AGROinLOG

INTEGRATED BIOMASS LOGISTICS CENTRES FOR THE AGRO-INDUSTRY

Basic analysis of targeted agricultural sectors – Cover report

Project AGROinLOG "Demonstration of innovative integrated biomass logistics centres for the Agro-industry sector in Europe"
Grant agreement: 727961
From November 2016 to April 2020

Prepared by: Wageningen Food & Biobased Research (WFBR)

Date: 31/05/2018

DELIVERABLE FACTSHEET

Project start date:	November 2016
Project website:	www.agroinlog-h2020.eu
Deliverable number:	D6.2
Deliverable title:	Basic analysis of targeted agricultural sectors – Cover report
Lead Partner:	Wageningen Food & Biobased Research (WFBR)
Work Package no. and title:	6. Generic strategies for the development of future IBLCs
Task no. and title:	6.2 Basic analysis of targeted agricultural sectors
Version:	Final
Version Date:	31-5-2018

Diffusion list

Dissemination level	
X	PU = Public
	PP = Restricted to other programme participants (including the EC)
	RE = Restricted to a group specified by the consortium (including the EC)
	CO = Confidential, only for members of the consortium (including the EC)

Approvals

	Company
Author/s	WFBR, SPANISH CO-OPS, CERTH, RISE, Lantmännen, UCAB, UBFME and AESA
Task Leader	WFBR
WP Leader	WFBR
Reviewer	CIRCE

Documents history

Version	Date	Main modification	Entity
1	08/03/2018	First draft based on country reports	WFBR
2	10/04/2018	Second draft for review by partners	WFBR
3	16/05/2018	Third draft for final review by partners	All authors
4	22/05/2018	Final draft for review by CIRCE	All authors
Final	31/05/2018	Final version submitted	All authors

DISCLAIMER OF WARRANTIES

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 727961."

This document has been prepared by AGROinLOG project partners as an account of work carried out within the framework of the EC-GA contract no 727961.

Neither Project Coordinator, nor any signatory party of AGROinLOG Project Consortium Agreement, nor any person acting on behalf of any of them:

(a) makes any warranty or representation whatsoever, express or implied,
  - (i). with respect to the use of any information, apparatus, method, process, or similar item disclosed in this document, including merchantability and fitness for a particular purpose, or
  - (ii). that such use does not infringe on or interfere with privately owned rights, including any party's intellectual property, or
  - (iii). that this document is suitable to any particular user's circumstance; or

(b) assumes responsibility for any damages or other liability whatsoever (including any consequential damages, even if Project Coordinator or any representative of a signatory party of the AGROinLOG Project Consortium Agreement, has been advised of the possibility of such damages) resulting from your selection or use of this document or any information, apparatus, method, process, or similar item disclosed in this document.

Abbreviations

DM	Dry matter
FM	Fresh matter
GWh	gigawatt hour
Ha	hectare
IBLC	Integrated Biomass Logistic Centre
kt	kilotonne
kWh	kilowatt hour
Ml	million litres
Mt	million tonnes
OMWW	Olive Mill Waste Water
OOWW	Olive Oil Waste Water
R&D	Research and Development
t	tonne
TPOMW	Two-phase olive mill waste

Partners Short Names

CIRCE: Fundación CIRCE

WFBR: Wageningen Food & Biobased Research

ZLC: Fundación Zaragoza Logistics Centre

CERTH: Ethniko Kentro Erevnas Kai Technologikis Anaptyxis

RISE: RISE Research Institutes of Sweden AB

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

This report contains the results of the research into the potential and possibilities of establishing Integrated Biomass Logistics Centres (IBLCs) in a number of specific agricultural sectors and industries in Europe. The research was conducted within the framework of the AGROinLOG project, demonstration of innovative integrated biomass logistics centres for agro-industry sector in Europe, that is funded from the European Union's Horizon 2020 research and innovation programme. Part of the research and innovation project AGROinLOG concerns the development of generic strategies for the development of future IBCLs in the EU (Work Package 6).

This study contains an in depth-description of selected agro-industrial sectors in Greece, Serbia, Spain, Sweden and Ukraine and a review of the sectors' potential as basis for IBLC activities and benefits. In addition to the analysis for the mentioned countries, a broad review of the sectors for the EU-28 countries was conducted with the objective to inventory potential footholds in other EU countries as well.

The study is a follow-up of the report "Updated conceptual description of an Integrated Biomass Logistics Centre (IBLC)" (Annevelink et al., 2017). In the report the following sectors have been reviewed for the respective countries:

Table I. Sectors chosen to be addressed per country and one extra for EU.

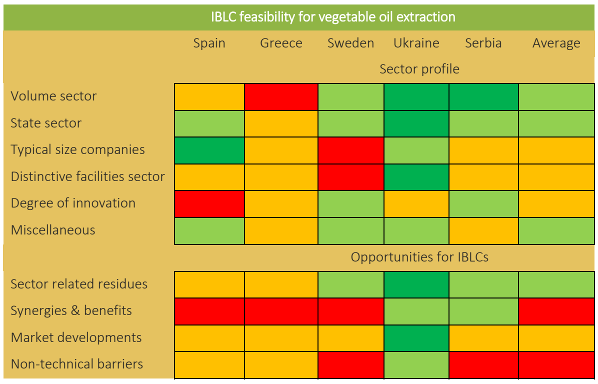
Chosen sectors per country						
Sector	Spain	Greece	Sweden	Ukraine	Serbia	Europe
1. Vegetable oil extraction	X	X	X	X	X	X
2. Olive oil chain	X	X	-	-	-	X
3. Feed and fodder	X	-	X	X	X	X
4. Wine sector (cellars & distilleries)	X	X	-	-	X	X
5. Grain chain (incl. straw until final product biofuel)	X	X	X	X	X	X
6. Sugar industry	-	X	X	X	X	X

Based on literature research, expert knowledge, inventory and analysis of data, and stakeholder interviews / feedback sessions (in Task 7.3), the report gives an accurate impression of the current potential and possibilities of establishing IBLCs in the investigated sectors and countries.

The result is the description and analysis of the 6 sectors / agro-industries that are of varying significance in each of the assessed countries. Given the fact that differences between countries are to be considered, the report contains in-depth analyses for the respective countries. These country reports are included as individual deliverables in Annex A of the report, and form the basis for the overall sector analyses in the main report.

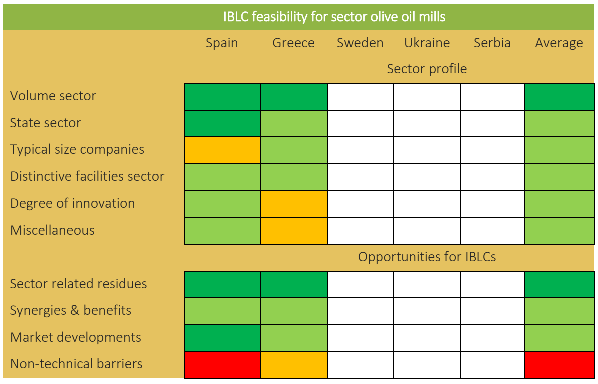
The researchers applied a so-called "traffic-light tool", which was developed to enable the evaluation of the quantitative and qualitative data in the report and to present the outcomes in a clear and concise manner. The following Table II provides an overview of the traffic light analysis for each of the 6 sectors, along with the main conclusions regarding the potential for establishing IBLCs (see section 2.1.6 for the legend of the colours).

Table II. Overview of sector traffic-lights and main conclusions



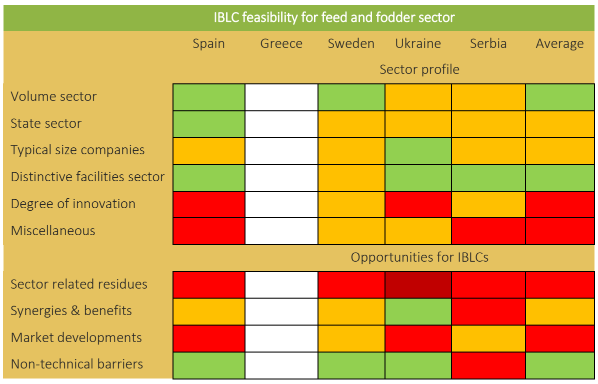
Vegetable oil

For all assessment categories the values for the vegetable oil extraction sector vary a lot between the countries. The analysis indicates that the vegetable oil extraction sector in general does not have many opportunities for establishing IBLCs. Although the sector has large volumes of residues, it only has a few synergies & benefits, only some market opportunities but rather uncertain and serious non-technical barriers with limited perspective to overcome.



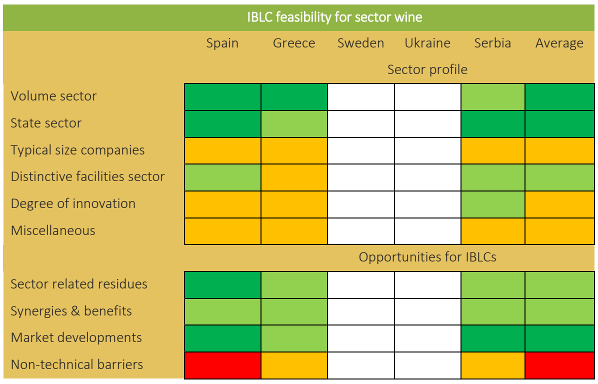
Olive oil mills

For all assessment categories the values for the olive oil mills sector vary only a bit between the two countries (Spain and Greece). The analysis indicates that the olive oil mills sector has many opportunities for establishing IBLCs since it has a very large volume of residues, many synergies & benefits and good market opportunities with promising perspective. The only problem is that there are serious non-technical barriers with limited perspective to overcome.



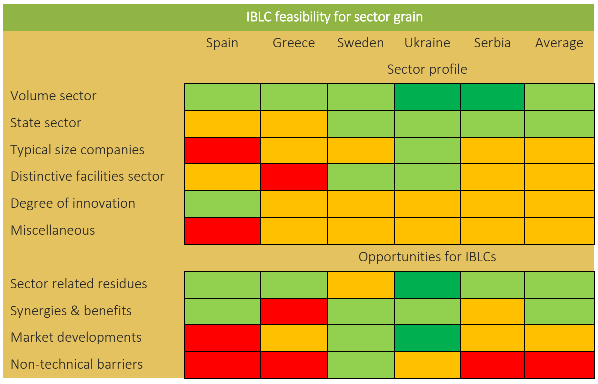
Feed & fodder

For all assessment categories the values for the feed and fodder sector vary between the four countries, but not very much. The assessment indicates that the feed and fodder sector has some but limited opportunities for establishing IBLCs, since it has only a low volume of residues (unless it uses residues from other sectors), some synergies & benefits and only a few good market opportunities that are rather uncertain. A positive point is that there are only small non-technical barriers that can be overcome.



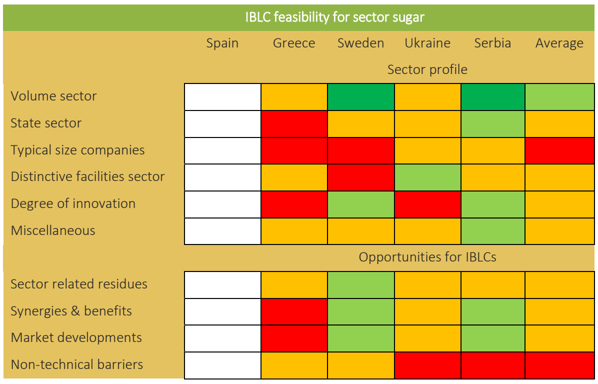
Wine

Although some of the major wine producing countries such as France and Italy are not included in the sector review, it is fair to state that the conclusions from this study apply to some extent to most of the wine producing countries in the EU. Based on the different aspects on which the sector's overall suitability has been inventoried and evaluated by the researchers, the wine sector is considered to have sufficient basis for further research into the feasibility of establishing IBLCs. Most importantly this will include research into feasible solutions to overcome the logistical bottleneck, as well as into the proposition of a market portfolio that will provide a balance between low – and high value added products from the IBLC.



Grain

Based on the sector analysis the grain sector does not seem to provide a convincing basis for the establishing of IBLCs. However, the analysis also showed that there are large differences between countries of the sector's suitability. The analysis of the grain sector in Ukraine and Sweden indicated a good basis for setting up IBLC activities both from production and market point of view, while the analysis of the grain sectors in Spain and Greece showed less favourable conditions. Given the fact that the grain sector is an important contributing sector in European (and global) agriculture, it is advisable to investigate the feasibility of establishing IBLCs in connection with the grain sector in those countries that have a sufficient starting point (amongst which the availability of feedstock and facilities, market perspective, business awareness, governmental support, etc.).



Sugar

In some European countries, the sugar industry is considered as one of the more innovating agro-industries in the field of bio-refinery and biobased products. The analysis of the sector that was done for 4 countries in this study shows, however, an outcome that the sector's suitability is characterised as medium to poor. An aspect that cannot be ignored is the recent change in the EU quota regime that has raised uncertainty within the sector of market prices and revenues within the sugar chain (for both sugar beet growers and processing industries). This may perhaps have changed once the transition to a market regime will be completed by the industries and their suppliers. But given its potential as an important European large scale agro-industry and its innovating potential in bio-refinery it is worthwhile to further investigate the feasibility of IBLCs in the sugar sector on a case-by-case basis.

TABLE OF CONTENTS

1 Introduction

AGROinLOG supports the demonstration of Integrated Biomass Logistic Centres (IBLC) for food and non-food products evaluating their technical, environmental and economic feasibility. For the European agribusiness (primary and processing sector), the occasion arises to benefit from their position in a sector that has a unique opportunity and potential to develop an infrastructure that enables the supply of biomass feedstock to a new and emerging bio-based industry (also including biofuels and bio-energy).

Deliverable 6.2 'Basic analysis of targeted agricultural sectors' of the AGROinLOG project studies several pre-identified priority agricultural sectors (per participant country and the overall EU-28) that are considered to have synergies for establishing an IBLC. The sectors include a first transformation of agrarian products being: vegetable oil extraction, olive oil chain, feed and fodder, wine sector (cellars & distilleries), grain chain (incl. straw until final product biofuel) and sugar industry.

The purpose of this study is to gain insight in the potential and possibilities to combine core production activities within the specific sectors with the processing of biomass and biomass residues as feedstock for bio-based industries. The sectors have been reviewed by consortium partners from Greece, Serbia, Spain, Sweden and Ukraine. The review included, amongst others, the availability of idle capacity for biomass handling and processing, and the availability of biomass residues.

This Deliverable 6.2 consists of a cover report and six country reports in the annex of this cover report. These annex reports contain five in-depth country studies for selected sectors that are especially relevant for these specific countries (Greece, Serbia, Spain, Sweden and Ukraine). The sixth annex report is a general sector review for all EU-28 countries.

2 METHOD

2.1.1 Introduction

The study was initiated by formulating clear and defined steps in order to converge the research efforts by each of the contributing research partners. This process was recorded in a set of workflow schemes (further elaborated in section 2.1.3) and agreed upon by the partners as blueprint for the study. For each participating country a number of sectors were described and analysed from the perspective of the potential implementation of the IBLC concept. The basic analysis of targeted agricultural sectors in Task 6.2 was organized by country at first and not by sector.

2.1.2 Responsible partners

For the three countries where the AGROinLOG project develops IBLC demo's the national partners (i.e. research partner and company demo partner) have operated as teams to research and elaborate on selected sectors that may qualify for developing an IBLC in these countries:

- Spain: CIRCE & Spanish Co-ops
- Greece:CERTH & INASO-PASEGES
- Sweden: RISE & LANTMÄNNEN

For the Ukraine and for Serbia the selected sectors were researched by UCAB and UBFME, respectively. The remaining EU-countries were the topic for a sector analysis by AESA. The overall co-ordination of this study was done by WFBR, who was also responsible for the drafting of the combined analysis report and for the review of the national and European analyses. The final review was performed by CIRCE.

2.1.3 Planning the work flow in Task 6.2

The first sub-process was the final selection of the sectors (a) that had to be described by the country teams. Then a decision was made on the common procedure and lay-out of the country reports (b). The main part of the work was the detailed analysis of the sectors per country (c) and the general sector review of the EU-28 countries (d). The results of (c) and (d) were then used as input in a combined analysis of the sectors' suitability/feasibility for the IBLC concept (e) which resulted in this cover report (f).

The main process flow chart of the whole Task 6.2 is given in Figure 1.

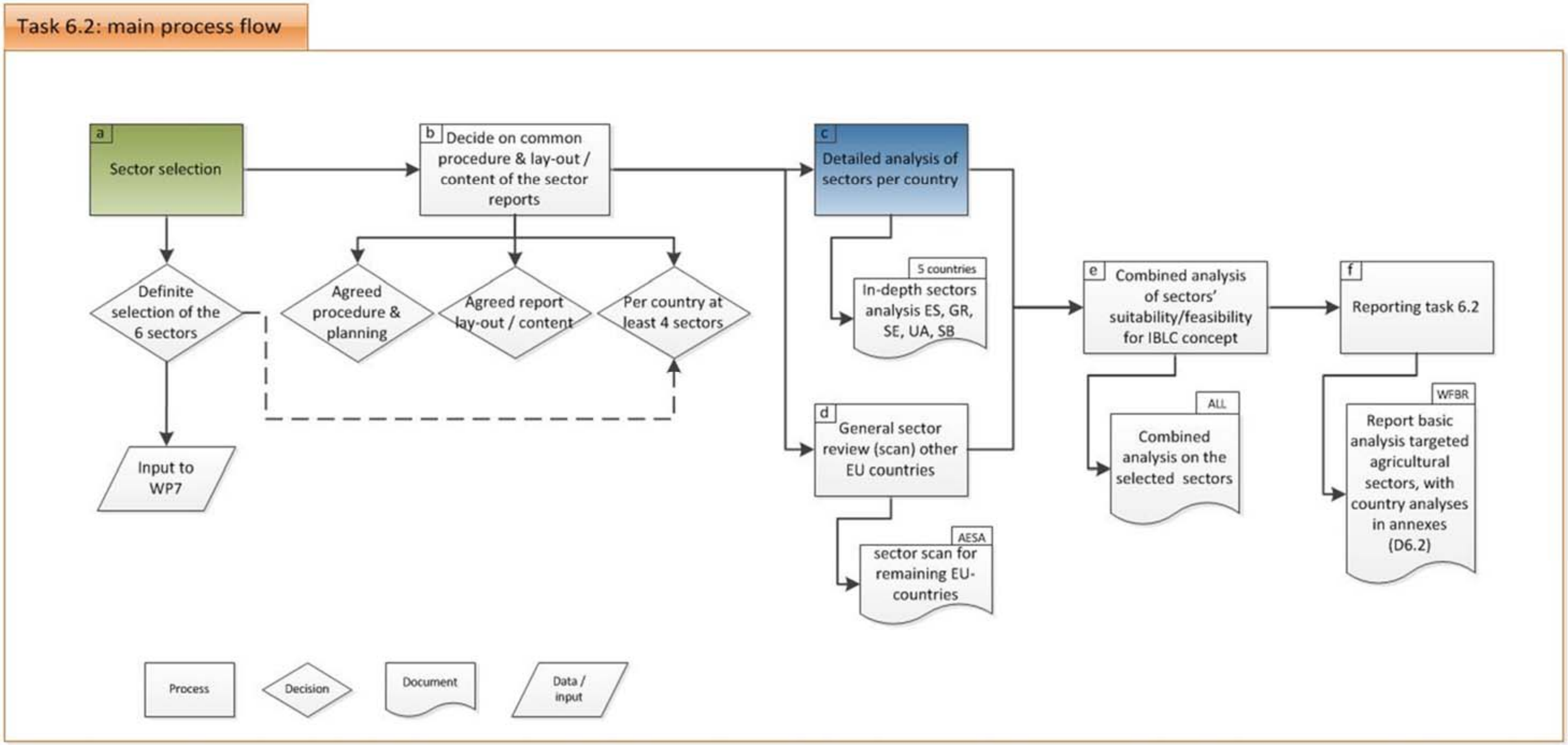


Figure 1. Main process flow chart of Task 6.2

The flow chart of the second part of Task 6.2 is given in Figure 2.

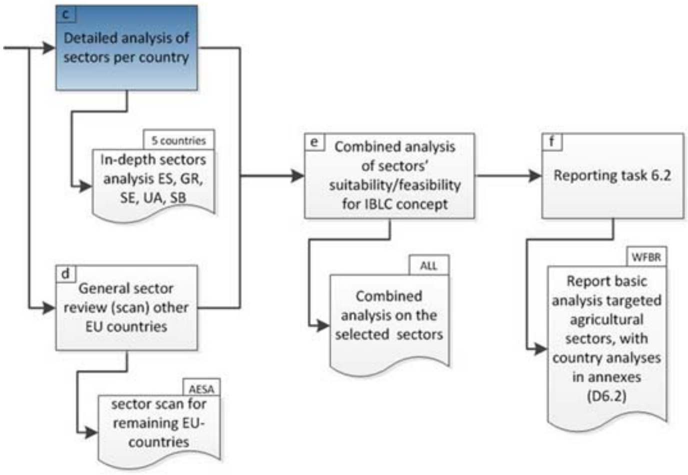


Figure 2. Process flow chart of second part of Task 6.2

Finally, the procedure for the detailed analysis per country (sub-process c) is given in Figure 3.

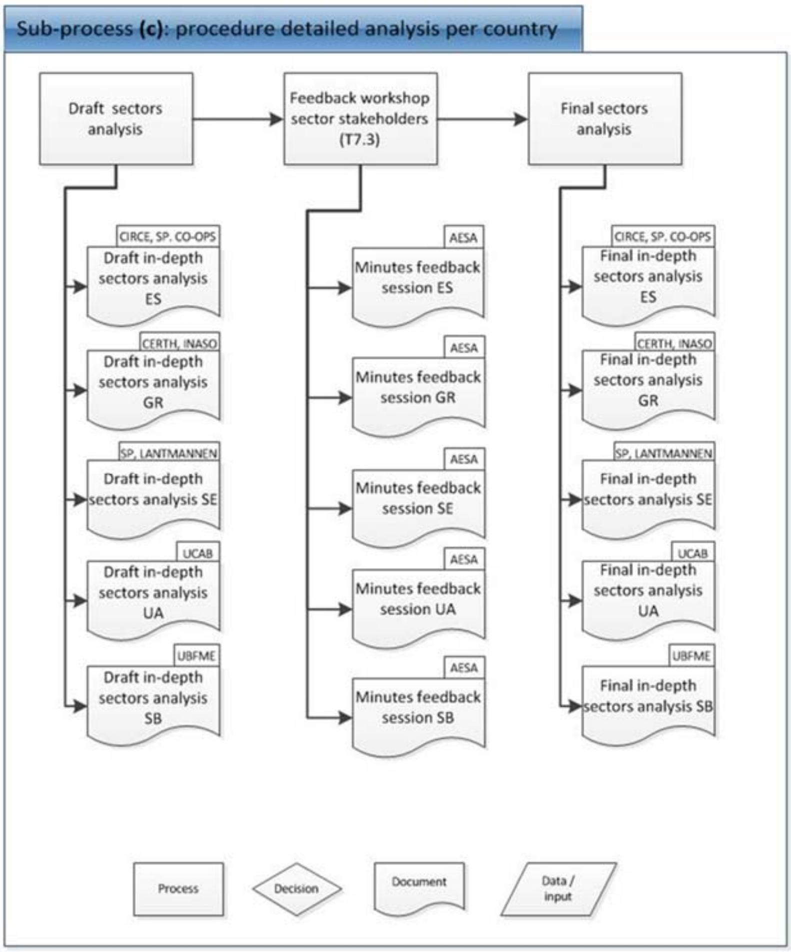


Figure 3. Process flow chart of detailed analysis per country.

2.1.4 Selection of the sectors

First a selection was made of the sectors that were going to be analysed. The food processing industry (with their residues) could also have a potential for establishing an IBLC. However, it was decided that this will not be studied by the individual countries, but that this would be addressed by AESA in the general sector review of the European countries. Given the scope of the research looking more at the primary agricultural sectors, the food processing industry was not studied in great depth.

The input from the partners resulted in the selection of six sectors for the in-depth sector analysis per country (see Table 1).

Table 1. Sectors chosen to be addressed per country and one extra for EU.

Chosen sectors per country						
Sector	Spain	Greece	Sweden	Ukraine	Serbia	Europe
1. Vegetable oil extraction	X	X	X	X	X	X
2. Olive oil chain	X	X	-	-	-	X
3. Feed and fodder	X	-	X	X	X	X
4. Wine sector (cellars & distilleries)	X	X	-	-	X	X
5. Grain chain (incl. straw until final product biofuel)	X	X	X	X	X	X
6. Sugar industry	-	X	X	X	X	X
7. Food processing industry	-	-	-	-	-	X

2.1.5 Country reports describing relevant sectors

In the country reports, the emphasis was put on the profile of the sector and the opportunities for an IBLC. The profile of the sector was described by addressing the following categories:

- Production - a brief impression of the steps/phases in the current production chain;
- Volume of sector - what is the overall size of the sector? Will it be large enough to play a role in the development of future IBLCs?
- State of sector - is the sector economically strong enough (capable) to invest in future IBLCs?
- Typical size of companies - are there enough companies of a certain size that could develop an IBLC? (please note that it is not always clear yet what that optimal size will be because that is part of the further research)
- Distinctive facilities of the sector - are there facilities that possibly have idle time and could be used for other (biobased) purposes and/or are there facilities that could be easily combined with new facilities for biobased purposes?
- Degree of innovation - does the sector have a history of looking at and investing in innovations, so that they will also be interested in developing an IBLC?
- Miscellaneous – description of various other items that could influence the development of future IBLCs in the sector

The opportunities for establishing an IBLC were described by the following categories:

- Availability of sector related residues - what residues from the sector could be available for processing in future IBLCs?
- Potential synergies & benefits - what synergies & benefits do we and/or the sector see for establishing future IBLCs in the sector?
- Market developments - does the sector already have any ideas about entering new markets for their residues?
- Non-technical barriers - what other non-technical aspects influence the establishment of future IBLCs in this sector?

Complementing remarks and suggestions for extra topics (underlined) in the country reports were:

- From the project Sucellog it was learned that <u>market barriers</u> were experienced as the most important factor in the process of establishing successful business cases for the processing of biomass residues to supply the bio-energy market (Sucellog, 2017).
- Similar reasons apply to <u>legal barriers</u>.
- <u>Technical barriers</u> can also be an important aspect. E.g. in the Sucellog project the quality of the agropellets gave unexpected problems in relation to the availability of suitable boilers.
- The contribution of biomass residues in the ecological cycle is also an aspect to be taken into consideration as specific topic of <u>sustainability</u>.
- A brief <u>reference to the current technologies used</u> in the respective sectors.
- Previous <u>experience with biomass handling</u> in the sector.
- The perspective from biomass residues only is rather narrow. It was therefore suggested to choose a somewhat altered approach for the IBLC concept by focusing on both <u>primary and secondary feedstock</u>.

The analysis was made, based on databases, available literature sources and input from local stakeholders through bilateral contacts. Draft versions of the country reports were reviewed and commented by WFBR. During the research and reporting process, two consultation rounds with stakeholders have taken place (in Task 7.3):

1. consultation for data collection when writing the draft report, and
2. consultation to validate the information in the final draft report.

The consultations were done by the country teams. The details about the consulted stakeholders can be found in the various country reports in Annex 6.2.1 until 6.2.6. The interviews were used to validate the information that was written in the country reports, specifically the qualitative data (e.g. the future of the sector, market opportunities). This kind of information gained value because it was cross-checked with sector stakeholders. Therefore, the final draft (95 % ready) was submitted to a selected number of stakeholders per country. Their comments have been processed in the final country reports. The final country reports and the European review report are included in the annex to this cover report (see the list in Annex A).

2.1.6 Combined analysis

The combined analysis report serves as a cover-report for the country reports. The combined analysis contains a high-level analysis of the different sectors concerning the possibility/feasibility of applying IBLC-like concepts in these sectors.

In this cover report, first of all, a general profile description of the sector is given based on the country reports. The sector review contains a map (when available), which shows the geographic importance of the respective sector in the European countries. A standardized flow diagram of the sector's supply chain processes was developed by using the standardised IEA Bioenergy Task 42 methodology for process mapping (see an example in Figure 4).

The summary tables of the various sectors in the individual country reports were an important starting point for the combined analysis. Per sector, the results of the analyses in the various countries were combined into an overall sector analysis summary.

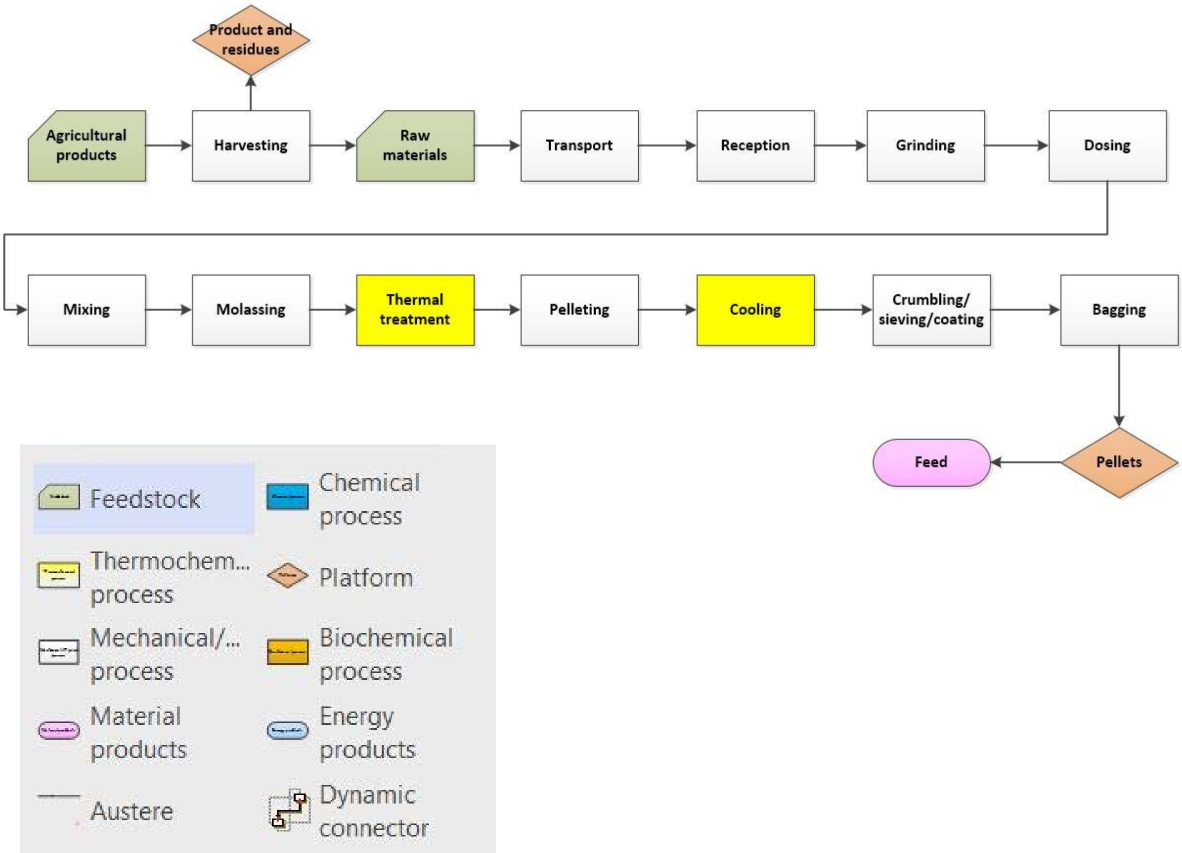


Figure 4. Example of a process flow diagram of the feed sector.

Finally, for each sector an indication for IBLC potential/feasibility is presented by means of a traffic light analysis (see example in Table 2). In this traffic light, the colour-spectrum from light green to dark red (see explanation of the colours in Table 3) presents this feasibility and enables the reader to get a quick overview of the sectors' possibilities. The scores were first filled in for the individual countries and then an 'average' was determined. This is of course a very rough estimate and therefor the traffic light analysis can only be used to get a quick general impression of the IBLC potential of a sector, and not to give a final verdict on the feasibility. For that purpose, the specific details of a certain case will always have to be studied in much more detail.

Table 2. Example traffic light analysis for the vegetable oil extraction sector.

IBLC feasibility for vegetable oil extraction						
	Spain	Greece	Sweden	Ukraine	Serbia	Average
Volume sector						
State sector						
Typical size companies						
Distinctive facilities sector						
Degree of innovation						
Miscellaneous						
	Opportunities for IBLCs					
Sector related residues						
Synergies & benefits						
Market developments						
Non-technical barriers						

Table 3. Explanation colour traffic lights.

Category - Assumption of the influence on establishing IBLCs					
Volume of the sector - A larger sector has more possibilities for setting up an IBLC	Very large sector	Large sector	Medium sector	Small sector	Very small sector
State of the sector – An economically healthy sector has more opportunities to build IBLCs	Very healthy sector	Healthy sector	Medium healthy sector	Unhealthy sector	Very unhealthy sector
Typical size of the companies – The number of companies with a suitable size determines the number of IBLCS that can be developed. The suitable size depends on the sector of course, but on the average one can assume that medium sized and larger companies will have more opportunities.	Very many suitably sized companies	Many suitably sized companies	Some suitably sized companies	Few suitably sized companies	No suitably sized companies
Distinctive facilities of the sector – If there are more facilities that can be shared then there are more opportunities to set up an IBLC	Almost all of the facilities to be shared (more than 5)	Many facilities to be shared (4-5)	Only a few facilities to be shared (2-3)	Only one facility to be shared (1)	No facilities to be shared
Degree of innovation – If a sector is more innovative it will be more likely to invest in innovative IBLCs	Very high innovation level	High innovation level	Medium innovation level	Low innovation level	Very low innovation level

Miscellaneous – Presence of other factors that might stimulate the choice for setting up an IBLC	Very many stimulating factors	Many stimulating factors	Some stimulating factors	Only few stimulating factors	No stimulating factors
Sector related residues – If the sector itself has residues this will stimulate setting up IBLCs	Very large volume of residues in sector	Large volume of residues in sector	Medium volume of residues in sector	Low volume of residues in sector	Very low volume of residues in sector
Potential synergies & benefits – If the sector sees synergies & benefits then this will stimulate setting up IBLCs	Very many synergies & benefits	Many synergies & benefits	Some synergies & benefits	Few synergies & benefits	No synergies & benefits
Market developments – If there are promising local (national) market opportunities for biomass/biocommodities then there are more opportunities for setting up IBLCs	Excellent market opportunities with promising perspective	Good market opportunities with promising perspective	Some good market opportunities but rather uncertain	Few good market opportunities and rather uncertain	No market opportunities at all
Non-technical barriers – These will hinder setting up IBLCs	No or minor barriers	Some small barriers that can be overcome	Barriers that require serious attention but can be overcome	Serious barriers with limited perspective to overcome	Serious barriers and no possibility to overcome

3 COMBINED ANALYSIS

3.1.1 Vegetable oil extraction

Vegetable oil can be extracted from several crops such as sunflower (Figure 5), rape, corn, soybean, peanut, etc. Small variations from the overall oil seed extraction process (see Figure 6) can be expected depending of the used raw material. After the reception of the seeds, the seeds are dried and conditioned for a better preservation during storage in the silos. The drying of the seeds is commonly done in vertical dryers. Compared with the rotary horizontal ones, these dryers are less suitable for the drying of biomass, as not so many biomass formats are compatible with these dryers (only granulate material but no straw and chips). At the time of performing the extraction, the husks are removed (shelling) to improve protein content in the final products and then the seeds are pressed to obtain the crude oil (NOTE: in Spain the process of separation of the husks is not a common practice and is done by only one vegetable oil extraction industry; see Annex D6.2.1). In this process (pressing), the cake is generated and subjected to solvent extraction (usually with hexane, which is later recovered) producing dry cake and miscellany (oil with solvent). From the distillation of this miscellany crude oil is obtained (that must be later refined to be suitable for consumption). In addition, after solvent removal of the dry cake, it is later dried and cooled for flour obtaining.

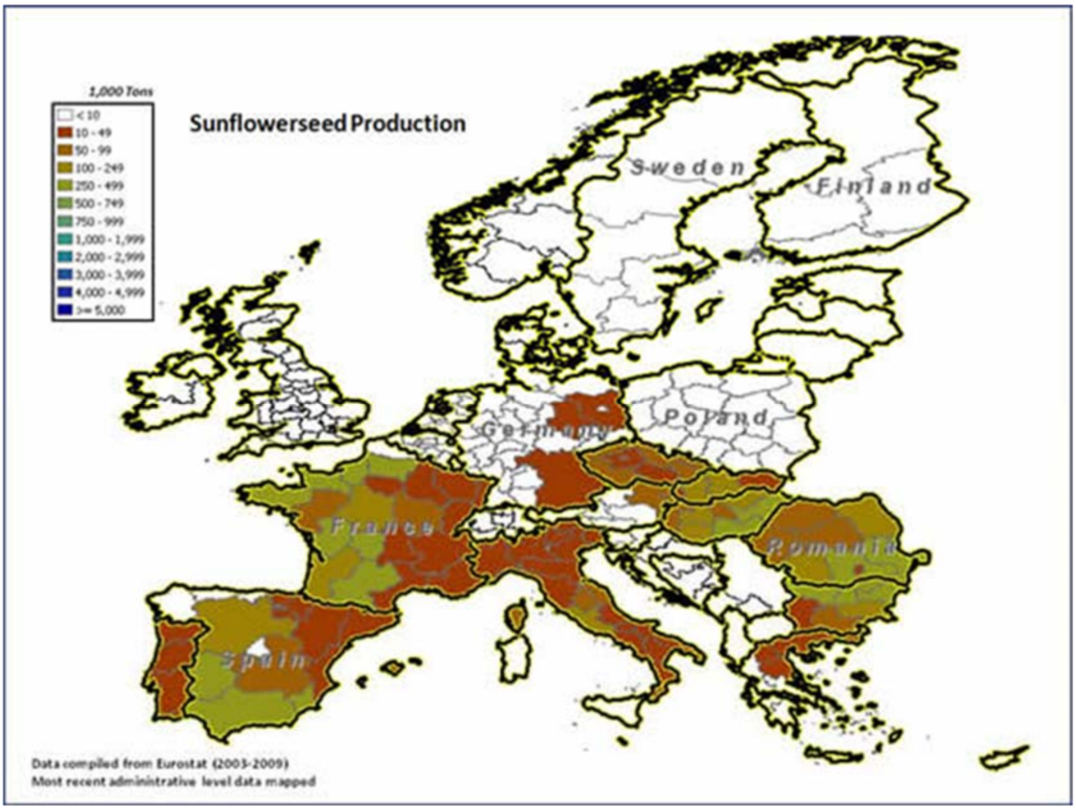


Figure 5. Sunflower production in Europe (source: USDA World Agricultural Production).

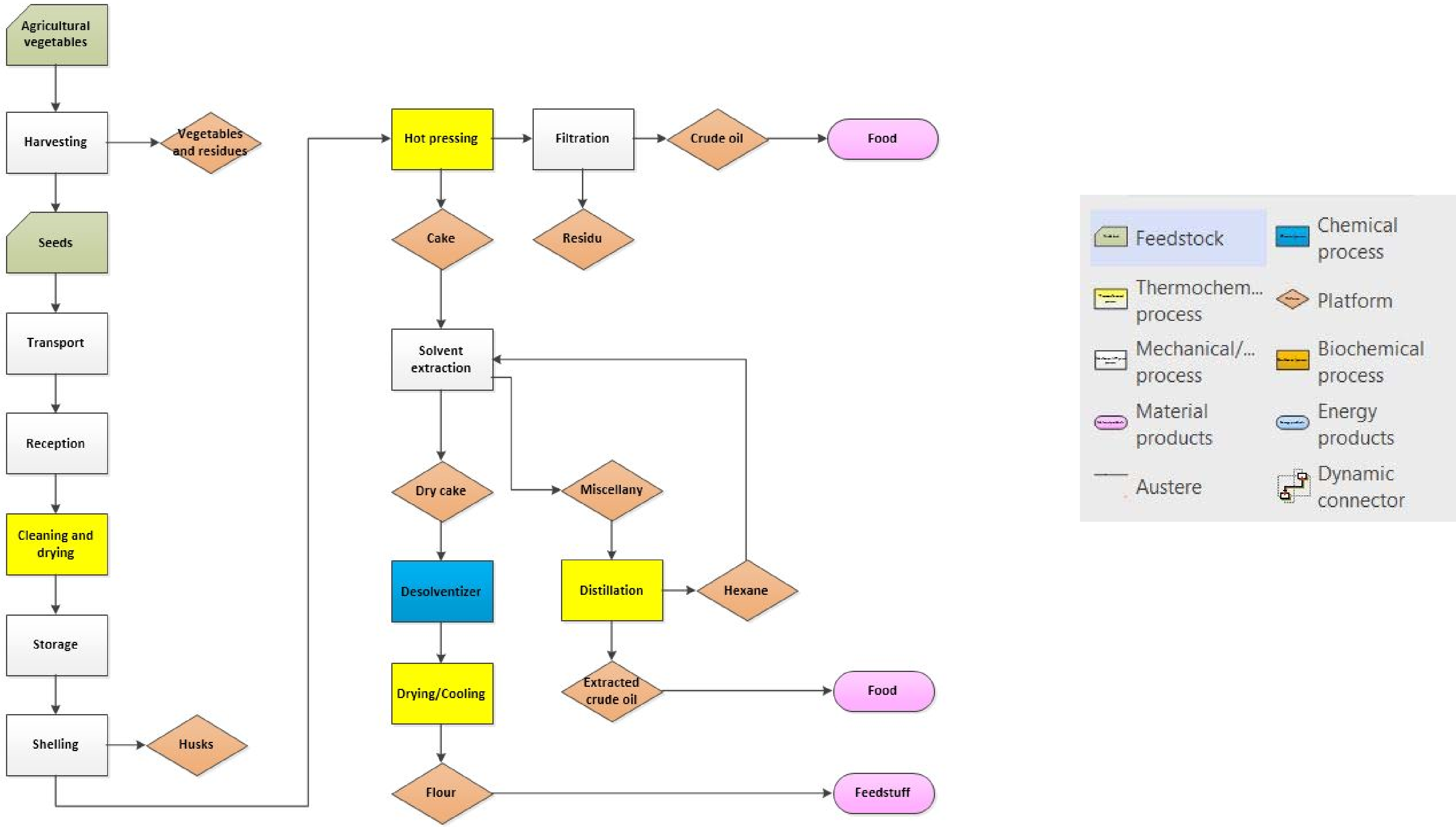


Figure 6. Process flow diagram of the vegetable oil extraction sector

Table 4 provides a cross-country analysis for the vegetable oil extraction sector in view of its potential for integration with IBLC concepts.

Table 4. Summary vegetable oil extraction sector.

<table>
<tr><th colspan="2">Sector vegetable oil extraction</th></tr>
<tr><th></th><th>Profile</th></tr>
<tr><td>Production</td><td>Seed crops are cottonseeds, soybeans, sunflower seeds and rapeseed.
The main primary residues during the crop production are stems and leaves
Products are vegetable oil, fat and seeds.
Secondary residues are seed husks and press cake.</td></tr>
<tr><td>Volume of the sector</td><td>Cultivated area in 2015:
Spain 0.80 million ha
Greece 0.11 million ha
Sweden 0.10 million ha
Ukraine 0.33 million ha
Serbia 0.33 million ha
Other important countries are France (2.27 million ha), Poland (0.99 million ha) and Hungary (0.93 million ha)
EU 11.5 million ha
Volume vegetable oil production 2016:
Spain 1,112 kt
Greece 136 kt
Sweden 136 kt
Ukraine 5,200 kt
Serbia 1,200 kt
EU 34,000 kt
Number of large scale vegetable oil extraction industries:
Spain 18
Greece 3
Sweden 1
Ukraine 15
Serbia 6
EU 180</td></tr>
<tr><td>State of the sector</td><td>Average yields of sunflower have been fluctuating in the recent years. Sunflower yields have seen a sharp rise since 2015 (in Ukraine and Serbia).
Soybean and rapeseed yields have been steadily increasing (in Ukraine and Serbia).
Rapeseed crops in Sweden are in a sharp rise.</td></tr>
</table>

	• In several countries vegetable oil extraction industry has a high profitability (e.g. in Sweden). • It is considered to be a stable sector in Greece for the last three years. • The sector is stimulated in the EU by biodiesel and renewable energy demand.
Typical size of the companies	• Size of the vegetable oil companies strongly varies between EU-countries: o For Spain the estimated production per vegetable oil industry and year is between 43 and 62 kt, generating an income of between 45 and 67 million euros. o A Greek company that produces cottonseed oil has an annual production of 2,000 tonnes. A typical vegetable oil company can operate 300-400 tonnes of seeds/day. o In Sweden AAK (the only industry) had an economic turnover of approximately 650,000 euros in 2016 (including imported seeds). o In the Ukraine the processing industries are primarily large companies. • In Spain most vegetable oil industries have a high investing capacity.
Distinctive facilities of the sector	• In some countries no idle equipment (Sweden) is available and in some other countries the industry still has available idle capacity (Spain, Serbia). • Facilities that could be shared are: workforce, logistical network, separators, storage (silos), centrifuges, storage facilities and crushers. • Vertical driers are suitable for granulate biomass only. • Vegetable oil industry in Serbia has a large experience with sunflower husks utilization. • Possibilities for IBLCs implementation exist e.g. in Serbia.
Degree of innovation	• In Spain there is no significant interest about innovation. However, high and unstable prices of olive oil have created an opportunity of growth that has to be exploited through innovation. • The vegetable oil extraction units use a simple technology, compared to pomace mills. No special R&D activities are performed on the vegetable oil sector in Greece. • The rapeseed oil and rapeseed meal industry is a mature industry in Sweden. • In comparison to other sectors analysed in this report, the vegetable oil sector in the Ukraine and Serbia may be considered as the most innovative.

Miscellaneous	• The vegetable oils are an agricultural product that is chemically most similar to mineral oils and therefore have a great potential as biological raw materials to replace the mineral oils in industries such as for biomaterials and chemicals. • The sector already has experience of handling biomass, mostly in form of producing solid biofuel – pellets – from sunflower husk for bioenergy. • Opportunities exist for the production of biocommodities.
	Opportunities for IBLCs
Sector related residues	• The main residues types are straw of crops, seed husks and oil waste. • Residues are currently used as animal feed or energy pellets. • When not used for animal feeding seed husks can be used for bio-energy production as well as for the extraction of waxes and phenolic compounds.
Potential synergies & benefits	• It is year-round production so vegetable oil extractors in Spain and Sweden do not have any idle period. • Some countries have no great opportunities for an IBLC (e.g. Sweden). • Although variating from year to year some countries have a capacity surplus that offers opportunities for IBLCs. (e.g. 40 % for the industry in the Ukraine, and in Serbian in soybean processing industry up to 70 %).
Market developments	• New markets can be attained (bio-energy and bio-commodities) through the processing of the own agro-industry residues and from the crop ones. • The absence of idle periods and the high investments consequently expected due to the lack of compatible equipment with the processing of biomass constitute important barriers to face at the time of implementing an IBLC. • There are research projects in Sweden investigating rapeseed straw used as raw materials in the manufacturing of renewable plastic materials and to convert the press-cake from rapeseed to human food. • The vegetable oil sector is in good shape in the Ukraine and Serbia. The market for sunflower oil, and respectively for sunflower seed, is likely to continue to grow in the future.
Non-technical barriers	• Lack of equipment compatible with biomass management in Spain demands higher investments (financial barrier). • Authorities in Spain allow burning practices (regulatory barrier), stimulating farmers to keep doing so (knowledge and awareness barriers).

- The vegetable oil sector in Spain is not properly mechanised to undertake the collection and processing of biomass (organisational barrier).
- Current low prices for fossil fuels (market barrier) and ease of use when compared with biomass (organisational barrier).
- Low acceptability of consumers and citizens.
- The attitude of the Swedish industry is that they are not interested in becoming a supplier of biocommodities.
- When generating energy by burning sunflower biomass (e.g. pellets) one should consider the emissions issue.
- Small farms in Serbia with insufficiently high capital reserves and with relatively small capacities for operation according to modern standards.
- Variability of prices in Serbia, especially for farmers since they have fewer possibilities to manage risk.
- Uncertainty related to agricultural policy measures in Serbia which support the production of oil crops.
- Transport problems for biomass delivery in Serbia - bad road infrastructure, bad conditions in railway sector and insufficient use of river transport.

Table 5. Traffic light analysis for the vegetable oil extraction sector.

IBLC feasibility for vegetable oil extraction						
	Spain	Greece	Sweden	Ukraine	Serbia	Average
	Sector profile					
Volume sector						
State sector						
Typical size companies						
Distinctive facilities sector						
Degree of innovation						
Miscellaneous						
	Opportunities for IBLCs					
Sector related residues						
Synergies & benefits						
Market developments						
Non-technical barriers						

Table 5 presents the traffic light analysis expressing the suitability of the vegetable oil extraction sector for establishing an IBLC, either as contributor of (sector related) agro-residues and/or of capacities for processing biomass. Based on the traffic light analysis the following observations were summarised:

- In Greece and Sweden the volume of the sector is small (both 136 kt vegetable oil production in 2016), in Spain and Serbia medium (1,112 kt and 1,200 kt) and in Ukraine it is very large (5,200 kt). So there is much difference between the studied countries but on the average the volume is large.
- The state of the sector ranges from very healthy (Ukraine and Serbia) and healthy (Spain and Sweden) to medium healthy (Greece). Remember that many of the judgments in the traffic light analysis (e.g. healthy/unhealthy) are qualitative and thus no exact figures can be given here. On the average the vegetable oil extraction sector is generally considered to be healthy, which is positive for investing in IBLCs.
- The typical size of the companies in the vegetable oil extraction sector also varies between the countries. A considerable amount of suitably sized companies (for an IBLC) can be found in Spain, as well as in Ukraine. Two countries only have some suitably sized companies (Greece and Serbia). Finally, Sweden has only few suitably sized companies. On the average some suitably sized can be found per country, which could invest in an IBLC.
- Only in the Ukraine almost all of the distinctive facilities can be shared. In three of the countries only few facilities can be shared (Spain, Greece and Serbia). And in Sweden only one facility can be shared. On the average only a few facilities can be shared, which is less favourable for establishing an IBLC, because it means that some of the needed equipment will have to be bought new.
- The degree of innovation varies from high in Sweden and Serbia to low in Spain. Greece and the Ukraine have a medium innovation level. On the average there is a medium level of innovation in the sector, which should be sufficient to at least consider IBLCs.
- Three countries have many stimulating miscellaneous factors (Spain, Sweden and the Ukraine) and two have some (Greece & Serbia). A stimulating fact is e.g. experience of handling biomass, mostly in form of producing solid biofuel – pellets – from sunflower husks for bioenergy. So on the average there are many stimulating miscellaneous factors, which is again favourable for the establishment of IBLCs.
- Some countries have more residues than others. In the Ukraine a very large volume of residues is available in the sector. The sector in Sweden and Serbia has a large volume of residues and in Spain and Greece only a medium volume of residues from the sector exist. On the average there are large volumes of residues (like straw of crops, seed husks and oil waste) in the sector that could potentially be processed at an IBLC.
- Unfortunately, only few synergies and benefits can be found in the sector in Spain, Greece and Sweden because there is a year-round production and thus no idle time occurs. On the other hand, many synergies and benefits can be found in the Ukraine and Serbia because there is a surplus of processing capacity. So on the average only few synergies and benefits can be found, but some countries have more opportunities than others.

- Most countries have some good market opportunities but they are rather uncertain, which is then also considered to be the average. Only the Ukraine has good market opportunities with promising perspective.
- In two countries (Sweden and Serbia) serious non-technical barriers with limited perspective to overcome are present (e.g. the industry does not seem to be interested in IBLCs in Sweden). In two others (Spain and Greece) non-technical barriers exist that require serious attention but can be overcome (e.g. a lack of equipment to collect the biomass). And only in Ukraine some small non-technical barriers exist that can be overcome. On the average the sector has serious non-technical barriers with limited perspective to overcome, which could constitute a major problem when implementing IBLCs.

General conclusions: For all assessment categories the values for the vegetable oil extraction sector vary significantly a lot between the countries. The analysis indicates that the vegetable oil extraction sector in general only has limited opportunities for establishing IBLCs. Although the sector has large volumes of residues, it only has a few synergies & benefits, only some market opportunities, but rather uncertain and serious non-technical barriers with limited perspective to overcome.

3.1.2 Olive oil mills

After the harvest, the olives (see Figure 7 for production areas) are transported to the olive oil mill where oil is produced by cold or hot pressing of the olive fruit. The mills carry out the first phase of olive oil production, which is then either directly available for consumption in bulk or promoted to commercial enterprises for resale, or it is supplied to processing and/or standardization companies.

In general, there are three main types of olive oil mills depending on the production process:

- traditional olive mills, where hydraulic presses are used;
- three-phase centrifugal mills, where the extraction process produces olive oil, pomace and olive mill waste water (OMWW); and
- two-phase centrifugal mills, which are the most advanced, producing olive oil and wet pomace.

Between the two types of centrifugal extraction, two-phase mills are both more productive (in terms of the amount of extracted olive oil) and more environmentally friendly. The main difference is that they require less water during the extraction process, leading to lower energy costs, less water waste during the process and a higher extraction rate of olive oil (output/input ratio). Analytically, the whole process of olive oil production is generally the following (see Figure 8):

- Receiving the fruit: After harvest, the olives are transported to the mill, where they are temporarily stored until they are processed.
- Defoliation – Washing: Placement in a picking hopper of olives, transport by conveyor or endless screw to a leaf removal, where leaves and other foreign bodies are removed and then washed to remove other impurities.
- Crack-milling of olives: Extrusion of the fruit and formation of olive oil (or olive paste).
- Malaxation: the olive oil is blended in softeners to achieve the merging of the oil traps into larger drops of oil.
- Extraction of olive oil: In the traditional process (hydraulic press), a liquid/water mixture is first extracted, which is separated in a subsequent phase by centrifugation to obtain the olive oil. As explained before, there are three possible ways:
    - Three-phase centrifugation: In this step a significantly amount of hot water is used to wash the oil. Separation of solid residue (olive cake) from the other two liquid phases is done in the decanter.
    - Vertical Centrifugation: The final separation of olive oil from the vegetation water.
    - Two-phase centrifugation: Same process as in three-phase centrifugation but the horizontal centrifugation is performed without the addition of water. Two output streams as it separates olive oil from solid phase (TPOMW- wet olive cake).

The olive mill wastes are sent to pomace mills where further processing occurs for retrieving edible pomace oil. Pomace mills are necessary steps in the olive oil value chain. They use as raw material the crude olive cake produced from the olive mills, dry it and extract the residual oil (usually using chemical solvents, such as hexane), known as pomace oil. Moreover, they produce one or more solid biofuels originated from the stone, flesh and skin of the olive fruit (along with some small quantity of residual oil). Depending on the process adopted, they can produce olive stones (mostly the pit part of the olive fruit), exhausted olive cake (mostly the flesh part of the olive fruit) or "combined" fractions.

Concerning the pomace oil mills, there are two main stages of pomace oil production:

- Drying process: During the drying process, the olive pomace is propelled into large cylindrical dryers, heated and rotated. With this procedure the large amount of water is reduced and the oil is easier to be separated.
- Extraction process: pure hexane (C_6H_{14}) is used for the extraction process of the olive pomace, which literally "rinses" the oil from it. The oil-hexane mixture is then propelled into special distillation tanks where the two components are completely separated. After this stage the pomace oil is ready for storage.

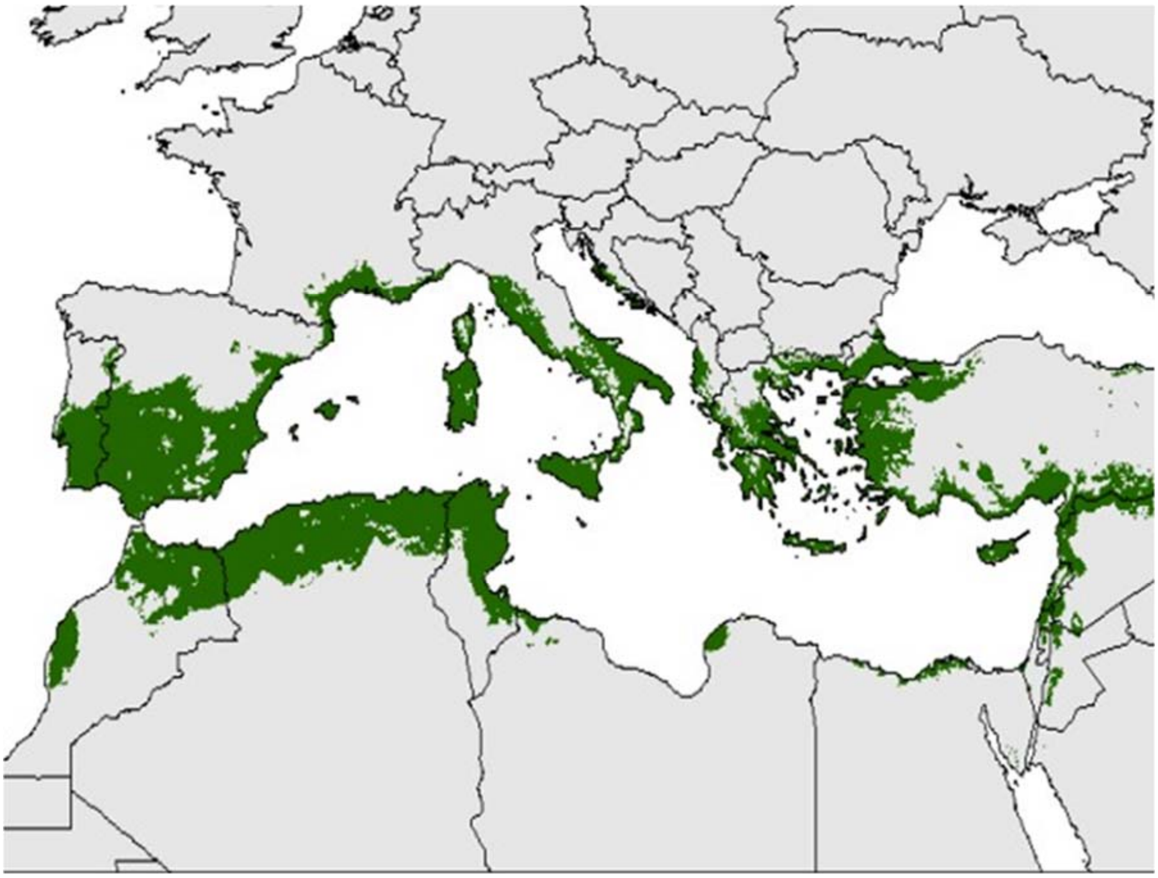


Figure 7. Distribution areas of Olea europaea (Source: J. Oteros, Phd thesis, University of Cordoba - Spain, 2014).

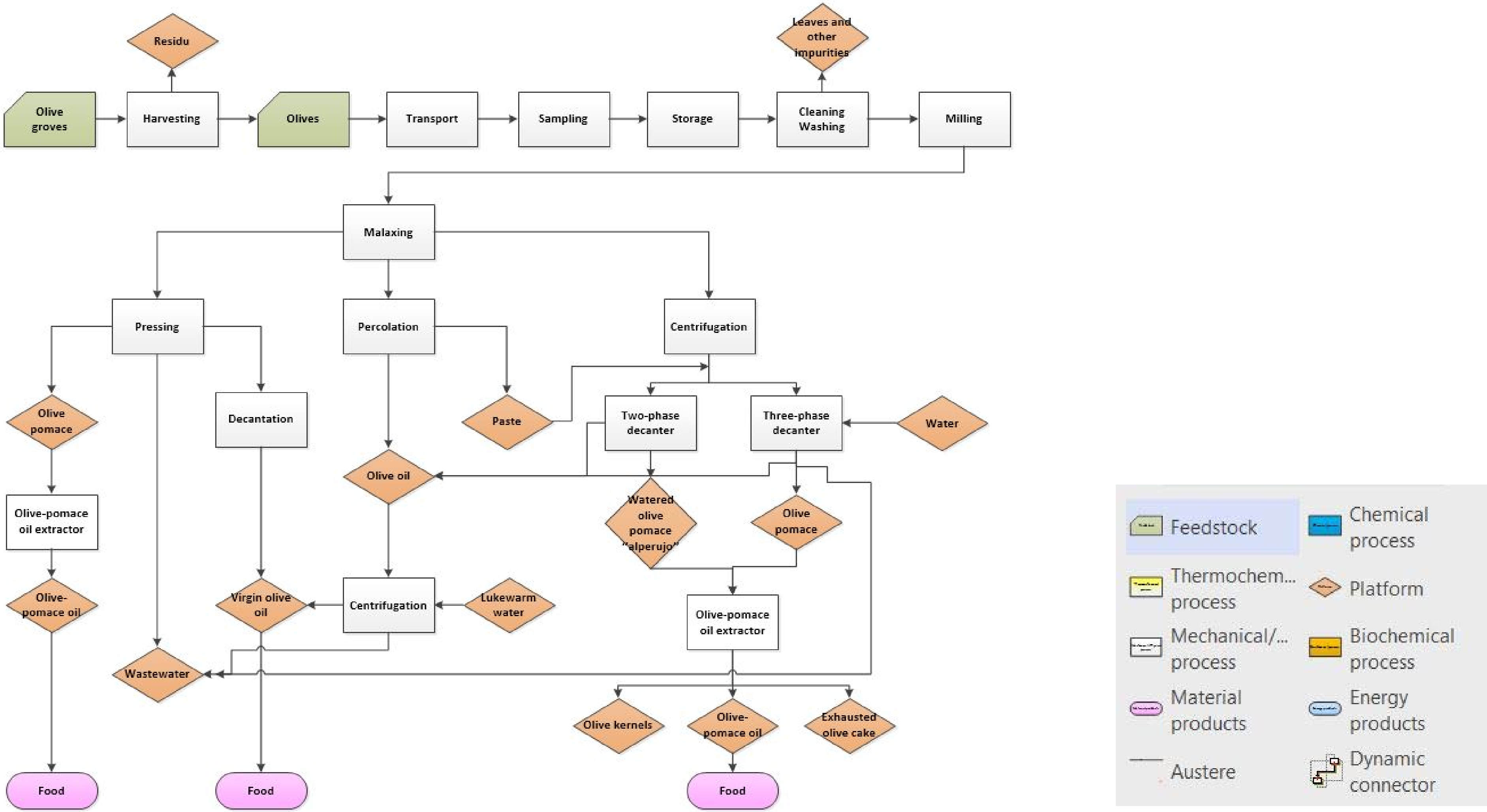


Figure 8. Process flow diagram of the olive oil mills sector

Table 6 provides a cross-country analysis for the olive oil mills sector in view of its potential for integration with IBLC concepts.

Table 6. Summary olive oil mills sector.

<table>
<tr><th colspan="2">Sector olive oil mills</th></tr>
<tr><th></th><th>Profile</th></tr>
<tr><td>Production</td><td>Crop: Olives
Crop production residues: prunings
Products: olive oil
Industry processing residues: leaves, TPOMW, exhausted olive pomace, olive stones and wastewater
Two main types of olive oil mills:
two-phase centrifugal mills and
three-phase centrifugal mills
Olive mills’ residues (pomace) are sent to pomace mills for pomace oil extraction and other by-products.</td></tr>
<tr><td>Volume of the sector</td><td>More than 5.0 million hectares (70 % of the world production) is concentrated in the Mediterranean area.
Cultivated area:
Spain 2.6 million ha
Greece 0.8 million ha
Italy 1.1 million ha
Portugal 0.4 million ha
EU 5.0 million ha
Volume olive oil production 2016:
Spain 1,080 kt
Greece 300-400 kt
Italy 475 kt
Portugal 109 kt
EU 2,322 kt
Number of olive oil mills:
Spain 1,780
Greece 2,500
Italy 5,000
Number of pomace mills:
Spain 67
Greece 35
Number of refineries:
Spain 26
Greece 10</td></tr>
</table>

State of the sector	• Olive growing is a perennial Mediterranean crop, meaning that there is rigidity in farm adaptation to economic trends. A plantation takes between five to seven years to become fully productive. • There are few alternatives to olive trees in marginal regions with poor productivity (mountainous or hilly areas); they can grow in poor, stony soil which it would be difficult to put to other crop uses. Consequently, they play an important environmental role (fixing soils, biodiversity, landscape and contribution to rural development). • In the EU, olive trees are grown in Spain, Italy, Greece, Portugal, France, Cyprus, Slovenia and Malta. • The oil mills average market value for the last seven campaigns was 3,270 million euros in Spain. The olive pomace oil industries market value in Spain was €150 million. The total sales for economic year 2014 in Greece amounted to 832.7 million euros, 16.2 million euros lower than the previous year. • Only the 27 % of the Greek olive oil is consumed domestically and the rest (70 %) is exported (100,000 to 135,000 tonnes). • The sector has a tendency to grow in Spain. In Greece its size is fluctuating: after the historical low productivity and sales of olive oil in the years 2011-2014 the productions and sales have increased again in 2017.
Typical size of the companies	• The structure of production is typically very fragmented (small holdings) and olive growing is a major feature of the heritage and socio-cultural life of Mediterranean regions. • Around half the olive oil operations in the EU producer countries specialise in olive oil production. However, there are major disparities among EU regions: in Andalusia and Apulia, between 65 % and 80 % of farms are specialised. In contrast, in Portugal, Cyprus and Slovenia, the majority of holdings do not specialise in olive growing. • In small farms, olive oil production may be a secondary, traditional and family activity: oil is produced for personal consumption and only a small amount may be marketed for direct sale. • Most part of Spanish olive sector industries are micro and small enterprises with small production and low investment capacity. The average production per oil mill and year in Spain is about 600 tonnes of olive oil. • In Greece, olive mills are characterised by a co-operative structure and high involvement of farmers in the processing of olives. For a typical Greek olive oil mill the average capacity is 200-230 tonnes of olive oil per year. A typical pomace mill has a capacity to treat 450-500 t of pomace/day. Around 15,000 seasonal workers are employed in olive

	mills. Around 210 permanent workers and 875 seasonal workers are employed in pomace mills. Around 140,000 seasonal workers in farming and harvesting activities of olives.
Distinctive facilities of the sector	• The peak in activity occurs in winter, which makes it compatible with other agricultural and non-agricultural activities. With traditional growing methods, labour represents over half of production costs; and therefore, olive growing plays an important role in society. • In Spain oil mills do not possess any compatible equipment with the processing of biomass. However, these industries have many other assets useful at the time of implementing an IBLC such as labour, transport, warehouses, conveyor belts and other machinery for biomass management (scales, tractors with spades, etc.). • Olive pomace oil industries in Spain own equipment ((horizontal) dryers) compatible with the processing of solid biomass and the extraction of bioactive compounds. They also could use warehouses, labour and transport. • In Greece the operation lasts from September (can also start earlier, climate dependent) to March. The off-season potential for using idle agro-industrial capacities is April-September. • Pomace mills in Greece are larger than olive mills and more sophisticated. Therefore, they are better candidates for IBLC implementation. Several facilities are available for implementing the IBLC concept such as dryers, separators and storage areas. These facilities could be exploited in idle times with other raw material as alfalfa, clover etc. However, also additional equipment is needed.
Degree of innovation	• Small producers and primary processors lack the means to adapt supply to demand and therefore the ability to invest in innovative technologies. As a result of this they are unable to benefit properly from the full value of their production. • In Spain new innovative products (hydroxytyrosol, oleuropein, and triterpenes) derived from the olive are being developed and produced at very competitive prices by olive oil sector industries. • In Greece the sector has the ambition to modernise with the state-of-art technologies. However, with limited resources only little R&D is possible for a minority of the companies. Pomace mills are absent in national development and funding schemes.
Miscellaneous	• Spain, Italy and Greece account for around 80 % of EU consumption. It seems to be stable in the producer countries, whereas it is increasing in France and in the non-producing EU member states. • In Spain both oil mills and olive pomace oil industries have a large experience in biomass handling.

	• However, extrapolating these data to olive oil sector target industries, the fact should not be neglected that only around 40 companies (2.2 %) in Spain seem to have optimal conditions for developing a new business line for biomass processing (considering their size and associated financial assets). • In Greece last years there is a tendency to change the three-phase to two-phase centrifugation as it is more eco-friendly and due to national legislation. The two-phase system has already been widely implemented by most Spanish oil mills to avoid the sustainability problems that the wastewater implies. • In Greece, some pomace mills have other activities during their low season period. One pomace mill used to dry and package alfalfa that has a similar moisture content with the olive pomace (70-80 %). Some pomace mills extract pomace oil from expired table olives in summer. • Taking into account the low margins and incomes, it is expected that most olive oil sector industries are not able to afford extra investments for developing an IBLC.
	Opportunities for IBLCs
Sector related residues	• Olive pruning total amount: o Spain: 2.6-10.4 Mt per year (fresh matter) o Greece: 1.13-1.72 Mt per year (dry matter) • Exhausted olive pomace two-phase: o Spain: 0.7-3.0 Mt per year o Greece: 0.754 Mt per year • Exhausted olive pomace three-phase: o Greece: 0.314 Mt per year • Olive Oil Waste Water (OOWW) in Greece: o Three-phase: 345-440 Ml per year (year 2014 estimations) o Two-phase: 0 Ml per year (year 2014 estimations) • Olive pits in Spain: 0.2-0.7 Mt per year • Olive stones and leaves in Greece
Potential synergies & benefits	• The equipment of olive pomace oil industries is more compatible than the equipment of oil mills but the idle periods are shorter. Nonetheless, the advantages provide great synergies to these industries for developing an IBLC. • Several agro-industries of this type in Spain have already developed business activities related with the valorisation of the biomass residues coming from oil mills, both for bio-energy and for biocommodities. This fact supports the hypothesis of a greater IBLC feasibility for these industries.

	• Several treatment options are proposed in Greece in order to improve the decontamination efficiency of the Olive Mill Waste Water (OMWW). • Processing residues such as olive tree prunings and exhausted olive cake is a possible synergy. • The capacity to store biomass is another possible synergy.
Market developments	• The bio-energy market (domestic heating, industrial power generation) can be addressed with the production of biogas, bio-fuels or solid biomass (exhausted olive cake and olive stones). • Olive sector residues (like exhausted olive cake and leaves) offer the opportunity to extract several bio-compounds (phenols, hydroxytyrosol, oleuropein, triterpenes and methanolic extracts) with a wide range of benefits for the pharmaceutical industry and food industry. • Exhausted olive cake can be used in animal feed industries as well as the biogas industry. • Phenols from exhausted olive cake (and leaves) can be used in pharmaceutics industry, food industry. • OMMW can be reused as fertiliser due to the organic matter and nutrients contained that could improve the quality of arid soils. • Olive prunings can find various applications such as production of pellets, particle boards or as fuel in power plants.
Non-technical barriers	• The law in Spain forbids the burning of olive pruning. However, despite of this, in some cases authorities allow these practices in determined periods (regulatory barrier), which stimulates farmers to keep doing so (knowledge and awareness barriers). In Greece, burning of prunings is not allowed from 1 May to 31 October. • The olive oil sector is not properly mechanised to undertake the collection and processing of biomass (organisational barrier). • Logistic problems with olive pruning collection are expected since most part is performed manually and transport costs are high (low density and added value from some feedstocks). Thus, mechanization and optimisation of logistic is needed to ensure profitability. • Fluctuations in the production of olive oil (climate dependent) and the processing of yields create uncertainty with regard to the expected volume of olive oil sector residues for potential valorisation industries. • There is an unwillingness of Greek citizens to have the pomace mills continue their operations during their idle times. This is because they are unhappy with the existing pomace facilities when operating due to odours and smoke (optical disturbance). • Olive oil mills and pomace mills are absent of national funding schemes in Greece, thus they lack funds for implementing new business concepts.

	• It is difficult for the solid fuel market to absorb exhausted olive cake as a fuel for residential heating due to intense odours. • The production of olives and pomace as well, is climate-dependent. As a result, technologies for exploiting by-products and residues of the oil production process have not been yet developed.

Table 7. Traffic light analysis for olive oil mills sector.

IBLC feasibility for sector olive oil mills						
	Spain	Greece	Sweden	Ukraine	Serbia	Average
	Sector profile					
Volume sector						
State sector						
Typical size companies						
Distinctive facilities sector						
Degree of innovation						
Miscellaneous						
	Opportunities for IBLCs					
Sector related residues						
Synergies & benefits						
Market developments						
Non-technical barriers						

Table 7 presents the traffic light analysis expressing the suitability of the olive oil mills sector for establishing an IBLC, either as contributor of (sector related) agro-residues and/or of capacities for processing biomass. Based on the traffic light analysis the following observations were summarised:

- In Spain the volume of the olive oils mills sector is very large (1,080 kt olive oil production in 2016). In Greece it is also very large but smaller than Spain (300-400 kt). Italy that was not analysed in a country report also has a very large volume (475 kt). So on the average there are several countries with a very large volume, where IBLCs could be positioned.
- The state of the sector ranges from very healthy (Spain) to healthy (Greece). Remember that many of the judgments in the traffic light analysis (e.g. healthy/unhealthy) are qualitative and thus no exact figures can be given here. On the average the sector is healthy, which is positive for investing in IBLCs.

- Some suitably sized companies (for an IBLC) can be found in Spain, while Greece has many suitably sized companies. On the average many suitably sized companies can be found per country.
- Both in Spain and Greece many of the distinctive facilities can be shared, which is favourable for considering the establishment of IBLCs. Pomace mills are probably better candidates for an IBLC than oil mills.
- The degree of innovation varies from high in Spain to medium in Greece. On the average there is a high level of innovation in the sector, which is good for considering IBLCs.
- Spain has many stimulating miscellaneous factors and Greece has some. An example of such a factor is that both oil mills and olive pomace oil industries have a large experience in biomass handling. So on the average there are many stimulating miscellaneous factors, which is again favourable for the establishment of IBLCs.
- Both Spain and Greece have very large volume of residues are available in the sector. So on average, there are very large volume of residues (like olive prunings, exhausted olive pomace, olive oil waste water, olive pits, stones and leaves) in the sector that could be processed at an IBLC.
- Also, many synergies and benefits can be found in the sector in Spain and Greece, which is also good for establishing IBLCs. The equipment of olive pomace oil industries is more compatible than the equipment of oil mills but the idle periods are shorter. The capacity to store biomass is another possible synergy.
- Spain has excellent market opportunities with promising perspective. Greece has good market opportunities with promising perspective, which is the average.
- In Spain serious non-technical barriers with limited perspective to overcome are present. In Greece non-technical barriers exist that require serious attention but can be overcome. On the average, the sector has serious non-technical barriers with limited perspective to overcome, which could constitute a major problem when implementing IBLCs. An organisational barrier is that the olive oil sector is not properly mechanised to undertake the collection and processing of biomass. Furthermore, there is uncertainty about the expected volume of processing residues due to fluctuations in the production of olive oil. Also there is a social barrier of citizens living near pomace facilities who dislike odours and smoke. Finally, lacking funds are an example of an investment barrier.

General conclusions: For all assessment categories the values for the olive oil mills sector vary only a bit between the two countries. The analysis indicates that the olive oil mills sector has many opportunities for establishing IBLCs since it has a very large volume of residues, many synergies & benefits and good market opportunities with promising perspective. The only problem is that there are serious non-technical barriers with limited perspective to overcome.

3.1.3 Feed and fodder

Feed industries (see map in Figure 9) final products are homogeneous mixes of several raw materials (grains, cereals, vegetable and animal by-products) and components (oil and fats, molasses, vitamins and minerals) from which a balanced and nutritious food is achieved providing a better conversion performance in the animal feeding. Grinding is usually required in the animal feed production activities and its position in the process leads to two main types of process flow diagrams: pre-grinding (see Figure 10) or pre-dosing processes. The difference resides in that grinding is carried out previous to the dosing in the first case but instead, in the second case, raw material is coarsely mixed before being round together by formula (Tesla, 2014).

Raw materials are usually transported by truck. Once in the plant, trucks are weighed and the load is discharged into the reception hoppers, from which feedstock are transferred by mechanical or pneumatic system to the grinding equipment. There, the particles are transformed with the aim of getting formulas with similar particle size. After particle homogenisation, those are carried to the dosing stage to get the right amounts of each raw material needed to prepare the formula. Having all the elements together, mixing operation distributes those in a homogeneous manner before receiving heat treatment for feed hygiene and being later pelletized and cooled. Sometimes, pellets can be broken (crumbling/sieving/coating) into smaller particles to improve the intake of small animals, or directly conditioned, loaded and delivered in bags or bulk (see Figure 10).

Fodder industries process herbaceous matter in order to achieve a better preservation of the nutritious elements contained in it through three different industrial processes; silage, haymaking and dehydration (see Figure 11). This last reduces moisture from 80-90 % to near 10 %, providing a higher concentration of dry matter and a better preservation of the carotenoids and protein content. Final products (see Figure 11) are marketed within two formats, bales, mainly for dairy production ruminants, and granulated format or pellets, for meat production and feed industry.

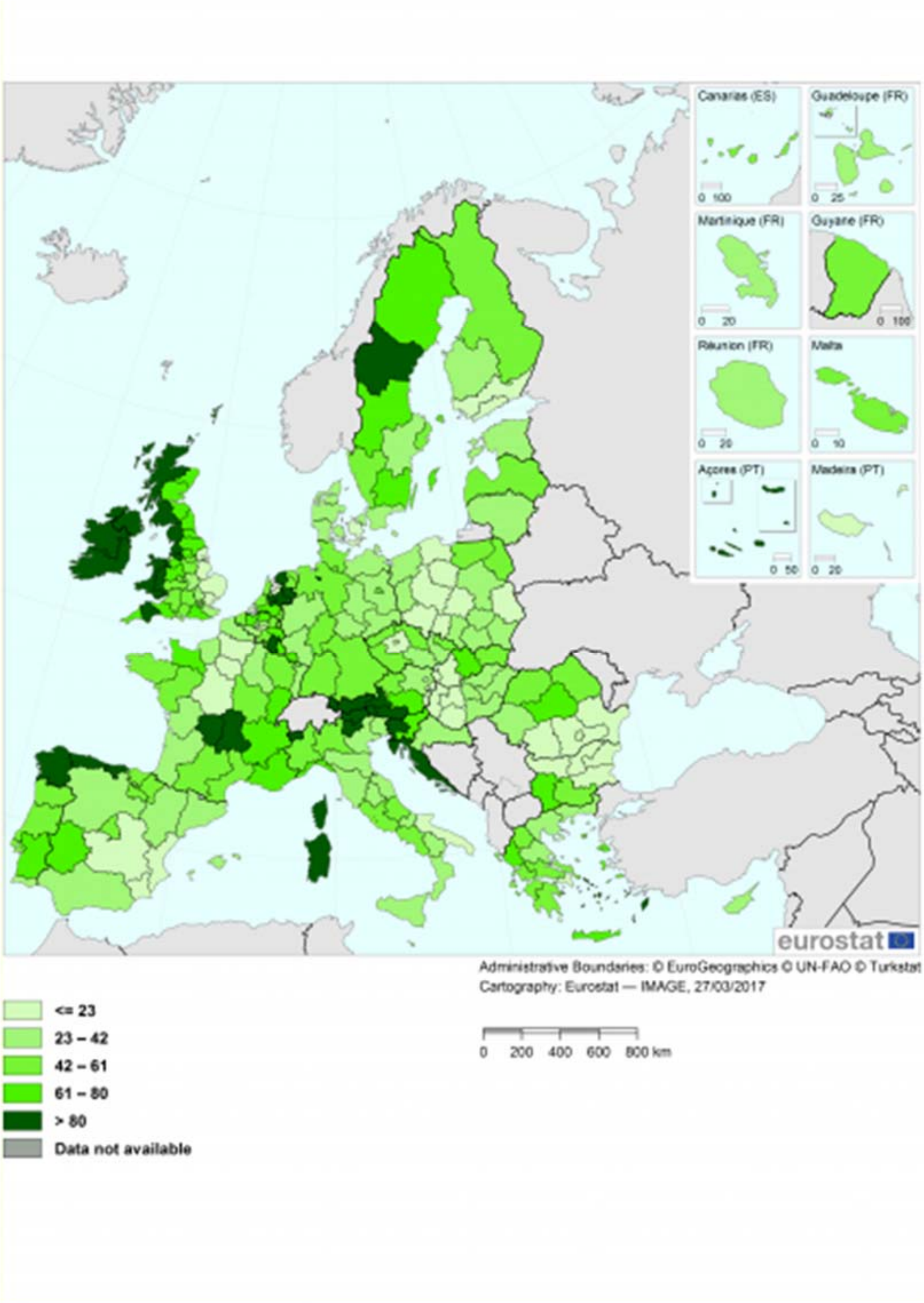


Figure 9. Map of the feed & fodder sector. Share of fodder area in Utilized Agricultural Area (UAA) by NUTS 2 regions for the EU-28 (Eurostat, 2017)

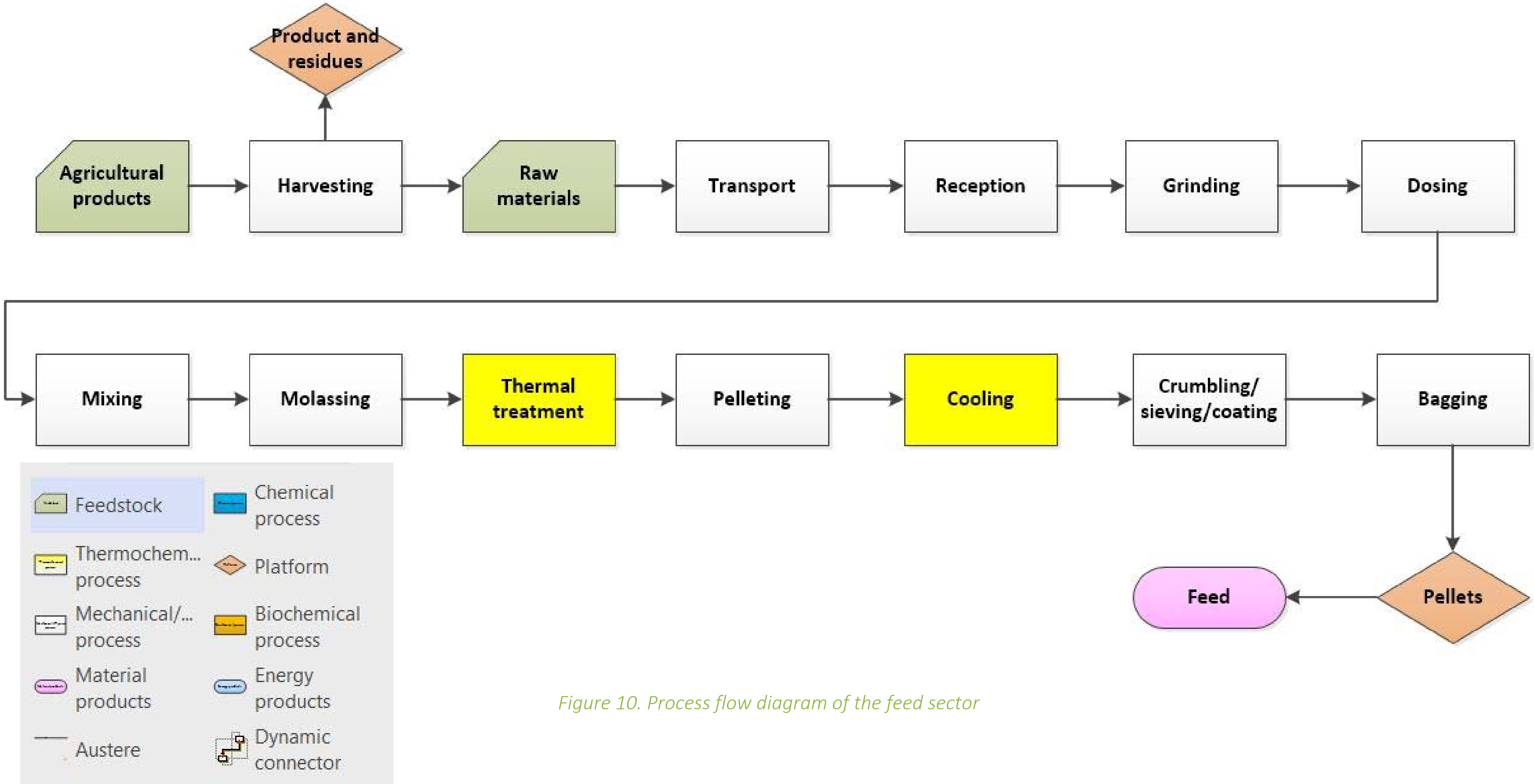


Figure 10. Process flow diagram of the feed sector

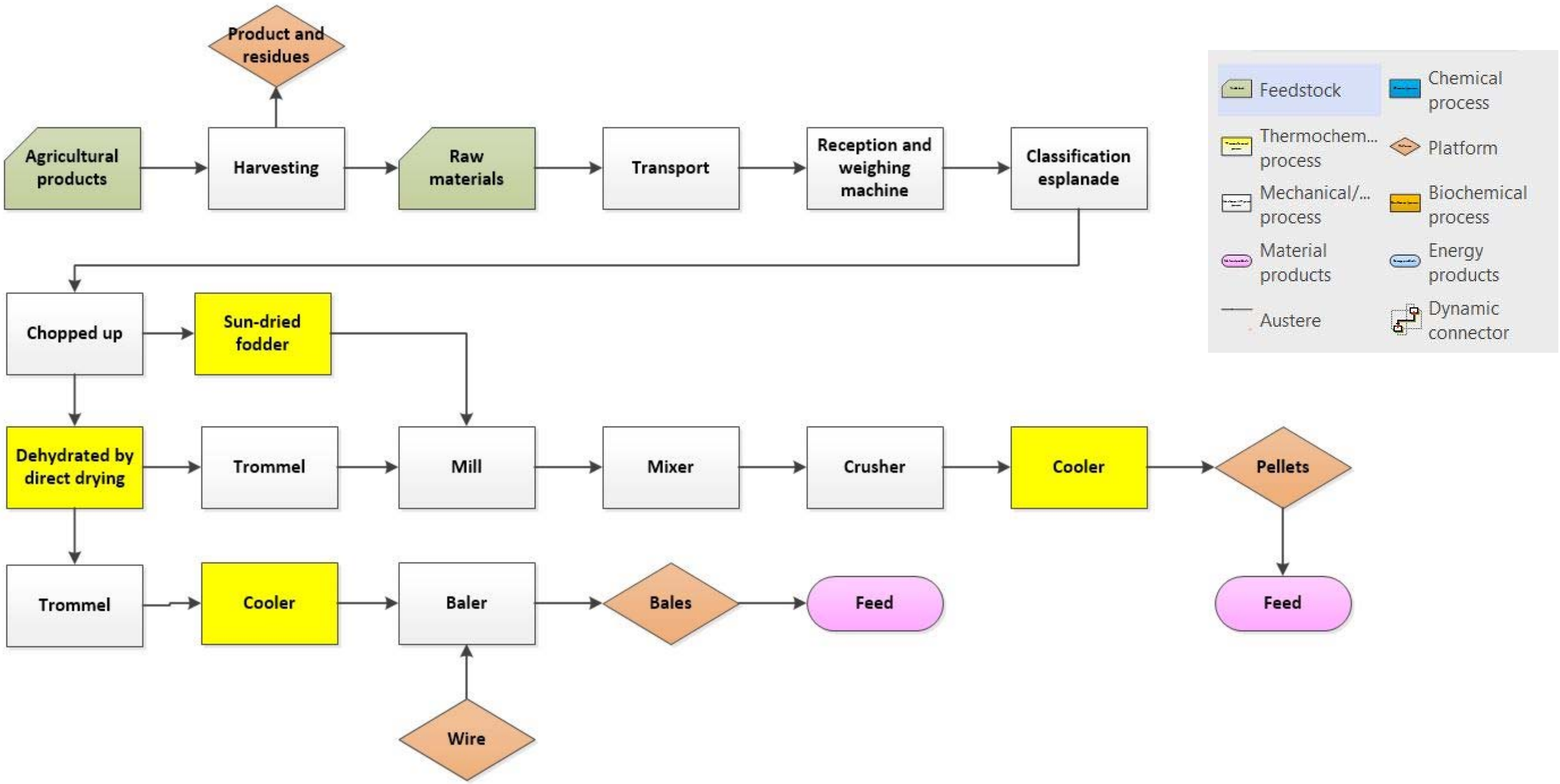


Figure 11. Process flow diagram of the fodder sector

Table 8 provides a cross-country analysis for the feed and fodder sector in view of its potential for integration with IBLC concepts.

Table 8. Summary feed and fodder sector.

<table>
<tr><th colspan="2">Sector feed and fodder</th></tr>
<tr><th></th><th>Profile</th></tr>
<tr><td>Production</td><td>Production of animal feedstuff requires several raw materials in order to prepare specific formulas (access to their residues).
Feed and fodder can consist of mixes of different crops such as: barley, wheat and oats, whole crop silages, protein crops like rape seed, peas and broad beans, grass as roughages, maize for forage, clover and alfalfa (Lucerne).
In Spain 85 % of the raw materials for dehydrated fodder industries corresponds to Lucerne.
Animal feed production can also use residues and by-products of other agricultural processes.</td></tr>
<tr><td>Volume of the sector</td><td>Cultivated area:
Spain (2014): forage crops almost 1.1 million ha.
Sweden: leys and green crops grown on 1.1 million ha.
Ukraine (2016): specialized cultures 1.932 million ha.
Serbia (2016): 0.215 million ha.
Size:
Spain (2015): feedstuff production 23.3 million tonnes; (2016-2017) dehydrated fodder production 1.61 million tonnes.
Sweden (2016): temporary grasses 4.9 million tonnes per year in average; leys and green crops grown on 1.1 million ha.
Ukraine (2016): 6.23 million tonnes of combined and concentrated feed.
Serbia (2016): 1,555 million tonnes (note: this concerns data of the raw material that is used for production of feed and fodder; there is no exact data of the capacity of final products from the industry because there are many small processing facilities that are not monitored for their production data).
Number:
Spain: 70 fodder dehydrator industries and almost 1,500 feed industrial manufacturers.
Sweden: 7 feed mills of Lantmännen and 4 of Svenska foder.
Ukraine: 440 producers of combined and mixed feeds.
Serbia: approximately 100 producers of animal feed.</td></tr>
<tr><td>State of the sector</td><td>The compound feed production in the EU 28 slightly increased by 0.4 % in 2016 to 155 million tonnes.</td></tr>
</table>

	• The share of rapeseed meal significantly increased with the development of the biodiesel sector (FEFAC, 2017). • The average value of the industrial production of compound feedstuff for farm animals in Spain was 6,820 million euros and 300 million euros in the case of fodder plants production. • If the animal sector in Sweden will decrease as predicted, then this will also affect the size and capacities of the feed and fodder industry. It also raises questions and thus opportunities for alternative use of available processing facilities and land. • The sector is not doing well in the Ukraine: the production of combined and concentrated feeds has been declining for the few recent years in a row. That is most likely due to the fact that the number of big farm animals (cattle, pigs, sheep and goats) has been declining as well. • Since livestock production occupies an important place in agricultural production in Serbia, the feed and fodder sector is important in the country's rural economy. Production facilities in the feed and fodder sector of Serbia are relatively well distributed in the country regions. Nevertheless, this branch of agriculture has been recording for the third decade negative trends. Only during the last ten years, the number of conditional heads per hectare agricultural land it was reduced from 0.34 to 0.27.
Typical size of the companies	• In Spain most animal feeding products industries are micro enterprises with 1-9 employees (around 48 %), followed by small companies with 1--49 employees (31 %) and companies with no employees (15 %). Only few of them had more than 50 employees (6 %) and none more than 500. • In Sweden Lantmännen produces 900,000 tonnes of feed yearly where about half is from grains. Svenska Foder produces 500,000 tonnes of feed. • Some 440 producers of combined and mixed feeds for farm animals operate in the Ukraine. Some 350 of them have a maximum production capacity of less than 75 tonnes of final product per day, and 90 have a production capacity above this – up to 1,150 tonnes per day. • In Serbia no data are available related to company size and production capacities.
Distinctive facilities of the sector	• In Spain 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 professionalization and many other valuable assets useful for the biomass processing activities (workforce, means of transport, etc.).

	• Fodder dehydrator industries in Spain own pelletizers, silos for storage, screening and chipping machinery compatible with the biomass handling. Besides, fodder dehydration process requires from horizontal rotary dryers to reduce the water content, completely suitable for biomass drying. • Occasionally, some of these Spanish agro-industries are consumers of biomass to supply their energy demands. • In Sweden the fodder factories seem to be in production all year round with little down time. • About 70 % of all mixed and combined feeds are produced in the Ukraine by the big integrated companies. • In Serbia all existing capacities are oriented only for feed and fodder production.
Degree of innovation	• In Spain around 94 % of feed and fodder sector industries are not expected to have economic strength and resources to implement an IBLC within their facilities. In spite of this, the remaining 6 % seem to reunite required conditions to start new biomass related business lines. The fodder dehydrator industries have a greater size than the feed industries and thus, have better chances of becoming an IBLC. • In Sweden there seems to be a focus on research in using domestically grown protein crops to decrease the need of import. There is also a focus on increased grass proportion for dairy cows to decrease the need of grains and other crops as supplement. • In the Ukraine the degree of innovation is rather low. Most of feeds and fodders produced are for own needs and are not being brought to the market. • In Serbia the entire technological process of animal feed production in all factories is automated. For the purpose of efficiency of production, the factories have modernized their production in order to meet the needs of its customers by investing in machinery and equipment, as well as by building a larger production and warehouse space.
Miscellaneous	• Food industry by-products are potential raw materials for animal feeding which inclusion could help to reduce the carbon footprint of the animal feedstuff. • Feed and fodder sector industries are used to handle both raw materials and final products such as bales, pellet or other granulated format and thus, they have wide experience in the management of biomass. • In Sweden there is a potential capacity for biomass growing in low utilised agricultural production fields (dedicated crops for bio-energy/ biobased production).

	• In Serbia there are no possibilities for future IBLC development in this sector, because producers use all by-products for further production.
	Opportunities for IBLCs
Sector related residues	• The EU debate on food waste in the context of circular economy has delivered a clear recognition that the feed industry is part of the solution. • The small amounts of residues from feed industries in Spain are not available for IBLC purposes since legislation obliges to remove them (CESFAC, 2017). • Fodder dehydration industries in Spain do not produce any important biomass residue, either in the agrarian or processing phase. Instead, those industries could have a relatively easy access to agrarian residues, which can be used as raw material for the production of solid biomass. • There are no biomass residues from feed production from grains in Sweden as the by-products are being reused in feed industry. • Grass production residues in Sweden are losses during harvest and transportation between storage and feeding place. Losses in dry matter varies between 3-30 %. • In the Ukraine and Serbia the feed and fodder sector generates no biomass related residues.
Potential synergies & benefits	• Feedstuff manufacturer industries in Spain keep their production ongoing during all the year (no idle period). • Fodder dehydrator industries in Spain have an idle period that lasts from November to March/April. • The start-up of IBLCs in Spain would bring up employment in the region as a social benefit and also environmental benefits. • In Sweden using grass as break crop in grain dominant production may benefit grain production and profitability on farm level in the long run. • In the situation that the number of animals and animal producers will decrease in Sweden, there is potential of using grass and feed crops for other applications, for example in the bioenergy industry. • In the Ukraine there is a processing capacity surplus (physical processing - grinding, granulating etc.) in the sector. The current underuse of processing facilities is estimated to be at the level of 20-40 %. Due to the fact, that the production of concentrated fodders shares some similar stages with the production of solid biomass (e.g. dehydration and granulation), this surplus capacity may be potentially of interest for an IBLC. • There are no available residues from feed and fodder sector in Serbia so there are no potential synergies and benefits, which could be obtained.

Market developments	• Despite the huge variations in feed material prices over the last years, the proportion of feed materials per category remained relatively stable (50 % for cereals, 27 % for oilseed meals) (FEFAC, 2017). • In the case of animal feed industries in Spain, the lack of idle period joined to the small size that features them constitute significant barriers that must be overcome for implementing an IBLC. • Studies in Sweden are showing that grasses have potential of being used in production of biogas, ethanol and other bio applications (Prade et al., 2015). • The market in the Ukraine has been shrinking during the recent year due to decline in livestock numbers. • Business plans of companies from this sector in Serbia have shown the intention for increase the production and export to other markets.
Non-technical barriers	• Low market activity and incentives (market barrier). • A complex logistic organisation (both the collection and the processing of the residues) makes the implementation of an IBLC less feasible (organisational barrier). • Mandatory disposal of the feed animal residues by an authorized manager (legislative barrier). • Feed industries will require higher investments (financial barrier). • The non-technical barriers of feed grains are the same as mentioned in the food grain sector. • There may be competition from feed industry using feed products in the bioenergy production, but biomass availability may increase if the need for feed to animals decreases. • Feed manufacturers have been able to help managing financial risks and to buffer price fluctuations of agricultural raw materials thanks to their market arbitration and hedging possibilities for key raw materials. However, livestock farmers will need better access to financial risk tools to improve the protection of their own income (FEFAC, 2017). • Dependency of production/yield to weather conditions.

Table 9. Traffic light analysis for feed and fodder sector.

IBLC feasibility for feed and fodder sector						
	Spain	Greece	Sweden	Ukraine	Serbia	Average
	Sector profile					
Volume sector						
State sector						
Typical size companies						
Distinctive facilities sector						
Degree of innovation						
Miscellaneous						
	Opportunities for IBLCs					
Sector related residues						
Synergies & benefits						
Market developments						
Non-technical barriers						

Table 9 presents the traffic light analysis expressing the suitability of the feed and fodder sector for establishing an IBLC, either as contributor of (sector related) agro-residues and/or of capacities for processing biomass. Based on the traffic light analysis the following observations were summarised:

- Both in Spain (32.3 million tonnes feed & 1.6 million tonnes fodder), Sweden (4.9 & 1.1 million tonnes) and the Ukraine (6.2 million tonnes combined) the volume of the feed & fodder sector is large, while it is medium sized in Serbia (1.5 million tonnes combined). On the average the volume the feed and fodder is large.
- In most countries (Sweden, the Ukraine and Serbia) it is a medium healthy sector. It is only in Spain where the sector is healthy. Remember that many of the judgments in the traffic light analysis (e.g. healthy/unhealthy) are qualitative and thus no exact figures can be given here. On average, the sector is medium healthy, which is rather positive for investing in IBLCs, but it could perhaps become a problem.
- Some suitably sized companies (for an IBLC) can be found in Spain, Sweden and Serbia, while the Ukraine has many suitably sized companies. On average, some suitably sized companies can be found per country, which could invest in an IBLC.
- In three countries (Serbia, Spain and Ukraine), many of the distinctive facilities can be shared. E.g. in Spain 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 professionalization and many other valuable assets useful for the biomass processing activities (workforce, means of transport, etc.). Fodder dehydrator

industries in Spain own pelletizers, silos for storage, screening and chipping machinery compatible with the biomass handling. Besides, fodder dehydration process requires from horizontal rotary dryers to reduce the water content, completely suitable for biomass drying. In Sweden only a few facilities can be shared because the fodder factories seem to be in production all year round with little down time. So on the average many of the distinctive facilities can be shared, which is favourable for establishing an IBLC.

- The degree of innovation varies from medium in Sweden and Serbia to low in Spain and the Ukraine. On the average there is a low level of innovation in the sector, which could be a problem because an innovative concept like an IBLC will be less likely considered then.
- Sweden and the Ukraine have some stimulating miscellaneous factors, but Spain and Serbia only have a few. An example is that the industry is used to handle both raw materials and final products such as bales, pellet or other granulated format. So on the average there are few stimulating miscellaneous factors, which is again not favourable for establishing IBLCs.
- Spain, Sweden and Serbia all have a low volume of residues available in the sector. Ukraine even has a very low volume of residues available. So, on average, only a low volume of residues is available. This makes the feed and fodder sector less suitable as a supplier of biomass to IBLCs. However, the feed and fodder sector could also process residues of other sectors.
- Only in Ukraine many synergies & benefits can be found in the sector, because there is a processing capacity surplus (physical processing - grinding, granulating etc.) in the sector. In Spain and Sweden, the sector could have some synergies & benefits. E.g the fodder dehydrator industries in Spain have an idle period that lasts from November to March/April. In Serbia only few synergies & benefits apply. So on average the sector could utilize some synergies and benefits.
- Sweden and Serbia see some good market opportunities in the sector that are rather uncertain. While Spain and Ukraine only have few good market opportunities that are rather uncertain. So the average is a few good market opportunities that are rather uncertain.
- Only in Serbia serious non-technical barriers with limited perspective to overcome are present such as financial, legislative and organisational barriers (see Table 8). In the other three countries only small non-technical barriers are present that can be overcome. On average the sector has small non-technical barriers are present that can be overcome so this should not constitute much difficulties for establishing IBLCs.

General conclusions: For all assessment categories the values for the feed and fodder sector vary between the four countries, but not very much. The assessment indicates that the feed and fodder sector has some but limited opportunities for establishing IBLCs, since the sector has only a low volume of residues (unless it uses residues from other sectors), some synergies & benefits and only a few good market opportunities that are rather uncertain. A positive point is that there are only small non-technical barriers that can be overcome.

3.1.4 Wine sector (cellars & distilleries)

The EU wine sector contains 50 percent of the global area that is dedicated to vineyards. With 65 percent of the global wine production, wine producing countries in the EU play a dominant role with Spain, France and Italy accounting for nearly 80 percent of the EU production share (and 75 percent of the vineyard area). Figure 12 shows how the EU vineyard area is distributed over the member-countries.

Since wine contains much more sugar than its residues, it is common that a part of the final production is sold to distilleries. Part of the grape processing residues (grape pomace, lees and stalks) are also used as feedstock in distilleries for the production of alcohol. The wine sector has therefore been divided into two parts: wine cellars and distilleries.

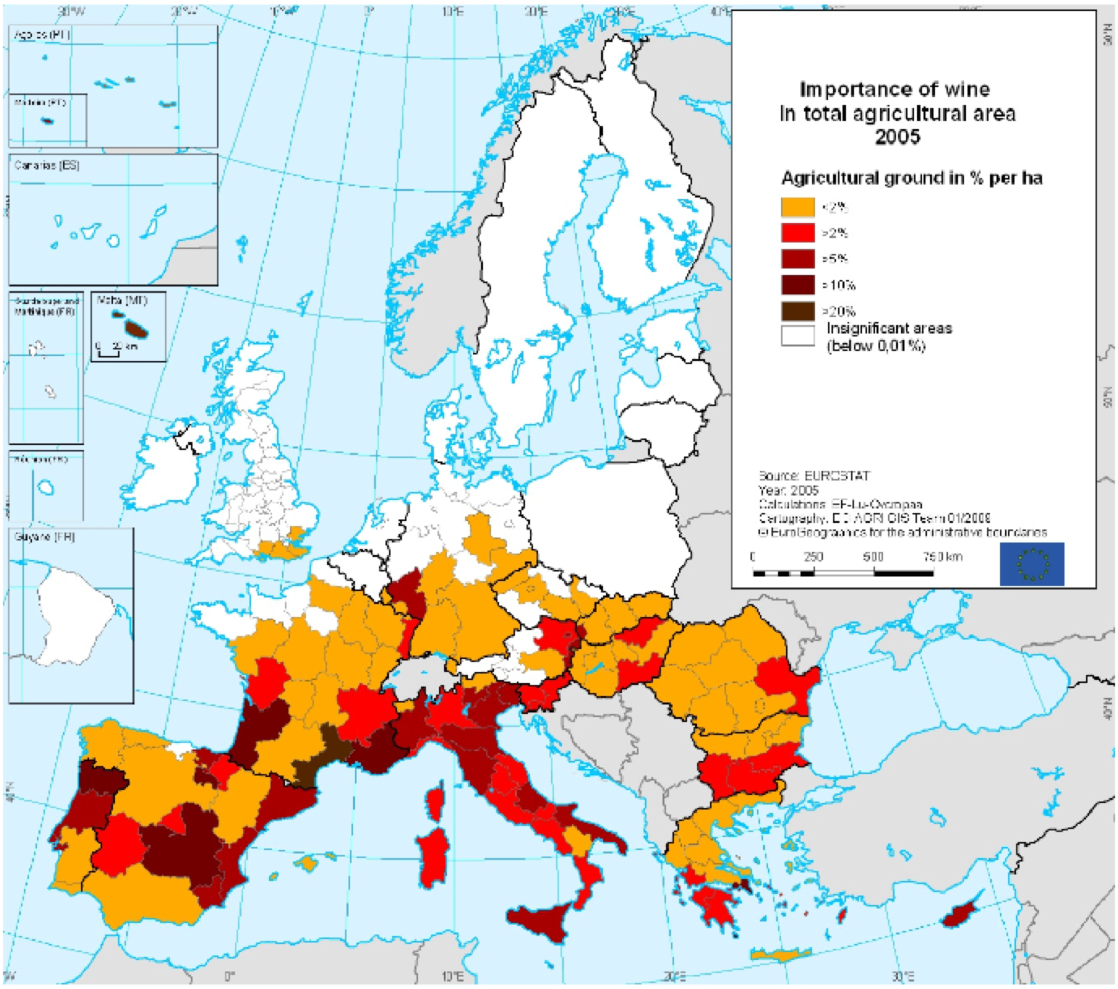


Figure 12. Wine grape surface on total agriculture area (source: Eurostat, 2005; elaborated by European Commission, 2017)

Wine cellars

The supply chain for wine is graphically presented in Figure 13. It shows the steps and processes from the harvest of the feedstock until the final product: wine. The figure also shows the various residues that arise from the feedstock handling and processing steps in the value chain (marked by the light-brown diamond shapes).

Grapes are the main feedstock for wine cellars. The grapes are harvested by vineyard farmers in bunches, together with leaves and grape stalks, and then transported to wine cellars facilities. After reception of the bunches, grapes are separated (destemming) from leaves and stalks (the latter are usually carried to distilleries, where they are washed to recover sugar for distillation). Sometimes they are crushed all together. At this point, depending on what final product is pursued (white or red wine), fermentation and pressing stages can be switched in time to achieve different features. At the pressing stage the main residue of wine cellars is generated, grape pomace (or grape marc), which is one of the main feedstock of distilleries for the production of alcohol.

Once ended fermentation and pressing phases, a combined stage of sedimentation, decanting and raking occurs. In this process, another residue called “lees” is obtained. Similarly to grape stalks and pomace, lees are usually sent to distilleries for their processing. Other common procedures for both white and red wine production are the ageing, clarification and stabilization, from where tartaric salts and filtration agents are extracted. After finishing of the whole process, the final product (wine) is bottled, packaged, or sold in bulk.

Distilleries

The distilleries’ main activity (Figure 14) is the production of alcohol, though many other co-products are usually obtained during the process (tartrate, grape seed oil, grape seed flour, etc.). There are several feedstocks (all coming from the winemaking process) that can be used for their purposes: grape pomace, grape stalks, lees and wine. These feedstocks have different (but significant) amounts of sugar, which is the basis of the distillation process.

In a first stage of the alcohol extraction process, grape pomace is washed in a diffusion band in which liquids called "pickets" are extracted with alcoholic and tartaric richness. Then, resulting pickets are sent to the distillers for alcohol obtaining. Each distiller is composed of several distillation columns, producing different types of alcohol, depending on which columns are used. Lees and wine follow a parallel distillation process, similar to the picket’s treatment.

Another usual product of distilleries is the tartrate. The dealcoholized pickets and lees pass to the tartrate extraction section, in which dissolved tartaric salts are recovered in a 4-step process (acidification, neutralization, concentration and drying). Lime tartrate, which has 50 % richness in tartaric acid, is sent to the chemical industries for the manufacture of pure tartaric acid.

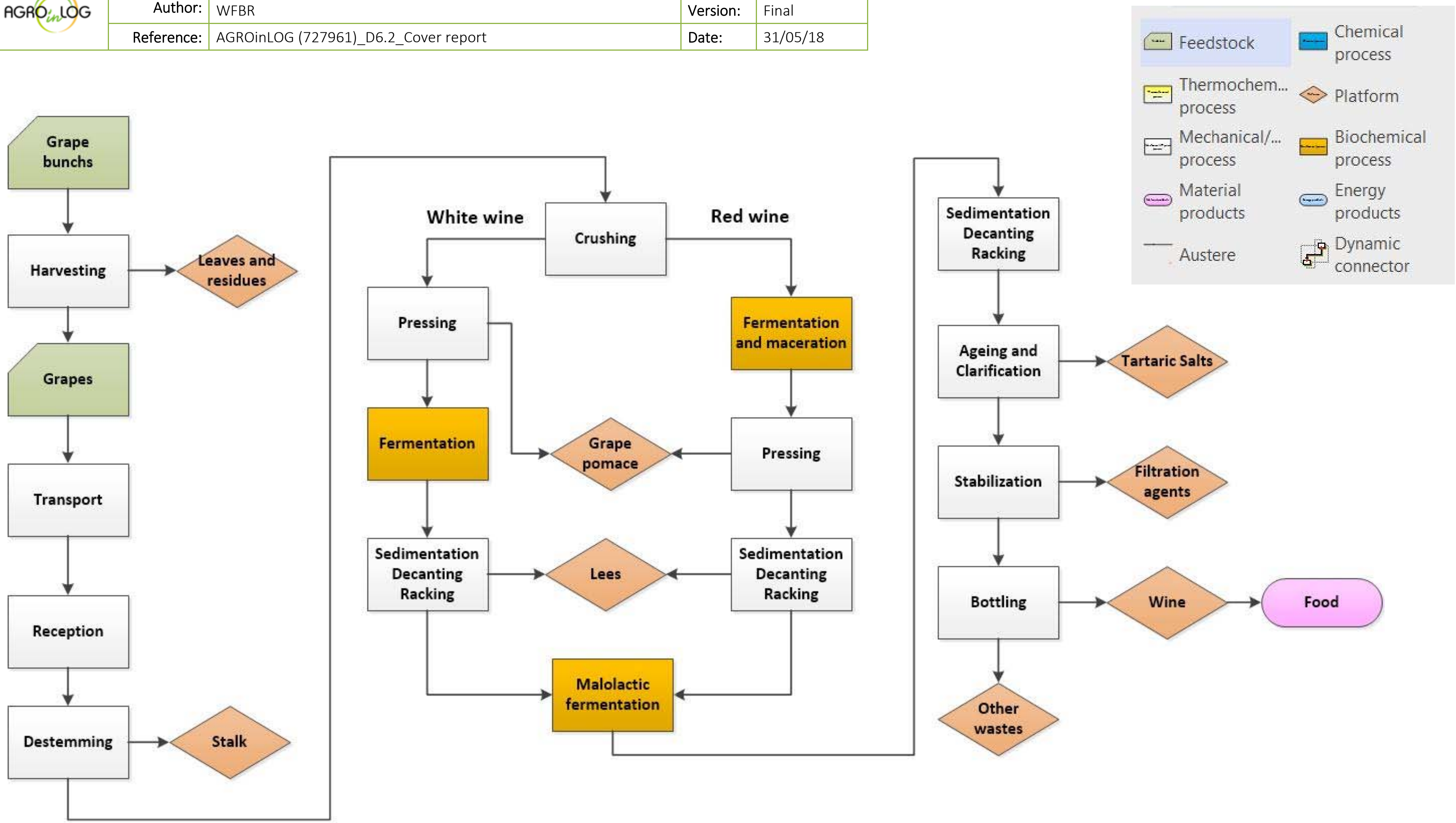


Figure 13. Process flow diagram of the wine sector

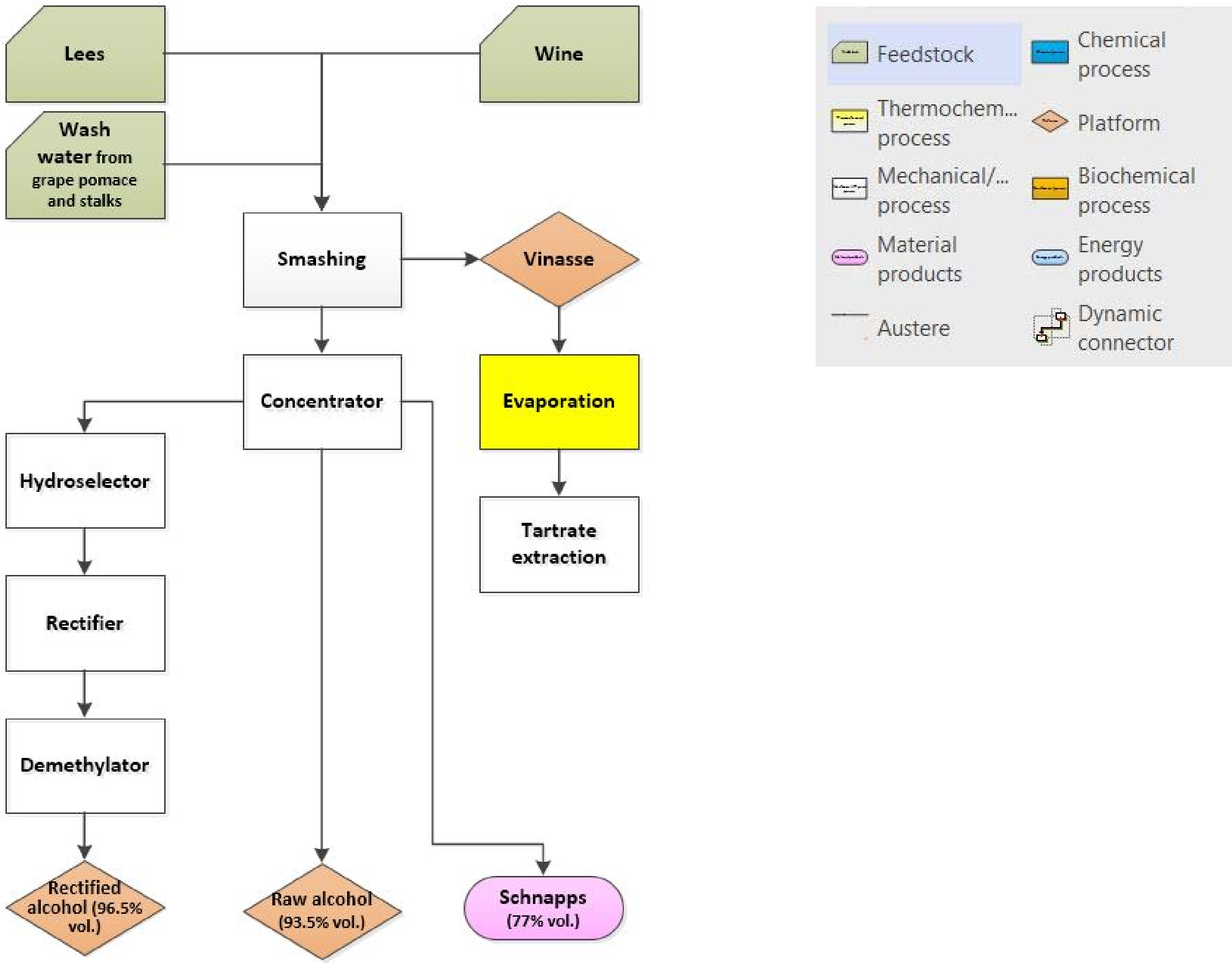


Figure 14. Process flow diagram of the wine distillery sector

Table 10 provides a cross-country analysis for the winery and distillery sector in view of its potential for integration with IBLC concepts.

Table 10. Summary wine sector.

<table>
<tr><th colspan="2">Wine sector</th></tr>
<tr><th></th><th>Profile</th></tr>
<tr><td>Production</td><td>

The main wine grape producing countries in EU (vineyard acreage / % of EU total vineyard acreage / grape production) (EUROSTAT, 2014/2015):
<table>
<tr><th></th><th>Vineyard acreage ('000 ha)</th><th>Share in total EU vineyard acreage</th><th>Share in total EU grape production</th></tr>
<tr><td>Spain</td><td>925,32</td><td>30%</td><td>23%</td></tr>
<tr><td>France</td><td>747,10</td><td>25%</td><td>26%</td></tr>
<tr><td>Italy</td><td>634,34</td><td>21%</td><td>30%</td></tr>
<tr><td>Portugal</td><td>176,87</td><td>6%</td><td>4%</td></tr>
<tr><td>Romania</td><td>169,55</td><td>6%</td><td>3%</td></tr>
<tr><td>Germany</td><td>99,91</td><td>3%</td><td>5%</td></tr>
</table>

By-products (or residues) originate from cultivation (pruning) and from feedstock processing in wineries and distilleries.
By-products from the wineries are used as input in the distillery process. Main residues from both wineries and distilleries are leaves, grape stalks, lees, vinasse, grape pomace, exhausted grape pomace, and grape seeds.

</td></tr>
<tr><td>Volume of the sector</td><td>

The production of grapes for wine processing consists of (mainly) small-scale vineyards. These are mostly small privately (family) owned orchards.
In some countries grape cultivation and wine processing are combined in large integrated firms or are organised in co-operative companies.

</td></tr>
<tr><td>State of the sector</td><td>

EU wines are exclusively produced with grapes cultivated in the diverse territories of the European Union. This wine sector is dependent on local production and it cannot rely on the international market to get its raw material. Wine production in the EU depends on the communities living in the rural areas. Here the wine sector creates value for local communities and provides the population in vulnerable rural areas with means for their daily existence where no other economic alternatives are available.
This dependence on territory is embodied in the strict EU wine legal framework, which prohibits mixing European wines with wines produced outside the European Union (CEEV, 2016).
Sector performance is largely weather dependent, with seasonal fluctuations in performance. Generally, it can be said that the sector is growing in the EU.

</td></tr>
</table>

	• A large part of the EU wine is produced for the export market (Russia).
Typical size of the companies	• The EU wine sector is composed of an overwhelming majority of small producers located in rural areas with around 2,400,000 wine producing holdings, for 3,000,000 direct fulltime jobs, most of them in rural areas. • The grape production and winery sector is generally small-scale and fragmented. A considerable share of wine production takes place in "in-house" cellars. • Economies of scale are more present in the (larger) distilleries and the larger industrial wineries. But also medium-sized (privately owned) wineries should be included as a target group of companies that may have a potential for developing IBLC concepts.
Distinctive facilities of the sector	• It is difficult to determine which specific available facilities and technologies, used in the processing and production of wine, are of interest for processing of biomass other than for grape processing. This also depends on the technological level of the specific industries and will have to be further investigated. For the wine sector at this point, there is no clear apparent match from a technological point of view. • Distillery industries may have a potential to create synergies in terms of using the available facilities for the processing of biomass residues. This was particularly recognised by the study on the Spanish wine and distillery sector. These synergies concern the use of equipment such as (horizontal) dryers that are compatible for the processing of solid biomass and the extraction of bioactive compounds. The fact that the distillery industries are in close contact with producers in the wine sector may create additional synergies, whereas it concerns the availability of residues for further processing and logistics to obtain these residues.
Degree of innovation	• The level of investment in innovations differs per country. Based on the EU review, most important innovations seem to be applied to increase efficiency in existing grape processing technology and innovations with a cost-reduction effect, rather than exploring new applications of grapes and grape residues in new products. • Innovations in the use of alternative renewable resources for own energy production and consumption may fit with the sector's need and ambition to remodel their processes towards increased overall sustainability. • Obviously, the economic sector's/ country's wellbeing has a large influence on the available means for innovation and modernisation. • The general impression is that funds for sector innovation are modest, and that innovation in the sector is partly dependent on the availability of subsidies.

<table>
<tr><td>Miscellaneous</td><td>

Opportunity to invest in processing biomass residues as part of the overall improvement of the sector’s sustainability.
Fragmented structure represents a serious problem to overcome when biomass residues are to be collected from the scattered vineyards. It will be a challenge to make it a feasible and sustainable operation.
Awareness of the need or urgency for biomass residue valorisation varies per country. In Greece there is a general lack of knowledge on the potential of processing agro-residues. While in Serbia, sector stakeholders have an interest in IBLC activities, but lack the technical capacity to organise it. The Spanish wine and distillery industry can be characterised as a sector with a high awareness regarding the potential and need for the processing and valorisation of residues in order to increase the sector’s overall sustainability.

</td></tr>
<tr><td></td><td>Opportunities for IBLCs</td></tr>
<tr><td>Sector related residues</td><td>

Current practice is that pruning from grape vineyards are not collected for further use. Most commonly (although prohibited by law) prunings are left in the fields to be burned, or more rarely, mulched into soil. This, and given the fact that different vineyard systems (vase, espalier, etc.) produce different volumes of pruning, make it difficult to obtain data that are accurate and representative.
For a large grape producing country such as Spain the potential yield from pruning is estimated from 1-4 ton/hectare/year (fresh matter with approximately 40 % moisture content). For a smaller producing country such as Greece the pruning yield is estimated from 1.4 to 8.6 ton/hectare/year (fresh matter with 40 % moisture content).
Product mass balance: production and estimation of by-products from grape processing (Agriconsulting, 2017; EUROSTAT, 2014 & 2015):

<table>
<tr><th></th><th>Share in feedstock</th><th>EU-28 (‘000t/yr)</th><th>Spain (‘000t/yr)</th><th>France (‘000t/yr)</th><th>Italy (‘000t/yr)</th></tr>
<tr><td>Grape processed</td><td>100 %</td><td>23,648</td><td>5,527</td><td>6,213</td><td>7,006</td></tr>
<tr><td>Must</td><td>80-85 %</td><td>19,510</td><td>4,560</td><td>5,126</td><td>5,780</td></tr>
<tr><td>Skins/peels</td><td>9-10 %</td><td>2,247</td><td>525</td><td>590</td><td>666</td></tr>
<tr><td>Seeds</td><td>3-4 %</td><td>828</td><td>193</td><td>217</td><td>245</td></tr>
<tr><td>Stalks</td><td>3-4 %</td><td>828</td><td>193</td><td>217</td><td>245</td></tr>
<tr><td>Pruning</td><td>2 t/ha</td><td>6,090</td><td>1,851</td><td>1,494</td><td>1,296</td></tr>
</table>
<table>
<tr><th></th><th>Share in feedstock</th><th></th><th>Germany (‘000t/yr)</th><th>Portugal (‘000t/yr)</th><th>Romania (‘000t/yr)</th></tr>
<tr><td>Grape processed</td><td>100 %</td><td></td><td>1,199</td><td>916</td><td>753</td></tr>
<tr><td>Must</td><td>80-85 %</td><td></td><td>989</td><td>755</td><td>621</td></tr>
<tr><td>Skins/peels</td><td>9-10 %</td><td></td><td>114</td><td>87</td><td>72</td></tr>
<tr><td>Seeds</td><td>3-4 %</td><td></td><td>42</td><td>32</td><td>26</td></tr>
</table>
</td></tr>
</table>

	Stalks	3-4 %	42	32	26
	Pruning	2 t/ha	200	354	339

- The collectability of pruning (2 t/ha dry matter (Europruning, 2017)) is considered a technical barrier. In particular when considering the variability in orchard types. The ability to mechanise the collection process has a large influence on the economic feasibility.
- In Spain, the company PELETS, COMBUSTIBLE DE LA MANCHA S.L. has developed and implemented a business case for the collection and processing of vineyard pruning for the production of pellets. It seems that they have been able to organise it as an economically feasible process.
- The main by-products of wine production are untreated grape pomace and the pruning. Although pruning collection from the fields could play a key-role, grape pomace is the residue offering the best opportunities for IBLCs. Untreated grape pomace is made of:
    - skins/peels
    - grape seeds (2-3 per grape berries); they have a hard epidermis protecting them from fermentation and distillation, seeds can be separated from the pomace for oil extraction;
    - stalks, that can be present or not; they affect the storage of the grape pomace.
- Untreated grape pomace is a main feedstock for distilleries and it is therefore questionable if untreated grape pomace will be available for other processing routes (such as biobased refinery).
- Grape pomace is less eligible as feedstock for feed industry because of its odour, and is therefore applied as fertiliser (Greece).

Potential synergies & benefits

- Distilleries have sufficient economies of scale and technology available that is appropriate for IBLC concepts for the processing of solid biomass and the extraction of bioactive compounds (Spain).
- The availability of facilities during the low season period in wine production (January until August) suggests availability for the processing of biomass (residues) in an IBLC. This applies in particular to the smaller wineries whereas larger wineries stay in production for a longer period August until January). Storage yards for grape pomace may provide opportunity as IBLC for the processing of grape pomace for energy and biobased production
- Efficient collection of biomass from the vineyards is complicated because of the small-scale structure in the sector, e.g. due to small fields and many owners. Also, the different ways of vineyard cultivation (vase,

	espalier, etc.) affect the level of mechanisation in the collection of pruning from the vineyards (as is the case in the Spanish winery sector). • Fragmented sector makes it difficult to obtain sufficient facilities/capacities that are useable for other biomass processing in idle periods with sufficient economies of scale. • Collection of biomass from vineyards requires careful logistical planning to minimise transport distance to a potential biomass processing facility. • It will contribute to optimize the supply chain to liaise with grower associations rather than with individual growers. • Wine industries have wide experience in the transport, management and processing of residues (from wineries to distilleries). • Labour in vineyard and wine production is seasonable and therefore sufficiently available for employment in IBLC activities.
Market developments	• Opportunities for residues from vineyards/ wineries/ distilleries as feedstock for the production of platform chemicals, biofuels, energy, soil fertilisation, and pharmaceutical / cosmetic use. • Opportunity for extraction of polyphenols, enocyanin, and other compounds for feed industry. • Utilization of biomass residues (pruning) provide opportunity as solid biomass for energy production. This market is already advanced with good insight in potential revenues based on market prices (€85-115 /t for consumer market and €70 /t for long-term contracts with biomass power plants). Successful examples have been recorded in Spain (Pelets de la Mancha) and Italy (Settesoli). • Due to the increasing costs of fossil-based chemicals and the increasing demand for sustainable resources, the by-products from grape-processing form a challenging pathway for IBLC development. • Deeper and dedicated research is needed in order to identify operators, available volumes and cost-revenue balances.
Non-technical barriers	• Regulatory framework is required to avoid suboptimal use of available biomass, and to create economic incentives for optimal valorisation. • Efficient logistical framework and effective mechanisation should overcome organisational barriers for collection of biomass. • The sector will need an impulse for modernisation and increase of awareness to exploit the potential of agro-residues. The reuse of residues from grape-processing will enable the circularity of the sector and the strengthening of the transition to overall sector sustainability. • Infant markets for high value biocommodities are impeded by a lack of demand and require a business strategy in which a balance exists between low value added (bulk) products with a secured demand and

	high value added products with low and insecure demand but potentially good prospects. • Agro-industries may lack the knowledge and technical assets to develop the activities as proposed by the IBLC concept. New associations with expert companies may circumvent this obstacle.

Table 11. Traffic light analysis for wine sector.

IBLC feasibility for sector wine						
	Spain	Greece	Sweden	Ukraine	Serbia	Average
	Sector profile					
Volume sector						
State sector						
Typical size companies						
Distinctive facilities sector						
Degree of innovation						
Miscellaneous						
	Opportunities for IBLCs					
Sector related residues						
Synergies & benefits						
Market developments						
Non-technical barriers						

Table 11 presents the traffic light analysis expressing the wine sector's suitability for establishing an IBLC, either as contributor of (sector related) agro-residues and/or of capacities for processing biomass. In this analysis the wineries and distillation of grapes and grape residues are taken as a combined activity within the wine sector, so no distinction was made between winery and distillation activities. Following this traffic light analyses the following conclusions can be drawn:

- According to the country studies the wine sector (grape cultivation + grape processing) the sector's volume is considered large to very large. This is not surprisingly when you take into account the European Union wine sector is the world leader (65 % of world production). Other wine producing countries that will score high on this criteria are France, Italy, Portugal, Romania and Germany (these countries combined with Spain produce 90 % of the EU's production volume).
- The sector is evaluated economically as very healthy which is expressed by a good market performance in terms of sales and a well-developed infrastructure for production and export.

Remember that many of the judgments in the traffic light analysis (e.g. healthy/unhealthy) are qualitative and thus no exact figures can be given here.

- The typical size of the companies operating in the wine sector can be phrased as 'medium'. This has largely to do with the fact that the sector is highly fragmented (many small scale grape-producers) and economies of scale are only available at the very few larger wineries and distilleries.
- A similar line of reasoning applies to the sector's innovation degree. Although innovations are implemented for increasing efficiency in grape production and harvesting, and for overall cost reduction in cultivation and processing, the perspective of innovating in alternative processing of product residues is rather limited.
- Although it was generally considered difficult to determine in which way facilities in the wine sector can be of use for alternative biomass processing, the overall potential of using the available facilities for IBLC purposes is judged as 'high' for most countries.
- According to the analysis the wine sector has the disposal of large volumes of sector related residues. This applies in particular to the availability of woody biomass from vineyard pruning, but also the grape processing yields potentially valuable residues, although the distilleries acquire a substantial share of the latter residues for the production of alcohol and spirits.
- The sector is estimated to create many synergies and benefits from facilities and technology that are available during the low-season of production, as well as of the available infrastructure and labour that can be mobilised for IBLC activities.
- Also the market is considered promising. That is, there are good market opportunities for the production and selling of various commodities and products from biomass (biobased) processing.
- The non-technical barriers to bring the potential of an IBLC into practice are evaluated as serious with a limited perspective to overcome. This has to do with the fact that the promising market outlets also contain new and relatively pioneering pathways towards industrial products based on renewables from biomass. But also the challenge of setting up cost-efficient and sustainable logistical infrastructure for the collection of biomass residues from the wine sector is considered difficult to overcome.

General conclusions: Although some of the major wine producing countries such as France and Italy are not included in the sector review, it is fair to state that the above conclusions apply to some extent to most of the wine producing countries in the EU. Based on the different aspects on which the sector's overall suitability has been inventoried and evaluated by the researchers, the wine sector is considered to have sufficient basis for further research into the feasibility of establishing IBLCs. Most importantly this will include research into feasible solutions to overcome the logistical bottleneck, as well as into the proposition of a market portfolio that will provide a balance between low – and high value added products from the IBLC.

3.1.5 Grain chain (incl. straw until final product biofuel)

In 2015, France accounted for more than one fifth (22.9 %) of the EU-28 cereal production (see map in Figure 15). Germany (15.4 %) and Poland (8.8 %) together contributed to nearly a quarter of the EU total. United Kingdom was the fourth largest cereal producer, accounting for 7.8 % of the EU-28 total.

Figure 16 presents the schematic design of the grain supply chain. Although it does not represent the chain for all types of grain, it does give a general impression of the steps that are involved in the processing of grains into its final product: flour. The figure shows the various residues that arise from the feedstock handling and processing steps in the value chain (marked by the light-brown diamond shapes).

After harvesting, both maize and rice need to reduce humidity rate, allowing better conservation along the food chain. This operation gets underway on vertical dryers. Depending on the local climate cereals need to be dried before storage as well. Once dried, feedstocks are dispatched to the different value chains. Generally, barley is used in two main industries: beer brewery and animal feed. The main destination of soft wheat is the industry of flours and bakery and durum wheat is used in pasta industry.

After reception into the bulk silos, a gas or thermal treatment to prevent infestation of grain is carried out. Before being milled, the wheat is fully cleaned from any impurities and wetted to the desired level for milling. The impurities that may be present in wheat are grains of other cereals, straw, paper, stones, sand, dust, glass, or metal.

The purpose of wetting or steaming of the grain is to allow a more efficient separation of bran from the endosperm and to achieve the appropriate degree of softness of the interior grain for the good performance during milling. Then a gradual milling process is applied consisting of the following three steps:

- The breaking system (which separates and removes the endosperm from the bran in relatively large pieces).
- The scraping system (which removes small pieces of bran and germ that are attached to the endosperm).
- The reduction system (which mills the endosperm into flour).

After the milling, the flour is mixed, enabling the creation of a large number of products, homogenising different flour and auxiliary materials at the desired ratio. Special processing consists of drying, separation of proteins, and the heat treatment of bran and milling fractions. After the mixing, the flour is transferred into storage silos or packed in bags.

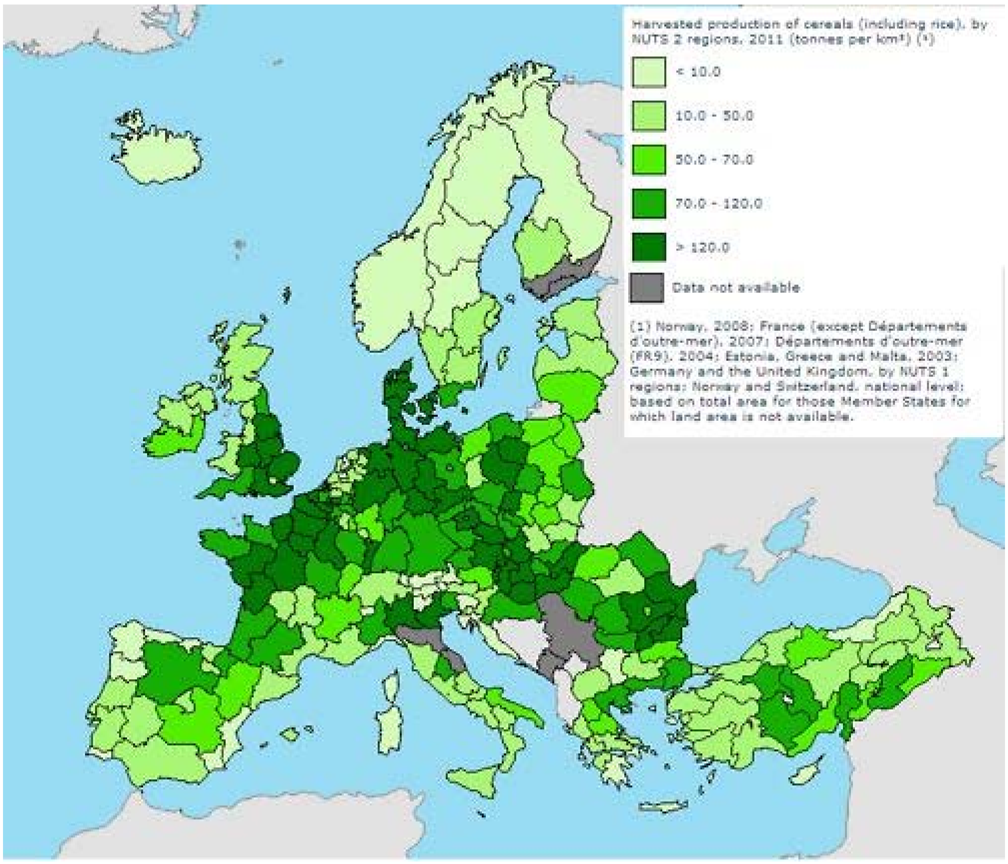


Figure 15. Map of the European grain sector (Eurostat, 2017).

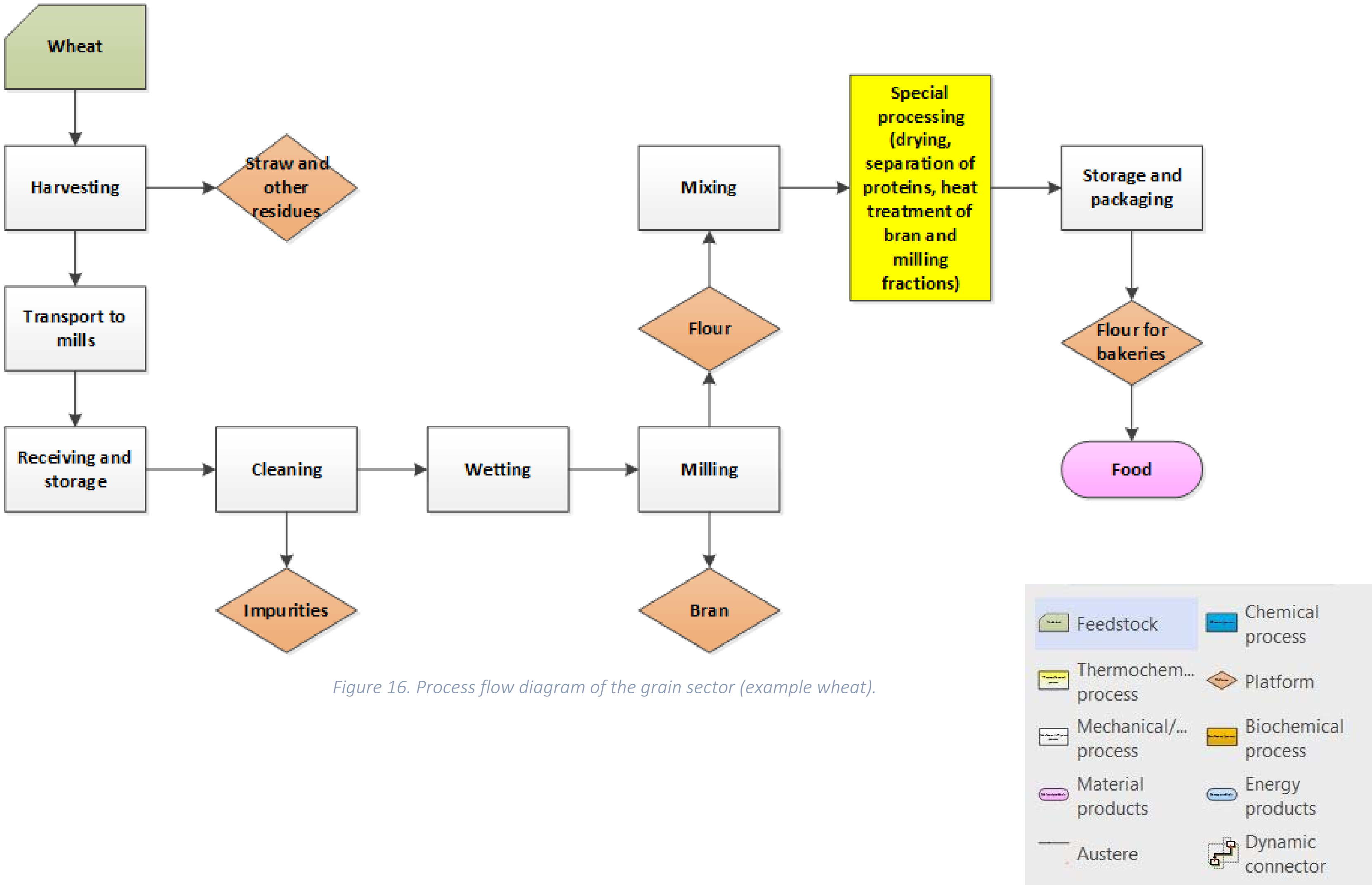


Figure 16. Process flow diagram of the grain sector (example wheat).

Table 12 provides a cross-country analysis for the grain sector in view of its potential for integration with IBLC concepts.

Table 12. Summary grain sector.

<table>
<tr><th colspan="2">Grain Sector</th></tr>
<tr><th></th><th>Profile</th></tr>
<tr><td>Production</td><td>Within the EU-28 large differences exist between countries and regions in production, yields and efficiency (both in farming and in processing).
The main feedstock from the grain sector are wheat, barley, maize, rye, and oats. Production of cereals (incl. rice) in 2015 was approximately 317 million tons.
Main cereal producing countries are France, Germany, Poland and UK.
Main rice producing countries are Italy, Spain, Greece and Portugal.
Grains are primarily processed for food (flour) and feed production.</td></tr>
<tr><td>Volume of the sector</td><td>Cereal producing countries in EU (acreage / production, 2016) (DG Agri. 2017):
<table>
<tr><th></th><th>Acreage ('000ha)</th><th>Production ('000 000t)</th></tr>
<tr><td>EU-28</td><td>56,900</td><td>295</td></tr>
<tr><td>Share in production:</td><td></td><td></td></tr>
<tr><td>France</td><td></td><td>22.9 %</td></tr>
<tr><td>Germany</td><td></td><td>15.4 %</td></tr>
<tr><td>Poland</td><td></td><td>8.8 %</td></tr>
<tr><td>UK</td><td></td><td>7.8 %</td></tr>
</table>
<table>
<tr><th></th><th>Acreage ('000ha)</th><th>Production ('000 000t)</th></tr>
<tr><td>EU-28</td><td>56,900</td><td>295</td></tr>
<tr><td>Of which:</td><td></td><td></td></tr>
<tr><td>Soft wheat</td><td>24.2</td><td>134.1</td></tr>
<tr><td>Durum wheat</td><td>2.7</td><td>8.9</td></tr>
<tr><td>Barley</td><td>12.3</td><td>59.3</td></tr>
<tr><td>Maize</td><td>8.5</td><td>60.2</td></tr>
<tr><td>Rye</td><td>2.1</td><td>7.9</td></tr>
<tr><td>Oats</td><td>2.5</td><td>8.1</td></tr>
</table></td></tr>
<tr><td>State of the sector</td><td>The grain sector contains a variety of different cereal crops, each of which largely dominated by the world market.
The grain sector is an important sector in the EU with (large) regional differences in performance in terms of production yields, processing efficiency and industrial development.</td></tr>
<tr><td>Typical size of the companies</td><td>Regional differences within the EU in both farming structure (small vs. large), and industrial processing.
Depending on the type of grain there are regional differences on scale/size of companies in production and processing:</td></tr>
</table>

	o Larger scale in Nordic countries (Sweden) and small scale structures in countries in the Mediterranean area. o Predominantly smaller mills in Europe operating for large brands. o Some countries with domination by a few (or one) large processing companies (Greece, Sweden) and vertical integrations (Serbia).
Distinctive facilities of the sector	• Very limited match between grain processing technology and methods for biomass processing. For example, vertical grain dryers are not suitable for drying biomass. • Availability of idle grain processing capacities is also limited to none because of year-round processing operations for the flour markets.
Degree of innovation	• Depending on the size of the processing industry there are more or less financial means available for innovation. • Technically outdated processing facilities lead to inefficiencies in industrial processing and relatively larger volumes of product residues. • Awareness of and motivation to reuse crop residues and/or residues from processing varies per country/region with a generally high awareness and motivation in the Nordic countries. Grain sectors and industries in the Eastern European countries with a low degree of innovation show inefficiencies and correlated product losses in primary production and processing (with large volume of residues).
Miscellaneous	• The potential of using crop residues for biobased applications has to be balanced with the necessity to avoid depletion of resources and to maintain the regeneration capacity of these resources (in particularly of agricultural soils). • The existence of opportunities for IBLC concepts depends on the interest of large industries and their willingness to invest in processing of biomass (residues) for biobased production. • As in some of the other sectors, the burning of crop residues (biomass) in the fields (legally or illegally) as a low cost disposal of 'waste', decreases the availability of potential feedstock for IBLCs. On the other hand, it offers opportunities to organise alternative processing through the collection of this biomass in a cost efficient way. • Interregional differences in (logistical) infrastructure and in the level of technological development influence the suitability and applicability of IBLC activities.
	Opportunities for IBLCs
Sector related residues	• The grain sector generally produces considerable volumes of biomass residues, including straw, stalks, stubble, corncobs, bran and husks (or hulls). These residues represent a lignocellulose-rich feedstock that could become available for bio-energy application in solid biofuels, gasification and for next generation biofuels.

	• Cereals delivered to the mills are mostly already cleaned from their residues. Availability of these residues will therefore require involvement from the farm sector, or an alternative approach towards the co-harvesting of these crop residues. • The use of rice husks (depending on the cultivar 17-23 % of grain weight) as biomass for bio-energy is interesting to further develop IBLC concepts, because the costs of acquiring these residues are low. Economic feasibility is, in other words, within reach. This applies to the main rice producing countries Italy (30.4 million tons), Spain (16.9 million tons), Greece (5.0 million tons) and Portugal (3.7 million tons). • The use of rice husks in fuel pallets will require attention to the problem of detrimental ashes in pellet combustion heaters. • Maize processing industries also have several unexploited residues such as corn cobs, leaves and stalks that potentially could be valorised both for bio-energy and the manufacture of bio-commodity purposes. • Straw can be considered as a potential feedstock for bioenergy although it has competing markets from the animal feed/husbandry sector.
Potential synergies & benefits	• Seasonality in grain processing may offer opportunities to combine core industrial activities with additional IBLC activities, although the potential match of equipment for rice and cereal drying and for the processing of biomass may be limited. • There are some good experiences with the use of straw for biobased processing (solid biofuel). Also the processing of chaffs is expected to offer opportunities. • Given the size of the grain sector, the sector is able to concentrate a potentially large amount of biomass residues. However, facilities are scattered over a wide territory. Large companies will cover large production areas and may have the disposal of modern agricultural mechanisation (Serbia). • It is recommended to apply IBLC activities in the first stage processing of residues close to the production areas. The involvement of the cereal processing industries seems (too) complicated. (Spain) • Complication is that substantial parts of the residues from the grain sector are consumed in the animal husbandry sector. • The fact that the grain sector is connected with a variety of industries may give some potential to combine these industries' activities with IBLC-operations (Serbia).
Market developments	• Residues from the grain sector are particularly interesting for the solid biofuel markets. • Other applications in for example biobased furniture and bioplastics are under investigation.

	• Price uncertainty (volatility) forms a considerable barrier (for grain sector industries) to invest in new biomass processing lines. Seasonality in supply and price volatility of the end-product pose barriers in the starting-up of new biomass processing activities (Spain). • Same line of reasoning holds for the investment in logistics for the collection of residues.
Non-technical barriers	• Insufficient idle periods so no capacity for the processing of biomass residues. • Also mentioned: insufficient residues / by-products (already consumed for animal feed and energy). • Uncertainties regarding the future production potential of crop production creates uncertainties concerning the bioenergy potential. • Sometimes low awareness in the sector, lack of government support, and lack of investment funds form blockades in the starting up of biomass processing activities. • Competition from low-priced fossil fuels hampers business cases for biobased equivalent products. • A significant financial barrier arises from the high costs of investing in biomass processing.

Table 13. Traffic light analysis for sector grain.

IBLC feasibility for sector grain						
	Spain	Greece	Sweden	Ukraine	Serbia	Average
	Sector profile					
Volume sector						
State sector						
Typical size companies						
Distinctive facilities sector						
Degree of innovation						
Miscellaneous						
	Opportunities for IBLCs					
Sector related residues						
Synergies & benefits						
Market developments						
Non-technical barriers						

Table 13 presents the traffic light analysis expressing the suitability of the grain sector for establishing an IBLC, either as contributor of (sector related) agro-residues and/or of capacities for processing biomass. In this analysis, the grain chain includes also the processing of straw until the final product biofuel. Based on the traffic light analysis the following observations were summarised:

- The volume of the grain sector is evaluated as large to very large. The reason for this is of course that the grain sector forms an important backbone in the European agricultural sector for the production of food.
- The state of the sector is generally considered to be healthy. Although large differences between countries in the sector's performance and efficiency exist, the overall performance of the sector on a global market is quite good. Remember that many of the judgments in the traffic light analysis (e.g. healthy/unhealthy) are qualitative and thus no exact figures can be given here.
- The typical size of the companies involved in the grain sector shows a more ambiguous picture. Whereas South European countries have predominantly small scale processing mills, Nordic and East European countries have larger scale production facilities. Nordic countries, with larger scale production facilities, are considered better equipped for combining with IBLC activities that southern European countries.
- A similar line of reasoning applies to the availability of facilities in the grain chain that could be shared with the processing of biomass in an IBLC.
- In view of this, it is remarkable that the Spanish grain sector has a high innovation degree, whereas for other countries this is valued as medium.
- In general, the grain chain yields considerable volumes of residues during cultivation and harvesting. The availability of these residues for alternative processing may be somewhat variable between the countries. This may be a reason for the differences between the countries in the interpretation of this aspect.
- On average, the synergies and benefits between the cultivation and processing activities in the grain chain and the processing of biomass in an IBLC are considered as being many. The traffic light analysis does, however, show differences for Greece (few synergies) and to a lesser extent also for Serbia (some synergies).
- Also, the aspect of market development shows different interpretations for the countries in terms of offering opportunities for setting up IBLCs in this sector. The overall impression is that there are some good but also rather uncertain market opportunities. For Spain, these opportunities are gloomier, whereas Ukraine's grain sector is expected to offer excellent opportunities for connecting IBLCs with this sector.
- Apart from Sweden, all countries have a rather pessimistic view on the establishing of IBLCs in the grain sector based on the non-technical barriers that will have to be overcome. This has partly to do with the availability of residues for biobased processing, as in current practice these residues already of market-outlets. Mentioned also are the low awareness in the sector and the lack of governmental support and financial means for investing risk-bearing biomass processing.

General conclusions: Based on the sector analysis the grain sector does not seem to provide a convincing basis for the establishing of IBLCs. However, the analysis also showed that there are large differences between countries regarding the sector's suitability. The analysis of the grain sector in Ukraine and Sweden indicated a good basis for setting up IBLC activities both from production and market point of view, while the analysis of the grain sectors in Spain and Greece showed less favourable conditions. Given the fact that the grain sector is an important contributing sector in European (and global) agriculture it is advisable to investigate the feasibility of establishing IBLCs in connection with the grain sector in those countries that have a sufficient starting point (amongst which the availability of feedstock and facilities, market perspective, business awareness, governmental support, etc.).

3.1.6 Sugar industry

The sugar production (Figure 18 & 19) starts in the field with the sugar beets and ends with a diversity of products, including sugar products, feed products (molasses, beet pulp), sugar factory lime, stones, beet soil and water. After harvest, the farmers supply the sugar beets to the sugar industry where the beets are unloaded, washed from all soil residues and then slices into pieces. The slices, or cosettes, then enter a diffusion process in which the slices are heated and a sugared juice is collected from a pulp residue. After compression of the wet pulp, the juice fraction will enter a process of purification through liming and carbonation. Through evaporation the purified thin juice will be transformed into thick juice that is condensed in a crystallization process. The residue that remains after centrifugation and drying is crystal sugar.

Some products made in the factory are recirculated into the system as biogas, steam and water. As an example, the biogas produced at the site is combusted and the heat is utilized in the process.

Figure 17 gives an impression of the main sugar beet production areas in the EU-28, as well as of the locations of the factories where sugar beets are processed into beet sugar. Part of the residues from sugar beet processing is used as feedstock in bio-energy production, including the production of biofuels (ethanol). In the map (figure 17) are therefore also the locations of the factories indicated where ethanol is distilled from sugar beets. The map clearly shows that France and Germany are leading in the processing of sugar beet and sugar beet residues into bio-ethanol.

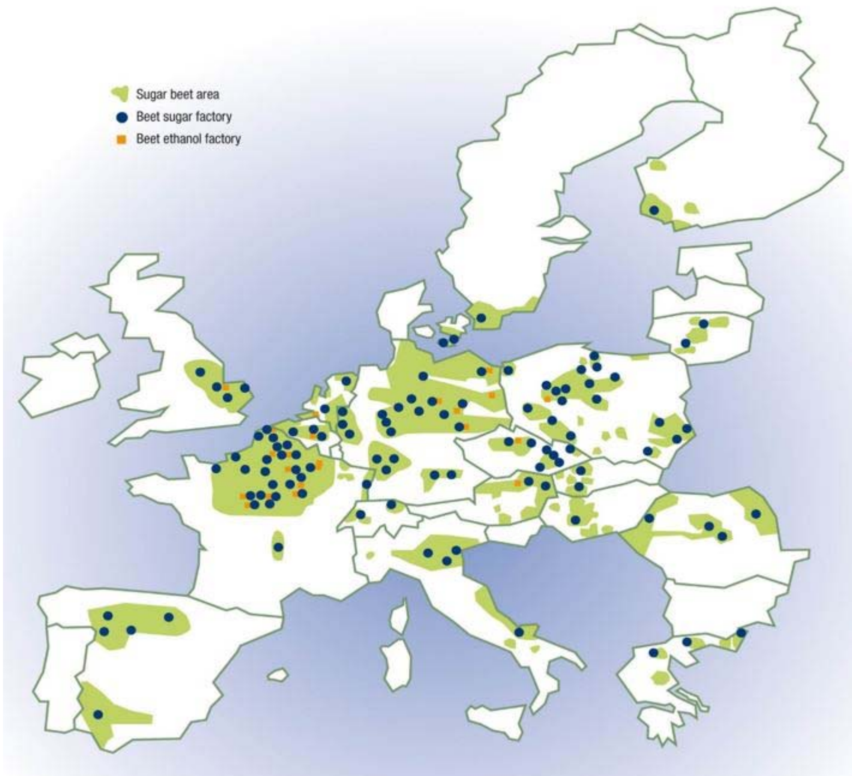


Figure 17. Sugar beet sector in the European Union (source: http://www.cibe-europe.eu).

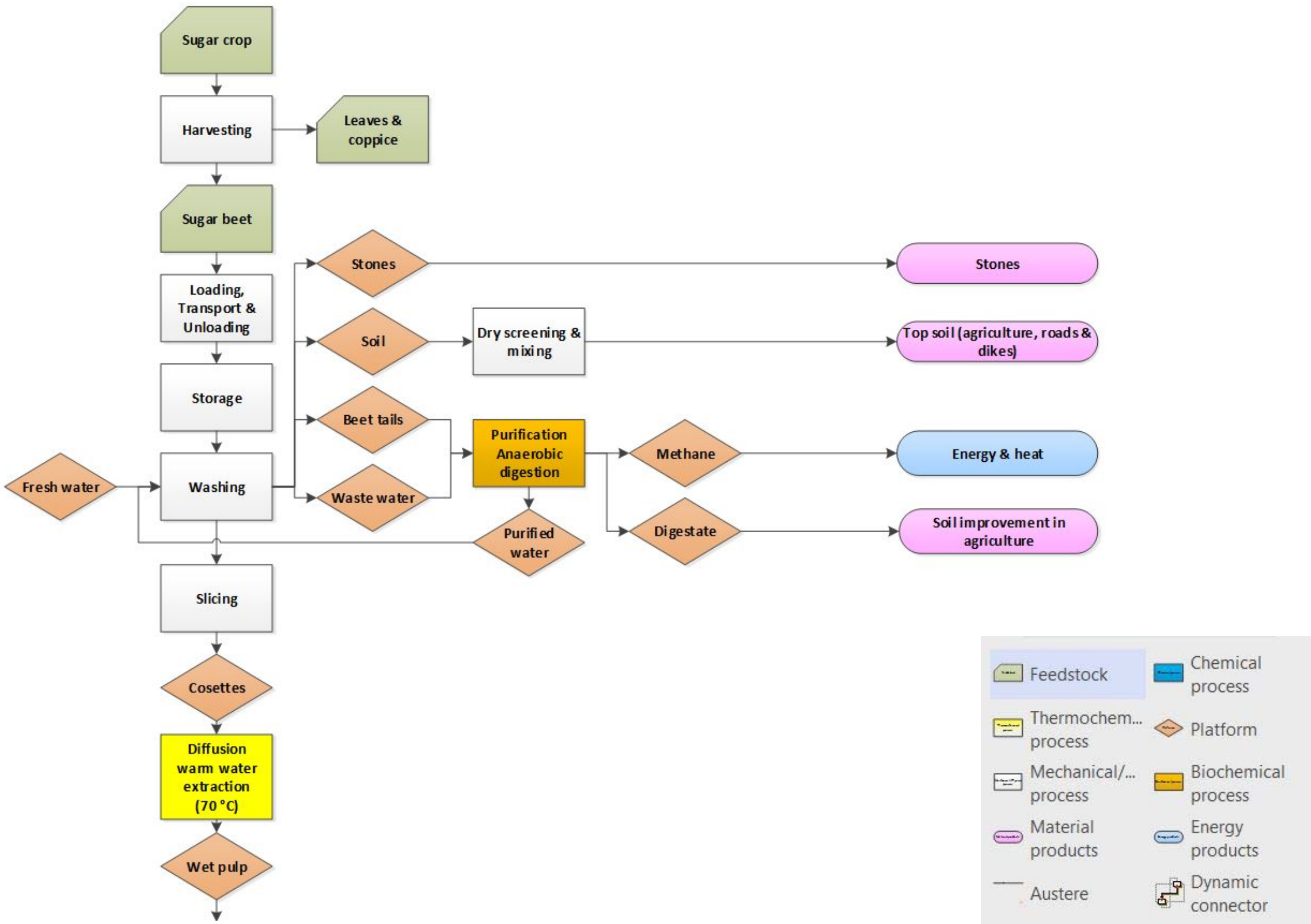


Figure 18. Process flow diagram of the first part of the sugar sector.

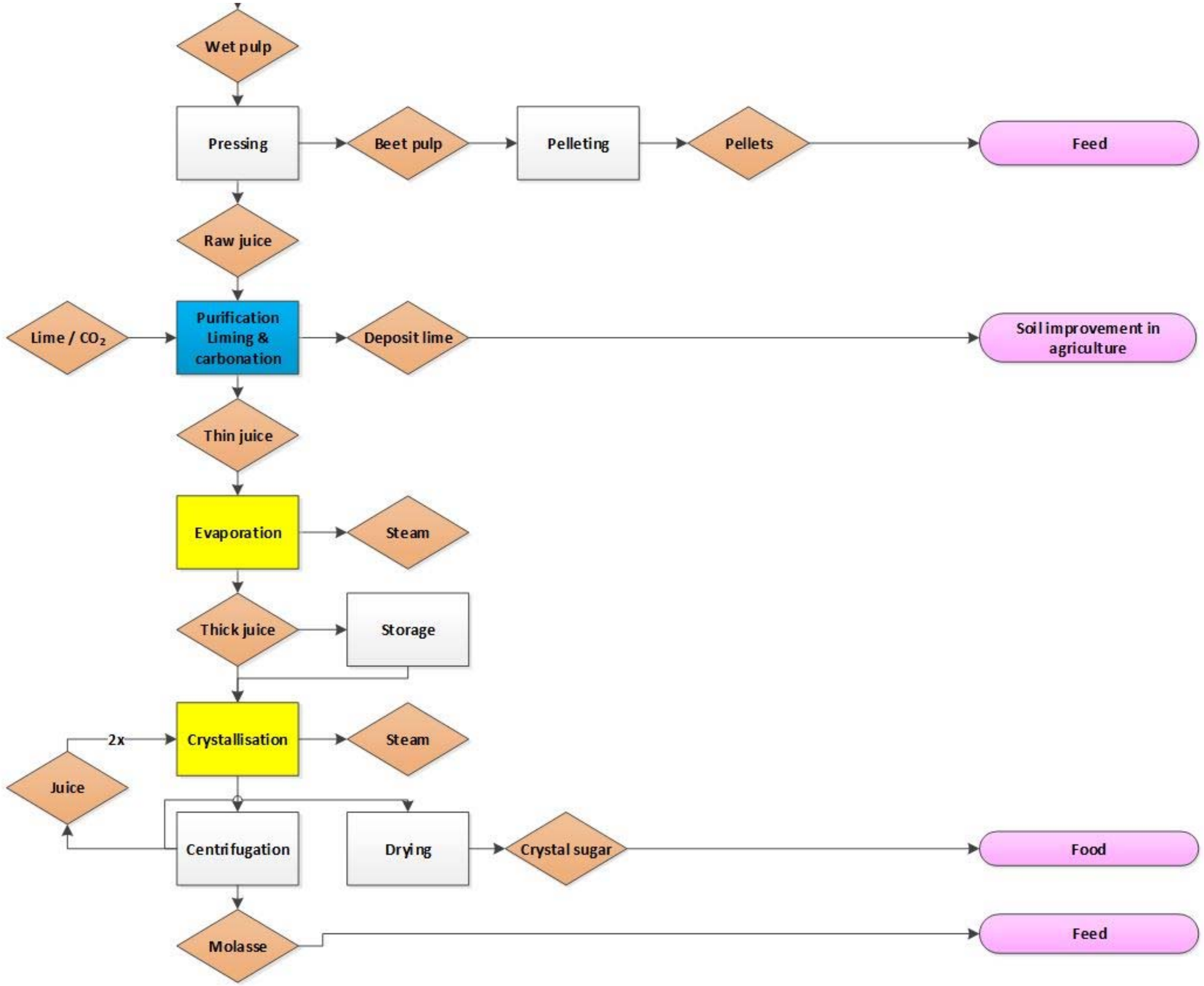


Figure 19. Process flow diagram of the second part of the sugar sector.

Table 14 provides a cross-country analysis for the sugar sector in view of its potential for integration with IBLC concepts.

Table 14. Summary sector sugar.

Sector Sugar	
Profile	
Production	• EU is the world's leading producer of sugar from sugar beet, with around 50 % of the total in yielded tons. Most of the EU's sugar beet is grown in Northern Europe where the climate is more suited to growing beet. The most competitive producing areas are in northern France, Germany, United Kingdom and Poland. • Depending on the size and the structure of the processing factory, a sugar beet processing plant is operational for 100 days per year (length of the beet campaign depends on the time between the first harvest and the first frost period). During this period, the total yield of sugar beet is processed into crystal sugar and molasses. • Sugar production starts in the field with the sugar beets and ends with a diversity of products: sugar products, feed products (molasses, beet pulp), lime, stones, soil and waste water. • A tonne of sugar beets yields 14-18 % of sugar, depending on the variety and the growing conditions.
Volume of the sector	• Sugar beet producing countries in EU, 2016 (acreage / % of EU total sugar beet acreage / sugar beet production / production white sugar) (EUROSTAT, 2017; UCAB, 2017; UBFME, 2017): (see table below)
State of the sector	• There is a strong interdependence between the sugar processing industry and the farming sector. Sugar factories contract farmers directly to supply sugar beets to their factory. Farm-gate prices for sugar beet and competition from other crops affect the farmers' commitment to grow sugar beet. Well performance by the sugar industry in an open global

	Acreage ('000ha)	Share in EU sugar beet acreage	Sugar beet production ('000t)	Production white sugar ('000t)
EU-28	1,411	100 %	141,094	n.a.
Share in production:				
France	405	27 %	46,257	n.a.
Germany	335	22 %	34,060	n.a.
Poland	206	14 %	14,040	n.a.
UK	86	6 %	9,000	n.a.
Netherlands	71	5 %	7,959	n.a.
Ukraine	292	-	12,000	1,700
Serbia	49	-	2,684	626

	market is important for the overall performance and continuance of the entire sugar supply chain. • Until October 2017 the EU market for sugar beets had been regulated for 50 years with quotas and minimum prices. With the expiration of the EU regulation the sector's performance has been under pressure in the past years. Effects of the ending of the EU quota regime may have uncertain price effects on the sector and on the industry. Uncertainty about the price responses in the markets, as well as about the farming sector's response across Europe may affect the overall performance in the supply chain. • Global demand for sugar products is expected to grow, even though in some regions demand may decrease.
Typical size of the companies	• European industry for processing sugar beet is generally large scale with in some countries single large industries such as: Nordzucker, Tereos France, Hellenic Sugar Industry, Suiker Unie and British Sugar. • In Serbia the sector is dominated by medium and large sugar producers (7 sugar plants in total).
Distinctive facilities of the sector	• The sugar beet processing is a seasonal activity (3-5 months). However, for the large scale sugar industries sugar refinery is a year-round process. • Facilities and equipment that are used for sugar beet processing may be suitable and available for IBLC activities, incl. storage areas, feedstock handling, driers / evaporators, and pelletisers. • In countries where sugar beet processing facilities are idle part of the year, there are good leads to further examine the possibilities for combining sugar industries with IBLC activities.
Degree of innovation	• The sugar industry is generally a mature industry. Innovation in sugar beet processing is primarily focused on increasing energy efficiency, although research and innovation in agronomic features of sugar beet cultivation has ample attention as well. • Energy efficiency of the processing factories also concerns the clean and sustainable fuelling of the processes, as is the case in Serbia where coal is still an important (cheap) energy resource. • Sugar processing industries in the northwest European countries are open to innovation in biobased processes and products, if it will strengthen their core business activities.
Miscellaneous	• The availability and price of sugar beet, as well as the LCA-comparison between sugar beet refinery and other competing crops (such as wheat) into biobased products influences the competitiveness of sugar beets as feedstock for biobased refinery.
	Opportunities for IBLCs
Sector related residues	• A ton of sugar beet (when including the leaves and coppice an extra 490 kg would be added) yields on average 14 % of its mass in granulated sugar

	(140 kg). The remainder consists of residues and by-products, incl. beet tails, soil, stones, water, molasses, beet pulp and deposit lime (Harmsen et al., 2014) • Applications of beet pulp are in energy production (biogas, solid biofuels), animal feed and paper. • The sugar industry's biomass residues are entirely used, mainly for animal feed.
Potential synergies & benefits	• Sugar beet processing capacity is idle for considerable part of the year (6-8 months, mid January until mid-September). • It is, however, unclear in how far this equipment is suitable and available for processing of other biomass. • In addition, the large scale capacity of the sugar beet processing lines will require equal scale of flows for other biomass feedstock. Some small-scale parts of the production line may be suitable. • Residues from sugar beet processing are all used, mainly for animal feeding and in bioenergy production. • Potential to use residues in the production of bioethanol or biogas creates alternatives for higher valorisation. • Same line of reasoning for use of sugar as feedstock in bioplastics and polymers. • Creating synergies with alternative biorefinery processing routes will create less dependence on fluctuating food markets and may strengthen the business case of the sugar beet crop.
Market developments	• It is difficult to predict how the abandoning of the quota regime will affect other (larger) sugar beet producing countries. The lifting of the quota regime may very well lead to a decrease of the sugar beet acreage in countries such as Serbia. • Sugar industries have an open innovative attitude towards finding alternative processing routes for sugar beet feedstock and its residues (such as for the production of PLA in bioplastics, platform chemicals). • However, generally the sugar industry's biomass residues are entirely used, mainly for animal feed. • Volatility of the sugar price makes it difficult to develop a business case for alternative processing. On the other hand, alternative processing of sugar feedstock may lead to new markets and niches that can strengthen the overall business case. • Currently beet leaves are left in the field and are not further processed. The fact that this is a biomass resource with a substantial volume (40 t/ha, 5 t DM/ha), and because it has a potential purpose as feedstock for food (Rubsico protein), feed and energy (biogas), sugar beet leaves may be interesting for further investigation.

Non-technical barriers	• The large scale sugar processing companies and the concentration of production in only three sugar beet producing countries (France, Germany and Poland) may very well lead to a monopolistic structure. • The industry may not be very open and is rather cautious towards other stakeholders as the margins are small and are yearly fluctuating with the beet price.

Table 15. Traffic light analysis for sector sugar.

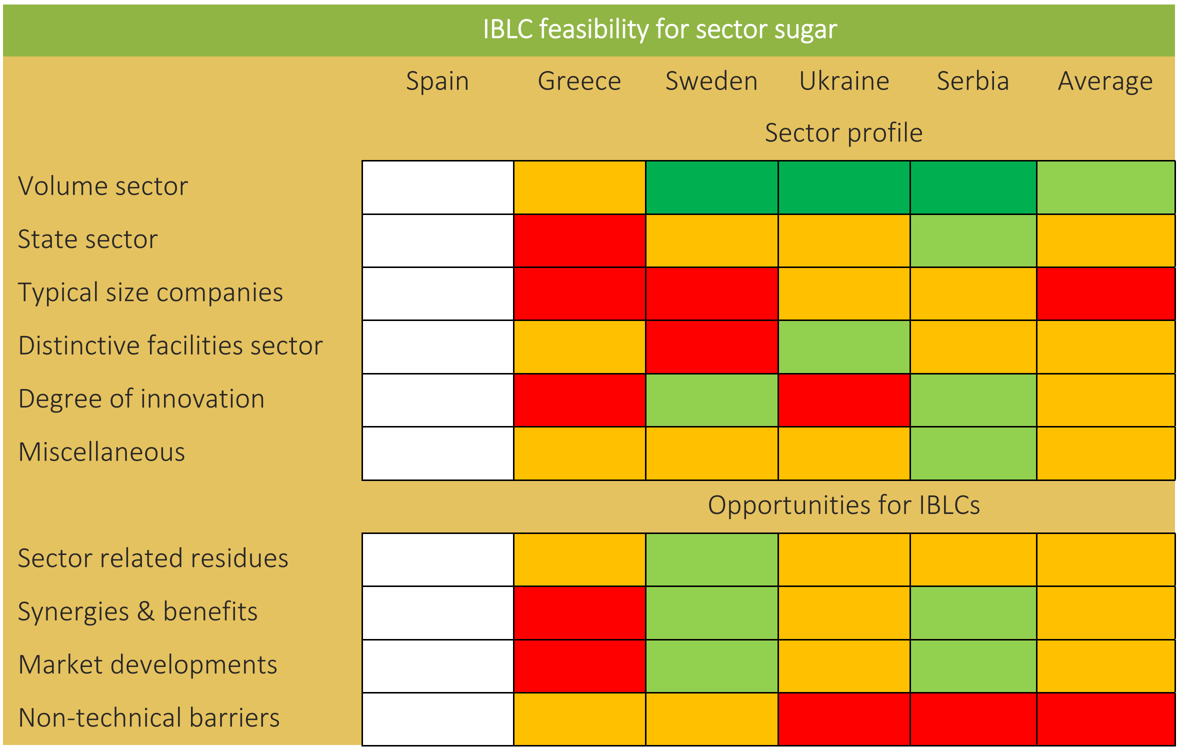


Table 15 presents the traffic light analysis expressing the suitability of the sugar sector for establishing an IBLC, either as contributor of (sector related) agro-residues and/or of capacities for processing biomass. Based on the traffic light analysis the following observations were summarised:

- In the countries that were investigated, the volume of the sugar sector is evaluated from medium (7.400 ha in Greece) to large (32,000 ha in Sweden and 49,000 ha in Serbia) and very large (292,000 ha in the Ukraine). In general, the sector is valued as adequately sized as starting point for setting up IBLCs.
- The state of the sector and also the typical size of the companies give a less favourable impression, especially for the sugar sectors in Greece and Sweden. The state of the sugar sector is reflected in the price uncertainty that is the result of the abolition of the EU quota regime for sugar and sugar beets (2017). Remember that many of the judgments in the

traffic light analysis (e.g. healthy/unhealthy) are qualitative and thus no exact figures can be given here.

- In the case for both Greece and Sweden few companies of suitable size are expected to be eligible as IBLC. This is due to the fact that the sugar sector (as in many other European countries) is dominated by very few or even one sugar producing company.
- The availability of distinctive facilities is generally considered medium, in which only a few facilities in the sugar chain are available and suitable for the processing of biomass residues. This is, however, hardly the case for Sweden (only one facility) whereas Ukraine has interpreted the availability of a wider range of facilities to be available.
- The degree of innovation in the sugar sector shows a rather mixed picture for the different countries. Both Greece and Ukraine have indicated low innovation levels in the sugar sector, while Sweden and Serbia indicate high levels of innovation. For Sweden, representing one of the largest sugar industries in Northwest-Europe, this particularly applies to innovation into alternative applications of residues from sugar beet processing in biobased products.
- The availability of sector related residues is for most countries medium, except for the sugar sector in Sweden. Here large volumes are considered to be available for processing in IBLCs.
- Synergies and benefits from combining sugar beet processing activities with biomass processing activities in an IBLC are expected to be many in the cases of Sweden and Serbia. In general, these two countries have a more positive attitude when it comes to the potential of the sugar sector in combination with IBLC activities.
- This is not the case for the Greek sugar sector that sees limited market opportunities for IBLC at this moment. Although Ukrainian sugar sector sees some good market opportunities, it considers non-technical barriers to be an obstacle that is difficult to overcome, which predominantly concerns the cautious attitude of the industry and their focus on becoming self-sufficient in the manufacturing of sugar.

General conclusions: In some European countries the sugar industry is considered as one of the most innovating agro-industries in the field of bio-refinery and biobased products. The analysis of the sector that was done for the 4 countries in this study shows, however, an outcome that the sector's suitability is characterised as medium to poor. An aspect that cannot be ignored is the recent change in the EU quota regime that has raised uncertainty within the sector of market prices and revenues within the sugar chain (for both sugar beet growers and processing industries). This may perhaps have changed once the transition to a market regime will be completed by the industries and their suppliers. But given its potential as an important European large scale agro-industry and its innovating potential in bio-refinery it is worthwhile to further investigate the feasibility of IBLCs in the sugar sector on a case-by-case basis.

4 OVERALL CONCLUSIONS

The average traffic light values if the six sectors are given in Table 16. This leads to some overall conclusions per sector.

Table 16. Traffic light analysis for the six sectors.

IBLC feasibility per sector						
	Vegetable oil	Olive oil mills	Feed & fodder	Wine	Grain	Sugar
	Sector profile					
Volume sector	light green	dark green	light green	dark green	light green	light green
State sector	light green	light green	orange	dark green	light green	orange
Typical size companies	orange	light green	orange	orange	orange	red
Distinctive facilities sector	orange	light green	light green	light green	orange	orange
Degree of innovation	orange	light green	red	orange	orange	orange
Miscellaneous	light green	light green	red	orange	orange	orange
	Opportunities for IBLCs					
Sector related residues	light green	dark green	red	light green	light green	orange
Synergies & benefits	red	light green	orange	light green	light green	orange
Market developments	orange	light green	red	dark green	orange	orange
Non-technical barriers	red	red	light green	red	red	red

Vegetable oil

For all assessment categories the values for the vegetable oil extraction sector vary a lot between the countries. The analysis indicates that the vegetable oil extraction sector in general does not have many opportunities for establishing IBLCs. Although the sector has large volumes of residues, it only has a few synergies & benefits, only some market opportunities but rather uncertain and serious non-technical barriers with limited perspective to overcome.

Olive oil mills

For all assessment categories the values for the olive oil mills sector vary only a bit between the two countries. The analysis indicates that the olive oil mills sector has many opportunities for establishing IBLCs since it has a very large volume of residues, many synergies & benefits and good market opportunities with promising perspective. The only problem is that there are serious non-technical barriers with limited perspective to overcome.

Feed & fodder

For all assessment categories the values for the feed and fodder sector vary between the four countries, but not very much. The assessment indicates that the feed and fodder sector has some but limited opportunities for establishing IBLCs, since it has only a low volume of residues (unless it uses residues from other sectors), some synergies & benefits and only a few good market opportunities that are rather uncertain. A positive point is that there are only small non-technical barriers that can be overcome.

Wine

Although some of the major wine producing countries such as France and Italy are not included in the sector review, it is fair to state that the conclusions from this study apply to some extent to most of the wine producing countries in the EU. Based on the different aspects on which the sector's overall suitability has been inventoried and evaluated by the researchers, the wine sector is considered to have sufficient basis for further research into the feasibility of establishing IBLCs. Most importantly this will include research into feasible solutions to overcome the logistical bottleneck, as well as into the proposition of a market portfolio that will provide a balance between low – and high value added products from the IBLC.

Grain

Based on the sector analysis the grain sector does not seem to provide a convincing basis for the establishing of IBLCs. However, the analysis also showed that there are large differences between countries of the sector's suitability. The analysis of the grain sector in Ukraine and Sweden indicated a good basis for setting up IBLC activities both from production and market point of view, while the analysis of the grain sectors in Spain and Greece showed less favourable conditions. Given the fact that the grain sector is an important contributing sector in European (and global) agriculture, it is advisable to investigate the feasibility of establishing IBLCs in connection with the grain sector in those countries that have a sufficient starting point (amongst which the availability of feedstock and facilities, market perspective, business awareness, governmental support, etc.).

Sugar

In some European countries, the sugar industry is considered as one of the more innovating agro-industries in the field of bio-refinery and biobased products. The analysis of the sector that was done for 4 countries in this study shows, however, an outcome that the sector's suitability is characterised as medium to poor. An aspect that cannot be ignored is the recent change in the EU quota regime that has raised uncertainty within the sector of market prices and revenues within the sugar chain (for both sugar beet growers and processing industries). This may perhaps have changed once the transition to a market regime will be completed by the industries and their suppliers. But given its potential as an important European large scale agro-industry and its innovating potential in bio-refinery it is worthwhile to further investigate the feasibility of IBLCs in the sugar sector on a case-by-case basis.

5 REFERENCES

Agriconsulting, 2017. Agriconsulting experience "Valorizzazione energetica delle biomasse residuali agricole nella serricoltura siciliana" F. Rossi, G. Mattei results of programme PRO.BIO, SER.EN.RI. project: pag 77-78; pag 89-104; pag 117-121.

Annevelink E., B. van Gogh B., F.S. Nogués, S. Espatolero, T. de la Cruz, D. Luzzini, M. Karampinis, M. Kougioumtzis and J. Olson, 2017. Updated conceptual description of an Integrated Biomass Logistics Centre (IBLC). Report of the project AGROinLOG, project funded by the European Union's H2020 research and innovation programme. http://agroinlog-h2020.eu/en/2017/05/09/d6-1_-updated-conceptual-description-of-an-iblc/

CEEV, 2016. European Wine: a solid pillar of the European Union economy. Brochure, 16 pp. www.ceev.eu/images/documents/press_releases/2016/Brochure_CEEV_-_High_resolution.pdf .

CESFAC – Confederación Española de Fabricantes de Alimentos Compuestos para Animales, 2017. www.cesfac.es

Harmsen P., S. Lips, H. Bos, B. Smit, S. van Berkum, J. Helming & R. Jongeneel, 2014. Suiker als grondstof voor de Nederlandse chemische industrie; gewassen, proces, beleid. Wageningen Food & Biobased Research / LEI Wageningen UR.

Europruning, 2017. http://europruning.eu/

Eurostat, 2017. Agri-environmental indicator - cropping patterns. http://ec.europa.eu/eurostat/statistics-explained/index.php/Agri-environmental_indicator_-_cropping_patterns

Eurostat, 2015. http://ec.europa.eu/eurostat/

Eurostat, 2014. http://ec.europa.eu/eurostat/

FEFAC, 2017. Annual report 2016-2017. Brochure, 24 pp. www.fefac.eu/files/75933.pdf

Prade, T., S.-E. Svensson, T. Hörndahl, E. Kreuger & J.E. Mattsson, 2015. Vall och helsäd ger mycket biogas! LTV faculty fact sheet 2015:27. SLU Alnarp

Smit A.B. & S.R.M. Janssens, 2016. Factsheet Reststromen suikerketen. LEI Wageningen UR. http://edepot.wur.nl/368098

Sucellog, 2017. Project deliverables. Available from: www.sucellog.eu/en/publications-reports.html

6 Annex A. Overview of supporting country reports

The supporting country reports have been published as separate deliverables with the following numbers:

D6.2.1. Country report Spain - SPANISH CO-OPS

D6.2.2. Country report Greece - CERTH

D6.2.3. Country report Sweden - RISE and Lantmännen

D6.2.4 Country report Ukraine - UCAB

D6.2.5 Country report Serbia - UBFME

D6.2.6 European view - AESA

7 ANNEX B. TRAFFIC LIGHT ANALYSIS PER COUNTRY

The traffic light analysis was performed by each individual country. The explanation of the colours for the various categories can be found in section 2.1.6 in Table 3.

Table 17. Integrated traffic light analysis for the six sectors for Spain (Sugar not covered).

IBLC feasibility per sector						
	Vegetable oil	Olive oil and olive pomace oil	Feed & fodder	Wine	Grain	Sugar
	Sector Profile					
Volume sector						
State sector						
Typical size companies						
Distinctive facilities sector						
Degree of innovation						
Miscellaneous						
	Opportunities for IBLCs					
Sector related residues						
Synergies & benefits						
Market developments						
Non-technical barriers						

Table 18. Integrated traffic light analysis for the six sectors for Greece (Feed & fodder not covered).

IBLC feasibility per sector						
	Vegetable oil	Olive oil mills	Feed & fodder	Wine	Grain	Sugar
				Sector Profile		
Volume sector						
State sector						
Typical size companies						
Distinctive facilities sector						
Degree of innovation						
Miscellaneous						
				Opportunities for IBLCs		
Sector related residues						
Synergies & benefits						
Market developments						
Non-technical barriers						

Table 19. Integrated traffic light analysis for the six sectors for Sweden (olive oil and wine not covered).

IBLC feasibility per sector						
	Vegetable oil	Olive oil mills	Feed & fodder	Wine	Grain	Sugar
				Sector profile		
Volume sector						
State sector						
Typical size companies						
Distinctive facilities sector						
Degree of innovation						
Miscellaneous						
				Opportunities for IBLCs		
Sector related residues						
Synergies & benefits						
Market developments						
Non-technical barriers						

Table 20. Integrated traffic light analysis for the six sectors for Ukraine (olive oil and wine not covered).

IBLC feasibility per sector						
	Vegetable oil	Olive oil mills	Feed & fodder	Wine	Grain	Sugar
	Sector profile					
Volume sector						
State sector						
Typical size companies						
Distinctive facilities sector						
Degree of innovation						
Miscellaneous						
	Opportunities for IBLCs					
Sector related residues						
Synergies & benefits						
Market developments						
Non-technical barriers						

Table 21. Integrated traffic light analysis for the six sectors for Serbia (olive oil not covered).

IBLC feasibility per sector						
	Vegetable oil	Olive oil mills	Feed & fodder	Wine	Grain	Sugar
	Sector profile					
Volume sector						
State sector						
Typical size companies						
Distinctive facilities sector						
Degree of innovation						
Miscellaneous						
	Opportunities for IBLCs					
Sector related residues						
Synergies & benefits						
Market developments						
Non-technical barriers						