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Feasibility studies for first of a kind commercial sustainable biofuel projects: A guidance document

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A consortium led by

E4tech (UK) Ltd

with

Biochemtex SpA,

BTG Biomass Technology Group BV

and

Consorzio per la Ricerca e la Dimostrazione sulle Energie Rinnovabili (RE-CORD)

E4tech Strategic thinking in sustainable energy

biochemtex

btg biomass technology group

RE·CORD

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Authors	Luca Bertuccioli (E4tech) Lucy Nattrass (E4tech) Claire Chudziak (E4tech) Sébastien Haye (E4tech) Ausilio Bauen (E4tech) Patrick Reumerman (BTG) Martijn Vis (BTG) Renato Nistri (RE-CORD) David Chiaramonti (RE-CORD) Stefania Pescarolo (Biochemtex) Valentina Tito (Biochemtex)

E4tech (UK) Ltd
83 Victoria Street
London SW1H 0HW
UK

Tel: +44 20 3008 6140
Fax: +44 20 3008 6180

Incorporated in England and Wales
Company no. 4142898
Registered address:
60-62 Old London Road
Kingston upon Thames, Surrey, KT2 6QZ
www.e4tech.com

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List of Acronyms

1G	First Generation (biofuel)
2G	Second Generation (biofuel)
AACE	The Association for the Advancement of Cost Engineering
AR	As received
BAT	Best Available Techniques
BREF	Best Available Technology Reference documents
CHP	Combined Heat and Power
CO_2	Carbon dioxide
CoC	Chain of Custody
DME	Di-methyl ether
DSCR	Debt Service Coverage Ratio
EC	European Commission
EIA	Environmental Impact Assessment
EPC	Engineering, procurement and construction
EU	European Union
FQD	Fuel Quality Directive
FT	Fischer-Tropsch
GHG	Greenhouse Gas
h	Enthalpy
IED	Industrial Emissions Directive
ILUC	Indirect Land Use Change
IRR	Internal Rate of Return
kt	1000 tonnes
M€	Million Euros
MS	Member State
MTBE	Methyl Tert-Butyl Ether
NDA	Non-disclosure agreement
NGO	Non-Governmental Organisation
NO_x	Nitrous oxide emissions
NPV	Net Present Value
O&M	Operation and maintenance
p	Pressure
RED	Renewable Energy Directive
RSB	Roundtable on Sustainable Biomaterials
SME	Small and Medium Enterprises
SO_x	Sulphur oxide emissions
SPV	Special Purpose Vehicle
T	Temperature

1 Introduction

For many years, the European Commission has undertaken a number of initiatives to help support the development of sustainable and advanced biofuel plants in the EU, including through the 7th Framework Programme of Research and Technological Development, and more recently the Horizon 2020 programme.

However, the Commission has identified that since many technology developers are SMEs, they often face significant problems in undertaking feasibility studies to prove the reliability and financial viability of their projects. This may be because they do not have the experience in developing such studies and investors may not always well articulate the information they require, or the company may not have the right skills in house or the capacity to keep up to date with changing policy requirements.

In order to deal with this issue, it was decided that a template or guidance document should be developed that could assist project or technology developers in preparing a robust feasibility study that would stand up to the scrutiny of potential financiers and planning departments.

This document therefore provides guidance to technology and/or project developers across the EU, developing feasibility studies for first of a kind advanced biofuel projects, although it may also be useful at other stages of technology development. It should be noted that this document does not provide guidance on standard engineering practices common to all feasibility studies but instead focuses on the peculiarities associated with first of a kind advanced biofuel projects.

The structure and content suggested in this document are not intended to be prescriptive, since the scope, purpose and audience for a feasibility study may vary significantly between projects. As such, the level of detail required or even the sections included in the study, may differ between projects. The feasibility study will need to be tailored to suit the particular project, and this document does not provide guidance to cover every eventuality. However, all the elements outlined in this report should be considered at some point during the planning phases.

The aim is that through the use of this guidance, a feasibility study can be developed efficiently and thereby help reduce the cost of development of advanced biofuel projects, particularly for SMEs, and consequently facilitate the deployment of advanced biofuels in Europe.

2 Project Description

2.1 Introduction

The project description is the first section of the Feasibility Study and provides a high level overview of the proposed project. The scope of the project description is broad as it should include a description of the technology, market, value proposition and project delivery. However, the level of detail provided should be the minimum that allows the objective to be met. The specific contents may be selected based on the intended audience, for example the policy context and environmental and social benefits may be of interest to governmental organisations, agencies, and investment bodies acting on their behalf.

2.1.1 Objectives

The objective of the project description is to allow the reader to quickly:

- Understand the scope of the proposed project,
- Identify the unique characteristics of the project; what distinguishes the project from other projects being considered,
- Identify to whom the Feasibility Study may be relevant; and/or
- Understand the context of the Feasibility Study and therefore better follow the detailed text.

2.2 What information should be provided in the feasibility assessment?

Table 1: Project description contents

Contents	Description
Project outline	Describe what the project aims to achieve in one paragraph. This may include feedstock, conversion technology, scale, product(s), market(s), location, and intended timeframe to which the Feasibility Study is relevant.
Background	Provide details of the background and context surrounding the identification and definition of the project. This may include details of who has initiated the Feasibility Study, and the market opportunity which the project intends to address.
Project developer (and delivery team)	Clearly illustrate the proposed plant ownership structure, and provide details of the plant owners and/or investors, and key project delivery partners.
Process description	Define the advanced biofuel pathway (including feedstocks, conversion technologies, and products), and clearly define the project boundaries.
Location and site details	Proposed plant location(s) or options, and where relevant, details of the site which impact the deliverability of the project, for example

Contents	Description
	existing utilities, installations, infrastructure, and/or proximity to feedstock or downstream users.
Supply chain	Specify the different phases of the supply chain (an example is provided in the figure below). 
Project execution timeline	At a high level, outline the expected timing and duration for the different project stages. Key stages that should be covered are: 1. Project inception 2. Permitting 3. Engineering 4. Construction 5. Start-up 6. Full operation Define the key project milestones (for example completion dates for the most important tasks or project stages), and any stage gates (dates at which the viability of the project is reviewed and/or key decisions made). Indicate the status of the project at the time of execution of the feasibility study.
Impact assessment	Where the feasibility study is intended to support applications for grant funding or public sector funded debt, it may be necessary to include an assessment of the social and economic impacts of the project, including: • Impact on European policies: the potential contribution to national or European targets (e.g. RED and FQD), and alignment with strategic priorities (e.g. Renewable Energy Roadmap, Strategic Energy Technology Plan including the European Industrial Bioenergy Initiative priorities) • Jobs impacts: the number of jobs created or secured as a result of the project. • Other socioeconomic impacts: this may include an estimate of the total value of feedstock used by plant per year.
Definitions	Where relevant, provide a glossary of terms and/or acronyms.

3 Supply chain and market assessment

3.1 Introduction

The reliable supply of feedstocks and the uninterrupted sale of products are essential to the efficient operation of any manufacturing facility. For advanced biofuel plants, feedstock costs may represent a very large proportion of production costs, and first of a kind commercial plants may be proposing to use feedstocks for which there is no established supply chain, or an immature market. Revenue streams will be dependent on a robust route to market for the product(s), and a guaranteed or appropriately defined route to market is normally an important pre-condition for the financing of biofuel production plants. The feasibility study must therefore investigate diligently the feedstock supply chain and market for products. The assessment can be demanding in terms of the resource required, and it can be diligent to seek external expertise to complete such assessments.

The supply chain assessment includes the supply of all resources and materials consumed by the plant. For advanced biofuel plants the main consumable is the feedstock, and therefore this section focusses on the reliable supply of all feedstocks. Individual plants may have additional requirements relating to consumables (for examples enzymes, hydrogen, etc.) and therefore the supply chain assessment may be expanded as appropriate. The technical assessment will help to identify other key plant inputs. On-site feedstock handling and pre-treatment is included within the plant design and therefore discussed in the technical assessment (Chapter 4).

The market assessment should include all products of the plant, and should reflect the product quality at the plant gate.

The most appropriate process for completing the Feasibility Study will depend on the position of the organisation conducting the assessment in the value chain, their expertise and their access to data.

3.1.1 Objectives

The objective of the supply chain and market assessments is to:

- Define a robust and cost-effective feedstock supply, this includes identifying what type(s) of feedstock will be used, including key (physical and/or chemical) characteristics or specifications where appropriate, and necessary storage requirements
- Estimate feedstock costs and sensitivities
- Define supply chain logistics
- Characterise the market for the biofuels and co-products
- Define a route to market and pricing strategy

3.2 Feedstock supply chain assessment

3.2.1 What should it cover?

In the feedstock supply chain assessment, a number of questions need to be answered, such as:

- What is the feedstock demand (how much, what type, costs, etc.)?
- What are my logistical needs and how will that be taken care of?

- Who will be the suppliers? Or, in the case of many suppliers, how many suppliers will be contracted? What will be the typical contact terms?
- What position will the project have on the feedstock market once the plant is up and running?
- What will be the future outlook of feedstock supply in terms of costs and security/risks?
- Is the feedstock classified as waste, what are the implications of this and are measures required to decrease associated risks?

3.2.2 How should it be tackled?

The following elements should be addressed in the Feasibility Study:

3.2.2.1 Feedstock Availability

- Assess the required biomass (types, quantities) and where and when it should be available, including seasonal availability
- Perform a feedstock availability study to assess the availability of feedstocks (local, regional, international – as appropriate). The approach to understanding feedstock availability will vary by feedstock. For example:
    - For agricultural and forestry residues and other products produced as by-products of another industry, it may be possible to estimate the size of the primary market (e.g. area planted with cereals) and estimate the potential of the by-product based on yield of by-product per unit main product. It is then necessary to understand the extent to which the by-products are currently used or sold, i.e. the competing uses or markets for those products, from producers.
    - For wastes it may involve working with local authorities or waste management companies to gather a detailed understanding of availability and whether it is possible to gain access to the material, or if there are long term contracts in place that limit the possibility to access the material.
- In all cases it may be necessary to work with experienced market experts to identify the local markets, particularly to understand the existing/competing use or treatment of the feedstock.
- Match availability with the required quantities and expand the survey area if needed.

3.2.2.2 Supply (suppliers and logistics)

- Perform a market survey of feedstock suppliers at an appropriate scale for the key feedstocks that will be used at the plant. It will be important to better understand the relevant land ownership structure or industry structure in the region where the plant will be located in order to understand whether it will be important to engage with product aggregators or co-operatives (potentially representing hundreds of producers) or the producers themselves (in the case that there are a relatively small number of large producers). In the case that suitable actors are not in place, it may be necessary to engage further in the development of the supply chain. This will likely require the involvement of experts with experience in dealing with small scale producers and aggregating their supply. The *feedstock characterisation* and *supplier profile* templates in Table 12 and Table 13 of

Appendix 1 may be useful for documenting information relevant to the case study. In all cases it remains important to have up-to-date and in-depth knowledge about the feedstock market and the players. It may be advisable to hire an external expert, who is familiar with the specific target feedstock market that you are aiming to source from.

- Identify options for transporting feedstock to the site, and estimate the associated cost and any infrastructure development or investment required. The *logistics and pre-treatment* template (see Table 14 of Appendix 1) may be useful for this purpose.
- Define a preferred supply chain, this may include potential partners/suppliers and, where possible, preferred suppliers – this assessment may be informed by the impact on initial investment, delivered cost, and/or risk profile.
- Dependent on the stage of the project, it may also be possible to obtain Letters of Intent or supply contracts from suppliers.

3.2.2.3 Feedstock cost

Feedstock costs are often one of the most significant and uncertain elements of an investment case. Therefore it is important to make a realistic estimate of the current delivered price of feedstocks, which reflects competing markets. In some cases the feedstocks will not be traded materials and therefore understanding the opportunity cost, or cost associated with collection and supply may be necessary. Care should be taken at all times to specify feedstock prices at a defined moisture content. In this document, we refer to the feedstock at the moisture content at which it is received from the supplier (as received, AR), unless otherwise specified. Moisture content will vary depending on the type of feedstock, time of year, supply chain, and so it is important to ensure that the feedstock can be supplied consistently at the moisture content assumed for your process. The assumed moisture content should be defined at all relevant times to avoid any element of doubt or confusion.

Determining the price for waste or residue feedstocks can sometimes be challenging as a robust market may not currently exist for them, although this does not mean they do not currently have a use.

Approaches that can be used to estimate the feedstock cost include:

- Review any available cost data for those feedstocks with current uses and note the sources of the price information, e.g. traders, producers, industry associations
- If appropriate, engage with feedstock producers to understand price expectations
- For agricultural residues that are currently not collected, the cost of replacing their current function (e.g., replacing the nutrients that they provide) plus the cost of collection and handling can give an indication of a minimum price. A mark-up should probably be included to make the collection worthwhile for the farmer.
- The process for agricultural residues can be applied more generally to any waste streams: namely add the cost of replacing any useful functions the streams currently provide, the cost of collection, handling and processing and a mark-up.
- Benchmark prices for energy commodities (e.g., wood chips) can sometimes provide a useful comparison point if compared on an energy basis.

Future prices will also need to be estimated throughout the life of the plant. Factors which will influence the cost of feedstock in the future should be identified, as these will impact feedstock supply contracts. It is likely that a different approach to contracting will be required for different types of feedstock.

For the purposes of the financial analysis, one method of estimating future prices is simply to inflate current prices using relevant price indices. However, for wastes and residues, particularly those that do not currently have markets, it is recommended that the potential impacts of the increased demand caused by the project might have on the price be considered. As a simple example, waste streams that may currently generate a cost for their disposal are unlikely to remain a negative cost commodity if an alternative, economically profitable use becomes available.

One further consideration is whether the form in which the feedstock is likely to be delivered to the plant gate is exactly the form in which it is required by the process. For example, will the feedstock be delivered in round bales when square bales are required for storage or transport? Is there a risk of foreign bodies (e.g. stones) in the feedstock that may be problematic for the machinery to deal with? Whilst it may be difficult to pre-empt many of these issues, attempting to anticipate any additional pre-processing that may be required and the associated costs will be beneficial in the long run.

3.2.3 What information should be provided in the Feasibility Study?

The table below summarises the information that will need to be gathered (left column) in order to provide the information that should be provided in the feasibility study (right column). The output tables in Appendix 1 may be a useful inclusion in the feasibility study.

Table 2: Data requirements for feedstock assessment

Input data	Output for Feasibility Study
• Feedstock specification based on the technical design: type of feedstock, quantity, physical and chemical characteristics (e.g. sugar content, lignin content), process sensitivity/tolerable limits • Plant location and local transport modalities available (roads, rail, waterways) • Locations of potential feedstock sources • Feedstock costs: Market prices, or prices paid for proxy feedstocks, costs of collection and disposal	Feedstock • Feedstock types • Feedstock quantities (tonne$_{AR}$/year) • Costs of feedstock (Euro/tonne$_{AR}$) (min/max) • Cost of feedstock (€/y) (min/max) • Cost of logistics (including pre-processing) (€/y) • Total cost of feedstock supply • Future feedstock prices and sensitivities: price estimates (where available), in the majority of cases this is unlikely to be readily available and therefore the market factors that may impact the future price of feedstock

	should be documented to inform scenario analysis (financial assessment) Suppliers • Preferred supplier name(s) • Quantities supplied • Willingness to enter into long term contract • Supply contracts terms (where available) e.g. duration and price mechanisms, quality specifications • Details of logistics: options for feedstock collection, transport, delivery and storage, and costs, and any requirements for additional infrastructure

3.2.3.1 Further considerations

In almost all cases, security of supply is an essential element of a biofuel feasibility study. To decrease risks with respect to the feedstock supply a number or strategies can be applied, such as

- Entering into long-term supply contracts
- Obtaining feedstock from several suppliers
- Including a feedstock supplier as a shareholder in the biofuel project (vertical integration)
- If possible, increasing the types of feedstock that are suitable for the process, e.g. by including pre-treatment equipment in the plant design.

3.2.4 Useful resources

3.2.4.1 Standards

There are a number of fuel quality standards for biomass available. Fuel quality standards are not mandatory, but can be of use in contracts with suppliers to have a common set of references.

Well-known standards are the ISO 17225 standard on solid biofuels - Fuel specifications and classes for all types of solid fuels such as wood and non-woody pellets and chips. Other relevant standards deal with the measurement and sampling of wood fuel quality (moisture content, calorific value)[1]. These standards can provide a common framework between biomass traders, and provide guidance to all parties in the supply chain.

[1] See the ISO site for an overview:
http://www.iso.org/iso/home/store/catalogue_tc/catalogue_tc_browse.htm?commid=554401

Alternatively, there are many classifications in use in certain regions or business areas, such as the Austrian Önorm M7133, and the Dutch classification of waste wood. These and other standards are not obligatory, but parties in the supply chain can use these at their discretion.

For the treatment of waste, the EURAL list[2] is an important way of classifying of waste, which may be necessary for transport, permitting, etc.

3.2.4.2 External references

The following resources can help in the development of the feedstock supply chain strategy:

- Biomass characteristics: https://www.ecn.nl/phyllis2/

- Biomass standards: http://www.iso.org/iso/home/store/catalogue_tc/catalogue_tc_browse.htm?commid=554401

Biomass price and supplier information is notably difficult to obtain from independent sources. References that may help are:

- C.A.R.M.E.N. for German solid biofuel prices: http://www.carmen-ev.de/
- Argus biomass markets: http://www.argusmedia.com/Bioenergy/Argus-Biomass-Markets
- UK Biomass supplier database: http://www.woodfueldirectory.org/
- European Biomass Association: http://www.aebiom.org/

3.3 Market assessment

3.3.1 What should it cover?

A number of questions need to be answered for all the products from the plant. These are:

- What is the current potential market size for the biofuel and any co-produced bio-products?
- What are the expectations for the size of the market for the biofuel and any co-produced bio-products over the lifetime of the plant (e.g. the next 20 years)?
- Are there any barriers to market entry (regulatory, competition)?
- Who are the ultimate customers, and what is the benefit to them of using the product? This may, for example, include price or sustainability benefits
- How will fuel pricing be approached, and how will the price compare to fossil and renewable alternatives?
- How, when, and where can the products be supplied to market? What are the appropriate routes to market?
- What are the requirements regarding certifications and standards? How can the necessary certificates be obtained (procedure, costs and timeline)?

3.3.2 How should it be tackled?

The following elements should be addressed in the feasibility study. The tables in Appendix 2 may be useful in recording this information in the study.

[2] http://eur-lex.europa.eu/legal-content/NL/TXT/?uri=CELEX:32000D0532

3.3.2.1 Market size

An overview of the size of the market in the country of interest and the likely level of competition for that market is crucial. This will involve having an understanding of the following aspects:

- Total size of the market in which the product will compete. For a drop-in gasoline or diesel fuel this could be equal to total gasoline or diesel sales in the target market. For 2G ethanol, this could be equivalent to the uptake potential of the gasoline vehicle fleet, taking into consideration the differing ability of differently aged vehicles to use different blend levels of ethanol.
- Any regulatory targets in the desired market for which the biofuel will be eligible which therefore create a specific market with a size defined by the policy or regulation
- Current volumes of competing products produced in the target market
- Levels of imports of competing product to target market
- Other plants in the planning phase that may compete with the product

Based on this information, it should be possible to identify whether there are any barriers to market entry, in terms of the size of the target market or the level of competition.

3.3.2.2 Regulatory requirements

It is important to understand which fuel standards or other regulations must be met for access to market and understand any challenges to meet these requirements. This will help identify any regulatory barriers to entry.

It is likely to be necessary to ask for guarantees from technology providers that the fuel product will meet these specification. However, for first of a kind commercial plants, there may be issues regarding consistent product specification and therefore the technology provider may have difficulty in giving these guarantees. It is therefore important to understand this risk and account for it appropriately when agreeing terms with the technology provider.

3.3.2.3 Advanced biofuel price

Since the production cost of most advanced biofuels is currently higher than the price of the fossil counterparts that they are intended to replace, the price of advanced biofuels is, at least currently, necessarily connected to a policy framework. Having said this, some purchases of advanced biofuel are also driven by non-policy and non-financial motivations (e.g., for corporate and social responsibility reasons or for differentiation).

Determining the price for advanced biofuels is often quite challenging as many of the fuels are not yet present on the market and specific policy requirements for such advanced fuels are limited. In light of the uncertainty in the potential price for the fuel, it is important to assess the financial viability of the project under a range of price assumptions to ensure that the project financial performance is robust to variations in the fuel price.

Suggested approaches to estimating fuel price that should be considered in the analysis include:

- As a floor price, current biofuel prices and forecasts (e.g., 1G ethanol and biodiesel) adjusted for energy content can be used.
- The current premium for available advanced biofuel can be assessed by comparing traded advanced biofuel prices with equivalent 1G biofuel (e.g. comparing the prices paid for 1G and 2G ethanol). This premium can then be used to estimate future advanced biofuel prices by adding it to a 1G fuel price forecast.
- The buy-out price that a fuel producer would need to pay if they do not meet their advanced biofuel quota from any member state policy that includes such a provision can also provide a useful reference price (at the time of preparation of this report the only member state with such a policy was Italy).

Using the various reference prices, scenarios for advanced biofuel prices can readily be constructed that can then be used to test the robustness of the project financial performance.

3.3.2.4 Co-product revenues

Revenues from co-product streams other than the biofuel can contribute quite significantly to the financial performance of the project and should thus be carefully considered. The co-product streams could be, for instance, a specialty chemical stream or excess heat and/or electricity. The latter, for instance, can often be the case for lignocellulosic ethanol processes where solid residues from the distillation process are used to power an on-site energy plant that provides electricity and steam to the plant and exports excess electricity.

Prices paid for the co-products will need to be estimated. Electricity exports in particular may benefit from green-electricity premiums depending on the local regulations.

3.3.2.5 Route to market

It is important to consider the options for the route to market for the different products. Specifically, it is necessary to identify customers of the product and understand the benefit to them of using the product. This is likely to be compliance with regulation, but there may also be benefits in terms of environmental credentials. As such it may be desirable to certify the product with particular sustainability standard. The process and costs associated with doing so should be considered (see Section 6.3.4).

Appropriate terms should be defined for off-take contracts for all products. These should demonstrate or be in line with industry standards and/or evidenced by specific negotiations/offtake discussions. An outline pricing strategy (which takes into consideration alternatives to the customer) will be required for entering into any negotiations with potential customers regarding offtake.

3.3.3 What information should be provided in the feasibility study?

The required output for this part of the feasibility study should be a defined route to market for the biofuels and other products. The level of detail is dependent on the stage of the project; however for a bankable project, it is essential that contracts for the sale of the biofuels and co-products are established. The column on the left shows the type of data that will need to be gathered in order to develop the right kind of information for the Feasibility Study.

Table 3: Data requirements for market assessment

Input data	Output for Feasibility Study
• Information regarding product characteristics and quality, such as volumes, chemical/physical properties, compliance with relevant specifications or standards (biofuel, co-products) • Information on the production location(s) and available transport modalities for export of products • Identified target market(s) size • Transport logistics available • Information on typical biofuel contract terms • Details of sustainability standards and their associated costs and requirements • Product price • Details of the relevant national and European legislation for the promotion of biofuels. Project developers should be familiar with the legislation, the appropriate procedures and the political environment relating to these issues. For the risk assessment it is essential to know of any possible future alterations that may jeopardise the business case.	• Description of products (biofuel, co-products) • Characterisation of the market including size of target market (kt/y) and level of competition in the market • Potential barriers to market entry • Expected current and future prices paid for biofuel and co-products (€/t) (max/min) – this should take into consideration any government incentives that the fuel will be eligible to benefit from. However, attention should be paid to the duration of such incentives. • Outline strategy for route to market and understanding of the unique or key selling points for the products in the proposed markets • Details of potential routes to market (logistics), and associated costs (fixed and variable)

Several template output tables are provided in Appendix 2 to help summarise this information in a feasibility study; a *biofuel characterisation template* (Table 15), a *biofuel price template* (Table 16), a *market characterisation template* (Table 17), a *promotion template* (Table 18) and a *market assessment output template* (Table 19).

3.3.3.1 Further considerations

A key issue relating to the market assessment is the relevant national legislation for the promotion of biofuels. At present the size of the market for advanced biofuels in Europe is closely linked to European policy and the individual MS implementation. Understanding the political environment surrounding such policy and specifically the long term direction and risks is essential.

3.3.4 Useful resources

Data on current commercial biofuel prices

- http://www.argusmedia.com/Bioenergy/Argus-Biofuels

Other useful resources

- http://www.ebb-eu.org/
- http://europeanbiofuels.eu/
- https://www.concawe.eu/
- http://www.epure.org/

4 Technical Assessment

4.1 Introduction

The technical assessment is the part of the feasibility study that allows users to identify and present the necessary information relating to the technologies, feedstocks requirement, and site details, that are necessary to support other elements of the feasibility study and, in particular, the financial analysis. Typically, the feasibility study will involve some refinement of plant design but the extent to which this is required is case dependent. Depending on the structure of the project, it may be possible that some engineering design needs to be done as part of the feasibility study. Alternatively, some of this may exist already. This chapter does not describe how to do the engineering design but rather focuses on the elements of engineering design that are required to make an estimate of the scale of investment and also the suitability of the proposed plant at the proposed site.

As such, the technology assessment will require information about technology selection, plant construction and commissioning, operational requirements, and maintenance.

Where industrial partners are reluctant to share detailed technical or economic information, it is likely to be necessary for a non-disclosure agreement (NDA) to be signed in advance so that this sensitive information can be shared.

Three separate elements of the technical assessment are considered: the plant description and operating parameters; the engineering design; and the plant costs and operations management.

4.1.1 Objectives

The objective of the technical assessment is to describe the functional and physical layout of the industrial plant necessary to produce the defined products (output), and to determine the corresponding investment expenditures as well as the costs arising during the operational phase. To do so, it will be necessary to have an overview of the engineering of the site and of all the activities required to deliver the process inputs and outputs and of the necessary ancillary infrastructure.

4.2 Plant description and operating parameters

4.2.1 What should it cover?

The plant description and operating parameters are required for the feasibility study to demonstrate that the process will work at the proposed site and provide inputs of costs to the financial analysis as well as technical data to other elements of the feasibility study such as permitting and sustainability. As such, the plant description must describe all the main process steps for the industrial production of the biofuel, starting from the biomass reception, storage and handling to the production, storage and shipping of the biofuel. In order to have a complete list of equipment and inputs and outputs, the different process steps are divided into the main key processes or plant areas, and each need to be described in detail, including the material, and energy flows, and the equipment utilized in the specific key process. The co-products and effluents exiting from the plant along with all the possible connections with public networks (electric power, water, roads etc.) should also be identified, as this identifies equipment that is required for feedstock, product, effluent and co-product handling.

If possible, each key plant area should be described in terms of operating parameters, such as temperatures, pressures, flow rates and other variables specific to the process. This enables an integrated energy assessment and furthers the understanding of necessary equipment, energy inputs and associated costs.

4.2.2 How should it be tackled?

A detailed mapping of the plant should be undertaken in order to understand the different equipment requirements and operational costs. Process flow diagrams will be essential for this purpose. An understanding of infrastructure connections at the site (including transport) will also be relevant.

4.2.3 What information should be provided in the Feasibility Study?

The following list details information that will need to be gathered in order to understand site suitability and investment costs:

- **Plan of the key plant process areas**
  - Biomass storage and handling
  - Biomass pre-treatment
  - Process and conversion of different biomass streams
  - Chemicals storage (if any)
  - Product storage
  - Product purification (if any)
  - Power plant (if applicable)
  - Utilities
  - Waste treatment
  - Flue gas treatment
  - Office space
- First draft of **plot plan**
- **List of critical equipment in each of the key areas (excluding proprietary/patented technology solutions)**
  - Technical description of the equipment
  - Performance of equipment (lifetime, efficiency)
  - Process data sheets for equipment
  - Supplier of equipment
  - Profile of suppliers/partners (including reliability)
- If using micro-organisms, any containment requirements to be implemented
- **Process overview**
  - Process Flow Diagrams
  - Mass balance (total raw material consumption, total material output)
  - Energy balance
  - Energy integration assessment
  - Piping and instrument diagrams (if available)
- **Demand for utilities and utilities specification:**

  - Electricity – yearly overall consumption and consumption by plant area, expected costs
  - Heat – yearly overall consumption and consumption by plant area, specifications (T,p,h), expected costs
  - Water demand (if any) per unit of product biofuel
  - Natural gas demand
  - Steam demand (temperature, pressure, mass flowrate)
  - Utility lines for electric power, water, gas, wastewater (and emissions up to the point connecting with the public networks where possible)
- **Description and characterization of co-products**
- **Assessment of emissions and wastes**
  - Waste water treatment requirements
  - Could any of the waste streams be reused (i.e. for energy purposes)
  - Details of all wastes (e.g. ash, gaseous emissions) and their treatment/disposal
  - Provide:
    - A list of pollution sources
    - An emissions inventory
- **Transport layout,** indicating roads, railways and other transport facilities up to their point of connection with public networks (if possible)
- **Technical, safety and health and standard requirements**
  - Additional equipment required (if known at this stage)

4.3 Engineering Design

4.3.1 What should it cover?

The completeness or level of detail of the engineering design will vary depending on the purpose of the Feasibility Study and the stage of development of the project. The engineering design helps to determine the required investment expenditures as well as the costs arising during the operational phase. The minimum level of detail required of the engineering design is what is needed for the financial analysis and to provide information to the other elements of the feasibility study. Examples of this are the estimates operational maintenance (OPEX) and capital costs (CAPEX), mass and energy balances, emissions inventories, process inputs, and yields.

4.3.2 How should it be tackled?

The following steps should be taken to develop the necessary information on engineering design required for the Feasibility Study:

1. Rationale for technology used
   - Justification of technology choice for project - how does the proposed technology solution meet the specified requirements for the plant?
   - Evidence to back up expected performance (e.g. mass and energy balance, plant availability assumptions)
2. Site investigation
   - Review of equipment and utilities already available on site and which can be re-used
   - Consider physical plant access

- Consider infrastructure required for on-site storage, handling and processing of feedstock, chemicals and waste streams

3. Collection of basic design data
    - Technology developer's generic process design package for the proprietary technology to be used on site: This will specifically require clarity on assumptions related to assumed plant capacity[3] and expected conversion efficiency.
    - Feedstock requirement: define the volume and specification of feedstock(s) required. Where available or relevant you could also provide a summary of the composition of the assumed feedstocks such as (depending on process technology):
        - Chemical parameters (proximate and ultimate analysis)
        - Physical parameters
        - Max allowable as-received moisture content
        - Cellulose, hemicellulose and lignin content
    - Product Specification: provide an outline of the chemical and physical properties of product, and details of product quality compared with the relevant international standards.
4. Development of a site specific plant and process design – the level of detail will vary depending on the stage of development of the particular project. Considerations will need to be made for particularities of the site (such as infrastructure already available) and adjustments in the capacity of the plant (compared with the capacity defined in the generic process design package).
5. Schedule for design, procurement, construction and start-up.

4.3.3 What information should be provided in the feasibility study?

To develop the engineering design, the elements listed in the right hand column below are required. This will rely on gathering and/or developing the input data listed in the left hand column below:

Table 4: Data requirements for engineering design

Input data	Output for feasibility study
• Technology provider's baseline process design package • Generic process design basis: nameplate capacity, technology, feedstock, conversion efficiency • Existing utilities, infrastructure and equipment • Feedstock specification • Product specification	Site specific plant and process design, which enables an estimation of investment costs. Design will likely require development of process flow diagrams, mass and energy balances, equipment sizing and process inputs and outputs Schedule for design, procurement, and construction and start-up

[3] For example, annual operating hours, size of the installed equipment, constraints set by available size or O&M intervals of key process equipment, technical conditions of the plant, such as normal stoppages, down time, holidays, maintenance, tool changes, desired shift patterns and the management system applied.

	A project timeline that outlines timing and duration for the key project stages including inception, permitting, engineering, construction, start-up and operation

4.3.3.1 Further considerations

A first of a kind commercial plant must be integrated (both for energy and process) in order to optimize all the process parameters and to achieve an efficient management of mass and energy flows within the system.

A production programme should define the levels of output to be achieved during specified periods. The programme plan should consider that the plant will not operate at full capacity during the initial production operations, as gradual ramp-up in capacity will be required to address technical and commercial challenges, which may include adjustment in feedstock, labour and equipment.

4.4 Plant costs and operations management

4.4.1 What should it cover?

For this element of the feasibility study, the plant operational maintenance (OPEX) and capital costs (CAPEX) should be estimated. Maintenance should be considered as the amount of effort associated with the day to day requirement of keeping the physical plant in good operating conditions.

4.4.2 How should it be tackled?

Costs associated with plant development and operations need to be prepared at a level of detail appropriate for the feasibility study. Using the engineering design as a basis, they should be developed in accordance with industry standard practice.

4.4.2.1 Project capex

The accuracy of a CAPEX estimate is strongly dependent on the level of engineering that has been carried out. Depending on the stage of development of the project and the technology developer, a detailed plant design package may not be available. However, at a minimum a preliminary engineering design of the plant will be necessary to provide the CAPEX estimate. The level of fidelity of the cost estimate should follow industry standard practices. For instance, the AACE International Recommended Practice No. 18R/97[4] suggests that for a feasibility study it may be expected that the engineering, procurement and construction (EPC) cost estimate should have an accuracy of -30% - +50% (in line with a Class 4 estimate in the AACE classification).

All the requirements specified in the plant description and engineering design should be carefully costed. Particular topics that should be taken into consideration in estimating capital costs for the project are:

- Integration with the site including physical plant access, and access to utilities.

[4] http://www.costengineering.eu/Downloads/articles/AACE_CLASSIFICATION_SYSTEM.pdf

- Infrastructure required for on-site storage, handling or processing of feedstock.
- Infrastructure required for storage and handling of any process chemicals.
- Infrastructure required for storage and handling of any waste streams including waste water treatment.
- For brown-field projects, integration of the plant with existing facilities and the extent to which those facilities can be reused.

Other topics that are not strictly speaking directly tied to the CAPEX estimate but derive from the plant engineering analysis and are relevant for the financial analysis are maintenance costs and, in particular, scheduled maintenance intervals. The latter are critical in estimating a realistic plant utilisation factor and thus important to the financial analysis.

4.4.2.2 Operation and maintenance costs

Operation and maintenance costs (OPEX) refers to the fixed and variable costs associated with the operation of the plants. Both fixed and variable OPEX can be expressed as a percentage of capital costs based on typical experience, if they are not available as a bottom up estimate at this stage. Fixed OPEX items include labour, scheduled maintenance, routine component/equipment replacement (for boilers, feedstock handling equipment, etc.), and insurance. Variable OPEX items include replacement of faulty equipment and repairs, as well as feedstocks, other consumables, power, utilities and waste treatment.

4.4.3 What information should be provided in the feasibility study?

The following table shows in the right hand column the information that should be included in the feasibility study and in the left hand column, the data that will be needed to prepare those high level numbers.

Table 5: Data requirements for plant costs and operations management

Input data	Output data for feasibility study
CAPEX estimates should be based on specifications of the following (where available): • Plant equipment • Vehicles • Store equipment and furnishings • Laboratory equipment • Large IT systems (Hardware and/or Software) • Buildings • Spare parts • Licensing costs (upfront) • Land and site development costs • Instrumentation and controls, piping, civil, mechanical • Utilities connections • Indirect costs:	Total CAPEX (M€) Total OPEX (M€)

◦ Engineering & supervision ◦ Construction ◦ Contractors' fees ◦ Contingencies ◦ Permitting costs OPEX • Maintenance schedule and associated costs €/y • Personnel costs: €/y • Number of persons employed: # • Consumable materials: €/y • Electricity: €/y • Heat: €/y • Ash disposal annual cost: €/y • Other waste material disposal costs, e.g. waste water treatment: €/y • Raw materials €/t • Office space rental and utilities costs: €/y • Insurance costs: €/y	

4.4.3.1 Further considerations

As mentioned above, the typical level of accuracy required for cost estimates in a feasibility study is -30% - +50% in line with a Class 4 estimate according to AACE International Recommended Practice No. 18R/97[5]. For new plants, that are "first of a kind" it could be difficult to estimate the costs for the feasibility study and the cost of making estimate itself could be significant. Typically, the more time and money invested in estimating the cost of the plant, the more accurate the estimate will be. Initial studies will be relatively inexpensive and give the order of magnitude of the cost of the project. The range of accuracy may be as wide as -50% to +100%. By the final planning stages, the level of accuracy in the cost estimate should be in the range of -10% to +15%. But this accuracy comes at a price; the cost of getting this estimate can be up to 100x more expensive than the initial order-of-magnitude estimates.

[5] http://www.costengineering.eu/Downloads/articles/AACE_CLASSIFICATION_SYSTEM.pdf

5 Permitting

5.1 Introduction

Permits are required to build and operate in a particular location; planning permits are required to construct new plants and environmental permits are required to operate. Consideration of permitting at the feasibility study stage is crucial, as it can be an important cause of delays to a lead time which is already quite long (>2.5 years). Permitting procedures vary between EU countries. In some countries integrated permits are used that include construction and environmental permits, others require individual permits for each topic.

A review of permitting is a necessary element in any biofuel plant feasibility study, and is needed to assess the viability of the project, both for internal and external audiences. Permitting affects and is impacted by:

- Location selection
- Process design
- Financial assessment
- Risk assessment

Crucially, it is important to remember that permitting is usually more complex than meeting the formal legal requirements. In certain locations, there may be additional requirements or reports that need to be prepared, so early engagement with local people, associations and NGOs will be crucial in understanding the situation for the particular plant of interest. This early engagement can also help in forming a view of the likelihood of success of the permitting application process.

5.1.1 Objectives

The objective of this section of the Feasibility Study is to develop a strategy for obtaining the appropriate permits and permissions required to build and operate the first of a kind advanced biofuels plant.

5.2 What should it cover?

With respect to permitting, questions that need to be answered are:

- What permits are required, and what is the timeline for permitting?
- Who is the competent authority?
- What requirements will most likely be part of the permit and how can these be fulfilled in a cost-effective manner?
- Who are the relevant stakeholders and what are their concerns? (e.g. NGOs, local associations etc.)
- What sensitive issues are there regarding permitting, and what are the positions of relevant stakeholders on these issues?

- How do I communicate with relevant stakeholders regarding permits and permitting?
- What is the likelihood of success of the permitting process?

5.3 How should it be tackled?

Advanced biofuel plants face specific challenges in the permitting process: the technology is often new for competent authorities that have to determine permit requirements; legislation is not always adapted to these plants; the public could have reservations about an unknown new plant being built in their vicinity; and environmental groups sometimes have strong opinions about the feedstock used. This potentially results in long lead times causing delays in the whole project and additional costs that could ultimately endanger project feasibility. Therefore careful planning and management of the permitting process is essential.

When approaching the development of the permitting strategy, the following structure may help:

What permits are needed?

A list of likely permits are:

- Coherence with land use plan
- Planning permit
- Environmental permit
- Environmental Impact Assessment
- Integrated Emissions Permit
- Construction permit
- Operational permit
- Production permit
- Grid access
- Others, e.g. water effluent discharge, ground water extraction, Greenhouse Gas (GHG) permit, proximity to special areas of conservation or special protection areas

Further detailed information on these different types of permits is provided in Appendix 3.

The legal status of biomass as waste or not influences the permitting process (need for Environmental Impact Assessment) and several permit requirements like rules on receipt, registration and handling of waste. Moreover, if the feedstock input is regarded as waste, the plant owner has to apply end-of-waste criteria if the biofuel is to be classified as a product (and not a waste). The Waste Framework Directive (2008/98/EC) provides guidance on what substances should be regarded as waste or not waste. Agricultural and forestry biomass can generally be regarded as not being a waste (for permitting purposes). Whether a waste is hazardous or not depends on whether it is classified as explosive, oxidizing, flammable, irritant, harmful, toxic, carcinogenic, or corrosive, See Annex III of Directive 2008/98/EC.

It should be noted that for reporting the sustainability criteria associated with the biofuel, there may be a different description of what should be considered a waste. This will typically be decided at a member state (MS) level as the definition of a feedstock as a "waste" brings with it certain advantages or potentially access to policy incentives which are decided at a MS level. Furthermore, what may be considered a waste in one MS may have uses in another MS. The definition of waste can therefore be very location- (and even, time-) dependent. It is therefore important to check with the relevant authority in the MS responsible for administering incentives related to the use of renewable fuel, what the status for the different feedstock is.

The permits required and the competent authority for issuing the permits will depend on the country or potentially the region. Care should be taken to understand the permitting framework and to engage the competent authorities in good time.

Is an Environmental Impact Assessment needed?

Directive 2011/92/EU[6,7] describes which projects require an EIA to be carried out before an environmental permit can be provided to the project owner[8]. Annex I of the Directive lists categories of projects for which an EIA is required. Relevant for biofuel projects are:

- Category 2a: Thermal power stations and other combustion installations with a heat output ≥300MW;
- Category 6: Integrated chemical installations, i.e. those installations for the manufacture on an industrial scale of substances using chemical conversion processes.
- Category 9: Waste disposal installations for the incineration, chemical treatment[9], or landfill of hazardous waste[10]. ***Therefore, in cases where biomass that is qualified as hazardous waste is used, an EIA is required, regardless of the capacity of the installation***.
- Category 10: Waste disposal installations for the incineration or chemical treatment[11] of non- hazardous waste **with a capacity > 100 tonnes per day**. ***Many biomass plants fall under this category, as many biomass types are legally classified as waste.***

Annex II of 2011/92/EU lists categories of project for which competent authorities should evaluate whether an EIA is required. Categories relevant to biofuel projects[12] are:

- Category 3a: Industrial installations for the production of electricity, steam and hot water;
- Category 6a: Treatment of intermediate products and production of chemicals;
- Category 11a: Installations for the disposal of waste.

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6 On the assessment of the effects of certain public and private projects on the environment and

7 And Directive 2014/52/EU amending Directive 2011/92/EU, to be implemented in national law at the latest on 16 May 2017

8 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02011L0092-20140515&rid=1

9 As defined in Annex I to Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste (3) under heading D9

10 As defined in point 2 of Article 3 of that Directive

11 As defined in Annex I to Directive 2008/98/EC under heading D9

12 That would not already be included in Annex I

The European directive does not provide minimum capacities. However, national transcriptions of this directive could include capacity ranges. For instance in the Netherlands, installations with a capacity < 200 MW do not require an EIA evaluation.

Annex III of the Directive shows which selection criteria competent authorities should use to evaluate whether EIA is required and Annex IV shows what information should be included in the EIA, if an EIA is required.

Does the land use plan need to be changed?

Consider the existing land use plan for the proposed location of the site. Will the addition of the proposed facility result in a change in land use?

How are all needed permits interlinked (is a permit needed as input for another permit, is an EIA)?

The permitting process should be mapped out. This should be checked with the relevant authorities in good time. Try to get an insight into if and how the planning or permitting procedures may change during the project initiation phase and consequently if there are any specific dates or deadlines that may affect the permitting process.

What is the procedure time of each permit?

The amount of time taken for each permit to be processed can vary widely. The relevant permitting authorities may be able to advise on the types of things that are likely to hold up applications, if there are typically particularly busy times when permit processing will take longer. In addition there may be a requirement for a public consultation period, which can add significant time on to the processing of the permit. Talking to others with experience of establishing similar projects via the same permitting authorities may lead to relevant insights to the permitting process. Understanding these nuances at the stage of developing the permitting strategy will help make the strategy as realistic and accurate as possible and should facilitate in making the permitting process more efficient.

The permitting strategy should also take into consideration the time required to gather the information needed for each permit, which may in some cases be quite extensive (see Annex 3 for the typical information required for an environmental permit).

What is the lead time, e.g. the time between the application of the first permit and the irrevocable issuance of the last permit?

This high level picture will be important for the feasibility study but given the uncertainties in the planning process, it may be more useful to provide a range of shortest possible time, to longest possible time, with an expected time somewhere in between.

Who are the relevant stakeholders that need to be engaged?

Consideration of the positions of relevant NGOS and local interest groups is important as they may have an impact on the success of the permitting process. Therefore such stakeholders should be identified and engaged early in the permitting process to understand their concerns, and establish a dialogue with the aim of achieving a consensus position on contentious issues.

5.4 What information should be provided in the feasibility study?

The output for the feasibility study is a permitting strategy which lists the types of permits needed, the timeline, costs, and the communication strategy around sensitive issues. This is summarised in the column on the right in the table below. The column on the left summarises the type of data that will need to be gathered in order to understand which permits may need to be applied for.

A bankable project will have to include all the actual permits needed to construct and operate the plant.

Table 6: Data requirements for permitting strategy

Input data	Output for feasibility study
• Proposed location of plant • Ownership of land (rented/owned) • Proximity to special areas of conservation • Land use plan for proposed plant location • Existing land use of the site (including whether it is contaminated) • Materials to be used on site, produced on site and stored on site • Emissions from site to air, soil and water[13] • Expected smell and noise from the plant • Existing transport links to the site • Expected operating hours • Expected size of the plant • Overview of activities undertaken at the site • Whether any permits are already in place • Volumes of wastes and products produced on site • Understanding of positions of relevant	Permitting strategy: • Permits needed • Timeline for getting permits including any required stakeholder engagement periods • Costs associated with permitting • Identified potentially sensitive issues • Communication strategy around sensitive issues • A risk assessment of the likelihood of getting planning consent

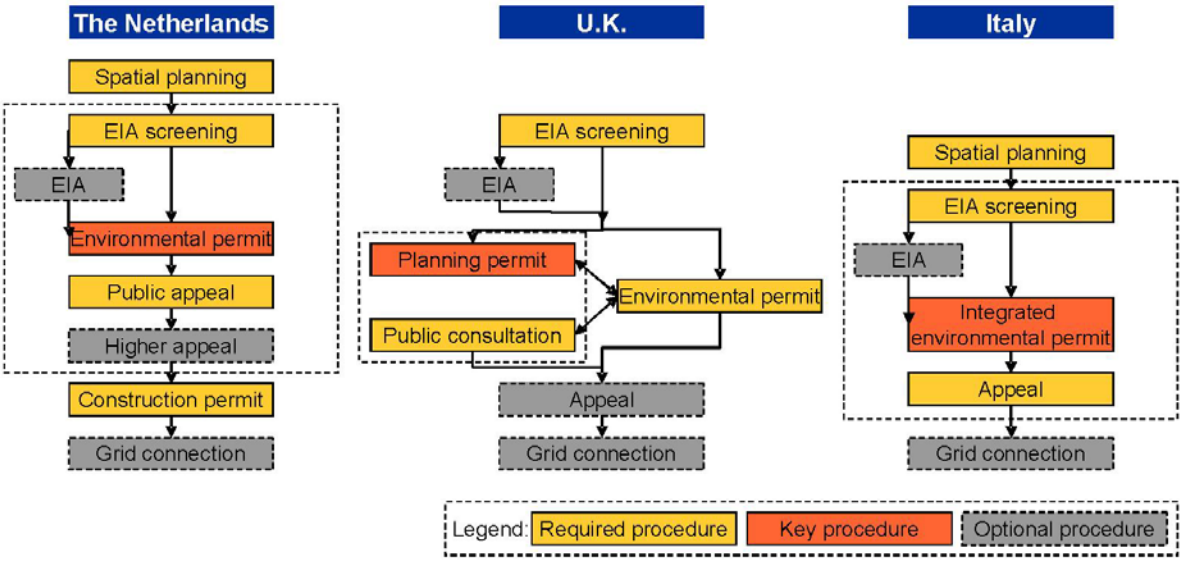
[13] The Industrial Emissions Directive 2010/75/EU provides general emission limits for the combustion and co-incineration plants that use biomass, non-biomass fuels and wastes. For a definition of biomass, see the Directive. Wastes need to meet stricter emission limits and monitoring regimes. Emission limits vary between countries.

stakeholders regarding the proposed project	

5.4.1.1 Further considerations

As mentioned earlier, permitting procedures vary between EU countries. Figure 1 shows simplified flow charts of permitting procedures in three different regions. In reality the picture is more complex than this as there may be additional requirements that are put in place as a result of concerns from particular stakeholder groups for example. Examples are taken from the Netherlands (typically representing the procedures in Belgium and Scandinavian countries), United Kingdom (representing all the British Isles) and Italy (representing also Germany and France).

Figure 1: Flow charts of typical order of permit procedures in the EU[14]



Regardless of the exact configurations, the permit procedure generally consists of the following steps:

- Pre-application activities, informal pre-discussion with authorities;
- Preparation and submission of application by operator;
- Receipt and initial check of application by competent authority;
- Consultation on the application with other authorities and the public;
- Assessment of application and determination of permit conditions;
- Issue of permit or notification of refusal;
- Possibilities to appeal to higher authorities.

[14] Ecofys and Golder Associates (2009) Benchmark of bioenergy permitting procedures in the European Union, for European Commission, DG TREN

A key issue with respect to the permitting process is the timeline. The lead time for biofuels projects is typically 2.5 years or more, and permitting is an important cause of delays. Legal issues such as appeals to permits may delay the project significantly. To avoid this, it is advisable to map sensitive issues regarding the permitting, and to engage with stakeholders early, before opinions have settled. The relative importance of certain stakeholder groups may vary between countries in Europe, and it is advisable to also investigate local circumstances early.

6 Sustainability

6.1 Introduction

Proving an advanced biofuels project meets particular sustainability criteria is essential. The Renewable Energy Directive 2009/28/EC (RED) and Fuel Quality Directive 2009/30/EC (FQD) provide some environmental requirements (land-use change and GHG savings) for transport fuels and bioliquids to meet biofuel targets, renewable energy targets or emissions reductions. Without proof that these requirements are met, biofuels cannot count towards volumetric quotas or emissions reductions objectives. Therefore, it is likely that at the feasibility study stage, you will need to undertake some work to understand whether the fuel being produced will meet the required sustainability criteria.

Some market players may aim to report higher level of sustainability assurance than required by the RED and FQD, e.g. by complying with additional socio-economic criteria included in certain voluntary schemes (see section 6.3.4). However, in this template we focus on the minimum land-use and GHG requirement that have to be met by all biofuel producers under the RED and FQD.

It should be remembered that, at the time of writing this report, sustainability requirements for biofuels in the European Union beyond 2020 have not been agreed and may differ to the current requirements. It is therefore important that a close eye is kept on policy developments relating to the sustainability requirements for biofuels beyond 2020.

6.1.1 Sustainability criteria

The RED currently specifies that the following environmental requirements have to be met by all biofuels used to 2020[15]:

- greenhouse gas savings relative to a fossil fuel comparator must meet the following criteria:
  - If the biofuel production plant starts operating before 1 January 2017, the emission savings should be >35%
  - If production starts after 1 January 2017 the emission savings should be > 50%
  - From 1 January 2018 the emission savings should be >60%.
- biomass is not obtained from land with high biodiversity value;
- biomass is not obtained from land with high carbon stock;
- biomass is not obtained from land that was peat land;

It should be noted that the final three "land-use criteria" do not apply to "wastes and residues, other than agricultural, aquaculture, fisheries and forestry residues[16]". Guidance is typically provided at a Member State (MS) level as to which feedstocks are considered wastes and processing residues,

[15] See RED article 17
[16] See RED article 17

although all the wastes and residues specifically mentioned in the RED are automatically considered as such across the entire European Union.

According to the provisional amendment to the RED (P8_TA-PROV(2015)0100)[17], there are further sustainability criteria that are relevant to advanced biofuels:

- “Advanced” fuels made from certain feedstocks are considered less risky in terms of “displacement” (indirect Land-Use-Change) and count double towards 2020 biofuel volumetric targets (10%).
- ILUC emissions have to be reported by fuel suppliers and the European Commission but are not taken into consideration for the required GHG savings calculation (however at present there are no default ILUC factors for advanced fuels so nothing has to be reported for these advanced fuels yet).
- A non-mandatory sub-target of 0.5% of transport energy should be supplied from advanced biofuels by 2020.

These environmental requirements are transposed into legislation in different MS through different national schemes and it is important to get a good understanding of the scheme in the country of interest, in particular traceability requirements (e.g. registration, product transfer documentation).

6.1.2 Objectives

The objective of this section is to determine the potential greenhouse gas savings to be expected from advanced biofuels and, if applicable, potential land-use change issues, to understand whether the biofuel complies with the aforementioned RED/FQD criteria.

GHG and land-use criteria must be met for the biofuel to meet the requirements of the RED and therefore count towards MS targets. In addition some funding organisations may have additional requirements in terms of sustainability performance. The most convenient route to demonstrate compliance with these requirements is the use of an EC-approved certification scheme (see section 6.3.4).

6.2 What should it cover?

With respect to sustainability, questions that need to be answered in the feasibility study are:

- What are the sustainability requirements for the project, including specific requirements in target member states?
- Are the GHG savings expected to be above the required thresholds?
- Would the biofuel be classified as an advanced biofuel?
- Which traceability system (Chain-of-Custody) should be put in place?

The sustainability assessment must cover all steps of the advanced biofuels supply chain, which includes feedstocks, processed materials and end-products.

[17] www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+TA+P8-TA-2015-0100+0+DOC+PDF+V0//EN

6.3 How should it be tackled?

6.3.1 GHG emissions

Regardless of whether the biofuel will be certified to a particular voluntary EC-approved standard (see 6.3.4), the GHG emissions savings associated with the biofuel must be calculated. There are two ways to estimate GHG emissions savings – “default” emissions savings or “actual value” calculations.

Default emissions savings can only be used if the advanced biofuel process has a default value associated with it in the RED, as shown in the right hand column below (see Annex V.B).

Table 7: Default emissions savings for advanced biofuels, taken from the RED

Biofuel production pathway	Typical GHG emission saving	Default GHG emission saving
Wheat straw ethanol	87%	85%
Waste wood ethanol	80%	74%
Farmed wood ethanol	76%	70%
Waste wood FT diesel	95%	95%
Farmed wood FT diesel	93%	93%
Waste wood FME	95%	95%
Farmed wood DME	92%	92%
Waste wood methanol	94%	94%
Farmed wood methanol	91%	91%
The part from renewable source of MTBE	Equal to that of the methanol production pathway used	

Even if the biofuel pathway does have a default value, there may be a benefit to calculating the actual emissions; the actual emissions may in fact be lower than the default and in certain countries, (e.g. Germany) where the legislation focuses on a GHG saving quota, rather than volumetric quotas, a biofuel with lower GHG emissions will be worth more than one with higher GHG emissions.

Actual calculations shall be performed according to the methodology laid out in Annex V, part C of the RED. Further guidance for carrying out the calculations can be found in a number of places, including the BioGrace user manual, which has instructions for how to use the BioGrace calculation tool[18] to conduct actual calculations.[19]

[18] http://www.biograce.net/content/ghgcalculationtools/recognisedtool/

[19] The UK RTFO Carbon and Sustainability guidance also provides in chapter 7 some more detailed support on how to perform the calculations and the UK Carbon Calculator may also be useful in conducting actual calculations. It should be noted however that some of the reporting requirements in these will be UK specific.

As part of the feasibility study, it is advisable to calculate the emissions of the entire supply chain, to have comfort that the proposed supply chain will meet the sustainability requirements. When the plant is operational, GHG emissions will need to be reported on an ongoing basis as part of the compliance process, and the data gathering for the calculations may be shared across the different operators in the supply chain, i.e. each operator calculates the share of life-cycle greenhouse gas emissions corresponding to the operations under her/his control. The last operator in the supply chain ultimately aggregates the greenhouse gas intensities calculated by all other operators and assign the total GHG intensity (and corresponding relative GHG savings compared to fossil fuel) to the end-product.

When calculating the GHG intensity of the entire supply chain, the process for calculating GHG emissions can be summarised as follows:

- Define the scope of the calculation and the system boundaries (i.e. where in the supply chain does the calculation start and where it stops);
- Understand whether the feedstock can count as a waste or a residue (See Section 5 in COM 2010/160/02[20]), and therefore whether any emissions should be allocated to its production process. This will involve checking the national guidance for the country in which the plant will be located, as feedstock classification can vary from MS to MS.
- Gather information on yields, energy consumption and chemical consumption, transport distances, etc. (see input data in Table 8)
- Determine the energy content (LHV in MJ/kg, at a specified moisture content) of any products and co-products coming out of the process, as this is an important part of calculating the emissions associated with the fuel
- Perform the calculation to understand total direct GHG emissions associated with the defined scope of operations or the entire supply chain, and estimated savings relative to a fossil fuel comparator. These calculations can be performed by hand using the methodology laid out in the RED, described in more detail in the guidance documents mentioned above or using a tool such as the BioGrace Calculation tool.
- Ideally a sensitivity analysis should be undertaken to understand how the calculations might change over time or with, for example, different feedstocks, feedstocks from different locations, different transport modes, or different process fuel (e.g. natural gas, biomass). To understand how sensitive the GHG emissions savings and (potentially) the biofuel price are to certain inputs.
- Having the GHG calculations undertaken or peer reviewed by experts can potentially provide more assurance around the results and the credibility of the GHG saving claims.

With the new ILUC amendment to the RED, it is required for fuel suppliers to report ILUC emissions alongside direct emissions calculations. At the moment, there are only ILUC values for food crops (which cannot be used for advanced biofuels) but in the future it is possible that the Commission will provide ILUC factors for energy crops and other materials such as straw, and that it may also be necessary to report these ILUC emissions.

[20] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:160:0008:0016:EN:PDF

6.3.2 Land criteria

In order to comply with the land criteria (i.e. demonstrate that the feedstock was not obtained from land with high biodiversity value, high carbon stock value or land which was previously peatland after January 1, 2008), it is necessary to gather the evidence about the origin of the feedstock. If the feedstock has met the requirements of a "voluntary (certification) scheme" that has been recognised by the European Commission as demonstrating compliance with the land criteria, no further evidence is required. However, evidence will obviously be required during the certification process (audit) in order to demonstrate compliance with this scheme. Certain schemes may require compliance with additional environmental and social criteria (see section 6.3.4).

Specific evidence about where exactly the feedstock was grown and evidence of previous land use categories for that location from January 1, 2008 onward can together provide sufficient evidence of compliance with the land criteria, if the previous land categories (i.e. in January 2008) are compatible (e.g. not peatland). The Commission has produced a guidance document to help identify the status of land in January 2008 and after to demonstrate compliance with the RED land-use criteria[21].

6.3.3 Chain of custody (CoC)

The chain of custody (CoC) is a crucial part of ensuring that compliant material is traceable throughout the supply chain and reaches end-users with a valid documentation and sustainability claim attached to it. Several tracking models exist: in an **identity preserved (IP)** model, batches of compliant products from a given origin are not physically mixed with non-compliant products or compliant-products from different origin; in a **segregation** system, compliant products are kept physically separate from non-compliant products but batches of compliant products from different origins can be physically mixed; in a **mass balance** system, batches of compliant and non-compliant products can be physically mixed and compliance claims on exit can only be attached to an equivalent volume as the entering compliant material (taking conversion factors into account); in a **book & claim** system, compliance claims are fully separated from physical products, traded ("book") through a dedicated platform and bought ("claim") by end-users willing to demonstrate their support to sustainable production upstream. Note that book & claim is not allowed under RED and FQD.

The RED requires economic operators to ensure CoC systems are in place that are accurate, reliable and protected against fraud and that they are independently verified by auditors to show that the chain of custody meets this requirement.

The RED requires economic operators to put a mass balance chain of custody system in place at the site level (i.e. one geographical location). This means that compliant and non-compliant materials of different origins (and therefore with different associated sustainability information, e.g. certified by

[21] Inventory of data sources and methodologies to help identify land status: http://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/sustainability-criteria

different voluntary schemes) can be mixed. Volumes of compliant material acquired and delivered are monitored and recorded to ensure that the volume of material that leaves the site with one set of sustainability information is in equal proportion of material that entered the site with that set of sustainability information. Most voluntary schemes allow operators to report on the balance of compliant material over a period of up to 3 months.

The EC also allows using IP and segregation tracking systems, although these are rarely used for biofuels.

Operators acquiring, handling, processing and delivering compliant material need to keep records of inputs and outputs to their site and any conversion factors associated with processes that occur on site, and these will need to be kept available for auditing purposes. Operators are also required to ensure that the documentation attached to a batch of product leaving their facilities accurately describes the technical and sustainability characteristics of the product. There are a number of documents that provide support on setting up a chain of custody.[22]

The feasibility study should take into consideration the financial and administrative burden required by the different parties in the supply chain associated with setting up a chain of custody. There are software packages that can support suppliers in developing the necessary tracking information. The different tracking systems described above have different financial implications, IP and segregation being the most expensive and complex systems to put in place from a logistical and infrastructural perspective.

6.3.4 Sustainability standards (Voluntary schemes)

The Renewable Energy Directive includes several implementation mechanisms to demonstrate compliance with the GHG and land criteria (Article 18.4), the most widely used being certification to an EC-approved voluntary certification scheme. At the time of drafting, there are 19 EC-approved voluntary schemes. While all EC-approved schemes are deemed to offer the same level of assurance as far as compliance with the RED/FQD land, GHG and CoC requirements, several schemes include additional environmental and social criteria. Furthermore, each scheme may have different requirements with regards to waste and residues, the product transfer documentation or the way audits are conducted for example. Finally the scope of EC-recognition may vary, as certain voluntary schemes are only partially recognised while others are fully recognised, some schemes only address GHG calculations (e.g. Biograce) and some have specific requirements for wastes and residues (e.g. ISCC, RSB).

If deciding to use an EC-approved certification scheme, it is important to identify the information that is needed to comply with the particular standard in question and understand how to gather the necessary information.

[22] For example, see the UK RTFO guidance, chapter 8: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/414387/RTFO_guidance_part_two_-_carbon_and_sustainability_guidance_year_8.pdf

At the stage of a feasibility study, the steps to achieving certification should be planned. The following paragraphs summarise these steps and should therefore help develop this plan. However, it is not expected to undergo all these steps as part of the feasibility study.

Step 1: Selection of a voluntary certification scheme

All recognised schemes can be found on the Commission website[23]. The following questions could be used to select a particular scheme:

- What is the level of sustainability performance aimed for: minimum (RED requirements)? Intermediary? Gold standard?
- Does the scope of the scheme formally allow to certify the biomass types that are used (e.g. waste and residues)?
- Is the scheme widely used throughout supply chains? How many certificates have already been delivered? Do fully certified supply chains exist or are there gaps in the chain of custody?
- What schemes have the strongest sustainability criteria beyond RED[24]?
- Is the scheme robust in terms of assurance (i.e. auditors' qualifications, training, monitoring, etc.)? What is the frequency of audits?
- Is the scheme transparent (e.g. member of the ISEAL Alliance[25]) and workable?
- How much does the certification process cost?
- How onerous is the information collection and compliance process?

Step 2: Self-assessment

Before starting the certification process, it is advisable to perform a self-assessment against the sustainability, chain-of-custody and other administrative requirements to evaluate potential gaps with the required level of compliance. A pre-certification assessment may also be performed by external experts.

Based on the outcomes of the self-assessment, it may be necessary to make some changes to the operations and processes. In addition, adjustments vis-à-vis suppliers, buyers or other involved parties may be necessary, e.g. for product transfer documentation or compliance of subcontractors with the scheme's requirement. If the self-assessment has a positive outcome, the actual certification process can be started. In case major gaps are identified, it is advised to consider a more accessible voluntary scheme or keep the certification process on hold until all the gaps are filled.

[23] http://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/voluntary-schemes
[24] NGOs like WWF performed comparative analysis of voluntary schemes against their sustainability and assurance internal benchmarks. See: http://wwf.panda.org/what_we_do/how_we_work/businesses/transforming_markets/solutions/certification/agriculture/biofuels/searching_for_sustainability/
[25] http://www.isealalliance.org/about-us

Step 3: Selection of a certification body for independent verification

An independent certification body needs to perform the verification according to the assurance requirements of the certification scheme. A list of accredited certification bodies can be found on the website of each scheme. The experience of the certification body with the scheme can be estimated by checking the amount of certificates that have been issued by the verifier. This information is made public on the website of the certification scheme.

The costs of the verification will mainly depend on the audit duration and the daily fee of the auditor. It is worth requesting offers from at least two certification bodies. The frequency of audits is determined by the scheme and has a significant impact on costs.

Step 4: The certification process

At the start of the certification process an initial audit is needed, which usually consists of a desk-check and a field check. Upon successful completion of the initial audit, the certification body will issue a certificate of compliance, in line with the scope of operations and selected tracking model (See section 6.3.3). Surveillance audits are then organised at regular intervals, usually every year (some voluntary schemes use a risk-based approach to determine the frequency of surveillance audits). Surveillance audits may be conducted as desk-audits or field-audits. In order to ensure full traceability of compliant products, all actors and intermediaries acquiring, handling or delivering compliant material throughout the supply chain (from biomass production until the end user) need to be certified against the chain-of-custody requirements of the scheme (sustainability requirements are often limited to feedstock production and processing only). However, often storage facilities and transport companies do not need to be certified separately and may be verified as part of the scope of the preceding or following operations (e.g. biofuel producers may include the storage and transport of the fuel to its final destination). The organisation—either the producer, processor, trader or end user—that owns or hires storage capacity or truck transport, is responsible for certifying this part of the supply chain.

After the audit, the certification body will report its findings to the operator and possible major and minor non-conformities. Major non-conformities need to be corrected within a given time and solved before biomass or biofuel can be certified. Major non-conformities are usually described in the public audit summary, as well as the date at which the auditor validated their closure. Minor non-conformities need to be solved before the next surveillance audit and are also mentioned in the public audit summary. Upon successful completion of the audit and closure of all major non-conformities, a certificate is delivered by the certification body, along with the right for the operator to use off-product and/or on-product compliance claims. The validity of certificates varies for each scheme (1 to 5 years).

Certificates can be suspended or revoked under certain conditions, for example failure to undergo a surveillance audit within the certificate validity period, misuse of claims and trademarks, and criminal offences. Certain schemes implement a grievance mechanism that allows third party to report irregularities and non-compliance to certification bodies and, whenever justified, trigger extraordinary surveillance audits.

The certification scheme manager will request a fee for each certificate delivered or based on volumes of compliant material processed or delivered, and/or a membership fee.

6.4 What information should be provided in the feasibility study?

Table 8 below summarises on the left the information that should be gathered and used in order to provide assurance in the feasibility study that the biofuel produced will meet the required sustainability criteria. The column on the right summarises the information that should be included in the feasibility study itself.

Table 8: Data requirements for conducting the sustainability assessment

Input data	Output for feasibility study
• Information for carrying out GHG calculations (e.g. supply chain description, status of feedstock as waste, residue, product or co-product), energy/fuel/chemical inputs, transportation inputs, energy content, yields, etc.) • Information for carrying out land criteria assessment (exact location of feedstock production and information about previous land use on which feedstock grown) • Understanding of how likely it will be to receive a continuous supply of compliant feedstock material • Information on potentially applicable voluntary schemes	• Estimate of GHG emissions savings for biofuel showing they are above the required threshold • If the biofuel feedstock is a waste or residue and the fuel is considered to be an advanced fuel, evidence should be provided that the MS agrees with this classification • Evidence that the biomass would not be obtained from land with high biodiversity value, land with high carbon stock and land that was once peatland • Plan for tracking biofuels through a mass balance system • Plan for achieving certification to a particular sustainability standard (if desirable)

6.4.1 Further considerations

Although the sustainability requirements for biofuels are established at an EU level, there may be small subtleties in their implementation that vary from Member State to Member State (MS). Reporting requirements (product documentation) may also vary from MS to MS. Some MS also have advanced certificate recording and tracking systems (e.g. Nabisy in Germany).

It is therefore important to understand the particular requirements of the MS in which the plant will operate.

It is also important to keep up to date on any updates to carbon and sustainability reporting by regulatory bodies (e.g. European Commission). Examples include updates to default values, a change to the fossil fuel comparator, additional ILUC factors for energy crops and residues. Furthermore, many of the plants in the planning stages now, will only come into operation just before 2020 or potentially even after 2020. The majority of the operating lifetime of the plant will be post-2020. The coming years are likely to see a lot of debate about how sustainability requirements will develop for biofuels consumed after this date and it is therefore important to keep abreast of any changes that may be coming from the policy/regulatory side.

7 Financial analysis

7.1 Introduction

The financial analysis can be conducted to support a number of both internal and external processes and decisions such as selecting plant configuration or supply chain options or pursuing financing. There are, however, no absolute external requirements that the analysis must satisfy, rather the requirements will need to be derived from the intended purpose of the analysis.

The level of detail and methodology of the financial analysis will need to be tailored to the specific needs of the stakeholder for which it is being prepared (as a simple example, the applicable amortisation methods may depend on the project country and the company accounting practices). The descriptions of the financial analysis in this section should only be taken as indicative and should certainly not be interpreted as being prescriptive.

Accompanying this document is an excel spreadsheet template that can be used to prepare a financial analysis for the plant. Detailed instructions for using the spreadsheet are provided in a separate document.

7.1.1 Objectives

The key objectives of the financial analysis are to:

- Support the project decision making and fundraising processes by providing insight into:
  - The expected financial performance of the biofuel plant and its robustness
  - The production cost and thus competitiveness of the biofuel produced
- Support the project design process by providing quantitative insight into the relative merits of different plant options (e.g., choice of feedstock, plant configuration, etc.)

These objectives are met by completing a cash flow analysis for the project that yields financial performance metrics such as net present value (NPV) and internal rate of return (IRR), and that allows the robustness of the financial performance to be evaluated by carrying out sensitivity analysis.

7.2 What should it cover?

The financial analysis requires a wide range of data inputs and the fidelity of the analysis is heavily dependent on the detail and accuracy of the data available. It should provide an estimate of the expected financial performance of the plant, using agreed financial reporting metrics. It should also include a sensitivity analysis to explore how sensitive the key financial metrics are to particular input parameters (for example, feedstock cost or price paid for co-products).

Key areas of data requirements are described below.

- **Project timeline:** The aspects of the project timeline that impact the financial analysis are, in particular, those that dictate the timing of expenditures and revenues. Namely, the start and duration of plant construction, the commissioning/plant ramp up period, the timing of commercial operation start and the plant lifetime.

- **Financial inputs:** The most significant financial parameters that are needed as inputs are the following:

    - Debt to equity ratio: the construction of a biofuel plant is typically financed using a project finance model where the project sponsors provide equity to a special purpose vehicle and the remainder of the required capital is obtained from commercial lending institutions. Defining the debt to equity ratio is thus critical to modelling the financial performance of the project.
    - Discount rate: this is typically the cost of capital for the project developer
    - Commercial interest rate and loan duration: Assuming that part of the project financing will be through debt, the interest rate and duration of commercial loans is obviously important
    - Prices for process input and outputs
    - Price index and exchange rate forecasts: Since the financial analysis will span the life of the plant, it is necessary to have price indices to inflate the prices of process inputs and outputs in future years. Similarly, where the plant operation requires transactions in more than one currency, exchange rate forecasts are required.

  Other financial and accounting inputs, such as amortisation and depreciation periods, loan duration are also required. These will typically just follow the practices of the developer and are not usually a challenge to identify.

- **Project CAPEX:** Project CAPEX is typically one of the major contributors to biofuel production cost thus the estimate of project CAPEX for both the plant and site preparation is one of the key inputs for the financial analysis. Issues that need to be considered in the CAPEX estimate are outlined in Section 4.4.2.1.
- **Process inputs and outputs:** All the process inputs and outputs that are the source of cost or revenue must clearly be included in the financial analysis. This obviously includes the feedstock and biological additives such as enzymes where those are relevant, but also must include any process chemicals, catalysts, hydrogen and utilities. Similarly, any process co-products that can generate additional revenue streams as well as any waste streams that incur disposal costs (e.g., waste water treatment or solid waste disposal) must be included, together with licences and all the variable costs. See section 4.4.3 for a more complete description of the costs that should be included.
- Relevant taxes and subsidies: Any relevant taxes and subsidies should also be incorporated into the financial analysis.

7.3 How should it be tackled?

The accompanying spreadsheet to this document provides a framework with which the financial analysis can be tackled.

The financial analysis can provide insight in to a wide range of questions both about the underlying fuel production process as well as about the specific project. Which particular questions and performance metrics are of most interest will depend on the specificities of the project partners and of the financial institutions backing the project. However, questions that are generally of interest include:

What will the financial performance of the project be?

Modelling the cash flow of the project allows a number of high level financial performance metrics to be calculated. Typical metrics that are of interest are the net present value (NPV) over the life of the plant and the internal rate of return (IRR). Similarly, the payback period can be used to provide an estimate of how long the plant needs to recoup the initial investment. The details of how these metrics are calculated (e.g., on a pre- or post-tax basis or whether a simple or discounted payback is used) will depend on the needs and accounting practices of the project partners and the financial institutions involved. Financial institutions providing credit may also wish to see the debt service coverage ratio (DSCR) which is the ratio of net operating income to debt service payments and gives an indication of whether the level and structure of debt in the project financing is appropriate to the expected revenue streams. In addition to a cash flow summary, the financial analysis also includes a project income statement and balance sheet allowing the project developers to verify that the project can operate on a sound basis.

How robust is the predicted financial performance?

For a new advanced biofuel project there is uncertainty in a number of the key parameters that have a strong influence on the financial performance. Of these, the most important are typically the fuel production cost and the fuel price that can be realized. The primary contributors to biofuel production cost are typically the feedstock, and plant CAPEX both of which can also have significant uncertainty, particularly in the early stages of a project. Finally, revenues from process co-products can also make a significant contribution reducing the net biofuel production cost. These aspects are discussed in sections 3.2.2 (feedstock costs), 4.4.2.1 (plant capex) and 3.3.2 (co-product revenues).

Robustness of the financial performance to variation in these and other parameters can be assessed by conducting a sensitivity analysis. The sensitivity analysis will depend on the development of scenarios. A framework for conducting the sensitivity analysis is included in the financial analysis template.

What will the fuel production cost be?

One of the key questions for any emerging alternative fuel production route is what the total cost for fuel production will be, allowing the competitiveness of the proposed fuel against other options to be assessed. If comparing alternative fuel production routes the relative importance of CAPEX and OPEX may be different. In these cases, comparing the fuel production cost on a levelised basis can be useful. The financial analysis template includes a calculation of the total fuel cost (including CAPEX) as well as production costs (excluding CAPEX) on a levelised basis[26]. The project income statement included in the financial analysis template also allows production costs for individual operating years to be calculated.

Which of the possible design choices results in the best performance?

The financial analysis can also be used to assess the relative merits of different plant configurations. One example of this, that is relevant for lignocellulosic routes, would be whether it makes sense to use process solid wastes (lignin) in an onsite power plant to provide steam and electricity to the plant or whether it is better to sell the solid waste. In this example, an onsite CHP plant would typically result in excess electricity and/or heat that could be sold to local utilities or customers, often at a preferential 'green' tariff. Such an option would however also mean higher capital and operational costs. The revenues from such co-product streams can be very important to the project financial performance. To assess the performance of such configuration options, different versions of the financial analysis with the appropriate changes to process inputs and outputs, CAPEX and OPEX need to be assembled.

7.4 What information should be provided in the feasibility study?

Details of the financial analysis model and outputs are provided in the accompanying Excel financial analysis model and the instructions that go with it.

The key outputs of the financial analysis are:

- The project cashflow summary, income statement and balance sheet
- Pre- and post-tax NPV, IRR and simple and discounted payback periods
- Debt service coverage ratio
- Levelised fuel production cost breakdown
- Sensitivity analysis to capex cost, feedstock price, co-product price, feedstock supply scenario, and advanced biofuel price scenario

[26] The levelised cost is calculated using the same approach that is used for levelised cost of electricity or energy (LCOE) calculations: namely both the fuel produced and costs are discounted.

8 Management and company profile

8.1 Introduction

For any advanced biofuels project, the organisations that are involved are of prime importance. The organisational set-up of the new venture should be clear, logical, focused, to the benefit of all parties involved, and the required expertise should be available. In this section some aspects of the management and company profile that should be reviewed as part of a feasibility study are highlighted.

8.1.1 Objectives

The objective of the management and company profile is to clearly illustrate the organisational set up, and demonstrate that the necessary expertise is available for a viable project. The management and company profile may inform the project risk assessment and may also be required as part of an external due diligence. A proper project structure can decrease risks and makes sure that the exposure of each partner is kept within appropriate bounds.

8.2 What should it cover?

With respect to this element, questions that need to be answered are:

- Which organisations will be involved in the biofuels project, what is their role and how will they cooperate?
- Do all organisations and their key personnel possess the necessary means and experience for their role?
- Do the organisations that are involved cover the necessary parts of the value chain?
- Are the strategic business interests of all relevant organisations sufficiently aligned to make the project a success?

8.3 How should it be tackled?

8.3.1 Project structure

An important first step in developing the management and company profile is ensuring careful consideration has gone into how the project is structured. The organisation of an advanced biofuels project will require in many cases the cooperation of multiple companies. Reasons for that are:

- Increased access to capital through a partner that brings in finances;
- Increased technical expertise;
- Access to relevant biofuels markets;
- More control over biomass resources.

One suitable way (there are many) of structuring such a project is through a new venture specially founded for the realisation and operation of the biofuels project. This is called a Special Purpose Vehicle (SPV). An SPV provides focus to a biofuels venture, limits exposure, and can be a convenient way of bringing in new partners into the venture. There are many aspects involved in setting up these types of new ventures and it can be prudent to hire legal advice to assist in the structuring and establishment. In the case of a new venture, the following information is required:

- Company name
- Legal form
- Foundation (country)
- Shareholders
- Division of shares

The partnership should, irrespective of the form of the cooperation, be logical and the strategic business interests should align. It should be clear what parts of the value chain are covered. For the parts that are not covered, there should be clear reasons why it would not be necessary, prudent or even possible to cover these.

8.3.2 Company profiles

It is also important to develop a relevant company profile in the feasibility study. For all the companies involved key company data should be included in a feasibility study. It is furthermore necessary to include a narrative on the company, and especially the reasons to undertake the new venture.

Important aspects that need to be included are details on the experience base on which they will draw to fulfil their role in the partnership, and a description of the strategic business interests of the partners, and how that fits with the advanced biofuels project. The relevant experience of a company can be shown by listing past or present projects or activities. The information provided should be complete and verifiable.

A logical way to determine the alignment of strategic business interests is for the parties to enter into a dialogue. Annual reports, mission statements, websites and other public documents help to determine what the strategic business interests of each party is. Subsequently, company activities that are harmed by a possible success of the advanced biofuels project should be identified. These can be competing products, existing contracts etc.

To show that partners can meet their financial obligations, financial data could be included. For bankable projects, audited financial annual accounts will also be required.

8.3.3 Management and project team

The management and project team of each company should have the necessary managerial and technical expertise for the biofuels project. This could be shown by including Curriculum Vitae of some key employees in the feasibility study, listing especially experience that is relevant for the advanced biofuels project.

It will be necessary to build up a picture of the technology know-how and services required to execute the project. This should include a description of in-house technical know-how relating to the project and acknowledgement of the skills, support and know-how that will be provided by external organisations. A useful way to check if all the necessary skills are available in the proposed employee pool is to make a skill-set table. Such a table is a matrix with the employees on one dimension and the required skills on the other where each available skill is appropriately indicated.

A clear project organisation model with a transparent decision structure is necessary for proper project implementation. The project should furthermore preferably not be overly-dependent on the expertise of one or two individuals.

Where major technical components are purchased or licensed from a third party, it will be important to consider the following issues which may impact on the necessary skills needed within the team:

- Duration and renewal terms of technology license agreements and warranty on technology.
- Non-restricted use of unpatented know-how after expiry of licensing agreement.
- Full and complete transfer of know-how from licensor.
- Access to improvements and related training during period of agreement.
- Training, both in-plant and in the plant of the licensor.

8.4 What information should be provided in the feasibility study

The following table summarises the key output data that is required for the feasibility study and the type of input data that this should be based on. Wherever possible it should be ensured that the output data is tailored specifically for the particular project in mind, and is not just generic information that could apply to any project.

Table 9: Data requirements for preparing the management and company profile

Input data	Output data for the feasibility study
• Roles of different project partners • Information on different company objectives • Company data: Name, legal form, foundation country and year, chamber of commerce registration, turnover in last fiscal year (€), number of employees, business area (NACE classification[27], independence[28,29], description of core activities and strategic business interests, earlier	• SPV profile and description • Project organisational structure • Management team: information on the key personnel with evidence of the required experience and expertise • Overview of interaction between different partner companies • Documentation of alignment between partner strategic business interests • Audited annual financial accounts (if required)

[27] http://ec.europa.eu/competition/mergers/cases/index/nace_all.html

[28] Independence of an organisation is defined in the SME definition of the EU: http://ec.europa.eu/enterprise/policies/sme/files/sme_definition/sme_user_guide_en.pdf

[29] If an organisation is not independent, include also the information from all parents

cooperation with the other partners, description of strategic reasons to enter new venture • CVs of key employees	

9 Risk assessment and management of risks

9.1 Introduction

Realisation of advanced biofuel plants involves risks. These risks and associated probabilities need to be identified in an early phase to make an informed decision about the viability of a project, and in order to implement measures so that they can be carefully managed and the project adapted if appropriate. This section contains details regarding risk assessment and management across the full project lifetime, including those within and outside control of the project.

9.1.1 Objectives

The objective of the risk assessment is to provide a clear insight into the project risks, the relative importance of each risk and ways to handle these risks.

9.2 What should it cover?

With respect to the risk assessment, the high-level questions that need to be answered are:

- What are the project risks?
- What are the consequences if these risks occur?
- Who is the owner of these risks?
- What is the risk probability and impact?
- What will be the risk management strategy?
- What will be the remaining risk when the risk management strategy is deployed?

Besides these questions, it is also necessary to determine the level of risk that is still manageable in the project. This is determined mostly by the partners and the financiers, and may not be known at an early stage. Especially financial institutions will want to have the risk profile reduced to their required level.

9.3 How should it be tackled?

9.3.1 Identification and categorisation of risks

There are several strategies to identify risks. One of the ways to identify risks is to use the list in the framework provided, which highlight the key areas of risk and some of the common themes relating to first of kind sustainable biofuel plants (see Table 10). This list is, however, not exhaustive, and project specific issues must be investigated. Strategies to identify risks are:

- Identification of risks during other activities carried out within the framework of the feasibility study.
- Brainstorm and talk with experts. This way it is possible to identify risks that are specifically related to your projects. Experts should be taken rather broadly here as people with relevant experience. For example, if you foresee working with a certain contractor, talk to other people who have had experience working with that contractor.

- Evaluate the project schedule for high-risk activities. Certain activities may entail more risks than others, for example, activities that lie on the "critical path", which means that these directly impact the overall timeline.

Table 10: Overview of risks, by category

Technical	
1)	Process performance, integration and yield
2)	Product quality and adherence to standards
3)	Biomass quality
4)	Development of competing technologies,
5)	Plant safety risks
6)	Implementation planning risks
Commercial	
1)	Accuracy of the market analysis
2)	Competitor behaviour
3)	Biomass price and availability
4)	Changing costs of logistics
5)	Undesirable market developments
6)	Exchange rate risks (in case of biomass supply from other countries)
Financial	
1)	Bankruptcy of project partners
2)	Exit of one or more partners
3)	Future biomass price increases
4)	Cost overruns in implementation and/or operation
5)	Revenue changes for main product and co-products (e.g. due to oil prices, policy, competing products, etc.)
6)	Bankruptcy of other partners in the value chain
Environmental	
1)	Tightening of environmental requirements for the process and for the application (e.g. as a result of local stakeholder concerns)
2)	Sustainability of the biomass is not guaranteed
3)	Adverse reactions from other stakeholders to the biomass production plant
4)	Land use issues
Regulatory	
1)	Uncertainty in biofuels incentives
2)	Duration of stimulus guarantees
3)	Changes in waste regulations
4)	Changes in product specification or certification
Management and organization	
1.	Technical and managerial expertise of the team
2.	Alignment of strategic interest partners

9.3.2 Qualification of risks

Once a comprehensive set of risks has been established, they can be categorised in terms of probability (how likely is it that the risk occurs) and impact (what happens to the project if the risk occurs).

9.3.3 Risk management

There are several strategies for risk management. The following four options can be considered:

- *Avoidance* – This means that the project is changed in such a way that the risk will not occur anymore. One example would be that risks of future biomass price increases are avoided by securing long term contracts
- *Transference* – this means that the risk is transferred to another party. This is commonly done with technical risks, which are transferred to a technology supplier through guarantees. Of course this leads to other risks, for example those relating to the reliability of the supplier. Similarly, insurance can be used to transfer the financial impacts of risks to a third party.
- *Mitigation* – Mitigation means reducing the probability and/or the impact of risks. An example would be to source biomass from various suppliers, which means that if one supplier withdraws, the resulting feedstock supply problem is less severe.
- *Acceptance* – If the other options are not viable a final strategy is acceptance. A contingency plan should be in place to prepare for any problems caused by the risk occurring.

The choice of strategies and how these are applied is project specific and therefore not discussed further. Triggers can also be identified. Triggers are indicators that risks are going to occur, allowing an advance warning system to be put in place so that appropriate measures can be taken in a timely manner.

9.3.4 Process for completing the template

To complete the template provided in Appendix 4 (Table 20)[30], the following process can be used:

- Identify risks, risk impact and probability, and risk owners
- Assign a priority to the most important risks
- Define risks management strategies for the most important risks. If needed, quantify risks further using scenario analysis or sensitivity analysis techniques.
- List the risks in order of descending severity. A useful measure for severity is the post-mitigation value.

[30] An editable version of this table is also provided alongside this document

9.3.5 Ongoing evaluation of risks

Risk management is an ongoing process in which the probability, severity and risk management measures are reassessed at suitable intervals. It is therefore important at the project inception phase to lay out a process which includes periodic re-evaluation of project risks.

9.4 What information should be provided in the Feasibility Study?

The following table shows the type of input data that needs to be gathered in order to prepare the necessary output data that should be provided in the Feasibility Study.

Table 11: Data requirements for risk assessment and management

Input data	Output data for feasibility study
Identification of risks Qualification of risks with respect to: • Impact to the project • Likelihood of the risk to occur Identification of suitable risk management options	A complete assessment of the risks and a plan for their management (see template in Appendix 4) Plan for periodic re-assessment of risks

9.5 Further considerations

A specific risk related to biofuel projects is the biomass supply risk. The biomass market is often volatile, and prices can fluctuate. On top of that, biomass availability is often dispersed which means that multiple suppliers are involved. Feedstock supply risks should be managed carefully and avoidance, transference or mitigation strategies should be in place.

Another specific risk is the income from sales of biofuels. This income is in many cases dependent on government policies, which carries its own specific risks. Another risk is that the biomass price increases or other operational expenses increase and may not be easily passed on to the consumers, creating problems with the financial viability of the project.

The third key issue is the technical risks. If a project includes technology that needs to be scaled up, which is typically the case for a first of a kind commercial plant, then there are risks regarding achieving expected performance and yields. The likelihood of not achieving expected goals is very difficult to assess. Typically these risks are assessed by a due diligence assessment from outside experts, but this will not eliminate all uncertainties.[31]

[31] A feasibility study is conducted to determine the viability of a project. A due diligence assessment is conducted to assess if the information provided by a party is correct.

Appendix 1 Supply chain information

Table 12: Feedstock characterisation template

Parameters	
Feedstock type (wood, grass, etc.)	
Morphology	
Bulk density ($tonne_{AR}$[32]/m^3)	
Composition (proximate analysis: moisture, ash, volatiles and fixed carbon) (%moisture)	
Composition (ultimate analysis: C, H, O, N, S) (% moisture)	
Biomass sugar content (glucan and xylans)	
Lignin content	
Average price and price range (Euro/$tonne_{AR}$)	
Sourcing area (geographical location)	
Total availability of the feedstock in sourcing area ($tonne_{AR}$/year)	
Proportion of available feedstock required for project (%)	

Table 13: Supplier profile template

Supplier name	Quantity available ($tonne_{AR}$/year)	Current use or fate	Price level (Euro/$tonne_{AR}$)
…			
…			

Table 14: Logistics and pre-treatment template

(Individual templates will be needed for different types of feedstock or feedstock from different locations)

Parameters	
Logistic steps required	1. 2. 3.
Transport modality per step	1. 2. 3.
Average costs of logistics per feedstock type (Euro/$tonne_{AR}$-km)	
Proposed logistics (e.g. outsourcing)	
Pre-processing requirements	
Pre-processing onsite of off-site	
Costs of pre-processing (Euro/$tonne_{AR}$)	
Capital costs of pre-processing equipment (Euro)	

[32] AR = As Received (from supplier), moisture content should be specified, to distinguish from “dry basis” or “dry and ash-free basis”

Appendix 2 Market information

Table 15: Biofuel characterisation template

Parameters	
Type of biofuel	
Quantity to be sold (tonne or litres per year)	
Primary applications (road transport, shipping, aviation, etc.)	
Technical characteristics (specify as desired)	
Competing products (type)	
- Fossil	
- Renewable	
Certifications required	

Table 16: Biofuels price template

Parameters	
Market price of the product	
Market price of competing products	
- Fossil	
- Renewable	
Monetary value of government incentives	
Difficulty of securing incentive (0% (impossible) to 100% (automatic))	
Duration of incentives	
Method of acquiring incentives (automatic, tender, etc.)	

Table 17: Market characterisation template

(Separate templates should be completed for each market)

Parameters	
Location/geography	
Market size (tonne or litre/year)	
Market trends	
Market share aimed for (%)	
Competitors	
- Fossil	
- Renewable	
Value chain between production and sale	
Logistic needs for biofuels sales	
Partners in value chain	
Costs for sales	

Table 18: Promotion template

Parameter	
Unique selling points	
Type of customers	
Marketing approach	

Table 19: Market assessment output template

Parameters	
Products (biofuel, co-products)	
Product quantities	
- Biofuel (tonne/year)	
- Co-product 1 (tonne/year)	
- Co-product 2 (tonne/year)	
Price	
- Biofuel (Euro/t)	
- Minimum	
- Maximum	
- Co-product 1 (Euro/t)	
- Minimum	
- Maximum	
- Co-product 2 (Euro/t)	
- Minimum	
- Maximum	
Costs of sales (Euro/year)	
Costs of logistics (Euro/year)	
Costs for acquiring incentives (Euro)	
Total income (sales minus costs) biofuels project (Euro/year)	
- Minimum	
- Maximum	

Appendix 3 Permitting information

Permit procedures differ among EU countries. In general the following permits are needed[33] .

Coherence with land use plan

Initially, the developer has to establish, in conjunction with the local authorities—usually the municipality and/or other regional authorities—to what extent the proposed biomass facility fits in the current land use plan. In case of discrepancy, the developer has to apply for a land use plan change. This procedure can be quite time consuming and may last several years, even in cases where all stakeholders act within the formal time periods and abstain from any legal processes. Even more importantly, the outcome is uncertain.

Planning permit

In some countries a planning permit is required by the regional authorities. This document generally lists all the permits that are obligatory before operating the production plant; the applicable authorities; the crucial technical documentation; a basic planning of the various steps of the project; a time line of the activities, etc.

Environmental permit

The environmental permit controls the emissions to the environment, primarily to the atmosphere, soil, water etc. In most countries, it is considered to be the most important permit since it is the permit that is most likely to be challenged by an appeal. This is probably related to the concern that if a lenient environmental permit is granted, the facility could impact the health and safety of local residents. The duration of the application process for the environmental permit is usually much longer than that of other types of permits.

An environmental permit may include an Environmental Impact Assessment (EIA) or some other country specific procedure.

Environmental impact assessment

Following European regulations, an EIA is required if the project is expected to have significant impact on the environment. The EIA directive (2011/92/EU) provides categories of projects that should perform an EIA. [See the separate section "Is an EIA needed or not"]. However, the exact thresholds depending on size, feedstock, technology or other criteria, vary throughout Europe. In some countries, the thresholds are determined by law. In others, a specific part of the procedure, referred to as EIA screening (EIA scoping), is included to establish if an EIA should be conducted or not (and how). Usually, this task is mandated by the regulatory authorities to a dedicated commission or task force (EIA commission).

In cases where an EIA is required, the duration of the permitting procedure is extended considerably. The reason is that a series of activities must be performed serially rather than in

[33] Ecofys and Golder Associates (2009) Benchmark of bioenergy permitting procedures in the European Union, for European Commission, DG TREN

parallel and the applicant has to await the guidelines of the EIA commission prior to further steps such as performing the actual assessment. In some countries the EIA procedure includes active public participation; in most countries it includes at least passive public participation. The outcome of an EIA is not subject to appeal however permits based on the EIA usually are. The EIA is also one of the major drivers for the costs of permitting procedures: according to Ecofys (2009)[34] the requirement of an EIA increases permitting costs by 50–400k€.

The Industrial Emission Directive (IED)

According to European Directive 2010/75/EC concerning the reduction of emissions from industrial installations, installations exceeding given thresholds, and/or belonging to specific categories, are required to have an Integrated Environmental Permit ("IEP"). The purpose of the IED is to avoid or at least to minimise the emissions to air, water and soil, and regulate waste management operations of large industrial activities. For energy-related facilities, there is a threshold of 50 MW thermal power capacity, above which the IED applies. As regards the emissions to air and water, the holder of the installation has to show that 'best available techniques' (BAT) are applied. The BAT are extensively described in Best Available Technology Reference documents (BREFs).[35] The competent authorities have to evaluate whether the project meets the BAT standard. In some cases BAT may lead to higher emission levels than required by national emission law. In that case usually the lower – i.e. stricter - limits prevail.

Construction permit

The environmental permit is followed by the construction (building) permit, granting the right to build the facility. This permit can be part of the environmental permit in the case of an integrated permit. The authority for the construction permit is usually the municipality. Appeal against the construction permit occurs less frequently than appeal against the environmental permit. In case of problems, these are usually related to issues with the land use plan that may not have been noticed in earlier stages of the process.

Operational permit

After construction, in some countries an operational permit (also referred to as activity permit, start-up permit or exploitation permit) is required to license the project developer to exploit the facility. It is typically awarded quite quickly without too many problems.

Production permit

In several countries, a production permit in order to license electricity and/or heat production is required. The duration of the procedure to obtain this permit is relatively short as well and major problems are not reported. The authority usually is the energy regulatory office. With the production permit may come a distribution permit, i.e., the license to distribute electricity or heat to end-consumers.

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[34] Ecofys and Golder Associates (2009) Benchmark of bioenergy permitting procedures in the European Union, for European Commission, DG TREN

[35] http://eippcb.jrc.ec.europa.eu/reference/

Grid access

In case of non-private use, a permit or license to access the grid may be required, in particular in cases where the grid is owned by the government. Grid access is identified as one of the most important non-technical barriers hindering the development of renewable energy, in particular in rural areas (PROGRESS 2008 in Ecofys 2009), and could also be a barrier for biofuels producers that produce electricity as a by-product. The authority may be the local grid operator.

Other permits

It is difficult to make a complete overview of all permit requirements in the EU. In some countries all topics are included in the environmental permit. Some countries have separate permits for specific topics:

- In some countries a separate permit is needed for water effluent discharge or groundwater extraction.
- In Poland a GHG emission permit is needed for all investments with a heat demand higher than a few MW.
- In the Netherlands a permit is needed if companies start their activities near to a Natura 2000 area and have to compensate for nitrate deposition in these protected areas.

Further information on environmental permits

For the application of an environmental permit a complete description of the facility and its expected impacts to the environment has to be collected. Typically the following information needs to be collected (based on Dutch situation, BTG 2010):

- General information
    - Address
    - Cadastral information of the site
    - Owner of the plant
    - Contact person
    - Manager of the facility
    - Main and partial activities of the facility
    - Type of permit
        - New permit or revision of old permit
        - Overview of permits already in place
        - Overview of other required permits
- The facility
    - Map of the facility

  - Organisation structure
  - Use of other buildings in the vicinity of the facility
  - Ownership of the land (rental or own property)
- Location of the facility
  - Land use plan
  - Topographical map
  - Site plan
  - Aerial photograph
- Activities
  - Overview of activities and processes in the facility
  - Capacities
  - Description of all parts of the facility
    - Biomass reception and storage
    - Pre-treatment
    - Biofuel production unit
    - Emission cleaning
    - Storage
    - Utilities
    - Process control and monitoring
    - Etc.
  - Operating time
    - hours/day
    - daytime or 24/7
    - hours per year
  - Traffic movements
  - Safety and security systems
    - By operator
    - Software
    - Hardware
    - Mechanical
  - Operating conditions

        - Normal operation
        - Start-up and close down procedures
        - Cleaning and maintenance procedures
        - Emergency procedures
    - Registration of environmental impacts
    - Expected changes in the facilities relevant for the permit application
    - Expected developments in first years of operation
- Substances
    - Overview of substances and waste present in the facility, including live micro-organisms if relevant
    - Yearly consumption of substances and production of waste
    - Supply, transport, transfer, storage and discharge of substances and wastes
- Specific topics (if applicable)
    - Environmental Impact Assessment (EIA) report
    - Integrated pollution prevention and control (IPPC) directive classification and relevant BREFs
- Emissions to air
    - Description of emissions to the air
        - Types of substance (NOx, SOx, dust, etc.)
        - Emission concentration (mg/Nm3)
        - Emission load (kg/hour)
    - Emission measurement protocol
    - Measures taken to reduce emissions to the air

    If applicable:

    - Benchmarking measures with best available techniques (BAT)
    - Air quality report showing emission to the local environment
    - Report on expected deposition acids (nitrogen and sulphur) to local Natura 2000 areas
    - CO_2 and NO_x trade
- Dust control/treatment
    - Processes for minimising and dealing with the generation of dust, mainly linked to feedstock (e.g. straw) handling and storage

- Odour
    - Description of odour sources
    - Odour report (if requested by authorities)
        - Odour emissions
        - Odour distribution in direct environment
        - Disturbance indication of the odour
- Noise
    - Description of sources of noise in the facility
    - Acoustic report showing impact on the direct environment
    - Measures to reduce noise
- Soil
    - Soil emission risk analysis
    - Measures needed to reduce soil emission risks
    - Monitoring quality of soil and ground water
    - Soil investigation report (showing state of soil before facility is implemented)
    - Report on soil decontamination activities (as far as relevant)
- Energy
    - Mass and energy balance
    - Energetic efficiency
    - Expected electricity and fuel use
    - Application of energy saving measures or heat recovery
- Prevention
    - Traffic management
    - Water saving
    - Waste prevention
    - Waste separation
- Storage
    - Storage of potential soil polluting substances in tanks
    - Storage of dangerous goods in packaging
- External safety
    - Check whether special regulations for external safety apply to the facility

  - Overview of parts of the facility with fire risk
  - Fire risk analysis
  - Fire prevention measures
  - Occupational safety plan.
- Waste
  - Overview of waste substances present in the plant
  - Overview of yearly production of wastes

  If the feedstock is classified as waste

  - Acceptance and registration procedure for waste coming from outside the facility
  - Administrative organisation and internal control measures
  - Benchmark whether waste is processed properly according to the waste hierarchy as provided in the Waste Framework Directive and worked out in the National Waste Plan

Appendix 4 Risk Assessment

Table 20: Risk Assessment template

(Please note, an editable excel version of this table is also provided)

						Risk Categories - Legal - Commercial: Contractual - Commercial: Financial/Funding - Political/Societal - Structures, Governance & Supply Chain - Health & Safety - Environment - Market Risks - Technical (with discipline)	Estimated Value of Risk				Estimated Residual Value of Risk (post mitigation action)		
							Risk Rating				Risk Rating		
							Scale	Scale			Scale	Scale	
							Low	Low			Low	Low	
							Medium	Medium			Medium	Medium	
							High	High			High	High	
Risk ID	Project Stage	Risk Description (Event)	Consequence / Impact on Project	Risk Owner[36]	Split (%)	Risk Categories (Please select from list above)	Probability	Impact	Pre-mitigation value[37]	Mitigation actions	Probability	Impact	Post-mitigation value

[36] Where more than one party is impacted by a risk, then estimates of the proportion of the impact that attaches to each party should be provided.
[37] The value of the risk should, wherever possible, also be identified as a monetary impact.