INTEGRATED BIOMASS LOGISTICS CENTRES FOR THE AGRO-INDUSTRY

Environmental, economic and social impacts of IBLC strategies

Deliverable D6.5

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ABBREVIATIONS

Cl: Chlorine

DI: Distribution Incentives

DM: Dry Matter

EAFRD: European Agricultural Fund for Rural Development

EISA: Energy Independence and Security Act

EPA: Energy Policy Act

ETBE: Ethyl Tert-Butyl Ether

FI: Farmers Incentives

FT: Full Time

FT eq.: Full Time equivalent (jobs)

FTA: Fault Tree Analysis

GHG: GreenHouse Gas

GMO: Genetically Modified Organisms

HP: High Pressure

IBLC: Integrated Business Logistics Centre

Incoterms: International Commercial Terms

K: Potassium

KPI: Key Performance Indicator

LCA: Life Cycle Analysis

LHV: Lower Heating Value

OTP: Olive Tree Pruning

PME: Palm Methyl Ester

PBS: Polybutylene Succinate

PVT: Photovoltaic Thermal

RHI: Renewable Heat Incentive

SA: Succinic Acid

SOC: Soil Organic Carbon

SON: Soil Organic Nitrogen

VSM: Value Stream Map

WTP: Willingness To Pay

WTS: Willingness To Sell

PARTNERS SHORT NAMES

CIRCE: Fundación CIRCE

WFBR: Stichting Wageningen Research

ZLC: Fundación Zaragoza Logistics Centre

CERTH: Ethniko Kentro Erevnas Kai Technologikis Anaptyxis

RISE: RISE Research Institutes of Sweden

CREA: Consiglio per la Ricerca in Agricoltura e L'analisi dell' Economia Agraria

APS: Agroindustrial Pascual Sanz S.L

NUTRIA: Anonymi Biomichaniki Etairia Typopiisis Kai Emporias Agrotikon

LANTMÄNNEN: Lantmännen Ekonomisk Forening

PROCESSUM: RISE Processum AB

Spanish CO-OPS: Cooperativas Agro-alimentarias de España. Sociedad Cooperativa

INASO: Institouto Agrotikis Kai Synetairistikis Oikonomias INASO PASEGES

AESA: Agriconsulting Europe S.A

UCAB: Association Ukrainian Agribusinessclub

UBFME: University of Belgrade. Faculty of Mechanical Engineer

EXECUTIVE SUMMARY

The goal of this deliverable is to provide with additional insights about the potential impacts of the IBLCs being assessed in the study cases developed in AGROinLOG deliverable D6.4. The approach consists of the analysis of previous studies where existing Key Performance Indicators (KPIs) are created and clustered into three areas:

Economic KPI: economic key performance indicators are fundamental to determine the economic viability of IBLCs. However, it is known that economic performance cannot be associated to a single actor, but to the several stakeholders collaborating in the associated supply chain, from suppliers, transport carriers, to producing plants, and distribution markets.

Social KPIs: apart from the economic impacts, the social implications need to be considered, mainly focusing on the number of jobs generated and the associated quality. It is well known that farmers as well as producers in the sector struggle to maintain the workforce during the year. The social sustainability is low and therefore these KPIs aim to evaluate the potential social conditions that could improve the working conditions in the regions where the IBLCs structures are going to be established.

Environmental KPI: finally, environmental indicators are also important since initiatives like IBLCs that create jobs and are economically viable, should be designed in order to contribute to lower emissions and not to damage to the environment comparing to alternative fossil fuel based options. Hence, these KPIs will investigate impacts with a focus on soil impacts as well as emissions of CO_2eq into the atmosphere.

The three sets of KPIs are then applied and analysed in the following five cases/sectors:

- CASE 1: Fodder Industry
- CASE 2: Olive Pruning
- CASE 3: Vineyards Pruning
- CASE 4: Grain Industry
- CASE 5: Sugar Industry

In terms of economic impacts, the cases studied in this report show promising results. The first case may achieve an annual profit of €97 728 with the assumptions established. Considering a discount rate of 7 %, the necessary initial investment of the new lines, €970 000, can reach a break even over a period of about 18 years.

The second case is also positive, showing similar profits in the range of €120 000 per year. Considering the investment of one production line and 3 harvesters, totally, €360 000, the breakeven for the Net Present Value can be reached after approximately 4 years. Increasing the purchasing costs to 170 €/tonne, profits could increase to about €216 000 per year.

The third case presents the highest potential revenues compared with the ones considered. Only the pellets production, in a very optimistic scenario with high demand-high availability of pruning, could raise revenues for about €68.04-90.72 million. Yet, this value considers that all farmers agree to sell the pruning, which is not the current situation and due to confidentiality issues, it is not possible to know with precision the real availability of raw material in the region analysed. In addition, the demand for pellets is estimated as low, at least in the short-medium term. Therefore, these potential

revenues would most likely need to be reduced. In addition, a more detailed cost analysis is necessary to determine the final profits. In this case study the importance to reach an agreement between farmers and pellet producers is key to share the profits across the supply chain.

The analysis of the fourth case, the grain industry, shows the potential high selling price of biochar retrieved from secondary data, 354 €/tonne. In this case, annual revenues of about €354 000 – €637 200 can be expected, making the business cases promising and economically sustainable.

Finally, the last case, sugar industry, has a potential of revenues from biocommodities ranking between 34 650 €/y and 48 300 €/y. Yet, more data is needed for this assessment as many of the costs involved e.g. production, transport, storage etc. could not be computed and used to discount the revenues.

In terms of social impact, the quantity and quality of the new employment created by the transition of agro-industries to IBLCs has been assessed for each agricultural sector, using as reference hypothetical and selected case study companies. Employment is, by far, the largest social impact of the new IBLC activities. In all cases, the number of new jobs created depend on the type and volume on the new innovative bioproducts to be manufactured, either for self-consumption or for the biofuel markets.

In most sectors, and based on the available information, solid biofuels from agricultural wastes represent the highest potential of all possible IBLC's products. The amount of new jobs is relatively modest, but the average company size increase is moderate due to the usual low company size (24 % average increase). Some companies intend to use their seasonal idle times or would undertake the new tasks with the existing staff, but most would be new hires.

In terms of job quality, there would not be a significant change on the feedstock harvesting side but new jobs at the IBLC would be enhanced. Salary-wise they are in the country average, but qualification requirements are usually low or very low. On the contrary, experienced workers are preferred. Jobs are usually seasonal and taken by men although no gender barrier has been identified. The positive aspects of IBLC jobs are related to the stability in long-term perspectives and the location of the new positions, enabling impoverished rural areas to fix population and improve their life standards. Finally, health and safety issues are highlighted in some sectors like fodder and grain, due to the dusty conditions of material handling. Especial care and protection measures should be provided.

The environmental impacts measured as potential emissions of CO_2eq into the atmosphere range between 6 200 and 617 258 KgCO_2eq annually. The vineyard sector may have the highest emissions, but this is due to the very high amount of pruning that can be collected from the study area (about 756 000 tonnes). On the other hand, the emissions are traded-off by the very high economic profit. Apart atmosphere emissions, only case 1 seems to have some potential impacts in terms of fertility loss. In this aspect, fertility loss has been depicted into a fault tree analysis showing the dependence on several factors connected to soil compaction and erosion (see also annex A).

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1 INTRODUCTION

This report aims to give insights about the potential Key Performance Indicators that should be considered to determine the impacts for establishing IBLCs within the following areas:

1) Economic: economic indicators aim to determine the economic viability of the cases assessed. In particular, the supply chain approach is used to identify KPIs on supply, production, and downstream markets.
2) Social impacts: social performance indicators such as number of jobs generated, etc. This set of indicators is important since jobs in the agricultural sector are seasonal.
3) Environmental impacts: environmental indicators, such as soil compaction, soil organic carbon content variation, and CO_2eq emission savings.

Hence, a toolset containing the following methods will be used to assess the environmental social and economic impacts of IBLCs development in the targeted sectors.

The key performance indicators and metrics have been identified and defined by means of searches, analysis, and elaboration of previous studies. The overall approach and classification of the KPIs follows the business model proposed in Task 2.2 where the supply chain is in focus, including its upstream, focal production company (the IBLC) and downstream parts. Thereafter the KPIs are collected from five case studies established and defined in previous deliverables, i.e. task 6.2 and 6.4. Additional data was collected by means of two questionnaires sent to partners involved in the development and definition of the study cases. One focused on social indicators and the other on economic/environmental indicators.

Another important part of this report is the development of Value stream maps (VSM) for each of the cases investigated. VSM is an important technique utilized in lean management to identify value-adding and non-value-adding activities in the value stream so that wasteful activities can be eliminated, and production can be aligned with demand. VSM are also useful for the identification of managerial strategies aiming to support the achievement and realization of advantageous business cases.

1.1 Report Structure

The report is structured as it follows:

- **Introduction** explaining the scope of the report.
- **Methodology** developing the approach followed in the study.
- **Framework for Economic, Social and Environmental impacts.** In this section, the framework for the economic, social, and environmental impacts is developed. Here, a list of relevant KPIs to be used to measure economic, environmental, and social impacts of the IBLCs in the chosen sectors.
- **Sectorial Analysis** focuses on the application of the framework to analyze the sectors / case studies proposed in AgroInLog D6.4. The sectorial analysis analyses the cases from three perspectives: economic, social, and environmental impacts. Finally, the visual stream maps for each of the cases is proposed are expounded and explained.

- Conclusion. In this section the results are summarized with a focus on the potential impacts of the IBLCs on sectors and recommendations to generalize the methodology adopted.

2 METHODOLOGY

This task will give insight in the economic, environmental, and social impacts of the IBLCs implementation in the targeted sectors. To accomplish the objectives the following steps have been followed:

Materials and deliverables from WP Tailored Business Plan and Exploitation of the Innovative Business Models but also findings from tasks 6.2 and 6.4 were used as an input to this task. The team started by looking at the documents produced to determine the following:

- Initial generation of KPIs, material from WP Tailored Business Plan and Exploitation of the Innovative Business Models, where ZLC developed simulation models for the Swedish, Greek, and Spanish demos.
- Choice of sectors and cases studies as defined in task 6.2 and task 6.4.

KPIs Identification. KPIs were identified and elaborated by means of a literature search. The main structure for the KPI identification and clustering builds on previous work developed and published in D5.1 in 2017 and published in Urciuoli and Muerza (2018) as an integrated Framework for Evaluating Costs of IBLCs' supply chains. Hence, the KPI have been arranged into 3 clusters, the first to identify economic related KPIs, the second for environmental impacts and the last for the social indicators.

After the literature review, the KPIs identified for the economic and environmental impacts were used to develop a questionnaire. The questionnaire was presented to AGROInLOG's partners in separate meetings. During these meetings, comments on the questionnaire were collected, allowing further refinement. Thereafter the answers were gathered and used as part of the results.

Data collected for the analysis of the cases consisted of the following parts:

- *Previous deliverables.* Some basic understanding of the case was determined through the analysis of deliverables from T6.2 and T6.4. that was completed with statistics at country and EU level of the different sectors, mainly from Eurostat. Synergies with other ongoing tasks were sought to optimise the efforts in the obtention of data.
- *Interviews.* Interviews scheduled at the end of 2019 contained questions related to social aspects of the acceptance of new products. The interview questions for the economic and environmental impacts followed a questionnaire that was sent at the beginning of 2020 to AGROinLOG's stakeholders.
- *Workshops.* Partners organising workshops in T7.6 were contacted with the request to include social-related questions in the workshops.

The collection and measurement of KPIs for the social impacts followed a similar approach, but the focus was on the evaluation and assessment of impacts of the innovations on work. In particular, two main types of indicators were considered: the number of potential new jobs generated by the agro-industries related to the transition to IBLCs and the quality of the new jobs created or the improvement of the conditions of the existing ones.

Case studies were used to measure the identified KPIs. Within the cases, data was collected by means of structured interviews. The cases are the following:

- CASE 1: fodder industry.
- CASE 2: Olive Pruning.

- CASE 3: Vineyard Pruning.
- CASE 4: Grain Industry.
- CASE 5: Sugar Industry.

Each sector was addressed by an AGROinLOG partner in a different country or region. The table with the case studies used as data source in the social analysis of T6.5 is compiled in Table 1.

Table 1. T6.4 list of case studies used as data source in T6.5 social assessment.

List of case studies						
Sector	Feedstock	Partner	case study	Equipment	Product	Market
CASE1	Straw	CIRCE	Agro-cooperative (Spain)	Pelletizer, dryer, storage	pellet	biofuels
CASE2	Olive pruning	CERTH	Pomace Mill (Crete, Greece)	Pelletizer, dryer, storage	pellet	biofuels
CASE3	Vineyard pruning	Spanish Coops	Agro-cooperative Castilla-La Mancha (Spain)	Dryer, storage	pellet	biofuels
CASE4	Chaff	RISE	Lantmännen (Sweden)	Pyrolyser, Pelletizer, dryer, storage,	Pelletized biochar	Soil improvement, carbon capture, filtration material, animal feed additive and bioenergy
CASE5	Sugar beet fibers	RISE	Nordic Sugar (Sweden)	dryer, grinder, digester, beet washer, pelletizer storage,	PBS	Diapers, Cosmetics toys, shoes, packaging clothing

All sectors are suitable for the production of biofuels, usually solid biofuels in form of pellets. This production process is well characterised by the AGROinLOG project and it is the potential or actual target of the case-study companies.

Value Stream Maps. Value stream maps have been generated for the case studies proposed in this report. The goal of theses maps has been to enhance understanding of logistic flows, processes and main managerial challenges to optimally manage the supply chain. The generation of the maps was performed with a deductive approach made of the analysis of primary and secondary data gathered from previous deliverables, 6.2 and 6.4, as well as the questionnaire based on the tables for the economic assessment shown in the next section (see Table 2 - Table 10).

3 Economic, social and environmental impacts analysis

Specifically, three types of indicators from different levels (e.g., resource productivity, supply chain, environment and public health, sustainable society, etc.) will be proposed:

1. Economic indicators, such as resource use efficiency, level of profit, added value in supply chain.
2. Social performance indicators such as number of jobs generated, etc. A toolset containing the following methods will be used to assess the environmental social and economic impacts of IBLCs development in the targeted sectors.
3. Environmental indicators, such as GHG emission savings, soil compaction, soil organic carbon content variation, percent recycled content for each raw material.

3.1 Economic performance indicators

The transition to a circular economy, where waste from agricultural activities is collected and transformed into biofuels, could offer several societal advantages like for instance reduced emissions of greenhouse gases (GHG) coming from the usage of fossil fuels, decrease on the resource depletion or the dependence on unstable foreign suppliers (Urciuoli et al., 2014). However, from an economical viewpoint there is still much uncertainty about the real costs for producing biofuels and other bio-commodities, whether these costs can be internalized in the final price offered to consumers, and ultimately if the bio-commodities will be competitive on the marketplace. Research has pointed out that governmental subsidies offered to companies, could turn the too high costs in positive profits (Steenblik, 2008). This raises doubts about the economic sustainability of these bio-chains and demand for additional studies aiming to uncover what economic indicators and impacts need to be considered when establishing an IBLC.

In this aspect, by means of a literature review, this section develops a framework to assess the economic viability of bio-based business in agro-industries. In this framework the following aspects have been considered:

- **Availability of raw material.** Arable areas dedicated to the selected supplies must be accessible within a reasonable distance. In addition, while demand for agricultural residues could increase farmers profits, there is still competition with other usage of the land, e.g. food production, bedding, animal feeding, fertilizers etc.
- **Transport and storage.** Analysis of transport and storage costs.
- **Production costs.** Production processes adds new costs in terms of labour, energy, and fixed investments, e.g. machinery.
- **Customers/Markets.** Products need markets where they can be sold. Demand for products steer the whole supply chain, from raw material, production, and distribution.

- **Government incentives.** Tax, governmental policies, or regulatory policies raise uncertainties about the sustainability of economic and social aspects of bio-commodities production. Therefore, it is of outmost important to monitor and evaluate the impacts of these policies.

Demand for biofuels could also increase farm income. On the other hand, because many biofuel feedstocks require land, water, and other resources, research suggests that biofuel production may give rise to several undesirable effects. Potential drawbacks include changes to land use patterns that may increase GHG emissions, pressure on water resources, air and water pollution, and increased food costs. Depending on the feedstock and production process and time horizon of the analysis, biofuels can emit even more GHGs than some fossil fuels on an energy-equivalent basis.

3.1.1 Availability of raw materials

Some bio-commodities products may need access or orginate from available cultivated lands. For instance, the production of biofuels has different dynamics compared to fossil fuels. Biofuels are based on agricultural products coming from cultivated lands (Rathmann, Szklo, & Schaeffer, 2010). Access to cultivated lands can be compromised by several factors.

A first problem encountered is the uncertainty of the availability of supplies, in terms of yield, type and quality (Awudu & Zhang, 2012). With access to arable land where specific crops can be cultivated, the potential amount of biofuel that may be produced could be limited. In addition, the availability and access to the cultivated areas raises concerns in procurement decisions but also in the overall decision to establish a conversion plant that could economically afford the collection and conversion into bio-commodities (Awudu & Zhang, 2012).

An important challenge is the land use competition, i.e. the decision made by farmers in terms of allocation of productive areas (Rathmann, Szklo, & Schaeffer, 2010). It has been pointed out, in several contexts, that the dedication of land to the production of raw materials for biofuels is shifting land use away from food production, posing the dilemma of favouring the greater monetary returns of farmers instead of the need of feeding humanity (Rathmann, Szklo, & Schaeffer, 2010). Examples from the past show that farmers may be willing to shift production. For instance, in Brazil there has been a shift of cultivations from soybeans to sugarcane, and in the United States from wheat to corn (Wright, 2006). While farmers can achieve better returns selling to biofuels, the scarcity of soybeans and wheat determined a decline of stocks of these agricultural commodities, and, contemporarily a rise of prices (Wald, 2006). It could be argued that circular economy principles based on the collection of waste from these lands can solve this dilemma. The production from arable land can still be used by the food sector and only the residuals can be collected to produce biofuels. Nevertheless, this implies that the farmer will continue using its land for the same crop and will not switch to a different one. Farmers need to make a choice about how to use their land, so what crop should be allocated. This decision can be summarized as the farmers' expectation of return and based on an evaluation of the following factors (Rathmann, Szklo, & Schaeffer, 2010):

- **Own skills and knowledge** about cultivating the land in optimal manner.
- **Technology available**, e.g. seeds and special machinery needed to harvest and collect.

- **Market structures**, i.e. easy to resell and presence of buyers.
- **Trends in prices**, a correct analysis of the prices is carried to determine whether the selected crop's allocation is going to be profitable.
- **Government policies**. Any important policies to consider in terms of treatment, storage, and transport and ultimately subsidies.

Even when residuals are available from farmers, it remains to determine whether farmers are willing to sell. For instance, residuals could be used for generating thermal energy in boilers installed at farmers sites. Likewise, these residuals could be used for animal feeding or bedding, and ultimately as fertilizers. To make the residuals available to a third party, there must be a clear business case, where the sale can generate higher revenues than the potential benefits from internal exploitation of the residues.

Climate changes, and their related extreme weather conditions, e.g. dry weather, or the opposite precipitations, can alter the availability of raw materials in selected regions. In this aspect, it is important to understand 1) how much the selected crops and growth depend on climatic changes and 2) the regions being studied are subject, or simply at risks, to these temperature variations.

Next table summarizes the KPIs that have been generated from the literature review (Table 2).

Table 2: KPI to measure availability of raw materials.

Availability of Raw Materials KPIs (ECO1_n)			
KPI	Name	Definition	Dimension
ECO1_1	Available cultivated lands	Lands dedicated to the cultivation of the studied raw material	ha
ECO1_2	Usable Waste	Correction coefficient to determine amount of waste from cultivated lands	% of usable waste from total production from cultivated lands, e.g. kg/ha
ECO1_3	Market competition	Correction coefficient to consider market structure competition from other usage of the waste, e.g. animal feeding, bedding, fertilizers	% or ratio competitive usage / a waste
ECO1_4	Weather	Correction factor considering extreme temperature variation, e.g. dry or high precipitation	% decrement of usable waste
ECO1_5	WTS	Willingness to Sell of farmers. Minimum price the farmers would accept to sell. This depends on local market structure and prices from available buyers.	€/kg
ECO1_6	Investment costs	Fixed costs needed to purchase necessary machinery to harvest and collect residuals from lands.	€

ECO1_7	Operations costs	Variable costs including energy consumption, labour, and fuel costs.	€/year

3.1.2 Transport and Storage Costs

There is plenty of research analysing transport and storage costs in biomass supply chains. When waste is collected and available from the arable lands it must be stored, waiting to be transported. Storage is necessary because a crop is harvested during one period of the year, while conversion plants must work continuously (Ba, Prins, & Prodhon, 2016). Hence, all material is collected once a year and then needs to be preserved to allow the production plant to process it within a reasonable time. Farmers or buyers of the biomass will organize the logistics operations where transport typically happens in heavy goods vehicles.

A known dilemma concerns who between the seller (the farmer) and the buyer will be monetary liable for the storage and transport costs or any risks for holding the inventory (e.g. obsolescence). In supply chains, these arrangements are standardized in contracts, where Incoterms agreements can be stipulated. However, in the biomass sector, the level of knowledge and adoption of these agreements is typically low. In agriculture and biomass, existing transaction costs economic theories, including bounded rationality and opportunism hold well, especially, when determining how transportation and storage costs should be shared between buyers and sellers. In general basis, there are no established and standardize practices to contract transport and storage of biomass. This lack of practices generates incomplete contracts, opportunism, uncertainty, and higher transaction costs, e.g. costs would include ex ante search and negotiation costs and ex post enforcement, monitoring, and renegotiation costs (Altman, Sanders, & Boessen, 2007).

The studies performed within AGROinLOG, where supplies and transportation in three different demos were analysed (Greece, Sweden, and Spain) demonstrated that risks and cost sharing between suppliers and buyers are often undefined and randomly established. It was not possible not find any effective mechanisms in place for hedging sales and purchases. This implies that the process to purchase transportation becomes cumbersome and costly when it comes to determine which of the actors will oversee the transport or the storage.

Within the biomass and agricultural sector, there seems to be much uncertainty in terms of the economics of transportation and logistics operations. The transport offer for this sector is still minor and relatively immature compared to others, and for that reason it is difficult to achieve consistent scale economies and convenient pricing. Likewise, the lack of scale economies is driven by the scarce utilization of unit loads, which ultimately implies a higher cost and a not-environmentally friendly transport arrangements (Awudu & Zhang, 2012).

If the storage is arranged at the farmers' site, in absence of proper infrastructure and equipment, the risk for deterioration increases, i.e. moisture content increases and with it the quality of the material deteriorates as well as its potential to produce energy from combustion processes or biofuels (based on work performed in AgroInLog WP5). The other way round, if storage is kept at the production site, the buyer will see production and storage costs significantly increased. Another typical problem that appears when buyer holds inventory concerns the intake rate of the production lines and the production rate. Input biomass will need to be transported first to a plant and then loaded in the production line in batches. To ensure a constant intake without interruptions, material needs to be stored close to the plant. If not, transport needs to be arranged in order to ensure continuous supply.

When farmers are not located close to the plant, proper intermediate buffers need to be created, to transport to a convenient storage place. These storage locations need to be equipped with technologies aiming to preserve quality of the biomass. However, establishing an intermediate location raises uncertainties in terms of which of the actors, buyer, or supplier, should bear the costs. Another option is to make an agreement with a Logistics Service Provider, to arrange temporary storage at some convenient intermediate location. This location should be then used by the LSP to optimally replenish the plant. Hence, it is important to scan the areas around the farmers locations, to identify and measure the accessibility to adequate infrastructure for intermediate storage.

As discussed above, the biomass production is usually seasonal, resulting into large quantities that needs to wait before being supplied to the production plant and processed in optimal batches (Bam Prins, & Prodhon, 2016). Large quantities of biomass are also needed, since for economic reasons the production line needs to be kept operative during the entire year. Peskett, Slater, Stevens and Dufey (2007) pointed out the importance of increasing storage, to reduce the problem of labour seasonality at production plants.

The size of the storage facility can also determine how the biomass is moved and the capacity of the vehicles to be used. Small size storage will require more frequent transportation with smaller loads. This implies also higher transport costs and environmental impacts (e.g. traffic generation, vehicle emissions, vehicle noise, visual intrusion, water pollution and the health and safety of workers and the public). The opposite occurs if the storage area is larger (Allen, Browne, Hunter, Boyd, & Palmer, 1998).

The KPI identified in the literature for transport and storage costs are summarized in the next table, together with a shorten definition and proposed dimension for the measurement (Table 3).

Table 3: Transport and Storage Costs KPIs.

Transport and Storage KPIs (ECO2_n)			
KPI	Name	Definition	Dimension
ECO2_1	Transport distance	Average transport distance to move materials from lands to plant	km
ECO2_2	Transport costs	Transport variable costs including vehicle usage, fuel, and labour to transport materials. In case fleet is not owned, freight rates are applicable.	€/km
ECO2_3	Storage costs/holding costs	Variable costs related to the storage of raw materials, either at farmers site or at plants, inbound warehouse.	€ or % of value of stock (see holding costs)

ECO2_4	Investments	Needed fixed investments for storage or transport.	€

3.1.3 Production Costs

The scope of producing bio-commodities is to develop alternative products whose production and distribution is sustainable in terms of energy used and environmental impacts. Production processes are necessary to transform the materials collected into bio-commodities and, typically, these have the largest influence on the total energy consumption in biofuel supply chain, i.e. comparing energy for planting, seeding, harvesting, transporting and producing (Janulis, 2004). Plenjai and Geewala (2009), by means of a Life Cycle Analysis, showed the potential to substitute diesel fuel with palm-oil based biofuel, palm methyl ester (PME). PME requires three main processes: crude palm oil extraction, refining, and biodiesel production, i.e. transesterification. For instance, the energy needed for the last process to produce biodiesel corresponds to about 5.98 MJ/Kg PME.

The transformation of raw materials into biofuels, has additional challenges, mainly related to the organization of the labour to run the production line, as well as machinery costs. The type of labour in plants involved in biofuel transformation is seasonal. The raw materials and residuals that can be collected from farmers are available once or twice per year, this temporary work positions, less attractive and with low wages. As discussed previously, storage increases can relieve issues with labour seasonality. The machinery necessary for the production, requires fixed capital investments. In some cases, initial investments are necessary for the plant facility and its machinery (Haas, McAloon, Yee, & Foglia, 2006). In other cases, a plant and a production line already exist. Yet, the production line will have to be adapted by investing in single machines to be introduced in the line. Apart the initial investment costs, operative costs are important, including labour, energy/electricity costs, maintenance and other sanitization costs that are necessary to clean machinery if switching from non-food to food production.

In case an existing production line needs to be used, the challenge is to synchronize the inbound receival of new raw materials and their transformation into biofuels, with the existing production processes. This can be possibly done during idle times, if any. An interesting challenge could be to balance purchasing and storage to keep an optimal and cost-effecting production.

KPIs related to production activities are summarized in the next table,

Table 4.

Table 4. Production Costs KPIs.

Production Costs KPIs (ECO3_n)			
KPI	Name	Definition	Dimension
ECO3_1	Production costs	Average costs to produce a given amount of bio commodity. It includes energy consumption, labour, training, and machines usage costs.	€/kg produced

ECO3_2	Switch Costs	When handling different production lines, production lines need to be switched to allow production of other commodities. This comes with additional costs since some machines in common need to be cleaned and sanitized (in case of food vs non-food production).	€/switch
ECO3_3	Investments	To extend a production line and allow the production of new bio-commodities companies may need to invest in new machines to be integrated in their old production lines.	€
ECO3_4	Supplies costs	Price of the supplies	€

3.1.4 Customers/Market

Creating and leveraging bio-commodities to the marketplace, implies that there is a final consumer that is willing to pay for them. Eventually willing to pay a higher price than those requested for existing products. As an example, the current state of biofuel supply chains shows that these systems are extremely uncertain in terms of access to resources and final demand, hence costs to purchase and arrange the logistics increase significantly. As a matter of the fact, prices can be high, despite the existence of governmental incentives (Savvanidou, Zervas, & Tsagarakis, 2010). Hence, it is important to determine what is the value added of biofuels, compared to fossil fuels, and with that, what prices could be feasible for final consumers.

Studies exist showing the willingness to pay for biofuels in diverse European countries. For instance, Savvanidou et al. (2010), by means of 571 face to face interviews reported that a great majority of the public opinion, about 90.7 %, is aware of the effects on climatic change of fossil fuels. Alternative sources of energy are important, however 53.9 % of the respondents identify biofuels as an effective solution. In this aspect, 44.8 % of the respondents are willing to pay between 0.06-0.079€/L on top of the current fuel market price. In a similar study, performed in Spain, in Aragon region, Giraldo, Gracia, and Do Amaral (2010) used a choice experiment to find that consumers were willing to pay 5 % more than fossil fuel prices. Interestingly, both in Greece and in Spain, consumers have quite low knowledge of the potential impacts on the environment for using biofuels. In this aspect, an Italian study with 260 individuals from Northern Italy shows that willingness to pay is negatively correlated with knowledge about biofuels (Lanzini, Testa, & Iraldo, 2016). Perhaps when consumers are more aware about government subsidizes and their impact on fuel prices, they will better understand the risks for potential future prices increments.

For customer/markets that are relevant for the distribution and sale of bio-commodities only one KPI has been identified, the willingness to pay of the markets. This is reported in Table 5.

Table 5. Customers KPIs.

Customers KPIs (ECO4_n)			
KPI	Name	Definition	Dimension
ECO4_1	WTP	The willingness to pay, is the price valued by the market for the specific commodity to be sold. It depends on the market structure, presence of competitors and prices offered for bio and non-bio versions of the same commodity.	€

3.1.5 Government Policies

Biofuels tend to require subsidies and other market interventions to compete economically with fossil fuels, which creates deadweight losses in the economy. Tailored policies are fundamental to avoid the detrimental effects on sustainability (Awudu & Zhang, 2012).

The European Union is currently promoting the production and usage of biofuels from biomass to produce electricity and heating. In a directive from 2009, the European Union established a common framework to promote production of energy from renewable sources. It gives mandatory targets on national level for the overall share of energy from renewable sources, i.e. 20 % share in the community's gross final consumption of energy in 2020 (EU, 2009). It is desired that the transport sector reaches a renewable energy use target of 10 %. More recently the share has been increased to 27 % in 2030 (EU, 2018).

Research is on-going in several countries, to develop plans aiming to secure the uninterrupted supply of biomass to transformation plants. At the same time, the economic feasibility is being studied in order to ensures sustainable benefits for farmers as well as biofuels producers. This is however a challenging task, since production of biofuels may imply both benefits and disbenefits that could be difficult to quantify and trade-off (EPA, 2019). Nevertheless, in order to testify the difficulties of biofuels to survive and compete on the marketplace, the following list enumerates examples of subsidizes that have been launched by governments in order to sustain R&D, innovation and biofuels supply chains:

- **Energy Policy Act 2005:** it introduced several economic incentives in the US, e.g. grants, tax exemptions, subsidies and loans to entities driving biofuel related research and development.
- **The Energy Independence and Security Act of 2007 (EISA).** Types of incentives proposed in the US, including cash awards, grants, subsidies, and loans for R&D, as well as for biorefineries displacing more than 80 % of fossil fuel to cellulosic biofuels.

A report aiming to understand the level of support given to liquid biofuels, proposes a supply chain based framework to discuss the level and magnitude of government interventions from feedstock crops to final consumers (Steenblik, 2008) (Figure 1). The report identifies supply chain subsidies upstream, at suppliers' stage, to produce intermediate inputs, i.e. to farmers producing biomass from waste or agricultural production. However, the magnitude of these incentives can be small and consists of fiscal discounts on capital goods, export taxes/duties, labour, or land use. For instance, some municipalities can provide the land for biofuel plants for free or below market prices; or grants can be made available or likewise loans can be given at affordable rates (Steenblik, 2008).

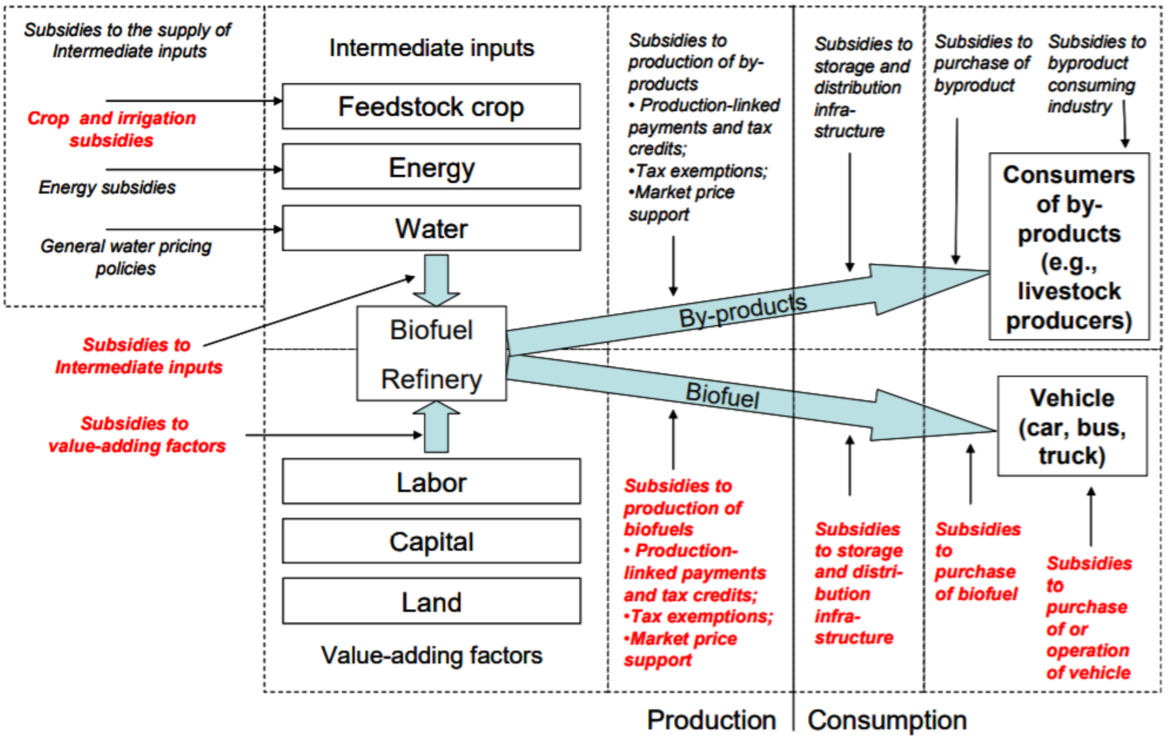

Figure 1. subsidies provided at different points of the supply chain (Steenblik 2008).

Subsidies are not limited to the upstream and manufacturing part of the supply chain, but they are offered to the downstream part as well. Subsidies can be provided in form of economic support for the output of the supply chains or to incentivize the markets to buy biofuels (Steenblik, 2008). For instance, import tariffs of bioethanol can be reduced, to increase demand from a specific region producing biofuels. Exemptions on fuel excises taxes, grants and tax credits can be given. In some occasions, credits have been given to help reduce the cost of storing biofuels; grants, tax credits and loans can be given for the infrastructure development, e.g. wholesale distribution and retailing of biofuels, grants to show the sustainability of biofuels in vehicle fleets, e.g. municipal buses; measures to reduce the cost of purchasing biofuel; public procurement programs to give preference to purchase of biofuels (Steenblik, 2008). For instance, in Spain subsidies were offered in form of value of excise tax reduction for ethanol/EBTE (Ethyl Tert-Butyl Ether) up to €420 per 1000 litres, or €290 per 1000 litre of biodiesel/pure plant oil (Steenblik, 2008). In Sweden, less than €150 per 1000 litres for ethanol/ETBE or less than €180 per 1000 litres of biodiesel/pure plant oil (Steenblik, 2008).

Other subsidies exist to produce heat from biomass, e.g. pellets from residual pruning collected form olive oil fields and vineyards. For instance, the UK has developed the renewable Heat Incentive, a governmental scheme to encourage the usage of renewable heat technologies among householders and businesses. The Renewable Heat Incentive (RHI). The incentives granted can be used to finance the following technologies (Ofgem, 2014):

- Biomass (wood fuelled) boilers
- Biomass pellet stoves with integrated boilers providing space heating
- Ground to water heat pumps
- Air to water heat pumps
- Solar thermal panels (flat plate or evacuated tube only) providing hot water for your home
- Air to air heat pumps, all log stoves, pellet stoves without back boilers and hybrid PVT are not supported by RHI.
- Water source heat pumps can potentially be eligible for the Domestic RHI – they are included in the definition of a ground source heat pump.
- Certain cooker stoves and certain high temperature heat pumps may also be eligible.

In view of the literature, two KPIs have been developed, the first concerns any subsidy, measured in €, that can be given to the upstream part of the supply chain, in this case farmers (FI, Farmers Incentives). The second includes incentives for the downstream part, hence including the manufacturing, distribution network and markets (DI, Distribution Incentives) (Table 6).

Table 6. Government Policies KPIs.

Government Policies KPIs (ECO5_n)			
KPI	Name	Definition	Dimension
ECO5_1	FI	Incentives for farmers. It can provide lower costs for investments or operational costs. An effect could be to reduce the WTS of farmers and thereby supply costs for production.	€
ECO5_2	DI	Incentive to support the distribution of bio-commodities. It could lower costs to produce/distribute, in order to keep selling price low and match a demanding WTP of customers or competing marketplace. Similarly, incentives could lower costs of actors purchasing biofuels or simply increase the WTP since part of the cost is subsidized.	€

3.2 Social Performance Indicators

The objective of the social assessment in this task developed by CIRCE is to analyse and measure the impacts on the society related to the conversion of agro-industries into IBLCs. Society is composed by many and different stakeholders. However, since this project aims at building on existing agro-industries by taking advantages of unexploited synergies in terms of equipment and staff capabilities, this social analysis will focus on one main aspect, which is the impact of the innovations on employment.

To evaluate this impact on labour, two types of indicators are considered: on one hand, the quantity of potential new jobs generated by the agro-industries' transition to IBLCs, and on the other hand, the quality of the new jobs created or the improvement of the conditions of the existing ones.

The most relevant social impacts of the innovations are expected to affect the employment. This is because the new activities created by the innovations will require new job positions.

As the quantity of new jobs generated is not the only aspect to consider, but also the conditions of the workers, social impacts on work will be assessed by analysing the quantity and quality of the employment created in and around the IBLCs.

The social KPIs deal with the employment associated to the IBLC activity and the rest of logistic activities related to the production and commercialisation of the new bio-commodities. The main aim of these KPIs is to measure the impact that the new activity has on the quantity and quality of these new jobs created.

The analysis of the impact on the employment is assessed through two different perspectives, with different indicators associated to each one of them. The first perspective is the *employment quantity,* that gathers information about the creation of jobs as a consequence of the new IBLC's activity and the second one is *employment quality,* that encompasses different aspects in order to outline the conditions of the jobs.

3.2.1 Employment quantity

The quantity approach has taken into consideration the labour needs of the new activity carried out. Due to the new activity implemented at each study case, there will be both creation of new jobs and impact on existing ones.

On one side, new employment will be created at a local level in order to develop the specific tasks related to the IBLC. However, the implementation of an IBLC does not only result in jobs creation, but also destruction. This is due to the changes in the traditional market, both at local and global scale. The destruction of jobs may come from sectors producing alternative fuels that may be pushed off the market by the new agro-fuel competition. In the case of fossil fuels, produced globally at large scale in automated process, the amount of jobs lost world-wide is considered irrelevant and not comparable. Therefore, this calculation is taken out of the scope.

For the sake of consistency, the chosen indicators for the assessment of the variations on the quantity of jobs are based on the methodological approach followed in the project to assess the social impact of the demo cases. The main indicator for employment quantity is the full-time equivalent jobs created on annual basis, both on absolute terms and on relative terms for the company and the sector.

Table 7. Employment quantity metrics.

Employment quantity metrics		
Type	Description	Unit
Employment Quantity	Full time equivalent jobs created	Full time equivalent jobs created, absolute and relative

3.2.2 Employment quality

The employment quality encompasses different indicators of the job definition in order to establish a comparable framework for the added value that each position incorporates. Every metric is measured in quantitative terms and qualitatively in a 1-to-3 scale according to the factor contributing to create low quality jobs (1) or high-quality jobs (3). These jobs factors have been extracted from the UN Environmental Programme social life cycle assessment guidelines (UN, 2013; UNEP/SETAC, 2009). The individual factors chosen to assess the job quality are given in the following Table 8.

Table 8. Employment quality metrics

Employment quality metrics		
Type	Description	Unit
Employment Quality	Incomes	€/year compared to country average. Scale 1-3
	Seasonality level	Seasonality level. Scale 1-3
	Level of expertise	Semiskilled/ Skilled/ Highly Skilled. Scale 1-3
	Localisation	Urban/Rural/both. Scale 1-3
	Gender	Male/female/both. Scale 1-3
	Health/ Safety	Incidence rate/ lost days per worker and year Scale 1-3
	Long term job perspective	Scale 1-3

In the table, the following factors are considered:

- *Incomes:* It measures how well the jobs are paid with respect to the average wage level of the country or sector. High quality jobs are paid above the average.
- *Seasonality level:* whether it is a continuous or a seasonal job. Many jobs in the agricultural sectors are highly seasonal, thus reducing the attractiveness of job seekers. High seasonality

means low job quality, although in some cases individuals may opt for seasonal jobs to reconcile other personal or professional activities along the year.

- *Level of expertise needed to carry out the activity:* it states the need of special abilities, trades or training to carry out the activity. High quality job positions are flexible in the level of expertise allowing low experienced workers to take the position
- *Localization of the activity:* this category takes into consideration if the position can be developed in an urban or rural environment. Higher quality jobs enable the attraction of population and talent to rural areas to strive against depopulation.
- *Gender:* this indicator reveals whether a specific gender is required for certain positions (low quality jobs), or on the contrary, if there is no preference for the recruiters regarding gender (high quality jobs).
- *Health/Safety:* incidence rate, as determined by secondary sources for the same type of task. High quality jobs imply the absence of risks for the health and safety of the workers.
- *Long term perspectives:* strictly related to the economic viability of the business model, it defines the estimated years that the activity is expected to continue and therefore, the future perspectives of the new employees. Preference for long-term jobs enable higher personal and economic investments and attract more people to certain positions.

3.3 Environmental Indicators

A supply chain aiming to transform residuals from agriculture needs farmers as upstream suppliers, a transformation plant and transport activities. Typically, environmental indicators measure GHG emissions, that in a supply chain are associated with energy usage to transport or manufacture. However, farmers activities imply land-use and eventually the deterioration of fertility of soil. When this happen, there are important implications for food production that could destabilize an important supply to societies. Hence, the following indicators are considered among the most important to measure when it comes to the environmental impacts caused by the production of bio-commodities:

- Soil impacts.
- Emissions of greenhouse gases in the atmosphere.

3.3.1 Soil Erosion and Compaction

Soil erosion consists of the removal of topsoil with high organic content, followed by a degradation fertility rate and soil life. The removal happens for diverse reasons:

- *Water, e.g. flooding or rainfall.* The effect of water can be incremented depending on the soil erodibility, texture, and permeability. If infiltration is hindered, runoff can increase in presence of water. A steeper terrain and absence of vegetation or crop residues can also increase runoff and erosion. Tillage practices also can deteriorate soil. Heavy machineries can create pathways, where water runoffs, accelerating erosion.

- *Wind erosion.* Winds can take away soil. However, this involves only very fine soils, e.g. sandy, organic or muck soils. Wind speed and exposure to wind affect the level of soil erosion.
- *Tillage erosion.* Action of tillage and gravity causing severe soil loss on upper-slope positions and accumulation in lower-slope positions. Soil on upper-slope positions is more exposed to water and wind, hence favouring erosion. The type of equipment used can have different impacts, likewise speed and depth of the tillage can affect impacts. It is important to reduce the number of passes to reduce erosion.
- *Soil compaction* occurs naturally as an effect of drying and wetting cycles to which soil are exposed to. However, external pressures applied on the soil can accelerate compaction. Examples of external pressures are heavy machineries moving on the soil, tillage practices and finally livestock trampling.
- *Compaction below topsoil.* Compaction can also take place in layers below the topsoil. In this case, water infiltration is slowed down and erosion initiates. A known practice to decrease impacts of machineries is to reduce the inflation pressure of wheels and tires.
- *Compaction – water infiltration.* Compaction reduces water infiltration and oxygen. In these conditions, erosion may increase, plant growth is hindered, and crop yields are ultimately reduced.

The dynamics of soil erosion and compaction and their ultimate impact on the potential loss of fertility of soils have been reproduced in a fault tree analysis shown in the annex of this document.

To conclude, Table 9 summarizes the KPIs identified in this section, i.e. water erosion, wind erosion, soil organic content and soil compaction.

Table 9. KPIs Soil Erosion and Compaction.

Soil erosion and compaction KPIs (ENV1_n)			
KPI	Definition	Explanation	Dimension
ENV1_1	Water Erosion	The amount of soil that is eroded due to water presence	m^3
ENV1_2	Wind Erosion	The amount of soil that is eroded to presence of strong winds	m^3
ENV1_3	Soil Organic content	It can be measured as carbon content %, where 12-18 % are organic soils, deserts <0.5 %	% Carbon content
ENV1_4	Soil Compaction	Penetration resistance measure, it measures necessary pressure to penetrate a certain height of soil.	PSI

3.3.2 CO_2eq emissions

An existing European directive, indicating the usage of 20 % renewable energy, have indicated the potential for saving GHG emissions caused by existing biofuels (see annex V of EU (2009)). For instance, these are between 87 % GHG emission savings for bioethanol production, up to 91 % for farmed wood methanol (EU, 2009). An existing fuel quality directive has indicated that all fuel suppliers all fuel suppliers must meet a 6 % reduction of GHG emissions by 2020 across all fuel categories to market (EU, 2018).

A representative KPI for measuring emissions of greenhouse gases consists of the amount of carbon dioxide emitted in the atmosphere (ENV2_1). In general, trucks used to transport raw materials, or bio-commodities produced by plants, are responsible of CO_2eq emissions. The same applies to all machines used in agricultural activities consuming fuel, e.g. harvesting, tractors etc. CO_2eq emissions can be measured in kg equivalent. Next table reports the CO_2eq emissions KPI to be used to evaluate cases.

Table 10. CO_2eq emissions KPIs.

CO2eq emissions (ENV1_n)			
KPI	Definition	Explanation	Dimension
ENV2_1	CO_2eq	Emissions of CO_2eq	Kg CO_2eq

4 Sectorial Analysis

Next table shows the case studies identified in Task 6.4 that will be used as a basis in this report.

- CASE 1: Biofuel from straw, in the case assess the pellets from straw are not sold. The case of a big company is evaluated in which the biofuel produced is used for self-consumption.
- CASE 2: biofuel from pruning are produced in a wine industry. Pelletized biofuel.
- CASE 3: biofuel from pruning are produced by an olive industry. Pelletized biofuel.
- CASE 4: biofuel made from chaff are produced by a grain industry.
- CASE 5: this case uses sugar beet fibres to manufacture chemicals for cosmetics, toys etc.

4.1 CASE 1: Fodder Industry

The case study was partially based on the inputs from a Spanish cooperative case and additional sources that have been combined to build the study case. The company has initiated circular activities already since 2015 when the cooperative has been a beneficiary of an aid from the Rural Development Program of Castilla y León 2014-2020. These aids have been used to support investments in transformation / commercialization and / or development of agricultural products. The grant awarded, co-financed by the European Union through the EAFRD (European Agricultural Fund for Rural Development), consist of a total sum of € 1,584,217.87.

4.1.1 Value Stream Map

From the perspective of the study case, the activity of interest consists of collection and dehydration of fodder for animal care and feeding. The produced pellets will then be shipped and used to produce thermal energy in a cheese dehydration process still managed by the same agro-industry that produces the pellets in another production plant (Figure 2).

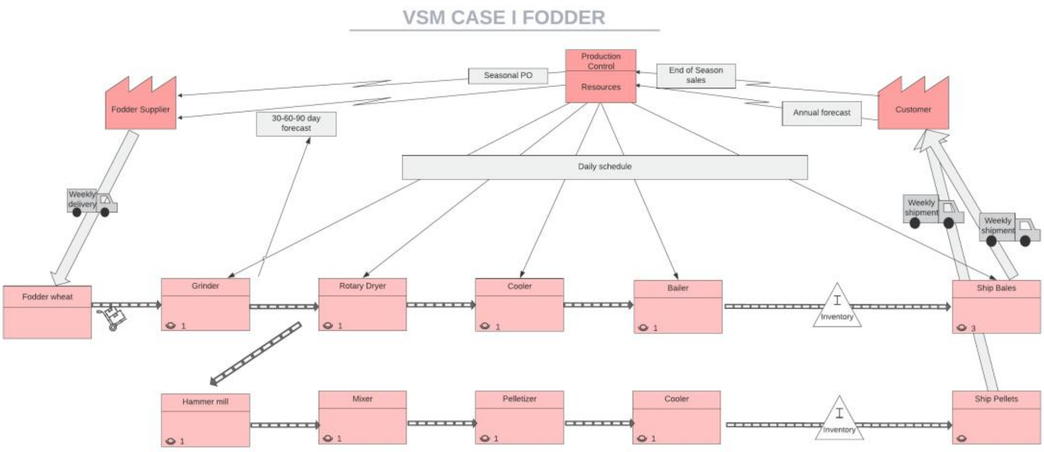

Figure 2. Value Stream Map, CASE 1 fodder.

4.1.2 Economic Viability

Availability of raw materials

The willingness to sell the available raw materials is mostly affected by the need for straw from the animal care and feed production. Of the total straw available that is currently being used in animal care and feed production, a surplus that could be used for solid biofuel production, i.e. pellets, represents approximately 4 % (Deliverable 6.2). However, expert's knowledge points out that animal breeding is going through a decreasing trend, implying that the 4 % estimate could be revised upwards (Deliverable 6.2 can be consulted for further details). Collection activity happens during summer period, hence from June to August.

Many by-products from other industries are already being used in feed production. It could be argued that there is competitiveness in the market presently which may be a barrier for future biomass uses.

Price of the feedstock can vary from: €20-€60 per tonne depending on the season climate. Yet, some fluctuations are assumed (Deliverable 6.2). as for the other cases evaluated in AGROinLOG's demo, ashes, and chlorine content (among other) in the collected material may reduce the quality. According to data collected during the project, the feedstock average characteristics are (Deliverable 6.2):

- LHV = 3 150 kCal/Kg
- Moisture content 8 %
- Ash content 6 %
- Corrosive elements, Cl and K.

Therefore, purchasing and inspection practices must be established accordingly (Deliverable 6.2).

Next table summarizes the KPI collected for the case. Some data are not available, while the usable waste and energy consumption (not operational costs) could be provided and reported. Energy consumption for the usage of machinery costs have been retrieved from a parallel project, SCOoPE (Table 11).

Table 11. CASE1 - KPI to measure availability of raw materials.

Availability of Raw Materials KPIs (ECO1_n)		
KPI	Name	
ECO1_1	Available cultivated lands	NA
ECO1_2	Usable Waste	The raw material collected is around 300 000 tonnes/year of straw. The cooperative members have the right to collect a percentage of this amount. This way, around 100 000 tonnes/year are available for the cooperative and, from it, only 4 000 tonnes/year are intended to solid biofuel production. This low amount is related to the special

		requirements for straw pellets boilers, which make necessary the development of specific boilers.
ECO1_3	Market competition	NA
ECO1_4	Weather	NA
ECO1_5	WTS	NA
ECO1_6	Investment costs	None in this case.
ECO1_7	Operations costs	**MACHINERY ENERGY CONSUMPTION.** Summing up (expressed as consumption ratio, %): Average energy consumptions distribution in a fodder dehydration line: Total electric power: 18.40 % Total thermal power: 81.60 % Average energy consumptions distribution in a cheese factory: Total electric power: 56.56 % Total thermal power: 43.44 %

Transport and storage costs

Next figure shows the availability of feedstocks (yellow circles) and current availability of forage dehydrators (Figure 3). Access to cereal processing industry and more specifically to their residues (i.e. corn stalks, wheat and barley straw, grain dust, etc.) should imply the collection of feedstocks from the yellow points, storage and transport to the forage dehydrators. In the areas where forage dehydrators are placed, additional storage both for inbound and outbound would take place. According to evidence collected in Deliverable 6.2, the raw materials are available in bulk or in bales format.

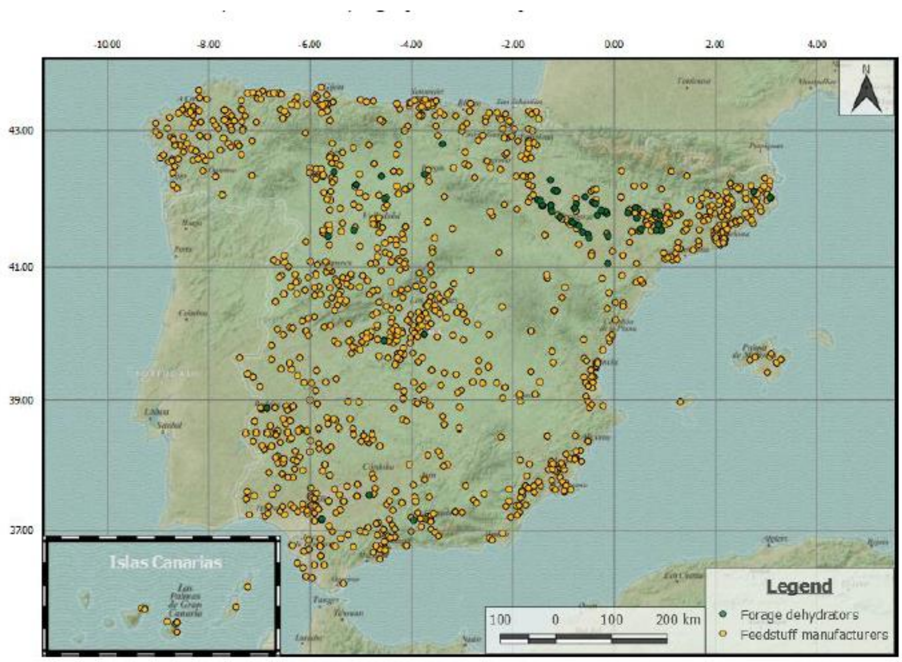

Figure 3. Map with feedstuff manufacturers and forage dehydrators (AgroInLog Deliverable 6.2).

Summarizing the data collected, in general no additional investment costs are necessary for transport and storage. A transport cost of 13 €/ton over a distance of 20 km was assessed.

Table 12. CASE1 - KPIs for transport and storage.

Transport and Storage KPIs (ECO2_n)		
KPI	**Name**	
ECO2_1	Transport distance	An average distance between the crop field and the intermediate warehouse of around 15 km is considered. This distance increases up to 70 km between the warehouses and the pelleting plant, being a very variable value.
ECO2_2	Transport Costs	According to an interview performed with experts from the sector contacted, the transportation costs are usually calculated considering an average value of distance (150 - 200 km) and a cost of 1 €/km. The costs can be distributed as follows, considering an average selling price of 42 €/tonne, including transport to the IBLC within a radius of 20 km: Average biomass cost per ton: 4 €/ton, (11 %) Average transport cost per ton: 13 €/ton, (34 %) CAPEX costs per ton: 3 €/ton, (8 %) Average baling cost per ton: 18 €/ton, (18 %)

ECO2_3	Storage costs/holding costs	No additional costs
ECO2_4	Investments	None

Production costs

Production machines to be used in the production are dehydrator and grinding. The expected production of pellets is about 700 tonnes/year. However, much of this production is meant to supply the 70-80 % plants required thermal energy demand. For this sector two cases have been considered: 1) the study case that does not face an idle period, i.e. the pelletizer is used for the pellet production and 2) the demo case where the pelletizer line is shared for food and pellet production (here the idle time is from June to August, Deliverable 6.4).

According to D6.2, some feedstuff industries own compatible equipment with the processing of biomass such as pelletizers, silos for storage, screening and chipping machinery, besides of a high degree of staff professionalism and many other valuable assets useful for the biomass processing activities (workforce, means of transport, etc.). Additionally, horizontal rotary dryers are needed to reduce the water content, i.e. biomass drying. In case this equipment is not available, additional significant investments will be required, implying that some companies may struggle financially, especially the small-medium sized ones.

In conclusion, there are no relevant production or switch costs to consider for this case. However, investment costs are quite consistent and reach €500 000 for the dehydration line and 475 000 for the boiler used in the steam line (Table 13).

Table 13. CASE 1 – KPIs production costs.

Production Costs KPIs (ECO3_n)		
KPI	Name	
ECO3_1	Production costs	None. They produce their own pellets (already have pelletizing systems for animal feeding pellets) for energy self-consumption
ECO3_2	Switch Costs	NA
ECO3_3	Investments	The innovations were applied in two well differentiated areas and, therefore, two different investments: • Fodder dehydration line. This process requires hot air to remove the moisture surplus from the collected fodder, to process them in granule form or in high density and pressure bales form. The investment reached € 500 000. • Steam line in the cheese factory. Steam at 8-10 bar of pressure is required for the pasteurisation processes of milk, cheese curd and cheese whey, as well as the equipment and

		machinery cleaning. The investment reached € 470 000 and, according to the manufacturer, the depreciation period of the equipment would be 6 years, considering a boiler service life of 25 years.
ECO3_4	Supplies costs	Na

Customers / Markets

It is difficult to say how many customers are willing to pay for the produced pellets since the level of knowledge in this regard is low. As of today, the biomass is used for self-consumption and in some isolated cases sold to other end users. In the latter case, specific agreements and pricing are established.

Research suggests that competition with other biofuels derived from different biomass is strong. E.g. potential customers seem to be used more to forestry biomass and consequently sceptical towards products derived from only herbaceous biomass. The deduction achieved is that this scepticism could be translated into a lower willingness to pay. On the other hand, there are some concerns related to deforestation problems due to the production of pellets from forestry biomass that could thwart the market in favour of straw based pellets (Fawthorp, 2009).

There is unfortunately no further information that could be collected from the questionnaire regarding this topic.

Government Policies

In terms of rules and regulations only one legislative barrier was identified, and it concerned the mandatory disposal of the feed animal residues to be performed by an authorized manager (Deliverable 6.2).

It has been estimated that during the period 1990-2007 cumulative economic interventions to subsidize the energy sector in Europe totalled to about €2012 70-150 billion. Around 40 % of these interventions has been allocated to biomass (25 % to wind and hydro, and 10 % to solar) (Ecosys, 2014). In some European countries the heating with biomass as input receives subsides and incentives from the European Union. These economic incentives help to create demand for biofuels, e.g. pellets, by decreasing their purchasing costs and therefore improving their competition with other fossil fuels available on the market.

Potential subsidies have been identified for the upstream part of the supply chain (Table 14).

Table 14. CASE 1 – KPIs Government policies.

Government Policies KPIs (ECO5_n)		
KPI	**Name**	
ECO5_1	FI	Both boilers installations funding is included in the CLIMA projects programme, a national funding call which promotes the development of projects with the aim to reduce de greenhouse gases production, fostered by the Spanish Ministry of Ecologic Transition and Demographic Challenge from the Spanish Government. The previously mentioned CLIMA projects program allowed the substitution of old equipment by the new ones in Villoldo and Baltanás' factories. AGROPAL signed a purchase-sale contract of verified emissions reductions of greenhouse gases with the previous Spanish Ministry of Agriculture, Food and Environment (MAGRAMA), currently called Spanish Ministry of Ecologic from the Spanish Government.
ECO5_2	DI	No incentives

4.1.3 Social Performance

Feed and fodder sector industries deal with mixes of different crops such as: barley, wheat and oats, whole crop silage, peas and broad beans, maize for forage, clover and alfalfa (lucerne), among others. However, alfalfa (*Medicago sativa*), also called lucerne, is the most common forage. More specifically, in Spain, it accounts for 85 % of the raw material for dehydrated fodder industries dedicated to animal food.

Nowadays, the total production of alfalfa all over the world is about 30 million hectares, the countries with the highest production being the United States, Canada, Italy, France, China, Russia, Chile, Argentina, South Africa, Australia and New Zeeland (Yuegao et al., 2009).

The European Union is the second producer of alfalfa in the world, with a cultivated area of 7.2 million hectares, which adds up to 25 % of the total production worldwide (Yuegao et al., 2009). Moreover, forage plants represent the 5.3 % of the total EU's agricultural sector outputs, which makes a total of 22.93 billion € per year (Coyette and Schenk, 2018). For a lucerne price of 186.31 €/tonne (Llotjadevic, 2019), that would constitute an annual production of 12.3 million tonnes of lucerne per year across the European Union. Spain plays a key role in this sector with 6.7 M tonnes of lucerne produced in 2018, a large part of it meant for exporting (Coyette and Schenk, 2018).

The main use of lucerne is animal feeding. This sector is heavily seasonal. AGROinLOG project in this sector focuses on the valorisation of straw, maize stalk and other agricultural wastes by taking advantage of the idle-period to use the existent facilities to produce other value-added products such as solid biofuels, which would foster new employments in the sector.

The main IBLC product opportunities identified in T6.3 for this sector are pellet from agricultural residues, and particle or fibre boards. The main barriers are the storing costs of the seasonal feedstock, the transport and logistic costs and the lower quality of the pellet for certain markets such as the residential heating fuel market.

Impact on employment of the transition into an IBLC

The case study for the feed and fodder sector is partially based on an agro-cooperative located in Spain as previously mentioned. The cooperative is constituted by farmers, producers and transforming industries, and manage a big variety of crops produced in Castilla y León and Cantabria, with a total population of 2.9 million people. This is a vast region dedicated to the cultivation of cereals. For this reason, it has been considered that the availability of straw wastes for biofuel manufacturing is guaranteed.

The agro-cooperative is already a sort of logistics centre for biomass. The company counts on large amount of straw supplies reaching up to 300,000 tonnes of straw per year. Out of them 4,000 t are used for energy purposes. The feedstock collected is used for self-consumption purposes in a nearby cheese production factory. More specifically, the straw is used as a solid fuel and burnt in a specially prepared boiler, thus saving the equivalent amount of energy from gas source.

Traditional lucerne dehydrating companies with good amounts of straw supplies at reach may divert this energy source to replace the current fossil energy sources of their drying processes. Other feed and fodder industries may not have enough diversified activities to ensure a self-consumption market. However, these companies may analyse the opportunity of pelletising these wastes and sell the biofuel to external clients.

In terms of employment, the agroindustry is a medium size company employing 20 % temporary workers. The gender distribution in the cooperative is egalitarian, with about 48 % female workers. The number of employees with secondary education level is about 22 %. The productivity per employee is quite high, about 334,000 €/employee and year.

The straw is transformed into pellet and used for cheese elaboration. This company burns 4,000 t of straw pellet in a specially prepared boiler, adapted for this fuel. Annual savings in replaced gas supply are estimated at 17.6 MWh/y. The number of full-time equivalent jobs employed in the straw pellet manufacturing, supply logistics and maintenance and operation of this boiler is 2.2 FT eq. jobs per year, distributed as follows. This is about 0.55 FT eq. jobs per annum per 1000 tons of straw pellet produced. For low production volumes the option may be to do it out of the fodder season with the available personnel without contracting additional new staff at all.

The productivity of this activity is 137,000 €/employee and year, which is lower than the overall company's productivity, but still very acceptable to dedicate resources in idle times out of the seasonal workload peaks.

Table 15. Estimation of Full-Time equivalent jobs per year in the IBLC.

Full time equivalent jobs	
IBLC	FT eq jobs per year
Savings year MWh/y	17.6 MWh/year
Savings year €	307,200 €/y
eq employment maintenance	0.7
eq employment logistics	0.1
eq employment pellet production	1.5
total eq. employment	**2.2**
Productivity per employee	137,108 €/y

The boiler maintenance implies a 15 % extra effort compared to a regular boiler, due to fouling and feeding problems. The increase of labour force at the agro-cooperative is only 0.6 % but additional straw could be harvested to increase the pellet production for other self-consumption applications in companies and centres of the cooperative. Finally, some biofuel could be destined for the external biofuel market. Every GWh_t/y of straw pellet produced would induce additional 0.125 FT eq. jobs.

Moreover, the gender rate is expected to remain in good stead, as it is in the baseline situation, i.e. 50 % / 50 %, which makes a very promising scenario in terms of gender equality. In terms of education, it is expected that the 85% of the new hires would not require high level education, opening the job opportunities to those more vulnerable for their educational level.

To have an overview of all the aspects related to work, a qualitative assessment was requested to experts in the sector, in order to estimate the quality of the employment that would be generated by the IBLCs. They were asked to assess the quality of jobs regarding the more important parameters related to job and required to organise them into groups of quality from 1 to 3, representing 1 the poorest quality and 3 the most desirable situation. The main results are shown below.

The new pellet production jobs are well rated in terms of type of contracts (most of them full time), and long-term perspective. They are badly rated in terms of qualification level as the level of qualification required is low, thus offering low professional promotion opportunities and medium level salaries. However, this low qualification requirements also open the door to low qualified job seekers, whose employability would be at risk for other type of jobs. In terms of Health and Safety, overall conditions are subject to very dusty environments that may bring respiratory diseases over time. In terms of gender, most of the workers are men, but in the case of the case study company, equality is kept proving that there are not important barriers in this sense.

Table 16. Assessment of the employment quality generated by the IBLCs aimed at producing straw pellets

Feed and Fodder job quality assessment		
Parameter	Quality (1-3)	Reasons
Salary	2	The salaries are in the average of the country for similar competences and requirements
Contractual modality (Seasonality)	3	The new business line could guarantee more full-time contracts.
Level of qualification	1	The level of qualification is low-medium. It is not necessary a high qualification for the feed and fodder sector.
Level of expertise	2	It is recommended expertise as drivers of wheel loader, harvesting operations and manufacturing process, since the specific sector machinery is very expensive.
Rural location	2	Feed and fodder factories are usually at rural areas, near the feedstock source. In this sense, IBLC new employment helps consolidate population at rural areas and even attract new migrants into unpopulated regions.
Gender	1	A vast majority of the people involved in the sector are men. However, there are not barriers or deterrents for women to take up new IBLC jobs.
Health and Safety	1	The work environment has a high risk of dust pollution - particulate matter-, which can cause respiratory diseases.
Long term perspective	3	As the IBLCs diversify the lines of activity of the current business line, they should provide more stability and protection to the company.

4.1.4 Environmental Impacts

Fodder comes from straw and according to literature straw left on soil can supply with important nutritive matters, ultimately contributing to a higher level of organic content and fertility (Qingxiang, 2002). Powlson et al. (2011) affirm that changes in Soil Organic Content provoked by the straw removal can deteriorate soil physical properties, by means of changes of aggregate stability (ability of aggregates to resist disruptions), water infiltration rate and plough draft. These changes may increase soil erosion activities and therefore contribute to the removal of top-soil and its organic content or humus content (Hargitai, 1993). If humus content is high then straw could be carefully removed for a limited number of years, until a minimum threshold is reached. To decelerate the loss of organic content and thereby slow down soil deterioration, an option could be to limit the removal of straw. For instance, some studies show that straw removal does not affect content of Soil Organic Carbon (SOC) and Nitrogen (SON) within a period of 50 years where <40 % of total aboveground residuals are removed from medium to heavy textured soils (Lafond et al., 2009). Likewise, spring wheat grain yields and grain protein concentration were not affected. Hence, Lafond et al. (2009) conclude that straw removal does not affect long-term productivity of these soils.

Another important effect of straw removal is the soil compaction due to the passage of machine collecting and baling the straw. Håkansson, Voorhees and Riley (1988) explained that the traffic of moving heavy machineries on soil causes consistent compaction that could be even persistent in subsoil. There are three factors determining the magnitude of soil compaction: the properties of soil, dimension of tyre and load (Håkansson, Voorhees and Riley, 1988). Therefore, it is a good practice to decrease the inflation pressure of tires or simply using larger wheels in order to increase the contact surface and thereby decrease pressure. Vehicles with more wheels have also demonstrated to have a lower stress value in soils (Håkansson, Voorhees and Riley, 1988).

4.2 CASE 2: Olive Pruning

This case aims to demonstrate mainly the transformation of olive pruning into biofuels, pellets, and investigate the potential of a supplementary activity such as the extraction of phenols from olive leaves. The scope is to analyze the potential of pruning in the region of Crete, one of the biggest olive oil producers in Greece.

4.2.1 Value Stream Map

These activities could be complemented with existing pomace oil extraction from the olive mill residues (pomace) performed in the pomace mill located in Crete, Greece. This mill is particularly suitable to develop biobased initiatives, in view of the long idle time available after pomace production. Hence, the pathways to be explored are essentially two:

1. Exploitation of residual olive tree pruning and production of biofuels (pellets)
2. Exploitation of olive leaves to extract phenols. Olive leaves have a high concentration of phenolic compounds. The phenols are further used for production of bio-based commodities.

The associated Value Stream Map is reported in Figure 4.

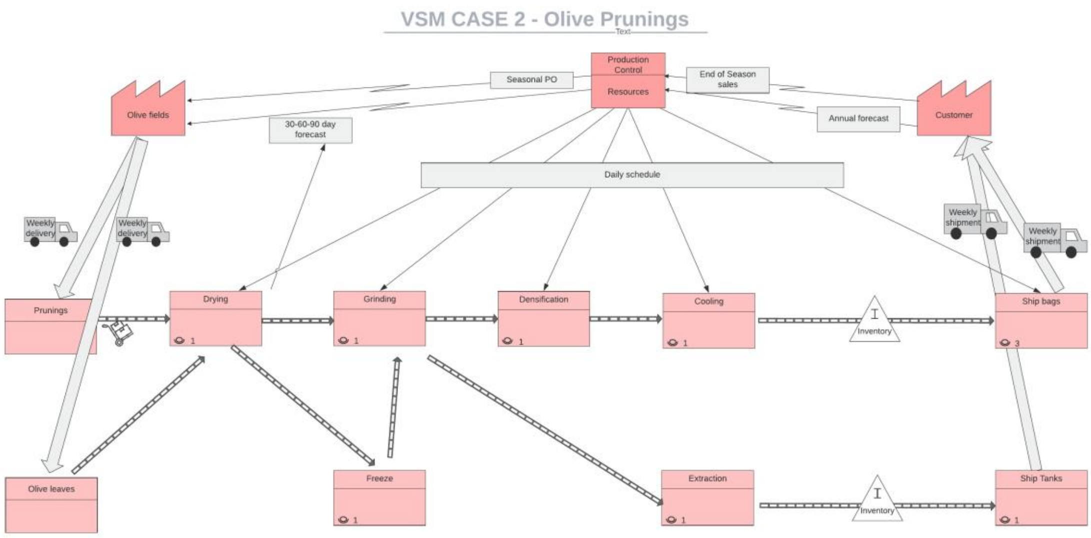

Figure 4. Value Stream Map, Case 2 olive pruning.

4.2.2 Economic Viability

Availability of raw materials

According to available statistics, 31.2 % of the total olive oil produced in Greece comes from Peloponnese, 24.8 % from Western Greece and 24.1 % from Crete. 2,500 olive mills and 35 pomace mills in Greece, 7 large scale and 3-4 small scale oil refineries. 36.5 % of olive mills in Peloponnese, 23.3 % of olive mills in Crete. Based on the work performed under workpackage 4, the total cultivated area available amounts to about 173 609 ha with a potential of 60kt olive oil production. A good proportion of olive mills are placed in Chania, and therefore the Greek partners proposed to locate the IBLC in this region. Production of existing activity (pomace oil production) would take place from November to June. Table 17 summarizes the KPIs collected for CASE2.

Table 17. Availability of Raw Materials KPIs.

Availability of Raw Materials KPIs (ECO1_n)		
KPI	Name	
ECO1_1	Available cultivated lands	For this case study, it was chosen to mobilize around 5,000 tonnes of dry olive tree pruning from a radius of around ~7 km distance from the pomace mill unit (pomace mill that is the case study in T6.4), in Chania, Crete. According to MyGIS platform (tool that CERTH developed regarding the olive groves potential in Greece) the available area dedicated to the cultivation of the raw material correspond to 1,600 ha of olive groves. The whole region of Chania has over 32 kha of olive groves, whereas Crete over 170 kha.
ECO1_2	Usable Waste	It is assumed an amount of around 3 dry tons of pruning per hectare (or around 4.2 wet tons of pruning per hectare)

ECO1_3	Market competition	So far, the common practice for treating pruning is for farmers to collect and burn their pruning in open fires. In some rare cases they use to shred the pruning and incorporate them in the soil. Thus, there is actually no competitive exploitation use of the olive tree pruning. However, by implementing the IBLC it is managed to create a new bio-based product competitive in the local market and suitable for use as fuel.
ECO1_4	Weather	Mainly, the climate in Crete is in general hot, with mild winters. Moisture is present due to the sea surrounding the island. High precipitation is not often.
ECO1_5	WTS	Currently, most of the farmers follow the technique of the open burning of their pruning, for which they have to pay the labor costs in order to collect pruning and burn them. By implementing the IBLC concept, farmers avoid the burning of the pruning and its cost. Thus, it is an avoidance cost for them and as a result, it can be considered as savings for the agro-industry (IBLC). In this sense, the basic scenario that the proposed IBLC can follow is to get the pruning for free from the olive groves or alternatively farmers can pay the IBLC 5 €/t to harvest their pruning.
ECO1_6	Investment costs	Based on calculations from the last demo activities in the region of Agios Konstantinos (Greek IBLC area) if it is required to move for 5 kt of dry pruning, 2 shredders minimum (probably a third one will be needed to secure the supply, assuming that a FACMA COMBY shredder has a harvesting efficiency of 2.5 dry ton/hr and for a period of 3 months the machine can work maximum for around 1,000 hours). The investment costs for these machines is 20,000 € / machine.
ECO1_7	Operations costs	Operations costs can be assumed as the same as calculated through the harvesting demonstrations performed in the Greek IBLC area in Agios Konstantinos, with an integrated harvester. The cost was around 45 €/dry ton of harvested pruning (or 33 €/wet ton, with an assumed 27.5 % moisture content).

Transport and storage costs

Crete has an area of 8 336 km^2, of which 1 236.09 km^2 are dedicated to olives cultivations (14.8 %), and a coastline of 1 046 km (Figure 5). Due to competition with other sectors, if storage places are needed, these would end up having quite high investment costs or holding costs. The road network has good geographic coverage, however, there is lack of modern highways, implying that maximum transport speed can be reduced as well as trucks' maximum axis load permitted. Hence, considering the limited geographic size of the island and the good road coverage where short distances are to be travelled, it could be possible to keep some inventory on the fields and establish local milk rounds to collect pruning and thereafter transport weekly to the plant. Some inventory will need to be kept at the pomace mill plant in the Chania region.

Figure 5. Map of Crete (Google maps).

Outbound inventory is necessary for exporting the biocommodities produced, hence pellets and phenols. However, to reach export markets there are only two ways available: air or sea transport. Air transport is not considered a viable option, due to the high costs for transporting. Some cargo could be mixed with tourist aircrafts by filling the belly space available. However, some challenges could appear due to safety regulations (pellets are flammable materials) as well as the actual space available, that is limited and very expensive. The only feasible option remaining is the transport via sea routes. There are 6 passenger ports available on Crete:

- Port of Kissamos (Kastelli), just outside the town. Ferries to Kythira and Antikythira only.
- Port of Souda, 14 kilometres from Chania
- Port of Rethymnon
- Port of Heraklion
- Port of Agios Nikolaos
- Port of Sitia

However, these ports are equipped to handle passengers and not freight cargo, like containers or bulk materials. Therefore, transport costs are expected to be high and existing challenges to export will need to be solved by developing further the infrastructure.

The KPIs collected for transport and storage are reported in Table 18.

Table 18. CASE 2 – transport and storage KPIs.

Transport and Storage KPIs (ECO2_n)		
KPI	Name	
ECO2_1	Transport distance	According to previous experience from various demo activities in the framework of AGROinLOG project, it was considered that a

		satisfactory quantity is 5000 tonnes of dry OTP. This can be collected within a radius of about ~7 km distance. Above this distance, logistics costs are assumed to increase rapidly, leading to economic disadvantages.
ECO2_2	Transport Costs	Based on data derived from the harvesting demonstrations in the Greek IBLC, for a distance of 5 -10 km radius the transportation cost (including vehicle usage, fuel and labour) for the biomass haulage is around 15- 17 €/ dry ton of harvested pruning. This cost (transportation cost from fields to IBLC) is included in the above-mentioned harvesting costs "ECO1_7" (45 €/dry ton).
ECO2_3	Storage costs/holding costs	There is no extra cost for the storage of the raw product on the farm. In the Greek IBLC area, farmers just leave the olive tree pruning in the middle of the rows after the pruning for 1-2 months in order to reduce their moisture content, prior to harvesting. No storage costs at plants are expected.
ECO2_4	Investments	Most of the pruning can be stored in open space after being harvested since summer months follow after harvesting (from March onwards), so not high investments for storage are considered. Transport is payed to third parties (e.g. agricultural cooperative, external company to perform the biomass haulage). This cost is mentioned previously.

Production costs

The olive pruning as residues of the olive sector can be exploited to produce pellets. The produced pellets can be distributed in the local market or even exported in neighbouring regions. To run this bio-business, new investments are needed for the harvesting equipment of the pruning. Operations are expected to run from September to March for olive and pomace mills.

Production technology for wood pellets include pre-processing, drying, grinding, densification, cooling, screening and bagging (Håkansson et al., 1988). In terms of machinery needed for production, dryers and centrifuges are needed. Olive and pomace mills could have some of these machines available, especially the pomace mills that are larger facilities. Dryers that exist in the pomace mills can be used in order to dry the pruning to be used for pellets production. The idle times of the pomace mills can be exploited for this aim.

When it comes to the production of phenols, olive leaves would need to be dried, frozen, and grinded. Thereafter, with a 70 % ethanol extraction of phenolic compounds would take place in the dark and in an orbital shaker (2 weeks' time).

It is important to highlight that Greek citizens have some reluctance towards the potential exploitation of the current facilities (olive and pomace mills) for other activities during their idle periods (e.g. pelletization process). The reasons are the odour and smoke produced during the activities of the pomace mill.

KPIs for production costs are summarized in next table.

Table 19. CASE 2 – KPIs production costs.

Production Costs KPIs (ECO3_n)		
KPI	**Name**	
ECO3_1	Production costs	The pelletization cost was estimated around to 80 €/tonne of pellet produced with the following cost break down: 25 €/tonne for electricity, 20 €/tonne personnel cost, 25 €/tonne maintenance, packaging, marketing costs and 10 €/tonne costs to banks, liabilities, etc. All the values are expressed per tonne of pellet produced at their moisture content, around 10 % over a wet basis.
ECO3_2	Switch Costs	So far, there is no certain answer, due to the fact that this case study is hypothetical. According to the feedback from another pomace mill, in which it was planned to visit and perform the drying of the olive tree pruning, the changing process and the cleaning of the dryer is neither costly nor time consuming. This activity was scheduled for mid-March but due to the virus, it was not feasible to perform it.
ECO3_3	Investments	For the pelletization line (based on quotes from a pellet owner) → Total investment cost of around 300,000 € for the production of 1 ton/h pellet. In the following costs, the dryer's investment is not recorded since the pomace mill already owns one. • Wood chipper → 65,000 € • Grinding mill → 60,000 € • Pellet press → 100,000 € • Cooler → 20,000 € • Packaging → 45,000 € The assumed lifetime span for all the above-mentioned equipment is > 30 years apart from the wood chipper for whom is >15 years
ECO3_4	Supplies costs	The only supply needed is the raw material (olive tree pruning). For the pellet production using olive tree pruning as feedstock, no additives are needed compared to the pellet production demonstration.

Customers / Markets

Pellets can release energy when burned. Therefore, potential customers could be households or business actors and industries. The quality of the produced olive tree pruning is not as high as A1 or A2 class wood pellets. The olive tree pruning pellets can be used either by domestic end-users who seek a cost competitive fuel and that own suitable boilers (automated ash cleaning system is preferred due to the high ash content of the fuel) or by industrial end-users. According to available data, price of pellets in Greece is about 230 €/ton (Vourdoubas, 2015).

The usage of phenols covers several sectors such as, healthcare, households, pharmaceuticals, etc. Some examples of usage are:

- Disinfectant in household products
- Intermediates for industrial synthesis. E.g. phenolic resins for plywood to make plastics, explosives and drugs as aspirin etc.
- Surgical antiseptic
- Dye industry for coloured azo dyes.

In terms of what customers are paying for phenols today, prices oscillate between slightly more than $1,400 to $1,000 per ton (about €1,296 to €926).

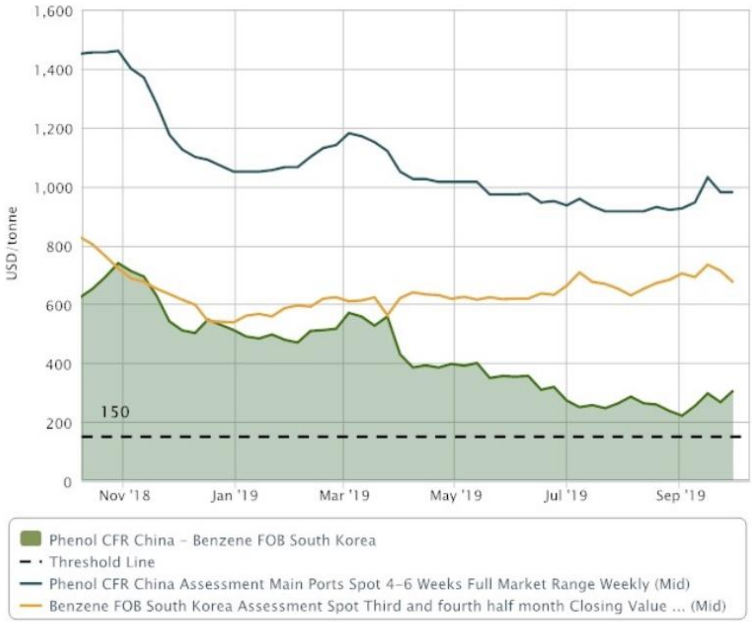

Figure 6. China imported Phenol price 2019-2019.[1]

Next table shows the collected information from CERTH response.

Table 20. CASE 2 – Customers KPIs.

Customers KPIs (ECO4_n)		
KPI	Name	
ECO4_1	WTP	The commercial price for the produced OTP pellets is estimated at 150- 170 €/ton. However, it is worth to mention that the commercial prices of several biofuels used in the current market in Chania and Crete are: • Exhausted olive cake for industrial use: 90-120 €/ton • Wood pellet: 250-350 €/ton.

1 https://www.icis.com/explore/resources/news/2019/10/11/10427654/epca-19-europe-phenol-acetone-industry-sweats-out-2020-plans-as-external-pressures-mount

		Pomace wood: 160-190 €/ton (this is referred to the wood fraction of the exhausted olive cake, after it is separated by the skin).

Government Policies

Pomace mills are absent of national funding schemes, thus they lack funds for implementing new business concepts. Hence, no incentives are available in the upstream, supply side, or downstream, distribution.

4.2.3 Social Performance

Olive trees form a perennial, Mediterranean crop which takes between five to seven years to reach the full productivity. This is why 95 % of the global production is concentrated in Southern Europe, North Africa and Near East.

The European Union is the largest olive oil producer in the world, producing the two-thirds of the global production. The total production of olives for oil in the EU was nearly 11 million tonnes in 2017 (Vourdoubas, 2015). Inside the European Union, the major producers are Spain (59 % of the EU production), Italy (24 %), Portugal (8.4 %) and Greece (about 7.3%). The rest of the EU production is residual (about 0,5-1 %) and is located in France, Slovenia, Cyprus and Malta. In monetary terms, this production represents the 1.5 % of the total output of the agricultural industry, which corresponds to 6.4 billion euros (EC, 2012).

In Greece, the agricultural outputs reached 11.3 billion euros in 2017, from which a 10.6 % percentage came from the olive oil production. Thus, the contribution of this sector in the overall agricultural industry is the largest throughout the EU.

The main IBLC product opportunities according to the analysis made in T6.3 were biofuels such as chips and pellets from pruning and olive stones. Biogas could be a second derivative bio-product. The main barriers for the OTP pellets are the difficulty to compete with cheaper alternatives like sunflower husk pellet, the transport and the drying costs of the OTP. However, the production of shredded OTP (OTP after being harvested by an integrated harvester/ shredder) that can be sold as hog fuel, with no further upgrading, can compete with other low-cost industrial fuels. However, boilers with appropriate feeding systems have to be used to burn such biofuel.

Finally, it must be noted that, in the olive production sector, the activity workload peak occurs in winter, which makes it compatible with other agricultural and non-agricultural activities. This represents a good opportunity for the implementation of IBLCs in the sector.

Impact on employment of the transition into an IBLC

The pomace mill is dedicated to the refining and production of pomace oil and exhausted olive cake (industrial biofuel) from olive mill residues (pomace). The main wastes (olive pruning) used by the mill in the IBLC concept, are generated during the olive-tree pruning (OTP). The total available wastes provided by the local olive-tree growers from Chania area are about 92,000 dry tonnes of pruning per year.

As in the case of feed and fodder, it must be noted that Crete is a region whose rural activity is very focused on the olive tree growing, so this type of waste has always a good availability. Olive trees belong to local owners and farmers that sell the olives to the mill.

The pomace mill in Crete, Greece, usually employs around 5 to 6 persons per shift. Due to the highly seasonal harvesting activity (3 months per year), temporary workers will be employed at harvesting and material handling. Temporary workforce makes up to 50 % of the total staff at plant, most of them are men with low qualification but preferably highly experienced in the sector.

The company's IBLC model consists of making use of the available local OTP to manufacture valuable pellet as biofuel. The advantages are environmental (avoidance of fossil fuels replaced by a renewable source), economic (it is a way for farmers to get rid of a waste at very low cost, instead of burning it in place) and social (it creates new activity in rural areas in job demanding activities). The resource can be obtained for free since farmers need to carry out pruning every year and get rid of the wastes at their cost and the investments are relatively low (pruning harvesters and pelletising equipment in factory).

For a production of 5,000 t/y of OTP pellet 7 FT eq. direct workers would be needed at the production floor, plus the support of 2 indirect personnel at logistics, administration and sales. This means 0.0014 employees per ton. Every GWh_t/y of OTP pellet energy produced would induce additional 0.42 FT eq. jobs. For harvesting, at least 2 FACMA teams with 5 people each would be needed for 3 months to harvest, chip and transport the OTP wastes from the olive groove to the IBLC. Converted into full-time equivalent jobs that would mean 2.5 additional jobs.

Productivity depends on the selling price of the OTP which varies according to alternative fuel prices. For a price of 150 €/t, the productivity per employee would be 107,000 €/y and employee.

In terms of quality of the new jobs created, an interview made to an olive sector professional expert delivered an overall high ranking for the IBLC jobs in most of the quality factors assessed. All jobs related to harvesting and many in the IBLC would be part-time jobs. These jobs do not require high qualification but high expertise levels in machinery handling and mechanics are requested, which is a handicap. Although gender balance is often not met, there are no barriers for women to take up those jobs. Salaries are not exceptional but in line with similar job levels in the country.

Table 21. Olive oil sector job quality assessment.

Olive oil sector		
Factor	Score (1-3)	Reasons
Salary	2	Satisfactory income motivates new employees to work more efficiently. Salary depends on the needs of each new job. The new jobs of the IBLC would have an average salary.
Seasonality	2	Continuous jobs offer stability to the employees and give them the opportunity to scale up their level of expertise. However, for the needs of this case study both seasonal and continuous jobs will be created.

Level of expertise	2	Good qualification is linked to higher efficiency and consequently an increase of the competitiveness. For the new jobs (in pruning harvesting and pelletising), very high expertise is not essential. However, in the case of the phenol pathway, higher expertise is required.
Rural localization	3	Provide resolving solutions to the desertification problem in provincial areas. The IBLC concept by itself supports the rural localization.
Gender	3	Equal opportunities between women and men, increase of the rural development and empower women to participate in more work environments by opening up new opportunities. Gender balance is promoted by the IBLC.
Health/Safety	3	Safety conditions ensure high level efficiency of new employees. It is important for employees to feel safety in their work environment. IBLC's new jobs are not risky.
Long term perspective	3	Very important for the local economic growth as it offers occupational stability to new employees. Employees from the new jobs have the opportunity to be allocated in different positions inside the IBLC.

4.2.4 Environmental Performance

Different practices are adopted by farmers to remove the pruning. The most frequent is to burn them in open fires. Obviously, these open fires have a negative impact on the environment and increase the risk of larger fires. Hence, collecting the pruning will have a positive impact on air quality and landscape (EU, 2019).

Removing the olive pruning from the soil can determine a loss of fertility in soils where olive groves are planted. Olive groves are typically planted on steep terrains that are known to increase the risk for soil erosion. Therefore, it is important to ensure the presence of vegetation covering the ground or by reusing the chopped pruning as mulch (Spinelli, Lombardini, Pari, & Sadauskiene, 2014). According to a survey carried out in Spain in 2005, with 215 olive farmers, this practice was adopted by 43 % of the surveyed farmers (Calatrava & Franco, 2011).

No environmental impact related to the activities of the IBLC are foreseen. On the contrary, the burning of pruning on field will be stopped, and the produced biofuel can even replace some fossil fuels and as a result a positive impact to the environment is foreseen.

4.3 CASE 3: Vineyard pruning

This case will examine the possibility to produce bio-commodities from some of the residual pruning generated from selected vineyards in the Castilla-La Mancha (Spain) region every year.

4.3.1 Value Stream Map

In this hypothetical case vineyard pruning can be used for pellet production. At present, some logistic companies in Castilla-La Mancha region collect pruning from the surrounding farmers and transform them in solid biofuels. This is done through a process that includes drying, chipping and cleaning process. The end products consist of solid biofuels (pellets, chips, briquettes, etc.) which are sold both in national and international markets.

Next figure shows the value stream map for this hypothetical supply chain, where wine grapes (harvested from September to December) and pruning (performed from October to March) are transported to wine cellars. Therefore, wineries are proposed to hold two different activity lines. The first, keeping the transformation of wine grapes into wine (bulk or bottles) as they already do. The second, dedicated to the transformation of pruning into pellets (Figure 7).

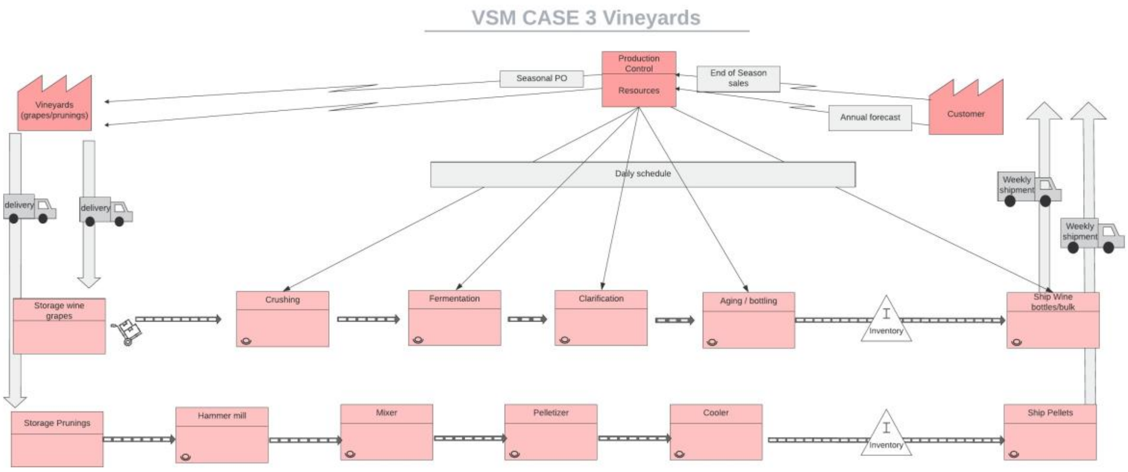

Figure 7. Value Stream Map, Case 3 Vineyards.

4.3.2 Economic Viability

Availability of Raw materials

The area of interest for this case concerns the region of Castilla-La Mancha in Spain, where around 756,000 tonnes of pruning are estimated to be produced every year. Pruning represents a burden for farmers: nowadays the pruning is usually moved to the fields boundaries where it is burned to avoid the risk of parasites. An IBLC could offer to remove these pruning and transport them to a plant (such as wineries) where they could be transformed into pellets. However, there is still uncertainty about the right compensation for farmers. This is a key issue to encourage farmers to make a deal with the IBLC. At the moment, some companies estimate that this compensation should be set at 10 €/tonne (see also AgroInLog D6.4, (2020)). However, this compensation only covers the collection and transport of pruning to intermediate gathering platforms. There, the pruning would be loaded in trailers and then transported to the final processing plant (this last task would be done by the own agro-industry or subcontracted companies). Discussions are on-going to raise this compensation in order to involve farmers in this new logistic chain.

Table 22. CASE3 - KPI to measure availability of raw materials.

Availability of Raw Materials KPIs (ECO1_n)		
KPI	Name	
ECO1_1	Available cultivated lands	In this specific case study, the following areas would be accessible: • 445,000 (ha) in Castilla La Mancha • 940,000 (ha) in all Spain
ECO1_2	Usable Waste	The amount of available pruning is estimated in around 756,000 tonnes, considering only Castilla la Mancha region.
ECO1_3	Market competition	Nowadays farmers usually burn the vineyard pruning in the margins of their fields. Very few of them chip it and then spread it around the fields as an input of organic matter.
ECO1_4	Weather	The availability of pruning can be affected by the weather conditions. Therefore, vineyards pruning yields can vary quite significantly. In Spain, the higher risk is associated to hot and dry weather, implying lower grape productions and amounts of pruning. However, average vineyard pruning yield is estimated to be around 1.7 tonnes/ha AgroInLog D6.4 (2020).
ECO1_5	WTS	At present, only a few companies exploit small volumes of vineyard pruning due to the difficulty of convincing farmers to collaborate (economic compensation) and the low economic margins. Though it seems essential for the success of the new logistic chain that every stakeholder involved get economic profit, some pellet manufacturers claim that removing the pruning from the vineyards represent a compensation to farmers by itself (saving of time and money).
ECO1_6	Investment costs	Most of the farmers usually own tractors and trailers that would allow them to perform collection and transportation tasks without making any additional investment. Agro-industries interested in becoming IBLCs will probably have to invest in telescopic handlers (most of them have tractors and trailers). Otherwise, if the gathering and transport tasks are outsourced to some third-party provider, no investment will be needed for this.
ECO1_7	Operations costs	Costs are associated to fuel consumption, approximately: 2.18 l/t - 4l/t

Transport and Storage Costs

The region of Castilla-La Mancha has a very good road infrastructure, totalling about 1,800 km of motorways and secondary roads. In case an IBLC located in this region decides to export to foreign markets, transport infrastructure in form of airports and seaports could be accessed, e.g. airports in

Madrid and port of Valencia. Given the availability of land, intermediate storage and transport solutions for the collected residuals from vineyards could be easily arranged.

A common practice is to prepare platforms near the farmer fields. The farmer transports all the pruning to the platforms. In some cases, transport to the final location can be arranged, but only if fields are very close to the processing plant.

The Port of Valencia is an exit/entry point of passengers but also containers and general freight. Together with its satellite ports, Sagunto and Gandía, it has traffic of iron, steel products, fertilizers, construction materials, timber, pulp, paper, furniture and perishable products. The port offers several logistics facilities and services and can handle both bulk and containerized cargo.[2] Hence, an IBLC could decide to use this sea terminal to export in bulk to other countries or continents, as long as the bio-product can compete with local production, e.g. in terms of costs, quality and customer experience.

KPIs for transport and storage costs are reported in the next table.

Table 23. CASE 3 - Transport and Storage Costs KPIs.

Transport and Storage KPIs (ECO2_n)		
KPI	Name	
ECO2_1	Transport distance	The activities performed include the preparation of platforms near the farmer fields. The farmer transport all the pruning over there. Sometimes they transport to the final location (if they are very close to the processing plant). Existing companies estimate that distance from fields to platforms is on average between 3.3 to max 5 km. From the platforms to the plant, data is not available.
ECO2_2	Transport Costs	Nowadays, some pellet manufacturers are starting to provide an economic compensation of 10 €/tonne if farmers are willing to gather and transport the pruning to the logistic platforms set in the nearby for that specific purpose. However, this amount only covers farmers' costs regarding the collection and transport of the pruning. Some farmers have accepted, but many of them are still sceptical. In order to solve this issue, some of these companies are trying to set economic arrangements with the cooperatives. In this way they can encourage their members to get involved in this new activity by explaining the related benefits that it implies for their business. However, if the farmers agree to lend the pellet companies to use their pruning but not with the gathering and transportation tasks, this implies that manufacturers must take care of the transportation. In this case, companies are not willing to make any

[2] https://www.valenciaport.com/en/port-authority-valencia/traffic-statistics/goods%e2%80%8b/

		economic compensation claiming that there is not enough profit to make it possible. From the platforms the IBLC could take care of the transport (no data available regarding this transport).
ECO2_3	Storage costs/holding costs	In some cases, there is the option to take advantage of areas available among the vineyards. In this case, the IBLC or a subcontracted company will take care of the logistics. In general, these pruning will need to be moved to platforms that are placed in selected locations in the area of interest. The arrangement of these platforms implies renting and some preparation costs, unfortunately figures are not available. Despite the costs, the usage of these platform can be justified economically, since the collection in these points increase volumes and thereby economies of scale on the line-haul shipment to the plant/IBLC. In all cases farmers own the land/places where the platforms are left to be collected. Finally, an inbound storage is necessary at the final plant where the pruning chips wait to be processed.
ECO2_4	Investments	As specified in the previous table, most of the farmers usually own tractors and trailers that are necessary to perform collection and transportation tasks. Yet, agro-industries interested in becoming IBLCs will probably have to invest in telescopic handlers (most of them have tractors and trailers). In case third party provider is hired for collection/transport tasks, no investment will be needed for this.

Production Costs

In this hypothetical case pellets could be produced in existing wine cellars/wineries. Pruning from surrounding fields will need a special set of production processes. These dedicated processes and machines will imply higher production costs. Vineyards pruning harvest and collection can happen from October to March (Table 24).

Production KPIs collected for this case are reported in the next table.

Table 24. CASE 3, KPIs production costs.

Production Costs KPIs (ECO3_n)		
KPI	Name	
ECO3_1	Production costs	Production of pellets can be added easily to existing plants. These exact costs are not available.
ECO3_2	Switch Costs	Cleaning and sanitation are expected to be mandatory. Costs are not available. Yet, there is no risk for contamination as the lines are not used for food production purposes.

ECO3_3	Investments	The cleaning system will reduce pollutants, decreasing the ash content residuals when burned. Other machines needed are those showed in the VSM of this case, i.e. hammer mill, mixer, pelletizer and cooler. The hot and dry weather favours natural dry. A company could arrange special facilities similar to greenhouses, where pruning could be stored and not get wet.
ECO3_4	Supplies costs	As indicated previously 10 €/tn.

Customers / Markets

Selling the bio-products to markets/customers could be managed at the following price: pellets 120 €/tonne. Prices above this threshold would imply a challenge for IBLCs to enter the market with a sustainable business model.

Table 25. CASE3, Customers/Market KPIs.

Customers KPIs (ECO4_n)		
KPI	Name	
ECO4_1	WTP	Pellets → 120 €/t

Government Policies

Many of the raw materials are considered by the Spanish regulation as "*residues*" and not as "*by-products*". An issue coming for the “*residue*” consideration can be summarized in a harder red tape process and stricter regulation in relation with their "*removal*" or valorisation possibilities. This varies among Spanish regions.

Table 26. CASE3, Government policies KPIs.

Government Policies KPIs (ECO5_n)		
KPI	Name	
ECO5_1	FI	Companies propose active participation to the national (e.g. Enforce the Integrated National Energy and Climate Plan, PNIEC), regional (promulgation of laws and decrees) and local administration (municipal bands) in the discouragement of burning. It is important that all stakeholders end up with profits. The actual compensation of 10 €/tonne is merely covering collection and transport costs but does not generate any real profits for farmers. Business models and cooperative mechanisms should be activated to ensure that a better compensation is provided to farmers.

		There are many legislations: e.g. Castilla La Mancha approved some legislations, but these are generic frameworks that are correctly encouraging this kind of initiatives. In addition, cooperatives could raise the concerns for burning pruning and provide recommendations to farmers in order to raise awareness.
ECO5_2	DI	Companies might have possibilities to export to UK and Denmark. In these countries, the company had some fiscal facilitations to sell some part of their production. There are some incentives for the energy production from biomass. Some cooperatives are generating thermal energy for their own processes. Then l electric energy is sold to the national grid. If energy production is considered as high-efficient they can get subsidies (high efficiency = taking advantage of the thermal energy and the electric energy).

4.3.3 Social Performance

The European Union is one of the most important stakeholders on the world's wine market. It accounts for 56 % of the annual world's production (16,000 litres/y), 54 % of global consumption and 75 % of exports in 2017 (Coyette & Schenk, 2018). In terms of vineyard areas, the EU has 44 % of the world's grapevine areas, which suppose 1.6 million vineyards covering 4 million ha.

A total amount of 21.2 million tonnes of grapes was produced to reach this numbers, being the main producers Italy (30.4 %), Spain (24.1 %) and France (23.5 %). The remaining percentage is divided among Germany, Portugal, Romania, Greece and Hungary.

In economic terms, wine production represents 5.1 % of the total agricultural outcomes of the EU, which makes a total of 224.9 billion euros. The wine sector of the EU-27 directly employs 2.2 million people (VINBOT, 2015).

The main sector opportunities identified in Task 6.3 was the exploitation of pruning wastes for pelletised or chipped biofuels.

Impact on employment of the transition into an IBLC

As mentioned above, the hypothetical case study was set in Castilla-La Mancha due to the wide availability of vineyard pruning and the presence of hundreds of wineries. This is a vast Spanish region with 2 million inhabitants. The proposed IBLC would be dedicated to the production of biofuel from vineyard pruning, more specifically pellets, chips in bulks or bales. Some companies in the region are already transforming the vineyard pruning into pellets or chips that are used for self-consumption in a co-generation heat and power plant located in the company facilities.

For instance, one of the companies working in this region is trying to exploit a total amount of 320,000 wet-based (30 % humidity) annual tonnes of pruning that they estimate are available in the surrounding area (190,000 ha) (AgroInLog D6.4, 2020). It can consider that this company is a biomass logistic company. All the workers that perform direct jobs have a seasonal temporary contract.

According to AgroInLog D6.4 (2020), the expansion of the current activities would carry out an estimated additional production of biofuels of:

- 15 000 annual tonnes of pellets (<10 % humidity) at 120 €/t.
- 25 000 annual tonnes of chips in bulk at 45 €/t.
- 2 000 annual tonnes of chips in bales at 40 €/t.

The annual revenues with the selling prices proposed above would be about 3 M €/year (AgroInLog D6.4, 2020), up by 35 %. It is expected that this additional activity would involve the recruitment of 25 workers (3.6 % increase) with a productivity per employee of 120,000 €/worker.

In an interview to the company representatives in the frame of task 6.4, they claimed to have made a project for the organized collection of vineyards pruning and were beginning to deploy it. In the future, they plan to start up a thermoelectric plant using the vine shoot as the only biomass material. A qualitative assessment of the potential activity of the IBLC was done, considering the most important parameters related to job quality and assessing them in a scale from 1 to 3, representing 1 the poorest quality and 3 the most desirable situation. The main results are shown in Table 27.

Table 27. Assessment of the employment quality generated by the IBLC in the vineyard sector.

Quality employment assessment for the IBLC in the vineyard sector		
Parameter	Score (1-3)	Reasons
Salary	2	There are not so many high-quality jobs that require high salaries. Normal salaries should be applied.
Seasonality	2	Seasonality of agricultural activities ensure job creation (pruning harvesting). Part time jobs may be a solution to hire more employees.
Level of expertise	3	A high level of expertise is not really required in jobs related with the harvesting of vine pruning or biofuel handling/production.
Rural location	3	Returning to rural environments will increase the economic growth of the nearby areas. Younger people have the

		chance to return to rural environments and get involved in agricultural activities.
Gender	2	It is important to give access to women in rural areas. The new IBLC jobs have no gender restrictions but work has to be done to reach gender equality.
Health and Safety	3	Security and health constitute vital factors for the new employees. No dangerous job positions are expected.
Long-time perspective	3	Long term perspective offers stability and "safety" for new employees. The new jobs of the IBLC can work towards this way.

4.3.4 Environmental Performance

In general, vineyards could be affected by problems related to soil erosion and compaction. For instance, several studies demonstrate that the steepness of terrains can affect erosion, especially in vineyards (Wicherek, 1993).

In addition, different management practices can affect soil erosion in vineyards plots: 1) bare ploughed soil, 2) bare soil with occasional shallow tillage or herbicide use and 3) cover of grass and weeds. Ploughing could increase infiltration compared to shallow tillage/herbicide control. Using grass and weeks to cover the soil could have the most beneficial effects, i.e. smallest amount of runoff and erosion (Tropeano, 1983).

In addition, traffic of heavy machineries will ultimately increase compaction with consequent loss of fertility. Nevertheless, this specific demonstrator aims to produce pellets from vineyard pruning.

The above consideration from the literature, were confirmed by the respondent interviewed: "*some people wonder if it would be better to ship pruning and spread the pruning over the field. In this way, organic matter could be returned to the field. But the fact is that there are no studies that say this with good reliability*". The pruning has very high lignocellulosic content, this organic matter needs more time to decompose in the soil and could affect the texture if applied to the soil.

Another important issue to consider is that usually farmers burned the pruning because, if it is stored at the side of the land, parasites may appear after few days, e.g. psyllids and whiteflies. The time necessary to spread the organic content return to the soil is about 30-60 days, which significantly increase the risk of parasites.

In terms of CO_2eq emissions, the energy produced is expected to reduce emissions considerable if compared with fossil fuel options. Some additional fuel consumption is expected for collecting and transporting pruning, as well as for the energy used in the production processes. In addition, pruning could be burned by the farmers directly on their lands. This increases local emissions.

4.4 CASE 4: Grain Industry

In Sweden, areas dedicated to production of cereal grain could be focusing on the production of chaff, the protective casing of cereal grain's seeds. One of Lantmännen's cereal handling site could be available for this purpose.

4.4.1 Value Stream Map

The plants receive many different types of cereals and seeds, about 55 000 – 70 000 tons of cereals and 30 000 tons of seeds. The plant is owned by Lantmännen. At the site, two facilities are available: one facility is cleansing seeds and the other is drying and cleansing different types of material such as cereal grains and fodder peas.

In this aspect, chaff comes as a residual from existing processes and it could be used for the following production:

- **Biochar.** The biochar is obtained from the carbonisation of the chaff, where the biomass is heated via pyrolysis (without oxygen) or gasification (limited oxygen). The markets to be targeted are soil improvement, carbon capture, filtration material, animal feed additive and bioenergy production.
- **Pellets.** Biochar can be pelletized and sold to the energy market.

Figure 8 depicts the Value Stream Map for the grain sector case assessed.

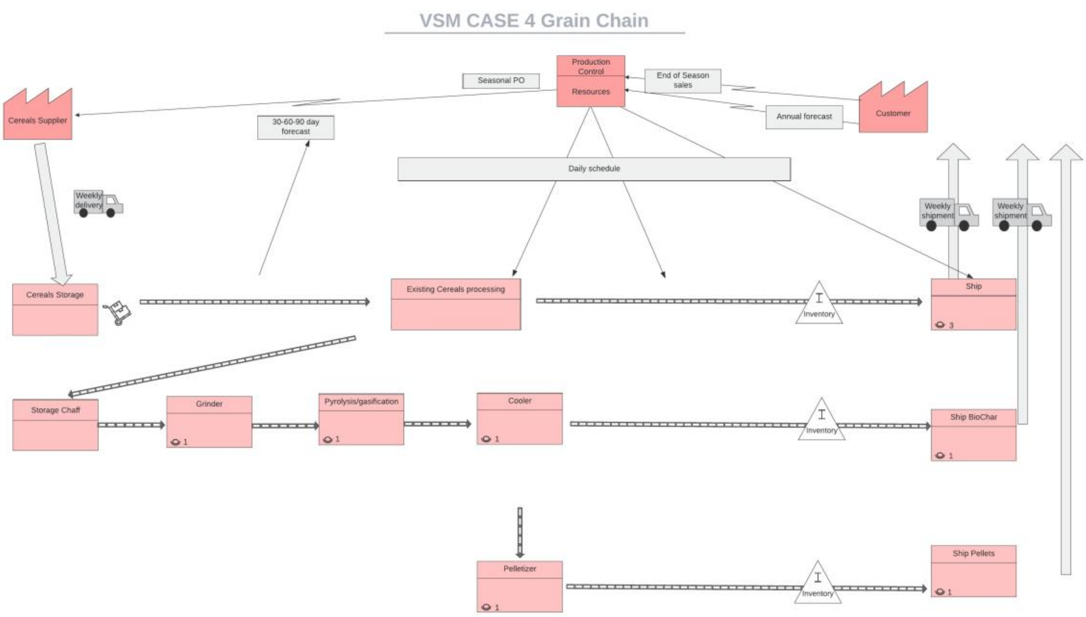

Figure 8. Value Stream Map, Case 4 Grain chain.

4.4.2 Economic Viability

Availability of Raw materials

Available raw material consists of about 55 000 – 70 000 tons of cereals and 30 000 tons of seeds. Exact size of land available cannot be retrieved, likewise other indicators are not directly applicable since residuals can be collected from existing production plants dedicated to cereals processing. Some market competition exists since the chaff, nowadays, is used for generating energy by means of combustion (Table 28).

Table 28. CASE 4 – raw materials availability KPIs.

Availability of Raw Materials KPIs (ECO1_n)		
KPI	Name	
ECO1_1	Available cultivated lands	Not applicable since a residue from industrial processing of grain, chaff, is utilized in the IBLC process.
ECO1_2	Usable Waste	Same as above
ECO1_3	Market competition	Applicable since the chaff is utilized for combustion today. 100 % goes to combustion today.
ECO1_4	Weather	Not applicable, see explanation above
ECO1_5	WTS	Not applicable, see explanation above
ECO1_6	Investment costs	Not applicable, see explanation above
ECO1_7	Operations costs	Not applicable, see explanation above

Transport and Storage Costs

Road transport in the region of study is very good. This is according to the results obtained with the simulation model developed in WP2, where fields in the region could be well covered within 1-2 hours travelling time. Likewise, land is available to build intermediate storages. In case, seed plants and grain receiving plants have some storage surplus capacity, then this storage can be used for the inbound interim storage of straw or the outbound interim storage of biochar and pellets.

Export can go by railway, road or seaports, e.g. port of Gothenburg or Port of Malmö can handle bulk, general cargo and container shipments. In terms of chaff transportation an average distance of 85 km has been identified for a transport cost of 6.3 €/km.

Table 29. CASE 4 – Transport and storage KPIs.

Transport and Storage KPIs (ECO2_n)		
KPI	Name	
ECO2_1	Transport distance	Two scenarios have been considered. In scenario 1 there is no transport from fields to plant where only chaff from the site is utilized, therefore this KPI does not need to be considered. But in scenario 2, chaff is transported from two other sites, the average distance between the sites is 85 km.
ECO2_2	Transport Costs	Transportation costs 6.3 €/km for scenario 2.
ECO2_3	Storage costs/holding costs	No on-farm storage. No such cost available.
ECO2_4	Investments	No on-farm storage. No such cost available.

Production Costs

Two facilities are available: one facility is cleansing seeds and the other is drying and cleansing different types of material such as cereal grains and fodder peas. Residue instead is made primarily of chaff. Table 30 identifies potential investments for the two scenarios considered for this case.

Table 30. CASE 4 – Production costs KPIs.

Production Costs KPIs (ECO3_n)		
KPI	Name	
ECO3_1	Production costs	Since this is a theoretical case study, cost data are lacking. No total production cost is available.
ECO3_2	Switch Costs	Not applicable
ECO3_3	Investments	Scenario 1: investment cost in the pyrolysis plant could range from 0.4 and 0.6 million euro and for scenario 2 from 0.7 and 1.0 million euro.
ECO3_4	Supplies costs	Transport cost available for scenario 2, see above. No other cost identified in the supply chain.

Customers / Markets

Biochar pellets are expected to target several markets. The product can be pelletized facilitating transport and/or use. The potential markets for these products (pelletized and non-pelletized) are: soil improvement, feed additives, water treatment, etc.

From data retrieved from interviews, it is difficult to estimate the willingness to pay of customers for this bio-commodity. Nevertheless, some comparative evidence has been collected to develop a rough understanding of the potential prices. In 2009 biochar had an average price of €354 per ton in Europe.[3] Its usage includes farming, decontamination and industrial activities. Farming includes soil amendment, livestock farming (e.g. water treatment, feed additive etc), and fertilizer support. For decontamination, it can be used to decontaminate water, soil, to treat wastewater and sewage, drinking water or as an exhaust filter, i.e. air room filters. Industrial activities include building materials, textile, digesting helper, conservation packages for food, cosmetics, paint and colouring and more.

Biochar pellets could also be a complementary product of wood pellets. Manufacturing of wood pellets has been growing rapidly during the last 20 years. Production was 1.7 million of tons in 2000 and went up to 19 million tons in 2014 in the EU. Experts agree that the pellet industry will continue to grow in the future. In 2015 the average wood pellet price was of 22.92 euro per kg. Straw pellets could be cheaper, about 25 % lower in price, i.e. about 17 €/kg.

Unfortunately, no data could be provided with the questionnaire used.

Table 31. CASE 4 – Customers / Markets KPIs.

Customers KPIs (ECO4_n)		
KPI	Name	
ECO4_1	WTP	Difficult to estimate since the market for biochar is a young and undeveloped market.

Government Policies

In terms of government policies, the team could not identify any relevant policies on farmer or market sides of the supply chain.

[3] http://vec.vsb.cz/katalog-obrazku/clanek-135/245-schmidt.pdf

4.4.3 Social Performance

According to Eurostat data, the harvested production of cereals in the European Union was 295 million tonnes in 2018. Cereals account for 31 % of the total utilisable agricultural area, which suppose about 55 million hectares (Eurostat, 2019).

All the member States produce cereals, being France the main producer, with 21 % of the European production, and followed by Poland, which produces the 14 % of the total, Germany with 13 % and Spain, with a production of 8 %.

Cereals in Europe are mostly used for animal consumption. One third of the total production is intended for human consumption and only the remaining 3 % is used for the generation of biofuels. Whereas in the past decade the amount of cereals used for biofuels increased until an extra quantity of 120 million tonnes of cereals, the current trend shows a rate of zero growth.

However, the AGROinLOG IBLC concepts may represent a good opportunity for the sector, because they are aimed at the valorisation of the cereal wastes such as chaff and straw into biofuels, leaving the grain for the usual applications.

Impact on employment of the transition into an IBLC

The case study for the grain sector is a Lantmännen's cereal handling site in Sweden close to a medium-large rural municipality.

The company is dedicated to grain handling. The site receives between 55 000 and 70 000 tonnes of cleansed cereals and 30 000 tonnes of cleansed seeds. The available feedstock considered is chaff since straw has secondary markets, mainly farming, and the cost is usually high in Sweden. The IBLC concept is the production of chaff-based products such as soil improvement, carbon capture, filtration material, animal feed additive and bioenergy. Feedstock could also be supplied from 2 cereal handling sites at less than 90 km distance. The first could supply from 4 250 to 5 000 t/y and the second around 3 800 t/y. Total supply would go from 8 000 to 9 000 t/y.

The IBLC innovative activities are made up by continuous automatized process with a low requirement of labour. Three extra employees are expected to deal with the production. The new hires would be allocated to the following processes: chaff handling, maintenance and supervision and administrative tasks (logistics/sales). Considering that the initial number of workers was 16, it would suppose an increase in the total number of employees of the company of 19 % to the company staff. However, they would be hired in a part-time modality, so they represent 1.5 FT equivalent jobs.

Two possible scenarios are envisaged. The first one assumes the supply from one grain-handling centre of 4 500 t/y of chaff to produce 1 000 t/y or biochar. The second assumes the supply from a second grain-handling centre of additional 4 000 t/y of chaff to produce a total of 1 800 t/y or biochar. Biochar selling price would be very unpredictable. With an assumption of 400 €/t, revenues would go up to 400 000 €/y in scenario 1 and 720 000 €/y in scenario 2. In percentual terms, that could suppose an increase in the current incomes in a range of 8 % to 15 %, maintaining the current company's productivity per employee in about the same rate as in the pre-IBLC situation.

The plant employs currently around 16 employees, 9 at production and 7 at sales, logistics and administration. Around 10 (63 %) are seasonal workers, two of them women. Continuous jobs are all held by men. Hence, gender equality is not met with 12.5 % of female personnel. This fact evidences the important gap between men and women in the sector and the instability of the job positions due to seasonality.

Average production salaries are below the average salary of Sweden workers. The main reason is that 100 % of employed workers only have compulsory education background as certain level of qualification is not demanded in many production positions in the primary sector.

Finally, another important issue related to job quality is Health and Safety conditions. Various experts of the sector think that the most important occupational hazard related to the grain handling activity is the generation of dust. This is particularly the case when dealing with cereal chaff. As particulate matter, dust may be harmful for the respiratory system and may cause several illnesses due to the irritation of the respiratory tract. For this reason, it constitutes an important hazard to be considered in order to plan the most appropriate protective measures. Table 32 shows how the grain sector job quality was assessed.

Table 32. Grain sector job quality assessment.

Grain sector job quality assessment		
Concept	Score (1-3)	Reasons
Salary	2	Low qualification forces salaries to be below the average of workers in the country, making jobs less attractive for candidates.
Seasonality	1	Most of the jobs would be seasonal according to the grain sector seasonality and availability of feedstock.
Level of expertise	2	Level of expertise is assessed as medium. Experience is demanded, especially in the operation of equipment and maintenance.
Location	3	Most of the jobs would be local, thus helping to consolidate population in rural areas.
Gender	1	Although there are no barriers refraining employers from contracting women and equality is a target for the company, the female rate is far from equal nowadays at the selected cereal handling site in this case study.
Health/Safety	1	High levels of dust in chaff handling is a problem that may bring about illness, although the right safety measures should be placed
Long time perspective	3	IBLC jobs are meant to last in time as the Business model and investments made are paid back in a long period and needs several exploitation years to get it back.

4.4.4 Environmental Performance

In terms of environmental performance, the case selected does not affect significantly the indicators that have been identified in this report, i.e. soil erosion and compaction as well as CO_2eq emissions.

According to existing studies, problems for soil erosion and compaction can appear. In essence, removing crop residuals from fields could imply the removal of nutrients matters that would contribute to keep its fertility level and organic content high (Qingxiang, 2002). Finally, soil compaction could be affected by the increased traffic of heavy machines aiming to collect and bale the straw directly on the fields. Nevertheless, this case is built upon existing activities for grain production, where land cultivated, harvesting, residual collection is not affected. The only change concerns the production activities, where additional processes are needed to obtain the bio-commodities. In terms of CO_2eq emissions, these are merely related to the added production activities. However, these could not be estimated by the respondents.

4.5 CASE 5: Sugar Industry

A sugar factory in Sweden has been identified where dedicated sugar production takes place.

4.5.1 Value Stream map

As for the previous grain industry case, the upstream part of the supply chain does not need to be modified for the IBLC concept implementation, i.e. it remains single sourced to one type of supply, sugar beets. The additional activities are necessary at the production site, where a coproduct is generated in large quantities from the production of sugar. The beet pulp is stored and then washed and pressed into pellets. The beet pulp can be used to produce succinic acid, a chemical intermediate that is necessary to produce several types of chemicals and products (Figure 9).

The period allocated for the sugar production goes from around late September to January. Therefore, idle time consisting of about 7 months (February to August) could be exploited for production of bio-commodities. In the context of the AGROinLOG project, the following bio-commodity has been identified: beet pulp.

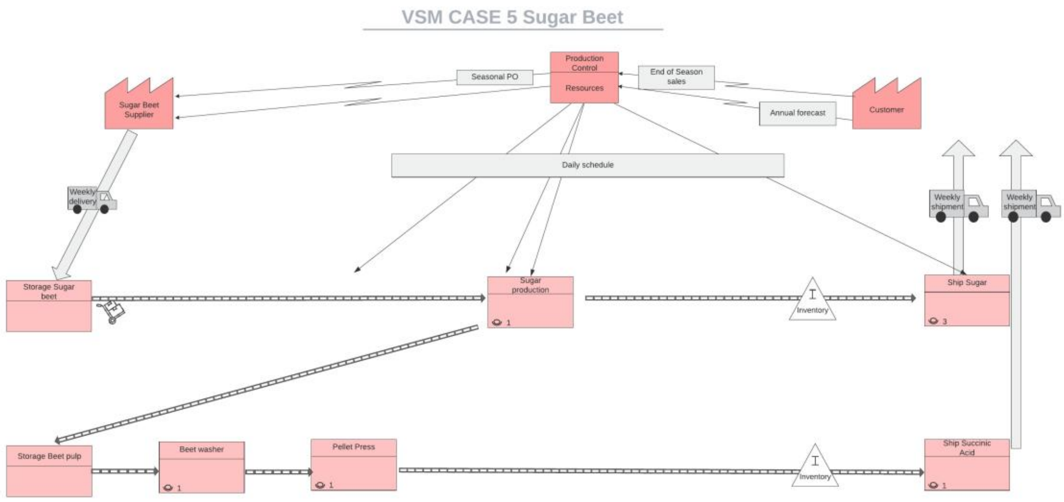

Figure 9. Value Stream Map, Case 5 Sugar Beet.

4.5.2 Economic Viability

Availability of raw materials

The bio-commodity expected for this case, is a co-product generated by the production of sugar. For this production sugar beets need to be collected from available fields.

In Sweden about 2 million tons of sugar beets are produced every year and that amount of sugar beets corresponds well to the number of beets that Nordic Sugar Örtofta receives and processes. Örtofta is one of the largest and most efficient sugar-producing facilities in northern Europe with a yearly production of sugar of 382 000 tonnes/year. The standard harvest for sugar beets in Skåne region is 64 547 kg/ha 2016 (17.8 % sugar content) and slightly lower for other regions (Jordbruksverket & SCB, 2016).

In terms of availability of raw materials, the major concern is the fact that beet pulp could be used as feed for animals. This could be sold for a price between 0.12 and 0.22 €/Kg (Table 33).

Table 33. CASE 5, Availability of raw materials KPIs.

Availability of Raw Materials KPIs (ECO1_n)		
KPI	**Name**	
ECO1_1	Available cultivated lands	Not applicable for sugar industry case since the utilized raw material is produced as a residue at the sugar industry not in the field.
ECO1_2	Usable Waste	Same as above.
ECO1_3	Market competition	Applicable for the sugar industry case since the residue used as raw material in the IBLC process is utilized as feed for animals today. The

		HP pulp (high pressure beet pulp) is mainly sold as feed today for between 0.12 and 0.22 euro/kg DM.
ECO1_4	Weather	Not applicable.
ECO1_5	WTS	Not applicable.
ECO1_6	Investment costs	Not applicable.
ECO1_7	Operations costs	Not applicable.

Transport and Storage Costs

Road transport in the region of Skåne, where the Örtofta factory is located, is very good. Likewise, land is available to build intermediate storages. Since, beet pulp is a co-product of the sugar production, plants have already in place facilities for inbound storage. On the other hand, the created beet pulp will need to be stored in the outbound of the plant. The plant has potentially some storage surplus capacity. Just before the production season or just after the season there is a possibility to utilize some parts of the factory as the storage facilities and the drum drier.

Örtofta is located on the South region of Sweden, Skåne, close to the cities of Lund, Malmo and Copenhagen. Export can go by railway, road or seaports, e.g. Port of Malmö and Copenhagen can handle bulk, general cargo and container shipments for further international export, i.e. to other European countries or continents.

Transport costs for this case would appear only in case beet is imported from Denmark, over 200 km and a corresponding price of 14.7 €/ton. In general, no additional storage is expected.

Table 34. CASE 5, Transport and storage KPIs.

Transport and Storage KPIs (ECO2_n)		
KPI	Name	
ECO2_1	Transport distance	Two scenarios were considered. No transport takes place between the farm and the plant in a hypothetical scenario 1 where only beet pulp from the Örtofta plant is utilized in the IBLC process. No storage on farm. But in a second hypothetical scenario (scenario 2) beet pulp from both Örtofta and Nykøbing (DK) are utilized, and there will be a transport from Nykøbing (DK) to Örtofta. One way transport distance 200 km Nykøbing (DK) to Örtofta (SE).
ECO2_2	Transport Costs	For scenario 1, this indicator does not apply. But for scenario 2 cost of pulp transport is 14.7 €/tonne delivered to Örtofta from a storage at Nykøbing.

ECO2_3	Storage costs/holding costs	No storage on farm is necessary in neither one of the scenarios.
ECO2_4	Investments	No storage on farm. In scenario 2, transport is performed by 3rd parties who are assumed to have their own fleets of vehicles and / or access to storage warehouses.

Production Costs

The sugar factory, Örtofta, in Sweden, is owned by Nordic Sugar, which is the only sugar producing company in Sweden. This factory runs only part of the year from mid-September to mid-January. During this period beet pulp is produced. It comes as the material left over after the sugar is extracted from sugar beets. This material could be dried in flakes or compressed in pellets and thereby stored. Another option is reuse and transform further the pulp into another by-product when the production site is idle, i.e. February to August. No additional data for the production KPIs could be collected with the questionnaire.

Customers / Market

According to available sources, beet pulp price can vary from free to about 0.55 €/kg when purchasing batches of 20 tonnes. The pulp is typically used as fodder additive for horses or other livestock.[4] Apart this, the Swedish case envision to use the beet pulp for only one sector: as a chemical material, succinic acid.

Apart the literature identified and reviewed in the frame of this project, no additional data could be found with the questionnaire.

Government Policies

This sector is being affected by a recent regulation established on the 1 October 2017 that has abolished the sugar quota system. This system was set up in 1968 and it aimed to regulate the sugar industry and move farmers to a sort of guaranteed price system. Instead the abolition of the quotas will remove limits on production and exports and will let producers to explore new export markets, in order to adapt to demand dynamically. The expectations of the legislative change are to increase production and export, but it will cause sugar prices to drop coming closer to world market prices.[5]

No subsidies are currently available for this bio-supply chain, not for upstream suppliers nor downstream.

[4] https://realnoevremya.com/articles/3361-beet-pulp-turns-out-to-be-quite-expensive

[5] https://ec.europa.eu/commission/presscorner/detail/en/MEMO_17_3488

4.5.3 Social Performance

The European production of sugar is based on the harvesting of beet. The total harvested beet area suffered a light decreasing from the beginning of the 21st century but remained stable in approximately 1.5 million hectares along the 2010's decade. In parallel, the sugar production from beet has been between 15 and 18 million tonnes, with moderated annual variations (CEFS, 2014). The annual production of sugar beet has varied in the range of 110 to 120 million tonnes per year (at standard humidity and excluding seed).

Main producers of sugar beet in Europe in 2018 were France (33 %) and Germany (22 %). About sugar Germany, France and Poland are the most important producers of the European Union with a contribution of 25 %, 21 % and 11 %, respectively (EU,2019).

As already mentioned in the previous section, the duration of the campaign usually lasts between 100 and 120 days per year, with an idle period from February to August that could be used to produce alternative bio-commodities. This high seasonality is usually a problem for the companies in the sector, but may represent a good opportunity for the setup of an IBLC business model by exploiting the side-streams or co-products generated during the campaign and transform them into valuable products in order to develop a new value chain that enables to prolong the productive period.

The main co-products for valorisation in this sector are beet pulp and beet leaves. The availability of beet in the European Union and in the project reference countries is summarised in Table 35 (Eurostat, 2019).

Table 35. Beet pulp availability in tonnes per annum. Source: Eurostat 2019.

Beet pulp availability	
Country	Production of sugar beet in 2018 (excluding seed) (1000 t)
Greece	367
Spain	3,064
Sweden	1,698
EU-28	119,690

According to D6.3, the main opportunities for IBLCs in this sector correspond to the production of proteins and PBS (Polybutylene Succinate), a thermoplastic biopolymer resin, based on the synthesis of SA (Succinic Acid) with multiple applications in the textile sector to make shoes, sport items, clothing, but also to fabricate hygienic products, cosmetics, toys, etc.

Impact on employment of the transition into an IBLC

The case study for the sugar sector is the company Nordic Sugar, which owns the only sugar refinery and sugar factory in Sweden as previously mentioned and therefore, it represents the totality of the sector in the country. Nordic Sugar is part of Nordzucker, a multinational company who provides sugar for the northern European countries owning plants in different countries, such as Denmark, Finland, Lithuania, Germany, Poland and Slovakia. A total amount of 3 200 employees work for Nordzucker in all Europe, 330 of them work in Sweden.

The studied plant is located in the Skåne County, a province with a population of 1.4 million inhabitants and its suppliers are local farmers from Sweden.

At the Skåne sugar plant, 140 employees are direct jobs related to production. Only the 5 % of these positions are part-time jobs but up to 22 % are seasonal jobs, with labour contracts covering 120 days/year (sugar campaign). The remaining percentage, about three fourths, are full-time, permanent jobs.

The gender balance rate is again very low: only the 22.8 % are women. The gender gap in the company is improvable.

Regarding the educational levels, most of the employees (70 %) have a qualification level beyond compulsory education. 10 % own a university degree. The degree of qualification is high. The annual gross average salary is 37 000 €/year, which is average in the country.

The current sugar production of the plant is 382 000 annual tonnes of sugar and the productivity per employee is 190 924 €/employee and year.

The new IBLC activity for the sugar sector is aimed at the manufacturing of succinic acid (SA) which will serve as a raw material for biopolymers synthetisation that can used as be components in food packaging, cosmetics and hygiene products. As in the case of Grain Chain sector, two scenarios were estimated, depending on the production of succinic acid, with an estimated selling price in the range of 4 – 5 €/ton

- Scenario 1: 9 900 tonnes of SA per year with estimated revenues of 34 650 €/y
- Scenario 2: 13 800 tonnes of SA per year with estimated revenues of 48 300 €/y

The second scenario means an increase on annual incomes 0.02 % per year at company level. However, it was not possible to give an accurate estimation of new jobs to produce the volume estimations above.

A qualitative assessment of the job quality factors was done during an interview carried out to a Nordic Sugar's management staff. She was asked to rate different job quality aspects in the company from 1 (job lowest quality level) to 3 (job best quality level). The main results are shown in Table 36. Salaries are competitive but in the average. Although not specific qualification degree is required, the level is relatively high. Hence, it is the experience required for some technical tasks. Jobs are concentrated in a large factory site but mobilise a significant amount of labour resources at rural areas. In terms of gender, although the situation nowadays is far from equal, the company is getting active in correcting it. The new IBLC productivity is meant for the long run and there are no issues in terms of Health & Safety. Job quality is overall assessed as good. The main concern is the high seasonality of jobs nowadays, that could be partially solved with the use of mixed business models as the AGROinLOG's IBLC model.

The use of GMO (Genetically Modified Organisms) for SA fermentation process may become a social concern but it is not clear yet. Nor it is the competition of beet fibre use for the production of succinic acid with the traditional animal feed use. These are specific social risks that may need further investigation.

Table 36. Assessment of the employment quality generated by the IBLCs aimed at producing succinic acid.

Employment quality assessment for new jobs in the Sugar sector		
Parameter	Score (1-3)	Reasons
Salary	2	There is high competition for skilled labour because there is a lot of industry in Skåne. Salaries are competitive, in the average.
Seasonality	3	Extra jobs are expected to be seasonal, though it is difficult to find workers. The IBLC model would help to overcome this problem.
Level of qualification	2	The nature of the new jobs is more difficult. The use of the machines requires higher demands on the operator's qualifications and competences.
Level of expertise	2	This parameter depends on the developed role. The company needs workers that should carry out both operators' and repairers' functions, since it is seasonal production.
Rural location	2	Nordic Sugar has a large area of labour in Örtofta. Many people have an agricultural background and grew up around the plant.
Gender	2	The company develops measures in order to equalize the proportion of men and women. They think it is good for the working group because the climate is affected in a positive way. If there two equal candidates with the same qualifications, the woman is chosen instead of the man. However, today's numbers do not reflect this equality level yet.

Health and Safety	2	The Health and Safety politics at the company is strong and well established. The younger generation seems to be more safety conscious and has greater demands.
Long-time perspective	3	The company cannot compete with fixed-term employment. Seasonal work is a matter of concern. However, the activity is expected to be run for long periods to pay back for the asset investment.

4.5.4 Environmental Performance

Soil erosion and compaction are not going to be affected in this case, since the beet pulp comes as a co-product from the production of sugar. Obviously, plantation dedicated to cultivation of sugar will be affected by soil erosion and compaction because of the existing processes to plant, harvest and collect the beets. However, the production of beet pulp is not going to affect this any further.

The only indirect effect that could happen is that the more profitable production of sugar combined with beet pulp utilization for production of Succinic Acid (SA), could increase the profit margins of producers and induce an increase of price of the raw materials. This price increase could affect land use in favour of beets cultivation. As anticipated in the framework, land use competes with food security issues. Likewise, the incremented production of sugar beets would increase the environmental impacts of cultivation and transportation to plant.

Finally, no special increment of CO_2eq emissions is expected. As in the previous case, the supply side is not going to be changed, only production activities. At the current status it was not possible to retrieve any additional information about potential impacts of the new processes and exact CO_2eq emissions.

5 CONCLUSIONS

This report aims to explain the IBLCs activities reported in T6.4 by determining the impacts of IBLCs activities in terms of Key Performance Indicators identified in the following areas: economic, social and environmental impacts. In this approach, it is important to use value stream maps in order to determine the underlying supply chains sustaining the activities driven by the IBLCs.

The collected KPIs are measured and analysed in five different cases/sectors:

- CASE1: Fodder Industry
- CASE2: Olive Pruning
- CASE3: Vineyards Pruning
- CASE4: Grain Industry
- CASE5: Sugar Industry

CASE1: Fodder Industry

Economic Impacts: some conclusions about the economic impacts could be drawn despite some of the KPIs for the economic impacts are missing. Considering that the plant can use 4 000 tonnes of raw materials, transportation, biomass, baling and CAPEX costs (when average distances to plant are 85km) are about €226 285. Then, assuming 1) a production cost of about €68 per tonne (this value was used in previous simulations in WP2), 2) the suppliers have a profit margin of about 10 % on their internal costs, 3) a market selling price of 162 €/tonne, potential profits could be about 125 728 €/y. Considering a discount rate of 7 %, the necessary initial investment of the new lines, €970 000, can reach a break even over a period of about 12 years.

Social Impacts: The number of new jobs derived from the conversion of feed and fodder sector industries into IBLCs for the production of straw pellet is modest (about 0.55 jobs per every 1000 straw pellet tones). For self-consumption, the market is ensured, and the biofuel production could be undertaken by the available personnel in idle times. About job quality, jobs are assessed as full-time and long-term, but with issues related to Health & Safety, due to dusty environments. In terms of gender, the majority are men but there are not critical barriers for women to take the jobs. Qualification levels are low, but this may extend the job opportunities to more vulnerable unqualified workers. The assessment in rural development and economic expectancies are good.

Spain is a country with the second highest unemployment rate (14 % by end of 2019) in the EU and a high migration rate from rural areas, where vast inland regions are getting empty. However, despite the low vacancy rate in agriculture sectors in Spain, many of the seasonal jobs are covered by temporary migrant labour, specially at harvesting. The reasons are several: the lack of local population at rural areas, the labour demand peak in many agricultural product campaigns and the low harvesting costs payed by the market, that are not attractive for local workers. IBLC deployments would have beneficial effects to increase the job quality factors and make them more attractive for locals.

Environmental Impacts: the potential environmental impacts could be associated to the transport activities that are necessary to move from suppliers to plant and from plant to customers respectively. Considering direct shipments on the distances used in the computation of economic impacts, and using a truck capacity of 5 tonnes, expected emissions are approximately 13 880 KgCO_2eq annually.

CASE2: Olive Pruning

Economic Impacts: considering the data gathered for the activities aiming to produce pellets, this case study shows profits of about €120 000 annually. Considering the investment of one production line and 3 harvesters, totally, €360 000, the breakeven for the Net Present Value can be reached after approximately 4 years. Increasing the purchasing costs to 170 €/tonne, profits could increase to about 216 000 per year.

Social Impacts: Olive tree pruning is currently both an important and unexploited resource, and a cumbersome residue to get rid of. The exploitation of this resource for an alternative local fuel source may become an important booster of relatively high-quality jobs in rural areas with long term perspectives for the IBLC pelletising tasks. Jobs at harvesting are affected by strong seasonality and high experience requirements that may compromise the search of the right professionals.

Environmental Impacts: environmental impacts are limited in the upstream part of the chain, where average transport distance is about 7 km. For the downstream part there is no data available, hence it is considered an average distance of 20km (leading to additional costs of 100 €/tonne). The expected CO_2eq emissions can amount to about 9 650 KgCO_2eq annually.

CASE3: Vineyard Pruning

Economic Impacts: The rough estimation carried out identifies a potential revenue of about 85-90 M€ if all material available in the region studied could be collected and used to produce pellets, as well as there is enough demand. Nevertheless, not all farmers may agree to sell the pruning. As of today, purchasing pruning from farmers including transport costs could be estimated to about 5 670 000 – 7 560 000 € inbound. This gives quite large margins to accommodate additional investments, fixed and variable costs for 1) production, 2) storage, and eventually 3) transport to final customers. In addition, there is some room to improve compensations offered to farmers.

Social Impacts: The wine sector has a great importance in all the Mediterranean countries. There are several residues that can be valorised as fuels, the most important being vineyard pruning and grape pomace, either for self-consumption (distilleries) or external fuel market (pellets). Some wine-producing companies already exploit vineyard pruning to produce pellet.

Relevant sector stakeholders think that the IBLC model deployment would contribute significantly to new employment creation and to the stability of the existing jobs, improving the current acute seasonality by extending the working seasons. The quality of the job positions is assessed as relatively good, only threatened by high seasonality and low gender equality, although no gender restrictions are identified. The level of qualification required is not high, but experienced workers are most preferred.

Environmental Impacts: as this is a hypothetical case, data related to the distances to be travelled could only be assumed to an average distance of 20 km both on supply and distribution, one way (IBLC inbound and outbound shipments). Using a truck capacity of 5 tonnes, potential impacts can be estimated to 462 944 – 617 258 KgCO_2eq.

CASE4: Grain Industry

Economic Impacts: much of data necessary for performing a good enough economic analysis is not available for this case. In general, there are two scenarios expected: scenario 1, availability of 4 500 t/y of chaff to produce 1 000 t/y or biochar. Scenario 2 assumes availability of 4 000 t/y of chaff to produce a total of 1 800 t/y or biochar. Considering the potential high selling price of biochar retrieved from secondary data, 354 €/tonne, revenues of about €354 000 – €637 200 can be expected, making the business cases promising and economically sustainable. There are some investments involved and operational costs to be considered. Therefore, the second scenario looks more promising in terms of potentially covering existing costs.

Social Impacts: Grain sector offers large amounts of agricultural wastes for IBLC's product portfolio diversification, outside the principal product mainstream (grain). Companies working in the sector usually handle big volumes of product with few employees. These companies are subject to high seasonality and a good part of their personnel are contracted on temporary basis.

New job demand is low in absolute terms but relatively high in comparison with the short size of the companies involved in the sector. The association of small companies in large cooperatives or corporations enables the availability of feedstock and the synergies on assets and resources.

Job quality is medium, with issues on seasonality, gender equality and health and safety. Since qualification and salaries are below the average many employers report problems to find enough experienced candidates to cover the new positions, especially in countries with low unemployment such as Sweden, where the jobs vacancy ratio in agriculture (1.5 %) and industry (2 %) are relatively high. This could be a social barrier for IBLCs that should work to improve the working conditions of the workers in the sector and make job opportunities more appealing for applicants.

Environmental Impacts: environmental impacts could be expected for the newly introduced process activities in the current plants and thereby the necessary distribution to markets. Due to lack of data, emissions couldn´t be calculated at this stage.

CASE5: Sugar Industry

Economic Impacts: Only for one scenario, where supply is imported from Denmark, 200 km at 14.7 €/km, transport costs could be computed to a total of €2 940 per year. Otherwise the case on production and distribution costs was lacking. In terms of potential revenues, some estimations could be done for the sale of succinic acid, where in a scenario of 9 900 tonnes per year, the potential revenues are 34 650 €/y. Increasing the quantity produced to 13 800 tonnes, the estimated revenues could further increase to 48 300 €/y (3.5 €/tonne).

Social Impacts: The use of beet pulp fibres to fabricate biocommodities for biopolymers for the bioplastic industry is a possible alternative for companies in the sugar sector in the future. This sector is clearly seasonal, being this reason one of the main barriers for employers to find candidates. An IBLC model would enable extending the activity beyond the sugar campaign to produce alternative products that are potentially very demanded due to the current environmental burden of fossil-based massive plastic usage. The integration of increasing number of women in the sector would also help mitigate the lack of job seekers in the sector.

Environmental Impacts: the data available is too limited to draw any significant conclusions in terms of environmental impacts. One shipment over a distance of 200 km for the supply would bring emissions of about 74.4 $KgCO_2eq$. considering a truck capacity of about 21 tonnes and a supply of 9 900 tonnes, the resulting emissions would be 35 105 $KgCO_2eq$.

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7 Annexes

ANNEX A: Fault Tree Analysis Risk of Soil fertility loss.

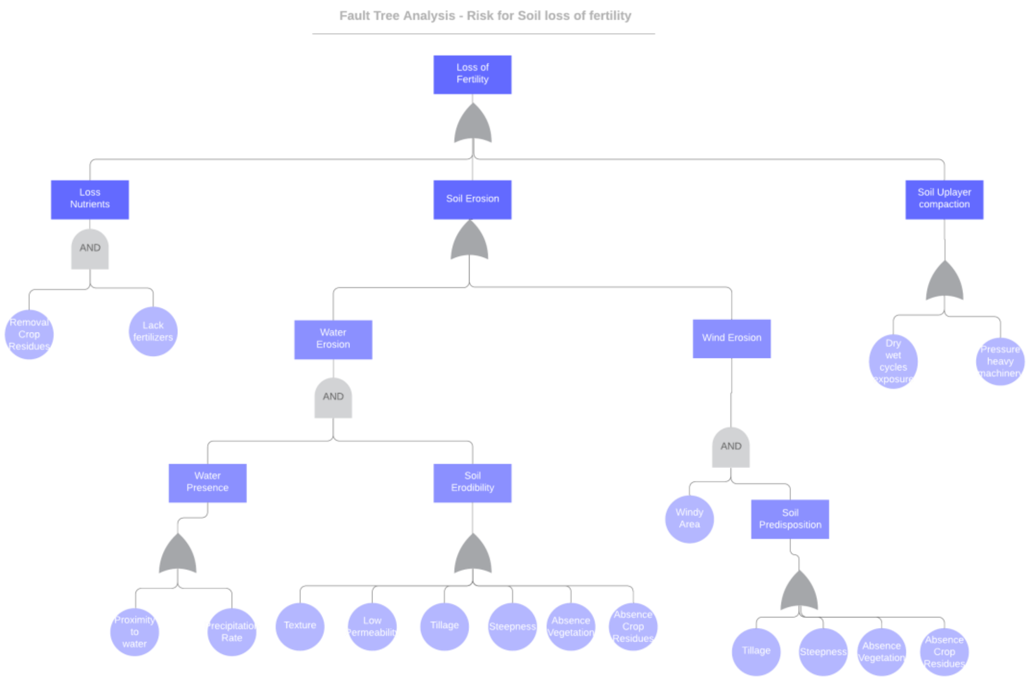

Figure 10 Fault Tree Analysis for the risk of Soil Loss of Fertility.