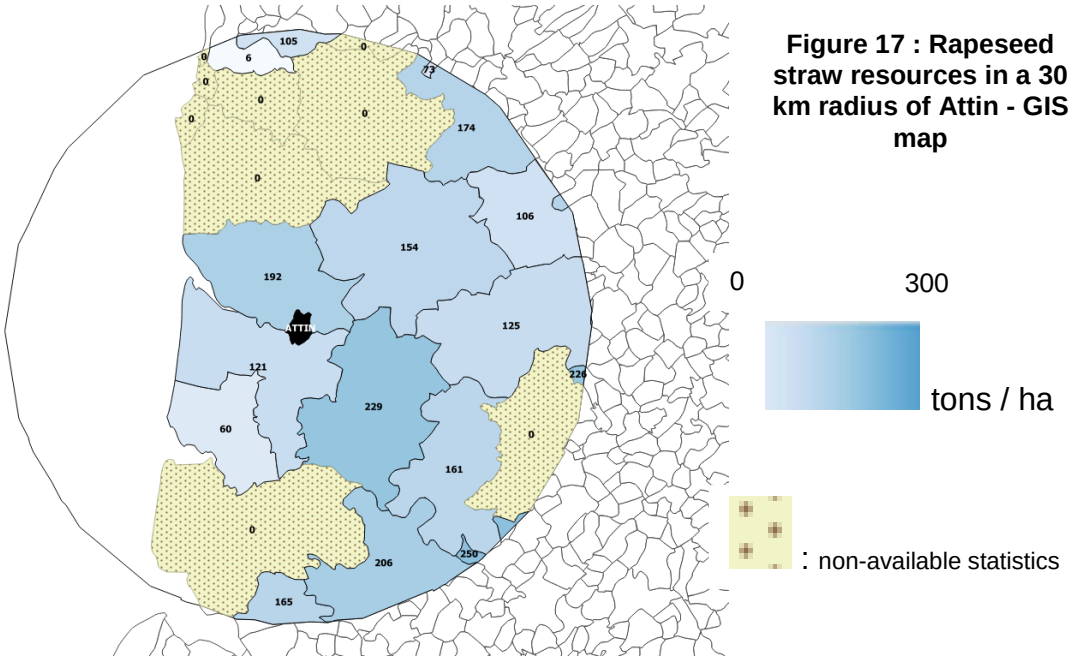
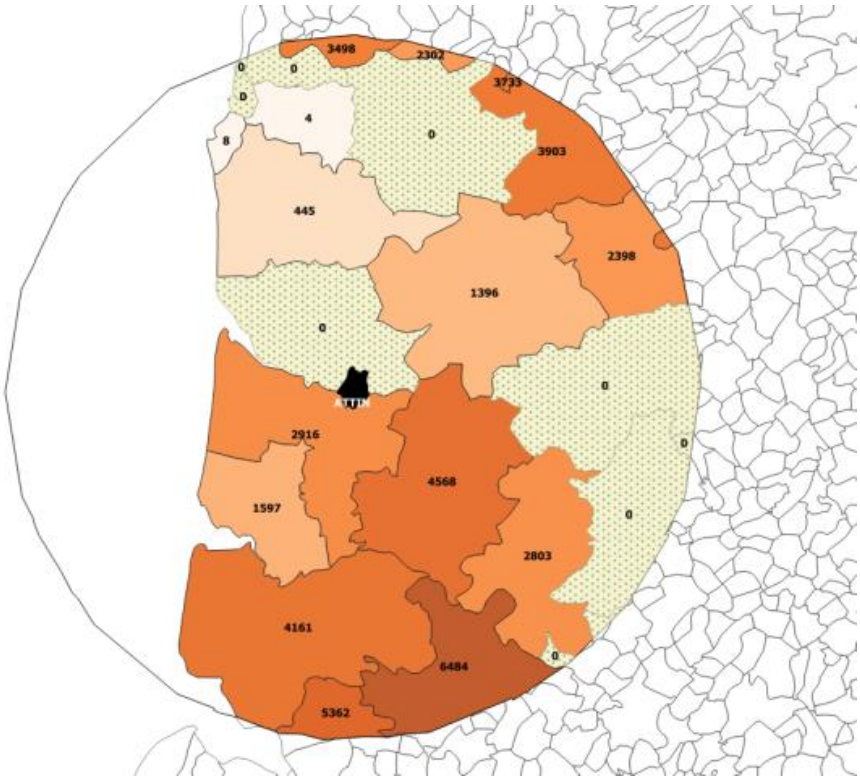


Figure 17 : Rapeseed straw resources in a 30 km radius of Attin - GIS map

Figure 18 : Wheat and barley straw resources in a 30 km radius of Attin - GIS map

non-available statistics



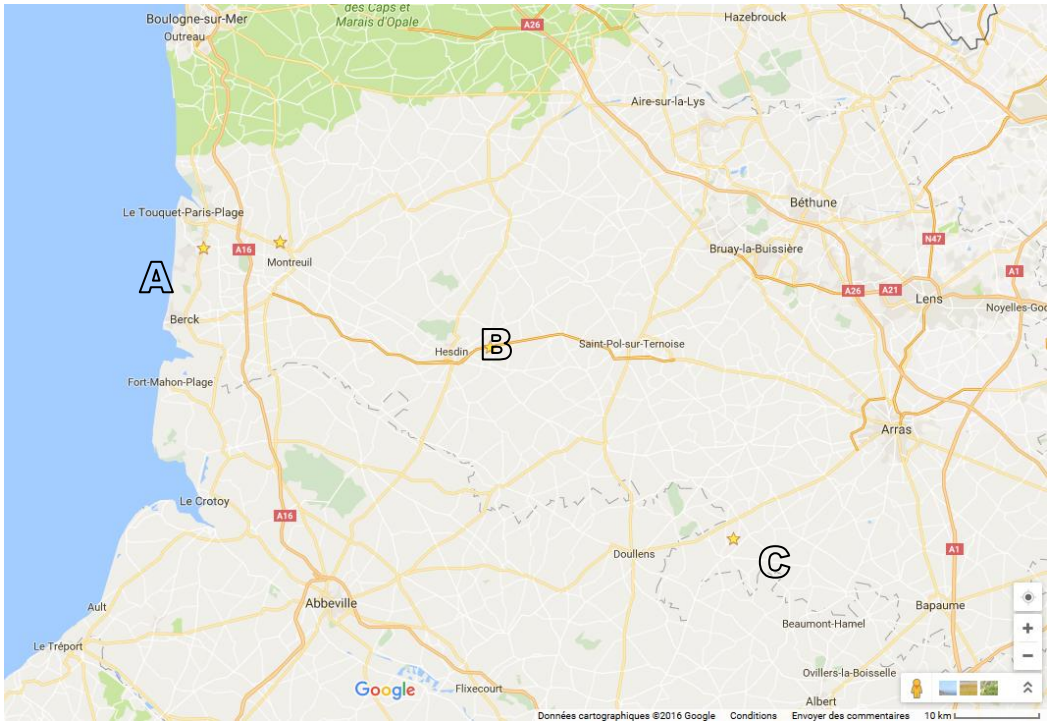


Figure 19 : Location of the co-product suppliers

A : AGRIOPALE Services for ligneous refusal of composting (Cucq, 12 km)
B : OPALIN for co-products of linen (Le Parcq, 38 km)
C : ORIACOOP for rapeseed cake and sunflower cake (Warlincourt Lès Pas, 82 km)

3.6.1.2. Equipment and facilities available

The production line of dehydration / granulation has a capacity of 10 t/hour (2x5 t/h). It consists of :

- A coal dryer PROMILL (5 t/h) - combustion furnace Promill, useful width 3,3m and length 7.5 m (18 MW + dryer of diameter 5.2 m and length 11 m in 3 passes. In optimal condition, approximately 22 t/h of evaporated,
- A circuit of dust removal and recovery of the materials from the dryer towards the press,
- Two presses KAHL (40-1,000 (160 kW power, 1,500 rpm), 45-1,250 (200kW power, 1500 rpm)),
- A cooler,
- A conveyor of pellets towards storage silos,
- Two storage silos.

Some equipment is missing (blender, refiner, crusher). An investment estimated at 500 000 euros will be necessary for the production of agropellets.

The Table 19 presents the common periods of availability of machines with the production of the vegetable raw materials and the request of the customers.

Table 19 : Common periods of availability of the unity of granulation with the production of the vegetable raw materials and the demand of customers

	J	F	M	A	M	J	J	A	S	O	N	D
Availibility of granulation plant	*								*	*	*	*
Production of the cereal straw												
Production of rape straw												
Ligneous refusal												
Linen co-product												
Oilseed cake												
Demand of municipalities												
Demand of industrials												

*: The unity of granulation is currently not used by the sugar refinery but has to remain available during the sugar beet harvest from September till December/January.

It will be necessary to store straws on a part of the year, or at the farmer or on-site.

3.6.1.3. Bioenergy market potential

At the level of the territory of TEREOS Attin, the market of the biomass energy is rather centered on wood chips. A framework contract was signed between de Hauts-de-France region and the forest wood sector for period 2015 in 2020. It aims in particular at developing local uses of the wood. The House of the Wood, located in Aulchy-lès-Hesdin at 40 km of Attin, develops a wood industry local energy. It covers several associations of local authorities (of Ternois, Montreuillois and 7 valleys). Four boilers with wood chips work in a 40 km beam around Attin (2 in Boulogne sur Mer, 1 to Outreau and 1 to Herly, see list of boilers in appendix 1).

Wood pellets are sold via distributors with the NF standard solid Biofuels, DIN, DIN +, EN or EN + between 250 and 320 €/ton (loose, delivered truck prompter, or 1 ton pallet in 15 kg bags). The price of the pellet can be estimated around 185 € the ton ex works (without transport). The wet forest chips and of unrefined size is situated near 50 € / t (energy content of 2.55 MWh / t), the small chips of moisture < 30 % is situated near 78 € / t (energy content of 3.7 MWh / t) (price from platform, given CEEB, in April, 2016).

The main competitor on the region is the VALBOVAL company to Artres, which produces 11 000 tons a year (for a 20,000 ton capacity) of two qualities of wood pellets: a coniferous pellet DIN plus and a wooden pellet of pruning of industrial quality. The purchasing area is 200 km around the factory (Hauts de France and Lorraine). The company sells pellets DIN plus to traders.

If the market of individuals seems difficult to access due to the absence of boilers or poly-fuels stoves in detached houses, associations of local authorities as well as those certified " Territories with positive energy for the green growth " (TEPCV) committed in the development of the renewable energies could represent an interesting market. Thirteen TEPCV were certified in Nord-Pas-de-Calais. An affordable agropellet with high calorific value and a low ash content should now be produced and sold to be able to compete with the wood pellet or wood chips.

Table 20 : Main competitors in the territory

Type of residue	Price		Ash content w-% db	Energy content (MWh / t) raw material
	€/t	€/MWh		
Wood chips LQ	50	19.6	2	2.55
Wood chips HQ	78	21.08	2	3.7
Wood pellets	185	37	1	5

3.6.2. Feasibility of the new business line as agro-industry logistic centre

The production would take place over a period of 3 months / 2x8 hours, with an objective of 7 500 tons of produced pellets.

Several scenarios of formulations were studied to find the good compromise between energy content, ash content and sale price. A theoretical mixture among the resources stated in the previous section has been done to respect the ISO 17225-6 standard in terms of quality. For that purpose, data about quality characteristics of the raw materials have been taken from bibliography and similar studies.

The Figure 20 compares the performances of these scenarios in terms of energy content, ash content and price.

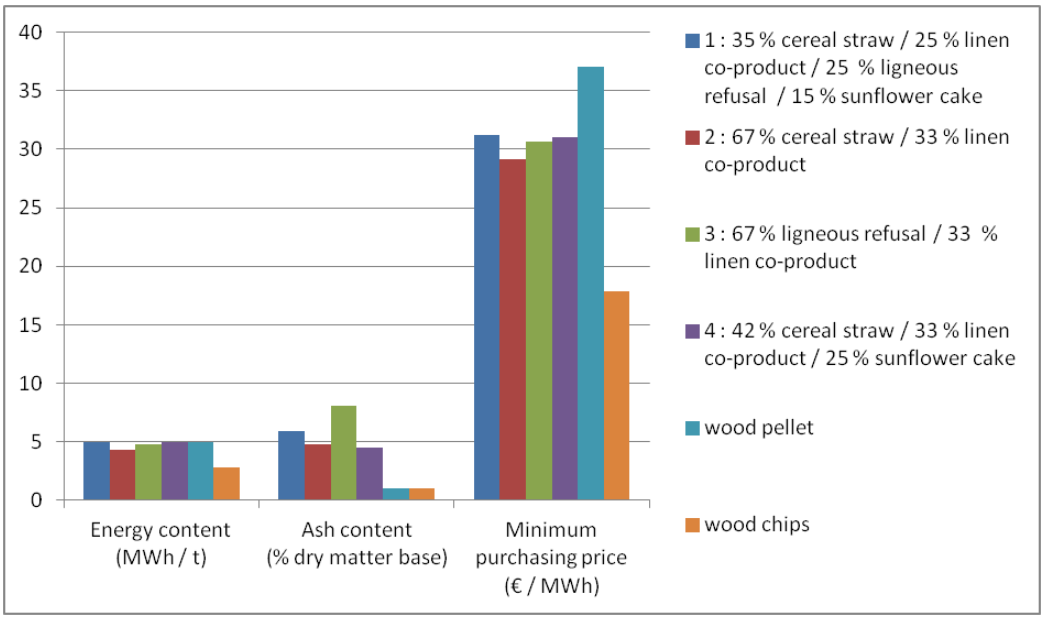


Figure 20 : Comparison between agro-pellets and competitors

The production costs divide up on average as:

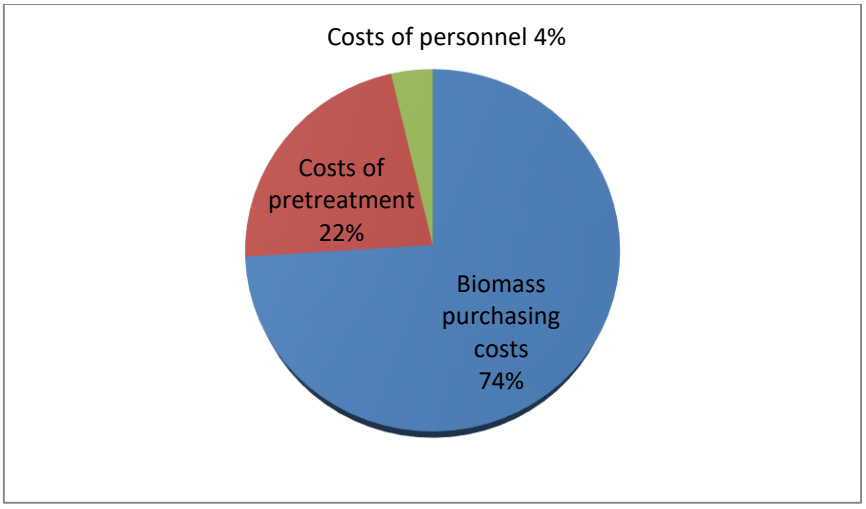


Figure 21 : Production costs

The cost of the resource represents the highest share in the total production costs in any of the agro-pellets analysed. The formulations 1 and 4 have a high energy content with a high rate of ashes but lower, in theory, than 6 %. The formula 3 will not be studied as the ash content is too high: compost wastes are not good quality materials to be burnt into boilers. The addition of cake of sunflower is essential to increase the energy content but stays an expensive resource. Pellets from these two formulae have a sale price upper to the forest wood chips, but competitive face to wood pellets, around 155 € / ton allocated. This scenario 4 is interesting as it does not to include refusal of composting which requires a drying and which is an important source of ashes. It will remain to verify if the pellet has a good pelletizing behavior with 25 % of cake of sunflower. The emissions of NOx and SOx must be also checked.

In order to ensure this statement, further analysis on quality characteristics of the agro-pellet are highly recommended specially to ensure the ash and Chlorine content. The higher ash content compared to wood fuels should also be taken into consideration since it will mean more maintenance operations for the consumer. Combustion tests in the facilities of the potential consumers are for this reason also recommended.

3.6.3. Conclusions

Due to its activity, TEREOS could easily become a logistic platform of biomass, the company would however have to invest in a preparation line of the biomass (crusher, blender, refiner) necessary to start the activity of production of solid biofuels.

The analysis of all the information collected during the audit SUCELLOG shows that TEREOS is in capacity to produce an economically viable agropellet with an energy content approaching 5 kWh/kg but with a high rate of ashes (5 % db). Analyses should be to estimate possible problems with the emissions of NOx, SOx and HCl. The market study allowed to show that, at present, there is not a market of the agropellet developed at a regional level. Partnerships with local actors (municipalities, industrialists, distributors) can contribute to make this biofuel known and develop the activity.

3.6.4. Extra support provided to the cooperative

The cooperative was interested in having an estimation of the feasibility of the project, knowing the available resources in its territory, the local bioenergy market and an estimation of the needed investments to adapt its equipment to become a biomass logistic center. This information is available in the audit carried out by French regional agrarian associations. Beyond the audit, the cooperative was also interested by a personalized extra-support, carried out by French SUCELLOG partners:

- **Looking for raw materials and find partners to develop its project**

> Coopenergie proposed, during the SUCELLOG project, a partnership between Tereos and UCAC. Indeed, UCAC owns residues from agricultural biomass and do not know how to use them but does not have equipment to develop a logistic center and will have to invest a significant amount to develop the SUCELLOG

concept. On the contrary, Tereos, as sugar industry, does not have available residues but already own a part of the needed equipment to develop a logistic center. That is why a partnership between the two neighbor industries is relevant. Thanks to SUCELLOG, the two companies are now in contact and are waiting for a better market context to develop the concept together.

- Moreover, Coopenergie worked with them to analyse the needed investments to adapt their facilities and become a biomass logistic center. They presented their project during a SUCELLOG meeting.

APPENDIX 1 : List of biomass boilers on the departments of Pas-de-Calais, Nord and Somme (in green , a radius of 40 km around Attin) :

DEPARTEMENT	Porteur	ville	puissance	année	type	constructeur	Distance Attin
PAS DE CALAIS	Réseau de chaleur	Arras	10,5	2016	CT	Weiss	90
	Calais Réseau de chaleur	Calais	4	1999	CT	Weiss	68
	Dalkia Calais	Calais	8	2014	CT	Vynck	68
	Herta	Saint Pol sur Terroise	4,5	2012	IND	Compte R	52
	Ingredia	Saint Pol sur Terroise	19		IND	Icavi	52
	CONTE SA	Boulogne sur Mer	1,125	1999	IND	Weiss	36
	Boulogne	Boulogne sur Mer	3,5	2015	CT	Weiss	36
	Pas de Calais Habitat	Achicourt	0,9		CT	SCHMID	93
	Outreau	Outreau	2,06	2007	CT	Weiss	37
	Fabec Cuisines	Saint Venant	1,66	1999	IND	Weiss	70
	Scierie Palette du littorale	Audruicq	1,2		IND	Weiss	87
	Ferrant PME earl	Rodelinghen	1,62	2013	AGR	UNICONFORT	65
	Lavogez Frères	Herly	0,812		IND	UNICONFORT	20
	LMK energy	Mazingarbe	1,5	2012	IND	UNICONFORT	92
		Arcques	2,5	2012	CT	Weiss	64
NORD	Réseau de chaleur	Roubaix	20	2011	CT	Schench	153
	Réseau de chaleur	Lambersart	2,5	2014	CT	Compte R	117
	Réseau de chaleur	Wattignies	2,1	2006	CT	Weiss	139
	Réseau de chaleur	Wattrelos	3	2013	CT	Compte R	157
	Campus Veolia	Lomme	2,5		CT	Weiss	117
	Trois suisses	Croix	2	1995	IND	Weiss	148
	Sains du Nord	Sains	1,6		CT	NR	226
	Mécameuble	Hazebrouck	2	2005	IND	Vynck	71
	Réseau de chaleur	Hazebrouck	5,5	2014	CT	Weiss	71
	3 suisses	Tourcoing	2		CT	Weiss	153
	Geerlandt	Halluin	3	1994	IND	Weiss	192
	Réseau de chaleur	Hellemmes	3,2	2006	CT	Weiss	140
	Toyota	Onnaing	0,9	2014	IND	Compte R	173
	Marc Darron	Godewaersvelde	2,3	2003	AGR	Vynck	87
	Réseau de chaleur	Mons en Baroeul	9	2015	CT	Compte R	124
	Candia	Awoingt	5,5	2012	IND	Compte R	147
	Sin le Noble	Sin le Noble	8,5	2013	CT	Compte R	129
	Réseau de chaleur	Villeneuve d'asq	3,2	2008	CT	Weiss	143
	Réseau de chaleur	Seclin	3,1	2015	CT	Weiss	129
	Réseau de chaleur	Wattignies	2,1	2006	CT	Weiss	139
	Demeyere	Pérenchies	9	2004	IND	Weiss	112
	Boiserie Siège Nord	Neuille en Ferrain	1,11	2005	IND	Vynck	159
SOMME	Chaufferie Amiens Etouvie	Amiens	5	2014	CT	Weiss	100
	Ville d'Amiens	Amiens	12,6	2015	CT	NR	100
	Nestlé SITPA	Rosières en Santerre	20	2012	IND	Kablitz	139
	Régie communale de Montdidier	Montdidier	1,5	2008	CT	NR	145

NR : Non Renseigné

CT : Collectivité

Source : Bioénergie International, 2016

IND : Industriel

AGR : Agriculteur

3.7. Summary of the audit study to UCAC

3.7.1. Company description

UCAC is a cooperative working as cereal collector and supplier of phytosanitary products in Oise department (Clermont). It collects 180,000 tons of grain every year and owns 7 storage sites in the area.

Figure 22 : UCAC storage places (source google maps)

UCAC started, in 2008 – 2009, an activity as wood chips producer to balance an unprofitable cereal campaign to create new incomes for farmers working with the cooperatives, as many of them own wood forests.

3.7.2. Development of a new business line as logistic center

UCAC would like to develop its activity of solid biomass used for energy and is planning to produced 2,500 tons of wood chips. In this context, the cooperative is interested in being supported by SUCELLOG to analyse the opportunity to develop an additional activity with agriculture resources in order to develop new markets.

3.7.3. Biomass resources availability:

3.7.3.1. Miscanthus producers in the area

The cooperative knows miscanthus' producers in its territory and can work with them. This resource is available to be used for energy without competitive uses. Nevertheless, the available amount is very small, that is why this resource will not be considered in this study.

3.7.3.2. Short rotation coppice producers

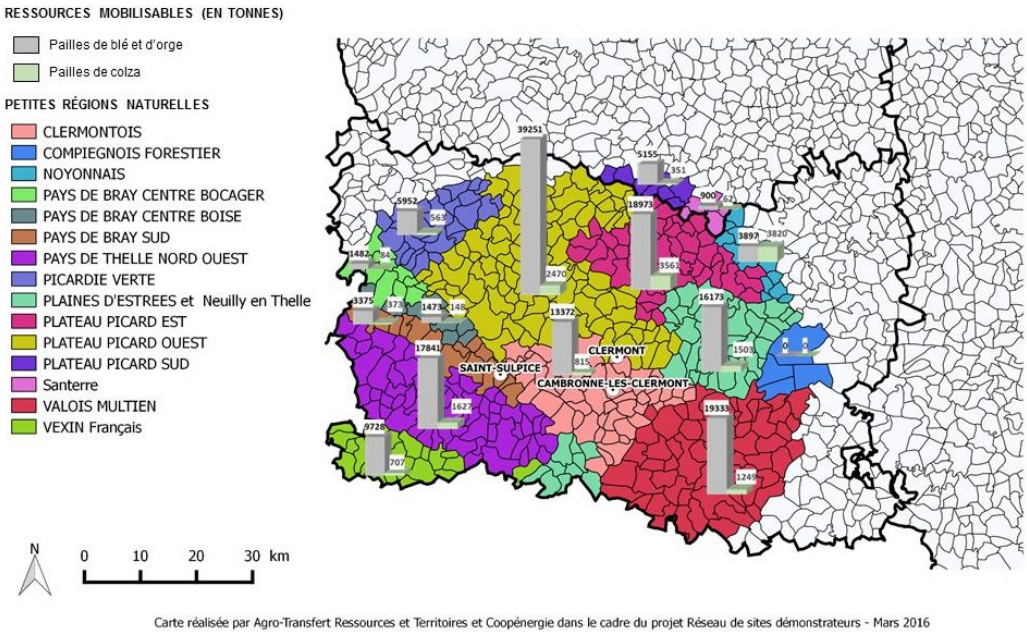
The cooperative is used to work with local producers of short rotation coppice and this resource may be used for the project. Nevertheless, the available amount is very small, that is why this resource will not be considered in this study.

3.7.3.3. Sawdust production

Biomass resources may be completed by sawdust biomass from neighbour sawmills. Nevertheless, this resource has a high moisture content. Considering the available equipment of the cooperative, not allowing a drying process, this resource cannot be taken into account in the study.

3.7.3.4. Wheat, rape and barley straw production

The area is a high cereals production area. Straws from wheat, rape and barley are available in the territory. The distribution of these resources is presented here-after:



Carte réalisée par Agro-Transfert Ressources et Territoires et Coopénergie dans le cadre du projet Réseau de sites démonstrateurs - Mars 2016

Figure 23 : Wheat, barley and rape straw in the territory (pink: cereal straw – beige : rape straw)

In this figure, the resources used for other markets (as organic matter and breeding resources) are taken into account. However, a total amount of 157,000 tons of straws from wheat and barley and 17,333 tons of rape straw are considered to be sustainably available for biomass production.

The price without transport is around 55 to 65 € / t (tax free).

3.7.3.5. Silo dust production

Other cereal agro-industries are available on the territory, resulting in a considerable amount of silo dust all the year in different quantity. They are used for animal feeding, composting and methanation. Their price is between 10 € and 50 € (free tax) per ton without transport. However, a part can be used for energy (between 10 and 20 %).

Available resources for the project are summarized in the Tableau .

Tableau 21 : Main available resources for the biomass logistic centre in 30 km around UCAC

Type of residue	Months of availability	Volume (t/yr)	Moisture content w-% ar	Regional price (€/t)
Cereal straw	July - August	15,7 000	<18%	55 à 65 €
Rape straw	July - August	17,333	<18%	55 à 65 €
Silo dust	All the year	1,345	<15%	10 à 50 €

3.7.4. Bioenergy market potential

The regional bioenergy market is based on wood chips. UCAC is sending a part of its wood production for local wood boilers.

Considering the local biomass market, the production of pellets seems more promising than selling loose biomass as there is no local boilers able to burn loose biomass. The cooperative does not have continuous demand of heat and cannot, thus, consumed solid biomass in its own site. Self-consumption will thus not be studied.

The main competitors in the territory are summaries in the table below.

Tableau 22 : Main competitors in the territory

Product	Price €/t	LHV MWh/t wet base	Price €/MWh	Ash content w-% db
Wood pellets DIN Plus	185	5	37	1
Wood chips low quality (LQ)	50	2.55	19.60	2
Wood chips high quality (HQ)	78	3.70	21.08	2

3.7.5. Equipment and facilities available

UCAC owns 2 outside storage platforms to store wood (Saint-Sulpice and Cambronne-lès-Clermont) and one storage hangar (Clermont). Wood is supplied from September to January and stored from 6 months to 1 year.

Except for the storage places, the cooperative does not own other equipment to treat solid biomass. To reduce the investment, the purchase of a pelletising line will be studied without drying system. Taking into account that moisture content of considered resources is low, this option is feasible.

The price of this pelletising line is around 810,000 € for 0.3 to 1 tons per hour (without building investment to store the pelletising line).

3.7.6. Feasibility of the new business line as agro-industry logistic centre

The cooperative is interested in starting a new activity, producing pellets from agricultural biomass. The production will last 6 months for 1,000 tons of production. Different composition of these pellets has been evaluated, taking into account values from bibliography.

Tableau 23 : Agropellets produced by the new activity

Type of agro-pellets	Produced quantity (t/yr)
Formula 1: 100 % cereal straw	1,000
Formula 2: 100 % rape straw	1,000
Formula 3: 100 % silos dust	1,000
Formula 4: 40 % cereal straw / 40 % rape straw / 20 % silo dust	1,000
Formula 5: 80 % cereal straw / 20 % silos dust	1,000

3.7.6.1. Economic analysis

Firstly, an investment costs analysis for the new production line is performed. Secondly, purchasing costs of residues, pre-treatment costs, personal costs and other costs are analysed.

3.7.6.2. Investment

The investment is the purchasing of the new pelletising line. The estimation is around 810,000 € for 3 t/h system.

3.7.6.3. Purchasing costs

As stated, 1,000 tons of residues are needed for the project. Residues needed for the logistic centres would be acquired to farmers already working with the cooperatives or neighbour agro-industries.

As silo dust is cheap residues, their use is interesting to reduce the cost of the final product.

3.7.6.4. Pre-treatment costs

Pre-treatment is needed to produce solid biomass. As silo dust does not need to be shredded, production cost are reduced when using them. Only milling, pelletising and cooling are foressen. For the rest of resources (straw) shredding has also been considered.

3.7.6.5. Production cost

Production costs allocation for the mixed pellet is shown in Figure 24. They are similar for every formula studied (personal cost are included in the pre-treatment cost).

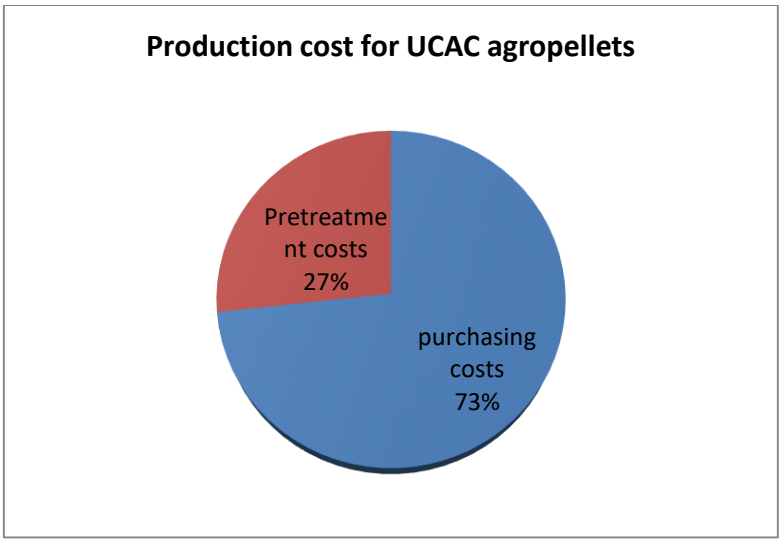


Figure 24 : Costs allocation for agro-pellet production

From the study, it was noted that :

- The Formula 100 % silo dust has a low production cost but with a lower quality. It can thus be used in big combustion unities.
- 100 % rape straw pellets have a high production cost for a medium quality.

Delivery cost is not included in these prices.

3.7.6.6. Risk analysis

Several scenarios were analysed to find the best formulas (LHV, ash content, selling price). They are compared in the figure hereafter.

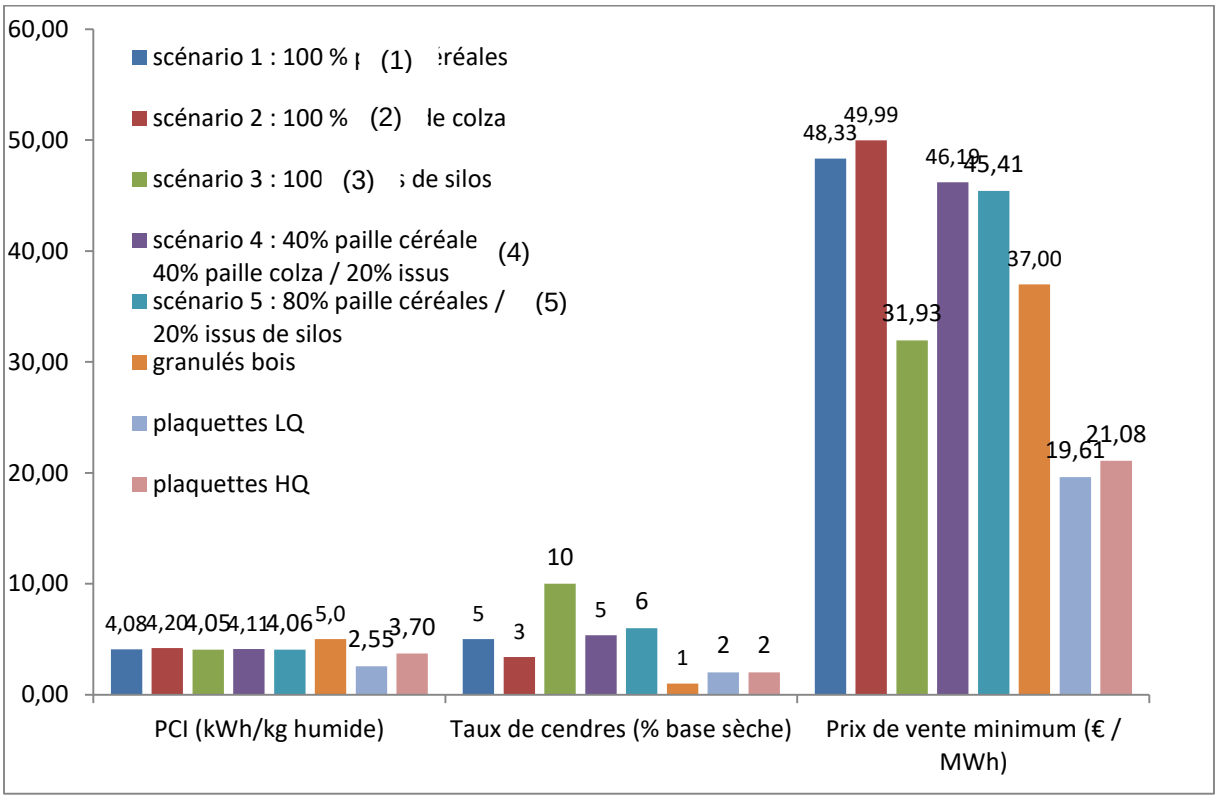


Figure 25 : Comparison of the agro-pellets and competitors in the area

Formulas 1, 4 and 5 have an interesting LVH for a low ash content. Nevertheless, the pellets have a high selling price, higher than wood pellets and wood chips (mainly because of the investment cost and price of materials).

The silos dust pellets are competitive with wood pellets considering the price but the quality is not good (high ash content and mineral contents). It cannot be competitive on the market.

3.7.7. Conclusions

UCAC is already producing wood chips for energy. Considering the results of this study, it seems to be difficult to develop an activity of agricultural biomass logistic centre as there is quite not market in the area and as production costs are very high for low quality products.

Working with another company owning equipment to treat biomass can be a solution. It can be noted that Tereos, also working in the SUCELLLOG project, owns an unused dehydration unity in Chevrières, far from 28 km from UCAC. A partnership between the 2 companies was proposed during the SUCELLOG project.

Specific partnerships with local stakeholders should be develop to organise a regional market and develop the activity.

3.7.8. Extra support provided to the cooperative

The cooperative was interested in having an estimation of the feasibility of the project of becoming a biomass logistic centre, knowing the available resources in its territory, the local bioenergy market and an estimation of the needed investments to adapt its equipment to become a biomass logistic center. This information is available in the audit carried out by French regional agrarian associations. Beyond the audit, the cooperative was also interested by a personalized extra-support, carried out by French SUCELLOG partners:

- **Having more information in the opportunities to use agricultural biomass for energy.**

> Coopenergie organized with UCAC meetings to develop the SUCELLOG concept, doing training about solid biomass from agricultural resources. It also organised specific meetings to find partners to develop the concept.

- **Looking for solutions to use its own residues (mainly silo dust)**

> Coopenergie organized a meeting between UCAC and Tereos, another company owning equipment to produce solid biomass (also involved in SUCELLOG). They began to work together to develop a common project, UCAC providing agricultural residues and Tereos producing the solid biomass without important investment. This project is ongoing but the different partners are looking for a market before initiating a production.

- **Looking for the best solution to produce solid biomass, including the best format taking in consideration the needed investment and the market in the area.**

> Coopenergie helped the UCAC to define the best format to be sold on the market. Under the SUCELLOG audit, he studied the market, the equipment of the cooperative and the available resources on the territory. But beyond this "classic" analysis, he tried to define the best format and the logistic issues for the logistic center. He stated that the production of briquets may also be an option. The feasibility study is studying the pellet opportunities as asked by the cooperative, but a small further analyse about briquets was also proposed to the cooperative who may also study this opportunity and try to develop a specific market.

- Coopenergie organized thus meetings with a producer of briquets from Miscanthus (Lamont Colin Energie) to show the opportunities that UCAC has to produce this kind of solid biomass.
- Coopenergie also contacted manufacturers of briquetting facilities to asked for costs for the equipment and technical information to use agricultural raw materials.

3.8. Summary of the audit study to NORIAP

3.8.1. Company description

Noriap is a cooperative which collects grains and supplies phytosanitary products in the North-West of France (head office sited in Boves). It collects 1,200,000 tons of grain annually and owns 150 storage places.

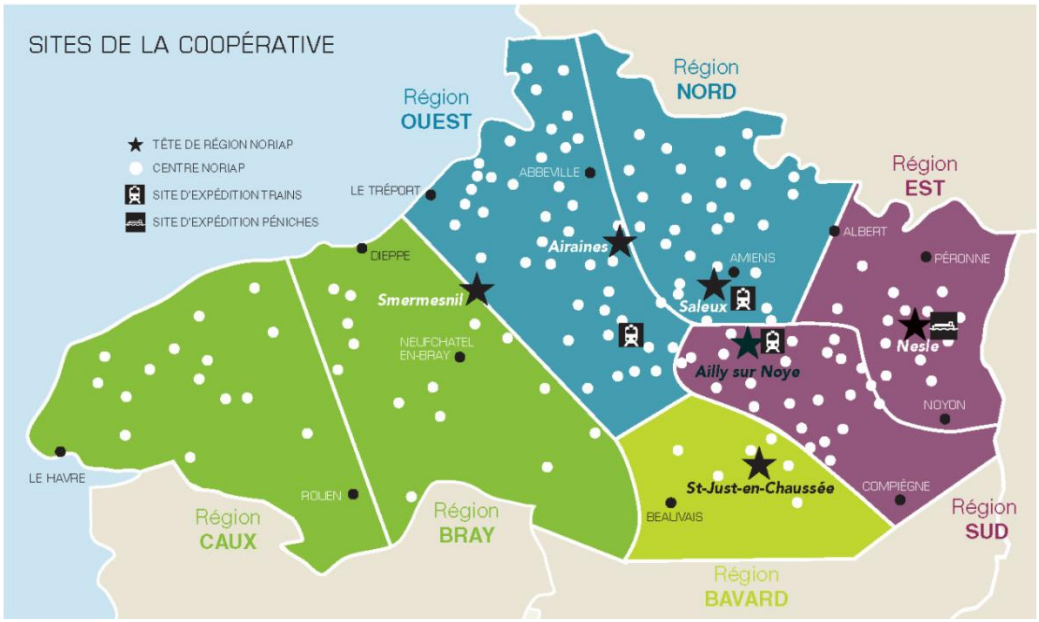


Figure 26 : Localisation of storage sites owned by NORIAP (source NORIAP)

The cooperative is looking for new activities linked with its strategic company project NEO 2020. Biomass from energy can be an opportunity because lots of work still have to be done to develop this activity.

That is why Noriap is interested in the SUCELLOG concept, to analyses its opportunity to produce solid biomass from agricultural and forestry resources from its farmers-members.

It can be noticed than Noriap already own storage place able to fit with wood chips storage.

The cooperative asked SUCELLOG to study the opportunity to develop a biomass logistic center in the site of Valmont, in Seine Maritime (Figure 27).

Figure 27 : Site of Valmont – Noriap cooperative (source google maps)

3.8.2. Biomass resources availability:

3.8.2.1. Wheat, barley and rape straw

Noriap is located in a high cereal production area. On the territory, wheat, barley and grape are grown.

A part of this straw has to be let on the soil as organic matter. Another part is already used for animal breeding. That is why, on the 43,775 tons or wheat and barley straw in Haute-Normandie, only 17,000 tons are sustainably available and on 7,884 tons of rape straw in Haute Normandy, 2,800 tons are sustainably available.

3.8.2.2. Lin flax production

There is 22,772 ha of line cultivation in Seine Maritime (7.7 tons of straw – AGRESTE). Line flax is already consumed as bio-sourced materials, heat production, bedding or mulch. However, it has been estimated that 1,000 to 1,500 tons (1 to 2% of the production) could be used by Noriap without a competitiveness with the local market.

5 sites of line flax producers could supply the Valmont site, sited at less than 30 km. The estimate price without transport is 60 € free taxes.

3.8.2.3. Sawdust from sawmills production

Sawdust from neighbour sawmill could complete the agricultural biomass supply Nevertheless, there is no sawmill in less than 30 km from the Valmont site.

Available resources for the project are summarized in the Tableau to supply the Valmont Site.

Tableau 24 : Main available resources for the biomass logistic centre in 30 km around the Valmont site

Type of residue	volume (t/yr)	Moisture content w%ar	Price (free tax) €/t
Cereal straw	17,000	<18	55 - 65
Rape straw	2,800	<18	55 - 65
Line flax	1,000 - 1,500	13	60

3.8.3. Bioenergy market potential

In Haute-Normandie, the biomass market is based on wood chips.

Considering the local biomass market, the production of pellets seems more promising than selling loose biomass as there is not local boilers able to burn loose biomass. The cooperative does not have continuous need of heat and cannot, thus, consumed solid biomass in its own site. Self-consumption will thus not be studied.

The main competitors in the territory are summaries in the table below.

Tableau 25 : Main competitors in the territory (without transport)

Product	Price €/t	LHV MWh/t wet base	Price €/MWh	Ash content w-% db
Wood pellets DIN Plus	185	5	37	1
Wood chips low quality (LQ)	50	2.55	19.60	2
Wood chips high quality (HQ)	78	3.70	21.08	2

3.8.4. Equipment and facilities available

Valmont site is a site not used anymore by the cooperative. Noriap is thus looking for new solutions to valorise this site. During the feasibility study, this Noriap site was a good candidate to develop a logistic center as the entire site may be dedicated to this activity. After a first visit during the audit stage, Coopenergie contacted different experts from the cooperative sectors to analyse the opportunity of this site to become a logistic center. After a strong study with them, it was concluded by the SUCELLOG partners that the use of biomass on this site is not possible:

- Storage silos are not easily accessible and cannot store bales or wood chips. Camions would not be able to empty in the specific cases.
- Vertical silos cannot store pellets
- A pelletising line cannot be installed in the existing buildings.

The needed investment to renovate the site for biomass purpose are really too expensive for the cooperative in an uncertain bioenergy market. Nevertheless, the cooperative owns storage places on the department to transform biomass and will continue to analyse this opportunity in the next few years for other sites.

The Anneville sur Scie plateform is available all the year. This site is near several sawmills and sited in an area were wheat, rape straws and line flax are available.

This site can be a good site to develop a biomass logistic center. A further study should be performed to validate the available resources in the area and complete the feasibility study.

3.8.5. Conclusions

The biomass energy market in Seine Maritime is developed but mainly with wood chips. Two boilers are nevertheless working with line flax. The agropellets can find a place in the bioenergy market in the area but is currently unknown and non-competitive face to other fuels such as wood chips or wood pellets.

This Valmont site from Noriap is sited in an area were wheat, rape straws and line flax are available, interesting resources for agropellet production. Sawmills can supplies wood residues to produce a good agropellets even if they are not close the site.

Nevertheless, the site is not a relevant site to develop a biomass logistic centre. Facilities are not adapted to store bales or loose biomass and a pelletising line cannot be integrated in the site.

Nevertheless, Noriap owns other storage platforms which can be used to develop a biomass logistic centre activity. A further study should be carried out to validate the available resources in the area and complete the feasibility study.

3.8.6. Extra support provided to the cooperative

The cooperative was interested in having an estimation of the feasibility of the project, knowing the available resources in its territory, the local bioenergy market and an estimation of the needed investments to adapt its equipment to become a biomass logistic center. This information is available in the audit carried out by French regional agrarian associations. Beyond the audit, the cooperative was also interested by a personalized extra-support, carried out by French SUCELLOG partners:

Looking for solution to use its silo dust residues

- Because of expectations of several cooperatives involved in SUCELLOG, SCDF decided, with Coopenergie, to develop a “silo dust group” to develop new solutions to use this product, in partnership with Coop de France. This group was launched with the impulsion of SUCELLOG partners (cooperatives and agrarian association). The energy uses as solid biomass was obviously studied during this group meeting, as well as other solutions such as chemical uses. This group took place the 13.09.16 and Noriap was attending. Another session will be done in June.

Noriap was looking for a new solution to use one of its abandoned silo. It asks for support to SUCELLOG in that purpose

- Coopernergie worked with Noriap to find a solution to adapt an unused silo for biomass. Under the SUCELLOG audit step, Coopenergie analysed residues from the cooperative and on the territory and looked for a market. Beyond the audit, he analysed the opportunity to use the silo to store biomass (analyse more complex than the use of equipment as done generally in WP6). After a large analyse, having contacted some cooperatives experts on silo and industrial facilities, he finally concludes that the structure of the facilities does not allow an easy work with biomass and the silo is too far from the main biomass sources. Another solution has to be find to use these facilities but biomass is not the best opportunity

3.9. Summary of the audit study to Durepaire

3.9.1. Company description

DUREPAIRE belongs to the OCEALIA Group, it is one of the three branches of the group. DUREPAIRE targets transformation of plants for animal feeding and bedding but also for energy sector. Patrick MESNARD is the company manager. The main production site is located in Verdille, in Charente. The second production site is located in Chives (15 km further).

Pelletizing is DUREPAIRE's original activity. Its main activities are:

- Production of food for feedstock (from raw material);
- Bedding production (mainly for poultry);
- Compacted fodder (for horses 55,000 to 65,000 tons per year);
- Fodder dehydration (small activity on alfalfa and silo waste).

The group's sales are mainly done in France (80 %). The other 20 % are used in exportation with the Charentexport association.
At the regional level, DUREPAIRE's clients are local authorities and private households.

DUREPAIRE company is ISO 14 001 – Environmental Management - certified.

3.9.2. Synergies to become an agro-industry centre

3.9.2.1. Biomass resources availability

There are many resources available on the neighboring departments of Durepaire. The vineyards are widespread (availability of vine prunings or even grape marc) as well as cereal field crops (straws, chaff or even cereals wastes for agro-industries responsible for the collection and processing of grains).

Data about residues in a 30 km radius around the cooperative are listed in the table below.

Moisture content, months of production and price of local available raw material (transporting costs excluded) are given in the same table.

Table 26: Available resources (30 km radius).

Type of resources	Available quantity t/an	Moisture content (%humid matter)	Moths of collection	Price (€/t)
Cereals straw	20,000 to 30,000	13	June, July, August	65
Wood chips	about 15,000[1]	Domestic quality: 20 à 35 Industrial quality: 30 to 50	All the year (pick in winter)	Small chips: 77.8 €/t, 21.03 €/MWh Large chips: between 20 and 50.1 €/t, 19.65 €/MWh *(Source CEEB T2 2016)*
Silos waste[2]	9,000	15 à 35	September to November	50

It should be noted that, in a radius of 50 km or more, potential supply is higher:

- Multiplied by 2 for straw;
- Multiplied by 1.5 for silo waste.

Currently, the markets for straw already mobilized in the Limousin region are:

- fodder for breeding;
- organic amendment (organic matter for agricultural soils).

However, part of the unused straw can be mobilized for energy without destabilizing the livestock sector or reducing soil fertility. Table 2 shows the additional available residues.

Table 27: Additional residues (50 km radius)

Type of resources	Surface (ha)	Yield (t of dry matter /ha)	Month of collection	Purchasing price (€/t)
Vine prunings[3]	80,000	1.5	November, December, January	75 à 80

It should be noted that, within a radius of 50 km or more, potential available amount is multiplied by 2.

[1] Source : statistic department of Ministry of Agriculture.
[2] 30 % of the quantity collected at the regional level (20 000 to 30 000 t/an)
[3] 20 % and 40 % of the 80,000 ha of Cognac production, that is 15,000 ha with a yield of 1.5 t of dry matter/ha (DUREPAIRE estimation).

3.9.2.2. Available equipment and facilities

On the Verdille site, DUREPAIRE has a complete pelletizing line.

DUREPAIRE has:

- a straw grinder, a vine prunings grinder are available on site;
- the Chives site has a dehydration tool dedicated to the treatment of alfalfa. Nevertheless, due to the cessation of this activity, there is no longer a dryer.
- Presses used for straw corks.
- A pelletizer;
- The other equipment of the pelletizing line are a cooler and a sieve (10 t/h).

DUREPAIRE's equipment are use all the year thanks to a details management of its resources.

3.9.2.3. Bioenergy market potential

Self-consumption: The DUREPAIRE company is planning (2017) to install a dryer for the dehydration of alfalfa. Implementation is planned for early 2017. The objective is to feed this dryer with biomass (about 3000 t/year). The investment of the new burner has not been considered in this study.

Market development: DUREPAIRE was able to diversify its activities by producing energy pellets. Today, this activity is reduced, dedicated to trading (5 000 t / year of wood pellets).

Biomass accounts for about 85 % of the renewable energy production in the Poitou-Charentes region. These statistics are close to the French average. The market is mainly focused on wood energy (mainly wood logs then pellets and chips) but also on agrofuels (to lesser degree). It should be noted that methanation is also booming. The Regional Plan Air Climate Environment of the Poitou Charentes region mentions, in its development guidelines, projects of methanation "from animal waste and some agricultural co-products".

The production of heat remains the first use. Collective or industrial heating systems account for most of the installed capacity.

The various interviews carried out as part of this audit confirm the continuation of these areas of development. The DUREPAIRE answers are presented in Table 3.

Table 28: DUREPAIRE answers about potentiel biomass consumers in Poitou Charentes

Agro-industry itself	To feed the future dryer
Other agro-industries or farms	Cognac distillery
Public buildings, gymnasiums, collective heating networks	Urban heating
Private individuals	Farmers (energetic autonomy)
Others	Few greenhouses

In order to develop their pelletizing activity, DUREPAIRE has tried to push the development of agro-pellet production, particularly by approaching the ADEME. The context was not favorable and the agro-pellet remained an unknown product. DUREPAIRE also approached RAGT Energie to work on optimized formulations of agro-pellets. Several production tests have been carried out. DUREPAIRE also approached manufacturers of boilers to carry out combustion tests (Hargassner boiler Agrofire, Italian burner, Canadian stove). Despite all these initiatives, there have been no follow-up actions.

Table 5 summarizes information collected on the biomass resources prices at the national level and on the territory of DUREPAIRE.

Table 29 : Main regional competitor products

Data scale	Product	Price €/t (VAT non included)	PCI kWh/kg humid base	Prix €/kWh	Ashes (% dry matter base)
National	**Agro pellets (domestic)**	**160**	**4.40**	*36.36*	*4.60*
National	**Agro pellets (industrial)**	**110**	**4.10**	*26.83*	*4.60*
National	**Wood pellets (hardwood)**	**180**	**5.00**	*36.00*	*1.00*
National	***Small wood chips**	**80**	**3.40**	*23.82*	*2.00*
National	***Large wood chips**	**53**	**2.70**	*19.63*	*2.00*
Regional[4]	**Wood pellets**	**250 à 350**			
Regional	**Log**	**72 € cubic meter**			

[4] Wood Fuels Price Survey in 2015- CODA STRATEGIES- ADEME 2015

3.9.3. Feasibility of the new business line as agro-industry logistic centre

Several scenarios have been studied for the production of pellets on the cooperative, theoretically respecting ISO 17225-6:

Table 30 : Studied scenarios

	Agro-pellets types	**Quantity** t/year
Scenario 1	40 % straw / 30% silo waste / 30 % vine prunings	20,000
Scenario 2	40 % straw/ 20 % silo waste / 40 % Wood chips	20,000
Scenario 3	40 % straw / 30 % silo waste / 30 % vine prunings	20,000
Scenario 4	50 % straw / 50 % vine prunings	20,000
Scenario 5	40% straw/60% wood chips	20,000

Scenario 5 is the most promising. By slightly reducing the costs of storage, transport or biomass buying, a competitive agro fuel on the market could be offered for sale. The price of 160 € per ton would cover all costs and investments while generating a margin of 10 € / t.

3.9.4. Conclusions

This study suggests the analysis of 5 scenarios of production that allow to treat several economic strategies:

- Option 1 : production of a type B agropellet (close to A quality) for moderate costs quite optimized (scenario 1) ;
- Option 2: production of a type A agropellet: The production costs increase, the performance of the product also. This improvement is possible thanks to a different formulation (wood chips instead of vine prunings, see scenario 2-4-5)
- Option 3: Lower production costs are preferred for a product of average quality (suitable for self-consumption in multifuel boilers for example) in pellets format (scenario 3). Nevertheless, the self-consumption of pellets by DUREPAIRE (as part of the relaunch of its activity of dehydration of alfalfa) in the biomass boiler seems unlikely.

DUREPAIRE controls the pelletizing process and already has experience in the production of agro-pellet energy. Current production costs are controlled. However, for a sustained production of agro-pellet energy, several constraints have to be considered:

- Investments considered as important by DUREPAIRE for the modernization of equipment and the increase of production capacity;
- A market which is currently not interesting because of a constraining economic context and supply of competitive biofuels. The study shows that there is currently no real market in Poitou Charentes for agro-pellets.

An aid for investment combined with a demand supported by the local authorities would make it possible to set up demonstrative projects and would be an interesting action to launch the production. The ADEME « Fonds Chaleur » could be mobilized for the boiler supply project. SUCELLOG project, thanks to these awareness-raising and communication actions, aims to promote the agro-pellets in general. Contacts carried out during the project have to continue to stimulate potential local markets. R & D work for the formulation of the pellet would also increase the performance of the DUREPAIRE agro-pellet and take advantage of the diversity of available co-products.

3.9.5. Extra support provided to the cooperative

Cooperative expectation from SUCELLOG:

Durepaire was first interested in having a feasibility study of the concept, based on local available resources, local bioenergy market and needed investments. Beyond the audit, Durepaire was interested in

- **Being integrated to a cooperatives network working on agriculture solid biomass to discuss about feedbacks from this kind of projects / concepts. Durepaire was also interested in having news contacts to develop its markets.**

> Durepaire would like to develop is local network. During a workshop in Bordeaux organized by SUCELLOG, Durepaire was able to meet new partners for its projects in the agricultural and energy sectors. Moreover, during the project, links with local institution were developed. The synergies with SOAL, another cooperative form Aquitaine involved in the SUCELLOG project was reinforced. Information about available aids to develop its projects were analyzed during the project.

> Because of expectations of several cooperatives involved in SUCELLOG, SCDF decided, with Coopenergie, to develop a “silo dust group” to develop new solutions to use this product, in partnership with Coop de France. This group was launched with the impulsion of SUCELLOG partners (cooperatives and agrarian association). The energy uses as solid biomass was obviously studied during this group meeting, as well as other solutions such as chemical uses. This group took place the 13.09.16 and Interval was attending. Another session will be done in June 2017. Durepaire was not able to be present but asked for information and reports. It already asked for information after a biomass logistic conference organized by Services Coop de France.

- **The company has a project of self-consumption and would be interested by a diagnosis to analyse the link between the SUCELLOG concept and the self-consumption project, to optimize the existing synergies.**

> The self-consumption project of the cooperative was analyzed during the audit stage and integrated in the SUCELLOG feasibility study as a global circular economy concept.

- **DURAPAIRE showed interest in the ADEME « Fonds Chaleur ».**

> Interaction with ADEME during one regional SUCELLOG workshop was carried out with that goal.

3.10. Summary of the audit study to SOAL

3.10.1. Company description

SOAL is one of the leaders of the animal nutrition sector in France. Subsidiary of the MAISADOUR Cooperative Group, it is the result of the consolidation of the animal nutrition activities of three cooperative groups, MAISADOUR, VIVADOUR and GASCOVAL, with more than 350 employees.

Located in the former regions of Aquitaine and Midi-Pyrénées, SOAL has a clientele of more than 3,500 breeders. It is the leading supplier of animal feed in the South of the Loire. SOAL represents 39 % of market share for all species and develops more than 400 food formulas, optimized continuously (relying on the work of Nutricia, a research subsidiary of the MAISADOUR group).

SOAL produces more than 750,000 tons of food per year and has 14 manufacturing sites in Aquitaine and Midi-Pyrenees. These products are marketed on more than 180 outlets in the South-West. Some production sites can be listed:

- Castelnau d'Auzan (32) is a site dedicated to the production of organic food (capacity 12 500 t). This 100 % organic food is available in gardening shop, to cover nutritional needs of lower yard animals;
- Haut-Mauco (40): food for poultry, wildfowl and breeding male;
- Auch (32): poultry;
- Pomarez (40) and Anan (31): Flaked foods, mainly for equine feeding;
- Saint-Sylvestre-sur-Lot (47): all species;
- Orègue (64): Site specialized in the production of fibrous mash food.

SOAL wants to diversify its production by investing in aquaculture feed, this sector being growing. A fish feed production plant was built in Roquefort (Landes) with a production capacity of 30,000 t of feed per year (marketing in France and export).

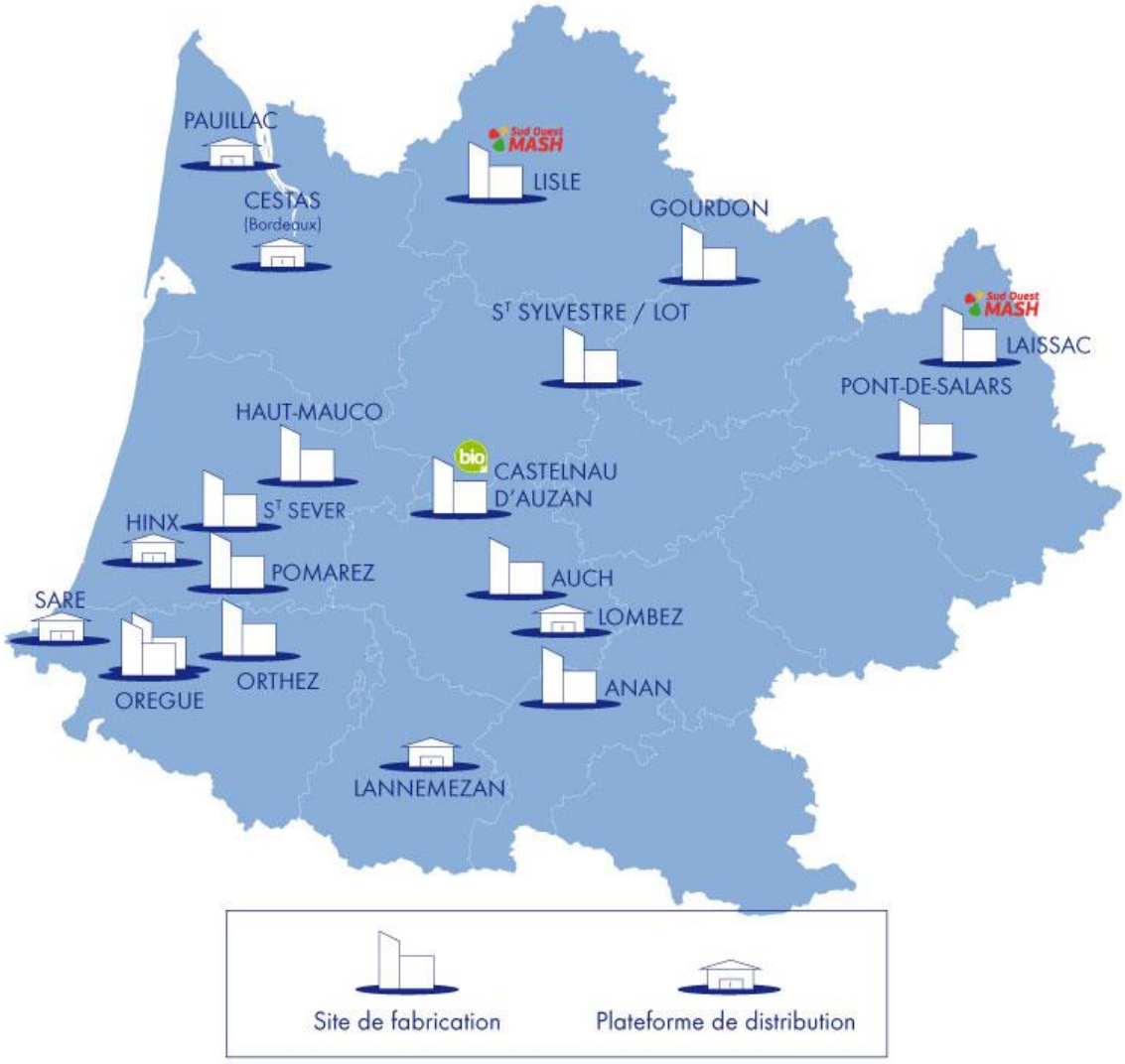


Figure 28 : SOAL territory and sites (Source: Maisadour.com)

3.10.2. Synergies to become a biomass logistic centre

Biomass resources availability

Cultural waste

According to a SOLAGRO[5] study, the estimated potential of crop residues is 614 000 tons (10 %).

Intermediate Cultures for Energy

According to this study, the mobilizable estimated potential is 400 000 tons per year.

[5]Data collected from Solagro report 2015 « Etude de gisement et de potentiel de développement de la méthanisation en Aquitaine.

Residues from viticulture: vine prunings

The total amount of vine prunings is estimated around 200,000 t/ha/year. The mobilizable amount is lower than this estimation as it must consider the other current uses of vine pruning.

Wood fuel

Sawdust is also present in the region (about 140 sawmills operating in Aquitaine identified in an annual survey of the sector in 2014). However, the mobilizable amount remains difficult to evaluate. Some sawmills already use this sawdust in trituration or pellets for households.

The AGRESTE 2014 inventory shows an estimation of 780,000 tons of "sawdust, bark, chips and other by-products" mobilized for other uses [than trituration], including energy production "

Sourcing study by Service Coop de France (SCDF)

When starting the new "fish feed" granulation plant, in the Roquefort site, the installation of a biomass boiler was planned to supply a dryer. NUTRICIA (research and development department of MAISADOUR) asked SCDF to study the technical and economic feasibility of this investment. This work included an available resources study in the cooperative sites, in order to:

- Identify the type of residues available for energy uses;
- Size the necessary annual supply.

This study identified the different available residues in the SOAL territory (members and others) and concluded on the interest to use corn cobs (about 8 000 t / year available in a 50 km radius).

Note:

- Corn cobs have an interested nutritional value and can be used for livestock feeding;
- Corn cobs have a calorific value twice higher than wood chips;
- The different production scenarios will be based on these conclusions. Straw will therefore not be integrated;
- Another option mentioned by SOAL is the photovoltaic / heat transfer fluid technology (R & D project under way in the Aquitaine region).

The moisture content, the months of production and the purchasing cost of locally available resources (excluding transport) are proposed in the same table (see below).

Table 31: Available resources (50 km radius and more).

Resources types	**Available quantity** t/an	**Moisture content (% humid matter)**	**Month of collection**	**Purchasing price** (€/t)
Corn cob	8 000	15	September October	20
Wood dust and chips	780 000[6]	Wood chips (domestic quality) : 20 à 35 Wood chips (industrial quality : 30 à 50) Wood dust : 50	All year	(Source CEEB T2 2016) Small wood chips : 77,8 €/t, 21,03 €/MWh Large wood chips: between 20 and 50,1 €/t, 19,65 €/MWh
Vine prunings	20 000[7]	35	November, December, January	75 to 80

3.10.3. Available equipment and facilities

On the Mont-de-Marsan site, SOAL already owns a pelletising line.

To achieve the production, SOAL will use existing equipment compatible with agro-pellet energy production. The chipper can treat wood chips and vine prunings, the press is reinforced to be able to also treat this kind of raw material.

It should be noted that SOAL does not have equipment able to treat fiber biomass such as straw. SOAL does not have any straw grinder.

The SOAL's equipment operates throughout the year thanks to a precise management of its residues.

3.10.4. Bioenergy market potential

Self-consumption: SOAL targets the households market for agro-pellets but would also like to cover the energy needs of the Roquefort site. The cost for changing the burner to be fed by agriculture resources has not been included in the economic study.

Self-consumption of pellets will be less profitable in comparison with the consumption of unused raw materials (e.g. corn cob which is currently the first option). Nevertheless, it may be considered to supply first group members or other agro-industrial sites (for

[6] Statistics department of French Ministry of Agriculture.
[7] Proportion of 10-20 % of the resource could be mobilized when analysing the regional context

their energy autonomy) to consolidate the overall logistic organization and prepare the future distribution to the new consumers.

Market development: the market is mainly focused on wood energy. The ADEME counts about 140 industrial and collective boilers in operation, for a total of approximately 95 MW of consumption per year.

Aids from the region and the ADEME is allocated for wood energy, biogas / methanation (e.g. through the methaqation support action, 13 methanation units are currently in operation for 290 000 tons of treated waste per year; 27 units are planned), biofuels and green chemistry.

Table 32 summarizes information collected on biomass prices at national and regional levels.

Table 32 : Mains regional competitor products

Data scale	Product	Price €/t (VAT non included)	PCI kWh/kg humid base	Prix €/kWh	Ashes (% dry matter base)
National	**Agro pellets (domestic)**	**160**	**4.40**	*36.364*	*4.60*
National	**Agro pellets (industrial)**	**110**	**4.10**	*26.829*	*4.60*
National	**Wood pellets (hardwood)**	**180**	**5.00**	*36.000*	*1.00*
National	***Small wood chips**	**80**	**3.40**	*23.824*	*2.00*
National	***Large wood chips**	**53**	**2.70**	*19.630*	*2.00*
Regional[8]	**Wood pellets**	**250 à 350**			
Regional	**Log**	**72 € cubic meter**			

3.10.5. Feasibility of the new business line as agro-industry logistic centre

Several scenarios have been studied for the production of pellets in the cooperative site, theoretically respecting the ISO 17225-6:

[8] Wood Fuel Price Survey 2015- CODA STRATEGIES- ADEME 2015

Table 33 : Studied scenarios

	Agro pellets types	Quantity produced t/an
Scenario 1	40 % Corn cob / 60% wood chips	15 000
Scenario 2	60 % corn cob/40% wood dust	12 000[9]

Scenario 1 is the most promising. According to this table, the threshold values "ash content" and "chlorine content" of the standard are respected. The pellets would be classified in class A (the one promoted by the SUCELLOG project and more adapted to the demand of the household market). A price around 160 € per ton can be proposed by the company, being competitive in the biomass market.

3.10.6. Conclusions

This study proposed the analysis of 2 scenarios of production with different economic strategies:

- Option 1: Production of a type A agro-pellet with optimized average costs (scenario 1);
- Option 2: production of type A agro-pellet. Production costs decreases, product performance also (ash content, clinker production and presence of corrosive elements);

Other scenarios could be considered in relation with SOAL's objectives.

SOAL manages the pelletizing process and already has experience in the production of pellets. Current production costs are controlled. However, in the context of a sustained production of agro-pellet for energy uses, several constraints have to be considered:

- Corn cob logistics to be implemented with suppliers;
- A market which is currently not attractive because of a constraining economic context and a supply of competitive biofuels. The study shows that, for the moment, there is no real market in the former Aquitaine region for agro-pellets.

The ADEME « Fonds Chaleur » could be mobilized to support a boiler project.

SUCELLOG project, thanks to these awareness-raising and communication actions, aims to promote the agro-pellets sector in general and its development. The project supported SOAL, being in contact with potential consumers in order to stimulate

[9] Préconisation UCFF afin de rester dans la limite des gisements disponibles en rafles sur le territoire de SOAL.

potential local markets. This action has to continue. R & D work for the formulation of pellets would also increase the performance of the SOAL agro-pellet and take advantage of the diversity of available residues.

3.10.7. Extra support provided to the cooperative

SOAL is building a new site of production with important energy needs. It is looking for the most profitable energy solution.

First of all, SOAL was interested in having a feasibility study to develop the SUCELLOG concept, having access to information about available biomass resources, local market and needed investments. Beyond the audit, it was other interested by other additional information.

Firstly, **SOAL asked to SUCELLOG partners to link the audit stage with a feasibility study leaded by Services Coop de France at the beginning of the project to develop a self-consumption project.** The idea was to organize the audit stage taking into account a part of self-consumption of agricultural solid biomass on the Roquefort site.

SOAL was also interested in developing its network on the energy sector, contacting other cooperatives, potential suppliers, possible consumers and potential partners.

- Services Coop de France worked with SOAL to develop a feasibility study to use agricultural biomass on the new site of Roquefort. Thanks to the feedback from Austria from the SUCELLOG project, it was shown that the use of its own corn cobs could be a good opportunity for the cooperative. Moreover, the methodology organized during the SUCELLOG project helped the SCDF team to realize the resources part of this feasibility study.
- After this first study and according to the SUCELLOG project, it was proposed to the cooperative to mix the SUCELLOG's audit with this first heating analysis to build a major project both self-consuming and selling solid biomass. This part is an additional part of the classical audit proposed by SUCELLOG.
- Moreover, the SOAL team was integrated to other projects lead by Services Coop de France thanks to their participation in the SUCELLOG project: they attended training and meetings about logistic biomass or use of agricultural biomass for energy or green chemistry. They are in regular contact with the SCDF team about these topics. During these meetings, they met other agro-industries interested in using agricultural biomass for energy. Moreover, during the WP6 of the SUCELLOG project, they met the Durepaire team, also involved in SUCELLOG, and also working to develop a biomass project. Innovative stakeholders were also met.

- Information about aids to develop the project, in the ADEME mainly, were proposed to the cooperative.