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Development of advanced BIOREFinery schemes to be INTEGrated into existing industrial (fuel producing) complexes

Excutive Summary

Organisation name of lead contractor for this deliverable: ECN

May 2010

Dissemination level

PU	Public	**X**
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the Consortium (including the Commission Services)	

Justification

This is the executive summary of the BIOREF-INTEG Project. BIOREF-INTEG is a 'Coordination and Support Action Project' within the framework of the FP7 Programme (Theme Energy). The project is funded by the European Commission from June 2008 until May 2010, with the main objective to develop advanced biorefinery schemes to be integrated into existing industrial (fuel producing) complexes.

Executive Summary

Introduction

A biorefinery is a facility that integrates biomass conversion processes and equipment to produce fuels, power, materials and/or chemicals from biomass. By producing multiple products, a biorefinery can take advantage of the differences in biomass components and intermediates and maximise the value derived from the biomass feedstock, and optimise the cost effectiveness of its products.

A biorefinery might, for example, produce one or several low-volume, but high-value chemical products, and low-value, but high-volume, liquid transportation fuels; while generating power and process heat for its own use, and perhaps enough for external sale.

BIOREF-INTEG is a 'Coordination and Support Action Project' within the framework of the FP7 Programme (Theme Energy). The project is funded by the European Commission from June 2008 until May 2010.

The main objective of the project is to develop advanced biorefinery schemes to be integrated into existing industrial (fuel producing) complexes. Several biomass processing sectors have been considered within the BIOREF-INTEG project including sugar/starch (bioethanol), biodiesel, pulp and paper, conventional oil refineries, power production, the food industry and the agrosector. The identification of innovative biorefinery concepts within this project could be beneficial to the aforementioned sectors by significantly increasing the overall economic profitability, and decreasing the overall environmental impact of their conventional processes.

The project is coordinated by the Energy research Centre of the Netherlands, ECN. Other participants involved are:

- **4 SMEs**: ETC (Sweden / forest-based biorefinery), Ten Kate (the Netherlands / high quality fats & proteins), VFT (Belgium / industrial marketing services with focus on renewable resource materials), and Fons Maes BVBA (Belgium / biodiesel);
- **3 industries**: Abengoa Bioenergy New Technologies (Spain / bioethanol), Cehave (the Netherlands / high quality animal feed), and Repsol (Spain / conventional oil refinery);
- **2 universities**: Aston University (United Kingdom), and University of Ghent (Belgium);
- **3 RTD institutes**: VTT (Finland), WUR Food and Biobased Research/A&F (the Netherlands), and Innventia (Sweden / pulp & paper).

The project is conducted by 7 separate but strongly interrelated work packages, as presented in the figure below:

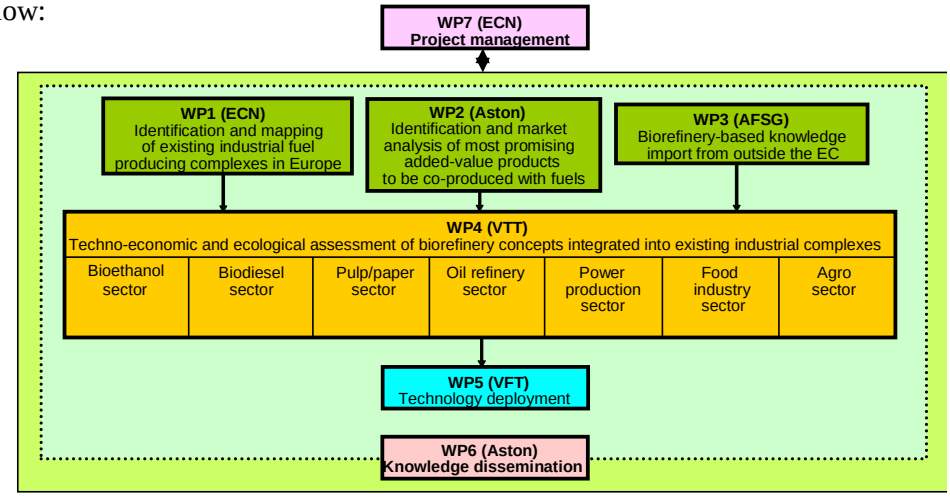

Figure S-1 *Bioref-Integ work packages*

- WP1: Identification of existing industrial (fuel producing) complexes in Europe;
- WP2: Definition of the most promising added value bioproducts;
- WP3: Knowledge import from outside the EC;
- WP4: Integral technical, economic, and ecological system assessments to select the most promising market specific integrated biorefineries;
- WP5: Technology deployment;
- WP6: Knowledge dissemination and training;
- WP7: Project management.

Methodology

A process flow of the Bioref-Integ project is given in Figure S-2.

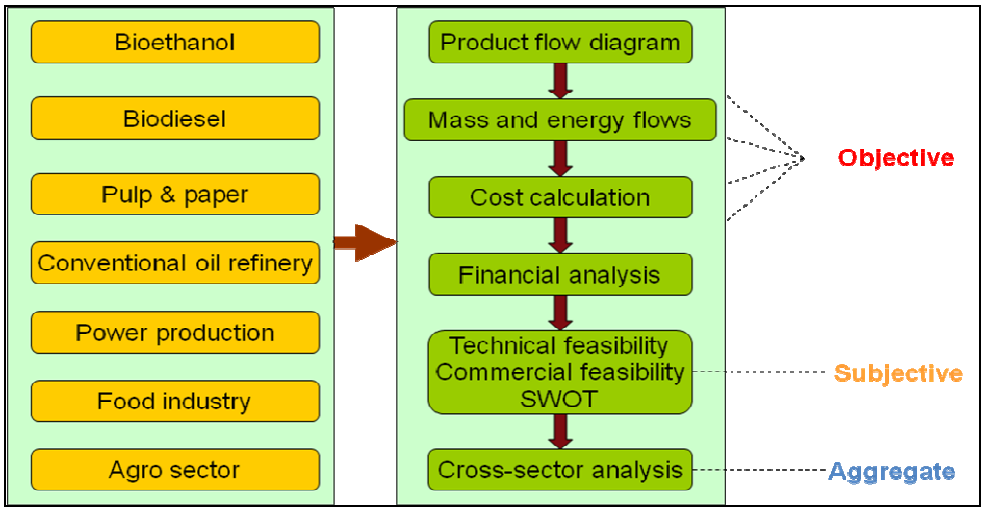

Figure S-2 *Bioref-Integ process flow*

Work package 1

For each considered biomass processing sector, the existing industrial (fuel producing) complexes have been identified for the six partner-related countries (Belgium, Finland, Spain, Sweden, United Kingdom, and the Netherlands). Based on the performed survey, at least one reference case per sector has been defined as a realistic representative of that sector. The reference cases include different feedstocks, such as cereals, oilseed crops, wood, milk, sugar beet, and grass. The cases use different conversion technologies: fermentation, transesterification, anaerobic digestion, combustion, gasification, fluid catalytic cracking and hydrotreating. The reference cases are briefly described, including a block diagram with main overall mass and energy balances (Deliverable 1total, 2009).

Work package 2

A literature analysis has been conducted within the field of biomass-derived products in order to identify current and potential materials and chemicals. The analysis has been based on the composition of the raw materials of the selected reference cases within WP1, i.e. wheat, straw, potatoes, rapeseed, sugar beet, grass, wood, pulp & paper residues, food industry residues and agro residues. More than 300 chemicals have been identified that can be derived from a biorefinery and that are of interest. There is a relatively small number of 'key' chemicals that act as primary sources for families of chemicals and are, therefore, potentially of greater importance. These have a well established presence, well established infrastructure, and well established markets, which have been identified too. A literature and web analysis on current market prices and volumes of the materials and chemicals identified has been carried out. The longer-term potential market developments that directly affect the future market volume demand and market price of these products have also been roughly assessed (Deliverable 2total, 2010).

Work package 3

Work on biorefinery views and activities outside the EC have been conducted, comprising the analysis of conference proceedings, seminars, workshops, and websites on biorefinery-related information, including information from the IEA Task 42 on biorefinery. An internal workshop 'Knowledge import from outside EU on advanced biorefineries' was held in January 2009 in Osnabruck, Germany, with invited speakers from Japan, Brazil, and USA, sharing their views on the topic of biorefineries (Deliverable 3total, 2009).

Work package 4

Economic data, regarding the selected reference cases within work package 1, have been gathered by the project partners. These data, together with the data on mass and energy balances of the reference cases, have been used for a techno-economic assessment. In the next step, the results of work packages 1 to 3 have been used to define integrated biorefinery schemes for each selected biomass processing sector.

ECN developed a biorefinery cash flow model for modelling purposes within work package 4. Based on the mass, energy and economic data, the production costs of the main product of each selected sector for both the reference case, as well as for the integrated biorefinery schemes have been calculated (see Figure S-3). Also the IRR (Internal Rate of Return) and the payback time of each case have been determined. The objective is to evaluate to what extent the co-production of the added value products could enhance the economic competitiveness of the main product in the reference cases.

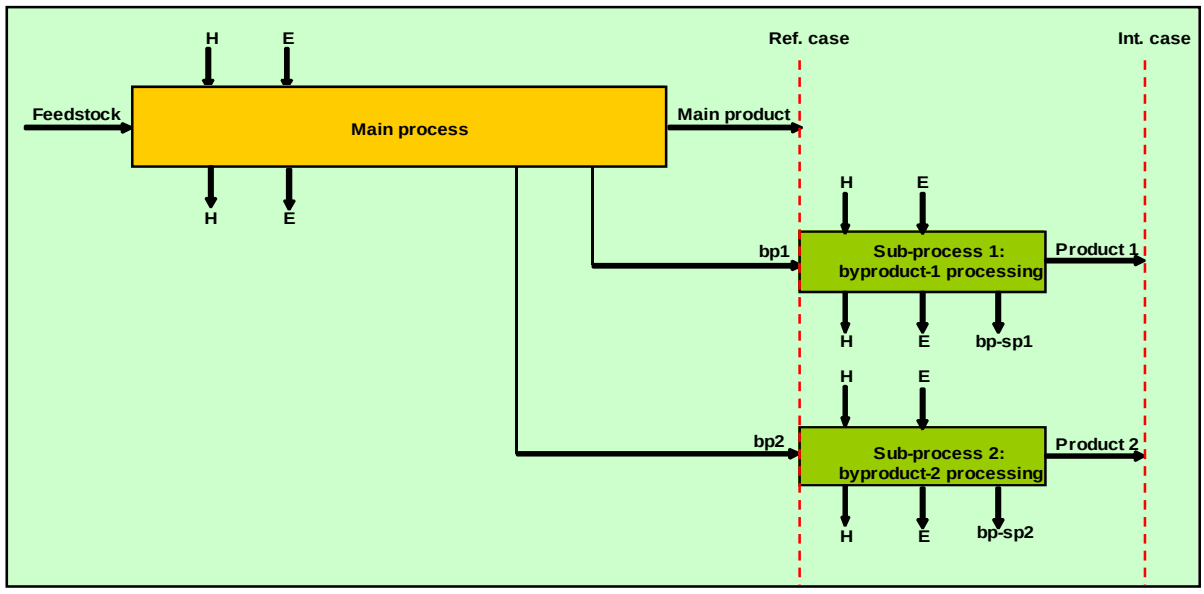

Figure S-3 *Block diagram for the ECN biorefinery cash flow model*

Work package 5

In work package 4, the Consortium has described and evaluated different reference and biorefinery cases for the 7 retained industrial sectors. The results obtained can be considered as 'objective', meaning that they are based on facts and figures gathered amongst sector specialists within and outside the Consortium.

In work package 5, the Consortium has analysed the more 'subjective' aspects of each biorefinery case. There are three steps in doing so:

1. Technical feasibility analysis: how feasible are the proposed processes?

2. Commercial feasibility analysis: are the commercial considerations (market prices, proposed volumes…) realistic?
3. SWOT analysis: what are the strong and weak points of each case? What are the underlying trends influencing potential success?

Next to the evaluation of the subjective aspects, this work package has also covered the cross-sector analysis. By aggregating all the results of different sectors, the Consortium has also tried to draw general conclusions on the addition of biorefinery cases to existing reference processes, including some recommendations (Deliverable 5total, 2010).

To assess the technical and commercial feasibility of the different cases, the Consortium chose to work with a questionnaire.

Statements and weight factors
In a first step, a set of criteria influencing the technical and commercial feasibility was edited as statements. These statements were assessed by the partners of the Consortium according to their importance. Based on the ranking made by the responding partners, each statement received a weight factor (Figure S-4). In both cases, the sum of the weight factors is 50.

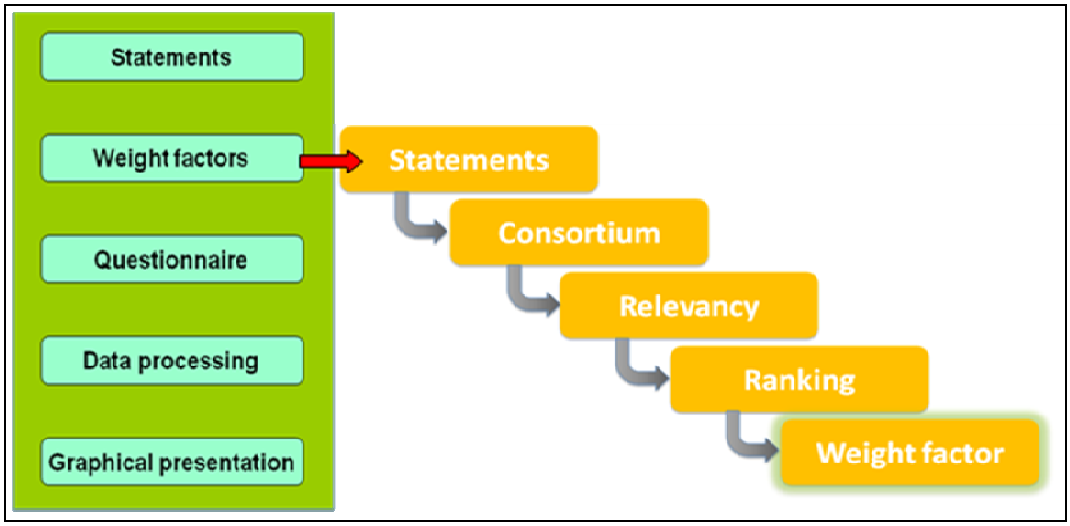

Figure S-4 *Methodology for evaluation of technical and commercial feasibility*

The statements influencing the technical feasibility have been clustered around the process development (required downstream processing, proof-of-concept, up scalability, safety and waste issues) and the applications development of the selected products issued from the biorefinery cases.

Similarly for the commercial feasibility, the statements have been clustered into project characteristics (how many new products/application combinations are proposed), market characteristics, competitive advantages, social & environmental impact, and regulatory impact.
Questionnaire
For each separate case a questionnaire has been filled in. Each statement has been answered as (= the score):

- I agree with the statement ➔ fill in '**2**'
- I'm neutral to the statement (or 'don't know') ➔ fill in '**1**'
- I disagree with the statement ➔ fill in '**0**'

Point of view: all statements were evaluated from the point of view of the state-of-the art of the technology/market, not from the perspective of a particular producer.

Technical and commercial feasibility calculation
The technical and commercial feasibility (TF and CF) has been computed as the sum of the products of the weight factor (WF) and the answer (A) for each statement.

$$TF \text{ or } CF = \Sigma(WF_i \times A_i)$$

As the sum of the weight factors is 50 and each statement could have a '0, 1 or 2' answer, the technical and commercial feasibility would vary between 0 (all answers are '0' or 'I disagree with the statement') and 100 (all answers are '2' or 'I agree with the statement'). For an easy understanding, the technical and commercial feasibility have been expressed in %.

Aggregate feasibility
For each biorefinery scheme, a questionnaire has been completed by different partners. The final feasibility score could be computed as the average score given by the respondents multiplied by the weight factor.

$$TF_{total} \text{ or } CF_{total} = \Sigma_i(\Sigma_j(WF_{ij} \times A_{ij}) / \#\text{ respondents})$$

where i = a particular statement and corresponding weight factor
j = a particular respondent

Overall feasibility
By multiplying the technical to the commercial feasibility, the overall feasibility of each biorefinery case could be obtained.

SWOT analysis
Together with the questionnaires on the technical and commercial feasibility, different partners gave also input on the SWOT (strength, weaknesses, opportunities, threats) analysis for each biorefinery scheme.

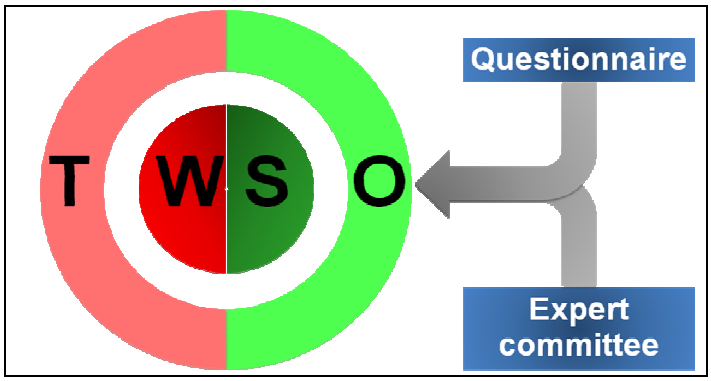

Figure S-5 *SWOT analysis*

All the comments have been brought together, clustered and summarised, to come with a comprehensive list of SWOT items. A lot of attention has been given in putting all comments in the proper SWOT category: S & W referring to the differentiating arguments for a biorefinery concept compared to the reference concept; O & T referring to the external trends affecting the biorefinery schemes. Together with the feasibility analysis, this SWOT completed the 'subjective' evaluation of the biorefinery cases.

Cross-sector analysis
Up to now each biorefinery case has been compared to the reference case and possibly other biorefinery cases within the same sector. In order to find out whether more general conclusions could be

drawn out of the Bioref-Integ project, it is necessary to also compare the different sectors to each other.

In a first step, each biorefinery case has been sorted according to the impact on the reference process to a low, medium, or a high impact case.

The major difficulty in comparing the different sectors is that the projects can have a totally different dimension. Also, as no subsidies have been considered in this project (subsidies are indeed highly versatile and different from case to case, from country to country), some projects could have a negative IRR. For all these cases, investment analysis doesn't provide elements to compare projects to each other. In an attempt to 'normalise' the different projects, the Consortium calculated the required sales price and corresponding difference compared to the actual sales price to obtain an IRR of 20%. This has been done for all cases, including the reference cases, and made comparison of projects to each other possible.

Finally, with this additional information on all projects, the Consortium made an attempt to look for correlations and trends between the impact levels / required sales price for IRR @ 20% and the technical and commercial feasibility.

Results

For each of the considered biomass processing sectors 1 to 2 reference case(s), and up to 3 integrated biorefinery cases are defined. This has resulted in 10 reference cases and 14 integrated biorefinery cases, as presented below:

1. Bioethanol: The reference case is a conventional grain-to-ethanol plant, with the following 2 integrated cases:
   1.1. Lactic acid production from C6 sugars;
   1.2. Ethanol production from DDGS via AFEX pretreatment.

2. Biodiesel: A rapeseed-based transesterification process is the reference case, with 2 integrated cases to be:
   2.1. Production of 1,3-propanediol from glycerol;
   2.2. Production of epichlorohydrin from glycerol.

3. Pulp & paper: The reference case is a chemical pulp mill with three integrated cases:
   3.1. Lignin extraction from black liquor;
   3.2. DME production via black liquor gasification (BLG);
   3.3. Ethanol production from softwood pulp.

4. Conventional oil refinery: The reference cases consist of 2 sub processes of a conventional oil refinery: the Fluid Catalytic Cracking process (FCC) and the Hydrodesulfurisation process (HDS). The integrated cases are:
   4.1. Vegetable oil as partial feed of FCC unit;
   4.2. Vegetable oil as partial feed of HDS unit.

5. Power production: The medium-scale reference case is a conventional CHP power plant fuelled with peat or biomass. For large-scale power plant an IGCC fuelled with biomass is considered. The following integrated cases are defined:
   5.1. Pyrolysis integrated in CHP;
   5.2. Chemical recovery in gasification process.

6. Food industry: The reference case for food industry is taken from the dairy sector, more specifically from cheese manufacturing, and the considered integrated case is:
   6.1. Lactic acid production from whey.

7. Agro sector: Finally, two reference cases are considered for the agro sector. The first reference case is a sugar beet refinery. The second reference case is a CHP system based on anaerobic co-digestion of grass and manure. The integrated cases for this sector are:
   7.1. Decentralised sugar beet biorefinery;
   7.2. Grass biorefinery.

The calculated cost of main product in each sector for 10 reference cases and the related 14 integrated biorefinery cases are presented in Table S-1. For comparison, the market price of main product in each sector is presented too. The colour codes used in Table S-1 are:

- **Black** for reference cases;
- **Green** for improvement compared to reference;
- **Red** for worse compared to reference.

Table S-1 *Main product costs and related current market prices*

	Case	Current market price	Main product cost
1	Bioethanol:reference	€800/T	€628//T
1.1	Bioethanol: lactic	€800/T	€368/T
1.2	Bioethanol: AFEX	€800/T	€577/T
2	Biodiesel: reference	€700/T	€726/T
2.1	Biodiesel: PDO	€700/T	€732/T
2.2	Biodiesel: ECH	€700/T	€668/T
3	Pulp & paper: reference	€500/T	€398/T
3.1	Pulp & paper: lignin	€500/T	€347/T
3.2	Pulp & paper: DME	€500/T	€367/T
3.3	Pulp & paper: ethanol	€500/T	€586/T
4a	Refinery: reference FCC	n.a.	n.a.
4.1	Refinery: vegetable oil FCC	n.a.	n.a.
4b	Refinery: reference HDS	n.a.	n.a.
4.2	Refinery: vegetable oil HDS	n.a.	n.a.
5a	Power: reference CHP	€50/MWh	€60/MWh
5.1	Power: CHP/pyrolysis	€50/MWh	€88/MWh
5b	Power: reference gasification	€50/MWh	€74/MWh
5.2	Power: gasification/chemicals	€50/MWh	€48/MWh
6	Food: reference	€2250/T	€1916/T
6.1	Food: lactic	€2250/T	€1441/T
7a	Agro: reference beet	€400/T	€329/T
7.1	Agro: decentralised beet	€400/T	€252/T
7b	Agro: reference grass	€50/MWh	€177/MWh
7.2	Agro: grass biorefinery	€50/MWh	€171/MWh

Figure S-6 shows the technical vs. commercial feasibility for all biorefinery schemes studied in Bio-ref-Integ. The chart is divided in 4 quadrants with axis crossing set at the average feasibility for the whole set of cases evaluated within this project, being 71%, both for technical as commercial feasibility.
The green area covers the zone with overall feasibility above par, the red below par.

Out of this graph, the following conclusions can be made per sector:

- **Bioethanol:** both retained cases are overall below average feasibility;
- **Biodiesel:** the two cases are in the top right quadrant of high feasibility;
- **Pulp & Paper:** three cases from neutral to above average;
- **Conventional oil refinery:** both cases technically well feasible, but commercially borderline;
- **Power generation:** both cases are underperforming regarding both technical and commercial feasibility;
- **Food:** the retained biorefinery case is below average on both feasibilities;
- **Agro:** this is the only sector with a positive (decentralised beet plant) and negative (grass biorefinery) case.

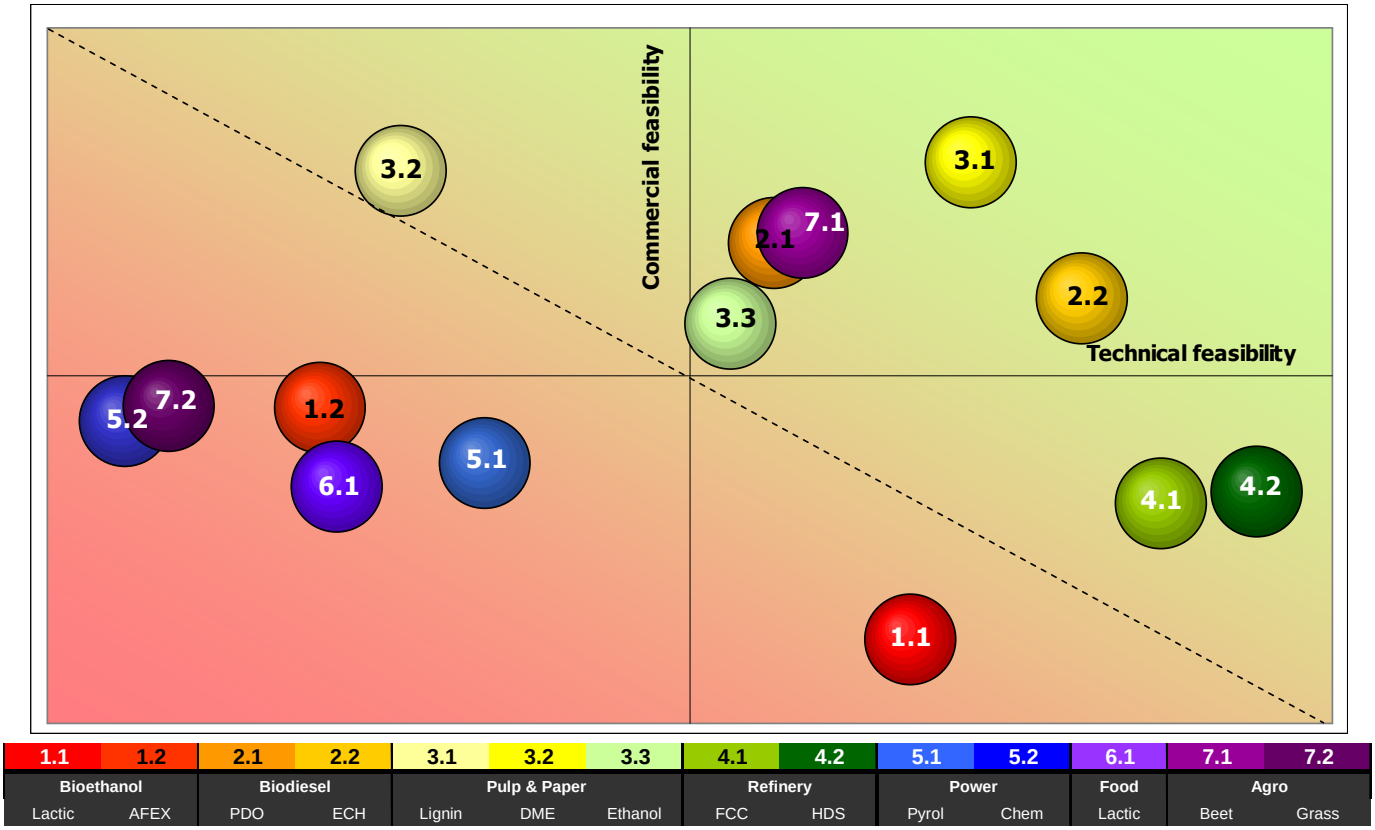

Figure S-6 *Graphical representation of the technical, commercial and overall feasibility*

Table S-2 gives a complete overview of the discriminating criteria for each reference and corresponding biorefinery case(s).

Colour code:	Subjective criteria;	**Green**: above average
		Orange: average
		Red: below average
	Objective criteria:	**Black**: reference cases
		Green: improvement compared to reference
		Red: worse compared to reference.

The new target sales price for an IRR of 20%, as well as the related percentage change versus market price are presented as objective criteria. For the refinery cases the IRR analysis could not be done, as no extra investment was needed and the operating cost in all cases was higher than the reference case. The required sales price for an IRR of 20% can be considered as a target for sales teams or as a combination of the market price and possible subsidies (subsidies have been discarded in this project due to their regional specificity).

Looking at the projects from this perspective gives a slightly different view than the product cost analysis as done in work package 4, with results presented in Table S-1.

Table S-2 *Subjective and objective criteria*

	Subjective criteria			Objective criteria	
	Impact level	Technical feasibility	Commercial feasibility	New target sales price (for IRR 20%)	% change vs market price (for IRR 20%)
Bioethanol: reference				€775/T ethanol	-3%
Bioethanol: lactic	Low	78%	56%	€545/T ethanol	-32%
Bioethanol AFEX 80	Medium	60%	69%	€710/T ethanol	-11%
Biodiesel: reference				€765/T biodiesel	9%
Biodiesel: PDO	Low	74%	79%	€815/T biodiesel	16%
Biodiesel: ECH	Low	83%	75%	€735/T biodiesel	5%
Pulp & Paper: reference				€630/T pulp	26%
Pulp & Paper: lignin	Low	80%	83%	€550/T pulp	10%
Pulp & Paper: DME	Medium	62%	83%	€710/T pulp	42%
Pulp & Paper: ethanol	Medium	72%	74%	€990/T pulp	98%
Refinery: reference FCC				n.a.	n.a.
Refinery: veg. oil in FCC	High	86%	64%	n.a.	n.a.
Refinery: reference HDS				n.a.	n.a.
Refinery: veg. oil in HDS	High	89%	64%	n.a.	n.a.
Power: reference CHP				€150/MWh	200%
Power: CHP/pyrolyse	High	65%	66%	€185/MWh	270%
Power: reference gasification				€110/MWh	120%
Power: gasification/chemicals	High	53%	68%	€200/MWh	300%
Food: reference				€2.250/T cheese	0%
Food: lactic	Low	60%	65%	€2.050/T cheese	-9%
Agro: reference beet				€430/T sugar	8%
Agro: decentralised beet	High	75%	79%	€385/T sugar	-4%
Agro: reference grass				€280/MWh	460%
Agro: grass biorefinery	High	55%	69%	€330/MWh	560%

Bioethanol:
Both bioethanol cases are an improvement compared to the reference case. This can give an edge to bioethanol producers, to preserve a sustainable profitability in case of fluctuations in feedstock price and crude oil benchmark.

Biodiesel:
For biodiesel, the cases are only dealing with a better –integrated- valorisation of glycerol. Depending on the case, this can improve the overall profitability of a biodiesel plant.

Pulp & Paper:
Here we have a first discrepancy between a simple cost calculation and a targeted investment analysis: the DME case reduces the pulp cost, but the profitability –with the current assumptions- is worse than the reference case.

Power generation:
None of the proposed biorefinery cases are improving the profitability of the reference cases. The targeted investment analysis revealed that even in the gasification/chemicals case, a lower product cost compared to reference case is not sufficient for a profitable process.

The message for thermal treatment of biomass seems to be double:

- Next to electricity, it is recommended to have a valuable outlet for heat;
- Keep it simple! Making the downstream complex does not improve the profitability.

Food:
Simple case, in correlation with the cost analysis.

Agro:
Especially for the grass biorefinery, the recommendations of the Power sector are valid: simplicity is the message. Alternatively, increasing the amount of products extracted from grass at the expense of electricity can also improve the picture.

Based on Table S-2, in many cases there is some concordance between the impact level and the targeted investment analysis: a low impact project tends to be more profitable. There is also a reasonable correlation between the technical feasibility and the economical value. However, there is surprisingly no correlation between the commercial feasibility and the economical value: data may look attractive, but the challenges may be big. This tends to prove the added value to incorporate such a feasibility analysis to more conventional objective return on investment analysis.

Finally, some projects have been clustered and compared to each other, as shown in Table S-3. The project clusters are:

- Co-product valorisation projects: biodiesel: PDO, biodiesel: ECH, pulp & paper: lignin, food: lactic;
- Co-production projects: bioethanol: lactic, pulp & paper: ethanol, agro: decentralised beet;
- Fermentation projects: bioethanol: lactic, bioethanol: AFEX 80, biodiesel: PDO, pulp & paper: ethanol, food: lactic, agro: decentralised beet;
- Power generation projects: CHP/pyrolysis, gasification/chemicals, grass biorefinery;
- Thermal treatment projects: pulp & paper: DME, power: reference CHP, power: CHP/pyrolysis, power: reference gasification, power: gasification/chemicals;
- Legislation-driven projects: refinery: vegetable oil in FCC, refinery: vegetable oil in HDS.

The first three clusters of projects are mostly low impact projects, have average or higher technical and commercial feasibility, as well as a good economical value. On the other hand, the last three clusters of projects are mostly high impact projects, have lower to average technical and commercial feasibility, as well as a poor economical value. In case of legislation-driven projects, both selected projects have a high technical feasibility. Commercial feasibility however is below par, fully explained by the higher cost and the lack of technical benefits (as perceived by some respondents). This score has to be put into the right perspective: our model gives a lower weight to legislative support compared to price and technical benefits. Seen the directive character of the legislative support for these projects, this should be opposite.

Table S-3 *Cross-sector overview against average*

Project type	Impact level	Technical feasibility	Commercial feasibility	Return on investment
Co-product valorisation	Low	Higher	Higher	Higher
Co-production	Low/Med/High	Higher	Average	Higher
Fermentation	Low/Med	Average	Average	Higher
Power generation	High	Lower	Average	Lower
Thermal treatment	Med/High	Lower	Lower	Lower
Legislation-driven	High	Higher	Lower	Lower

Conclusions

- 366 existing industrial (fuel producing) complexes in partner-related countries have been identified, and 10 market-specific reference cases have been defined.
- Based on the results of WP1, WP2, and WP3, 14 integrated biorefinery cases for 7 considered biomass processing sectors have been defined within WP4.
- Integral technical and economic system assessments of defined biorefinery schemes have been performed within WP4.
- In WP5 the Consortium tried to analyse the different biorefinery cases according to both objective (profitability measurement) and subjective (technical and commercial feasibility; SWOT analysis) criteria.
- The technical and commercial feasibility, as well as the SWOT analysis were measured by a questionnaire filled in by experts within the Consortium.
- Regarding Technical Feasibility, major deviation from the average are related to process development (proof-of-concept, scalability…). Application development (referencing new products in the market) are mostly considered as less critical.
- Concerning the Commercial Feasibility, not surprising, the tangible competitive advantages (cost, price, technical benefits) are key success factors. The other key determinant, the perception of the products, processes… by the consumers is generally speaking scoring rather high for all projects. A good point for 'bio-based economy' projects as studied in Bioref-Integ! But this makes the perception criteria less discriminative for the different projects.
- The objective criteria used are related to investment analysis. In WP5 we proposed a 'targeted investment analysis'. In a similar IRR calculation model as used in WP4, we computed the required sales price for the main product to reach an IRR = 20%. This gives a better perspective to compare the different projects to each other.
- Another new parameter is the 'impact level': how deep will a biorefinery concept affect the reference process. We clustered the biorefinery projects in 3 groups: low, medium and high impact.
- Out of our study, there is a positive correlation between the technical feasibility and the economical value (measured as targeted sales price for IRR=20%). Low impact projects are also leading to a higher economical value.
- The commercial feasibility has no correlation with the economical value. It should be considered together with financial analysis to make an educated decision on biorefinery schemes.
- Projects involving thermal treatment of biomass (CHP, pyrolysis, gasification) are clearly still immature and not yet industrially feasible. This appears clearly in a low technical feasibility and a negative economic value.
- Power generation (electricity from biomass) projects also have a negative evaluation (subsidies were not taken into account!). This is of course in line with the comments on thermal treatment, as frequently the same technology is used. The message to electricity-from-biomass projects is: find a value application for heat and … keep it simple or … change focus and produce products from biomass.
- Biorefinery projects that have the potential to improve the economics of reference cases are low impact projects (no significant impact on the reference process), fermentation projects and co-product valorisation projects. These projects frequently also have an above average technical and commercial feasibility score.
- Finally, legislation is an important factor, driving the use of bio-based feedstock (see biofuel directive) or supporting directly biorefineries by several subsidy incentives.

Bioref-Integ newsletters, public reports and presentations

Deliverable 1total (http://www.bioref-integ.eu/publications/): *Identification and mapping of existing fuel producing industrial complexes in Europe*. Deliverable lead contractor: ECN, January 2009

Deliverable 2total (http://www.bioref-integ.eu/publications/): *Identification and market analysis of most promising added-value products to be co-produced with the fuels.* Deliverable lead contractor: Aston University, May 2010

Deliverable 3total (http://www.bioref-integ.eu/publications/): *Biorefinery-based Knowledge Import from outside the EC*. Deliverable lead contractor: WUR Food and Biobased Research (A&F), December 2009

Deliverable 5total (http://www.bioref-integ.eu/publications/): *Technology deployment plan.* Deliverable lead contractor: VFT, April 2010

Final report (http://www.bioref-integ.eu/publications/): *Development of advanced biorefinery schemes to be integrated into existing industrial (fuel producing) complexes.* Deliverable lead contractor: ECN, May 2010

Internal Workshop (presentations: http://www.bioref-integ.eu/publications/): *Knowledge Import from outside EU on Advanced Biorefineries, 29th January 2009, Osnabruck, Germany*

Public Workshop (Presentations: http://www.bioref-integ.eu/publications/): *Preliminary results assessments and innovative biorefinery concept*. 2nd December 2009, Solihull, UK

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