



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

Report on drivers and barriers for retrofitting

WP 4: Industry Platform – Market uptake

Deliverable no.	D4.2
Nature, dissemination level	Report, public
Lead beneficiary	DBFZ
Main authors	Niels Dögnitz
	Stephanie Hauschild
	Arne Gröngröft
Email lead author	Niels.Doegnitz@dbfz.de
Date, version	7 th of Dezember 2020, Version 3



Table of contents

Executive summary	3
Objective	4
Method	5
Conception	5
Dissemination activities	6
Evaluation	7
Results	8
Participants	8
Drivers	1
Barriers12	2
Discussion and Conclusion	5
Drivers	5
Barriers19	9
Overall assessment 22	1
Conclusion	3
Annex	5
Annex 1 Online survey 25	5
Annex 2 All drivers and barriers	D
Annex 3 Drivers and barriers within the survey	2



Executive summary

This deliverable reports the results of the survey on drivers and barriers for bioenergy retrofitting, which will be considered in the sectoral recommendation papers (D4.3 Sectoral recommendation papers on conditions and options for retrofitting in five industrial sectors). The aim is to identify the most relevant drivers and barriers for the uptake of bioenergy retrofitting and to estimate the influence of these driver and barriers in the BIOFIT industry sectors.

Important drivers, identified by this survey, are the higher flexibility of the plant, the achievement of the climate goals and less production time losses. Main barriers prohibiting retrofitting are an instable regulatory framework, the limited availability of adequate amounts of biomass and the missing coordination between EU and national/country policies.

For the evaluation, the drivers and barriers have been clustered in technical, economic, environmental and political categories. The most relevant drivers are linked to the environmental and the technical category. The industry that has not retrofitted so far, pay less attention to the entrepreneurial drivers (better corporate image, diversification of product portfolio) and needs obviously strong political drivers to start retrofitting.

The results point out that (especially technical) drivers differ from sector to sector, so sector-wise recommendations are necessary to foster bioenergy retrofitting. Across all sectors the most relevant barriers have a long-term relevance, especially a stable regulatory framework could be estimated as crucial. These barriers could be reduced by political decisions with long-term innovation and investment strategies.

In sum, a great number of drivers could be identified to effectively boost bioenergy retrofitting. But first, several barriers must be addressed to bring more retrofitting investments in the industry sectors.



Objective

Within the BIOFIT project several activities focus on evaluating bioenergy retrofitting. Part of these activities is this survey on the drivers and barriers for bioenergy retrofitting. The aim is to work out the essential results, to present them clearly and use the findings in different recommendation activities within the BIOFIT project. Analysing the drivers and barriers for bioenergy retrofitting from the industry perspective can lead to essential insights and foster the further integration of bioenergy in commonly fossil-based industries. The industry representatives know best what has been hindering them so far or what have been causing them to integrate more biomass in their processes.

Throughout the project, the survey focuses on five different industries: first-generation biofuels, pulp and paper (P&P), fossil refineries, fossil-fired power, and combined heat and power (CHP). However, the survey was open to answers from other industry sectors as well. It was mainly aimed at industry that have not yet been retrofitted, to learn from their barriers, but responses from the retrofitted industry were also welcome and needed for comparison.

The focus of the survey is on technical, economic, environmental and political drivers and barriers for retrofitting on plant level. Therefore, the following research questions should be answered:

- What are the most important drivers and barriers at plant level for the uptake of bioenergy retrofitting?
- How relevant are these drivers and barriers in the examined industry sectors, especially for those companies that has not retrofitted?
- Which central statements can be derived from the answers and which indications can be given for following recommendations?

The aim of this survey is to evaluate the drivers and barriers for bioenergy retrofitting.

As a result, the main drivers and barriers for each sector and the not retrofitted industry should be highlighted. Furthermore, indications for following recommendations should be given.



Method

Conception

The online survey consists of 13 questions. To assess the drivers and barriers, the main part of the survey includes two closed multiple choice questions. These questions are comprised of eleven subordinate questions about the classification of drivers and barriers, in addition these questions are open for comments.

The survey was been built using LimeSurvey (limesurvey.org) and the original text of the survey can be found in Annex 1.

The preparation of the survey has begun with the selection of relevant drivers and barriers, using the following sources:

- The findings from the BIOFIT handbook [1]
- Results of the first BIOFIT industry forums (later in the project published as Deliverable D4.4 [2])
- The results of the first BIOFIT industry survey in "Motivations, experiences, and perceptions in best practice cases of retrofitting" (Deliverable D2.3 [3])
- Publication on drivers and barriers for large scale retrofitting [4]

In sum, 20 drivers and 23 barriers have been extracted from these references and are shown in Annex 2. As part of an assessment process, these drivers and barriers are summarised and reduced to 14 drivers and 18 barriers in order to shorten and precise the survey (to be found in Annex 3 with a description). The selection is based on merging similar aspects and removing less relevant aspects from the list, following a review by the BIOFIT Industry Advisory Board (IAB) [5].

The survey structure is based on a study on sample design for industry surveys [6] and additional literature [7]. Aspects from the survey in Task 2.3 [3] and from other projects (survey structure [8], evaluation figure [9]) are also included. The draft of the survey has been provided to project partners and the BIOFIT IAB for comments and test runs.

In sum 14 drivers and 18 barriers are ranked in the survey.



Dissemination activities

In order to get a high number of responses, the survey has been distributed as a broad online survey. To reach this goal, it has been advertised by social media during the events in Task 4.3 of the BIOFIT project: Namely the industry forums on biofuels in Madrid, on pulp and paper (online) and the BIOFIT workshop at the e-EUBCE. Due to covid-19, less events (and most of them online) took place during the assessment period of the survey. In addition, the survey has been distributed to all project partners with several mailing campaigns. The project partners include the 14 project partners and the associated partners within the case studies.

As additional mailing channel all respondents of the first BIOFIT online survey and all relevant associations in Europe where addressed by the mailing campaign. In total, more than 110 private mailings where send out with the request to spread the information of the survey to further addresses. During the assessment time of the survey it has been advertised on the BIOFIT website and the Website of the DBFZ (Deutsches Biomasseforschungszentrum gemeinnützige GmbH).



The survey was advertised by webpage links, mailing and social media campaigns.

Figure 1 Banner to advertise the survey online

As an additional distribution option an online campaign has been set up within the online business network LinkedIn to reach the broader online community. With the banner displayed in Figure 1 the campaign attracts interest of more participants. With this advertisement 53,401 impressions could be reached within the network, which resulted in 146 clicks on the survey link.



Evaluation

In order to evaluate the results of the drivers and barriers, the scope of the questions is summarized into one number. Therefore, the answers (Y) in the categories crucial, relevant, hardly relevant and irrelevant are spread uniformly on a number line between 0 and 1, with 1 being crucial and 0 being irrelevant. This leads to the single parameter *REL* (for relevance) for each driver and each barrier. Thereby, the aspects are easier to compare. The calculation can be represented by the following equation:

$$REL_{driver/barrier} = \frac{Y_{crucial} + \frac{2}{3}Y_{relevant} + \frac{1}{3}Y_{hardly \, relevant}}{\sum Y_{all}}$$

Since this parameter does not represent the exact evaluation, it is only used in the discussion and conclusion section of this document to enable an easy comparison of the drivers and barriers.



Results

Participants

The survey page has been visited 2,321 times, even though only 45 answers have been sent in total. The participants of the online survey came from four relevant sectors (Figure 2). No participants were registered from the fossil refineries sector, as there are only a few companies overall in Europe apparently and the contact through the project consortium did not reach them. 21 percentage of the survey participants work in other sectors (Research Centre, biogas, second generation biofuels) industrial services, which are not originally addressed in the BIOFIT project.



Most of the participants work in the first-generation biofuels and CHP sectors.

Figure 2 Sectoral distribution of the participants in the online survey

The survey collected answers from 13 different countries all over Europe (also an answer from Canada was recognised), as can be seen in Figure 3.

Stakeholders from 14 countries took part in the survey.





Figure 3 Countries in Europe with participants in the online survey

The participating companies have a quite different implementation status about bioenergy retrofitting. In the survey, one third had carried out a retrofit, another third had not done retrofitting so far, while the last third indicated that there is nothing to retrofit at all. This can be derived from Figure 4.



64% of the participants have no retrofitting experiences so far.

Figure 4 Answers to the question "Have any bioenergy retrofitting measures, according to the definition above, been implemented in your company yet?"

Some companies, which have already done retrofitting, share their previous efforts as additional information. A selection is compiled in Table 1. The documented retrofits show the broad spectrum of retrofitting within the BIOFIT sectors. These reach from trial runs with biomass to a complete conversion of factory parts.



Table 1 Answers to the question "Please describe the retrofit you are referring to (e.g. Co-feeding biomass, Integration of biomass in the production, utilization of bio-oil...):"

Sector	Denoted Retrofitting
combined heat	Biomass co-firing trial runs
and power plants	In [our plant] [], 2012 [a] [] biomass steam boiler (SB)[with] 16MW [power] was installed [, also a] flue gas condenser (4.7MW). [The] Flue gas condenser increase [the] common system efficiency that recovers the latent heat from SB polluted flue gas and additional supply recovered heat to the district heating network.
	Co-feeding biomass
first-generation biofuels	High pressure esterification system for the use of biomass (animal and vegetable fats and oils with high FFA (free Fatty acid), considered waste & Residues (RED-II, Annex IX, Part A)
	Production of biodiesel entirely from waste oils and fats
	Integration of waste feedstock (UCO) into the production
	Substitution of energy crops for food utilization with another feedstock. Application of agronomical techniques to avoid food/feed vs bioenergy competition reducing ILUC risk
fossil firing	Complete conversion of two former coal fired units to fire 100 %
power	biomass (one with white pellets, other with steam exploded black pellets)
pulp and paper	Biomethane

Beside the status of bioenergy retrofitting within their companies, the participants had to evaluate the retrofitting percentage within their sectors, as shown in Figure 5. The retrofitting term, as used in the BIOFIT project was therefore explained at the beginning of the survey (Annex 1). Only 6 % claim that more than 70 % of the companies in their sector have already performed retrofitting activities. The majority of a half see the retrofitting percentage by less than 30 % and 19 % see no bioenergy retrofitting within their sectors (mainly from the biofuels and other (Research Centre) sectors).



Most of the participants evaluate the retrofitting level in their sector in a low percentage.

Figure 5 Answers to the question "To what extend do you think your competitors have applied bioenergy retrofitting in the last 10 years?"



Drivers

The main objective of the survey focusses on evaluating various drivers and barriers for bioenergy retrofitting. At first, the 14 drivers should be evaluated, which could be rated from crucial to irrelevant. The results of this evaluation are shown in Figure 6, ordered by the most crucial answers.

All drivers are rated merely as relevant or crucial (70 – 95 percentage of all answers), only the rating between crucial and relevant is slightly different. More than 50 % of the participants rated "Flexibility of the plant" as a crucial driver, more than 40 % selected "Achievement of the climate goals" and "Less production time losses" as a crucial driver. Further evaluations of the drivers can be found in the conclusion chapter.

Important drivers for retrofitting are the flexibility of the plant, achievement of the climate goals, less production time losses, low emissions and diversification of product portfolios.





The final question of the survey is addressed to those who already retrofitted: "Please provide the two most important arguments for bioenergy retrofitting (further)", the answers, sorted by sector are listed in Table 2. The drivers are ordered by sector here because of the partial explicit sector specific drivers. On the other hand, some respondent answered for all sectors, even though they were likely just expert in one of them, so the named sector in the table means only the sector of the respondent.



Table 2 Selected driver named as reason to retrofit (further), (corrected spelling)

Sector	Named driver as reason to retrofit		
pulp and paper	Less fossil CO ₂ emission (even more less than 1.)		
combined heat	Environmental benefits		
and power	Emissions reductions/ CO ₂ cut		
plants	Coal use decreasing		
first-generation biofuels	Long-term legislative security both at the European and country level, in order to undertake investments, which are expensive and take a long time to develop and implement		
	Conversion of existing production asset to bioenergy saves financial resources as well as natural resources		
	New incentives schemes for bioenergy		
	More economic aids for developing new technologies to use new raw materials of the RED-II, Annex IX, Part A		
	In some cases, it might decrease timeframe necessary for commissioning new bioenergy production unit (compared to green field solution)		
	Reduce feedstock costs		
Other sectors	Objective is to constantly lower emission of plants		
(2G-biofuels)	Build flexibility around raw materials		

The vast number of the stated drivers are already implemented in the survey (e.g. environmental benefits, CO_2 cut). As additional drivers there are mainly named sector specific drivers, which has been spared in this survey to keep the survey open for all five addressed sectors. Apparently, all the important drivers were dealt with within the survey.

Barriers

The questioned 18 barriers are rated from crucial to irrelevant. The results of this evaluation are shown in Figure 7, sorted according to the most crucial answers.

Important barriers that prohibit retrofitting are the lack of stable regulatory framework, limited availability of adequate amounts of biomass, missing coordination between EU and national/country policies and missing guarantee schemes to promote investments in risky innovations.

BIOFIT EU Horizon 2020 no. 8178999 Report on drivers and barriers for retrofitting





Figure 7 Answers to the question "How relevant do you think the following barriers are for the decision to retrofit?"

The most crucial rated barrier "no stable regulatory framework" affects not only the retrofitting but also greenfield plants. Nevertheless, it is rated as the main barrier that prohibits retrofitting. Other important barriers also effect the regulatory frame especially the missing coordination between EU and national policies and missing guaranteed schemes to promote risky investments. Another field of relevant barriers affects the local availability of the needed amount of biomass.

Comparable to the Drivers section, at the end of the survey the final question, addressed only to those who have not retrofitted yet: "Please provide the two most important arguments for not bioenergy retrofitting (further)". Selected answers, sorted by sector, are listed in Table 3.

As also seen in the Drivers' chapter the main barriers are named here again. Especially the unstable political framework and the availability of biomass are an issue. Main arguments not to consider retrofitting are the fact that the technologies are relatively new and lack of ideas what to retrofit. Nevertheless, it seems all relevant barriers are included in the survey. The participants also formulate the assessment that significant modifications have already been implemented, from which it could be deduced that there are missing or unknown alternatives / perspectives.



Table 3 Selected barriers named as reason not to retrofit (further), (corrected spelling)

Sector	Named barrier (or comments) as reason not to retrofit
combined heat and power plants	Unstable long-term legislations
first-generation biofuels	Plant is the state of the art for second generation biodiesel. /Our technology is very new
	Unstable political framework/the political framework is not stabile enough
	too expensive/too little profit
	Volatility of road transport biofuels market in the coming years
	limited feedstock availability
fossil firing power	Last solid fuel units in fleet already converted
	Low regional demand for electricity
pulp and paper	All Things Done so far
Other sectors (2G-biofuels)	Biofuels in Switzerland have to be waste-based. This limits the amount of raw-materials.



Discussion and Conclusion

Drivers

This survey focuses on drivers and barriers in four different categories given by project team: technical, economic, environmental and political. The driver-related results from the survey are presented in Figure 8, sorted by these categories. Some drivers cannot clearly assign to one category, in these cases the most appropriate category is chosen. Assigning some drivers to several sectors would make the evaluation more confusing than it would be clearer. The evaluation should focus more on the individual statements than on the categories.

The results in Figure 8 can be interpreted along the four different categories. Thereafter, environmental and technical drivers are the more relevant drivers (with REL > 0,68 in both categories). The results of the political drivers are strongly related to the environmental drivers, as the driver "high target for emissions reduction" could also be environmental driver. But all in all, the other political drivers are rated lower (REL = 0,57 - 0,65). Also, the economic drivers seem to be less important (REL = 0,61 - 0,68).



The drivers and barriers are clustered in four categories:

- Technical
- Economic
- Environmental
- Political

Themaindriversareattributedtotheenvironmentalandthetechnical categories.

Provision of technical solutions is an appropriate option to foster retrofitting.

Figure 8 Results of the drivers sorted by category

As a conclusion it seems that the environmental drivers must be set by the society and the politicians and the technical solutions must be





provided to foster retrofitting. As the environmental conditions are only marginally changeable by an organisation or state, the required technical solutions are the most appropriate option to get retrofitting ready to start.

To gain more detailed information about the single drivers the answers are divided in the two groups of participants: "Industry with bioenergy retrofitting" or experienced retrofitters (ER) and "Industry with no bioenergy retrofitting" or non-retrofitters (NR). Using the four categories from above, the allocated results (represented by the parameter *REL*) are illustrated as radar chart in Figure 9. In this chart the distance of a point from the centre symbolizes its relevance. Results in the centre represent irrelevant drivers, the more the results head to the periphery the more crucial is this driver. The answers from the ER are coloured grey, from NR in red. Some answers from both groups show no relevant difference in the REL, e.g. for the technical drivers. It seems, that these drivers can be ranked similar by both groups with their professional expertise.



Industry that has not retrofitted so far could learn from the retrofitted industry, e.g. by best-practise examples.

Economic impacts of retrofitting have to be highlighted comprehensively to foster retrofit activities.

Industry with bioenergy retrofitting

Figure 9 Agreement on retrofitting drivers depend on the status of retrofitting sorted by categories

The relevance of the drivers in the economic category differ much more. Interestingly the positive effect of retrofitting for economic aspects (corporate image, diversification product portfolio) are rated higher by the ER. With their experience from their own retrofitting, they seem to have more confidence in these effects of retrofitting. On the other hand, The industry that haven't retrofitted yet need strong political signals to start the process.



the risks are maybe underestimated by the NR, the ER seem to have negative experience with this topic. In the future, the positive economic benefits must be better highlighted to the NR, without hiding the entrepreneurial risks.

Within the political drivers, a strong hope from the NR for a CO₂ tax and penalising of fossil fuel use is visible. Clearly this would help the industry to start retrofitting. As they have already acted, the ER does not demand such political statements. It could be that they have an intrinsic motivation and need no external impulse.

Environmental drivers are more important in the ER. All drivers in this category are rated with less importance by the unfitted industry. The lack of the awareness of the importance of environmental factor maybe hinder the industry to retrofit. This could be changed by highlighting the social and economic benefits from climate protection.

Unfortunately, there are not enough answers to the survey from all BIOFIT industry sectors to be able to compare all five industries. Only for the CHP, P&P and biofuels sector, the number of answers suffices to have a validated statement.

In Figure 10 the calculated *REL* of all three considered sectors are shown, in a radar chart comparable to Figure 9.

The extent of the impact of the technical drivers depend strongly on the respective sector, in the P&P sector production time is essential, while in the biofuels sector flexibility and fast implementation play a very important role. In the CHP sector the importance of all technical parameters is similar high. Further recommendations have to focus on the individual sector relevant technical conditions, overall technical drivers don't exist.

The importance of the environmental drivers isn't seen by the not retrofitted industry.

Further recommendations have to assume to the special technical conditions of the different sectors, while overall drivers don't exist.





Figure 10 Agreement to retrofitting drivers depend on the industry sector sorted by categories

The economic drivers are almost irrelevant for the P&P sector, for the CHP and biofuels sector the economic drivers seem to be as relevant as the other categories. For sure the economic drivers cannot stand alone in the argumentation for bioenergy retrofitting.

The political drivers play an essential role in the CHP sector. Here, politics can influence the development of bioenergy retrofitting. In the other sector this influence is low.

Analogously the environmental drivers are ranked, these have the most relevant role in the CHP sector. Low emissions and clean (green) energy seem to be crucial for retrofitting in this sector. Future communication on retrofitting recommendations should be focused on stakeholders in this sector.

It can be considered that all the sectors must be treated with their own incentives. In an argumentation for bioenergy retrofitting, not a single driver can play a key role, rather it must be an overreaching argumentation with an inclusion of the sector relevant drives. To address the industry more precisely sector-wise recommendations are necessary.

Relatively to the other drivers, economic aspects are less relevant in the P&P industry than in the other sectors.

Essential effects of political drivers can mainly be seen in the CHP sector.

Environmental aspects must address in the communication in the combined heat and power sector.

Sector-wise recommendations are necessary to foster retrofitting in the considered sectors.



Barriers

Following for answers concerning the barriers the parameter *REL* is calculated. As it can already be seen in Figure 7 the barrier "no stable regulatory network" is by far the most relevant barrier. Based on that evaluation it can be assumed, that in general long-term barriers are more relevant than short-term barriers. To proof this, the barriers are sorted by the categories long- and short-term in Figure 11. In general, barriers with an impact of more than 5 years are assessed as long-term, shortterm barriers are those which could have changed completely during this period. Again, not every barrier can be sorted to one of these categories, some barriers don't have a clear time relevance, so all barriers are sorted to the most appropriate category. Figure 11 shows that the four highest ranked barriers ("No stable regulatory framework", "No coordination between EU and national/country politics", "High complexity of the process/plant", "No guarantee schemes to promote investments in risky innovations") have a long-term impact. This is not only valid for retrofitting investments but also and moreover, because of the higher investments, relevant for greenfield plants. Nevertheless, a retrofitting investment bears risks and will not be realized without a long-term stable regulation. So, with the advantage to gain lower capital expenditure (CAPEX), less production time losses and lower risk, retrofitting investments also need stable regulatory framework.

Long-term barriers most often prevent investments. In particular, stable regulatory frameworks are the common request of the survey participants.



Figure 11 Results of the barriers sorted by long-term/short-term relevance of the barriers



As in the Driver's section, the different relevance of the barriers in the evaluated three sectors should be compared. Figure 12 depicts the radar chart for the barriers to retrofitting.



Figure 12 Barriers for bioenergy retrofitting sorted by sector

The technical barriers are truly relevant in the biofuels sector. This is probably due to the complexity of the biofuel production processes. Mostly a retrofitting of the whole plant is necessary. In the other sectors partial components can be retrofitted more easily, therefore in the CHP and P&P sector these technical barriers are less relevant.

For all sectors, but especially in the P&P sector, the barrier "CAPEX of biomass integration facilities is relatively high", is important in the economic category.

All sectors voted for a stable political framework and in the biofuels sector this is by far the most crucial barrier. In the P&P industry the political barriers are seen most important in hindering retrofitting investments. These data indicate political circumstances as the crucial barrier for all industries.

The environmental barriers have a strong relation to the political barriers. Accordingly, they are comparably relevant in all sectors. While in the CHP sector instruments for the financial support for CO_2 reduction are crucial, in the biofuels sectors a lack of adequate amounts of biomass is the most important barrier in this category.

The complexity of the biofuels plants hinders retrofitting in this sector.



Compared to the drivers, the barriers differ less across the different categories. Similarly, the lack of a stable regulatory framework makes retrofitting investments difficult. Also, other long-term barriers are important and could be reduced first of all by politics with a long-term innovation and investment strategy.

Overall assessment

In the chapters above drivers and barriers have been evaluated separately. Though the assessed drivers and barriers are not directly comparable, an overall assessment is possible through the findings in the different categories. To evaluate these drivers and barriers, the different categories altogether are compared. Therefore, an average of the *REL* for every category is calculated. The results of this, divided in the three evaluated sectors, are shown in Figure 13.

At the first glance it is visible, that the drivers are generally rated more relevant than the barriers, which is seen as a positive signal by the survey initiators. The drivers are easier adjustable than the barriers and often just have to be promoted better to let more industry representatives know about their benefits. Nevertheless, a reason for the general differences could be the generally meaning of the drivers. So, more companies may identify themselves with statements like "low emission" than a more complex context like "no instruments for financial support for CO2 reduction measures". The wish for valid driver to foster retrofitting could also be much higher than a problem focussed barrier.

Anyway, the ratings are individually distributed over the sectors. While within the CHP sector the differences are relatively high, they are comparable high in the biofuels sectors. In the P&P sector, in sum the barriers are rated higher than the drivers.





Figure 13 Evaluation of the drivers and barriers in the three sectors

So again, each sector must be treated individually, with all sectors having a stronger focus on the environmental drivers. For the barriers decisive solutions should be presented for individual problems. It makes sense to address political barriers first and associate them to the environmental barriers. An individual treating of the sectors seems necessary to foster retrofitting.



Conclusion

This publication presented the results of the survey on drivers and barriers for bioenergy retrofitting. To sum up these results the research questions formulated in the objectives section should be answered:

- What are the most important drivers and barriers at plant level for the uptake of bioenergy retrofitting?

It turns out that technical and environmental drivers predominate. Important barriers arise from the unclear long-term development, especially the future political framework.

- How relevant are these drivers and barriers in the examined industry sectors and especially for those companies that haven't retrofitted?

There are huge differences in the relevance of the examined drivers and barriers between the sectors considered, which is why for recommendations the sectors should be addressed individually in the future. The environmental drivers being assessed as less relevant in the industry that has not yet been retrofitted.

- Which central statements can be derived from the comparison of the answers and which indications can be given for later recommendations?

In sum, a number of technical and environmental drivers could be identified to effectively boost bioenergy retrofitting. Based on these drivers further sectoral specific recommendations should be formulated. But nevertheless, several long-term barriers must be reduced to bring more retrofitting investments in the industry sectors.



References

- D. Rutz, R. Janssen, P. Reumerman et al., "TECHNICAL OPTIONS FOR RETROFITTING INDUSTRIES WITH BIOENERGY," 2020, www.biofith2020.eu/publications-reports/BioFitHandbook-2020-03-18.pdf.
- [2] DBFZ, "Documentation of the WG Meetings and B2B matchmakings: Deliverable 4.4," 2021.
- [3] G. Nuhoff-Isakhanyan, J. Verstegen, and L. Mellink, "Motivations, experiences, and perceptions in best practice cases of retrofitting: Report, confidential," Wageningen Economic Research, 2019.
- [4] A. Veenstra, P. Kaashoek, K. van Deelen et al., "Drivers and barriers for large scale retrofitting in the Netherlands: And the role of Climate-KIC," 2016.
- [5] BIOFIT, "Industry Platform: BIOFIT Industrial Advisory Board (IAB)," 10/2/2020, https://www.biofit-h2020.eu/industry-platform/.
- [6] L. Donzé, R. Etter, N. Sydow et al., "Study onSample Design for Industry Surveys," Swiss Federal Institute of Technology (ETH), https://ec.europa.eu/economy_finance/db_indicators/surveys/doc uments/studies/eth_kof_2004_final_report.pdf.
- S. Schumann, Repräsentative Umfrage: Praxisorientierte Einführung in empirische Methoden und statistische Analyseverfahren, Oldenbourg, München, 2012.
- [8] "OSCAR-H2020," https://oscar-h2020.eu/.
- [9] A. Uslu, R. J. Detz, and H. Mozaffarian, "Barriers to advanced liquid biofuels & renewable liquid fuels of non-biological origin: Key barriers to advanced fuels - Results of the stakeholder consultation," www.advancefuel.eu/contents/reports/advancefueld11-key-barriers-final.pdf.



Annex

Annex 1 Online survey

Annex 1 contains the original text of the whole BIOFIT Retrofitting Survey. The survey is split in the three parts introduction, Drivers and barriers for bioenergy retrofitting, General questions.

1. Introduction

Dear participant,

thank you for your interest and assistance in assessing the technical, economic, environmental and political drivers and barriers for retrofitting on plant level. Please direct your questions or feedback per mail to Mr. Niels Dögnitz. For more information see https://www.biofit-h2020.eu/

Dear participant, thank you for contributing information on your personal experiences with and knowledge about bioenergy retrofitting. The survey will take about 5-10 minutes. The goal of this survey is to learn more especially about the particular drivers and barriers for bioenergy retrofitting in order to highlight these in the BIOFIT 2020 projects' policy documents. It is one of the projects' core objective that these shall then be addressed by the EU and national policy makers.

Before filling out the survey please note:

The projects' understanding of bioenergy retrofitting: The bioenergy retrofits studied in the BIOFIT project are technical measures applied to existing production plants that support bioenergy utilization as an alternative to fossil energy. The retrofit measures can result in either of the following: A. Using additional biomass as an input to the production plant

• for primary bioenergy products

• for process energy

B. Producing additional output from biomass at the production plant

- Heat and/or electricity
- Intermediate bioenergy carriers
- Transport biofuels



A short summary of the project itself: "Besides erecting entirely new bioenergy plants, retrofitting – i.e. replacing a part of a factory or installation with state-of-the-art equipment – can be a very good alternative to replace fossil fuels or to upgrade renewable technology. The BIOFIT project will support and initiate bioenergy retrofitting opportunities in five industry sectors, namely first-generation biofuels, pulp and paper, fossil refineries, fossil firing power and Combined Heat and Power (CHP) plants.

1: Which of the following sectors would you most likely assign your company to?

Please choose only one of the following:

- O first-generation biofuels
- O pulp and paper
- O fossil refineries
- O fossil firing power
- O combined heat and power plants
- Other

2: Have any bioenergy retrofitting measures, according to the definition above, been implemented in your company yet?

Please choose only one of the following:

- OYes
- O No
- O Nothing to retrofit

2a: Please describe the retrofit you are referring to (e.g. Co-feeding biomass, Integration of biomass in the production, utilization of bio-oil,...):

Please write your answer here.

2. Drivers and barriers for bioenergy retrofitting

3: How relevant – either from your personal experience or in your professional opinion – are the following drivers for the decision to retrofit?

Please choose the appropriate response for each item:

	irrelevant	hardly relevant	: relevant	crucial
Flexibility of the plant	0	0	0	0
Fast implementation	0	0	0	0
Diversification of product portfolios	0	0	0	0
Less production time losses	0	0	0	0
Available expertise within the company	0	0	0	0
Low entrepreneurial risk	0	0	0	0
Better corporate image	0	0	0	0
Achievement of the climate goals	0	0	0	0



irrelevant hardly relevant relevant crucial

The EU ETS penalizes fossil fuel use Ο Ο Ο Ο Low emissions 0 Ο 0 Ο Introduction of a CO₂ tax 0 Ο Ο \cap High targets for emission reductions \bigcirc Ο 0 Ο Support of bioeconomy developments 🔘 Ο 0 Ο Clean (green) energy \bigcirc Ο \cap Ο 4: How relevant do you think the following barriers are for the decision to retrofit?

Please choose the appropriate response for each item:

	irrelevant	hardly relevant	relevant	t crucial
No space for additions	0	0	0	0
Difficult compatibility to new processes	0	0	0	0
High complexity of the process/plant	0	0	0	0
Raw material availability from reasonable distance is hard to meet	0	0	0	0
Processing time for implementing innovations takes too long	0	0	0	0
Strong competition from fossil-based industry	0	0	0	0
No guarantee schemes to promote investments in risky innovations	0	0	0	0
Higher operational costs of biomass	0	0	0	0
Prices for raw materials are high and volatile	0	0	0	0
Increasing biomass share generates little additional profit	0	0	0	0
Availability of adequate amounts of biomass may be limited	0	0	0	0
CAPEX of biomass integration facilities is relatively high	0	0	0	0
Availability of financial resource	0	0	0	0
Shareholders prefer quick profits	0	0	0	0
No instruments for financial support for CO2 reduction measures	0	0	0	0
No coordination between EU and national/country politics	0	0	0	0
No stable regulatory framework	0	0	0	0
Local opposition exists	0	0	0	0



3. General questions

In order to process and evaluate the data you provided, we need some general information on you and your company.

5: Country of origin (of your plant or company)

Please choose only one of the following:

OAustria	OCzech	OGreece	OLuxembourg	Oslovakia
OBelgium	ODenmark	OHungary	OMalta	OSlovenia
OBulgaria	OEstonia	Olreland	ONetherlands	OSpain
OBosnia-Herzegovina	OFinland	Oltaly	OPoland	OSweden
OCroatia	OFrance	OLatvia	OPortugal	OUnited Kingdom
OCyprus	OGermany	OLithuania	ORomania	OOther

6: Number of employees

Please choose only one of the following:

- 01-10
- 011-50
- 051-200
- 0 201-500
- 0 501-1000
- O > 1000

7: How would you rate the growth prospects of your company for the coming years?

Please choose the appropriate response for each item:

 \bigcirc shrinking \bigcirc stable

○ steady growth ○ major expansion

8: To w	vhat extend	do you t	think your	competitors	have	applied	bioenergy	retrofitting i	n the
ast 10	years?								

Please choose only one of the following:

- O This is not done by any competitor.
- O less than 30% of the companies in the sector have already applied bioenergy retrofitting.
- O More than 30% but less than 70 % of the companies in the sector have already applied bioenergy retrofitting.
- O More than 70% of the companies have already done retrofitting.

9: Has your company currently set itself sustainability goals in general?

Please choose only one of the following:

- O Yes
- O No

If yes, please shortly specify/ describe these goals:



10: Does your company have strategic sustainability goals with specific targets concerning emissions?

Please choose only one of the following:

- OYes
- O No

If possible please shortly specify/ describe:

11: Does your company intend to retrofit (further) in the future?

Please choose only one of the following:

- O Yes
- O No

12: Please provide the two most important arguments for bioenergy retrofitting (further). / Please provide the two most important arguments for not bioenergy retrofitting (further).

Please write your answer(s) here:

- 1.
- 2.

13: If you would like to receive the results of this survey, you can enter your email address here:

By submitting my email address, I confirm that I have read the data protection declaration and agree that my data will be stored electronically and processed and used for the purpose of receiving the results of this survey. I am aware that I can revoke my consent at any time by sending an e-mail to Niels.Doegnitz@dbfz.de.

Thank you very much for your participation!

If you are interested to learn more about the project, we would like to invite you to have a closer look at the BIOFIT homepage and the projects' activities related to retrofitting.



Annex 2 All drivers and barriers

Annex 2 contains the complete list of drivers and barriers, collected during the conception of the survey. Based on this list, the comprehensive list of the survey (Annex 3) has been created.

Barriers

- High complexity of the process/plant
- No space for additions
- Compatibility to new processes
- Compatibility to other process steps
- CAPEX of biomass integration facilities is relatively high
- Raw material availability from reasonable distance is hard to meet
- Competition from fossil-based industry
- No guarantee schemes to promote investments in risky innovations.
- Processing time for implementing innovations takes too long
- Expensive investments
- Higher operational costs
- Sufficiency of the biomass resources
- Availability of financial resource
- Difficult Procurement of equipment
- No instruments for financial support for CO₂ reduction measures.
- No coordination between EU and national/country politics
- Availability of adequate amounts of biomass may be limited
- Shareholders prefer quick profits
- Turnover of the biomass share is very little
- Feedstock cost still supposes a high contribution to the total cost.
- Prices for raw materials are high and volatile
- Technological adaptations in the industry.
- No stable regulatory framework

Drivers

- Simplified company expansion
- Higher flexibility of the plant
- Expertise within the company
- Shorter lead times
- Lower entrepreneurial risk
- Lower capital expenditure (CAPEX)
- Faster implementation
- Better corporate image



- Long-term goals for climate protection
- Less production time losses and lower risks
- Corporate social responsibility
- The EU ETS penalizes fossil fuel use and not bioenergy.
- GHG mitigation stated in the RED II are promoting advanced biofuels.
- Uncertainty if there will be a CO2 tax
- Biomass as a storable renewable resource
- The high targets for emission reductions
- Support of bioeconomy developments
- Lower emissions
- Clean (green) energy emission
- Diversification of product portfolios



Annex 3 Drivers and barriers within the survey

Annex 2 contains the list of the within the survey used drivers and barriers, with a description if necessary (due to the structure of the survey nearly all drivers and Barriers have to be shortened).

Driver	Description
Flexibility of the plant	Retrofitting have the potential to increase the flexibility of the plant.
Fast implementation	The implementation of a retrofitting is faster compared to the greenfield alternative.
Diversification of product portfolios	Retrofitting have the potential to increase the diversification of the product portfolio.
Less production time losses	The implementation of a retrofitting has less production time losses compared to the greenfield alternative.
Available expertise within the company	The expertise for the retrofitting is available within the company.
Low entrepreneurial risk	The implementation of a retrofitting lowers the entrepreneurial risks compared to the greenfield alternative.
Better corporate image	Retrofitting can have a positive impact on the corporate image.
Achievement of the climate goals	Retrofitting can help to reach the company climate goals.
The EU ETS penalizes fossil fuel use	The EU ETS (European emission trading scheme) set a prize for greenhouse gas emissions and therefor penalizes fossil fuel use.
Low emissions	Retrofitting can lead to lower emissions.
Introduction of a CO ₂ tax	An introduction of a CO ₂ tax can foster retrofitting
High targets for emission reductions	High targets for emission reductions for the industries can support retrofitting.
Support of bioeconomy developments	Financial or structural support of further bioeconomy developments can foster retrofitting.
Clean (green) energy	Electrical energy produced with less CO ₂ emissions (or by using biomass) can be an incentive for the industry to retrofit



Barrier	Description
No space for additions	On the factory site is no space for retrofitting additions.
Difficult compatibility to new processes	The processes are to complex to easyley add a new component, it need a rebuilt.
High complexity of the process/plant	The processes are to complex to easyley add a new component, it need a rebuilt.
Raw material availability from reasonable distance is hard to meet	
Processing time for implementing innovations takes too long	
Strong competition from fossil-based industry	The fossil based industry use its advanteges and is hard to conquer.
No guarantee schemes to promote investments in risky innovations	
Higher operational costs of biomass	Some times biomass compared to fossil based materials have higher costs.
Prices for raw materials are high and volatile	Some times biomass prices are much volatiler.
Increasing biomass share generates little additional profit	
Availability of adequate amounts of biomass may be limited	
CAPEX of biomass integration facilities is relatively high	
Availability of financial resource	Financial resources for retrofitting investments is hard to get.
Shareholders prefer quick profits	Invesments have are long-term investments without quick profits.
No instruments for financial support for CO2 reduction measures	
No coordination between EU and national/country politics	
No stable regulatory framework	The regulartory frame is instable and changes ofter, it is unclear how it is in a few years.
Local opposition exists	A local organisation or the people argues against an investement.



This study is a part of the project BIOFIT ("Bioenergy Retrofits for Europe's Industry", www.biofit-h2020.eu), which has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 817999. The overall aim of the BIOFIT project is to facilitate the introduction of bioenergy retrofitting in the following five industry sectors: first-generation biofuels, pulp and paper, fossil refineries, fossil-firing power and combined heat and power plants. IMPORTANT: All data (be personal or company related) will be protected and kept confidential according to the EU laws and regulations.

Citation, Acknowledgement and Disclaimer

Dögnitz, Niels, Hauschild, Stephanie and Gröngröft, Arne (2020) Bioenergy Retrofits for Europe's Industry. BIOFIT, Horizon 2020 project no. 817999, WP4: Industry Platform – Market Uptake, Report on drivers and barriers for retrofitting, DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH, <u>www.biofit-h2020.eu</u>

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

The content of the document reflects only the authors' views. The European Union is not liable for any use that may be made of the information contained therein.

