D6.3: Guidance Document for IBC Project Development

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857806.

Project acronym:	MUSIC
Project title:	Market Uptake Support for Intermediate Bioenergy Carriers
Project no.	857806
Project duration:	September 2019 – February 2023 (42 month)
Work Package:	WP6
Work Package leader:	CERTH
Task:	T6.3 (‘Guidance Document for IBC Project Development’)
Task leader:	BTG
Deliverable title:	D6.3 Guidance Document for IBC Project Development
Due date of deliverable:	August 2022
Actual submission date:	October 2022

Authors	Organization	Email
Patrick Reumer-man	BTG Biomass Technology Group BV	reumerman@btgworld.com

Dissemination level		
PU	Public	X
PP	Restricted to other programme participants (including the Com-mission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, restricted under conditions set out in Model Grant Agreement	

1 Acknowledgment & Disclaimer

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857806.

The information and views set out in this report are those of the author(s) and do not necessarily reflect the official opinion of the European Union. Neither the European Union institutions and bodies nor any person acting on their behalf may be held responsible for the use which may be made of the information contained therein.

2 Executive summary

MUSIC aims to improve logistics and trade of biomass and Intermediate Bioenergy Carriers (IBCs): torrefied biomass, fast pyrolysis bio-oil (FPBO) and microbial oil. Furthermore, MUSIC targets to inform, engage, train and support consortium partners as well as (industrial, regional, and other) stakeholders on this topic.

The aim of this document is to serve as a guide for project developers to help them develop feasibility studies for implementation of IBC value chains. A feasibility study is a necessary step to define a project, and can be used for many reasons, such as policy advice, internal reasons, etc. This guide is however about feasibility studies conducted for one specific reason: to allow external financiers to make an informed investment decision on the implementation of a commercial IBC technology.

IBC value chain development is in some respects different from regular project development, for example because biomass feedstock sourcing is an issue and sustainability and regulations play an important role. Throughout the guide these specifics are highlighted and additional guidance and resources are given.

A feasibility study that can serve as the basis for investment decisions should contain many elements. It needs to contain a project description, detailing the scope and outline of the project, the background, and more in general the 'setting' of the project. Essential elements are the supply chain and market assessment, technical assessment, permitting, sustainability issues, an insight in the financial feasibility, and an overview of the envisaged management and organisation of the project.

Risk assessment and the management of risks is a pivotal part of a feasibility study. Structured identification and assessment of risks, coupled with risk management strategies and a period re-assessment of risks needs to be considered carefully to allow for an informed investment decision.

Table of Contents

Figures

Tables

Abbreviations

CS	Case study
Dx.x	Deliverable, with x.x designating the specific deliverable number
EC	European Commission
EU	European Union
EU ETS	Emission Trading Scheme
GHG	Greenhouse gases
IBC	Intermediate bioenergy carrier
ktoe	kilo tonnes oil equivalent
NECP	National Energy and Climate Plan
RED	Renewable Energy Directive
TJ	Tera Joule (10^{12} Joule, or 1000 GJ)
TRL	Technology readiness level
Tx.x	Task, with x.x designating the specific task number
WP	Work Package

3 Introduction

The MUSIC project

Intermediate bioenergy carriers (IBCs) are formed when biomass is processed to energetically denser, storable, and transportable intermediary products analogous to coal, oil, and gaseous fossil energy carriers. The MUSIC project focused on three types of IBCs, pyrolysis oil, torrefied biomass, and microbial oil, as shown below.

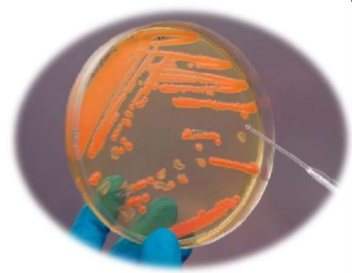
Pyrolysis oil - PO	Torrefied biomass - TB	Microbial oil - MO
		
Obtained by fast heating of biomass in the absence of oxygen, resulting in a liquid IBC.	Obtained by slow heating of biomass in the absence of oxygen, resulting in a solid IBC.	Obtained by fermentation of lignocellulosic-biomass derived sugars, resulting in a clean and energy-dense lipid-based IBC.

Figure 1: Three types of Intermediate Bioenergy Carriers (IBCs) covered in MUSIC

The EU H2020 MUSIC project supports market uptake of Intermediate Bioenergy Carriers (IBCs) by developing feedstock mobilisation strategies, improved cost-effective logistics and trade centres.

IBCs can be used directly for heat or power generation or further refined to final bioenergy or bio-based products. IBCs can lead to wider implementation of renewable energy, thus contributing to energy security, reduced greenhouse gas emissions, thus providing a sustainable alternative to fossil fuels in Europe.

The MUSIC case studies

In the MUSIC project, case studies have been carried out in four ‘regions’, namely Sweden/Finland, Italy, Greece, and an ‘international’ region. This last case study region is named such because the corresponding case study is centred on the steel company ArcelorMittal, which has plants across Europe, hence the designation ‘international’. Information of these case studies has been used for this document.

Scope of this document

IBCs are a promising way of increasing the use of renewable energy but are not yet widely implemented. Further market uptake and thus project development activities are necessary. Since many of the companies that are working on the development of IBCs are SMEs, knowledge, and experience on conducting feasibility studies and more general developing projects may be lacking. Similarly, investors and financiers may not always be very clear in which information they require.

This document serves as a guidance for SME technology developers to develop a robust feasibility study that can be used to convince financiers to enable project implementation.

3.1 Task Methodology

This document builds on a guidance document for sustainable biofuel projects, published by the EC in 2015 (E4tech et al. 2015). Additional information that was taken into account:

- The advanced and strategic case study reports (Patrick Reumerman et al. 2021; 2020);
- The three 'white papers' on the IBCs developed in MUSIC Task 6.1, namely:
    - The White Paper on Fast Pyrolysis Bio-Oil (P. Reumerman, Vos, and Lammens 2022)
    - The White Paper on Torrefied Biomass (Wild, Gauthier, and Calderon 2022)
    - The White Paper on Microbial Oil (Talluri 2022)
- The "Risk Assessment Guideline for Bioenergy Project Finance" - (Arranz, Horta, and Navarro 2018)
- Other information from literature, publications, etc.

The draft guidance was sent to the MUSIC case study leads for comments before it was published.

This guidance document is intended as a guide and is not meant to be exhaustive, but it aims to provide support and pointers to additional information on the various topics that need to be dealt with in a feasibility study.

The document starts with the role of a feasibility study in technology development, followed by a high level overview of what a feasibility study should contain. The remaining chapters deal with the various aspects that all need to be covered for a robust feasibility study aimed at IBC project development.

4 Feasibility studies purpose and content

4.1 Role of a Feasibility Study in Technology Development

New technologies such as IBCs are typically researched and developed in a laboratory and then developed further; first to pilot plant scale, then to demonstration scale, followed by scale up, in accordance with their Technology Readiness Level (TRL). During that technology development trajectory, different, and increasing levels of finance are needed.

Initially, regional, national, and European public funds can be used, together with own finance to develop the technology. Equipment is smaller and thus associated funds are limited. During demonstration and scale up costs increase substantially, while public funding is less available. Reason for that is the desire not to cause market distortion by subsidising technologies that can compete commercially with established technologies. This stage between pilot/demonstration and full commercial implementation is the well-documented "Valley of Death" – see e.g. (European Commission 2009).

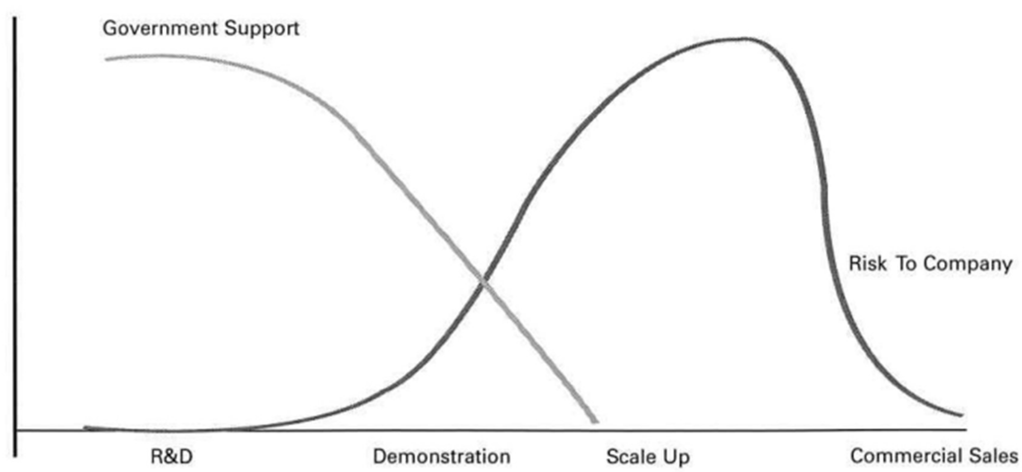


Figure 2: Graphic depiction of the 'Valley of Death' (European Commission 2009)

During technology development, technology developers will need to request funding many times. These can take the form of subsidy applications, internal requests for funding, etc.

In the specific case when a commercial plant needs to be implemented, the required finances need to come in almost all cases from external sources. Such a financial transaction is in many cases a combination of some form of public finance, loans and possibly equity investments. To convince external financiers to enter in such a transaction a feasibility study is one of the requirements. Such a transaction typically involves negotiations. If all parties agree to proceed, then 'financial close' is reached, and the project can commence.

Feasibility studies can be conducted for many reasons, such as policy advice, internal procedures, etc. This guidance document is however about feasibility studies conducted for one specific reason: to allow external financiers to make an informed investment decision on the implementation of a commercial IBC technology. This type of feasibility studies typically requires that information is presented with a higher confidence level, and risks are reduced as much as possible.

A business plan can be part of a feasibility study. A business plan is a document that defines in detail a company's objectives and how it plans to achieve its goals. A business plan lays out a written roadmap for the firm from marketing, financial, and operational standpoints[1]. A business plan is thus focused on a company, while a feasibility study is focussed on a project. A key point in any feasibility study is if an investment can yield a profitable return on investment against acceptable risks.

[1] https://www.investopedia.com/terms/b/business-plan.asp

5 Project description

The project description is the first part of a feasibility study. It gives an overview of the project and its background and should give the intended audience a summary of the key project characteristics. It should be clear what the goal and targeted audience of the feasibility study is, what the unique characteristics of the project are, and what the scope and context of the project is. The project description should at least contain the following elements:

Table 1: Feasibility project description subjects

Content	Description
Project scope and outline	Overview of the project and its aims. This can already include the type of feedstock, the conversion process, the markets, and the timeframe.
Background	Context of the project, the rationale and any other information which justifies the choices that were made in the project set-up.
Management and Organisation	Descriptions of the organisations that are behind the project. The project ownership structure, the partners, and their aims with respect to the project. Also, other key organisations, e.g., technology suppliers, should be described.
Process description	Description of the value chain, including the feedstock, the conversion process, and the products.
Location and site details	Information on relevant locations of the value chain, such as pre-treatment plants, conversion plants and/or upgrading plants.
Supply chain and market assessment	A description of the supply chain - including for example harvesting, collection, pre-treatment, transport, and logistics – and of the market: who are the customers, what are their requirement and what is the impact of a new supplier. Relevant framework conditions should be mentioned.
Project timeline	Planning of the project implementation and production ramp-up. In the case of IBCs this will likely be one to several years. Provide a credible phasing of the project
Sustainability and impact	The social and environmental impacts of the project should be clearly detailed. Alignment with national and/or European priorities, such as the production of renewable energy, resource efficiency and environmental sustainability should be detailed, as well as socially important aspects such as investment, jobs and growth prospects.

6 Supply chain and market assessment

6.1 Aim

For any IBC project, the sourcing of the biomass is an essential issue. Feedstock costs are usually a high percentage of the operational costs of any project and biomass sources are often dispersed. Transport costs – especially for untreated biomass – are high because of the generally low energy density (the amount of energy per m^3). A stable, preferably uninterrupted supply of biomass is critical for any IBC project.

A proper assessment of the market is likewise critical. Since IBCs are relatively new, there is not yet a commodity-like market, and identifying secure off-take of the product(s) is key to securing financial support. Specific aims of the supply chain and market assessment section in the feasibility study are:

- To describe a robust and cost-effective feedstock supply strategy, including type, quantities, costs, suppliers, transport routes and off-site pretreatment
- To determine the sensitivity of the feedstock supply towards adverse shocks
- A comprehensive market assessment detailing i.a. which consumers, price levels, logistical routes to the consumers, desired product characteristics and standards, market sizes and volumes, etc.

6.2 Information to be provided

The information to be provided in the feasibility study is detailed in Table 2 for the supply chain, and in Table 3 for the market assessment.

Table 2: Supply chain characteristics information requirements

Content	Description
Biomass physical and chemical characteristics	All relevant physical characteristics, such as types, appearance, form (chips, bales, etc.), moisture content, energy content, element analysis, sugar content, seasonality, etc. Note the relevant standards that are used.
Quantities	Feedstock quantities in tonnes per year.
Locations	Locations where the biomass becomes available
Supplier info	Who are the suppliers (names, quantities supplied, willingness to enter into long-term contract).
Logistics	How the biomass is collected, what pre-treatment is necessary, and who is responsible for that, how it is transported, transport cost data.

Costs	Integral costs of biomass supply and the factory gate. Ideal is the drafting of cost-supply graphs, showing which biomass can be sorted against what price.
Supply market characteristics	Total amounts of biomass available; share that the project will take, likely behaviour of competitors, etc.

Table 3: Market assessment information requirements

Content	Description
Products physical and chemical requirements	All relevant physical requirements of the products, such as types, appearance, form, moisture content, element analysis, sugar content, seasonality, etc
Quantities	Product quantities in tonne/a
Locations	Locations where the product will be supplied
Consumer info	Who are the consumers (names, quantities that can be purchased, willingness to enter into long-term contract)
Logistics	How the product will be transported to the consumers, storage requirements
Prices	Price levels of the product(s), including any by-products, including trends
Market characteristics	Market size and volume, who are the competitors, will they be able to lower their prices, etc.

6.3 Specific issues

Security supply is very important for any IBC project. Any IBC project should try to mitigate supply chain risks to the extent possible. Ways to do that are:

- Ensure there are multiple suppliers, to avoid reliance on a single one
- Consider making a dominant supplier part of the project, so that the supplier has a stake in its success. This is called 'vertical integration'.
- Try to negotiate longer term contracts

For a bankable feasibility study, binding contracts with biomass suppliers is usually a must.

Especially when the feedstock is a waste, it is important to also consider:

- For waste usually regulations are in force that place requirements on its use. Generally, the project will need to comply with the national variant of the EU waste hierarchy[2], which means e.g., that if recycling or material use is possible, use as energy source is prohibited. Also, criteria regarding transport should be investigated and followed.

[2] https://ec.europa.eu/environment/green-growth/waste-prevention-and-management/index_en.htm#:~:text=The%20Directive%20defines%20a%20'hierarchy,be%20the%20very%20last%20resort.

- Waste prevention and reduction may lead to lower quantities over time. The feedstock supply strategy should take that into account.

Specific issues relating to the market assessment are:

- IBCs are not (yet) commodities. This means that off-take – securing a customer that agrees to buy the product – is an essential part of any project development. Longer term contracts can reduce the risk, just as vertical integration, and having multiple off-takers.
- Especially in the case of a first-of-its-kind plant, it is good to select off-takers that do not rely on the IBC product. This avoids penalties for non-delivery when there are operational issues.
- Part of the plant income may come from exploitation subsidies because renewable energy and/or materials are produced. If that is the case, it is essential to list the conditions, the reasons why the project qualifies, and give insight into the level of certainty.
- A bankable IBC feasibility study contains binding sales contracts for at least a significant percentage of the product, and – if there is no automatic granting of the subsidy – binding contracts for any exploitation subsidies. Exact conditions are typically negotiated to obtain financial close.

6.4 Resources

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

- Biomass characteristics: https://phyllis.nl/
- Biomass standards overview: https://www.iso.org/committee/554401/x/catalogue/p/1/u/0/w/0/d/0

Biomass price information and availability is region-specific and difficult to determine. Dedicated biomass supply studies are recommended before embarking on an IBC project.

Some sources can provide information on biomass types that are widely traded and have become – or are on the verge of becoming commodities. These include:

- C.A.R.M.E.N. for German solid biofuel prices: http://www.carmen-ev.de/
- National Biomass Associations, such as AVEBIOM in Spain (https://www.avebiom.org/proyectos/indice-precios-biomasa-ex-works) and Propellets Austria (https://www.propellets.at/en/wood-pellet-prices) publish market prices for certain solid biomass fuels, especially used in the residential sector
- Argus biomass markets: https://www.argusmedia.com/en/bioenergy Argus reports daily spot prices and industry news on international biofuels, ethanol, feedstock, and biomass markets including wood chips and pellets

- Hawking Wright: https://www.hawkinswright.com/biomass. Hawkins Wright is an independent consultancy firm that providing on a regular basis in-depth multi-client reports on wood pellets, chips, palm kernel shells and other biomass
- S2Biom Biomass chain data tools: https://s2biom.wenr.wur.nl/. S2Biom was an EU funded project that developed a series of tools related to biomass supply, costs, logistical components, and others. The tools provided by S2Biom can be used for a preliminary assessment of the availability and cost supply of numerous biomass types down to a NUTS3 level
- Bioenergy Europe: https://bioenergyeurope.org/. The European Bioenergy Association publishes on an annual basis its Statistical Report, which aggregates information on wood pellet production, consumption, and prices from numerous sources (national associations, industrial actors, consultancies, etc.)

7 Technical Assessment

7.1 Aim

Implementing an IBC value chain will involve one or more conversion facilities. This will involve the design, construction, and start-up of new equipment. This will involve technology supplier(s), plant implementation costs, and implementation time. Especially when it is a first-of-its-kind plant, there are risks related to costs and performance.

Selection of a technical supplier is essential. Ideally, the supplier can provide guarantees and is able to back these up with a credible track record. It is important that the supplier is indeed of sufficient size to back up its guarantees.

Specific aims of the technical assessment are:

- To describe the technical layout of the project in such a way that it is clear what the inputs and outputs are, needed physical equipment and its functionality.
- To present comprehensive information on the engineering process, and all activities required to implement and start-up the plant, with a credible timeframe.
- To determine the costs for implementing and running the plant, and the uncertainties of the cost estimations.
- To give confidence that the plant(s) can indeed be implemented as planned, with the expected performance, within the budget as foreseen; the reputation of the technology provider is essential here, as well as the specific track record of implementing similar plants.

7.2 Information to be provided

The following information is needed for this section

Table 4: Technical assessment information requirements

Content	Description
Main design characteristics	Technology description, nameplate capacity, mass and energy balances, etc.
Location characteristics	Location(s) where the plant will be built, description of utilities, infrastructure
Process design package	Process design showing the main equipment, enabling an estimation of the costs, plot plan (layout of the plant)

Schedule	Planning for the design, detailed design, procurement, construction, commissioning and start up. For a typical IBC plant this process takes one to two years. Complex chemical plants can take up tot 4 years to build.
Cost information	Estimates on the total costs needed for implementing the plant, and for the costs required for the yearly operation of the plant.
Technology supplier information	Who will be the technology supplier(s), what is the track record, etc.

7.3 Specific issues

The following specific issues are important with respect to the technical assessment:

- 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 (see paragraph 7.4).
- For "first of a kind" plants it could be difficult to estimate the costs for the feasibility study, as the costs of making cost estimate could be significant. Typically, the more time and money invested in estimating the cost of the plant, the more accurate the estimate will be.
- A bankable IBC feasibility study will normally contain a binding offer from a technology supplier. If there is uncertainty, for example the -10% - +15% uncertainty of a class 1 estimate, the feasibility study will have to contain measures to overcome these cost overruns.

7.4 Resources

Information on uncertainties of plant cost estimations:

- https://www.costengineering.eu/Downloads/articles/AACE_CLASSIFICATION_SYSTEM.pdf

Information on technology providers is provided in i.a. the three White Papers published in the framework of the MUSIC project:

- The White Paper on Fast Pyrolysis Bio-Oil (P. Reumerman, Vos, and Lammens 2022)
- The White Paper on Torrefied Biomass (Wild, Gauthier, and Calderon 2022)
- The White Paper on Microbial Oil (Talluri 2022)

8 Permitting

8.1 Aim

In general, several permits are required to implement IBC plants. For construction of buildings, planning permission is usually required, as well as a building permit. Since industrial plants have an impact on the environment, an environmental permit is required. Dependent on the specific activity, additional permits such as water permits, etc. are required. Permitting procedures vary across the EU, but the principles are in many cases comparable.

The aims of this section of the feasibility study are:

- To identify all permits that need to be requested, including the time frame foreseen, costs involved and possible bottlenecks.
- To develop a credible strategy on informing relevant stakeholders so that the permitting process can be completed without delays.

8.2 Information to be provided

The following information needs to be provided for the permitting section.

Table 5: Permitting information requirements

Content	Description
Permit types	A description of the permits that need to be requested, and the expected time schedule and procedure per permit. It is also important to determine at an early stage if a (time consuming) Environmental Impact Assessment needs to be carried out.
Competent authority	Which government body is the Competent authority. It may be possible that there are more than one, dependent on the permit
Permit status	Overview of work already done on permitting and status of exiting permits.
Overview of sensitive issues	What sensitive issues are there, and how can these be fulfilled in a cost-effective way. Typical sensitive issues are emissions, sound pressure levels, increase in traffic, etc.
Identification of stakeholders	At some point key permit applications will be made public, allowing stakeholders to object and appeal, which can cause long delays. Key stakeholders, such as residents living nearby need to be identified at an early stage.

8.3 Specific issues

The following specific issues are important:

- Permitting procedures can take quite a lot of time. In 2009 this time was estimated to be 23 months on average in the EU (Ecofys 2009).
- It is advisable to contact local stakeholders early on, and discuss the project with them, so as to avoid delays in the project implementation.
- When an IBC project uses waste as feedstock, the permitting becomes usually more elaborate. Waste regulations need to be followed, and it could also be that emission requirements are stricter.
- Before a project can be financed, all the required permits need to be irrevocably granted.

9 Sustainability

9.1 Aim

Increased sustainability is often one of the drivers of an IBC project. Saving fossil fuels is a pre-requisite – also for funding, but on top of that it is also necessary that other impacts to the environment are minimised, and that no significant harm is done. This last requirement (Do-no-significant-harm, or DNSH) is elaborated by the EU, and applied among others on funding related to the Green Deal[3]. These requirements will be checked during the permitting process, but also stakeholders and financiers consider this of essential interest. Unsustainable projects are a risk for financiers, and many have also a mandate that forbids them to support unsustainable projects. Compliance with sustainability criteria can be demonstrated by making use of an EU approved certification scheme.

The aims of this section of the feasibility study are:

- To determine the expected greenhouse gas savings that can be achieved by the project, according to an approved methodology.
- To determine which EU certification scheme could be used to demonstrate compliance.
- To flag any other sustainability issues for example by considering the DNSH principles.

9.2 Information to be provided

For IBC projects that expect to receive public funding – which is nearly always the case - there are additional sustainability criteria that relate i.e. to the percentage of the greenhouse gas emission savings. These are detailed in the RED II (see paragraph 9.4), and are:

a) at least 50 % CO_2-eq reduction for biofuels, biogas consumed in the transport sector, and bioliquids produced in installations in operation on or before 5 October 2015;
b) at least 60 % CO_2-eq reduction for biofuels, biogas consumed in the transport sector, and bioliquids produced in installations starting operation from 6 October 2015 until 31 December 2020;
c) at least 65 % CO_2-eq reduction for biofuels, biogas consumed in the transport sector, and bioliquids produced in installations starting operation from 1 January 2021;
d) at least 70 % CO_2-eq reduction for electricity, heating and cooling production from biomass fuels used in installations starting operation from 1 January 2021 until 31 December 2025, and 80 % for installations starting operation from 1 January 2026.

[3] https://ec.europa.eu/info/sites/default/files/2021_02_18_epc_do_not_significant_harm_-technical_guidance_by_the_commission.pdf

The total GHG emissions and the GHG emissions saving arising from the of IBCs are to be calculated in accordance with the methodologies and principles described in the EU RED II. All relevant emissions should be included, with as main exception that emissions from waste and residues before the point of intake do not have to be included.

It should be noted that at the time of writing, the legislative process for adopting a revised Renewable Energy Directive - the so-called “REDIII” – has started. This will be an elaborate process, with different EU institutions and Member States having different positions which will need to be reconciled before REDIII is adopted. In any case, all signs point out that the further strengthening of the biomass sustainability criteria is to be expected. Therefore, IBC project developers should closely follow the legislative process since their projects will be directly affected by this change.

The following data should be provided in this section of the feasibility study:

Table 6: Permitting information requirements

Content	Description
Certification schemes	Choice of certification scheme. In case of advanced biofuels or energy, an EU recognised voluntary scheme or national certification scheme should be selected.
CO_2-eq calculation	At least initial assessment on the CO_2-eq emission reductions that can be achieved, to check if it meets the RED II requirements (applicable for energy and biofuels projects).
Related issues	All other relevant information on sustainability, such as the non-applicability of exclusion criteria, etc.
Product classification	Whether the products can be considered advanced biofuels or not and why.

9.3 Specific issues

The following specific issues require attention:

- In the last few years there has been rapid development and evolution of sustainability criteria. This means that project developers should remain familiar with the latest policy development and ensure that their project adheres to the strictest ones.
- IBC value chains often result in the production of biofuels. It is important – also for the selling price – to have the products classified as ‘advanced biofuels’, which means biofuels produced from residues and waste. This may mean additional support and can facilitate proving the sustainability of the value chain. A list of the approved residues

and wastes that allow product the label “advanced biofuels” is given in Annex 9a of the EU Directive 2018/2001(RED II).

9.4 Resources

The following resources could be useful:

- List of EU approved voluntary certification schemes: https://energy.ec.europa.eu/topics/renewable-energy/bioenergy/voluntary-schemes_en
- RED II, including Annex 9a (the list of biomass feedstocks that are allowed for advanced biofuels):https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0082.01.ENG&toc=OJ:L:2018:328:TOC

10 Financial feasibility

10.1 Aim

The financial feasibility section involves a projection of the future costs and revenues of the project and provides information on the financial viability of the associated investment. It is highly dependent on proper inputs, such as the Capital and operational expenditure (CAPEX and OPEX) and can as such be seen as a 'financial conclusion' of the previous sections.

In the basis, a financial feasibility study involves a cash flow analysis, where the projected cash-flows in the future years are compared to each other. In financially viable projects, the initial cash outflows (like the CAPEX) are compensated over the years by net positive cashflows that are generated i.e., by the sale of products. An important consideration that financiers need to make is whether that compensation of the investment is high and fast enough.

The main aims of the financial feasibility section is:

- Provide insight in the expected financial performance of the investment and its robust-ness.
- Assist the weighing of alternatives by showing the financial consequences of these al-ternatives.

10.2 Information to be provided

Key information to be provided for the financial feasibility section:

- The total capital expenditure (CAPEX) required to implement the project. This involves the costs for designing and building the plant, but also all other costs related to the project, such as costs for permitting, interest during construction, infrastructure, utili-ties, etc. Via so called 'hand factors' these costs can be estimated (see for example (Perry et al. 2000), but to obtain more accurate information it is needed to investigate and calculate these costs, by obtaining offers, price tables, etc.
- The total Operational expenditure (OPEX) and the total revenues are required to deter-mine the yearly cash inflows and outflows. OPEX involves the costs of running the plant (feedstock costs, personnel, utilities, maintenance, etc), but also related costs such as management and overheads, logistics, taxes, license payments, etc. To determine these costs, all relevant inputs and outputs for a plant need to be known.
- Again, quick 'hand factor' methods can be used to estimate these costs; but the use of actual offers, prices, etc., lower the uncertainties.
- The financial structuring of the investment. The question of how the total capital re-quired for the project is brought together is an essential question in any feasibility study.

Often it is a combination of own funds, loans and – if possible – subsidies. The ratio between own funds and loans is called the debt-to-equity ratio. External financial parties such as banks can – dependent on the project – provide either. Loans mean in principle less risks for the financier, also because most financiers require a 'collateral' – an asset that can be sold when the lender defaults. Equity means more risks, and typically investors will require higher returns on an equity investment. When the debt-to-equity ratio is high, the investment is 'high-leveraged'. This means in general that it is risky for the equity investors since they are liable for the debt as well. Part of the information required is the conditions for the loan(s):
  - Loan maturity date – the date the full loan needs to be paid back
  - Interest rate and possible grace period[4]
  - Form of repayment – e.g., linear, annuity
- The discount rate[5] is the interest that determines the costs of capital for the investor.
- Price indices are needed to inflate the cost and revenues over the years. In the last few years inflation has been near zero, which means that this effect is not very prominent, but recently (2022) inflation has increased in the EU to above 8%[6]. A sustained, high inflation means that the return on capital need to be even higher, which means that investment projects are generally less viable.
- Taxes need to be considered in the financial analysis. Usually there is a tax on profit, but there may be other taxes as well.

One way to determine the financial feasibility of a project is to collect the above-mentioned information in a Discounted Cash Flow (DCF) model. There are many such models, ranging from very simple Excel sheets towards highly complicated models that cover many details. In a DCF model the future cashflows are recalculated to a single figure (discounted), taking into account the 'time value of money'[7]. This concept means in short that future income is worth less now because of interest/inflation. Typical outcomes of a DCF model are:

- The Internal Rate of Return (IRR): This is the interest rate that an investment will generate if it is invested in the project. A higher IRR means a more profitable project
- The Net Present Value (NPV): This is the current value of all current and future cashflows. A positive NPV means that the project generates more than the investment
- The Payback time – sometimes called the 'simple payback time' – is the amount of years it takes to recoup the initial investment, and can be used as a quick indicator on the viability of the project. The shorter this is, the more viable the project is.

[4] Grace period = period during which no interest and/or no payback is due.
[5] https://www.investopedia.com/ask/answers/052715/what-difference-between-cost-capital-and-discount-rate.asp#:~:text=The%20discount%20rate%20is%20the,or%20investment%20in%20the%20present.
[6] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Inflation_in_the_euro_area
[7] https://www.investopedia.com/terms/t/timevalueofmoney.asp

The required IRR/payback time is for each project and for each financier different. Generally, if a project is considered riskier, investors will demand a higher IRR. For very low risk projects the IRR can be nearly the inflation rate. Examples of low risk projects are district heating in an existing housing project. These are low risk since the technology is proven and there is a guaranteed off-take. Projects involving IBC production will likely considered riskier because they involve relatively new technology, and off-take is less secure. For comparison, an average IRR of 14-18% is achieved for investments in chemical plants[8]. A summary of the information that needs to be provided is given in Table 7:

Table 7: Financial analysis information requirements

Content	Description
CAPEX, OPEX and revenues	Capital expenditure, operational expenditure, all revenues, and any other relevant cash flow related to the project
Financial structure	Debt/equity ratio, subsidies, loan conditions, etc.
Discount rate, price indices	Financial parameters to conduct the financial analysis
Taxes	All taxes that are levied with respect to the project

10.3 Specific issues

The following specific issues require attention:

- To test the robustness of the financial analysis, it can be useful to conduct a sensitivity analysis. This shows what happens when certain key variables such as product prices are varying
- In IBC projects, the feedstock costs are generally the single biggest factor that determines the financial viability. This means that proper attention should be given to the feedstock sourcing, quality (is a lower quality viable?) and risks.

10.4 Resources

The following information can be useful:

- Background information on Discounted Cash Flow (DCF) models: https://iifpia.org/dcf-model-in-excel-your-complete-guide-to-dcf-valuations/
- Background information on calculating the viability of investments: https://www.aiche.org/sites/default/files/cep/20130934.pdf

[8] https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/chemicals/pdfs/chemical_innovation_an_investment_for_the_ages.ashx

11 Management and Organisation

11.1 Aim

The organisations initiating an IBC project are of prime importance. They should have experience in the field and have the capacity to implement the project. A new IBC project will in many cases also mean a new organisation to operate the plant, for example a Joint Venture of two existing companies. This new organisation needs to be set-up and staffed properly, with a clear mission, mandate, and organisational structures.

The aim of this section in the feasibility study is as follows:

- Show that all the organisations involved can credibly complete the project and that the project fits in their strategic interest.
- Detail the commercial relations between the organisations that cooperate in the project and show that these are appropriate.
- Explain the new organisational structure and show that it is appropriate.
- Explain the experience and suitability of key personnel.

11.2 Information to be provided

The following information should be provided in the feasibility study

Table 8: Management and organisation information requirements

Content	Description
Organisation profiles	Description of all key organisations involved in the project, explaining their strategic interest in the project and their role and their relevant experience. It should be clear that the organisations all have a distinct but necessary role, like capital provision, technology provider, access to feedstocks or markets etc.
Organisational structure	Description of the future organisation; what will be the structure, legal form, shareholders, division of shares, and how will the organisation be able to operate the plant
Key personnel	Profiles and CVs of key personnel showing that they have the required experience to develop and operate the plant.

11.3 Specific issues

The following specific issues should be considered:

- For a partnership to be logical, it is important that the strategic interests of the companies align. This should be confirmed, but it should also follow from the profiles of each organisation.
- In this section it is also good to include information on the financial strength of the organisations, to make clear that future problems with the IBC value chain development can be tackled. Including of annual accounts could be considered to tackle this.
- Any competing interests that the participating organisations have should be identified, and strategies should be developed to ensure that this does not adversely affect the project.

12 Risk Assessment and Management of Risks

12.1 Aim

Risk assessment is an essential part of any feasibility study. Implementing new plants involve many risks, which can make a project unviable. All relevant risks should be properly identified, and their probability and impact should be determined. Also, risk mitigation strategies should be devised and when the project is proceeding, a regular reassessment of the risks should be taking place.

Aims of this section of the feasibility study are:

- A structured identification of project risks, their probability and impact.
- Risk mitigation strategies for the most important risks.

12.2 Information to be provided

Risk identification

Before risks can be properly assessed, its important to identify them. One way of doing that is to go over all risk categories (e.g. technical, commercial, financial) and determine if and how these risks apply to the IBC project. In Annex A an overview of risks, copied from (E4tech et al. 2015) is given, which can be used as a guidance. Other ways to identify risks are talking with experts and evaluate the implementation schedule for activities that could cause delays. It is also useful to cross-check risks with the financial analysis, to identify the activities with the largest impact on the financial viability of the project

Risk assessment

When risks are identified, they can be categorized on two axes, namely 'probability' and 'impact'. The least important risks are the ones with both low probability and low impact, and the most important risks are the ones with a high probability and high impact.

An effort could be made to quantify the probability and impact of risks (say 1% probability and 100,000 Euro impact), but this is often not possible. An alternative is to rate them as 1 (low), 2 (medium) and 3 (high), so that risks can be ordered on a probability x impact scale.

Risk management

Risk management is about devising strategies to manage the most important risks. There are several ways of doing that, here listed in order of preference:

- *Avoidance* – This means that the project is changed so that it won't occur anymore. One example is to secure a long term contract for the sale of the products, so that the risk of price variations is overcome.
- *Transference* – this means that the risk is transferred to another party. One typical example of this is that a technology provider gives performance guarantees on their equipment. Another example is when certain risks can be insured against. Typically, financial parties seek to transfer their risks to others to the maximum extent possible.
- *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. One example is replacing a piece of equipment when it breaks down.

Not all strategies are suitable for all risks. On a case-by-case basis risks and specific mitigation strategies should be paired.

The following information should be provided in the feasibility study

Table 9: Risk assessment and management information requirements

Content	Description
Risk identification and assessment	An overview of all risks, rated on probability and impact, categorised from the highest risks to the lowest
Risk management strategies	Description of ways in which the risks can be managed, and a reassessment of the risk after these risk management strategies have been employed.
Periodic re-assessment of risks	A tentative plan for re-assessment of risks when the project is implemented.

To support the risk assessment and management, a template provided in Annex B can be used. This template was originally published in (E4tech et al. 2015).

12.3 Specific issues

The following specific issues should be considered:

- Within IBC implementation projects, the technical risks are important. Especially a first-of-a-kind plant may not reach full capacity in the first few years or may fall short regarding efficiency and yield. Considerable attention should be given to risk management for the technical risks.
- Feedstock related risks are usually important in IBC projects. There may be problems with security of supply, quality issues, etc. mitigation, like using more suppliers, having

feedstock suppliers as part of the project, and even altering the project scope to reduce these risks should be considered.

- Policy framework should be carefully evaluated as well. Stricter sustainability and GHG savings criteria will probably influence an IBC project, affecting both the potential biomass supply as well as the potential end-uses of an IBC.

13 References

Arranz, Pol, Frederic Horta, and Pere Navarro. 2018. “A Risk Assessment Guideline for Bioenergy Project Finance.” http://www.securechain.eu/wp-content/uploads/SecureChain_Financing_Guidelines_Brochure_2018.pdf.

E4tech, BTG Biomass Technology Group, Biochemtex, and Re-CORD. 2015. “Feasibility Studies for First of a Kind Commercial Sustainable Biofuel Projects : A Guidance Document.” https://ec.europa.eu/energy/sites/ener/files/documents/FeasibilityStudyBiofuelProjects GuidanceDocument_Final.pdf.

Ecofys. 2009. “Benchmark of Bioenergy Permitting Procedures in the EU.” https://fdocuments.net/document/benchmark-of-bioenergy-permitting-procedures-in-the-this-report-describes-the-results.html.

European Commission. 2009. “Bridging the Valley of Death : Public Support for Commercialisation of Eco- Innovation Particularly at These Relatively High Volume Products .” https://ec.europa.eu/environment/enveco/rd_innovation/pdf/studies/exec_summary_bridging_valley.pdf.

Perry, S, Robert H Perry, Don W Green, and James O Maloney. 2000. *Perry’s Chemical Engineers’ Handbook*. *Choice Reviews Online*. Vol. 38. https://doi.org/10.5860/choice.38-0966.

Reumerman, P., J Vos, and T Lammens. 2022. “White Paper Fast Pyrolysis Bio-Oil.” https://www.music-h2020.eu/Deliverables_upload.

Reumerman, Patrick, John Vos, Felipe Ferrari, Magnus Matisons, Alexey Kononov, Gonzalez Olivia Morales, Mark Richters, et al. 2020. “MUSIC D5.5 : Set of Four Strategic Case Studies.” https://www.music-h2020.eu/publications-reports/MUSIC_Strategic_Case_Study_Report.pdf.

Reumerman, Patrick, John Vos, Magnus Matisons, Vesa Kainulainen, Alexey Kononov, Rianne de Vries, Johannes Schürmann, et al. 2021. “MUSIC D5.3 : Set of Four Advanced Case Studies.” https://www.music-h2020.eu/publications-reports/MUSICD5.3SetoffourAdvancedCaseStudies_publicedition.pdf.

Talluri, Giacomo. 2022. “WHITE PAPER : MICROBIAL OIL.” https://www.music-h2020.eu/publications-reports/MUSIC_D6-1_WhitePaperPart3MicrobialOil_FV.pdf.

Wild, Michael, Gilles Gauthier, and Cristina Calderon. 2022. “WHITE PAPER: TORREFIED BIOMASS.” https://www.music-h2020.eu/publications-reports/MUSIC_D6-1_WhitePaperPart1TorrefiedBiomass_FV.pdf.

Annex A: Overview of risks per 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

Annex B: Risk assessment template

						<u>Risk Categories</u> - 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)	Consequences / Impact on Project	Risk Owner[9]	Split (%)	Risk Categories (Please select from list above)	Probability	Impact	Pre-mitigation value[10]	Mitigation actions	Probability	Impact	Post-mitigation value

[9] 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.
[10] The value of the risk should, wherever possible, also be identified as a monetary impact.

Citation, Acknowledgement and Disclaimer

Patrick Reumerman, 24 October 2022
Market Uptake Support for Intermediate Bioenergy Carriers. MUSIC, Horizon 2020 project no. 857806, WP6, D6.3: Guidance Document for IBC Project Development.
BTG Biomass Technology Group BV, www.music-h2020.eu.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 857806.