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Joint deliverable report Biorefinery Euroview (addenda D1.2 and D1.3) & Biopol (D4.2) Note with results identification, classification and mapping of existing EU biorefineries

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PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
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Preface

In March 2007 a close cooperation between the projects BIOREFINERY EUROVIEW (Project no. 044275 – FP6-2005-SSP-5A) and BIOPOL (Project no.: 44336 – FP6-2005-SSP-5A) was initiated. Through this cooperation, maximum added value should be created for further development of advanced biorefineries in Europe. Among others, this involved joint efforts on mapping of existing and future biorefineries, which is a topic in both projects.

The cooperation established between the two projects included initially a common survey of industrial acceptance of the biorefinery concept and was strengthened during the course of the programs by a common mapping analysis. To enhance the added value, complementary approaches were chosen for finalization and upgrading this joint work. The results are reported in this combined report of the addenda of deliverables D1.2 “Selection and description of existing platforms” and D1.3. “Mapping of existing European industrial biorefinery sites and D 4.2 “Note with results identification, classification and mapping of existing EU biorefineries” from BIOREFINERY EUROVIEW and BIOPOL respectively.

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Summary

The overall goal of this joint deliverable report is to present a common overview on the state of the art of biorefineries in Europe based on the combined results from the BIOREFINERY EUROVIEW project and the BIOPOL project. This joint deliverable report is a concrete product of the cooperation between the two projects BIOREFINERY EUROVIEW and BIOPOL in order to create optimal added value of their respective work. To this end all necessary information including deliverable reports, reports of visits and results of questionnaire were exchanged by the consortia with due respect for the confidentiality levels of the information received. This deliverable report is divided in three parts.

The first part consists of a short summary of the results from a survey based on a joint questionnaire that was developed in cooperation by the BIOREFINERY EUROVIEW (WP1 “State of the art of existing biorefineries” and WP2 “State of the art of socio-economic impacting factors”) and BIOPOL (WP2 “assessment of social and environmental implications” and WP4 “Review of current implementation status”) project consortia. The questionnaire was sent to 2800 industrial stakeholders in 16 EU countries plus Norway, Switzerland and the USA. A total of 110 returned questionnaires from 11 countries were used for the extraction of data for mapping of agro-industrial sites and further analysis. The results were presented at the BIOREFUTURE 2008 Workshop in Brussels on February 12th 2008 and in deliverable report D1.2 “Selection and description of existing platforms“, submitted by BIOREFINERY EUROVIEW in April 2008. In the context of the BIOPOL project, results of the survey (in the form of a descriptive analysis) have been reported by Agnes Klein c.s. of the University of Weihenstephan in joint Deliverable report D 2.1.3 / D 4.1.

In the survey a total of 110 industrial sites in Europe interested by the concept of biorefinery were identified mainly located in Germany, Netherlands, France and Belgium. These sites are mostly biomass processing industries belonging to the activity sectors Chemical industry and Biofuels industry (each approx. 20%) and Forestry sector including pulp and paper production (approx. 15%). A number of companies were classified as Multiple industry companies (ca. 15%). The Sugar and starch sector was less represented at approx. 8%. A substantial number of sites (26%) were classified outside of these sectors as "Other sectors", comprising mostly green and white biotechnology companies, agricultural trading firms and food and feed industries. The results of the survey and additional input were used by the BIOREFINERY EUROVIEW consortium to identify biorefinery sites based on more stringent definitions. In total 21 advanced biorefinery sites were identified including:

- 9 biorefinery sites in the categories Oilseed, Cereal, Green and Forest based and Lignocellulose biorefineries and Integrated biorefineries
- 4 R&D center, pilot plants and demonstration plants working on a biorefinery concept.
- 8 “Future” biorefinery sites

These results have been reported in detail in BIOREFINERY EUROVIEW deliverable report D1.2 “Selection and description of existing platforms“.

The second part of the work reported was performed by the BIOPOL Consortium and consists of a review of the practical implementation status of the biorefinery concept in Europe by identification, classification, and mapping of existing and future biorefineries in the EU27 plus Norway, Switzerland and Iceland (EU27+). For this work a “top-down approach” was used consisting of several elements:

- a quantitative assessment and mapping of the presence of industry sectors in the EU27+ where current biomass processing plants are in operation or under development as indicated by the results of the industry survey, i.e. Chemical industries, Agricultural/sugar and starch

sectors, Forestry sector and the Biofuels sector. Especially in these sectors current or future biorefineries may be expected or could potentially evolve.

- a quantitative assessment and mapping of the availability in the EU27+ of specific feedstocks for various types of biorefinery i.e. wheat, sugar beet, maize, potato, rapeseed, agricultural residues of food and feed crops, grass, wood and wood products. The aim is to assess the potential relationship between the availability of these feedstocks and the presence of related biorefinery initiatives.
- identification, description and mapping of the occurrence of existing and planned biorefinery plants as well as biorefinery related R&D, pilot and demonstration projects projects in the EU27+. This analysis was based on the results from the mapping exercise performed by EUROVIEW (24 advanced biorefinery sites) which was supplemented by the BIOPOL consortium based on partner expertise and additional sources.

A total of 34 existing or planned biorefineries have thus been identified in the BIOPOL and EUROVIEW projects. These biorefineries are based on different concepts of cereal biorefinery, whole crop biorefinery, oilseed biorefinery, green biorefinery, lignocellulosic feedstock / forest based and lignocellulosic biorefinery, multiple feed / integrated biorefinery, as defined in the BIOPOL and EUROVIEW projects. In addition 45 biorefinery-related major R&D projects, pilot and demonstration projects have been identified.

The majority of the identified biorefineries (i.e. 23 out of 34), as well as biorefinery-related major R&D projects, pilots and demonstration projects (28 out of 45) are located in Western Europe, followed by Northern and Southern Europe. About 75% of the biorefinery sites are located in an area comprising Northern France, Germany, Denmark, Belgium, the Netherlands, and the UK. These 6 countries have beside a variety of suitable feedstocks for biorefinery applications, also an intensive (petro)chemical industry. No existing biorefineries or major R&D projects or pilot plants have been identified in the Eastern EU countries.

The mapping results confirm a positive correlation between existing and planned biorefineries and the occurrence of chemical industries, biofuel industries and agro-industries mainly in the starch and sugar sector and with the availablility of the feedstocks wheat and sugar beet.

A relatively high number of green biorefineries using grass as feedstock (7) was identified, given the fact that grass can be considered a second generation feedstock that requires innovative processing technology. Furthermore a substantial number of current and planned lignocellulosic feedstock biorefineries (11) were identified that are positively correlated with the availability of wood (including forestry residues) and straw. Based on feedstock availability there is a large potential for expansion of these advanced concepts.

The mapping of feedstocks in the EU27+ shows, that several Eastern EU countries have a high potential for biorefinery based on feedstock availability. The fact that no biorefineries, or biorefinery-related R&D, pilots and demonstration projects were identified in these countries seems to imply that beside feedstock availability other factors such as a good infrastructure, the presence of (petro)chemical industries, and possibly other factors are required for the development of biorefinery plants.

The third part of the work performed consists of a detailed review and analysis of industrial sites of biorefineries identified in Europe, visited and interviewed by different partners of the two consortia mainly during the second year of the project in order to identify which site could be considered as biorefineries, or on the way to become a biorefinery, according to the various concepts and definitions retained by Biorefinery Euroview partners. The selected sites covered the major type of resources that can be used in the biorefinery approach: sugar industry; sugar and starch industry; starch industry; oilseed industry, paper industry, waste industry. These industries were located in

the various countries of Biorefinery Euroview and BIOPOL consortium: Belgium, France, United Kingdom, Netherlands, Italy, Spain, Sweden and Germany.

The objective of the performed visits was first to give a more accurate focus on existing European sites of biorefineries according to the final consortium definition. Another objective was to get information about specific data, such as energy balance, life cycle analysis, and economic aspects, which could be important impacting factors not well informed in the initial questionnaire. The last objective was to try to identify key factors of success stories regarding the evolution of agro-industries towards biorefineries, mainly based on economic and environmental aspects.

Based on those more accurate and detailed information collected by interview and/or visit, important key factors of success leading to the development of biorefineries have been identified:

- The main product has a guaranteed market and is supported at the national level (in volume and in long time);
- On-site existing of a major bio-industry is attractive for the development of the other one;
- On-site existing of an R&D center already well developed and experimented for the implantation of another company;
- Proximity to the local agroresources which facilitate the contract relations with the farmers allowing to define specifications and impose a regularity and a quality of the supply;
- Proximity with transportation facilities;
- Real synergy between actors (Industrial Ecology);
- Integration of sustainability in future developments;

The detailed reports of those visits have been compiled in the addendum of the BIOREFINERY EUROVIEW deliverable report D1.2, which will be submitted to the European commission at the same time as this deliverable report.

Based on the results of the performed mapping studies several recommendations for follow-up activities can be given:

- To perform a more detailed analysis of the factors that have led to the relatively successful implementation of the biorefinery concept in Western and Northern Europe;

- To analyse the existing barriers and obstacles for the development of the biorefinery concept in the Eastern European countries and to identify potential solutions to alleviate these obstacles;

- To continue monitoring of the evolution of biorefineries in Europe by periodic updates of the mapping results. Especially by employing a more regional approach with respect to feedstock availability, the presence of specific industries and other relevant factors;

- To take into account the identified key success factors in policies for fostering the development of future biorefineries in Europe.

This deliverable reports includes in the Appendices: draft of the common industrial questionnaire (Appendix A), the guide of interview for the visits (Appendix B), results of Quantitative assessment and mapping of industry sectors where biorefineries have developed or may develop cf. the industry survey and available major biorefinery feedstocks in the EU27+ (Appendix C), Identification of biorefinery sites in the European Union (Appendix D) and Quantitative assessment of industry sectors where biorefineries have developed or may develop cf. the industry survey and available major biorefinery feedstocks in the EU27+ (Appendix E).

1. Introduction

1.1 Background and objectives

Biorefinery concepts are aimed at relevant market-competitive and environmental-friendly synthesis of bio-products – chemicals and/or materials – together with the production of secondary energy carriers – transportation fuels, power and/or CHP.

The identification, classification and mapping of existing and future biorefineries in the EU is a topic in the SSA projects Biorefinery Euroview and Biopol. The main objectives are to provide an overview of existing biorefineries, pilot plants and major RTD projects in the EU, to generate a view of the integration level of biorefineries in existing and new industry sectors and to provide information on other aspects relevant for formulation of policy recommendations.

BIOPOL WP4 has reviewed the practical implementation status of biorefinery concept in the EU27 countries plus Norway, Iceland and Switzerland with the goal to identify, classify and map existing bio refineries. Thus and overview of the existing and future biorefinery plants, pilot plants and major biorefinery R&D projects was obtained. This inventory and other sources have been used to estimate the current processing potential and the improvement potential of existing and future biorefineries. These results have been used for an assessment of future prospects of biorefinery concepts and assessment of the potential and demonstration costs of advanced biorefinery concepts alongside existing facilities and for new plants (BIOPOL WP5).

The BIOREFINERY EUROVIEW WP1 consortium has identified, classified and mapped the main existing European agro-industries that could be considered as biorefineries, according to the various concepts proposed by the consortium. This first mapping exercise was performed from an analysis of an industrial questionnaire that was excuted in cooperation with Biopol but did not take into account the level of integration of these concepts. Based on these data and additional information a more accurate analysis was performed. This was completed by interviews and visits of selected existing industrial sites (or under construction).

The combined results of the mapping work in the two projects are presented in this report.

2. Approach and methodology

This section describes approach and methods followed in the various parts of the study that are complementary.

The BIOPOL team has selected and performed a “top-down approach” consisting of a mapping of existing industry sectors where current biorefineries have developed or can be expected to evolve according to the industry survey, a mapping of the presence of specific feedstocks for various biorefinery types in the EU27+ and the occurrence of biorefinery pilots, demo's and major biorefinery related R&D projects in the EU27+. For the latter classification relatively strict definitions were used to distinguish “real” biorefineries as outlined in Section 2.3.

The Biorefinery Euroview team has followed a “bottom up” approach and made 19 sites interviews and or visits of selected known EU biomass industrial processing and biorefinery initiatives (pilot, demonstration). This approach provides more information on background, rationale, history, les-

sons that can be drawn from these specific initiatives. Specific key factors leading to the successful development of biorefineries have been identified.

2.1 Methodology based on the joint questionnaire.

A joint questionnaire (Appendix A) was prepared by the Euroview and Biopol consortia at the start of the project, and was sent to approx. 2800 industrial stakeholders in Europe. Each partner from the Biorefinery Euroview and Biopol consortia was in charge of disseminating the questionnaire to industrial parties within its country. The other EU countries that were not represented in the consortia were handled depending on special contacts of each partner within those countries.
The stakeholders of this questionnaire were either existing industrial companies or under project within the next 2 years, or pilot plant. They were targeted among the following industry categories:

1. Chemicals industry
2. Paper & pulp industry
3. Sugar/starch industry
4. Biofuels and biodiesel industry
5. Syngas industry
6. Heat & power (only co-production)
7. Industry that transform co-products
8. Petrochemical industries (Total, BP)
9. Food/Feed industries

2.2 Methodology of "Top down" approach followed by Biopol partners

The performed Industry Survey (reported in BIOPOL Deliverables D2.1.3/D4.1 and EUROVIEW Deliverable D1.2) indicates that "current biorefineries" are mostly so-called 1st-stage biorefineries or biomass processing industries (according to the chosen definition, these are not necessarily biorefineries) in the industrial activity sectors:

- Chemical industries (including Biotechnology);
- Sugar and starch sector;
- Forestry sector (including pulp and paper);
- Biofuels sector.

Furthermore the identified biomass processing industries have been categorized as "Multiple industry companies", and "Other industries" according to the findings of the joint survey and the combined Biopol deliverable D2.1.3/ D4.1.

Based on these initial results a 2-fold approach was selected and performed by the Biopol team to finalize the mapping study, consisting of a top-down approach through:

- mapping the presence in the EU27+ of the industrial sectors given above where biorefineries can be expected now or in the future based on aggregate data from Eurostat and other sources. Detailed results are presented in Appendix C and Appendix E.
- mapping of the presence in the EU27+ of a number of major biorefiney feedstocks based on FAO and other data. The detailed results are presented in Appendix C and Appendix E.
- production of maps locating all gathered data in the EU27+ countries. All maps on sectors and feedstock are presented in Appendix C. A selection of these maps is presented in Section 3.2.

In addition the Biopol consortium performed an inventory aimed at

- identification of existing or planned biorefinery plants in the EU27+. The detailed results are presented in Table 2 (Appendix D) and evaluated in Section 3.2

- identification of biorefinery related R&D, pilot and demonstration projects in the EU27+. Detailed results are presented in Table 3 (Appendix D) and evaluated in Section 3.2.

The starting point for this inventory were the results of the EUROVIEW study in deliverable report D1.2. Additional biorefineries were identified by the BIOPOL consortium based on partner expertise, and other sources. Table 2 in Appendix D provides a description of existing and existing or planned biorefineries. Table 3 in Appendix D presents an overview of biorefinery related R&D, pilots and demonstrations in the EU27+. The contents are based on the information gathered by the EUROVIEW consortium supplemented with additional information gathered by by the BIOPOL Consortium.according to the definitions in 1provided below. The results are presented in a number of maps for EU 27+ accompanied by an evaluation of the main findings in Section 3.2.

2.3 Definitions of Biorefinery used in this study

The following definitions of biorefineries by Kamm and Soetaert are available and were used in the BIOPOL and EUROVIEW projects respectively. For the current, joint mapping study a common set of definitions is required.

The definitions of Biorefinery by Kamm and Soetaert are different but do not seem to conflict with each other, in fact they can be considered as complementary.

BIOPOL (Kamm)	**EUROVIEW (Soetaert)**
The sustainable processing of biomass into a spectrum of marketable products and energy (IEA Task 42 Biorefinery, 2008)	**Integrated bio-based industries, using a variety of different technologies to produce chemicals, biofuels, food and feed ingredients, biomaterials (including fibers) and power from biomass raw materials**

The categories of Biorefinery systems/concepts used by both experts are different and seem to conflict as outtined below:

BIOPOL (Kamm)	**Common characteristics**	**EUROVIEW (Soetaart)**
Whole Crop Biorefinery	**Feedstock: cereals, maize and starch**	***Cereal Biorefinery***
	(BIOPOL: also sugar crops)	
No specific type	**Feedstock: oil crops (rape, sunflower, …)**	***Oilseed Biorefinery***
Green Biorefinery	**Feedstock: wet biomass**	***Green Biorefinery***
	However some differences between projects:	
	BIOPOL: non storage organs (green grass, lucerne clover)	
	EUROVIEW: storage organs from starch plants (potato, tapioca) & sugar plants (sugar beet)	
Lignocellulosic Feedstock Biorefinery	**Feedstock: lignocellulosic biomass (wood, straw, corn stover, waste, …)**	***Forest based and lignocellulosic biorefinery***
***Two-Platform concept (Sugar & Syngas*)**	**Feedstock: according to Kamm and Kamm: biomass (not further specified)**	**-**
	Could therefore include starch/sugar crops and lignocellulose.	

A solution has been found by focussing on whole crop and cereal biorefineries, oilseed biorefinery, green biorefinery, and lignocellulosic feedstock biorefineries as the 4 main categories and to consider the two platform concept as a specific case for the lignocellulosic biorefinery or the whole crop biorefinery. The Two platform concept is therefore no longer separately categorized.

A final discrepancy lies in the definition of green biorefinery. For the purpose of this mapping study the definition according to Euroview is followed, while one additional and separate type of green biorefinery i.e. for the processing of wet biomass incl. grass, lucerne, clover has been indentified in this mapping study. The final types of biorefinery that are distinguished and used in this mapping study are therefore:

- Cereal biorefinery (EUROVIEW)
- Whole crop biorefinery (BIOPOL)
- Oilseed biorefinery (EUROVIEW)
- Green biorefinery (EUROVIEW)
- Green biorefinery (BIOPOL)
- Lignocellulosic feedstock / forest based and lignocellulosic biorefinery (BIOPOL / EUROVIEW)
- Multiple feed / integrated biorefinery (EUROVIEW).

An additional criterion used in the BIOPOL consortium is that biorefineries should produce 2 or more products plus energy, where a biofuel such as biodiesel or ethanol does not count as a product but instead is counted under energy, together with e.g. generated electricity and/or heat. Following this criterion a biodiesel factory using rapeseed producing biodiesel (=energy) plus the products press cake and glycerol would count as a biorefinery. However this case is considered an exception and has not been counted as a biorefinery plant. Similarly a G1 ethanol plant co-producing DDGS and CO_2 is not seen as a biorefinery.

2.4 Methodology of "Bottom up" approach followed by Biorefinery Euroview (BE) partners

The WP1 approach of Biorefinery Euroview consisted in listing and analyzing the main agro-industrial sites present in Europe, in order to identify which could be considered as biorefineries, or on the way to become a biorefinery, according to the various concepts and definitions retained by Biorefinery Euroview partners. The selected sites covered the major type of resources that can be used in the biorefinery approach: sugar industry; sugar and starch industry; starch industry; oilseed industry, paper industry, waste industry. These industries were located in the various countries of Biorefinery Euroview and BIOPOL consortium: Belgium, France, United Kingdom, Netherlands, Italy, Spain, Sweden and Germany.

The objective of the performed visits was first to give a more accurate focus on existing European sites of biorefineries according to the final consortium definition. Another objective was to get information about specific data, such as energy balance, life cycle analysis, and economic aspects, which could be important impacting factors not well informed in the initial questionnaire. The last objective was to try to identify key factors of success stories regarding the evolution of agro-industries towards biorefineries, mainly based on economic and environmental aspects.

In the addendum D1.2, a report on 14 industrial platforms or companies (visited or interviewed by partners from BE and BIOPOL) is presented. Among the selected sites, 5 other companies were initially planned to be visited, and available information about these sites was furnished by the partner in charge of the visit and presented in this common report.

The two first sites (Cristanol/ARD/Chamtor (F) and Royal Nedalco/Cargill (NL)) were visited during the first year in 2007 by almost all BE partners, on the occasion of a Project Executive Board

meeting. The other industrial sites were visited or interviewed mainly in the second year of the project by almost two partners from BE or BIOPOL consortium. For each site, a leader was in charge to organise the visit or interview (Table 1). A visit guide was written in order to follow about the same scheme of discussion. A final version of this visit guide was gradually actualized during the second year (Appendix B). This version took in consideration the last general definition of biorefinery, in order to get comments from industrials about it. The interviews (during visits or calls) followed the same items of the survey sent to industrials and described in D1.2 : Biorefinery process i.e. Feedstocks (raw materials and co-products) ; Products ; Technology; but also questions about Research aspects ; Employment and Rural aspects ; Economic and environmental aspects. In the last interviews, main positive and negative impacting factors for industrial sector evolution were taken into consideration.

Table 1: *Industrial sites in Europe visited or interviewed (14), and note visited/interviewed (5)*

NAME OF INDUSTRIES	LOCATION	CONCEPT	SECTOR	DATE OF VISIT/INTERVIEW	PARTNER IN CHARGE
Cristanol/ ARD- Soliance/ Chamtor	Pomacle- Bazancourt (F)	Green biorefinery	Sugar and starch industry	12/07/2007 (visit of ARD/CRISTANOL) 15/09/2008 (visit of CHAMTOR)	IAR/CARINNA (BE project)
Cargill/ Royal Nedalco/ Bioro	Sas van Gent (NL)	Cereal biorefinery	Starch industry	31/10/2007 (visit)	UGENT (BE project)
Roquette	Lestrem (F)	Cereal Biorefinery	Starch industry	09/09/2008 (visit)	IAR, CARINNA (BE project)
Syral (subsidiary of Tereos)	Aalst (Be)	Cereal Biorefinery	Starch industry	18/09/2008 (visit)	CARINNA (BE project)
Solander Science Park	Piteå (Sw)	Forest based biorefinery	Forest industry	15/09/2008 (visit)	VTT, CARINNA (BE project)
Vandeputte SA	Mouscron (Be)	Oil Biorefinery	Oilseed industry	17/09/2008 (visit)	CARINNA (BE project)
Oleon SA	Ertevelde (Be)	Oil biorefinery	Oilseed industry	05/06/2008 (visit)	UGENT, CARINNA, AGW (BE project)
GreenMills project	Port of Amsterdam (NL)	Oil (& waste) biorefinery	Oil (& waste) industry	September 2008 (call interview)	UGENT (BE project)
CIMV	Levallois-Perret (Headquarter-France)	Forest-based and lignocellulosic biorefinery	Paper and Forest industry	23/09/2008 (visit)	IAR, CARINNA (BE project)
Choren Industries	Freiburg (D)	Forest-based and lignocellulosic biorefinery	Paper and Forest industry	September 2008 (call interview)	CEPI (BE project)
Rodenhuize biorefineries	Port of Ghent (Be)	Multi-concepts	Biofuels (biodiesel and bioethanol) industries	September 2007 interview of BIORO) ; report actualized in 2008	UGENT (BE project)
British Sugar	Peterborough (UK)	Green biorefinery	Sugar industry	15th October (interview)	ICSTM I (BIOPOL project)
Abengoa	Babilafuente(S)	Lignocellulose	Biofuels (bio-	November (inter-	ECN (BIOPOL

		biorefinery	ethanol from straw)	views))	project)
Biowanze	Wanze (Be)	Green biorefinery	Sugar industry	November 2008 (interview)	AGW (BE project)
Solanics	(NL)	Green biorefinery	Not determined	No visit, nor interview	CEPI (BE project)
Processum	Örnskoldsvik (Sw)	Forest-based biorefinery	Forest industry	No visit, nor interview	VTT, CEPI (BE project)
Novamont	Terni(I)	Cereal biorefinery	Corn industry	No visit, nor interview	EBIO (BE project)
Tereos	Origny Sainte-Benoite (F)	Green biorefinery	Sugar industry	No visit, nor interview	IAR (BE project)
Novance	Compiègne (France)	Oilseed biorefinery	Oleochemistry	No visit, nor interview	IAR(BE project)

2.4.1 Definition of biorefinery used in this part

The Biorefinery Euroview consortium partners agreed in May 2007 about a general definition of biorefinery. This definition is included in the Deliverable D1.1 that was submitted in May 2008. Biorefineries are **"Integrated bio-based industries, using a variety of different technologies to produce chemicals, biofuels, food and feed ingredients, biomaterials (including fibers) and power from biomass raw materials ».**

The terms of "*Integrated bio-based industries*", means that by-products of one industry will become the source of added value of another company closely related on a same geographical site or even located on a distant site; the ultimate degree of integration will gather several industries on this scheme, in the perspective of industrial ecology.

Biorefinery should not be a bio-industry that process biomass only for food and feed applications, but have to produce also other marketable products (from the raw materials or their by-products) for other applications. Moreover, in the concept of biorefinery all plant components (straw, grains, lignocellulosic biomass) or other type of organic biomass (algae, home waste products, by-products from animals or plants processing) are used to generate marketable products such as biomolecules, biomaterials and energy. Plant biomass as a source of raw material is very attractive in that concept of biorefinery due to the exploitation of renewable carbon.

Based on different comments from experts (industrials, scientifics and government authorities) during the different workshops (Biorefuture 2008 - Brussels - February 12th 2008 ; WP3 workshop - Rotterdam - 4th July 2008 ; "Comité de suivi transfrontalier autour des bioraffineries" - Gembloux - July 4th 2008) and during the first visits and interviews of industrials sites in the first year of the project, we agreed that the definition needs to be refined by including specific issues that could be essential for general acceptance. The main objective is still to propose a simple definition that expresses the full potentialities of biorefineries.

As a consequence, during another brainstorming held in Helsinki (September 2nd 2008) in the framework of the Project Executive Board (PEB) of the project, the consortium has drawn a parallel between the first general definition that the consortium has given until now and the one adopted by the International Energy Agency (IEA Bioenergy - Task 42 : "Biorefineries: Co-production of Fuels, Chemicals, Power and Materials from Biomass"): *"Biorefinery is the sustainable processing of biomass into a spectrum of marketable products."*

Based on this reference, the partners agreed to complete the general definition with:
→ The term of "*sustainability*";
→ The notion of "*maximising the added value*".

The general definition has been completed by the consortium in that way: **" Biorefineries are integrated bio-based industries using a variety of technologies to make products such as chemicals, biofuels, food and feed ingredients, biomaterials (including fibers) and heat and power, aiming at maximising the added value along the three pillars of sustainability (Environment, Economy and Society)"**

It is important to remark that this definition was considered as an "ideal situation", and it could be possible to consider different levels of biorefinery development according to the level of integration.

Moreover, considering the advancement state, each sites of agro-industries identified were classified in two types among those terminologies and their definition:

- "Existing ": an agro-industrial site already in activity and that was characterised as biorefinery based on the general definition proposed by the Biorefinery Euroview consortium;
- "Future": an agro-industrial site in construction or which could be classified as a biorefinery, once complete development of pilot/demonstration R&D projects will be achieved.

3. Results: Identification, classification and mapping of existing EU-biorefineries

3.1 Review of agro-industrial sites in the European Union and proposed classification

3.1.1 Composition of the sample

3.1.1.1 By country

Each partner from Biorefinery Euroview and Biopol consortium was in charge of disseminating the questionnaire to industrial stakeholders within its country. The other countries of the EU that were not represented in the consortium were handled depending on special contacts of each partner within other countries. The format of dissemination was slightly different in each consortium, but was based in two rounds (July, September)

- BIOPOL: around 2600 contacts → 70 feedbacks (2 % response rate)
- EUROVIEW: around 200 contacts → 40 feedbacks (22 % response rate)

The total list of industrial stakeholders was constituted of ca. 2800 contacts in 16 European Union countries and also in Norway, Switzerland and in the USA:

1. Austria
2. Belgium
3. Denmark
4. Finland
5. France
6. Hungary
7. Germany
8. Greece
9. Ireland
10. Italy
11. Lithuania
12. Norway
13. Portugal
14. Spain
15. Sweden
16. The Netherlands
17. The United Kingdom
18. The USA
19. Switzerland

Among the 19 targeted countries, a total of 110 answers was received back from 11 countries and was used for the extraction of data concerning mapping of the industrial sites (geographical repartition according to parameters previously described) and quantitative analysis. However, two sites have not been located on the map since the industrial respondents did not provide the location of their industrial site(s) involved in the concept of biorefinery.

We can observe a concentrated area of identified agro-industrial sites in the European Union, mainly in Germany (50), Netherland (17), France (14) and Belgium (12) with a predominance in Germany (
Figure 1).

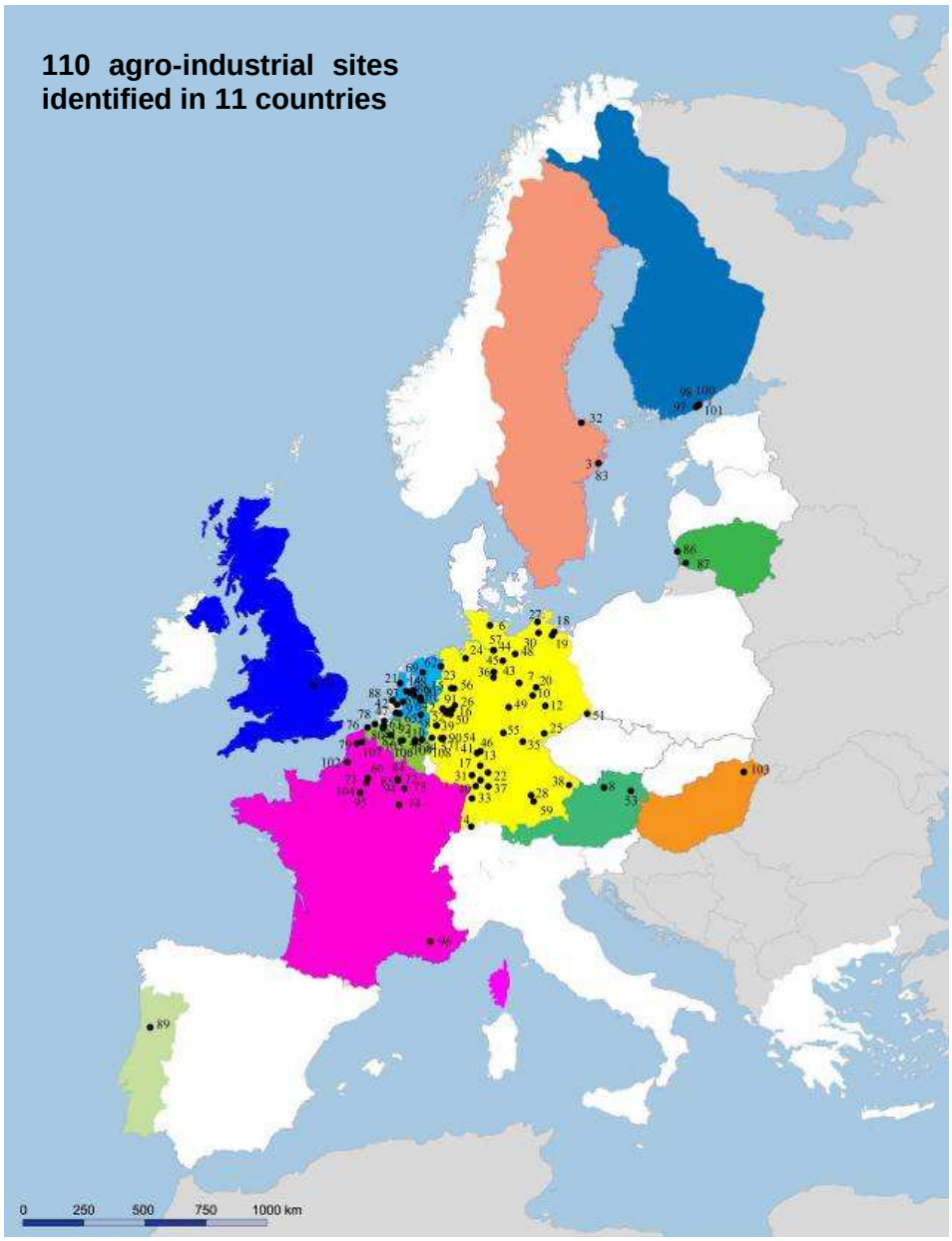


Figure 1: *Geographical repartition of identified agro-industrials sites in Europe from the 110 answers returned back to Biorefinery Euroview consortium and Biopol consortium/*

In the South of Europe, we obtained only one answer from an agro-industry implanted in Portugal. However, on the basis of information gathered in the previous deliverable (Biorefinery Euroview D1.2), we noticed that there exist some sites in Spain and Italy. Among those that were targeted for the survey, no answer has been received. No answers came from Poland, Greece even if some members of the two consortia were issued from those countries. A few agro-industrial sites have been located in Austria (2), Hungary (1) and Lithuania (2).

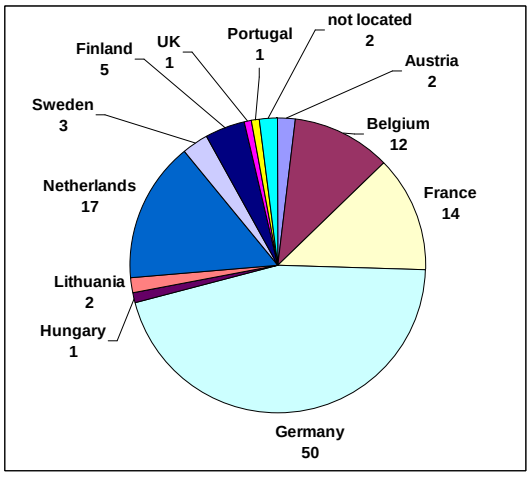


Figure 2: *Number of identified sites in European countries. Data were obtained from the 110 answers returned back to Biorefinery Euroview and Biopol consortia.*

To complete this observation concerning the concentrated area of identified agro-industrial sites in Germany, Netherland, France and Belgium, and moreover the fact that it seems that there is no agro-industries other European countries, this can be explained by the methodology of sent chosen by the consortium. Indeed, each partner from Biorefinery Euroview and Biopol consortium was in charge of disseminating the questionnaire to industrials within its country. The other countries of the European Union that were not represented in the consortium were handled depending on special contacts of each partner within other countries, and as examples, only 2 questionnaires were sent to an agro-industry in Italy and 5 to Spain.

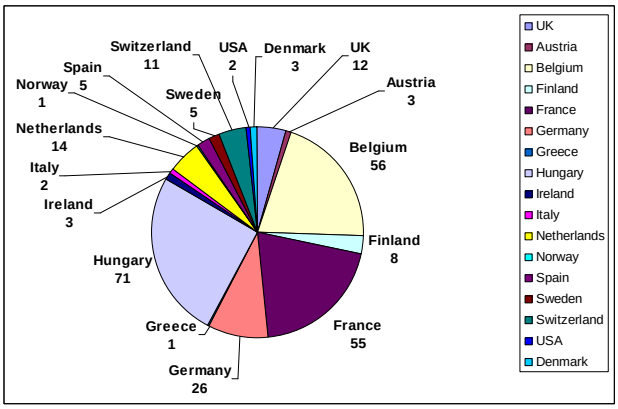


Figure 3: *Repartition by countries of number of questionnaires sent to different industries by countries (for Biorefinery Euroview consortium)*

3.1.1.2 By activity Sector

The stakeholders of the questionnaire were industries that could be already considered as existing biorefineries or under construction within the 2 next years (i.e. industrial, demonstration and pilot plant), or industries that could potentially evolve towards these activities. They were targeted among the following industry categories:

1. Chemicals industry
2. Paper & pulp industry
3. Sugar/starch industry
4. Biofuels and biodiesel industry

5. Syngas industry
6. Heat & power (only coproduction)
7. Industry that transform co-products
8. Petrochemical industries (Total, BP)
9. Food/Feed industries

There is a good repartition of the returned answers within the various industry sectors. We can observe a predominance of chemical and biofuel industries with about the same frequency (around 20%). The forest industry is also well represented (around 15%). We can also notice the presence of companies with multiple activity sectors (around 15%) called “multiple industry companies”. However, sugar and starch industries are less represented. We can notice a high number of answers from industries that can not be classified in the previous activity sectors (“other sectors”). This represents the highest proportion of answers (26%) that comes mainly from green and white biotechnology companies, agricultural trading, food and feed industries.

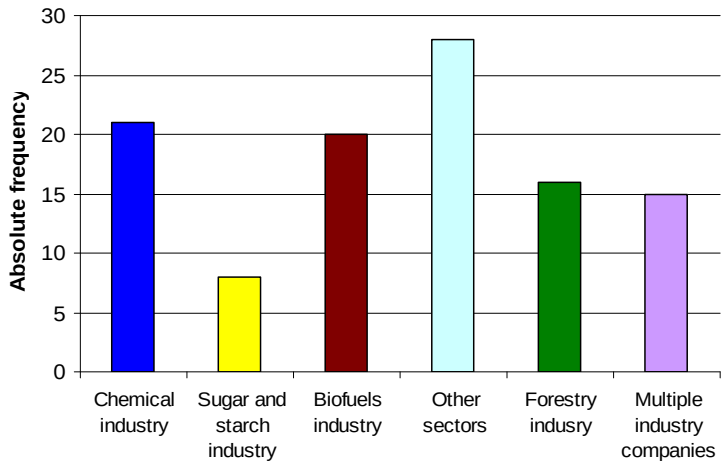


Figure 4: *Composition of the stakeholder sample according to the sector of activity (industry branch of the companies).*

The results of the industrial survey and additional input were used by the EUROVIEW consortium to identify biorefinery sites based on more stringent definitions. In total 21 advanced biorefinery sites were identified including:

- 9 biorefinery sites in the categories Oilseed, Cereal, Green and Forest based and Lignocellulose biorefineries and Integrated biorefineries
- 4 R&D center, pilot plants and demonstration plants working on a biorefinery concept.
- 8 “Future” biorefinery sites

These results have been reported in detail in EUROVIEW deliverable D1.2 “Selection and description of existing platforms". These data formed the starting point for the further developement and expansion of the mapping by the BIOPOL consortium reported in Appendix D and in Section 3.2

3.2 Identification, classification and mapping of biorefinery sites in the European Union

3.2.1 Identification and classification of biorefinery sites in the EU27+

Detailed results of the survey concerning existing or planned biorefineries in Europe are presented in Table 2 (Appendix D). The results are listed per country and for the EU27 plus Norway, Switzerland and Iceland. The listed sites with green shading in Table 2 are biorefineries identified within the EUROVIEW project, while those shaded orange are additional biorefineries that were identified in the BIOPOL project.

Figure 5 summarises the results based on the biorefinery concepts. In total 34 existing and planned biorefineries are identified:

- seven whole crop (BIOPOL) or cereal (EUROVIEW) biorefineries;
- four oilseed (EUROVIEW) biorefineries;
- nine green (BIOPOL / EUROVIEW) biorefineries;
- six lignocellulosic feedstock (BIOPOL) or forest based and lignocellulosic (EUROVIEW) biorefineries;
- seven multiple feed / integrated (EUROVIEW) biorefineries;
- one not yet specified biorefinery (see Table 2 in Appendix D / Belgium / plant number 5: a plant converting glycerine to propylene glycol to be considered as a future biorefinery platform, if located near and using glycerine of an existing biodiesel plant of Cargill).

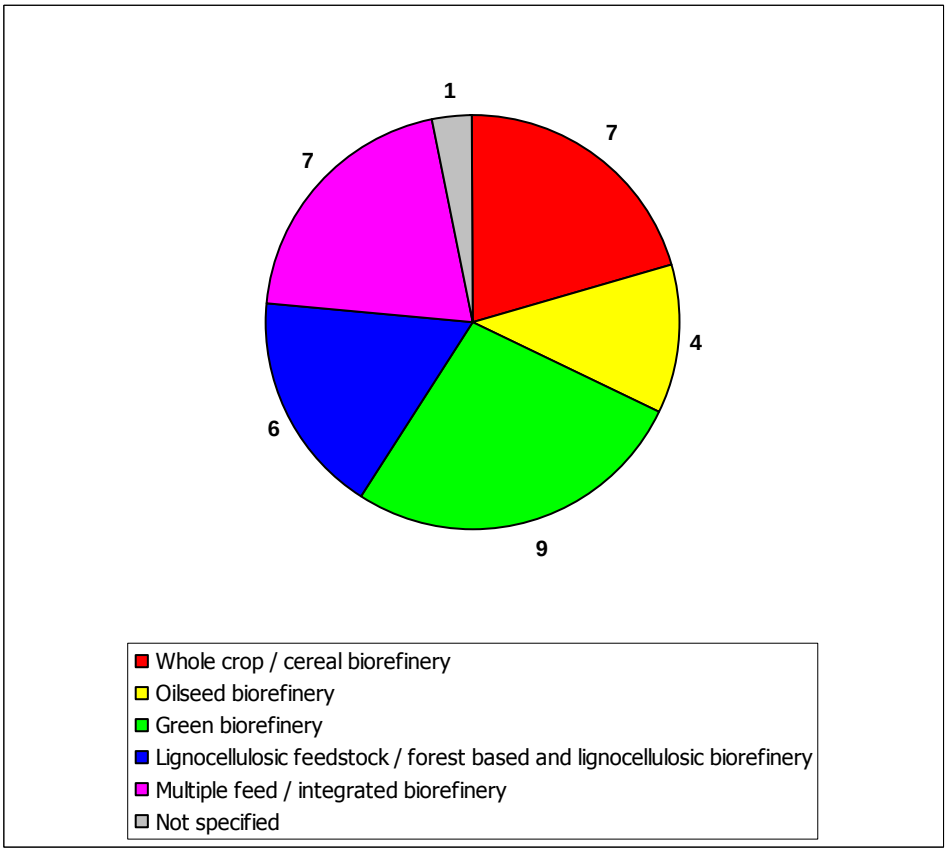


Figure 5: *Existing or planned biorefineries in Europe (concept related)*

Figure 6 presents the identified biorefineries according to the country in which the plants are located. Belgium has the most biorefineries (6), followed by France (5), Germany (4), Denmark, Netherlands and the UK (3), Finland, Italy and Sweden (2), Ireland, Austria, Spain, and Iceland each with 1 biorefinery.

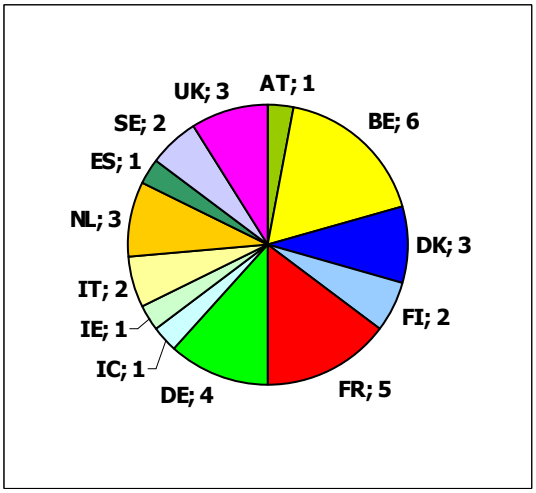


Figure 6: *Existing or planned biorefineries in Europe (country related)*

As presented in Figure 7, the majority of biorefineries are located in West Europe (23), followed by North Europe with 8 biorefineries, and South Europe with 3 biorefineries. There are no biorefineries identified in one of the Eastern European countries.

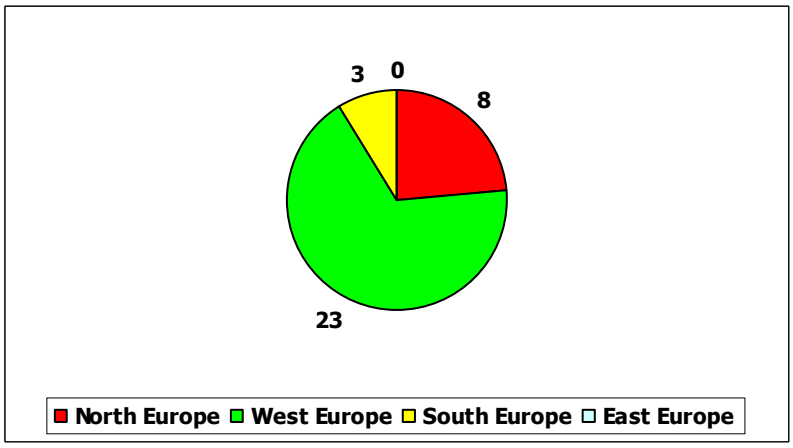


Figure 7: *Identified existing or planned biorefineries in Europe (region related)*

In March and April 2009 3 additional biorefineries were identified in Europe and 1 in Canada:

- A future starch biorefinery in Wroclaw, Poland.
- A lignocellulosic biorefinery based on sulfite pulping of wood, producing pulp and several additional products on the Lenzing site in Austria.
- A lignocellulosic biorefinery based on sulfite pulping of wood (with various products) was identified in Sarpsborg, Norway, operated by Borregaard.
- An additional biorefinery plant based on wood pulping was identified in Canada operated by Tembec

The latter 3 plants belong to the pulp and paper sector, which has a long tradition in biorefinery.

3.2.2 Biorefinery-related R&D, pilots and demonstrations in the EU

Detailed results of the survey concerning biorefinery-related major R&D projects, pilots and demonstrations in Europe are presented in Table 3 (Appendix D). In total 45 projects, pilots and demos were identified as per 1 December 2008. The results are listed per country and for the EU27 plus Norway, Switzerland and Iceland. The activities coloured in green are biorefinery-related R&D, pilots and demonstrations identified within the EUROVIEW project, while those coloured in orange are additional biorefinery-related R&D, pilots and demonstrations recognized within the BIOPOL project.
As presented in Figure 8, the majority of biorefinery-related R&D, pilots and demonstration projects take place in West Europe (28), followed by North Europe with 16 projects, and South Europe with one project. There are no biorefinery-related R&D, pilots, and demonstration projects recognised to be located in one of the Eastern European countries.

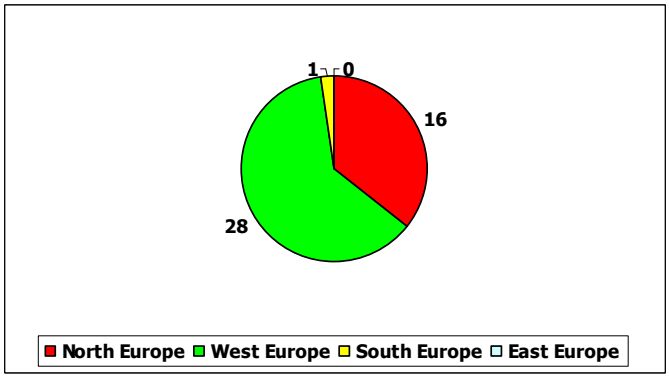


Figure 8: *Identified biorefinery-related R&D, pilots and demonstrations in Europe (region related)*

An additional biorefinery Pilot project was announced in January 2009, i.e. the Bio Base Europe project performed by the EC, The Netherlands and Vlaanderen. The project is a cooperation of Ghent Bio-Energy Valley and Biopark Terneuzen and comprises the establishment of a training centre for biotechnological process operators and a pilot scale installation for production of second generation biofuels. [Source: Technisch Weekblad, 10th January 2009.]

3.2.3 Mapping of industry sectors where biorefineries have developed or may develop cf. the industry survey and mapping of available feedstock

A quantitative assessment and mapping has been performed based on data from Eurostat, FAO, EurObserv'er Biofuels Barometer and other sources. Detailed results of the mapping of industry sectors with identified biomass processing plants and/or current (or future) biorefineries in Europe are presented in Table 4 (Appendix E). In addition Table 4 contains the gathered data on the availability of feedstock per country in the EU27+ i.e.: sugar beet, wheat, maize, potato, rapeseed and grass land area.

The results are listed per country for the EU27 plus Norway, Switzerland and Iceland. The following sectors (and relevant biomass feedstock if applicable) have been mapped in this manner:

- Chemical industries
- Agricultural / sugar and starch sectors (including grassland)
- Forestry sector
- Biofuels sector

Based on the results presented in Table 4 (Appendix E) maps of the EU27+ have been generated displaying the results. All developed maps are presented in Appendix C.

The map of Europe used has been created by S. Solberg J. (Ref. 9: 2008) and has been published under the GNU Free Documentation License (Ref. 10: GFDL, 2002), being modified by ECN using Inkscape, an open source cross-platform vector graphics editor (Ref. 11 : Inkscape, 2008).

A selection of the developed industry sector and feedstock maps have been used for the mapping and the evaluation of the occurrence of biorefineries in EU27+ as explained in section 3.2.4.

3.2.4 Mapping of biorefinery sites

In this section the identified and classified existing and planned biorefineries in the EU27+, as described in section 3.2.1, have been mapped on basis of the defined biorefinery concepts. In a number of cases this has been combined with the maps of relevant industry sectors and major biomass feedstocks in the EU27+. In the sections below the results are presented and evaluated.

3.2.4.1 Whole crop / cereal biorefineries

Figure 9 summarises the existing or planned whole crop biorefineries according to the BIOPOL definition (in light blue), as well as cereal biorefineries according to the EUROVIEW definition (in red). The sites with more than one colour relate to multiple feed / integrated biorefineries according to the EUROVIEW definition. The numbers shown on the map are the same as the site numbers in Table 2 (Appendix D). Based on Figure 9, a majority of whole crop/cereal biorefineries are located in four West European countries, followed by two in Italy and one in Sweden.

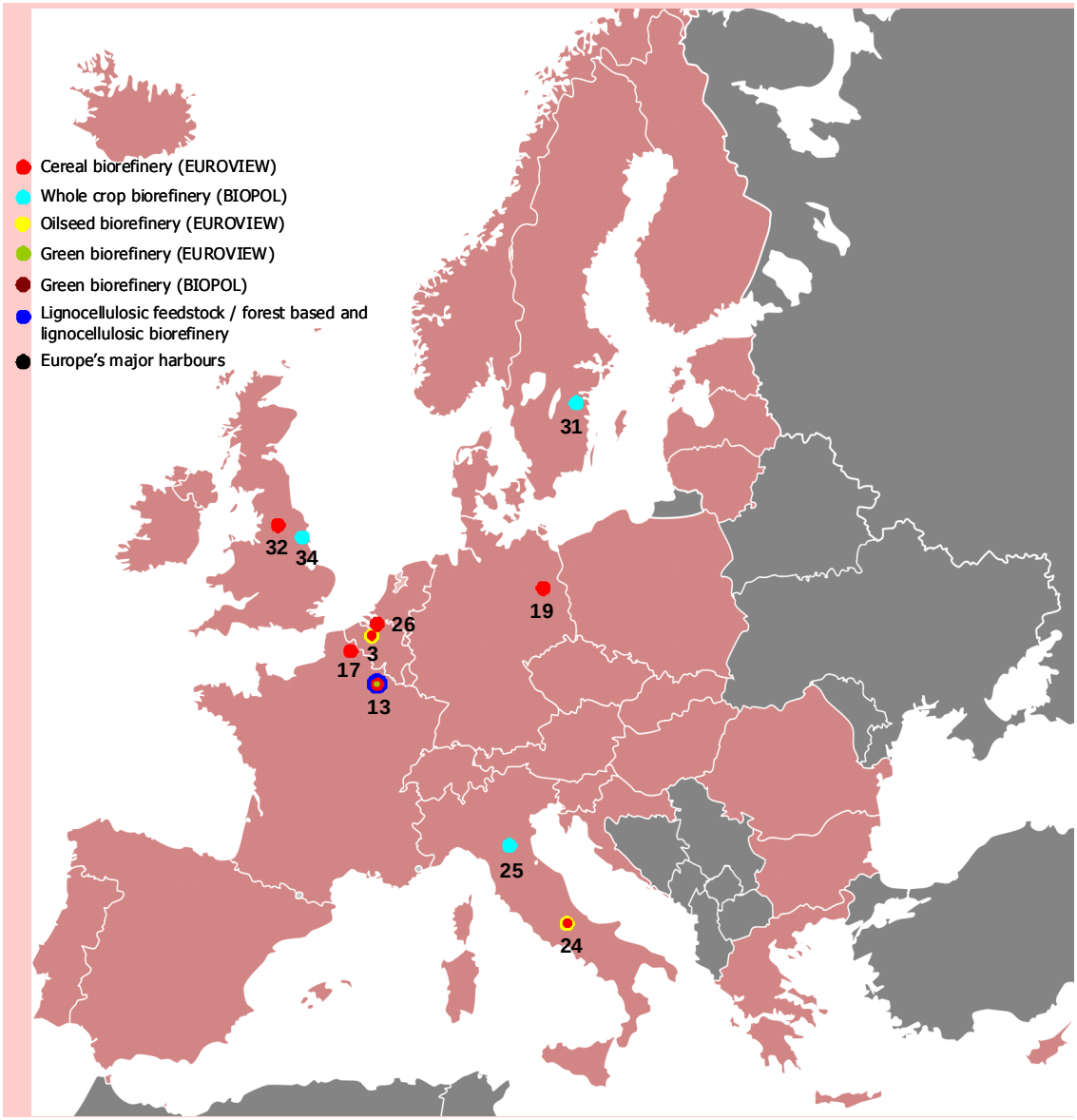


Figure 9: Whole crop / cereal biorefineries in Europe (see Table 2 Appendix D for detailed data)

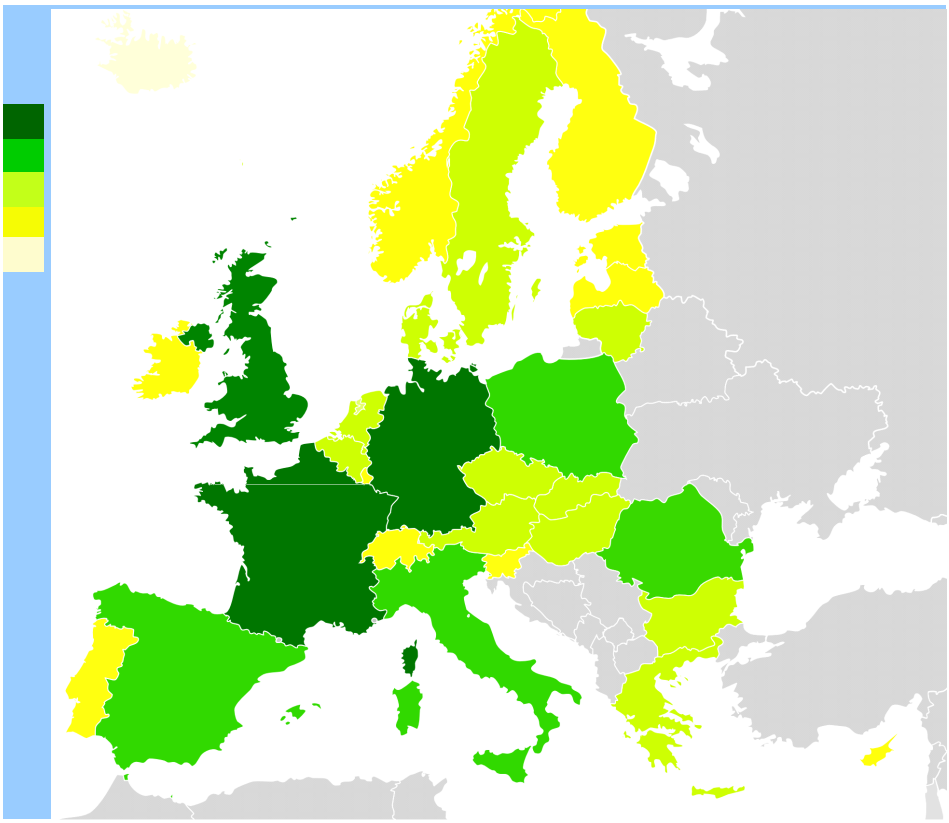


Figure 10: *Production of wheat in EU27 incl. NO, CH, and IC* (*Ref. 1:* FAO *statistics 2006/2007)*

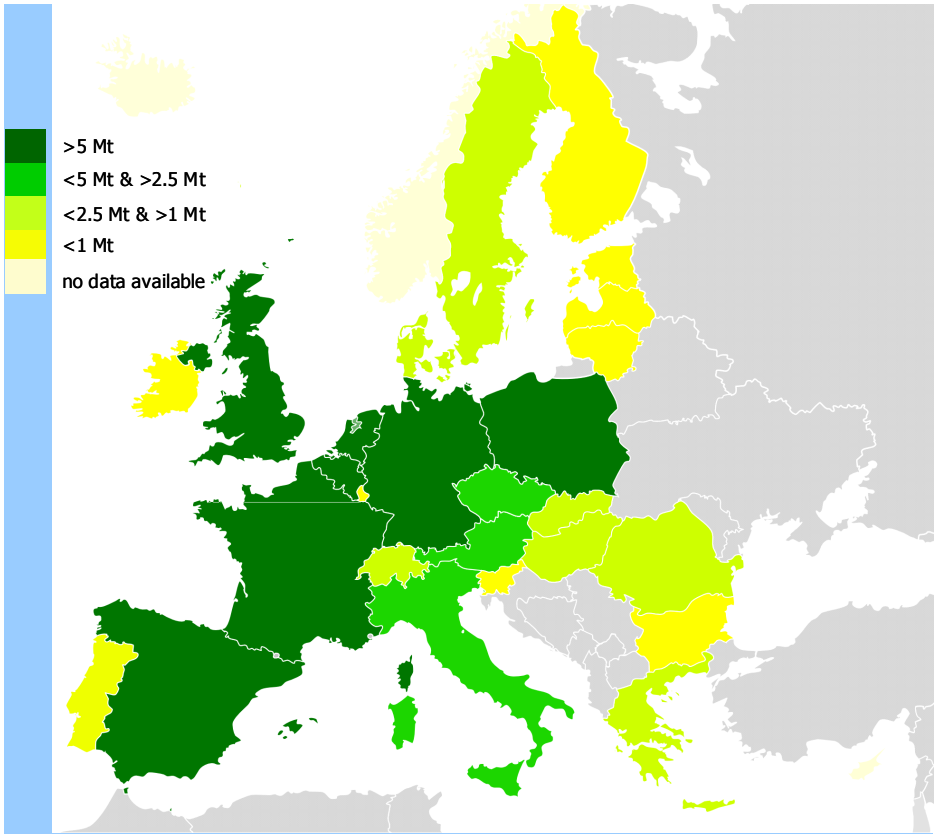


Figure 11: Production of sugar beet in EU27 + NO, CH, and IC (Ref. 1: FAO statistics 2006/2007)

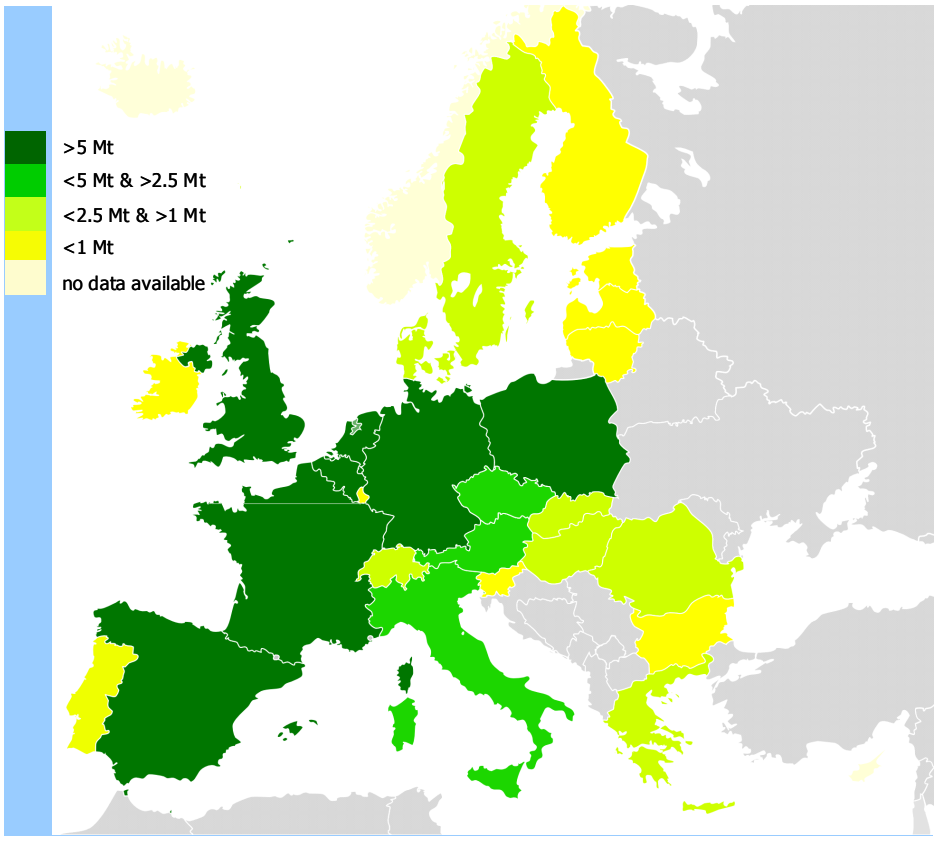


Figure 12: *Production of maize in EU27 incl. NO, CH, and IC (Ref. 1: FAO statistics 2006/2007)*

Figure 10 to
Figure 12 present the mapping of the current production levels of major feedstocks (wheat, sugar beet, and maize) for these biorefinery concepts (see also Figure 33 to Figure 38 in Appendix C). As can be seen, the locations of biorefineries are in good agreement with the current availability of the feedstocks for these biorefinery concepts.

3.2.4.2 Oilseed biorefineries

Figure 13 summarises the existing or planned oilseed biorefineries according to the EUROVIEW definition (in yellow). The sites with more than one colour relate to multiple feed / integrated biorefineries according to the EUROVIEW definition. The numbers shown on the map are the same as the site numbers in Table 2, (Appendix D).

Based on Figure 13, a majority of the oilseed biorefineries are located in Belgium and the Netherlands, followed by one in France, one in Italy and one in Finland.

Major feedstocks for oilseed biorefineries in Europe are rapeseed followed by sunflower. Figure 14 shows the mapping results of the current rapeseed production levels in Europe (see also Figure 41 and Figure 42 in Appendix C). As can be seen, the major rapeseed producing countries are Germany and France, followed by the UK, East Europe, Denmark, Sweden and Finland. It is not clear why no oilseed biorefineries were identified in Germany and only one (Novance) in France. One

reason could be that classical biodiesel plants are not counted as biorefineries due to a limited number of products. Another reason is the fact that vegetable oil processing plants do not exchange materials or products with each other (see section on Oilseed industrial biorefinery 3.3.2.3).

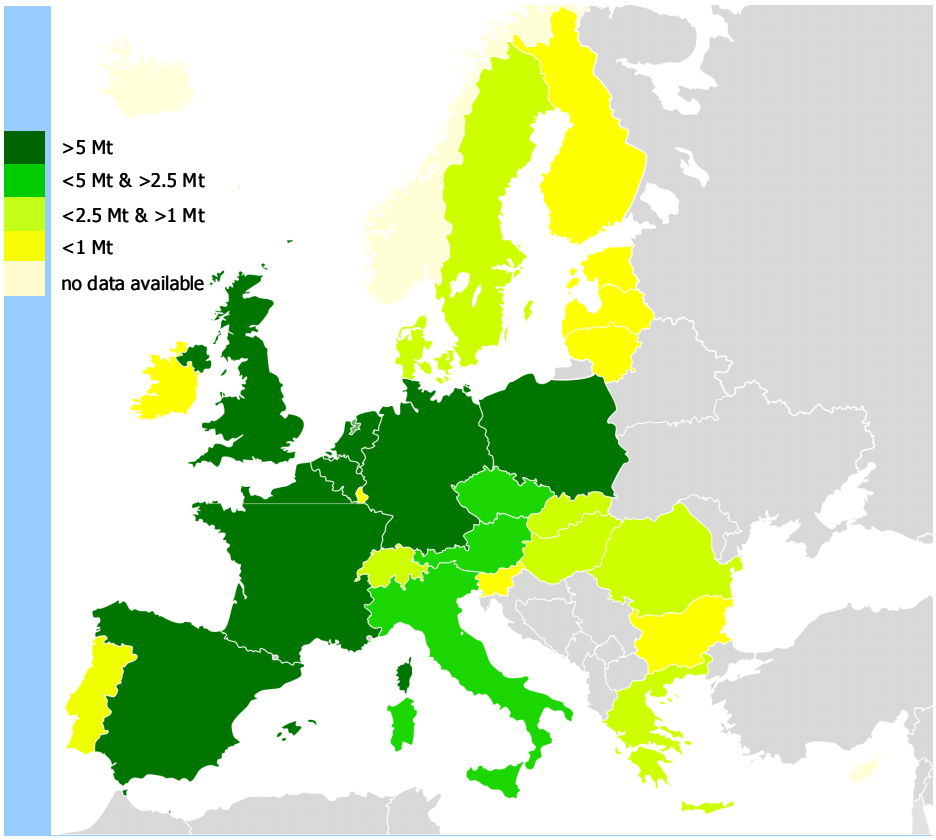


Figure 13: *Oilseed biorefineries in Europe (see Table 2* Appendix D *for detailed data)*

As can be seen from Figure 14 and the mapping of current biodiesel production levels in Europe, presented in Figure 15 (see also Figure 55 and Figure 56 in Appendix C) biodiesel production is not coupled only to the cultivation of rapeseed because more countries are active in the biodiesel sector, especially the Southern European countries. This could mainly be due to using more sun-flower as feedstock in that region.

For Belgium and the Netherlands the main reasons for the presence of oilseed biorefineries could be a combination of the presence of important sea harbours and the highly intensive conventional oil refineries / chemical industries (see Figure 31 and Figure 32 in Appendix C) in these relatively small countries.

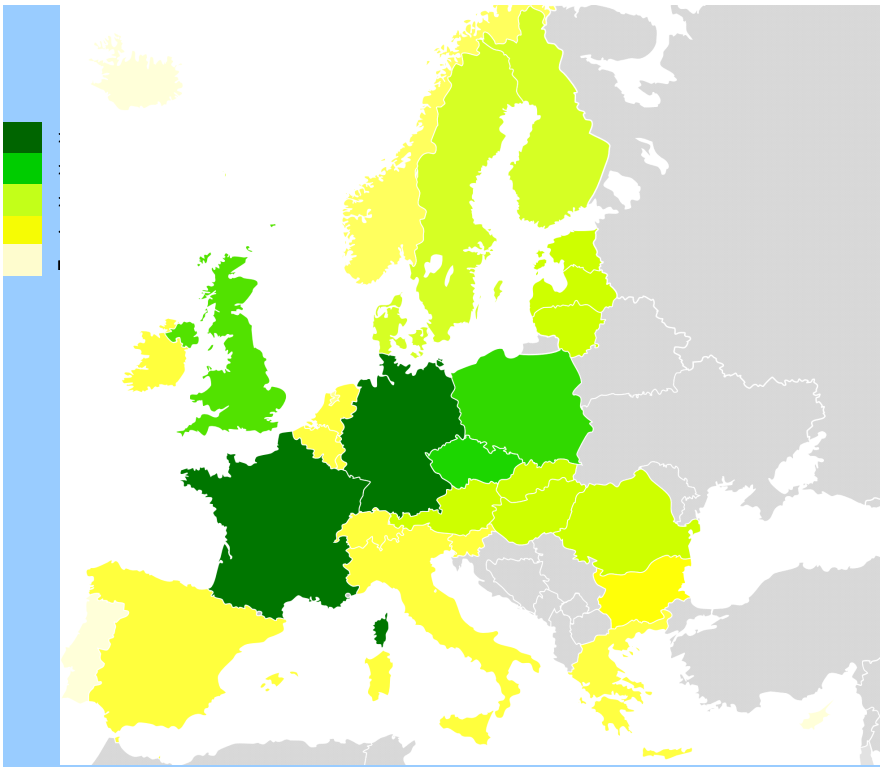


Figure 14: *Production of rapeseed in EU27 + NO, CH, and IC (Ref. 1: FAO statistics 2006/2007)*

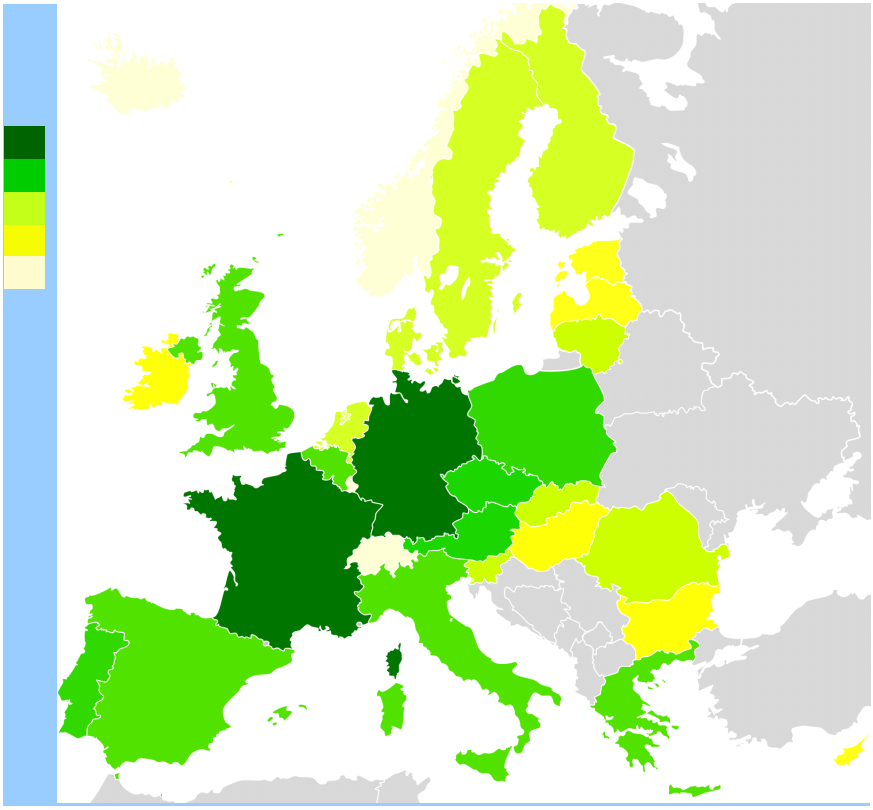


Figure 15: *Production of biodiesel in EU27 including NO, CH, and IC (Ref. 2: data for 2006/2007, EurObservÉR Biofuels barometer, 2008)*

3.2.4.3 Green biorefineries

Figure 16 summarises the existing or planned green biorefineries according to the BIOPOL definition (in brown), as well as the green biorefineries according to EUROVIEW definition (in green). The sites with more than one colour relate to multiple feed / integrated biorefineries according to EUROVIEW definition. The numbers shown on the map are the same as the site numbers in Table 2 (Appendix D).

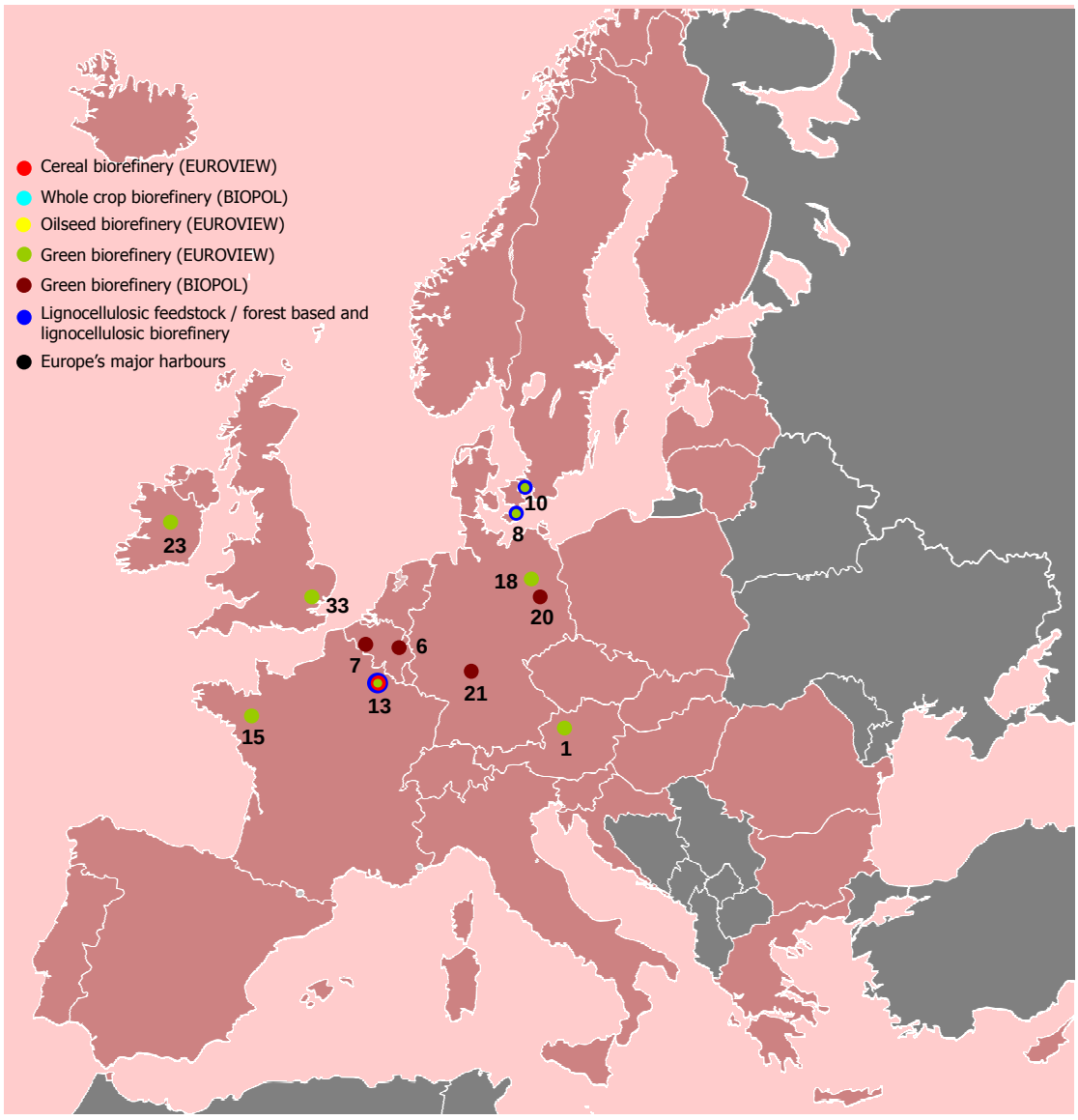


Figure 16: *Green biorefineries in Europe (see Table 2,* Appendix D *for detailed data)*

Figure 17 gives estimations of the total grass production in grassland area in Europe (in green), as well as the grass used for feed (in yellow), both for the year 2000 (Ref. 3: Fischer *et al.*, 2007). As can be seen, in some countries like France, Germany, the UK, Austria and Denmark more grass is available than required for feed, while for other countries like Belgium and the Netherlands the supply of grass is equal to the demand for feed. The grass not used as feed could potentially be available for biorefinery applications. This is mapped in Figure 18. In Figure 16 many biorefinery sites (sites number 1, 8, 10, 18, 20, 21 and 23) are grass-based, two sites are based on sugar beet (sites 13 and 33, also at site 18 sugar beet is used together with grass, lucerne and alfalfa as

feedstock), two biorefinery sites (sites 6 and 7) are based on pea and chicory, and one site (site number 15) is based on seaweeds.

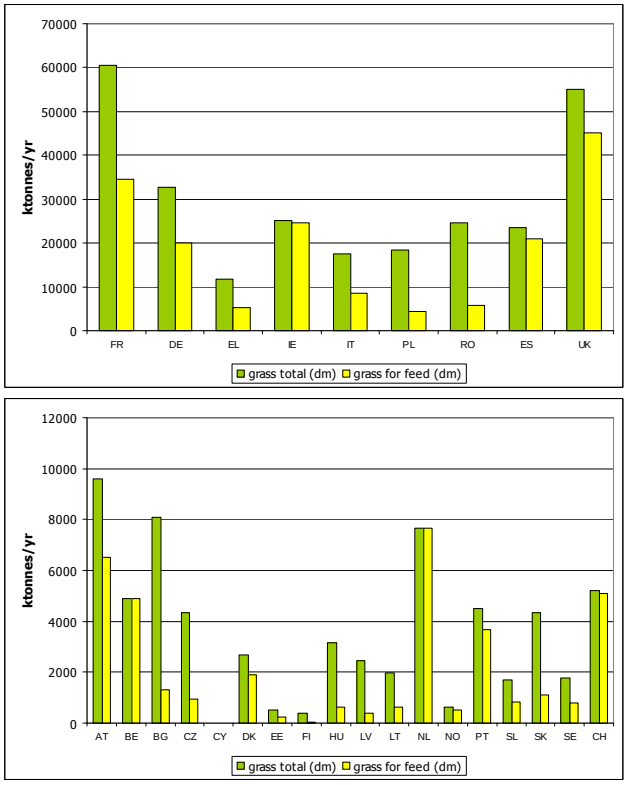


Figure 17: *Grass production in EU27 incl. NO, CH; green: total grass production in grassland area, yellow: grass used for feed; data refer to year 2000 (Ref. 3: Fischer et al., 2007)*

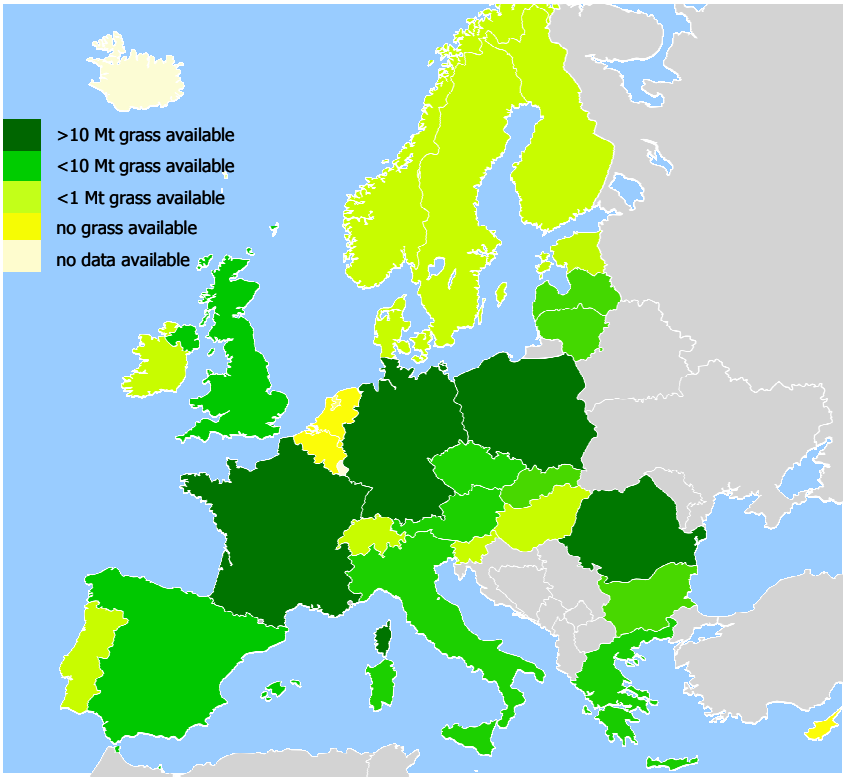


Figure 18: *Grass not used as feed and potentially available for biorefinery applications. Data refer to the year 2000 in EU27 including NO, CH, and IC* (Ref. 3, 2007)

Based on potential grass availability, future green biorefineries based on grass as feedstock could be expected in Poland and Rumania.

3.2.4.4 Lignocellulosic feedstock / forest based and lignocellulosic biorefineries

Figure 19 summarises the existing or planned lignocellulosic feedstock / forest based and lignocellulosic biorefineries according to BIOPOL / EUROVIEW definitions (in dark blue). The sites with more than one colour relate to multiple feed / integrated biorefineries according to EUROVIEW definition. The numbers on the map are the same as the site numbers in Table 2, Appendix D.

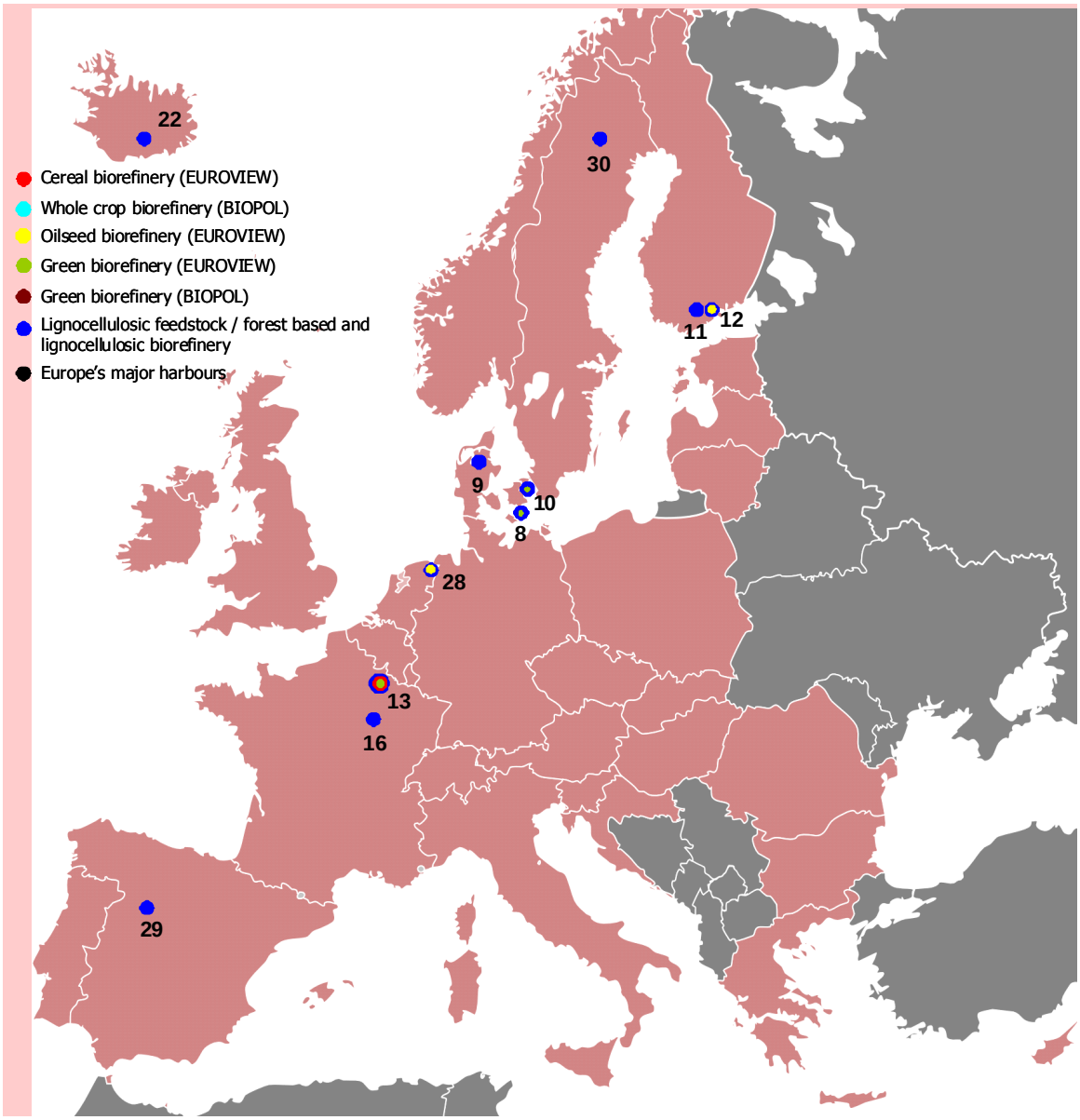


Figure 19: *Lignocellulosic feedstock / forest based and lignocellulosic biorefineries in Europe (see Table 2 Appendix D for detailed data)*

Two major feedstocks for this biorefinery concept are wood (including forest residues and black liquor) and straw. Wood and wood-based residues are available in the whole of Europe, but more significantly in the Scandinavian countries. As an example, Figure 20 presents the results of map-

ping the production of pulp for paper in Europe, with the highest production levels in Sweden and Finland.

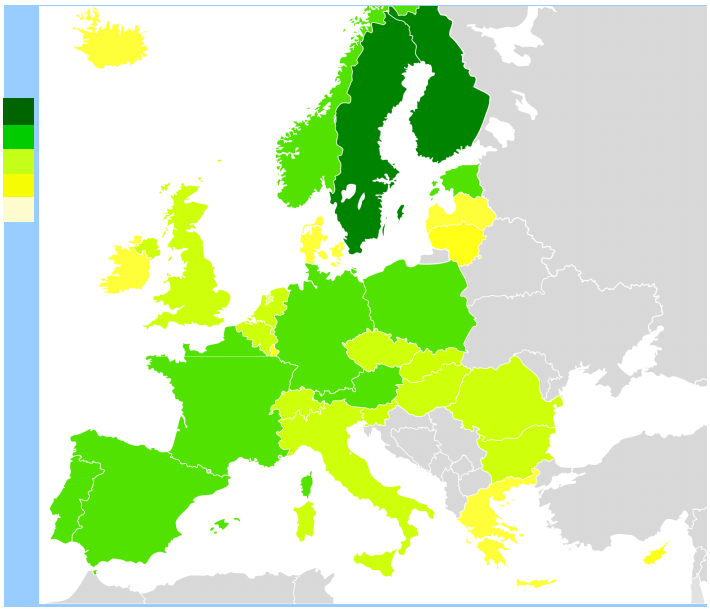


Figure 20: *Production of pulp for paper in EU27 incl. NO, CH, and IC (Ref. 1: data for 2006, FAO statistics)*

On the other hand straw is more available in West, East and South Europe, as for example could be seen from the current production levels of wheat in Europe (see Figure 35 and Figure 36). This is also indicated by the mapping of agricultural residues from food and feed crops in the EU 27 that consists to a substantial extent from straw (Figure 21).

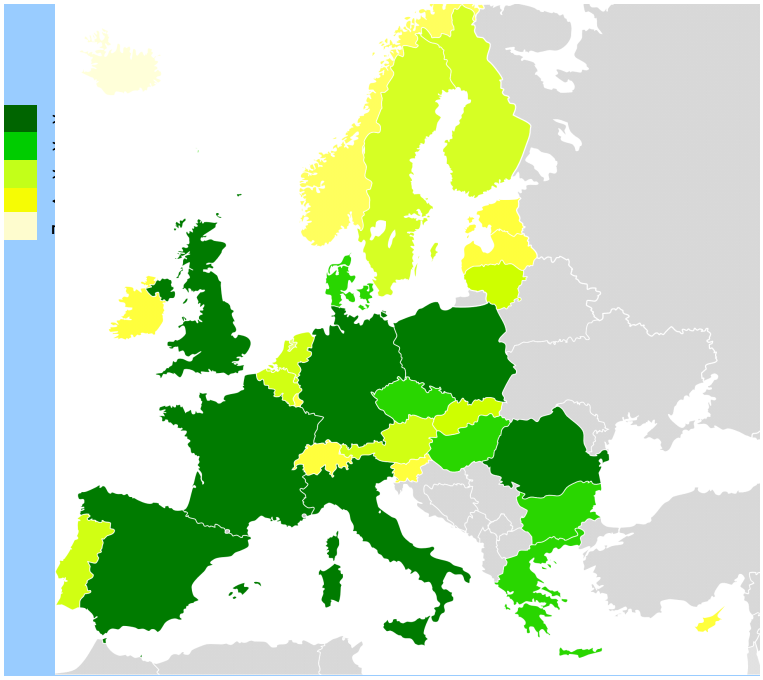


Figure 21: *Agricultural residues of food and feed crops (data for 2000) in EU27 including NO, CH, and IC (Ref. 3:Fischer et al., 2007)*

The biorefinery sites presented in Figure 19 are also more or less based on both wood and straw as feedstock, however, with more emphasis on wood in North Europe and straw in the other regions.

3.2.4.5 Overview of all identified existing and planned biorefineries

Finally, all 34 recognised biorefinery sites within BIOPOL and EUROVIEW projects are mapped in Figure 22.

As can be seen about 75% of the biorefinery sites are located within an area comprising Northern France, Germany, Denmark, Belgium, the Netherlands, and the UK. These 6 countries have beside a variety of different suitable feedstocks for biorefinery applications, also an intensive (petro)chemical industry, as presented in Figure 31 and Figure 32.

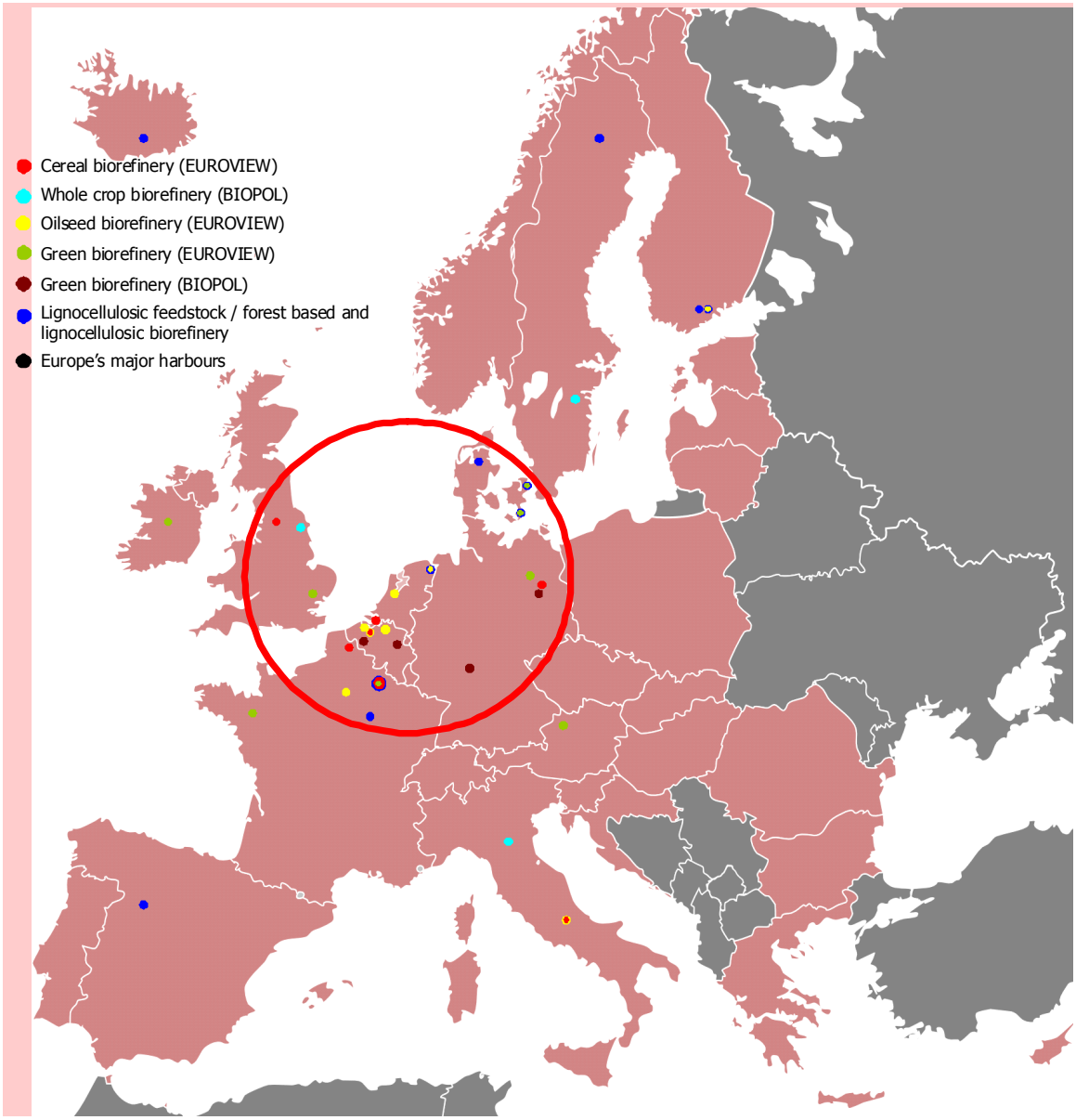


Figure 22: *Existing or planned biorefineris in Europe*

The mapping results confirm a positive, correlation between existing and planned biorefineries and the occurrence of chemical industries. Furthermore a positive correlation is indicated with the presence of biofuels producers, pulp/paper and forestry companies and agro-industries mainly in the starch and sugar sector and the availablility of the corresponding feedstocks wheat and sugar beet.

Oilseed bioefineries are currently less developed in the EU27+, in spite of a large production of oil seed crops that seem to be mostly used for biodiesel production.

A relatively high number of green biorefineries using grass as feedstock was identified, given the fact that grass can be considered a second generation feedstock that requires innovative processing technology and product outlets.

A substantial number of current and planned second generation lignocellulosic feedstock biorefineries were identified that are positively correlated mainly with the availability of wood (including forestry residues) and straw.

3.3 Classification of visited or interviewed sites according to industrial sectors

3.3.1 Introduction

In this section, we propose a global classification of specific platforms identified as potential bio-refineries based on the general definition of BE consortium (§ 2.4) and the list of potential sites (see table 1 and table 3 – Appendix D) according to the following sectors (detailed in §3.3.2).

- Starch Industrial biorefinery
- Sugar Industrial biorefinery
- Paper-Mill Industrial biorefinery
- Oilseed Industrial biorefinery
- Waste Industrial biorefinery

The advancement state of the biorefinery was also specified, i.e. existing or future biorefinery, considering those terminologies and the general definition proposed by BE consortium:

- "Existing ": an agro-industrial site already in activity and characterised as a biorefinery.
- "Future": an agro-industrial site in construction, or which could be classified as a biorefinery, once complete development of pilot/demonstration R&D projects will be achieved.

This section is based on the report elaborated by Adeline Menet, in August and September 2008, completed by datas from the reports of the different visits or interview of selected industrial sites, and from bibliographic data found on internet sites.

3.3.2 Approaches according to five industrial sectors:

3.3.2.1 Starch industrial biorefinery

This type of refinery is one of the oldest one, since this industry has developed for several years from cereals (wheat, maize, rice…), a lot of food products (flour, proteins, bran, food additives, sugar derivates…) derived from starch.Most of the developments were dedicated mainly to the food industry, but evolved also to the non food industry (corrugated paper industry, chemical industry, pharmaceutical industry). More recently, the introduction of fermentation process has given rise to new value products such as alcohol production for transportation. However, one has to be attentive that the strong added value brought by intensive development of ethanol production does not break the balance between food and non food industry development.
Consequently,, we try to identify starch industries that fit to the biorefinery concept, with the aim to integrate valorisation of the whole grain. Thus, the ideal refinery based on starch development into added value products will be able to refine the grain in its totality with less energy consumption. Co-products with low value will be valorised for sugar fermentation, in order to produce ethanol. The other part of by-products that were usually considered as waste will be burned into a fatal issue, or digest to produce biogas in oreder to create added value.
Success factors impacting the development of this industry appeared to be a good partnership between industrials that have complementary knowledge for creating added value products. The result will be a platform development for starch outlets, localised in the heart of the cereal production area.

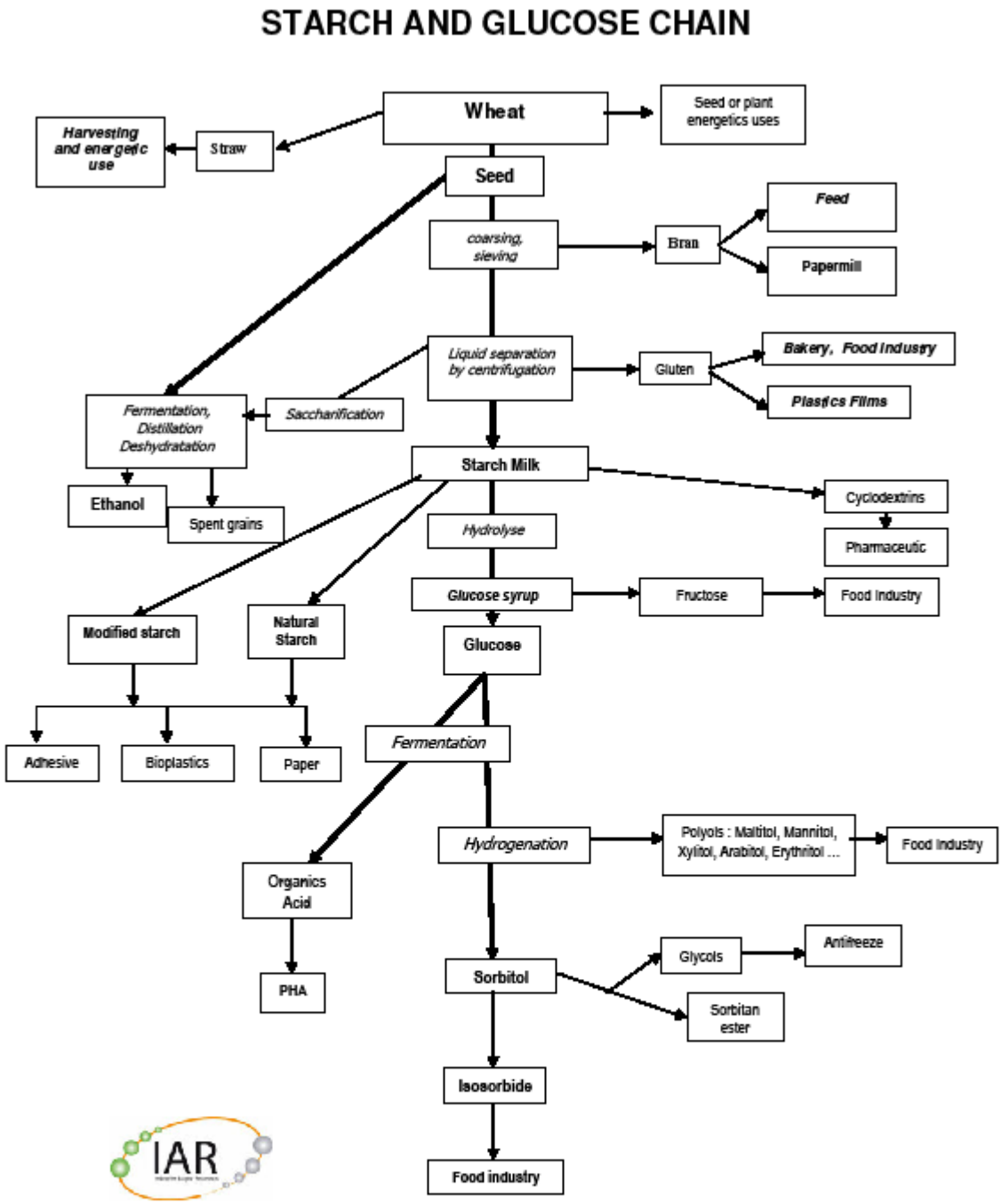


Figure 23 : *Various added-value products derived from wheat (*Ref. 5*)*

3.3.2.2 Sugar industrial biorefinery

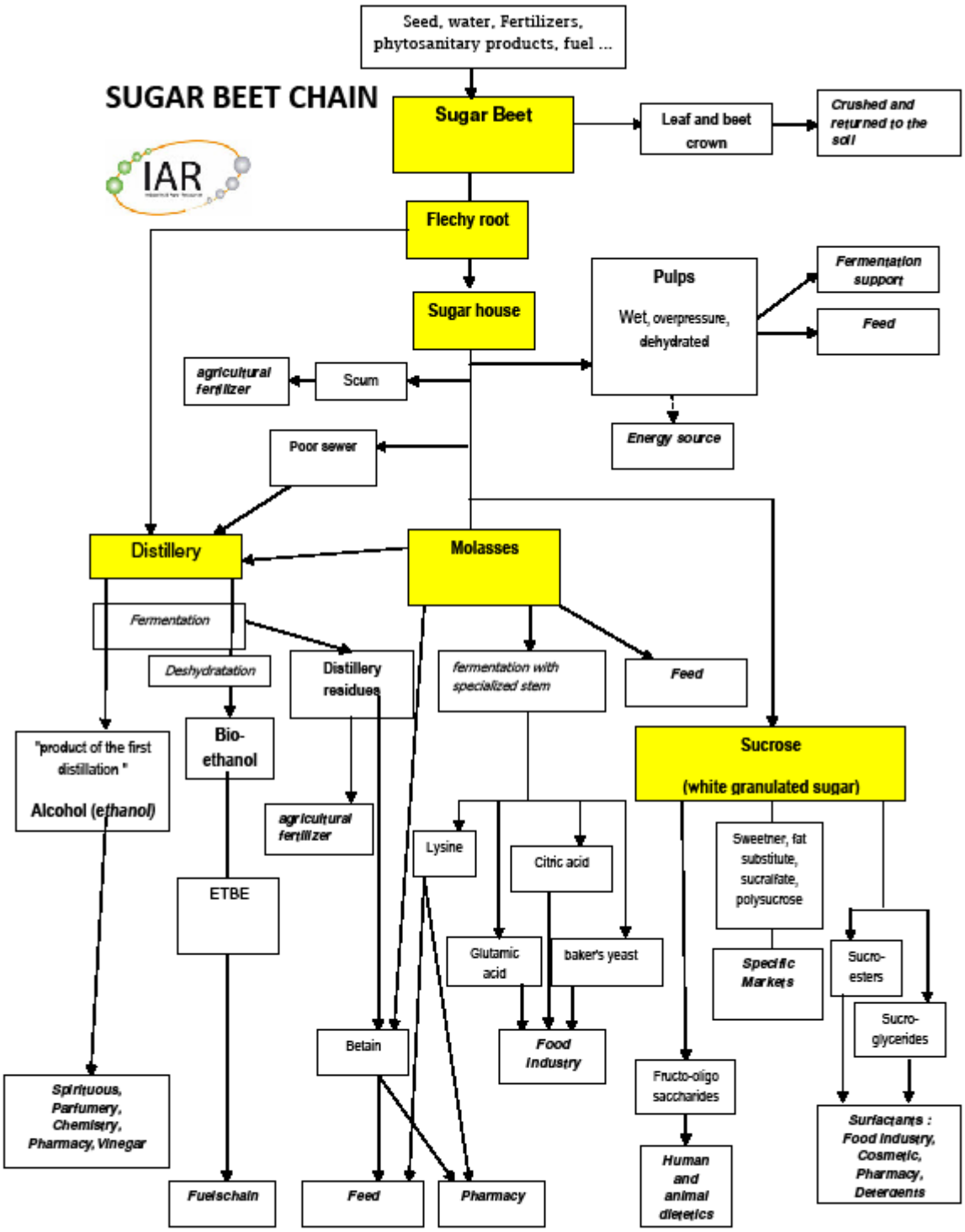


Figure 24: *Various added- value products derived from sugar beet (*Ref. 5*)*

Sugar industry is supported by the local sugar beet. Even if the main product was historically saccharose as food ingredient, with two main co-products (molasses and pulps), a wide diversification into high value products was observed for animal feed, cosmetic, pharmacy and more recently alcohol production The ethanol production (mainly for transportation), is derived from the sugar factory co-products due to the development of enzymatic fermentation combined to distillation . As a consequence, sugar and ethanol plants are working together and are linked for the exchange of products. Furthermore, the steam is also exchanged, and the produced power in general is shared. Concerning success factors, proximity of plants with specialised technological process is an essential to guarantee competitiveness. Optimisation of existing structures belonging to the sugar plant for distillery can be required. These developments can be illustrated by Tereos activity in France. Research is on going to find new outcomes for the principal co-products of distillation, vinasses, into energy, *via* development of a new process (pyrogazeifaction) that allows to burn organic biomass for gas production. A general scheme of various added-value compounds derived from co-products of sugar industry is presented in Figure 25.
Other type of industry, such as starch industry, can optimise sugar distillation into bioethanol; An example is the site of Pomacle/Bazancourt in France where starch juices can be injected directly into the sugar distillation process. This addition leads to optimisation of the original process.

3.3.2.3 Oilseed industrial biorefinery

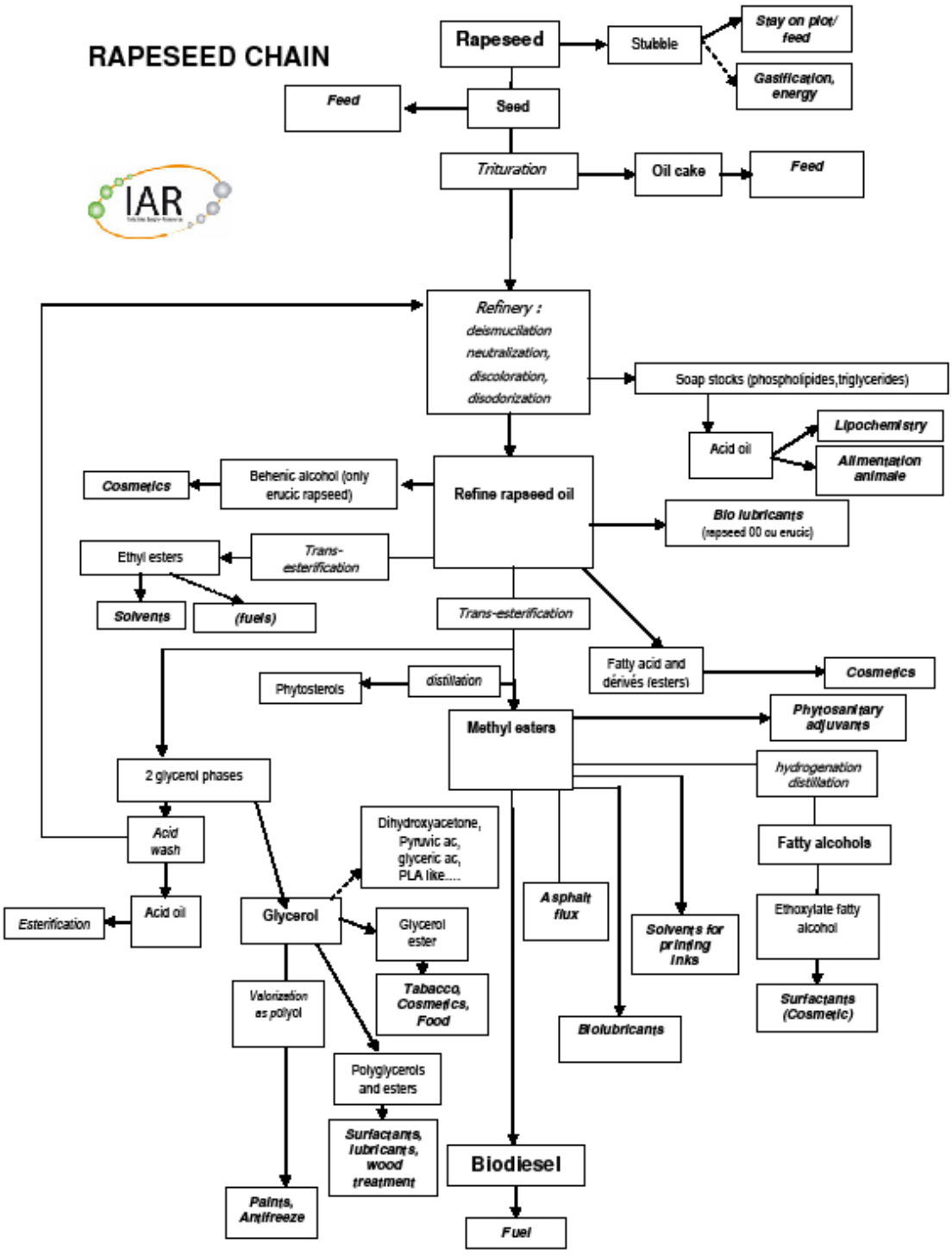


Figure 25: *Various added- value products derived from rapeseed oil (*Ref. 5*)*

The oilseed-based refinery is represented most of the time by chemistry factories or biodiesel plants. However, this industrial sector cannot fit well with our biorefinery definition, since most plants do not seem to exchange materials or products between each other. We can mention one oloeochemical industry in this sector, Novance, in France, that can be considered as refinery according to our definition. Indeed Novance, a subsidiary of biodiesel industry (Diester Industrie) produces and trades diester from semi-refined rapeseed oil (produced by Sofiproteol) and other oleoproducts in the sectors of detergents, solvents, paints, resins... These added value products are mainly derived from glycerine, a major co-product of biodiesel production. One success factor for this refinery development can be due to a good logistic transportation of oil, by 3 communication routes (railways, road, fluvial). Oleon in Belgium, also belonging to Sofiproteol, is another oil industry producing various intermediates as substitutes of derived petroleum derived products for various markets (cosmetic, coating, lubricants, detergents,…) The strategy of acquisition of Oleon by Sofoproteol allows the group to be present on the whole seed processing industry giving a leader position of the group on oil international trade . An illustration of various routes for production of high added-compounds is given in Figure 26.

We can also consider in this classification the waste oil based biorefinery, where waste oil is collected separately and refined so that it can be used to produce biodiesel by transesterification. Most of the time, the same process as the oil refinery can be used for waste oils, and in other cases used oil can be tretated with all sorts of wastes. So it is a mix between oil refinery and waste refinery, depending on the dominance of the raw material.

3.3.2.4 Paper mill industrial biorefinery

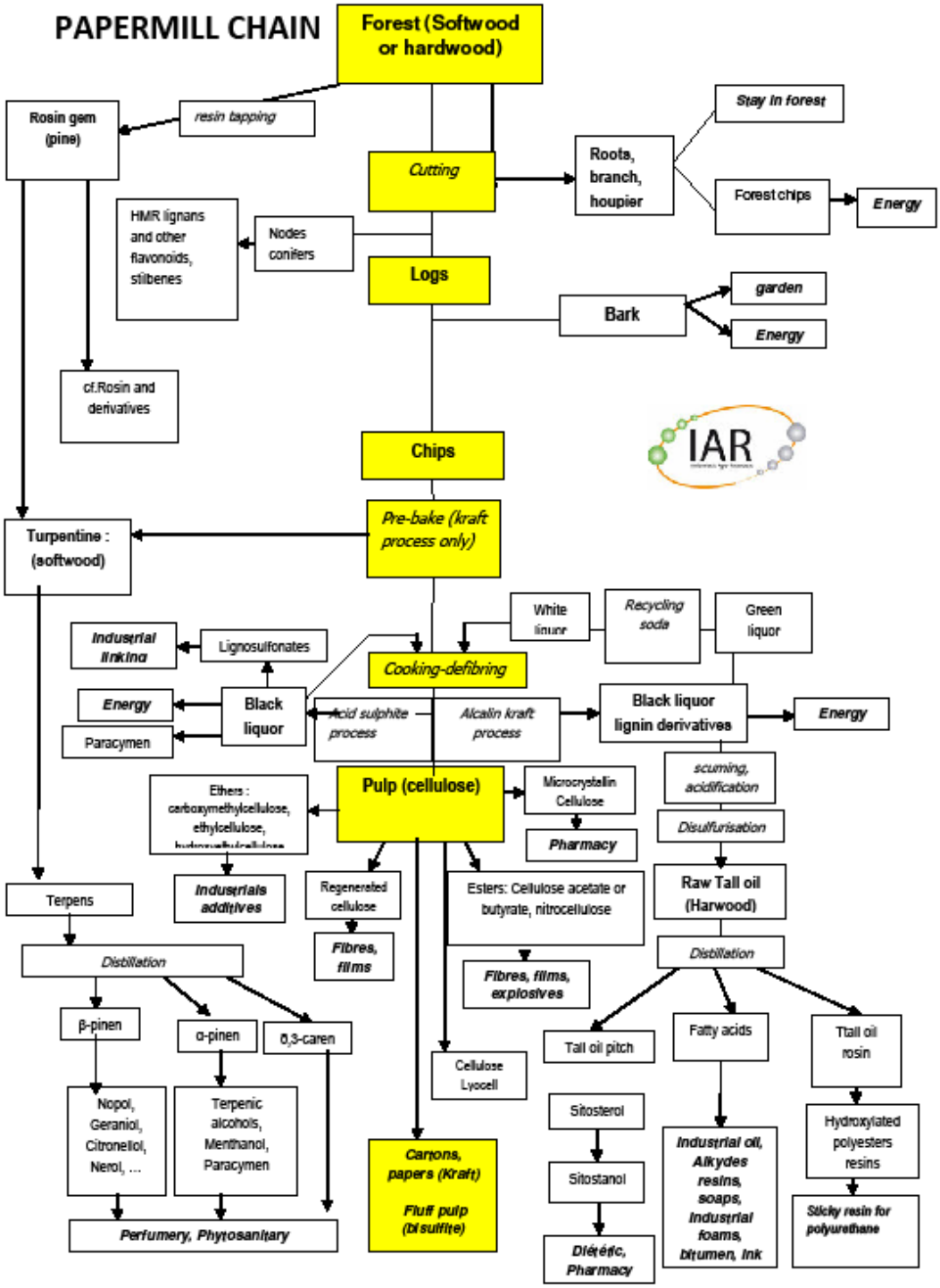


Figure 26 : *Various routes for increasing value of co-products paper-mill chain (*Ref. 5*)*

In this industrial sector, the aim is to develop new products from co-products resulting from the paper mill process.This type of industry is not yet optimised considering environment point of view (high volume of water consummation, chemical uses and low added value valorisation of the wood). Indeed, only cellulose from wood gives rise to increase value products. All the other polymers from wood (lignin, oligosaccharides..), and important co-products of cellulose production like black liquor, are not for the moment used for production of high-value products. Research is on going in this field with various projects concerning improvement of lignin transformation into new sources of energy, but also for the production of chemical intermediates for various valuable markets. Therefore, the aim of a refinery based on paper industry, will be to introduce in this sector specific knowledges to create novel chains of high value compounds. As a consequence, high technologies and cooperation between companies will increase the added value of this industry, and lead a better environmental balance.

3.3.2.5 Waste biorefinery – an emergent sector.

A waste biorefinery will convert anything which has no structure, no uniformity, and which does not belong to one of the main feedstock classes (oil, carbohydrates, fibres), and therefore can not be used for anything else than digestion or liquefaction. A 'pure' waste biorefinery will never exist commercially on its own but should always be connected to another kind of biorefinery to make it profitable. In this scenario the waste "biorefinery" will also provide associated plants with valuable products out of their waste such as biogas, fertilizer, electricity…. At this state of the art, no example of existing waste biorefinery has been described. Some projects have been developed, but at a research stage (one example in the report of the research and pilot or demonstration plants). The methanisation process for transforming waste products can lead to high value products, but these plants are still isolated and not integrated to an industrial site. Therefore, this type of emergent refinery industry represents another opportunity for existing industries having waste products to give rise to high value compounds such as power that in return could be used for industry running.

3.3.3 Description of the sites by industrial sectors

This part was excluded from the public version for mainly based on the results of the industrial questionnaire and interview containing confidential information.

3.3.4 Mapping of industrial biorefineries in Europe

3.3.4.1 Mapping by industrial sectors

The follow map (Figure 27) presents the geographical repartition of the selected sites considered as existing of future biorefineries among the 5 industrial sectors:

- Starch Industrial biorefinery
- Sugar Industrial biorefinery
- Paper Mill Industrial biorefinery
- Oilseed Industrial biorefinery
- Waste Industrial biorefinery

We can remark that most of those sites are located in the center of Europe, and that among the 3 paper-mill industrial biorefinery identifies, two are in Sweden and the third one is in France. In Italy, two atypical initiatives have been selected as real initiative of biorefinery, in spite of the fact that it was difficult to have more detailed and accurate information on those sites.

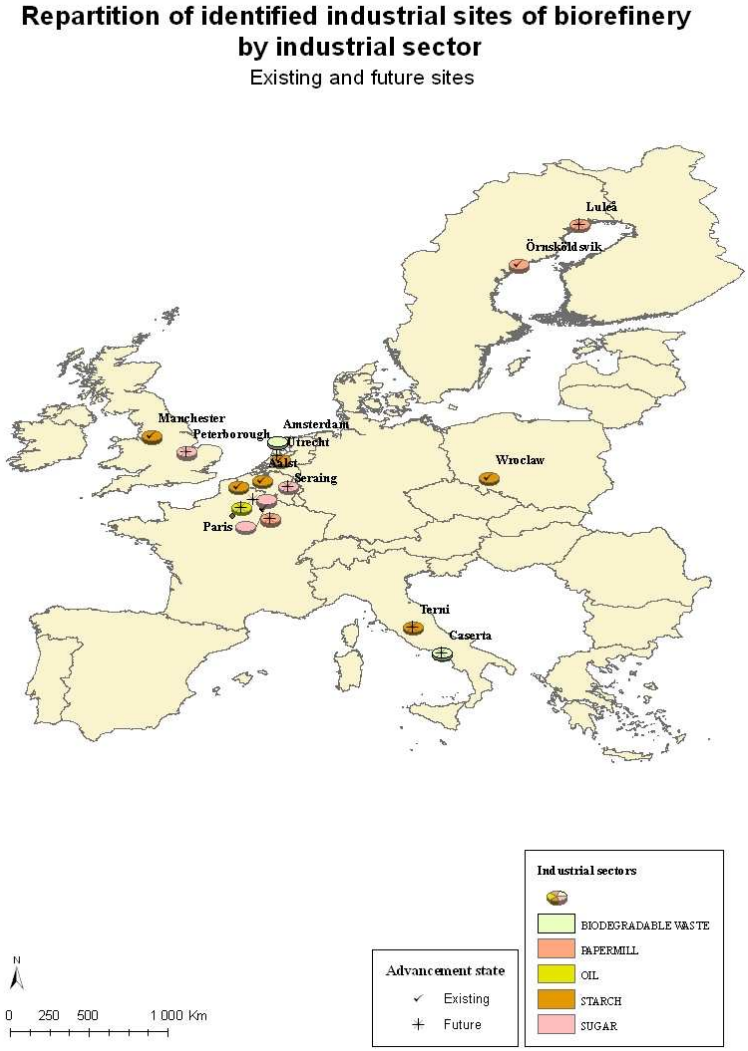


Figure 27: *Repartition of identified industrial sites of biorefinery by industrial sector – Existing and future sites.*

3.3.4.2 Mapping by type of end-products

The follow map (Figure 28 and Figure 29) show the geographical repartition of the selected sites considered as existing of future biorefineries and producing the different type of product that can be classified among the 5 type listed below:

- Food and Feed
- Biofuels
- Heat and powers
- Biomaterials
- Biochemicals

We can notice that most of the sites are producing mainly food and feed. As a consequence, it seems that we cannot separate from the concept of biorefinery, often associated to the production of biochemicals or biofuel, the necessary link with the food and feed companies. Moreover, in the same way, the production of biofuels seems to be the other main products of those different sites, and this as much as for bioethanol or biodiesel producers.

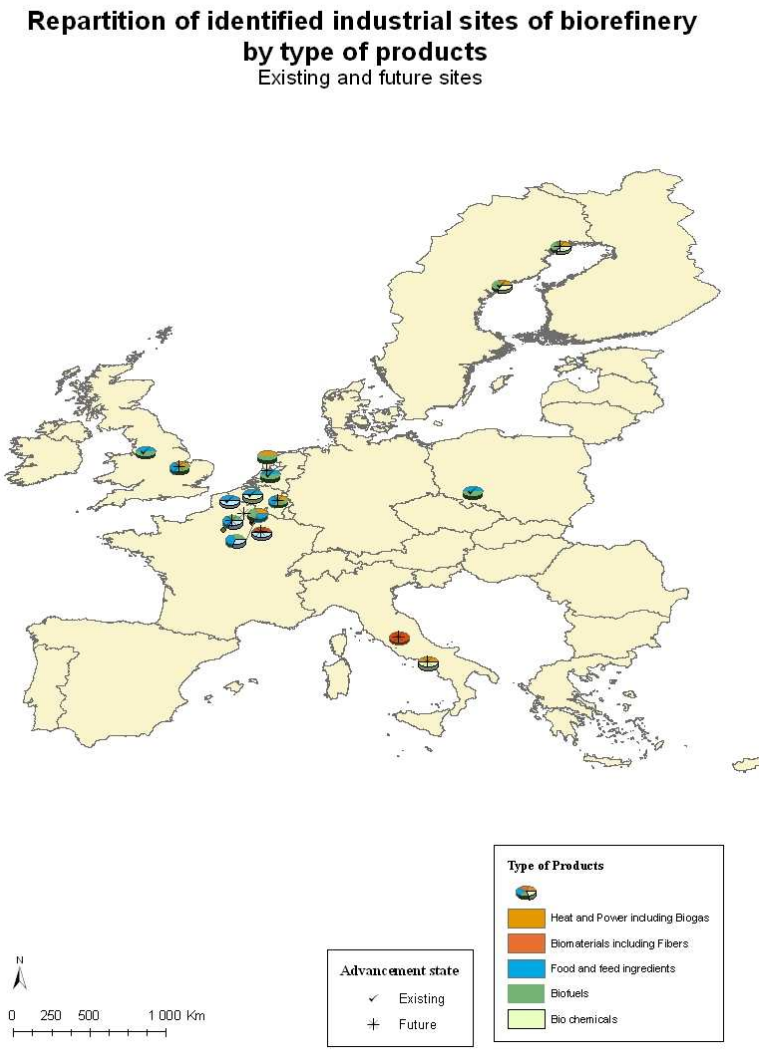


Figure 28 : R*epartition of identified industrial sites of biorefinery by type of products – Existing and futures sites.*

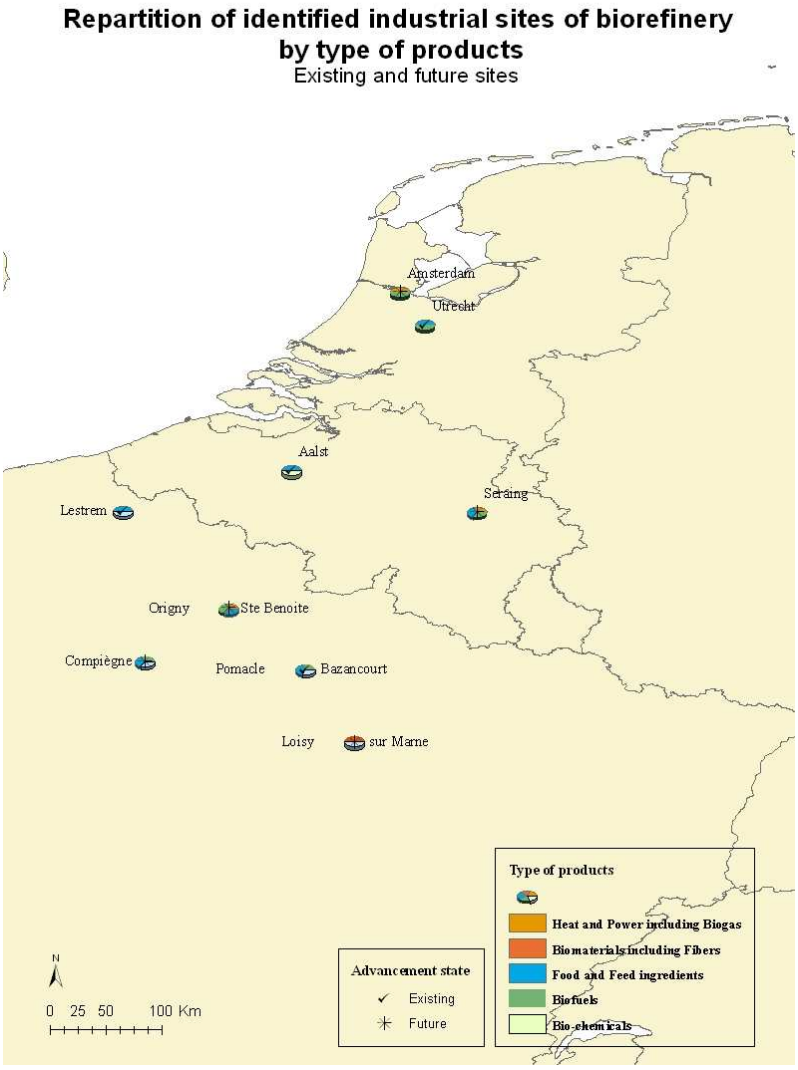


Figure 29: *Repartition of identified industrial sites of biorefinery by type of products – Existing and future sites.*

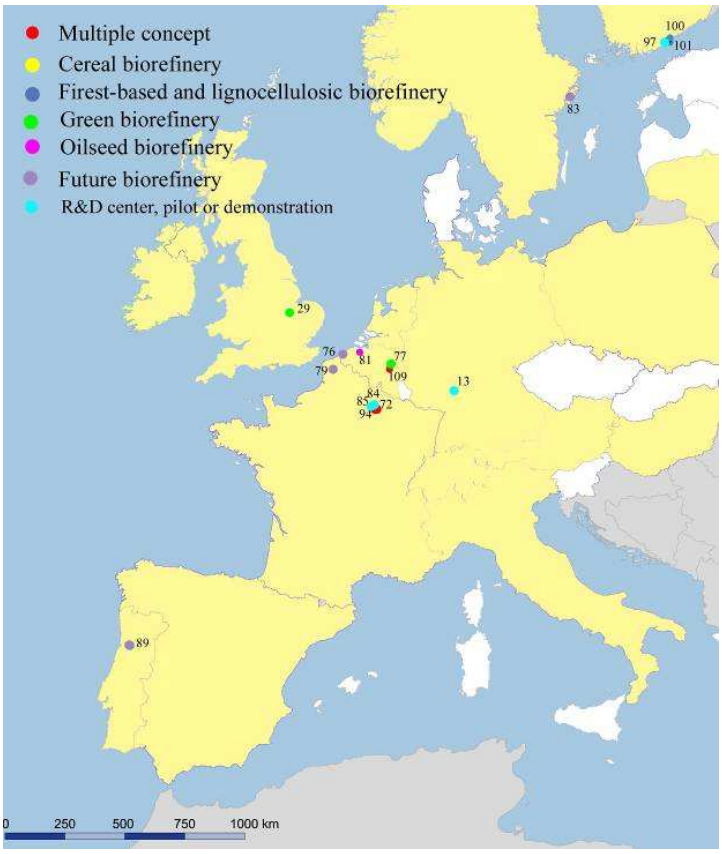
4. Conclusions

4.1 Conclusions from the review of agro-industrial sites in the European Union

A few integrated biorefineries regarding the definition developed by the Biorefinery Euroview consortium have been identified. We have tried, based on the benchmarking of European agro-industries proposed in the deliverable D1.2 of Biorefinery Euroview, and the data given directly by the industrial in the questionnaire to propose a first classification of the different types of agro-industries among this terminology and their definition:

- **Not a biorefinery**: agro-industrial sites which use biomass but which cannot be defined as a biorefinery considering the definition explain in the deliverable D1.1 of Biorefinery Euroview Consortium;
- **Important R&D center, pilot plant and demonstration plant** alone working on biorefinery concept;
- Biorefineries plants which can be classified among the four selected concepts (**Oilseed, cereal, green and forest-based and Lignocellulosic biorefineries**)
- **Integrated biorefineries**: different plants on the same site, which cannot be considered as biorefineries alones, but together part of an integrated biorefinery, or one plant using different type of feedstocks, consequently different possible classification among the four selected concepts.
- **Future biorefineries:** considering information collected (some directly from the industrial survey concerning planning in the next 5 to 10 years) on projects that will transform the agro-industrials plant to a biorefinery site (construction of another plant close to the existing, pilot plant).

Among the 110 answers from the questionnaire, 89 industries have not been characterized as biorefineries, but 9 agro-industries have been classified as biorefineries or part of an integrated site of a biorefinery (integrated biorefinery), 8 as future biorefineries and 4 as R&D center, pilot or demonstration plant on Biorefinery subject



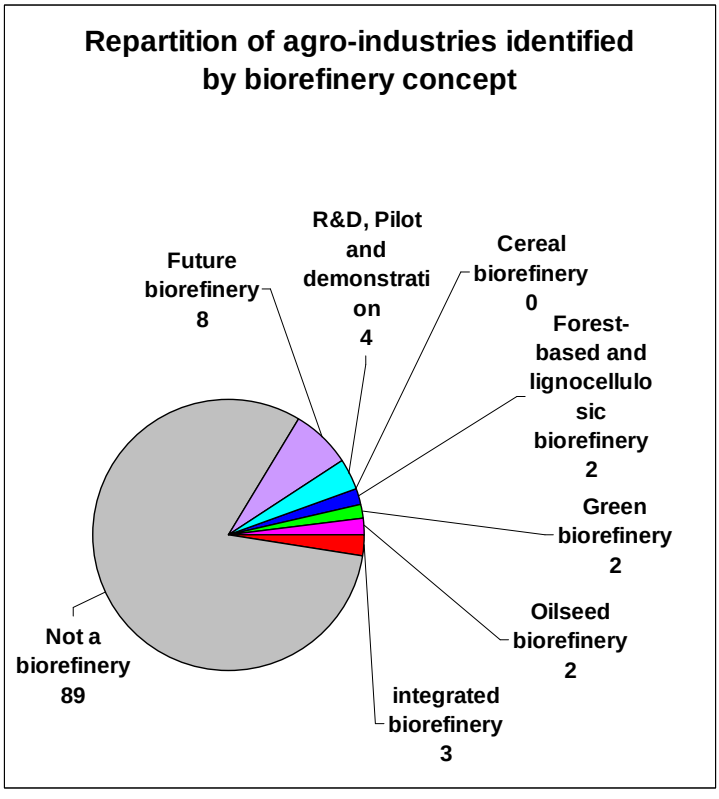


Figure 30 : *Mapping and graph representing repartition of identified biorefineries, future biorefineries or R&D center, pilot and demonstration plants.*

4.2 Conclusions of identification and mapping current and planned biorefinery sites and biorefinery related R&D, pilots and demonstration projects in the EU27+

- An up-to-date, elaborate mapping of existing and planned biorefinery plants, R&D projects, pilots and demonstrations in the EU27+ is available. A substantial number of biorefinery plants and projects using a range of feedstocks is operational in the EU27+ or can be expected to be realized in a short term.

- Thirty four existing or planned biorefineries are recognised within the BIOPOL and EUROVIEW projects. These biorefineries are based on different concepts of cereal biorefinery, whole crop biorefinery, oilseed biorefinery, green biorefinery, lignocellulosic feedstock / forest based and lignocellulosic biorefinery, multiple feed / integrated biorefinery, as defined within the BIOPOL and EUROVIEW projects.

- The majority of the identified biorefineries are located in Western Europe (23), followed by Northern (8) and Southern Europe (3). No existing biorefineries have been identified in the Eastern EU countries.

- Also the majority of the identified biorefinery-related R&D, pilots and demonstration projects take place in Western Europe (28), followed by Northern Europe (16) and Southern Europe (1). No biorefinery-related R&D, pilots, and demonstration projects were identified in the Eastern European countries.

- About 75% of the biorefinery sites are located in an area comprising Northern France, Germany, Denmark, Belgium, the Netherlands, and the UK. These 6 countries have beside a variety of suitable feedstocks, also an intensive (petro)chemical industry.

- The mapping results confirm a positive correlation between existing and planned biorefineries and the occurrence of chemical industries, biofuel industries and agro-industries mainly in the starch and sugar sector and with the availablility of the feedstocks wheat and sugar beet.

- Oilseed bioefineries seem currently less developed in the EU27+, in spite of a large production of oil seed crops that seem to be mostly used for biodiesel production.

- A relatively high number of green biorefineries using grass as feedstock (7) was identified, given the fact that grass can be considered a second generation feedstock that requires innovative processing technology. Furthermore a substantial number of current and planned lignocellulosic feedstock biorefineries (11) were identified that are positively correlated with the availability of wood (including forestry residues) and straw. Based on feedstock availability there is a large potential for expansion of these advanced concepts.

- The mapping results of the availability of specific feedstocks in the EU27+ show, that several Eastern European countries have a high potential for biorefinery based on feedstock availability. The fact that no biorefineries, or biorefinery-related R&D, pilots and demonstration projects were identified in one of these countries seems to imply that beside feedstock availability other factors such as a good infrastructure, the presence of (petro)chemical industries, and possibly many other factors are equired for the development of biorefinery plants.

4.3 Conclusions of results of industrial interviewed or visited sites

Based on those more accurate and detailed information collected by interview and/or visit, important key factors of success leading to the development of biorefineries have been identified:

1) The main product has a guaranteed market and is supported at the national level (in volume and in long time). As an example, CARGILL prices are guaranteed by the American government. Indeed, if the market guarantees the investment, then it is possible to valorize the co-products, structure's costs of this new valorisation could be absorbed (case of complexe of Novance/Diester industries/Saipol).

2) On-site existing of a major bio-industry is attractive for the development of the other one. This key factor is typical of the sites of Cargill/Royal Nedalco and the site of Origny-Ste-Benoite of Tereos.

3) On-site existing of an R&D center already well developed and experimented for the implantation of another company;. Nevertheless, this point is only profitable to the new company if R&D developments and facilities are shared (case of thecomplexe of ARD/Cristanol/Chamtor on the site of Pomacle/Bazancourt).

4) Proximity to the local agroresources which facilitate the contract relations with the farmers allowing to define specifications and impose a regularity and a quality of the supply (case of the future CIMV industrial plant.

5) Proximity with transportation facilities ; It is the case of the site of Venette/Compiègne of the complexe of Novance/Diester industries/Saipol which is easily accessible by boat, train and truck and the one of Cargill/Royal Nedalco in Sas Van Ghent close to the port of Ghent.

6) Real synergy between actors (Industrial Ecology). This is typically the case of Cargill/Royal Nedalco in Sas Van Ghent and of the one of Pomacle/Bazancourt.

7) Integration of sustainability in future developments. All the sites interviewed and visited have shown a real interest tin integrate those aspects.

5. Recommendations

Based on the results of the performed mapping studies the following recommendations for follow-up activities can be given:

- To perform a more detailed analysis of the factors that have led to the relatively successful implementation of the biorefinery concept in Western and Northern Europe;

- To analyse the existing barriers and obstacles for the development of the biorefinery concept in the Eastern European countries and to identify potential solutions to alleviate these obstacles;

- To continue monitoring of the evolution of biorefineries in Europe by periodic updates of the mapping results. Especially by employing a more regional approach with respect to feedstock availability, the presence of specific industries and other relevant factors;

- To take into account the identified key success factors (§ 4.3) in policies for fostering the development of future biorefineries in Europe.

References

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Appendix A Introducing letter and questionnaire on Biorefinery-Technology and socio-economic impacts

Date

Object : Status of biorefinery concepts

Dear partners,

The European Commission is financially supporting two research projects named BIOPOL and BIOREFINERY EUROVIEW which aim to analyse the current state of the art as well as potential impacts of biorefinery concepts in Europe, and elaborate recommendations for policy strategies and activities in this field. For more project details please visit the BIOPOL (http://www.biorefinery.nl/eu-ssa-biopol/) and BIOREFINERY EUROVIEW (http://www.biorefinery-euroview.eu) websites. The two projects have agreed to jointly analyse the view of relevant industries in Europe with respect to biorefinery concepts.

All the partners of those projects kindly asks your support for these activities by participating in a questionnaire-based survey. This is a vital step to ensure that the study is underpinned by a solid data base. Your input would be an important step towards the goal to accurately analyse the view of relevant European industries. It herewith contributes to the political and regulatory framework in the EU in this field, in order to facilitate the development and implementation of industrial biorefineries.

We guarantee that your data remain absolutely confidential. They only will be used for the aforementioned studies on an anonymous basis. It would be very helpful if you return the attached questionnaire completed per email (leena.fagernas@vtt.fi), or alternatively by fax (+ 358 20 722 7048) before 07/09/.2007. Also not fully completed questionnaires are welcome.
If you have any problems or queries in completing the questionnaire please do not hesitate to contact Leena FAGERNAS (+ 358 20 722 5453).

Thank you very much for your kind support and best regards,

Dr ir Bert Annevelink

Biorefinery Euroview Coordinator
Marc Chopplet
Biopol Coordinator
Bert Annevelink

Enclosures:
Questionnaire

Questionnaire on
Biorefinery-Technology and socio-economic impacts

Questionnaire to be returned before september 7th to:

Europol'Agro
9 Boulevard de la Paix
F- 51100 Reims - France
FAX: +33 3 26 91 39 45
Email: delphine.christian@univ-reims.fr

1. Bio-based/ biorefinery activities (feedstock, production, technology)

1.1 Which of the following feedstocks is used/ is transformed in your company? Is this feedstock produced within the region or do you import it? Which of the feedstocks will be probably used/ transformed in five to ten years in your company? Additionally, indicate the estimated amount(s) your company uses today and will probably use in five to ten years. *Please assess all of the following feedstocks, if possible.*

Feedstock	We do not use …	We use … Estimated amount [1.000 tons/year]	… is produced within the region	… is imported	We probably use … in 5-10 years … Estimated amount [1.000 tons/year]	Feedstock	We do not use …	We use … Estimated amount [1.000 tons/year]	… is produced within the region	… is imported	We probably use … in 5-10 years …. Estimated amount [1.000 tons/year]
Sugar beet	☐		☐	☐		Hemp	☐		☐	☐	
Wheat	☐		☐	☐		Flax	☐		☐	☐	
Maize	☐		☐	☐		Sunflower	☐		☐	☐	
Grass	☐		☐	☐		Olive	☐		☐	☐	
Lucerne (Alfalfa)	☐		☐	☐		Soy	☐		☐	☐	
Straw	☐		☐	☐		Peanuts	☐		☐	☐	
Wood/ Forest-biomass	☐		☐	☐		Palm	☐		☐	☐	
Organic waste	☐		☐	☐		Peat	☐		☐	☐	
Ligno-cellulosic-biomass (e.g. reed)	☐		☐	☐		Fossil fuel	☐		☐	☐	
Switch grass	☐		☐	☐		Coal	☐		☐	☐	

Rapeseed	☐		☐	☐		Fossil gas	☐		☐	☐	
Sorghum	☐		☐	☐		Others:	☐		☐	☐	

1.2 Do you produce or plan to produce one of the following product categories based on renewable resources in your company? Which raw material do you use, in which quantity do you produce them and which turnover do you realise with it? Additionally, please specify which product you exactly produce (e.g. lactic acid, polylactid).

Product category	We produce…	We plan to produce in 5-10 years…	We do not produce…	Raw material used	Estimated quantity [1.000 t/a] or rather kWh	Estimated sales (1.000.€/a) or rather kWh	Type of products
Fuels	☐	☐	☐				
Starch	☐	☐	☐				
Sugar	☐	☐	☐				
Syngas	☐	☐	☐				
Paper	☐	☐	☐				
Pulp/fibers	☐	☐	☐				
Heat	☐	☐	☐				
Power	☐	☐	☐				
Chemicals	☐	☐	☐				
Fine chemicals	☐	☐	☐				
Bulk chemicals	☐	☐	☐				
Speciality chemicals	☐	☐	☐				
Biopolymers/biomaterials	☐	☐	☐				
Other:	☐	☐	☐				

1.3.1 What are your major co-products and in which quantity do you produce them?

Co-product	Produced quantity [1.000 t/a]

1.3.2 Do you transform/ use these co-products within or outside the company?

☐ yes, on the same site	☐ no, but we plan to use it on another site
☐ yes, on another site	☐ no, but we plan to sell it
☐ yes, we sell it to another company	☐ no, we do not use it and do not plan to use it

☐ no, but we plan to use it on the same site	☐ I do not know

1.4 What major conversion/ separation technology or industrial processes do you currently use in your company? What technology will you probably use in five to ten years?

Technology	We use…	We do not use…	We probably use in 5-10 years…	I do not know		We use…	We do not use…	We probably use in 5-10 years…	I do not know
Pyrolysis	☐	☐	☐	☐	Mechanical conversion	☐	☐	☐	☐
Gasification	☐	☐	☐	☐	Extraction	☐	☐	☐	☐
Fermentation	☐	☐	☐	☐	Distillation	☐	☐	☐	☐
Biocatalysis	☐	☐	☐	☐	Acid hydrolysis	☐	☐	☐	☐
Digestion	☐	☐	☐	☐	Enzymatic hydrolysis	☐	☐	☐	☐
Combustion	☐	☐	☐	☐	Chemical conversion	☐	☐	☐	☐
Other:	☐	☐	☐	☐	Other:	☐	☐	☐	☐

1.5.1 Is your biorefinery activity integrated with existing "classical" production facilities?

☐ yes, please continue with 1.5.2	☐ no, please continue with 2.1

1.5.2 What were the major reasons for integrating biorefinery activities in your existing "classical" production processes? *Please tick appropriate answers*

☐ Similar feedstock or intermediary products (or even residues) from original process are used.

☐ Sharing utilities and other production facilities. We share :

☐ Synergy in logistics.

☐ Our technological know-how and the market make biorefinery a logical step.

☐ Other technological synergies between our classical process and biorefinery, i.e.

☐ Other reason :

1.5.3 Please state your classical production process and the main product(s) you manufacture :

_____

2. Evaluation of biorefinery concepts

Within this interview we define „Biorefinery concept" as follows:
"Integrated bio-based industries, using a variety of different technologies to produce chemicals, biofuels
food and feed ingredients, biomaterials (including fibers) and power from biomass raw materials"

2.1 Please, rate the following statements for the biorefinery concept, as we defined it above.					
The biorefinery concept…	**I fully agree**	**I agree**	**I do not agree**	**I do not agree at all**	**We don't know**
is a promising concept for our company	☐	☐	☐	☐	☐
makes good economic sense	☐	☐	☐	☐	☐
is a technically sophisticated concept	☐	☐	☐	☐	☐
can not be implemented in our company	☐	☐	☐	☐	☐
offers interesting markets	☐	☐	☐	☐	☐
is characterised by a high environmental performance	☐	☐	☐	☐	☐
improves working conditions for the employees	☐	☐	☐	☐	☐
fits well in existing regulations and technical standards	☐	☐	☐	☐	☐

2.2.1 Do you think that biorefinery concepts and/ or biorefinery-based products offer advantages for your company?	
☐ yes, please continue with 2.2.2	☐ no, please continue with 2.3.1

2.2.2 If you think that biorefinery concepts offer advantages, please tick the most important aspects according to your opinion. (*Multiple responses are possible*)	
☐ Price advantages	☐ Improvement of the quality of the products
☐ New customer segments/ advertising appeal	☐ Good availability of the feedstock
☐ Increasing in the efficiency of the production	☐ Going easy on non-renewable resources, decreasing ecological damage
☐ Strengthening of the regional economy	☐ Decreasing imports of fossil raw materials
☐ Other:	

2.3.1 What are the main disadvantages/ problems of biorefinery concepts according to your opinion? (*Multiple responses are possible*)	
☐ Variable quality of the feedstock	☐ Deficient consumer acceptances/ no adequate markets
☐ Fossil feedstock too cheap	☐ Investment costs too high
☐ Deficient availability of the feedstock	☐ Production process too expensive
☐ Immature technology	☐ Established regulations do not fit with new technologies

☐ Other:

3. Barriers/Future of biorefinery concepts

3.1 What are the main barriers for the development of a biorefinery concept in your company? *(Multiple responses are possible)*	
☐ Political framework	☐ Economic barriers
☐ Legal framework	☐ Market conditions
☐ Technological barriers	☐ Qualification/ knowledge of the staff
☐ Environmental regulations	☐ Co-operation of actors/ knowledge transfer
☐ Behaviour of clients	☐ Negative opinion from some stakeholders
☐ Other:	☐ Other:

3.2 How necessary are the following aspects for accelerating the adoption of biorefinery concepts within the industry branch in which your company is active?

	Very necessary	necessary	Rather not necessary	Not at all necessary	We do not know
R&D activities concerning feedstock	☐	☐	☐	☐	☐
R&D activities concerning technology	☐	☐	☐	☐	☐
R&D activities concerning: _____	☐	☐	☐	☐	☐
Public financial support of R&D activities	☐	☐	☐	☐	☐
Publicly financed product price incentives for a restricted time period	☐	☐	☐	☐	☐
Availability of seed or venture capital	☐	☐	☐	☐	☐
Increased interest of potential industrial actors	☐	☐	☐	☐	☐
Closer co-operations between scientific research institutes and the industry	☐	☐	☐	☐	☐
Technology transfer activities	☐	☐	☐	☐	☐
Improved qualification of potential staff	☐	☐	☐	☐	☐
Improvement of political and legal framework	☐	☐	☐	☐	☐
Improved availability of feedstock	☐	☐	☐	☐	☐

Marketing activities for biorefinery-based products	☐	☐	☐	☐	☐
More and better consumer information	☐	☐	☐	☐	☐
Other:	☐	☐	☐	☐	☐

4. Socio-economic aspects

4.1 How important are the following factors for the establishment of biorefineries in a region according to your opinion?

Factors	Very important	important	Rather not important	Not at all important	Do not know
Existing capacities	☐	☐	☐	☐	☐
Accessibility of raw materials	☐	☐	☐	☐	☐
Availability of technology	☐	☐	☐	☐	☐
Availability of skilled/ qualified labour force	☐	☐	☐	☐	☐
Availability of trainable labour force	☐	☐	☐	☐	☐
Existing infrastructure/ transport connection	☐	☐	☐	☐	☐
Effective and supporting regional or governmental co-operation	☐	☐	☐	☐	☐
Availability of public financing of R&D activities	☐	☐	☐	☐	☐
Availability of venture capital	☐	☐	☐	☐	☐
Tax preference attached with the activity	☐	☐	☐	☐	☐
Exemption from local taxes	☐	☐	☐	☐	☐
Financial support by EU	☐	☐	☐	☐	☐
Environmental regulation	☐	☐	☐	☐	☐
Availability of knowledge transfer: research institute-enterprise networks	☐	☐	☐	☐	☐
Marketing activities for the region	☐	☐	☐	☐	☐
Leisure time facilities	☐	☐	☐	☐	☐
Other:	☐	☐	☐	☐	☐

4.2 How important are co-operations/contacts with the following actors concerning biorefinery activities. If you have already co-operations/contacts with one of these actors, please mark the relevant with a cross.

	Very important	important	Rather not important	Not at all important	We have a cooperation/ contacts
Private and public research institutes	☐	☐	☐	☐	☐
Universities or other educational institutions	☐	☐	☐	☐	☐
Labour offices	☐	☐	☐	☐	☐
NGOs	☐	☐	☐	☐	☐
General public	☐	☐	☐	☐	☐
Regional governments	☐	☐	☐	☐	☐
National government	☐	☐	☐	☐	☐
EU institutions	☐	☐	☐	☐	☐
Regional development agencies	☐	☐	☐	☐	☐
Companies of the same industry branch	☐	☐	☐	☐	☐
Supplying industries	☐	☐	☐	☐	☐
Technology transfer institutions	☐	☐	☐	☐	☐
Financing institutions	☐	☐	☐	☐	☐
Customers/retailers of your products	☐	☐	☐	☐	☐

Other: _____	☐	☐	☐	☐	☐

4.3 Does the Biorefinery concept have an impact on the following aspects? If yes, to what extent?						
	No impacts on ...	Very little impact on ...	Average impact. on ...	High impact on ...	Very high impact on ...	I do not know
rural development	☐	☐	☐	☐	☐	☐
utilization of agricultural raw materials from the region	☐	☐	☐	☐	☐	☐
creating employment in the region	☐	☐	☐	☐	☐	☐
the structure of the labour market in the region	☐	☐	☐	☐	☐	☐
the labour market reintegration of the disadvantaged and excluded people of the region	☐	☐	☐	☐	☐	☐
capacity and skill building of such groups for gaining employment	☐	☐	☐	☐	☐	☐
increasing activities of higher education institutions in the region	☐	☐	☐	☐	☐	☐
forming networks among the actors of the industry in the area/region	☐	☐	☐	☐	☐	☐
raising ecological awareness	☐	☐	☐	☐	☐	☐
decreasing CO_2 -emissions	☐	☐	☐	☐	☐	☐
agricultural/forestry structure	☐	☐	☐	☐	☐	☐
increasing transportations	☐	☐	☐	☐	☐	☐
increasing of infrastructure facilities	☐	☐	☐	☐	☐	☐
the activity of NGOs in the region	☐	☐	☐	☐	☐	☐
Other :	☐	☐	☐	☐	☐	☐
Other :	☐	☐	☐	☐	☐	☐

4.4 Where do you get information concerning biorefinery issues from? (*Multiple responses are possible*)	
☐ Own inquiries	☐ External (expert) inquiries
☐ Reports	☐ Articles from the press
☐ Reports of economic organisations and chambers	☐ Reports of state and governments organisations and institutions
☐ Reports of NGOs	☐ Personal contacts
☐ Internet searches	☐ Reports of agricultural extension services
☐ Reports of self governments	☐ Other:

5. Questions on your company

5.1 How many employees does your company have?		
☐ less than 50	☐ 50 to 250	☐ 250 to 1,000
☐ 1,000 to 10,000	☐ 10,000 or more	

5.1.1 What volume of sales realised your company in 2006?
_____ €

5.1.2 Which percentage of the volume of sales was realised by bio-based/ biorefinery-based products?

Approximately: _____ %	
5.2.1 How many of your employees work in the R&D department?	
☐ We have no R&D-department (*please continue with 5.3.1*)	☐ Number of R&D employees:

5.2.2 Which R&D projects on biorefineries and/or bio-based products are currently carried out in your company? Please characterise the relevant R&D projects in the following table.

Category	Target of research	Phase of development (e.g. laboratory, pilot phase, prototype)
Feedstock		
Product		
Technology		

5.2.3 In which country is your main R&D department located?
5.3.1 In which country is your headquarter located?

5.3.2 If you have divisions/subsidiaries in other countries, please indicate in which countries. Additionally, please indicate the main business activity (trading, production, distribution, R&D, services).

Country	Main business activity

5.4 To which industrial sector does your company belong to?

☐ (Petro-) Chemical-Industry	☐ Forestry Industry (Pulp and Paper)
☐ Sugar Industry	☐ Starch Industry
☐ Biofuels (biodiesel, bioethanol, biogas)	☐ Heat and Power
☐ Other:	

Thank you very much for your answers. Please, indicate:
Organisation name:
Address of headquarter:

If you would like to receive an abstract of the most important results of this survey, please indicate your email:

Appendix B Guide of interview for industrial sites visited or interview

1.The concept of biorefinery:

Considering the international IEA definition: "Biorefinery is the sustainable processing of biomass into a spectrum of marketable products."
In this project we consider more particularly biorefineries as:

- ***Integrated bio-based industries;***
- ***Using a variety of technologies to make products such as chemicals, biofuels, food and feed ingredients, biomaterials (including fibers) and heat & power;***
- ***Aiming at maximising the added value along the three pillars of sustainability (environment, economy, society).***

The aim of this meeting is to identify and to analyse the positive and negative factors that contribute to the biorefinery initiative.

2. Biorefinery process:

A Feedstock (raw materials and co-products)

- What is the **first resource** used in your company, at the beginning of the base activity?
-Can you describe the **evolutions** since? Which **new resources** have been introduced?
-What are the reasons why? (Differentiation of the work, new opportunities (market), fusions, acquisitions of new company, economic opportunity, policy makers, evolution of the plant due to another company?…)
-Actually, which **feedstocks** (vegetable) are used/ transformed in your company?
-Do you reuse **co-products** from your process as a feedstock?
-Is this feedstock **locally** produced or do you import it?
-What competitive advantage have you obtained by saving your feedstock locally?
-How have you secured your sourcing? (Degree of integration), do you integrate the long term development? (Environment...)
-In the next five to ten years: Which **feedstock will be probably used**/ transformed in your company?

B Products

-What is the base activity of your company? Which products were produced at first?
-Which type of main products (only from renewable resources) do your company currently produce in those categories?
-What have been the evolutions since the begining of the activity?
-What do you think of the next few years? Have you planned to valorise an other ressource or co-product?

Final product \ Feedstock			Sugar	Cereals	Oilseed	Fiber	Waste	Co-products	Other
Biofuels									
Bioénergie									
Food, feed									
Biochemicals									
Paper, pulp									
Other									

Products from raw material:

- Biofuels :
  - Bioethanol from sugar beet, wheat....; forest waste, straw...
  - Biodiesel from rapeseed, sunflower....
  - ..
- Bioenergy :
  - Heat from burn of co-products or residues of process
  - Heat and power(electricity) from biogas, bran of wheat.... (co-generation CHP)
  - ...

- Food, Feed and ingredients :
  - Sugars (sucrose, glucose,...) from sugar beet...
  - Starch and derivatives from wheat....
  - DGGS (co-product) as animal feed
  - ...

- Biochemicals :
  - Amino acids, proteins from grass
  - Syngas from biogas as methane, hydrogen...
  - Fertilizers from last residues of process..
  - Lactic acid from grass, maize... (to produce bioplastic(PLA) or solvents, surfactants... ?)
  - Glycerin (co-product) from rapeseed....

- ...

- Biopolymers and bioplastics
  - Bioplastic (PLA, ...) from maize (from lactic acid)
  - ...

- Paper/pulp/fibers
  - Black liquor(co-product) from wood chips (Kraft process)
  - Turpentine (co-product)
  - ...

Co-products

What do you do with the co-products and residues of your main process?

- Do you sell it to another company without any transformation?
- Do you make specific purification/ chemical modification to increase the added value of this co-product before selling it?
- Do you exchange those co-products with another company site close to your company (if yes, how: by transportation, by pipeline…etc)?
- Do you have an industrial partnership with other company? (Which degree of investment?)
- Do you burn your co-products without any valorisation?
- Do you burn your co-products and valorise them into heat and power? Do you produce biogas? (If yes, do you share this bioenergy with another company or sell it to a close neighbour?)? do you plan to increase the efficiency and/or the added value?
- Actually, do you reuse it in the process? Can you explain your motivations?
- What is the investment? How much money it permits you to save? Can you estimate the return of investment time?
- Which advantages it provides to you? (Economics, image, marketing, environmental benefits, societal impacts?)
- Are you searching for optimisation of co-products, by the maximisation of the added value?
- If not, have you planned to do it?

C Technology

What major conversion/ separation technology or industrial processes do you currently use in your company? (See categories and examples below)

(PROPOSE A FLOW CHART WITH MAIN TECHNOLOGIES OF THE PRODUCTION SITE)

- **Physical conversion (Biomass fractionation)**
  - Mechanical separation ;
  - Extraction / Purification ;
  - Distillation.
- **Biochemical conversion**
  - Fermentation ;
  - (Bio)catalysis ;
  - Digestion ;
  - Hydrolysis ;
  - Other chemical processes.
- **Incineration (combustion & co-generation)**
  - Simple combustion
  - Co-generation (production of heat and power)
- **Thermochemical conversion :**
  - Pyrolysis:
  - Gasification

D Research:

-Are you doing research? Do you realise it in intern or in extern or both?
Where? (Headquarter?)
-Which are the financers, are you working in partenarials?
-which step of research do you attempt? Pilot plan? Demonstration plant?
-What is your strategy: pilot on the lab, on the same site? Have you planed to build the pilot or the demonstration plant on a different site?
-In the next five to ten years, have you planned the construction of a pilot or demonstration plant (if yes, on what technology will it be based on?)?

3. Environmental aspects

A Greenhouse gases (GHGs) emissions

-Do you measure you greenhouse gases emissions? (CO2 emissions) If yes, which method is used? Which company realise it?
-Do you measure CO2 saving actions? Are you involved in the carbon trading system in relation with the carbon taxes? Have you planned to do it on the next future?
-What are your motivations?

B Energy efficiency

-Do you measure your energy efficiency for biofuel production?
Energy efficiency *is the ratio between energy provided by biofuel and primary energy used for its production. The ration needs to be positive for good energy efficiency.*

-If yes, what is the methodology? (Which company?)
-Does it consider the co-products? Or have you planned to do it on the next future?
-Which benefits does it provide to you?

C – Life Cycle Analysis (LCA)

-Do you measure the LCA in your company?
LCA: *Life Cycle Analysis, but more recently two terms have come to largely replace that one: Life Cycle Inventory (LCI) and Life Cycle Assessment (LCA) difference between these two terms?). These better reflect the different stages of the process : evaluate the environmental aspects associated with a product, process, or activity by identifying and quantifying energy and materials used and wastes released to the environment. The analysis of the life cycle is the object of international standards: the series ISO 14 040-14 043 and 14 047-14 048.*
-If yes, which method is used? Or have you planned to do it on the next future?
-Are you satisfied of the results?

4. Employment and rural aspects:

- Number of employees on this site? For the whole group?
- Evolutions since new investments?
- Local employments? Directs or indirects? (For biomass supply?)

5. Economic aspects:

-Can you estimate the profits engaged by new product valorisations?
-Did the co-products reused have increased you gains?
-How long do you estimate the return on investment?

6. Factors of success for the evolution of the sector industry.

Appendix C Quantitative assessment and mapping of industry sectors where biorefineries have developed or may develop cf. the industry survey and available major biorefinery feedstocks in the EU27+

C.1 Chemical industries

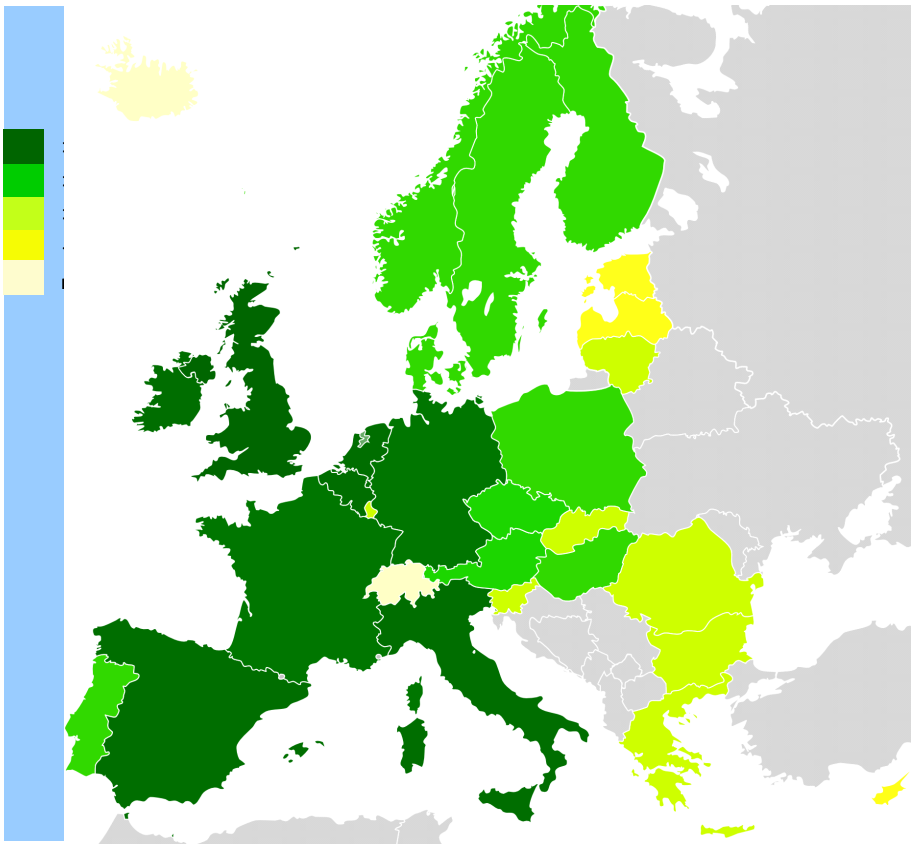


Figure 31: *Total production of basic chemicals, pharmaceuticals, medicinal chemicala, botanical products, man-made fibres, plastic & rubber products in EU 27 including NO, CH, and IC in M€ (Ref. 6: data for 2005, Eurostat)*

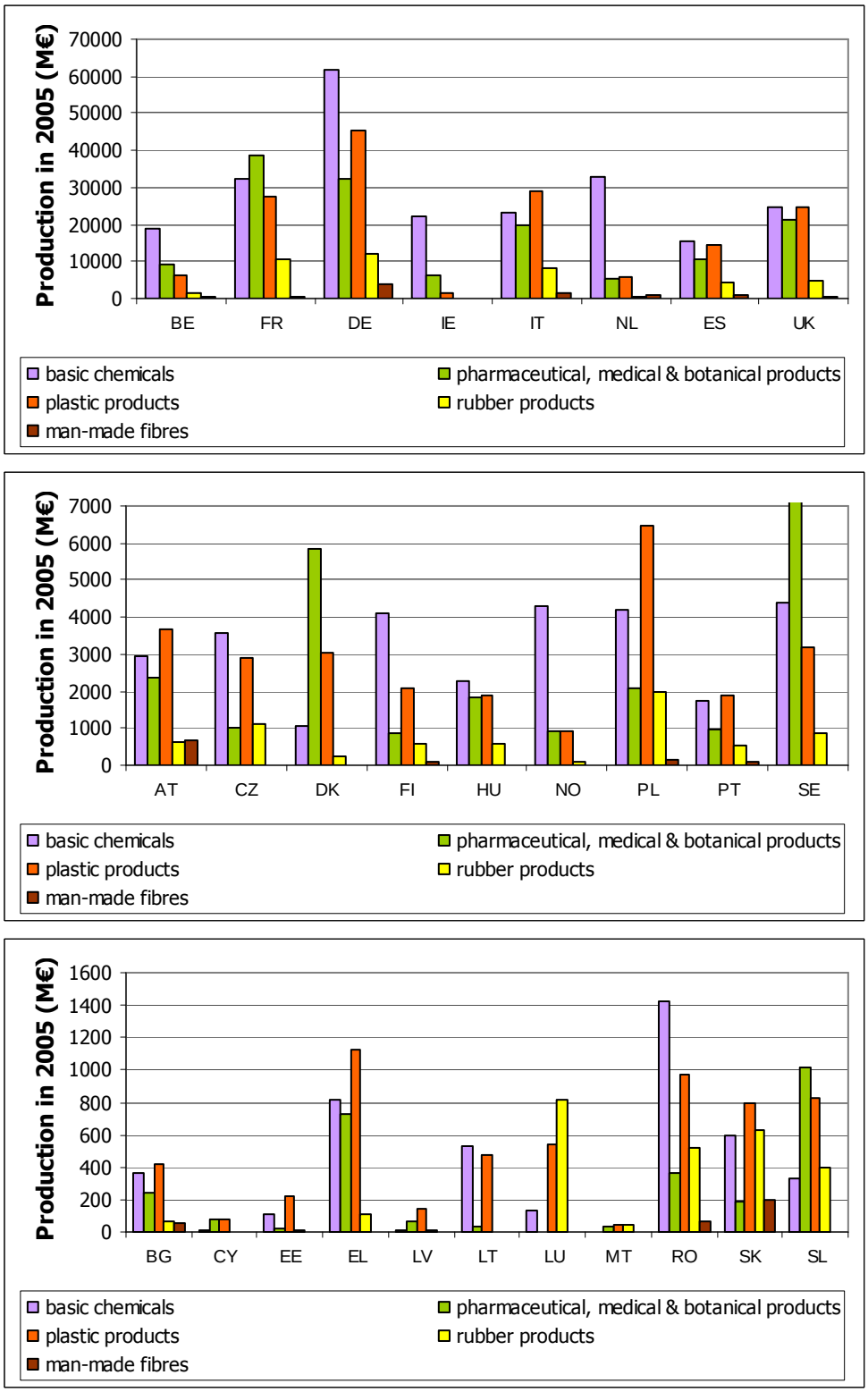


Figure 32: *Production of basic chemicals, pharmaceuticals, medicinal cheemicala, botanical products, man-made fibres, plastic & rubber products in EU 27 including NO, CH, and IC in M€ (Ref. 6: data for 2005, Eurostat)*

C.2 Agricultural / sugar and starch sectors (including grassland)

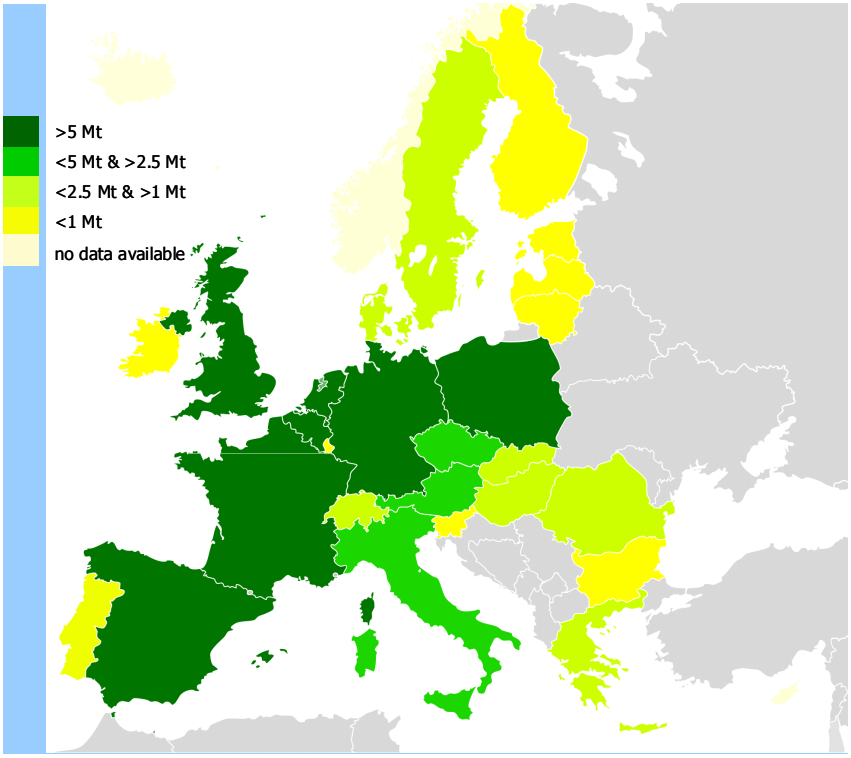


Figure 33 *Production of sugar beet in EU27 including NO, CH, and IC (FAO statistics 2006/2007)*

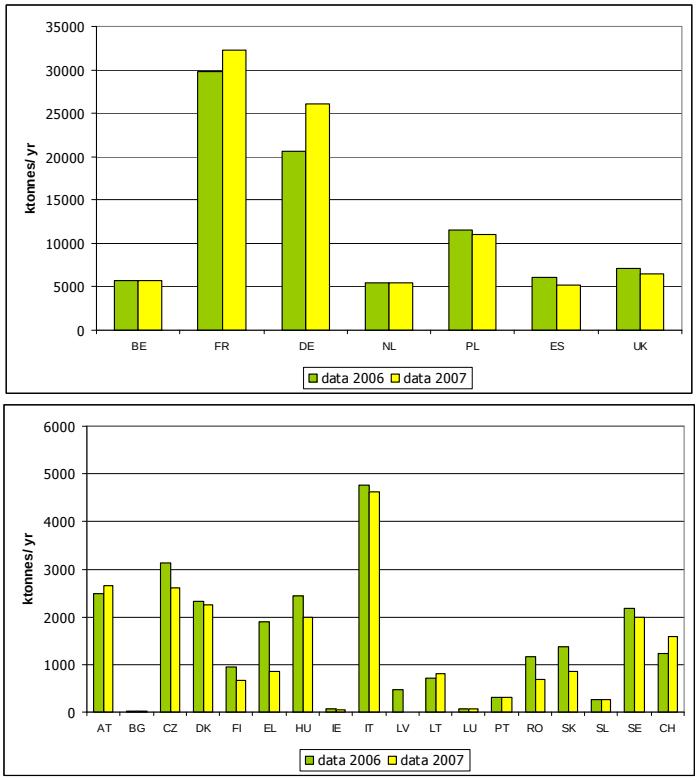


Figure 34: *Production of sugar beet in EU27 including NO, CH, and IC (FAO statistics 2006/2007)*

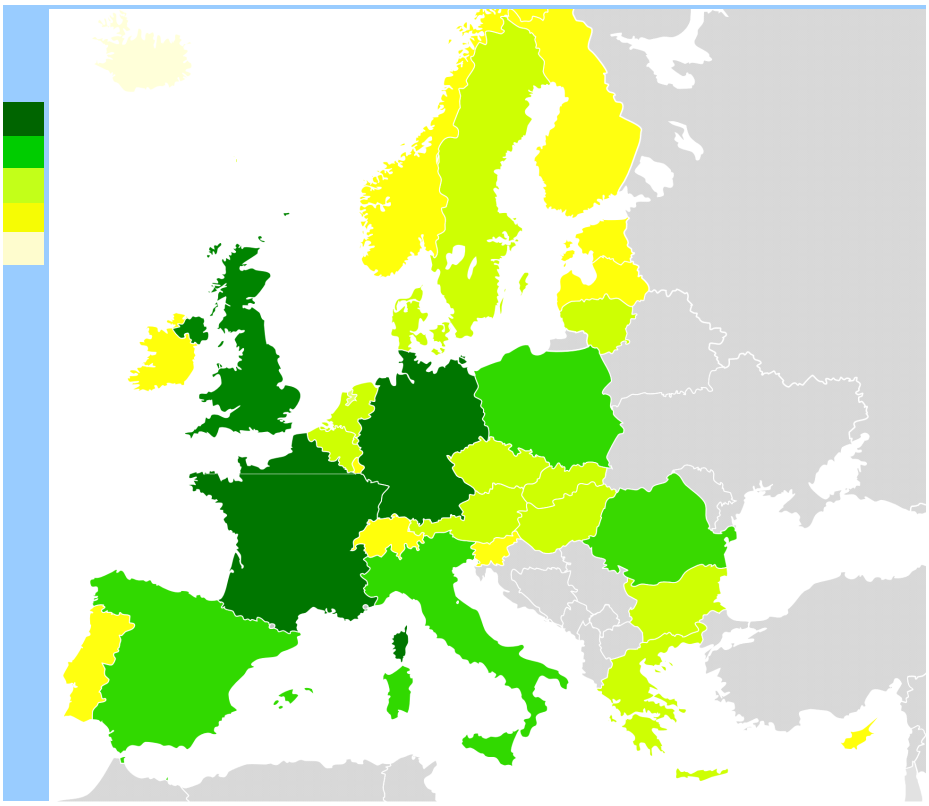


Figure 35: *Production of wheat in EU27 including NO, CH, and IC (FAO statistics 2006/2007)*

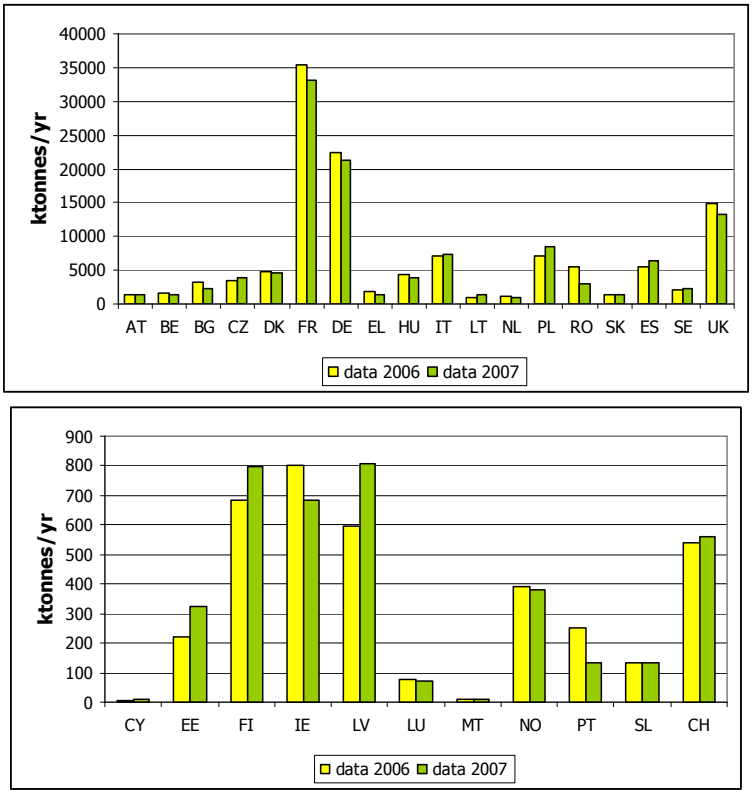


Figure 36: *Production of wheat in EU27 including NO, CH, and IC (FAO statistics 2006/2007)*

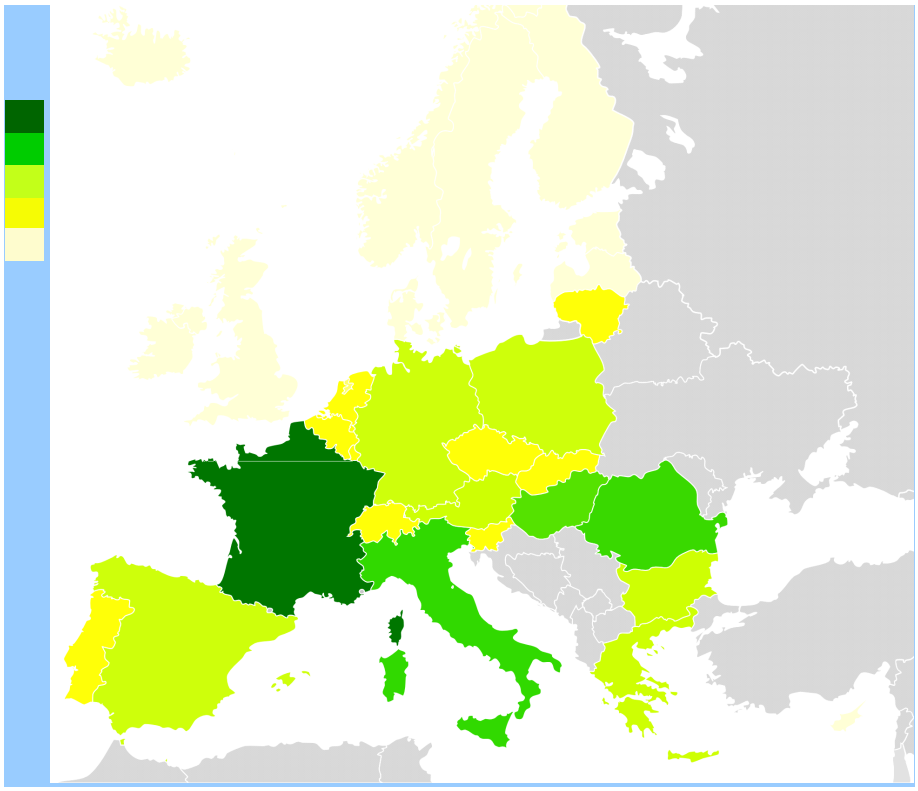


Figure 37: *Production of maize in EU27 including NO, CH, and IC (FAO statistics 2006/2007)*

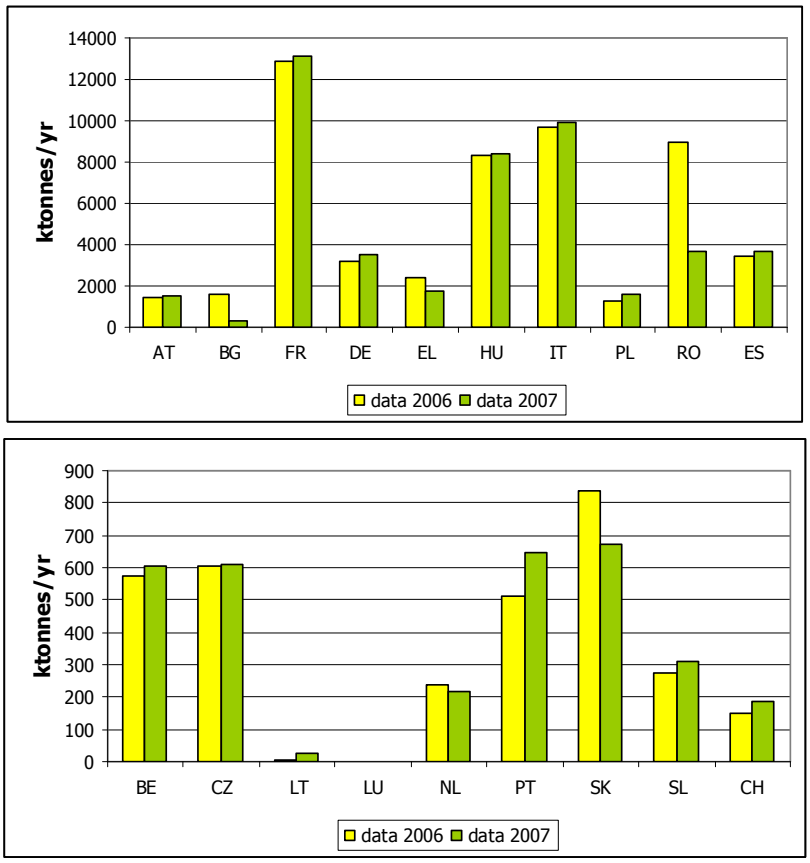


Figure 38: *Production of maize in EU27 including NO, CH, and IC (Ref. 1: FAO statistics 2006/2007)*

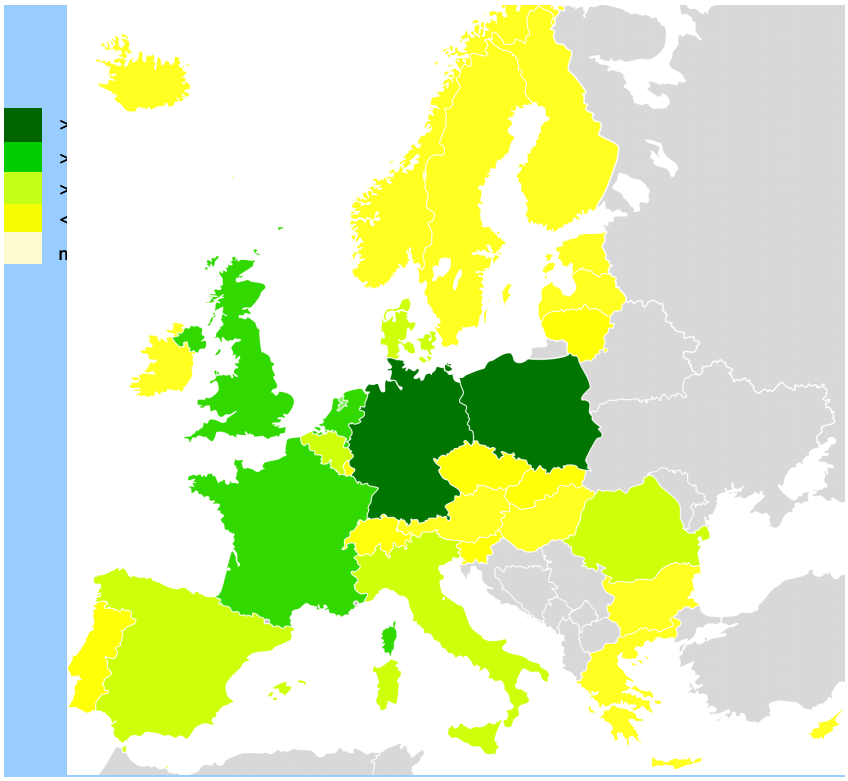


Figure 39: *Production of potato in EU27 including NO, CH, and IC (Ref. 1: FAO statistics 2007)*

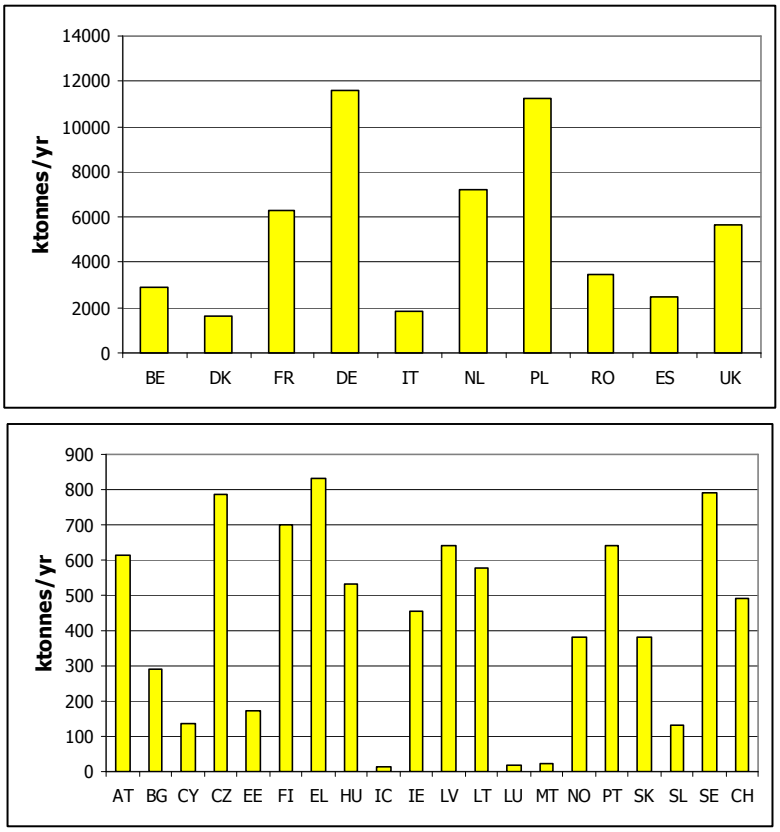


Figure 40: *Production of potato in EU27 including NO, CH, and IC (Ref. 1: FAO statistics 2007)*

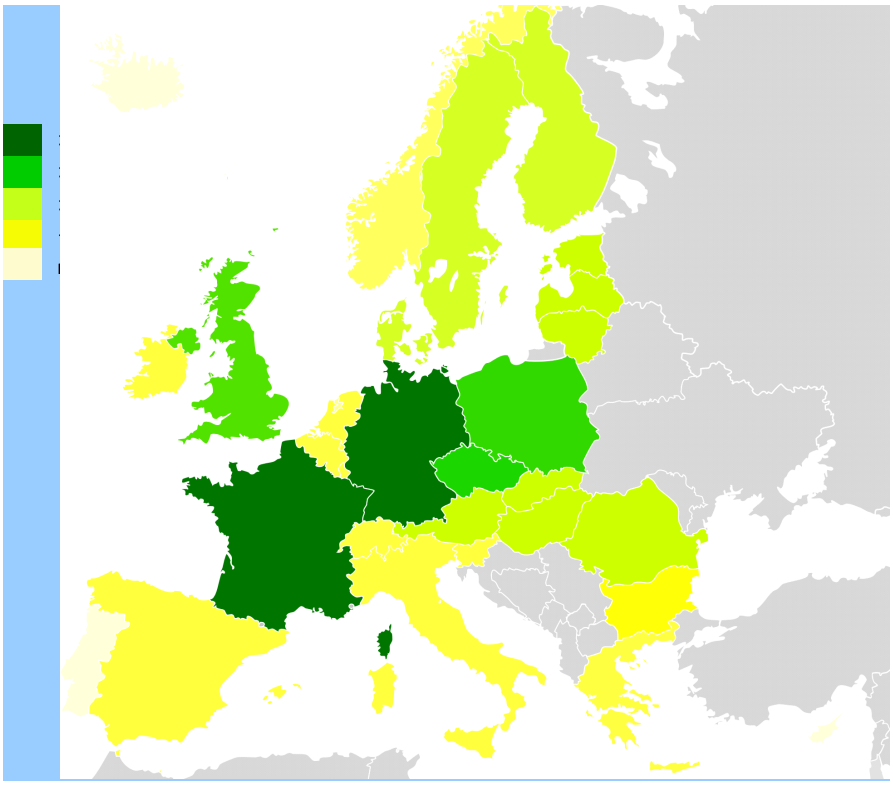


Figure 41: *Production of rapeseed in EU27 including NO, CH, and IC (Ref. 1: FAO statistics 206/2007)*

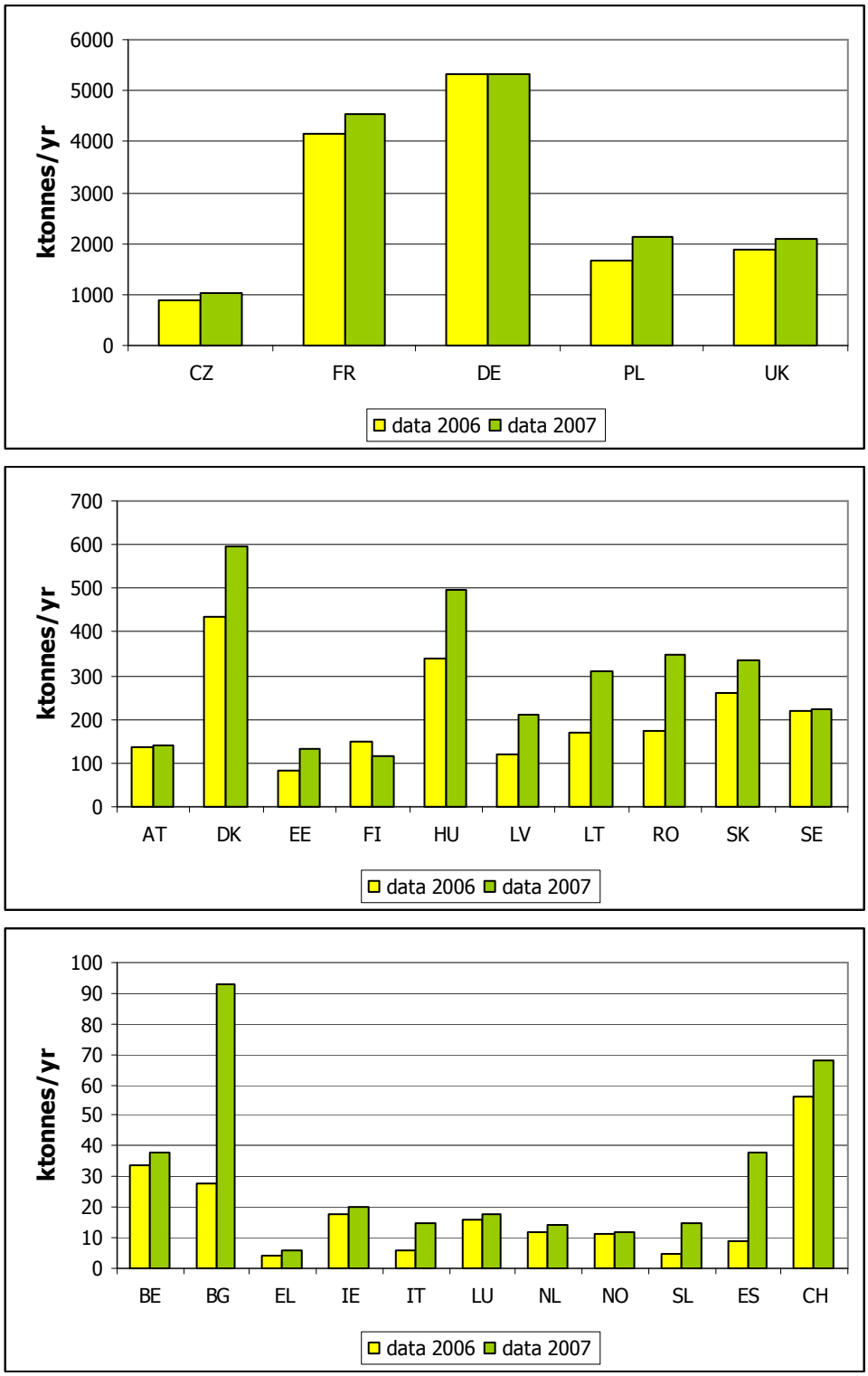


Figure 42: *Production of rapeseed in EU27 including NO, CH, and IC (Ref. 1: FAO statistics 206/2007)*

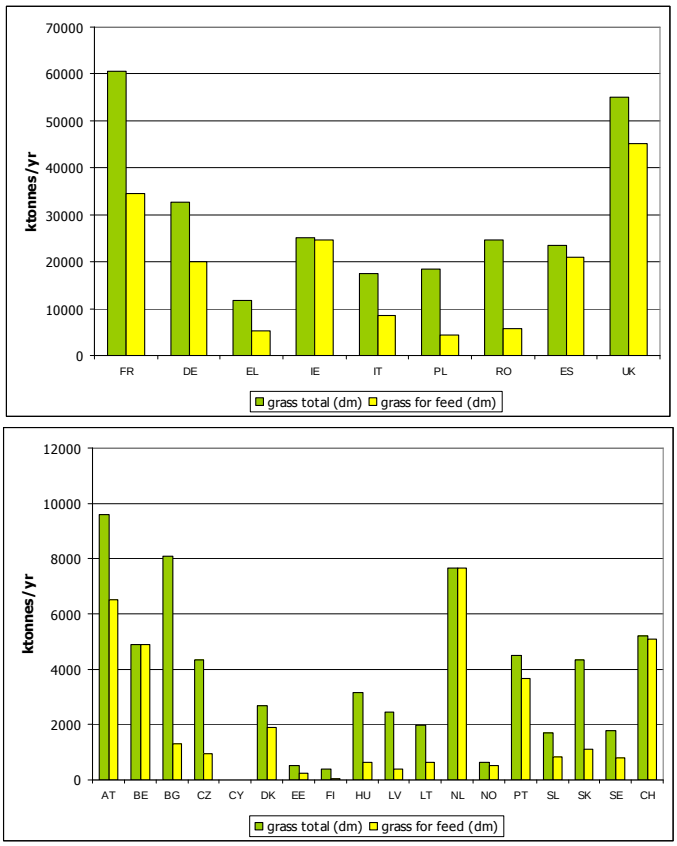


Figure 43: *Grass production in EU27 including NO, CH; green: total grass production in grassland area, yellow: grass used for feed; data refer to the year 2000 (Ref. 3:Fischer et al., 2007)*

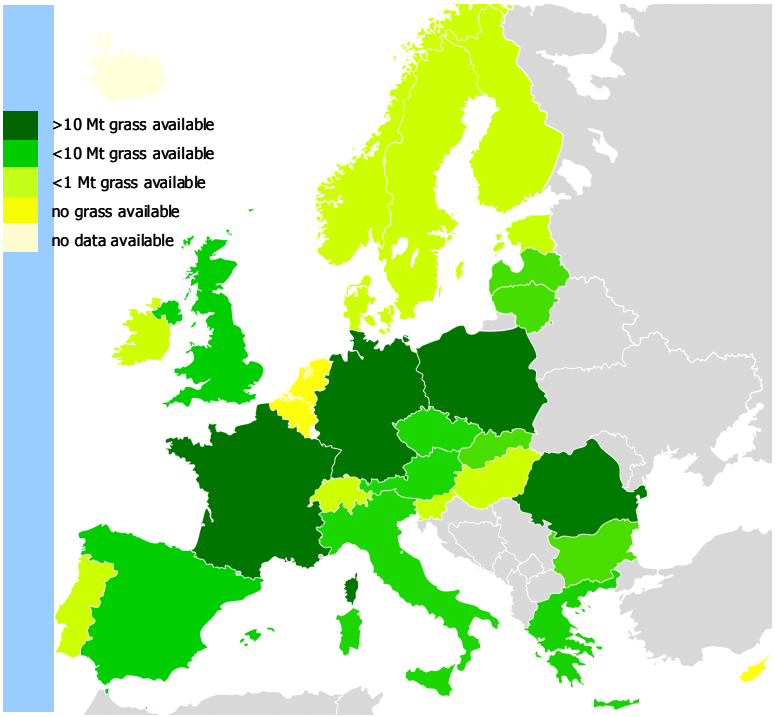


Figure 44: *Grass not used as feed and potentially available for biorefinery applications. Data refer to the year 2000 in EU27 including NO, CH, and IC*

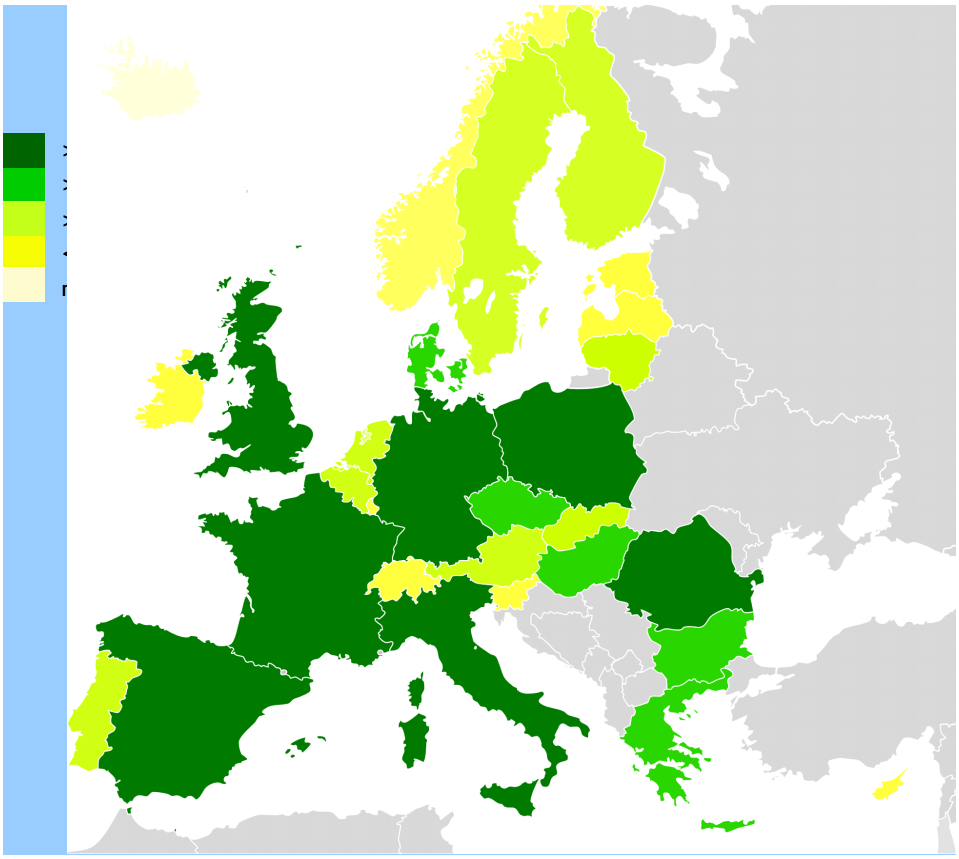


Figure 45: *Agricultural residues of food and feed crops (data for 2000) in EU27 including NO, CH, and IC (Ref. 3:Fischer et al., 2007)*

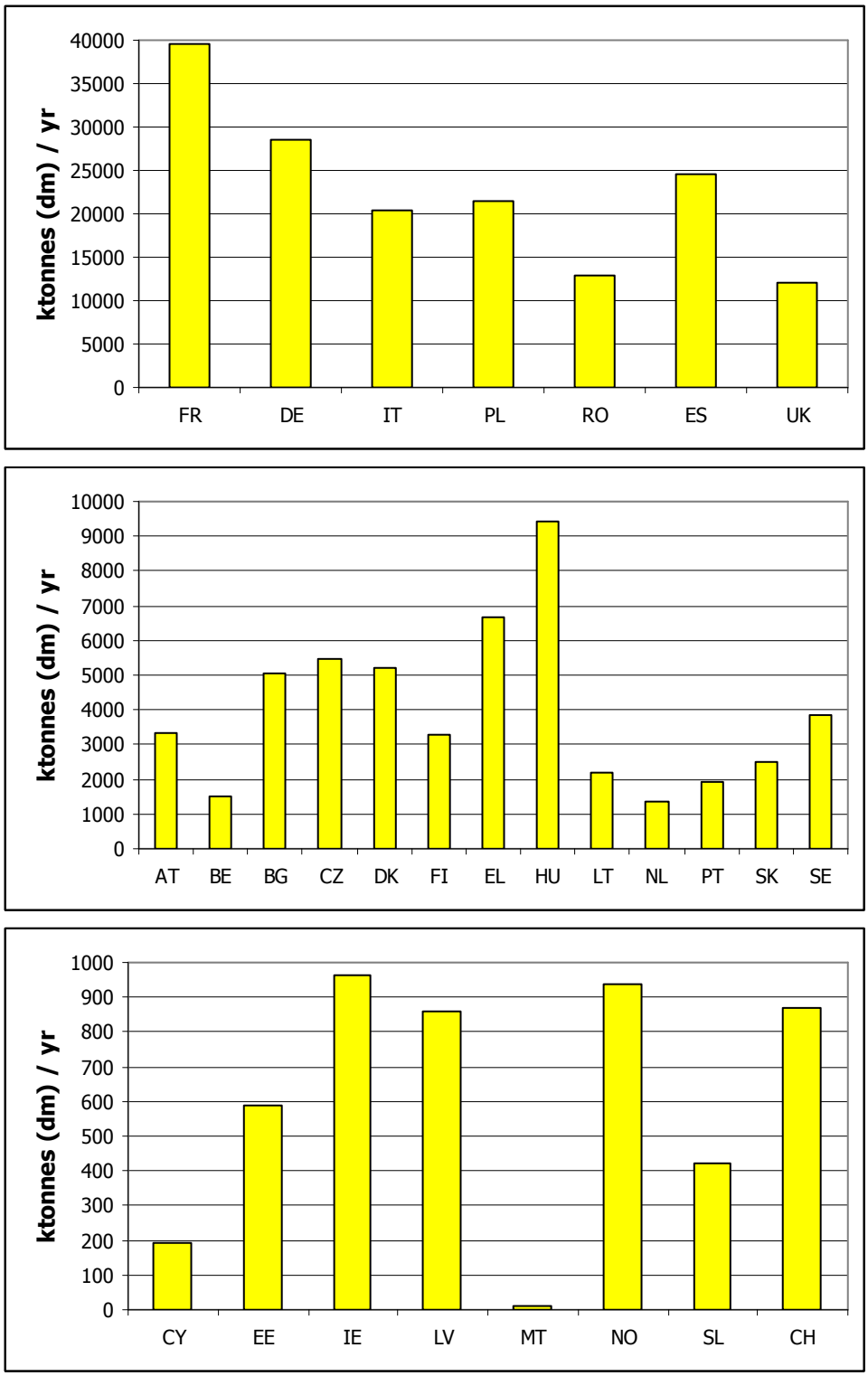


Figure 46: *Agricultural residues of food and feed crops (data for 2000) in EU27 including NO, CH, and IC (Ref. 3: Fischer et al., 2007)*

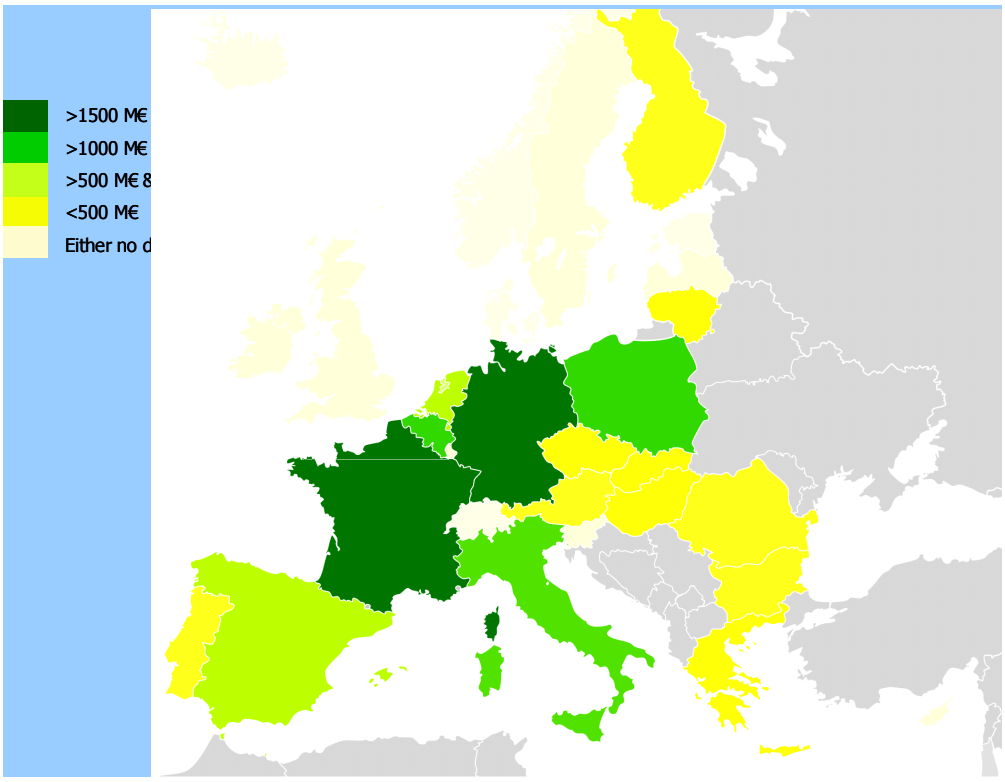


Figure 47: *Turnover by manufacture of sugar in EU27 including NO, CH, and IC (data for 2005, Eurostat)*

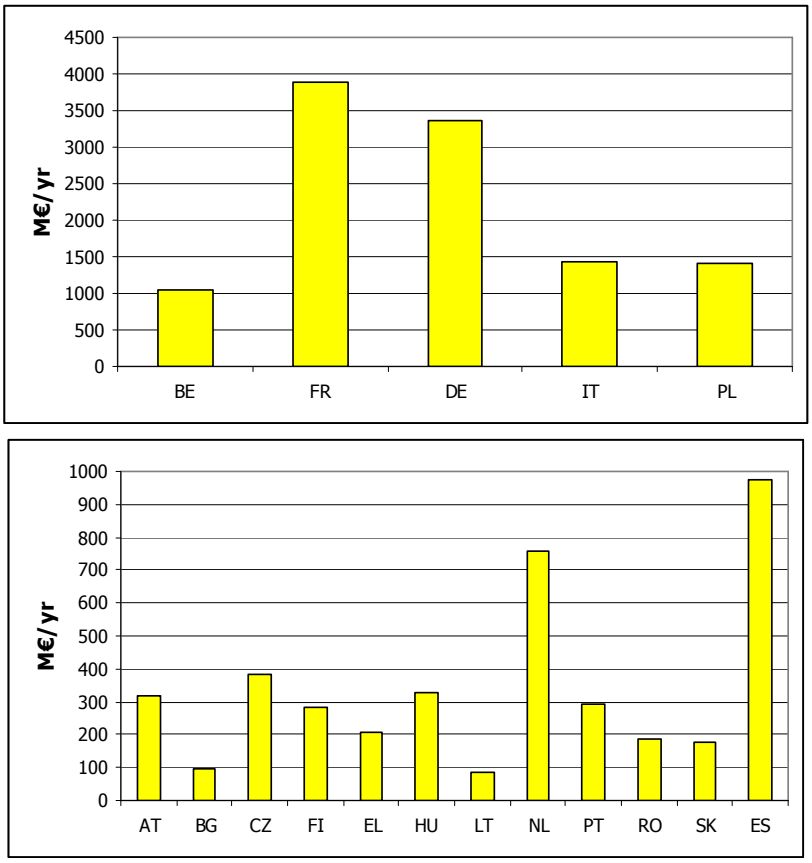


Figure 48: *Turnover by manufacture of sugar in EU27 including NO, CH, and IC (Ref. 6:data for 2005, Eurostat)*

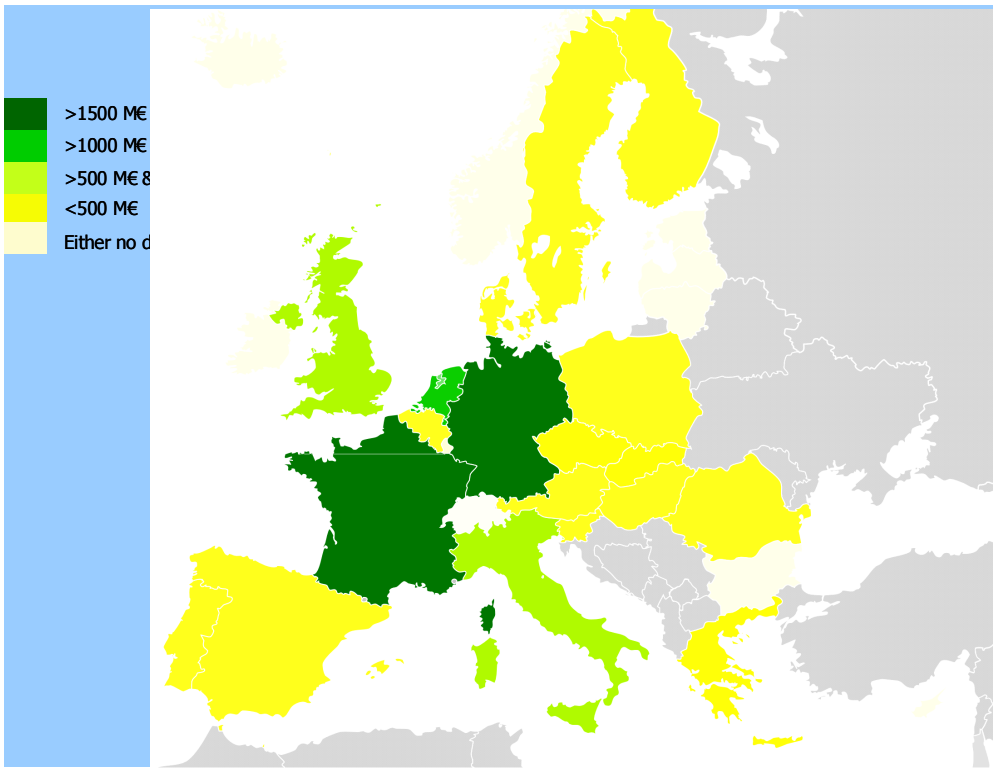


Figure 49: *Turnover by manufacture of starches and starch products in EU27 including NO, CH, and IC (Ref. 6: data for 2005, Eurostat)*

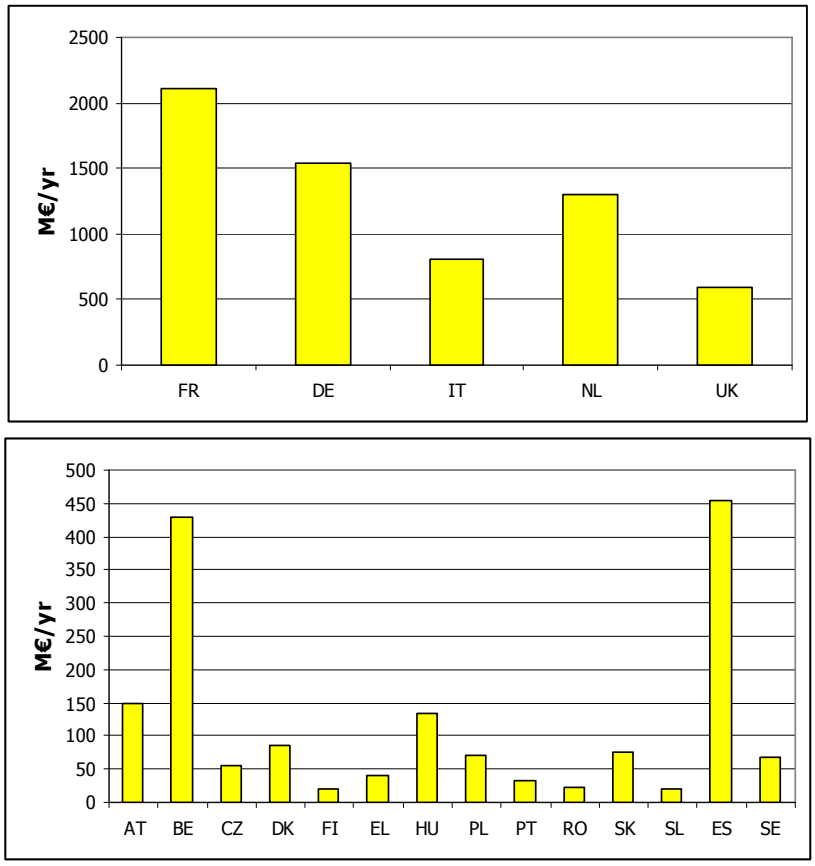


Figure 50: *Turnover by manufacture of starches and starch products in EU27 including NO, CH, and IC (Ref. 6:data for 2005, Eurostat)*

C.3 Forestry sector

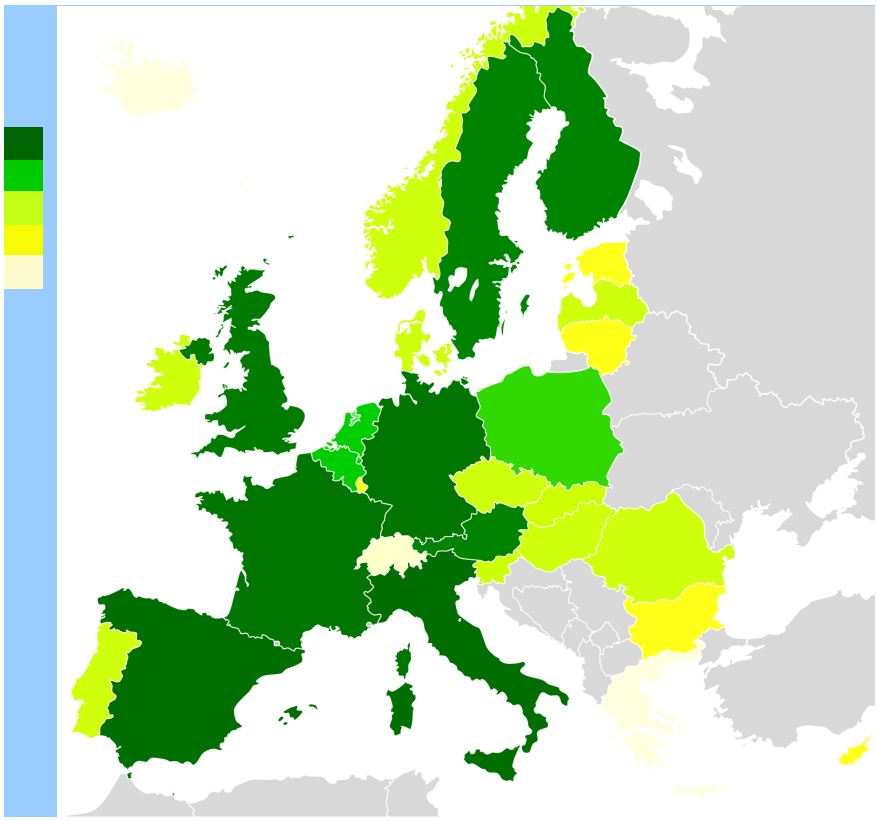


Figure 51: *Production of wood and wood products, pulp, paper and paper products in EU27 including NO, CH, and IC (Ref. 7:data for 2004, Eurostat)*

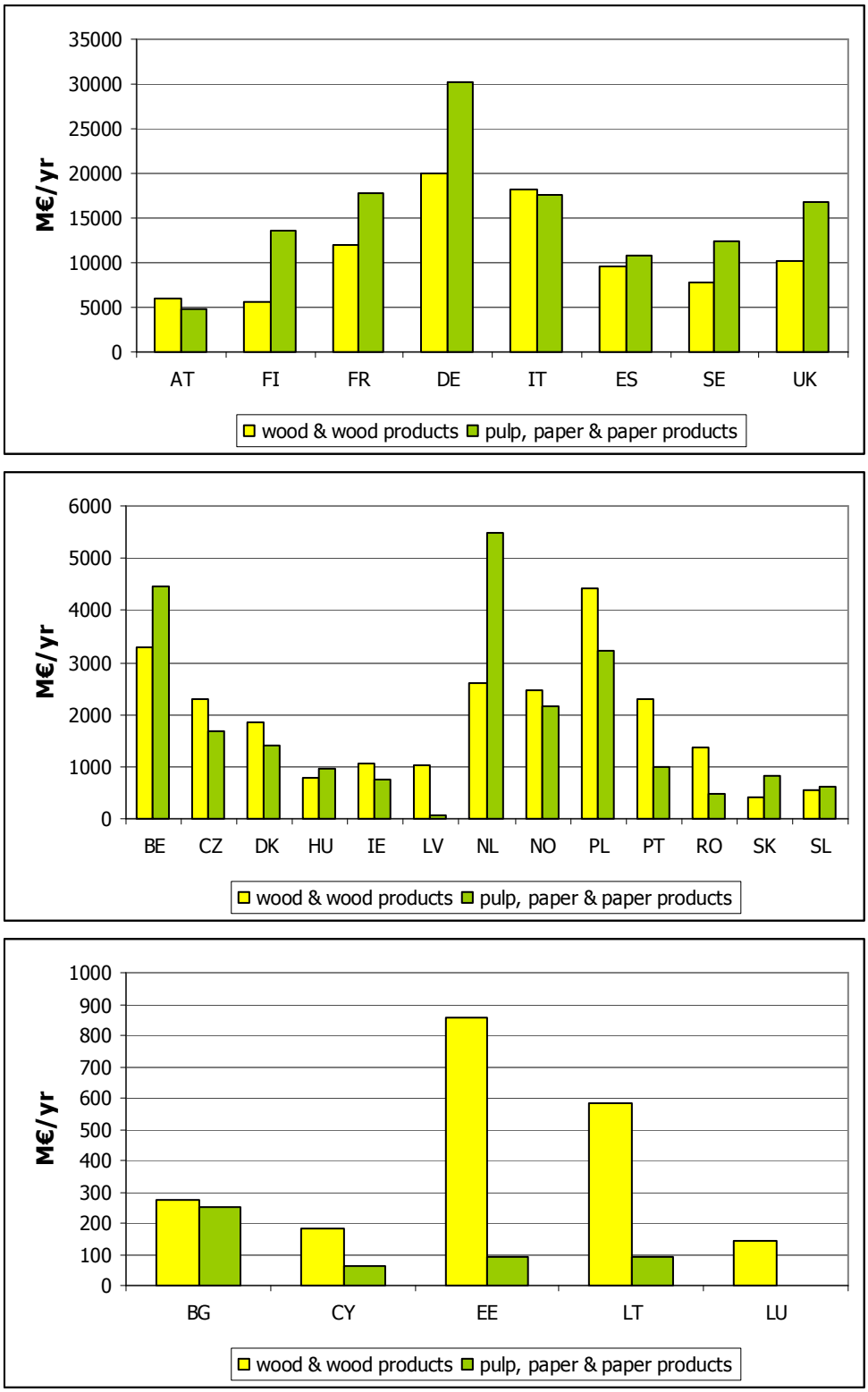
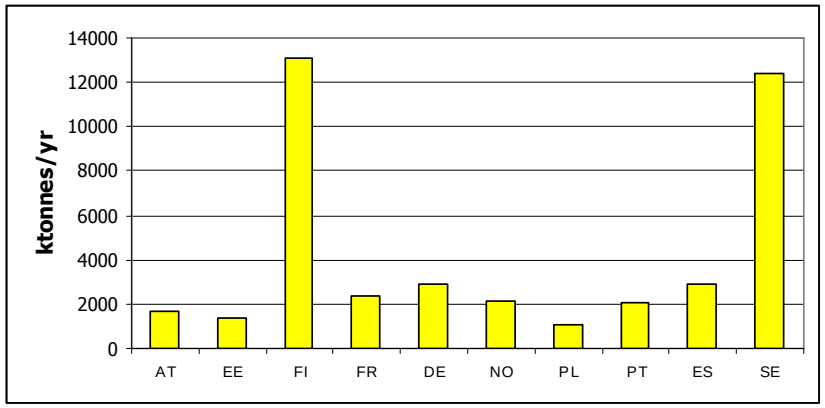


Figure 52: *Production of wood and wood products, pulp, paper and paper products in EU27 including NO, CH, and IC (Ref. 7:data for 2004, Eurostat)*

Figure 53: *Production of pulp for paper in EU27 including NO, CH, and IC (Ref. 1: data for 2006, FAO statistics)*



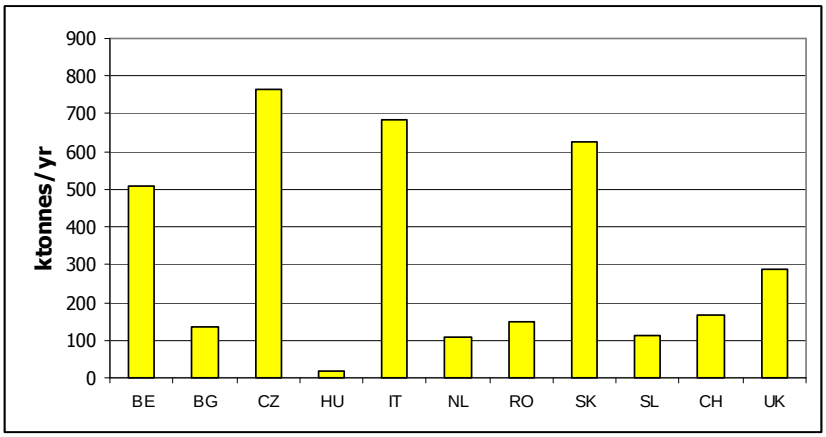


Figure 54: *Production of pulp for paper in EU27 including NO, CH, and IC (Ref. 1: data for 2006, FAO statistics)*

C.4 Biofuels sector

Figure 55: *Production of biodiesel in EU27 including NO, CH, and IC (Ref. 2: data for 2006/2007, EurObservÉR Biofuels barometer, 2008)*

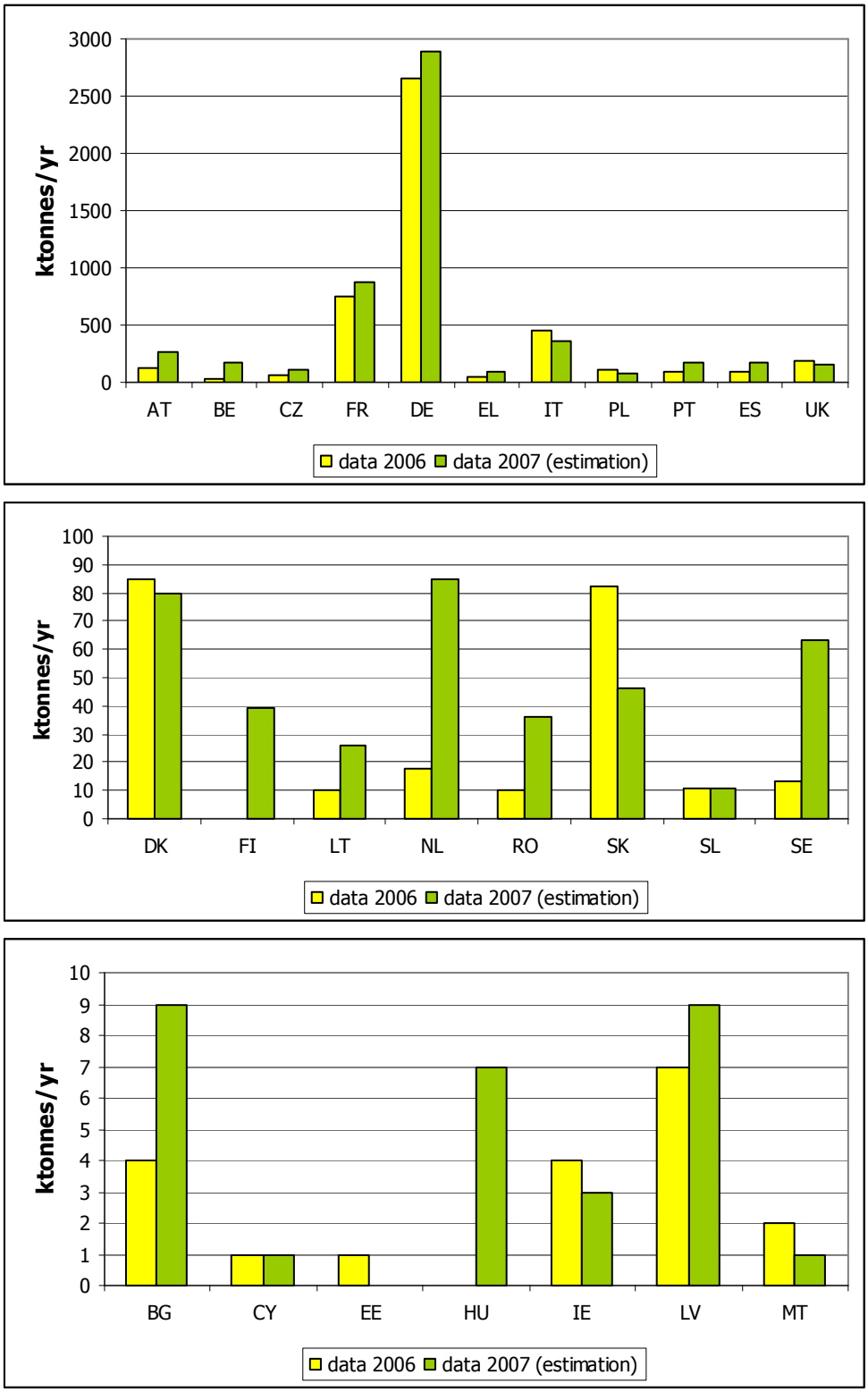
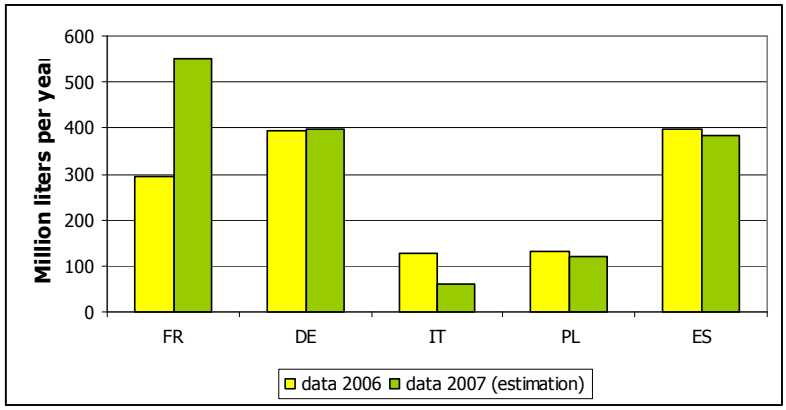


Figure 56: *Production of biodiesel in EU27 including NO, CH, and IC (*Ref. 2*: data for 2006/2007, EurObservÉR Biofuels barometer, 2008)*

Figure 57: *Production of bioethanol in EU27 including NO, CH, and IC (Ref. 2: data for 2006/2007, EurObservÉR Biofuels barometer, 2008)*



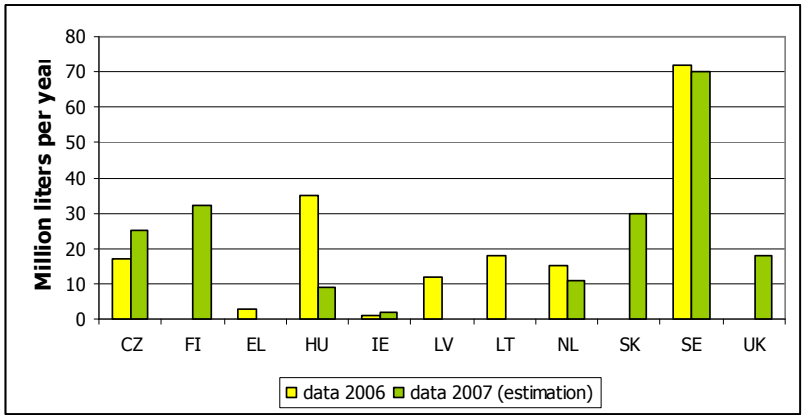


Figure 58: *Production of bioethanol in EU27 including NO, CH, and IC (Ref. 2: data for 2006/2007, EurObservÉR Biofuels barometer, 2008)*

Appendix D Identification of biorefinery sites in the European Union

Table 2: *Existing or planned biorefineries in Europe*

Country	Type of plant / feedstock	Company	Location	Feedstock	Type of Biorefinery	Website(s)	Reference(s)
No.					Green biorefinery / whole crop biorefinery / lignocellulosic feedstock biorefinery / Oilseed biorefinery / Integrated biorefinery		
Austria (AT)							
1	Bio-chemicals & biogas plant	Energie AG Oberösterreich; Oberösterreich Ferngas AG; RohölAufsuchungs AG	Utzenaich North Austria, Oberösterreich	Green grass	Green biorefinery	www.energieag.at www.ooeferngas.at www.rohoel.at	**BIOREFINERY EUROVIEW**
Belgium (BE)							
2	Petrochemical & biodiesel plant	OLEON NV	Ertvelde	Oilseeds: rapeseed, flax, sunflower, soy, palm	Oilseed biorefinery	www.oleonbiodiesel.com www.oleon.com/downloads/jaarverslag_2007.pdf www.gbev.be/news.htm	**BIOREFINERY EUROVIEW** (additional info from websites)
3	Biodiesel plant	BIORO (Cargill, Vanden Avenne, Biodiesel Holding NV)	Rodenhuizedok (Port of Ghent)	Vegetable oil (rapeseed)	Integrated biorefinery at Rodenhuizedok, Port of Ghent	www.gbev.be/news_0032.htm www.vilt.be/nieuwsarchief/detail.phtml?id=17042	**BIOREFINERY EUROVIEW** (additional info from websites)
3	Bioethanol plant	Alco Bio Fuel	Rodenhuizedok, Port of Ghent	Wheat		www.portofghent.be/Documents/Nieuwsbrief%204%20oktober%202006%20NL.pdf	See website
4	Petrochemical plant and biodiesel	PROVIRON	Hemiksem	Use: Rapeseed, soy	Future oilseed refinery	www.proviron.be	**BIOREFINERY EUROVIEW**
5	Biobased chemicals	Ashland Inc. and Cargill	Specific site undetermined, in Europe	Glycerine	Future biorefinery platform if located near and using glycerine of an existing biodiesel plant of Cargill		**BIOREFINERY EUROVIEW**
6	Chicory	Orafti	Tienen	Chicory	Green biorefinery	http://www.orafti.com/content/show/id/106	Biopol/AFSG
7	Pea/Chicory	Cosucra	Warcoing	Pea/Chicory	Green biorefinery	http://www.cosucra.com/Public/	Biopol/AFSG
Denmark (DK)							
8	Second generation bioethanol plant (pilot)	BornBiofuel	Aakirkeby (island Bornholm)	Multi-feedstock: agricultural residues (straw), biowaste, green grass	Multiple feed biorefinery (lignocellulosic feed-stock biorefinery)	www.biogasol.com	**BIOREFINERY EUROVIEW & KBBE questionnaire**
9	Second generation bioethanol plant (pilot)	IBUS pilot plant (Elsam; Sicco; Risø; KVL; TMO; Dong)	Fynsvaerke Skærbækværk, power plant site in Jutland	Straw, wheat grains, biowaste	Forest based and lignocellulosic biorefinery	www.dongenergy.com www.bioethanol.info	**BIOREFINERY EUROVIEW & KBBE questionnaire** (additional info from websites)
10	Second generation bioethanol (pilot)	BIOCentrum DTU (department of Technical University of Denmark)	Lyngby	Multi-feedstock: agricultural residues (straw), biowaste, and green grass	Multiple Concept Biorefinery (forest based and lignocellulosic biorefinery/Green biorefinery)	www.aaue.dk/diverse/BBS_pro.pdf	**BIOREFINERY EUROVIEW** (additional info from, e.g., website Baltic Biorefinery Symposium, Aalborg, Denmark, 2005)
Finland (FI)							
11	R&D Forestry industry	M-Real Oyj	Espoo	Wood & forest biomass	Forest-based and lignocellulosic biorefinery?		**BIOREFINERY EUROVIEW**
12	Second generation biofuels (pilot)	VTT	Espoo	Straw, wood, waste, lignocellulose, sun flower, olives, coal, peat, and others: lignin, oil shale, tall oil	Multiconcept lignocellulosic and forest based biorefinery and oilseed biorefinery		**BIOREFINERY EUROVIEW**

				soap, wastes			
France (FR)							
13	Bioethanol plant integrated with sugar factory	CRISTANOL 1 & 2 (Cristal Union, with assistance from ARD	Pomacle - Bazancourt (Champagne Ardenne)	Sugar beet, lucernes	Integrated biorefinery	www.cristal-union.fr www.bio-amber.com/release/pdf/361e75e639.pdf www.iar-pole.com www.peer2006.teledetection.fr/documents/slide/parallel_2/2d_P1_Steinmetz.pdf	**BIOREFINERY EUROVIEW** (additional info from websites)
13	Bioethanol plant integrated with starch factory	CHAMTOR (INRA, Institut National de la Recherche Agronomique)	Bazancourt (Champagne Ardenne)	Wheat		www.iar-pole.com www.twanetwerk.nl/upl_documents/TWASpecialBio-basednr2_2008.pdf www.glucidoc.2008.free.fr/PPT/Oui/Vandeputte.pdf	
13	Biorefinery based on straw (pilot)	CIMV	Pomacle (Champagne Ardenne)	Straw (annual fiber crops) and hardwood		www.cnrs.fr/chimie/recherche/programmes/docs/rdr1_26_11_07/martel.pdf	
13	Bio-chemicals plant (demo)	BioAmber ARD & DNP Green Technology of the USA	Pomacle - Bazancourt (Champagne Ardenne)	Wheat and CO_2 from bioethanol plant		www.bio-amber.com/release/pdf/361e75e639.pdf www.icis.com/blogs/biofuels/archives/2007/03/bioamber-may-help-make-ethanol.html www.globalprocessing.texterity.com/globalprocessing/200705/?pg=1	
13	R&D centre: sugar and starch	ARD/ SOLIANCE	Pomacle (Champagne Ardenne)	Sugar beet, wheat, lucernes, straw, switch grass, sorghum, hemp			
14	Biodiesel and bio-chemicals plant	NOVANCE	Compiègne	Rapeseed, sunflower, soy	Oilseed biorefinery	www.novance.com	**BIOREFINERY EUROVIEW** (additional info from websites)
15	Green plant	MORGANE project OLMIX	Ploërmel (Brittany)	Juice of green seaweeds and clay (Amadéite), animal waste, and plant-food-processing waste	Future green biorefinery	www.olmix.com	**BIOREFINERY EUROVIEW**
16	Biofuels / Chemicals / feed	SMBE - Soufflet Group	Nogent sur Seine	Wheat	Future forest-based and lignocellulosic biorefinery	www.soufflet.fr www.smbe.fr/Extranet/Holding/InterSMBE_FR.nsf/0/9FB0BE938C984A8DC125730F0030999D/$FILE/Plaquette+SMBE.pdf	**BIOREFINERY EUROVIEW** (additional info from websites)
16	Co-generation	EMINLEYDIER, SAIPOL, SOUFFLET	Nogent sur Seine	Paper-waste ; rapeseed waste ; wheat waste			
17	Starch industry / biofuels (BIOHUB®, demo)	ROQUETTE Group (leader of consortium; with Arkema, France; COGNIS, Germany; DSM, the Netherlands)	Lestrem (headquarter)	Wheat, maize, potatoes	Future biorefinery: cereal biorefinery	www.roquette.com www.aii.fr http://www.twanetwerk.nl/upl_documents/TWASpecialBio-basednr2_2008.pdf (TWA Nieuws (2008): Innovative Technologies for a Bio-Based economy. TWA nieuws Special, 46, № 2, Ministry of Economic Affairs, the Hague, Netherlands, March / April 2008)	**BIOREFINERY EUROVIEW & KBBE questionnaire & TWA Nieuws, 2008** (additional info from websites)
Germany (DE)							
18	Biorefinery and drying plant (demo)	FMS GmbH	Selbelang (Brandenburg - Havelland region)	Grass, lucerne, beets, alfalfa	Green biorefinery	www.bioraffinerie.de	**BIOREFINERY EUROVIEW**
19	Biochemicals plant (pilot)	Leibniz-institut für Agrartechnik	Potsdam	Rye	Future cereal biorefinery		**BIOREFINERY EUROVIEW**
20	Green Biorefinery (demo)	Research Institute Biopos e.V., FMS Futtermittel GmbH	Teltow-Seehof	Green biomass	Green biorefinery	www.biopos.de	KBBE questionnaire
21	Grass refinery (pilot)	Biowert Industrie GmbH	Brensbach/Odenwalt	Grass (Wiesengras)	Green biorefinery	www.biowert.de	KBBE questionnaire
Iceland (IC)							
22	R&D Lignocellulosic Feedstock Biorefinery (preparation of pilot)	Icelandic Biomass Company (Iceland), Tetra Ingenieure, Biopos (Germany)	To be determined	Lignocellulose biomass	Lignocellulosic feedstock biorefinery	www.biopos.de www.landbunadur.is/landbunadur/wgsamvef.nsf/8bbba2777ac88c4000256a89000a2ddb/b22760d8e60d480900256fd9003f1c05/$FILE/RALA-029-JA-004.pdf (Björnsson et al (2004): *Feasibility study of green biomass procurement*. Biochemicals and Energy from sustainable Utilization of herbaceous	KBBE questionnaire (additional info see websites)

						Biomass (BESUB), The Agricultural Research Institute, Reykjavík, Iceland, December 2004)	
Ireland (IE)							
23	R&D Biorefinery plant / grass	Birorefinery Ireland Ltd	Demonstration plant to be constructed in Irish Midlands to take advantage of infrastructure and feedstock.	Grass (fresh and silage)	Future green biorefinery	www.biorefinery.ie	**BIOREFINERY EUROVIEW /** **BIOPOL**
Italy (IT)							
24	Biopolymer factory, looking to expand into chemical intermediates	Novamont (plus Coldiretti since 2006)	Terni, Umbria	Maize and vegetable oils (mainly sunflower)	Multi-concept biorefinery: Oilseed and cereal biorefinery	www.novamont.com www.coldiretti.it http://www.materbi.com/	**BIOREFINERY EUROVIEW**
25	Bioplastics from sugar beet	Bio on, and Copro.B	Emilia Romagna	Sugar Beet		http://bio-on.it/	
Netherlands (NL)							
26	Agro-industry	CARGILL	Sas van Gent	Wheat and corn	Integrated biorefinery		**BIOREFINERY EUROVIEW** (additional info from websites)
26	Second generation biofuels plant	Royal Nedalco	Sas van Gent	Wheat (by-products of nearby CARGILL plant)		www.ebcd.org/EPISD/2007/27Mar2007/Biofuels%20%20Sustainability%20-%20Royal%20Nedalco.pdf	
27	Biofuels and energy plant	ROTIE and Biodiesel Amsteredam; part of Greenmills project	Hornhaven (Port of Amsterdam)	Used vegetable oils, greases and other biodegradable residues from Noba	Interated biorefinery	www.greenmills.nl	**BIOREFINERY EUROVIEW**
27	Trading company (oil, grease, and fatty acids)	Noba vetveredeling BV; part of Greenmills project	Hornhaven (Port of Amsterdam)	Storage of 75,000 t of used vegetable oils, greases, and other biodegradable residues		www.greenmills.nl	
27	Biogas plant	Organworld BV; part of Greenmills project	Hornhaven (Port of Amsterdam)	Organic waste (vegetable, fruit, and garden waste) from catering, food and luxury foods industry		www.greenmills.nl	
28	Core=Biomethanol plant (gasification). Expansion to Biorefinery Cluster planned	Bio-MCN / Biorefinery cluster	Delfzijl, Groningen Seaport, Industrial Area, North Netherlands	Glycerol, solid lignocellulosic biomass	Future Lignocellulosic Biorefinery ??? Future Integrated Biorefinery ???	http://www.groningen-seaports.com/index_english.php http://www.biomcn.eu	BIOPOL Info from websites, direct contacts
Spain (ES)							
29	Demonstration ligno cellulose-ethanol plant (to be upgraded to biorefinery plant) co-located with 1st generation wheat ethanol plant	ABENGOA: Biocarburantes de Castilla y Leon. Abengoa Bioenergía Nuevas Tecnologías (ABNT)	Babilafuente, Salamanca, Spain	Demo plant: Wheat and barley straw	Future Lignocellulosic Biorefinery ???	http://www.abengoabioenergy.com www.biosynergy.eu	BIOPOL Info from websites, direct contacts
Sweden (SE)							
30	Pulp & paper mill, biogas plant, and chemical plant	BioDME project CHEMREC AB (biogas technology), SMURFIT KAPPA KRAFTLINER (pulp & paper mill), Haldor Topsoe Preem	Piteå	Black liquor	Future forest based and lignocellulosic biorefnery	www.chemrec.se	**BIOREFINERY EUROVIEW**
31	Grain to ethanol plant.	Lantmännen Agroetanol	Norrköping	Grain	Whole crop biorefinery	www.agroetanol.se/	BIOPOL/IIIEE

United Kingdom (UK)							
32	Wheat processing plant	CARGILL	Trafford Park, Manchester	Wheat	Integrated biorefinery	www.cargill.com	**BIOREFINERY EUROVIEW**
32	Biofuel plant	Royal Nedalco	Trafford Park, Manchester	Wheat liquefaction by-product of CARGILL		www.nedalco.com	
33	Sugar beet refining and bioethanol plant	British Sugar plc	Wissington (Norfolk)	Sugar beet	Future green biorefinery?		**BIOREFINERY EUROVIEW & KBBE questionnaire**
34	Integrated biorefinery (demo for biobutanol)	Associated British Foods, BP, DuPont	Saltend, Hull	Wheat for bioethanol, wide variety of feedstocks for biobutanol	Integrated biorefinery		KBBE questionnaire

Additional biorefineries

Country	Type of plant / feedstock	Company	Location	Feedstock	Type of Biorefinery	Website(s)	Reference(s)
No.					Green biorefinery / whole crop biorefinery / lignocellulosic feedstock biorefinery / Oilseed biorefinery / Integrated biorefinery		
Austria (AT)							
	pulp & paper / wood	Lenzing	Lenzing site, Austria	wood	lignocellulosic biorefinery	http://www.lenzing.com http://forschung.lenzing.com	H. Weber: The wood biorefinery concept in Lenzing: scope and limitations; Helsinki, December 2008
Canada (CA)							
	pulp & paper / wood	Tembec Termiscaming Biorefinery	Canada	wood	lignocellulosic biorefinery	http://www.tembec.com	L. Biglow: Experience of biorefinery operation at Tembec Temiscaming Integrated forest biorefinery, Helsinki, December 2008
Norway (NO)							
	pulp & paper / wood	Borregaard Sarpsborg (900 employees, sales: 540 M$)	Norway	wood	lignocellulosic biorefinery	http://www.borregaard.com	G.L. Johansen: Biorefining for the pulp and paper industry 2008; Helsinki, December 2008

Table 3: *Biorefinery-related R&D, pilots, and demonstrations*

Country	Type of plant / feedstock	Company	Location	Feedstock	Type of Biorefinery	Website(s)	Reference(s)
					Green biorefinery / whole crop biorefinery / lignocellulosic feedstock biorefinery / Oilseed biorefinery / Integrated biorefinery		
Austria (AT)							
	R&D Green Biorefinery	Joanneum Research Forschungsges mbH	Vienna		Whole crop biorefinery	www.joanneum.at www.biorefinery.nl/.../docs/publications/presentations-kick-off/_7__Country_status_Austria_IEA42_160307.pdf	Status Report Biorefinery 2007 (additional info from websites)
	R&D Green Biorefinery Austria	Joanneum Research; TU Graz; consortium with other Austrian R&D partners	Feldbach	Green grass	Green biorefinery	www.fkit.hr/cabeq/pdf/18_1_2004/Biorefinary%20CABEQ_2004_01.pdf (Kamm and Kamm (2004): Biorefinery - Systems. Chem. Biochem. Eng. Q 18 (1), 1-6, 2004) www.pbf.hr/cabeq/pdf/18_1_2004/Green%20CABEQ_2004_01-2.pdf (Kromus et al (2004): The Green Biorefinery Austria – Development of an Integrated System for Green Biomass Utilization. Chem. Biochem. Eng. Q 18 (1), 7-12, 2004) www.joanneum.at	Status Report Biorefinery 2007 Nusser et al (2007): *Potenzialanalyse der Industriellen, weißen Biotechnologie*. Fraunhofer Intistut, Karlsruhe, Germany, March 2007 (additional info from websites)
Belgium (BE)							
	R&D ECO-BINDERS	TransFurans Chemicals bvba with 12 partners in international consortium	Belgium		Forest-based and lignocellulosic biorefinery	www.ecobinders.net	BIOREFINERY EUROVIEW (additional info from website)
Denmark (DK)							
	R&D Biorefinery Denmark	Bioraf Danmark (Fraunhofer, Germany; The Royal and Agricultural University Denmark; 7 other international R&D partners)	Aakirkeby (island Bornholm) / Frederiksberg	Agricultural residues and/or green grass?	Green biorefinery?	www.ist-world.org/OrgUnitDetails.aspx?OrgUnitId=5c9d5134361d4414949f261b83d1e808	See website
	R&D Biorefinery South Jutland	Dansk Biomass A/S	To be decided	Green grass?	Green biorefinery?	http://info.ub.uni-potsdam.de/zsr/bub/separata/vol08/BUB08251.pdf (Kamm et al (2000): Green Biorefinery - European Network for the Implementation of Biorefineries. Brandenburgische Umwelberichte (BUB), 251-259, 2000) http://alexandria.tue.nl/extra2/200511821.pdf	Raven, R.P.J.M. (2005): *Strategic Niche Management for Biomass*. PhD Thesis, TU Eindhoven, Netherlands, 2005 (websites)
Finland (FI)							
	R&D Biotechnology for lignocellulose biorefineries (BIOBIO)	Agriculture and Forestry University of Helsinki	Helsinki	Wood & forest biomass	Lignocellulosic feedstock biorefinery	www.cost.esf.org/.../domain_files/FPS/Action_FP0602/progress_report/progress_report-FP0602.pdf	See website
	R&D BIOCELSOL	Tamlink Innovation-Research-Development Ltd	Tampere	Wood & forest biomass	Lignocellulosic feedstock biorefinery	www.tut.fi/units/ms/teva/biocelsol/Biocelsol-ProjectPresentation.pdf	BIOREFINERY EUROVIEW (additional info from websites)
	R&D BIOCOUP	VTT	Helsinki	Wood & forest biomass	Multiple feed biorefinery?	www.biocoup.eu	BIOREFINERY EUROVIEW Status Report Biorefinery 2007 (additional info from websites
	R&D BioRefine	Tekes	Helsinki	Wood & forest biomass	???	www.akseli.tekes.fi/opencms/opencms/OhjelmaPortaali/ohjelmat/BioRefine/en/etusivu.html	see website

	R&D Innovative Forest Products Biorefinery	Helsinki University of Technology and University of Maine	Helsinki	Wood & forest biomass	???	www.tekes.fi/uutisia/223971.rtf www.aka.fi	BIOREFINERY EUROVIEW (additional info from websites)
	R&D WoodWisdom-Net	Tekes	Helsinki	Wood & forest biomass	???	www.woodwisdom.net	BIOREFINERY EUROVIEW (additional info from website)
	R&D WaCheUp	VTT	Helsinki	Pulp mill waste streams	Forest-based and lignocellulosic biorefinery?	www.ili-lignin.com	Status Report Biorefinery 2007 (additional info from website)
France (FR)							
	R&D CERBERUS	Centre Technique du Papier (CTP)	Grenoble			www.webctp.com/ctp/fr/rd/default_projets_europe.html	BIOREFINERY EUROVIEW (additional info from websites)
	R&D NILE (New Improvements for Lignocellulosic Ethanol)	Institut Français du Pétrole (IFP)	Paris			www.nile-bioethanol.org	BIOREFINERY EUROVIEW (additional info from websites)
	R&D EPNOE (European Polysaccharide Network Of Excellence)	CEMEF ARMINES-Ecole des Mines de Paris/CNRS	Paris			www.epnoe.org	BIOREFINERY EUROVIEW (additional info from websites)
	R&D BIOREFINERY EUROVIEW	Industries & Agro-ressources Cluster			Current situation and potential of the biorefinery concept in the EU: strategic framework and guidelines for its development	http://iarpolefr.nexenservices.com/biorefinery/public/index.html	Status Report Biorefinery 2007 (additional info from websites)
	R&D AGRICE					www.ademe.fr/partenaires/agrice/htdocs/action01.asp	BIOREFINERY EUROVIEW (additional info from websites)
Germany (DE)							
	Biorefinery R&D and related products and services	Biorefinery.de company (GmbH)	Potsdam			www.biorefinery.de	See website
	R&D and pilot plant BIOLIQ	FZ Karlsruhe	Karlsruhe	Straw	Lignocellulosic feedstock biorefinery	www.fzk.de/fzk/groups/pkm/documents/presseinformationen/id_058368.pdf	BIOREFINERY EUROVIEW (additional info from websites)
	R&D RENEW	Volkswagen AG	Wolfsburg			www.renew-fuel.com	BIOREFINERY EUROVIEW (additional info from websites)
	R&D Green Biorefinery Brandenburg	Biorefinery.de company (GmbH) Research Institute Biopos e.V.	Potsdam / Teltow-Seehof (Selbelang, State of Brandenburg for prototype)	Wet biomass, green grass, alfalfa, clover, immature cereal?	Green biorefinery	www.fkit.hr/cabeq/pdf/18_1_2004/Biorefinary%20CABEQ_2004_01.pdf (Kamm and Kamm (2004): Biorefinery - Systems. Chem. Biochem. Eng. Q 18 (1), 1-6, 2004) www.rrbconference.ugent.be/presentations/Kamm%20Michael%20and%20Birgit.pdf (Kamm and Kamm (2005): International Biorefinery Systems. Int. Conf. Ren. Resources and Biorefineries Ghent, Belgium, Sept. 19-21, 2005)	Zwart, R.W.R (2006): *Biorefinery The worldwide status at the beginning of 2006*. Biorefinery.nl, 2006. www.biorefinery.nl/fileadmin/biorefinery/docs/bioref/bioref0603.pdf (additional info see websites)
Netherlands (NL)							
	R&D IEA Bioenergy Task 42	Wageningen University and Research Centre (WUR)	Wageningen			www.biorefinery.nl/ieabioenergy-task42 www.biorefinery.nl/fileadmin/biorefinery/docs/publications/presentations-kick-off/_1__Introduction_Kick_off_IEA42_150307.pdf	Status Report Biorefinery 2007 (additional info from websites)

	R&D BIOBU-TANOL	Instituut voor voedselveilig-heid, Wagenin-gen University and Research Centre	Wageningen		Lignocellulosic feedstock biore-finery	www.onderzoekinformatie.nl/nl/oi/nod/onderzoek/OND1323478/	BIOREFINERY EUROVIEW Status Report Biore-finery 2007 (additional info from websites)
	R&D CatchBio	Utrecht Univer-sity	Utrecht		Green biorefinery	www.catchbio.com	Status Report Biore-finery 2007 (additional info from websites)
	R&D Biorefinery.nl	Wageningen University and Research Centre (WUR), ECN	Wageningen and Petten			www.biorefinery.nl	BIOREFINERY EUROVIEW (additional info from websites)
	R&D BIOSYN-ERGY	Energy Research Centre of the Netherlands (ECN)	Petten			www.biosynergy.eu/fileadmin/biosynergy/user/docs/BioSynergy-Brochure.pdf www.biosynergy.eu/fileadmin/biosynergy/user/docs/IntegratedLignocellulose_Biorefinery_Reith_et_al_2008.pdf	BIOREFINERY EUROVIEW Status Report Biore-finery 2007 (additional info from websites)
	R&D BEMZ	ECN and Royal Nedalco	Petten and Bergen op Zoom			http://bemz.ecn.nl/psp-03-033.pdf	BIOREFINERY EUROVIEW (additional info from websites)
	R&D BIOREF-INTEG	Energy Research Centre of the Netherlands (ECN)	Petten			www.bioref-integ.eu www.biorefinery.nl	Status Report Biore-finery 2007
	R&D HYVOLU-TION (Non-thermal pro-duction of pure hydrogen from biomass)	Wageningen University and Research Centre	Wageningen			www.biohydrogen.nl/hyvolution	BIOREFINERY EUROVIEW (additional info from websites)
	R&D Jatropha curcas	University of Groningen	Groningen			www.knaw.nl/cfdata/nieuws/laatstenieuws_detail.cfm?nieuws__id=518	BIOREFINERY EUROVIEW (additional info from websites)
	R&D LignoValue	Agrotechnology & Food Innova-tions BV, Wageningen University and Research Centre	Wageningen		Lignocellulosic feedstock biore-finery	www.biobased.nl/lignovalue www.senternovem.nl/eos/Projecten/EOS_Lange_Ter-mijn/2006/Hoogwaardige_grondstoffen_en_producten_uit_lignine_(LignoValue).asp	BIOREFINERY EUROVIEW Status Report Biore-finery 2007 (additional info from websites)
	R&D N-ERGY	Agrotechnology & Food Innova-tions BV, Wageningen University and Research Centre	Wageningen			www.onderzoekinformatie.nl/nl/oi/nod/onderzoek/OND1323477/	BIOREFINERY EUROVIEW Status Report Biore-finery 2007 (additional info from websites)
	Microalgae for coating chemi-cals and biofu-els	R&D project Akzo	Delfzijl	CO2 from the Delesto energy power plant in Delfzijl plus nutrients.	??	http://www.p-plus.nl/artikel.php?IK=1470	BIOPOL Info from websites, direct contacts
	Micro-algae for biodiesel and co-products.	R&D project AquaPhyto, Teijin Ltd + other industrial partners.	AquaPhyto R&D and pro-duction facili-ties Zeewolde	CO2, nutrients	??	www.aquaphyto.com	BIOPOL Info from websites, direct contacts
	Wheat/Oil seeds	'Bioport' (is not a company)	Rotter-dam/Delfzijl	Wheat/Oil seeds	Whole crop/green biorefinery		Biopol/AFSG
Portugal (PT)							
	RD&D ECOREFINE	Tecnia				www.tecnia.net/research_innovation/ecorefine	BIOREFINERY EUROVIEW Status Report Biore-finery 2007

							(additional info from websites)
Sweden (SE)							
	R&D CHRISGAS (Clean Hydrogen Rich Synthesis Gas)	Vaxjo University	Vaxjo	Forestry biomass	???	www.chrisgas.com/	BIOREFINERY EUROVIEW Status Report Biorefinery 2007 (additional info from websites)
	RD&D FRAM2 (Future Resource-Adapted Pulp Mill)	LignoBoost AB (a subsidiary of STFI-Packfrosk)	Stockholm	Wood & forest biomass	???	www.lignoboost.com/templates/Lignoboost/LBPage____2066.aspx	BIOREFINERY EUROVIEW (additional info from websites)
	R&D WaCheUp (upgrading pulp and cork mill waste streams)	STFI-Packforsk AB (partner in EU-wide R&D consortium)	Stockholm	Low-value residual products from pulp and cork manufacture	(R&D for) Lignocellulosic feedstock biorefinery?	www.biomatnet.org/secure/FP6/S1878.htm www.stfi-packforsk.se/templates/STFIPage____7149.aspx	Status Report Biorefinery 2007 (additional info from websites)
	Cellulose to ethanol plant.	SEKAB E-technology	Örnsköldsvik	Wood chippings or other raw material that contains lignocellulose.	Lignocellulosic feedstock biorefinery	www.sekab.com/	BIOPOL/IIIEE
	RD&D BLG2 (High Temperature Kraft Black Liquor Gasification)	ETC	Piteå	Black liquor	???	www.etc.pitea.se/BLG	BIOPOL/IIIEE
Switzerland (CH)							
	R&D Grass refinery	2B AG Biomass and Bioenergy ETH Zürich	To be decided	Grass?	(R&D for) Green biorefinery? 2000-?	http://opus.kobv.de/ubp/volltexte/2006/791/pdf/vol08.pdf (Jänkel and Loschelder, Ed. (2006): Umweltforschung an der Universität Potsdam. Brandenburgische Umwelt Berichte, Potsdam, Germany, 2000) www.bafu.admin.ch/php/modules/shop/files/pdf/phpB8K0HG.pdf	Kamm et al (2000): Green Biorefinery - European Network for the Implementation of Biorefineries. Brandenburgische Umwelberichte (BUB), 251-259, 2000 (see websites)
United Kingdom (UK)							
	R&D EPOBIO	Centre For Novel Agricultural Products (CNAP)	York			www.epobio.net	BIOREFINERY EUROVIEW Status Report Biorefinery 2007 (additional info from websites))

Appendix E Quantitative assessment of industry sectors where biorefineries have developed or may develop cf. th biorefinery feedstocks in the EU27+

Table 4: Results of quantitative assessment of industry sectors where biorefineries have developed or may develop cf. the industry survey and available major biorefinery feeds

Country / sector	Area ha	Turnover M€/yr	Production M€/yr	Production [3]	Consumption TOE	Production Tonnes/yr	Import Tonnes/yr	T
Austria (AT)								
Surface area	**8385800**							
Chemical industries								
Manufacture of basic chemicals		**2,939.5**	**2,967.1**					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		**2,694**	**2,368.8**					
Manufacture of man-made fibres		**688.7**	**661**					
Manufacture of plastic products		**3,921.4**	**3,667**					
Manufacture of rubber products		**909.8**	**619.1**					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet						**2493097** **2651210**		
Wheat						**1396300** **1399341**		
Maize						**1471668** **1555891**		
Potato						**613527**		

Agricultural residues of food and feed crops				3354000				
Manufacture of sugar (NACE ….)[7]		316.7						
Manufacture of starches and starch products		147.9						
Forestry sector								
Forestry sector (incl. pulp & paper)		10,337	10,845					
Wood and wood products (NACE 20)[7]		6,186	5,998					
Pulp, paper, and paper products (NACE 21)[7]		5,151	4,847					
Pulp for paper						1678000	697000	
Biofuels sector								
Biodiesel (2006 / 2007)				123000 [4] 267000 [2][4]	333429 367140 [2]			
Bioethanol (2006 / 2007)					0 21883 [2]			
Belgium (BE)								
Surface area	3052800							
Chemical industries								
Manufacture of basic chemicals		19,722	18,718.7					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		7,599.4	9,072.2					
Manufacture of man-made fibres		663.2	591.2					
Manufacture of plastic products		6,635.6	6,309.1					
Manufacture of rubber products		1,596.5	1,214.2					
Agricultural/ sugar and starch sectors (including								

Rapeseed						33976 38470		
Grassland area	574000							
Estimated grassland area providing required livestock feed	574000							
Grass production (total)				4879000				
Grass potential for bioenergy				0				
Agricultural residues of food and feed crops (Belgium & Luxembourg)				1534000				
Manufacture of sugar (NACE ….)[7]		1,039.7						
Manufacture of starches and starch products		428.7						
Forestry sector								
Forestry sector (incl. pulp & paper)		8,488	7,728					
Wood and wood products (NACE 20)[7]		3,370	3,286					
Pulp, paper, and paper products (NACE 21)[7]		5,118	4,442					
Pulp for paper						509000	807665	
Biofuels sector								
Biodiesel (2006 / 2007)				25000 [4] 166000 [2][4]	897 91260 [2]			
Bioethanol (2006 / 2007)								
Bulgaria (BG)								
Surface area	11091200							
Chemical industries								

Sugar beet						26788 16281		
Wheat						3301882 2390610		
Maize						1587805 312900		
Potato						290553		
Rapeseed						28463 93018		
Grassland area	1616000							
Estimated grassland area providing required livestock feed	259000							
Grass production (total)				8080000				
Grass potential for bioenergy				6787000				
Agricultural residues of food and feed crops				5069000				
Manufacture of sugar (NACE ….)[7]		97						
Manufacture of starches and starch products		N/A						
Forestry sector								
Forestry sector (incl. pulp & paper)		674	526					
Wood and wood products (NACE 20)[7]		299	274					
Pulp, paper, and paper products (NACE 21)[7]		275	252					
Pulp for paper						135000	19404	
Biofuels sector								

Manufacture of basic chemicals		11.2	12					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		79.1	79.8					
Manufacture of man-made fibres		0	0					
Manufacture of plastic products		81	75.1					
Manufacture of rubber products		1.2	1.1					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet								
Wheat						7262 9000		
Maize								
Potato						135000		
Rapeseed								
Grassland area	4000							
Estimated grassland area providing required livestock feed	4000							
Grass production (total)				10000				
Grass potential for bioenergy				0				
Agricultural residues of food and feed crops				191000				
Manufacture of sugar (NACE ….)[7]		0						
Manufacture of starches and starch products		0						
Forestry sector								
Forestry sector (incl. pulp & paper)		254	245					
Wood and wood products (NACE 20)[7]		183	182					

Czech Republic (CZ)								
Surface area	7886600							
Chemical industries								
Manufacture of basic chemicals		3595.2	3,553.4					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		1,090.2	992					
Manufacture of man-made fibres		N/A	N/A					
Manufacture of plastic products		3,034	2,905					
Manufacture of rubber products		2,257	1,089.1					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet						3138326 2598676		
Wheat						3506252 3955437		
Maize						606366 608179		
Potato						784661		
Rapeseed						880172 1038400		
Grassland area	961000							
Estimated grassland area providing required livestock feed	211000							
Grass production (total)				4325000				
Grass potential for bioenergy				3373000				

Pulp, paper, and paper products (NACE 21)[7]		1,840	1,675					
Pulp for paper						766000	171000	
Biofuels sector								
Biodiesel (2006 / 2007)				61000 [4] 107000 [2][4]	18290 32660 [2]			
Bioethanol (2006 / 2007)				17 [5] 25 [2][5] 15 [6] 33 [2][6]	1140 180 [2]			
Denmark (DK)								
Surface area	4309400							
Chemical industries								
Manufacture of basic chemicals		966.4	1,052.2					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		5,655.9	5,837.3					
Manufacture of man-made fibres		N/A	N/A					
Manufacture of plastic products		3,061.4	3,019.3					
Manufacture of rubber products		225.2	219					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet						2314200 2255300		
Wheat						4801600 4519200		

Grass potential for bioenergy				806000				
Agricultural residues of food and feed crops				5193000				
Manufacture of sugar (NACE ….)[7]		N/A						
Manufacture of starches and starch products		86.9						
Forestry sector								
Forestry sector (incl. pulp & paper)		3,349	3,263					
Wood and wood products (NACE 20)[7]		1,894	1,865					
Pulp, paper, and paper products (NACE 21)[7]		1,455	1,398					
Pulp for paper						0.0	72252	
Biofuels sector								
Biodiesel (2006 / 2007)				85000 [4] 80000 [2][4]	0 0 [2]			
Bioethanol (2006 / 2007)					3611 6025 [2]			
Estonia (EE)								
Surface area	4510000							
Chemical industries								
Manufacture of basic chemicals		137.9	114					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		24.2	20.5					
Manufacture of man-made fibres		0	0					
Manufacture of plastic products		231.4	216.5					
Manufacture of rubber products		15.9	14.6					

Rapeseed						84609 132400		
Grassland area	131000							
Estimated grassland area providing required livestock feed	55000							
Grass production (total)				524000				
				304000				
Agricultural residues of food and feed crops				586000				
Manufacture of sugar (NACE ….)[7]		0						
Manufacture of starches and starch products		N/A						
Forestry sector								
Forestry sector (incl. pulp & paper)		977	952					
Wood and wood products (NACE 20)[7]		882	859					
Pulp, paper, and paper products (NACE 21)[7]		95	93					
Pulp for paper						136300	3347	
Biofuels sector								
Biodiesel (2006 / 2007)				1000 [4] 0 [2][4]	633			
Bioethanol (2006 / 2007)								
Finland (FI)								
Surface area	33814500							
Chemical industries								

						673100		
Wheat						684100 796800		
Maize								
Potato						701600		
Rapeseed						148200 114000		
Grassland area	114000							
Estimated grassland area providing required livestock feed	16000							
Grass production (total)				399000				
Grass potential for bioenergy				343000				
Agricultural residues of food and feed crops				3300000				
Manufacture of sugar (NACE ….)[7]		281.9						
Manufacture of starches and starch products		19.8						
Forestry sector								
Forestry sector (incl. pulp & paper)		20,199	19,358					
Wood and wood products (NACE 20)[7]		5,868	5,679					
Pulp, paper, and paper products (NACE 21)[7]		14,331	13,679					
Pulp for paper						13067000	267309	
Biofuels sector								
Biodiesel (2006 / 2007)				0 [4] 39000 [2][4]				

botanical products								
Manufacture of man-made fibres		634.1	585.9					
Manufacture of plastic products		29,443.1	27,655.3					
Manufacture of rubber products		11,968.3	10,690.9					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet						29878767 32338000		
Wheat						35366784 33219000		
Maize						12901769 13107000		
Potato						6271000		
Rapeseed						4144485 4554000		
Grassland area	10087000							
Estimated grassland area providing required livestock feed	5750000							
Grass production (total)				60522000				
Grass potential for bioenergy				26024000				
Agricultural residues of food and feed crops				39657000				
Manufacture of sugar (NACE ….)[7]		3,877.6						
Manufacture of starches and starch products		2,108						
Forestry sector								
Forestry sector (incl. pulp & paper)		32,157	29,785					

Bioethanol (2006 / 2007)				293 [5] 550 [2][5] 293 [6] 578 [2][6]	147800 272937 [2]			
Germany (DE)								
Surface area	35702200							
Chemical industries								
Manufacture of basic chemicals		74,266.5	61,996.8					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		36,051.5	32,319.2					
Manufacture of man-made fibres		3,841.5	3,637.5					
Manufacture of plastic products		48,883.3	45,585.5					
Manufacture of rubber products		14,881.4	12,073.4					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet						20646600 26114000		
Wheat						22427900 21366800		
Maize						3220300 3480600		
Potato						11604500		
Rapeseed						5336500 5320000		
Grassland area	5048000							

Forestry sector								
Forestry sector (incl. pulp & paper)		53,594	50,193					
Wood and wood products (NACE 20)[7]		21,116	19,982					
Pulp, paper, and paper products (NACE 21)[7]		32,478	30,211					
Pulp for paper						2938000	4577000	
Biofuels sector								
Biodiesel (2006 / 2007)				2662000 [4] 2890000 [2][4]	2532003 2957463 [2]			
Bioethanol (2006 / 2007)				395 [5] 399 [2][5] 431[6] 394 [2][6]	304738 293078 [2]			
Greece (EL)								
Surface area	13195700							
Chemical industries								
Manufacture of basic chemicals		845.8	815.8					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		737.7	725.4					
Manufacture of man-made fibres		4.7	4.9					
Manufacture of plastic products		1,206.2	1,125.3					
Manufacture of rubber products		114.9	111.5					
Agricultural/ sugar and starch sectors (including grassland)								

						6000		
Grassland area	4675000							
Estimated grassland area providing required livestock feed	2104000							
Grass production (total)				11688000				
Grass potential for bioenergy				6428000				
Agricultural residues of food and feed crops				6644000				
Manufacture of sugar (NACE ….)[7]		204.7						
Manufacture of starches and starch products		39.5						
Forestry sector								
Forestry sector (incl. pulp & paper)		N/A	N/A					
Wood and wood products (NACE 20)[7]		N/A	N/A					
Pulp, paper, and paper products (NACE 21)[7]		N/A	N/A					
Pulp for paper						0.0	76290	
Biofuels sector								
Biodiesel (2006 / 2007)				42000 [4] 100000 [2][4]	46440 80840 [2]			
Bioethanol (2006 / 2007)				3 [5] 0 [2][5]				
Hungary (HU)								
Surface area	9303200							
Chemical industries								

						2000000		
Wheat						4376235 3988177		
Maize						8281666 8400000		
Potato						531300		
Rapeseed						338006 498200		
Grassland area	1051000							
Estimated grassland area providing required livestock feed	210000							
Grass production (total)				3153000				
Grass potential for bioenergy				2522000				
Agricultural residues of food and feed crops				9433000				
Manufacture of sugar (NACE ….)[7]		326.9						
Manufacture of starches and starch products		134						
Forestry sector								
Forestry sector (incl. pulp & paper)		2,141	1,730					
Wood and wood products (NACE 20)[7]		981	786					
Pulp, paper, and paper products (NACE 21)[7]		1,160	944					
Pulp for paper						19000	164326	
Biofuels sector								
Biodiesel (2006 / 2007)				0 [4]	334			

Chemical industries								
Manufacture of basic chemicals		**N/A**	**N/A**					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		**N/A**	**N/A**					
Manufacture of man-made fibres		**N/A**	**N/A**					
Manufacture of plastic products		**N/A**	**N/A**					
Manufacture of rubber products		**N/A**	**N/A**					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet								
Wheat								
Maize								
Potato						**13000**		
Rapeseed								
Grassland area								
Estimated grassland area providing required livestock feed								
Grass production (total)								
Grass potential for bioenergy								
Agricultural residues of food and feed crops								
Manufacture of sugar (NACE ….)[7]		**N/A**						
Manufacture of starches and starch products		**N/A**						
Forestry sector								
Wood and wood products (NACE 20)[7]		**N/A**						
Pulp, paper, and paper products (NACE 21)[7]		**N/A**						

Manufacture of basic chemicals		22,826.2	22,051.4					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		6,120.6	6,079.9					
Manufacture of man-made fibres		N/A	N/A					
Manufacture of plastic products		1,386.8	1,337.3					
Manufacture of rubber products		92.1	92.7					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet						75600 45000		
Wheat						801000 684900		
Maize								
Potato						454800		
Rapeseed						17900 20000		
Grassland area	3333000							
Estimated grassland area providing required livestock feed	3300000							
Grass production (total)				24998000				
Grass potential for bioenergy				250000				
Agricultural residues of food and feed crops				963000				
Manufacture of sugar (NACE ….)[7]		N/A						
Manufacture of starches and starch products		N/A						
Forestry sector								

				3000 [2][4]	4612 [2]			
Bioethanol (2006 / 2007)				1 [5] 2 [2][5]	1117 2352 [2]			
Italy (IT)								
Surface area	30131800							
Chemical industries								
Manufacture of basic chemicals		25,145.6	23.231.6					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		22,067.4	19,718					
Manufacture of man-made fibres		1,501.5	1,477.7					
Manufacture of plastic products		29,097.4	28,762.3					
Manufacture of rubber products		9,151.4	7,979					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet						4769614 4629900		
Wheat						7181720 7260309		
Maize						9671206 9891362		
Potato						1837844		
Rapeseed						5961 14962		
Grassland area	4353000							
Estimated grassland area providing required	2133000							

Forestry sector (incl. pulp & paper)		37,498	35,950					
Wood and wood products (NACE 20)[7]		18,952	18,252					
Pulp, paper, and paper products (NACE 21)[7]		18,546	17,698					
Pulp for paper						682329	3671794	
Biofuels sector								
Biodiesel (2006 / 2007)				447000 [4] 363000 [2][4]	148967 139350 [2]			
Bioethanol (2006 / 2007)				128 [5] 60 [2][5] 78 [6] 60 [2][6]				
Latvia (LV)								
Surface area	6460000							
Chemical industries								
Manufacture of basic chemicals		11.8	10.8					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		72.4	66.8					
Manufacture of man-made fibres		N/A	N/A					
Manufacture of plastic products		145.1	142.8					
Manufacture of rubber products		11.7	10.9					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet						473900 10800		
Wheat						598300		

livestock feed								
Grass production (total)				2444000				
Grass potential for bioenergy				2053000				
Agricultural residues of food and feed crops				861000				
Manufacture of sugar (NACE ….)[7]		N/A						
Manufacture of starches and starch products		N/A						
Forestry sector								
Forestry sector (incl. pulp & paper)		1,182	1,099					
Wood and wood products (NACE 20)[7]		1,126	1,043					
Pulp, paper, and paper products (NACE 21)[7]		56	56					
Pulp for paper						0.0	619	
Biofuels sector								
Biodiesel (2006 / 2007)				7000 [4] 9000 [2][4]	1447 2 [2]			
Bioethanol (2006 / 2007)				12 [5] 0 [2][5] 12 [6] 18 [2][6]	1037 1738 [2]			
Lithuania (LT)								
Surface area	6530000							
Chemical industries								
Manufacture of basic chemicals		517.3	524.7					

Wheat						809800 1390700		
Maize						4700 26000		
Potato						576100		
Rapeseed						169600 311900		
Grassland area	492000							
Estimated grassland area providing required livestock feed	157000							
Grass production (total)				1968000				
Grass potential for bioenergy				1338000				
Agricultural residues of food and feed crops				2196000				
Manufacture of sugar (NACE ….)[7]		85.1						
Manufacture of starches and starch products		N/A						
Forestry sector								
Forestry sector (incl. pulp & paper)		699	675					
Wood and wood products (NACE 20)[7]		602	582					
Pulp, paper, and paper products (NACE 21)[7]		97	93					
Pulp for paper						0.0	2109	
Biofuels sector								
Biodiesel (2006 / 2007)				10000 [4] 26000 [2][4]	13900 41000 [2]			

Manufacture of basic chemicals		135.2	135.2					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		N/A	N/A					
Manufacture of man-made fibres		N/A	N/A					
Manufacture of plastic products		743.9	542.4					
Manufacture of rubber products		886.9	816					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet								
Wheat						75603 70400		
Maize						1875 1900		
Potato						20200		
Rapeseed						16250 18400		
Grassland area								
Estimated grassland area providing required livestock feed								
Grass production (total)								
Grass potential for bioenergy								
Agricultural residues of food and feed crops				See Belgium				
Manufacture of sugar (NACE ….)[7]		0						
Manufacture of starches and starch products		0						
Forestry sector								

					34098 [2]			
Bioethanol (2006 / 2007)					0 865 [2]			
Malta (MT)								
Surface area	31600							
Chemical industries								
Manufacture of basic chemicals		N/A	N/A					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		29.8	30.5					
Manufacture of man-made fibres		0	0					
Manufacture of plastic products		41.7	42.4					
Manufacture of rubber products		47.9	49.2					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet								
Wheat						9500 9200		
Maize								
Potato						25000		
Rapeseed								
Grassland area								
Estimated grassland area providing required livestock feed								
Grass production (total)								
Grass potential for bioenergy								

Biodiesel (2006 / 2007)				2000 [4] 1000 [2][4]	835 0 [2]			
Bioethanol (2006 / 2007)								
Netherlands (NL)								
Surface area	4152800							
Chemical industries								
Manufacture of basic chemicals		36,718.6	32,825.6					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		5,627.8	5,328.5					
Manufacture of man-made fibres		1,018.1	1,009.4					
Manufacture of plastic products		6,141.2	5,781.6					
Manufacture of rubber products		730.4	583.9					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet						5414100 5400000		
Wheat						1184400 990000		
Maize						237000 217000		
Potato						7200000		
Rapeseed						11600 14000		
Grassland area	902000							
Estimated grassland area providing required	902000							

Forestry sector (incl. pulp & paper)		8,648	8,099					
Wood and wood products (NACE 20)[7]		2,754	2,612					
Pulp, paper, and paper products (NACE 21)[7]		5,894	5,487					
Pulp for paper						109000	1224800	
Biofuels sector								
Biodiesel (2006 / 2007)				18000 [4] 85000 [2][4]	14761 n.a. [2]			
Bioethanol (2006 / 2007)				15 [5] 11 [2][5] 15 [6] 14 [2][6]	15349 8670 [2]			
Norway (NO)								
Surface area	38515500							
Chemical industries								
Manufacture of basic chemicals		4,443.3	4,299.7					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		864.1	929.5					
Manufacture of man-made fibres		0	0					
Manufacture of plastic products		955.9	902.1					
Manufacture of rubber products		121.4	88.8					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet								
Wheat						389700		

livestock feed								
Grass production (total)				632000				
Grass potential for bioenergy				120000				
Agricultural residues of food and feed crops				937000				
Manufacture of sugar (NACE ….)[7]		0						
Manufacture of starches and starch products		N/A						
Forestry sector								
Forestry sector (incl. pulp & paper)		4,841	4,626					
Wood and wood products (NACE 20)[7]		2,666	2,476					
Pulp, paper, and paper products (NACE 21)[7]		2,175	2,150					
Pulp for paper						2149000	58957	
Biofuels sector								
Biodiesel (2006 / 2007)								
Bioethanol (2006 / 2007)								
Poland (PL)								
Surface area	31268500							
Chemical industries								
Manufacture of basic chemicals		4,387.7	4,223.3					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		2,546.3	2,073.4					
Manufacture of man-made fibres		114.6	162.2					
Manufacture of plastic products		6,918.3	6,463.3					
Manufacture of rubber products		2,109.3	1,969.6					

Potato						11221100		
Rapeseed						1651525 2112600		
Grassland area	4076000							
Estimated grassland area providing required livestock feed	978000							
Grass production (total)				18342000				
Grass potential for bioenergy				13940000				
Agricultural residues of food and feed crops				21536000				
Manufacture of sugar (NACE ….)[7]		1,419.6						
Manufacture of starches and starch products		70.4						
Forestry sector								
Forestry sector (incl. pulp & paper)		7,941	7,650					
Wood and wood products (NACE 20)[7]		4,565	4,435					
Pulp, paper, and paper products (NACE 21)[7]		3,376	3,215					
Pulp for paper						1062300	413700	
Biofuels sector								
Biodiesel (2006 / 2007)				116000 [4] 80000 [2][4]	42218 15480 [2]			
Bioethanol (2006 / 2007)				130 [5] 120 [2][5] 161 [6] 155 [2][6]	52548 85200 [2]			

Manufacture of plastic products		1,990.2	1,899.4					
Manufacture of rubber products		567.7	529.9					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet						319246 320000		
Wheat						249600 135800		
Maize						513700 646500		
Potato						638900		
Rapeseed								
Grassland area	1284000							
Estimated grassland area providing required livestock feed	1053000							
Grass production (total)				4494000				
Grass potential for bioenergy				809000				
Agricultural residues of food and feed crops				1916000				
Manufacture of sugar (NACE ….)[7]		294.6						
Manufacture of starches and starch products		33.4						
Forestry sector								
Forestry sector (incl. pulp & paper)		3,504	3,302					
Wood and wood products (NACE 20)[7]		2,265	2,293					
Pulp, paper, and paper products (NACE 21)[7]								

Surface area	23839100							
Chemical industries								
Manufacture of basic chemicals		1,522.1	1,418.7					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		378.6	367.4					
Manufacture of man-made fibres		69.8	66.2					
Manufacture of plastic products		1,070.3	968.6					
Manufacture of rubber products		515.8	516.3					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet						1152200 698575		
Wheat						5526190 2866234		
Maize						8984729 3686502		
Potato						3498443		
Rapeseed						175050 348169		
Grassland area	4949000							
Estimated grassland area providing required livestock feed	1138000							
Grass production (total)				24745000				
Grass potential for bioenergy				19054000				
Agricultural residues of food and feed crops				12894000				

Pulp for paper						148000	14000	
Biofuels sector								
Biodiesel (2006 / 2007)				10000 [4] 36000 [2][4]	2752 n.a. [2]			
Bioethanol (2006 / 2007)								
Slovakia (SK)								
Surface area	4903300							
Chemical industries								
Manufacture of basic chemicals		587.6	592.4					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		195.2	188					
Manufacture of man-made fibres		205	196.3					
Manufacture of plastic products		845.7	795.7					
Manufacture of rubber products		676.3	623.9					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet						1370908 855343		
Wheat						1342693 1440637		
Maize						838326 675226		
Potato						381650		
Rapeseed						259650 336368		

Manufacture of starches and starch products		75.9						
Forestry sector								
Forestry sector (incl. pulp & paper)		1,383	1,241					
Wood and wood products (NACE 20)[7]		466	427					
Pulp, paper, and paper products (NACE 21)[7]		917	814					
Pulp for paper						626000	90000	
Biofuels sector								
Biodiesel (2006 / 2007)				82000 [4] 46000 [2][4]	12820 n.a. [2]			
Bioethanol (2006 / 2007)				0 [5] 30 [2][5] 0 [6] 30 [2][6]	340 13262 [2]			
Slovenia (SI)								
Surface area	2025600							
Chemical industries								
Manufacture of basic chemicals		350.8	327					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		1,061.4	1,011.4					
Manufacture of man-made fibres		N/A	N/A					
Manufacture of plastic products		893.6	823.3					
Manufacture of rubber products		494.9	402.1					
Agricultural/ sugar and starch sectors (including grassland)			N/A					

Rapeseed						4991 14740		
Grassland area	308000							
Estimated grassland area providing required livestock feed	151000							
Grass production (total)				1694000				
Grass potential for bioenergy				864000				
Agricultural residues of food and feed crops				422000				
Manufacture of sugar (NACE ….)[7]		N/A						
Manufacture of starches and starch products		20						
Forestry sector								
Forestry sector (incl. pulp & paper)		1,214	1,149					
Wood and wood products (NACE 20)[7]		586	539					
Pulp, paper, and paper products (NACE 21)[7]		628	610					
Pulp for paper						112000	194819	
Biofuels sector								
Biodiesel (2006 / 2007)				11000 [4] 11000 [2][4]	4092 12993 [2]			
Bioethanol (2006 / 2007)					170 794 [2]			
Spain (ES)								
Surface area	50603000							
Chemical industries								

Sugar beet						6045400 5141000		
Wheat						5575800 6376900		
Maize						3460800 3647900		
Potato						2502300		
Rapeseed						9000 37800		
Grassland area	9396000							
Estimated grassland area providing required livestock feed	8362000							
Grass production (total)				23490000				
Grass potential for bioenergy				2584000				
Agricultural residues of food and feed crops				24562000				
Manufacture of sugar (NACE ….)[7]		975.6						
Manufacture of starches and starch products		454.7						
Forestry sector								
Forestry sector (incl. pulp & paper)		21,253	20,482					
Wood and wood products (NACE 20)[7]		10,101	9,648					
Pulp, paper, and paper products (NACE 21)[7]		11,152	10,834					
Pulp for paper						2887600	926000	
Biofuels sector								

Surface area	44996400							
Chemical industries								
Manufacture of basic chemicals		5,013.9	4,394.6					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		6,989.1	7,643.5					
Manufacture of man-made fibres		1.4	1.2					
Manufacture of plastic products		3,422.6	3,197.2					
Manufacture of rubber products		941.3	848.9					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet						2189000 2000000		
Wheat						1967400 2254700		
Maize								
Potato						790100		
Rapeseed						220000 223000		
Grassland area	447000							
Estimated grassland area providing required livestock feed	201000							
Grass production (total)				1788000				
Grass potential for bioenergy				983000				
Agricultural residues of food and feed crops				3858000				
Manufacture of sugar (NACE ….)[7]		N/A						

Biofuels sector								
Biodiesel (2006 / 2007)				**13000 [4]** **63000 [2][4]**	**44981** **99602 [2]**			
Bioethanol (2006 / 2007)				**72 [5]** **70 [2][5]** **140 [6]** **70 [2][6]**	**162875** **181649 [2]**			
Switzerland (CH)								
Surface area	**4128400**							
Chemical industries								
Manufacture of basic chemicals		**N/A**	**N/A**					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		**N/A**	**N/A**					
Manufacture of man-made fibres		**N/A**	**N/A**					
Manufacture of plastic products		**N/A**	**N/A**					
Manufacture of rubber products		**N/A**	**N/A**					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet						**1242728** **1584000**		
Wheat						**540700** **562200**		
Maize						**151100** **186000**		
Potato						**490000**		

Agricultural residues of food and feed crops				870000				
Manufacture of sugar (NACE ….)[7]		N/A						
Manufacture of starches and starch products		N/A						
Forestry sector								
Forestry sector (incl. pulp & paper)		N/A	N/A					
Wood and wood products (NACE 20)[7]		N/A	N/A					
Pulp, paper, and paper products (NACE 21)[7]		N/A	N/A					
Pulp for paper						164742	532561	
Biofuels sector								
Biodiesel (2006 / 2007)								
Bioethanol (2006 / 2007)								
United Kingdom (UK)								
Surface area	24290000							
Chemical industries								
Manufacture of basic chemicals		27,520.3	24,529.7					
Manufacture of pharmaceuticals, medicinal chemicals and botanical products		23,029.7	21,280.2					
Manufacture of man-made fibres		564.8	569.3					
Manufacture of plastic products		25,917.5	24,710.6					
Manufacture of rubber products		5,273.2	4,766.6					
Agricultural/ sugar and starch sectors (including grassland)								
Sugar beet						7150000		

Grassland area	**10017000**							
Estimated grassland area providing required livestock feed	**8214000**							
Grass production (total)				**55094000**				
Grass potential for bioenergy				**9917000**				
Agricultural residues of food and feed crops				**12140000**				
Manufacture of sugar (NACE ….)[7]		**N/A**						
Manufacture of starches and starch products		**595.7**						
Forestry sector								
Forestry sector (incl. pulp & paper)		**29,207**	**26,898**					
Wood and wood products (NACE 20)[7]		**10,989**	**10,156**					
Pulp, paper, and paper products (NACE 21)[7]		**18,218**	**16,742**					
Pulp for paper						**287000**	**1314195**	
Biofuels sector								
Biodiesel (2006 / 2007)				**192000 [4]** **150000 [2][4]**	**131820** **270660 [2]**			
Bioethanol (2006 / 2007)				**0 [5]** **18 [2][5]** **0 [6]** **20 [2][6]**	**48450** **78030 [2]**			

[1] Vegetable oil consumed as such in Germany, Ireland and the Netherlands, and biogas for Sweden (EurObserv'ER Biofuels barometer, June 2008)
[2] Estimation (EurObserv'ER Biofuels barometer, June 2008)
[3] Biodiesel production in tonnes; bioethanol production in million liters; agricultural residues and grass in tonnes dry matter
[4] According to EBB (EurObserv'ER Biofuels barometer, June 2008)
[5] According to UFPA (EurObserv'ER Biofuels barometer, June 2008)