BIOFIT
Bioenergy Retrofits for Europe's Industry

EU Horizon 2020 no. 8178999
01/10/2018-31/09/2021
www.biofit-h2020.eu

Template for case studies

WP3: Case studies for retrofitting

Deliverable no.	**D3.1 Template for case studies**
Nature, dissemination level	**Report, PU**
Lead beneficiary	**BTG**
Main authors	**Dr J. Spekreijse (BTG), P. Reumerman (BTG), D. Bacovsky (BE2020), C. Dißauer (BE2020), D. Kourkoumpas (CERTH)**
Email lead author	**spekreijse@btgworld.com**
Date, version	**March 2019, 1st version**

btg biomass technology group

BTG Biomass Technology Group BV
Josink Esweg 34, 7545 PN Enschede, The Netherlands
Tel: +31 53 486 1186
www.btgworld.com

Table of contents

1 Introduction

This case study template is set up for the BIOFIT project. However, it holds value for interested parties outside of the consortium as well. This template helps to determine the scope and contents of a case study focusing on a retrofitting scenario. This template is designed for the ten case studies performed within BIOFIT but can be used for other retrofitting scenarios in other projects as well.

The purpose of this template document is to guide the case study teams in their respective case studies. A challenge for the case studies is the differences between each sector and each specific case study topic. Moreover, the scale of the plant under investigation will differ between case studies. Following this template document should ensure that the case studies all follow the same pattern and contain the same information. This template document will help to minimise the differences between the case studies.

The template is not fully descriptive and there is room for the case study teams for interpretation that best suit their respective case study or industry sector. The template can be adjusted to the specific questions that arise from each case study, however, it should be kept in line with the outline of this template in order to guarantee consistency in each of the case studies.

Depending on the case study, the alternative scenario may differ significantly. In some case studies a greenfield or brownfield option would be the most suitable scenario, where other retrofits do not have a feasible scenario for comparison. In this case, other solutions should be found. For example, the comparison could be made between the retrofitted situation and the current situation in order to assess the KPIs for this case study. In any case, the alternative scenario should produce the same main product (in case that the retrofit introduces more bioenergy) or the same biofuel (in case that the retrofit introduces production of a biofuel) and be typical for the industry sector.

The level of detail will vary between the case studies due to information being unknown or highly confidential. Here, it is important to at least obtain a minimum amount of detail in order to answer each bullet and give a definite conclusion for each KPI.

The KPIs determined in the case studies will help to summarise the case studies. Moreover, they can be aggregated in order to provide overall datapoints for the BIOFIT project. They should not be used to compare or rank individual case studies, since too many details will be lost when the case studies are expressed in a handful of numbers.

The authors of this document will be monitoring the overall process of their respective parts of the case studies. This will help to unify the case studies and enable sound comparisons and conclusions.

2 Case study chapters

Brief description of the case study: industry sector, company, location of the facility investigated, main product of the facility, purpose of the retrofit, expected impact.

2.1 Description (CST Leaders)

The first case study chapter is a description of three items: the current situation, the suggested retrofit, and what the alternative would be when no retrofit takes place. These three items should be made clear by the description and by a flow sheet of all three situations.

- **The current situation**

Type and details of industry
Market situation of the industry sector as a whole
The current situation of the plant with a descriptive flow sheet.
Location site details, including plant ownership, geographical location, transport connections (road, rail, port, etc.)
Input and output details (feedstock types and quantities, product types and quantities, energy requirements)

- **Suggested retrofit**

The suggested retrofit of the plant with a descriptive flow sheet.
Description of the retrofit (including feedstocks, conversion technologies, products)
Reasoning for retrofit (new policy, etc.)
Timeline of the retrofit

- **Alternative to the retrofit**

The alternative to the retrofit with a descriptive flow sheet, e.g. a greenfield or brownfield scenario. The most logical alternative will depend on the specific case study.
Describe how the alternative would look like.

2.2 Supply Chain (BE2020)

The supply chain chapter will be led by BE2020. For this chapter the following items will be described for the current situation, the suggested retrofit, and the alternative scenario:

- **Feedstock type and costs (special attention for waste streams)**

Amount and type of annual raw material utilisation incl. the raw material costs.
Share and/or quantities of annual bioenergy or biofuel production

- **Feedstock availability and logistics**

Types of biomass in the focus of the case, incl. sectors of utilisation (also consider situation of competition for a certain type of biomass feedstock)
Situation of available transport infrastructure (roads, highways, ports, etc.)
Current import/export

- **Set up of the supply chain (graphical presentation)**

Description and visualisation of an exemplifying supply chain with all actors involved, including logistics modes used (companies, flows, logistics routes used, transport modes used, quantities & qualities-e.g. raw material assortments, etc.).
A supply chain is a network between a company and its suppliers to produce and distribute a specific product, and the supply chain represents the steps it takes to get the product or service to the customer.

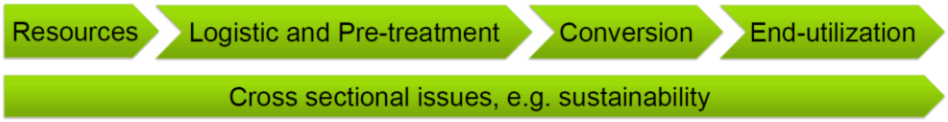

Figure 1: Simplified Supply Chain example

Please evaluate the degree of regional integration, so to what extent does the supply chain remain on regional level and to what extent is it based on import/export.

- **Actors in the supply chain**

The actors shall be described and their role in the case shall become clear (e.g. suppliers, transport companies, customers etc.). Are they important for the case's performance? In what respect?

2.3 Market assessment (BE2020 and case study companies)

In this chapter a market assessment will be performed of the product that the retrofit produces. In the case of the industry using the product itself (e.g. energy), the market of the replaced product should be assessed (e.g. natural gas). Input from and discussion with the case study companies is crucial for this assessment.

- **Potential markets & Market benefits**

Who are the actual and potential customers of the product?
Please specify the utility of the product (characteristics, functional requirements, transport requirements, (potential) areas of applications, etc.)
What are the benefits of your product?
Define the total market broadly enough to include all potential end users so that you can both identify the appropriate drivers of demand and reduce the risk of surprise product substitutions.

- **Market trends and expectations**

Which magazines/journals publish articles that are related to your product?
Which products do have an increasing demand in your products product line?
Specify changes in the product spectrum of the past.
Which perspectives do you expect for your products future?
Which developments on the market impose the highest risk for your product?
Which problem in your products business (in general) would you aspire to solve?
Are there any disruptive technology developments in your products area?
Which accelerated competition did you detect? Is there any competition around that is ahead of your product and which problems does it solve (e.g. price, shortcomings)?

- **Routes to market**

How will you sell your product? (directly to customer, hub, other option)

- **Market penetration**

Which activities do you have in mind to increase the market share of your product? (strategies such as bundling, advertising, lower prices, or volume discounts)
Which markets does your product provides service to and which emerging regions did you identify?
Which market share do you think you will have in different countries? (Formula: Sales volume of a product x 100 ÷ Total sales volume of all competing products)

2.4 Techno-economic assessment (BTG and CST Leaders)

BTG will supervise a techno-economic assessment on each business case. In order to facilitate this, the case study teams are required to assess the following:

- **Technical description**

A complete overview of the current technical situation should be given by use of input and output flows, mass balances and energy balances. The same has to be done for the retrofit and the alternative situation.
The key equipment should be described, and the main process steps highlighted.
The space required and the technical challenges of both the retrofit and the alternative situation should be given.

- **Economic description**

A substantiated estimation of the CAPEX has to be determined for both the retrofitted situation and the alternative situation, where the individual contribution to the CAPEX, including amongst others instalment costs, land costs, and project development, is clearly indicated.

A substantiated estimation OPEX has to be determined for both the retrofitted situation and the alternative situation, where the individual contribution to the OPEX, including amongst others energy costs, costs for waste treatment, operational hours, and (increased) labour requirements, are clearly indicated.
The revenues should be determined by indicating the price of all sold products and their amounts.

- **Economic assessment**

All avoided costs should be listed. Together with the other information provided in this chapter, a final overall economic assessment can be performed. This should lead to the KPIs indicated for the economic assessment.

2.5 Sustainability (CERTH and CST Leaders)

The sustainability aspects include social and environmental aspects. The social aspects will be descriptive and provided by the CST leaders. The environmental aspects of the retrofit will be analysed by CERTH. For these analyses the following items will be developed:

- **Social aspects**

A description of the most important regional social aspects that are identified together with the case study company. Examples include the increase in employment, training of staff members, use of locally sources biomass, or increased traffic from trucks.

- **Policy issues: RED**

The following factors will be determined using the RED II methodology:
Transportation fuel
Renewable energy source blending
GHG reduction

- **Methodology: Environmental assessment**

A preliminary definition of the boundaries needs to be made: Processes to be included/excluded (Supply chain, Transport, Operational, end user)
A set of databases to be applied in the calculations will be selected
A standardised implementation methodology will be used

2.6 Risks (CST leaders)

In order to make a decision on investments, the risks need to be assessed and ranked on importance

- **Risk assessment for the retrofit**

A comprehensive list of risks should be made. Only the risks directly related to the retrofitting and retrofitted situation have to be taken into account. The current situation and alternative can be left out of the scope of the risk assessment.
Determine likeliness/probability of each risk
Determine consequence/severity for each risk
Ranking of the risks in terms of importance based on likeliness and consequence

3 Key Performance Indicators (KPI)

The following items are defined as the KPIs for the business cases in order to evaluate the different cases. The KPIs can also be aggregated to obtain overall numbers for the BIOFIT project. The KPIs should not be used as a comparison between the case studies or as a ranking tool, since the KPIs will quickly result in unfair comparisons between the different scenarios.

Each KPI will be calculated separately and even though some KPIs may be interconnected (such as biomass use and bioenergy production), they will all be independently evaluated and discussed.

For the KPIs determined by the CST leaders, a fill-in form is available in order to guarantee identical calculation methods. For the remainder of the KPIs, the project partner responsible for the calculation will ensure a single method is used for the KPI determination.

3.1 Technical (CST leaders)

The following technical KPIs are defined:

- **Increase in biomass converted per year**

  The increase in biomass conversion for the retrofit compared to the current situation should be determined. This can be determined by taking the yearly biomass input (on dry weight) for the retrofitted situation and subtracting an averaged yearly biomass input for the current situation. The same should be done for the alternative case, where the same amount of product is made.

- **Increase in bioenergy or biofuel generated per year**

  A net increase of bioenergy or biofuel production should be determined for the retrofitted situation and compared to the current situation. This can be calculated by taking the LHV energy value of the yearly produced bioenergy or biofuel and subtracting the yearly average of the current situation.

3.2 Economic (CST leaders and BTG)

The following economic KPIs are defined:

- **Internal rate of return; IRR (BTG)**

  Based on the data provided by the economic assessment from the CST, the internal rate of return will be determined.

- **CAPEX reduction compared to alternative (CST leaders)**

  The CAPEX reduction can be calculated by subtracting the CAPEX required for the retrofit from the CAPEX required for the alternative scenario. The obtained CAPEX reduction

should then be normalised on the annual capacity of the main product. This will result in a reduced CAPEX per GJ/yr added capacity.

3.3 Environmental (CERTH)

Environmental KPIs will be determined by CERTH, indicative environmental KPIs are:

- **Carbon dioxide Equivalent Emission Reduction of supply chain and operation**

Greenhouse Gases (GHGs) are gases in the atmosphere that absorb infrared radiation that would otherwise escape to space; thereby contributing to rising surface temperatures. There are six major GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). Emissions of other gases can be converted to CO_2 equivalents through specific methodologies. Since the main sources for CO_2 emissions are combustion processes related to energy generation and transport, CO_2 emissions can therefore be considered a useful indicator to assess the contribution of retrofitting on climate change.

- **Increased efficiency of resources consumption**

Percentage and mass reduction in non-renewable material consumption of the project. As proposed in the “Clean Energy for All Europeans”, the target for renewable energy consumed should reach 32%. Through assessing the specific KPI, the renewable share of energy will be monitored and thus the expectation will be met. [“Clean energy for all Europeans | Energy.” [Online]. Available: https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans. [Accessed: 22-Jan-2019].]

Citation, Acknowledgement and Disclaimer

J. Spekreijse, P. Reumerman, D. Bacovsky, C. Dißauer, D. Kourkoumpas, 2019.
Bioenergy Retrofits for Europe's Industry. BIOFIT, Horizon 2020 project no. 817999, WP3, Template for case studies, D3.1. BTG Biomass Technology Group BV, Enschede. www.biofit-h2020.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 817999.

KPI BASIC INFORMATION			
Name	Increase in biomass converted per year	**Acronym**	**Biomass**
Description	The increase in biomass conversion for the retrofit compared to the current situation.		
Formula (if applicable)	Biomass use in retrofitted situation (dry weight) – Current biomass use (dry weight)		
Units of Measurement	Dry ton	**Responsible partner** [1]	
		In accordance with… [2]	
KPI CALCULATION PROCEDURE			
Measurement procedure [3]	1. Data collection 2. KPI calculation		
KPI BOUNDARIES			
Boundaries of the assessment [4]	**Included in the assessment**	**Excluded from the assessment**	
KPI RESULTS			
Alternative scenario [5]	To be calculated		
Retrofitting scenario [6]	To be calculated		
GENERAL COMMENTS			

[1] Partner in the CST responsible for the calculation of the KPI

[2] Partners involved in the calculation of the KPI, coordinated by the partner in 1

[3] The procedure which will be followed for the utilization of the KPI

[4] The boundaries of the KPI assessment – procedures that are included or excluded from the assessment

[5] Value of the KPI in an alternative scenario

[6] Expected value of the KPI after the retrofit

KPI BASIC INFORMATION			
Name	Increase in bioenergy produced per year	**Acronym**	**Bioenergy**
Description	The increase in bioenergy production for the retrofit compared to the current situation.		
Formula (if applicable)	Bioenergy produced in retrofitted situation – Current bioenergy production		
Units of Measurement	GJ	**Responsible partner** [1]	
		In accordance with… [2]	
KPI CALCULATION PROCEDURE			
Measurement procedure [3]	1. Data collection 2. KPI calculation		
KPI BOUNDARIES			
Boundaries of the assessment [4]	**Included in the assessment**	**Excluded from the assessment**	
KPI RESULT			
Retrofitting scenario [5]	To be calculated		
GENERAL COMMENTS			
Please use LHV for biofuels.			

[1] Partner in the CST responsible for the calculation of the KPI

[2] Partners involved in the calculation of the KPI, coordinated by the partner in 1

[3] The procedure which will be followed for the utilization of the KPI

[4] The boundaries of the KPI assessment – procedures that are included or excluded from the assessment

[5] Expected value of the KPI after the retrofit

KPI BASIC INFORMATION			
Name	CAPEX reduction	**Acronym**	**CAPEX reduction**
Description	The reduced CAPEX of the retrofit compared to the alternative situation.		
Formula (if applicable)	CAPEX required for the alternative scenario – CAPEX required for the retrofit		
Units of Measurement	Million EURO	**Responsible partner** [1]	
		In accordance with… [2]	
KPI CALCULATION PROCEDURE			
Measurement procedure [3]	1. Data collection 2. KPI calculation		
KPI BOUNDARIES			
Boundaries of the assessment [4]	**Included in the assessment**	**Excluded from the assessment**	
KPI RESULTS			
Retrofitting scenario [5]	To be calculated		
GENERAL COMMENTS			

[1] Partner in the CST responsible for the calculation of the KPI

[2] Partners involved in the calculation of the KPI, coordinated by the partner in 1

[3] The procedure which will be followed for the utilization of the KPI

[4] The boundaries of the KPI assessment – procedures that are included or excluded from the assessment

[5] Expected value of the KPI after the retrofit