Emerging Techniques Pilot Project at the Swedish EPA

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Preface

Protecting the environment against emissions and other environmentally hazardous activities caused by anthropogenic activities is one of the main challenges in the society today. In the SOER (State and Outlook Environmental Report) from 2015, the European Environmental Agency (EEA) concluded that to reach the ambitious environmental policy objectives set by the European Union until 2050, transformative actions are needed. One of the findings is that neither current environmental policies nor economic and technology-driven efficiency gains will be enough to achieve the goals set by 2050. The EEA concludes that, to reach the desired targets, fundamental transitions are required.¹ This would also mean a possibility for Europe to be at the frontier of science and technology.² However, these types of transitions would require a greater sense of urgency and would require changes in important institutions, practices, technologies and policies.³

Considering the conclusions from the SOER-report, the Swedish Environmental Protection Agency (from hereby abbreviated Swedish EPA) has decided to increase the focus on innovation to accelerate the work towards the Swedish environmental objectives and the international sustainability goals.

As a part of the work with industrial innovation, the Swedish EPA launched a pilot project in January 2017 related to the agency’s involvement in the European Commission’s work with the Industrial Emission Directive (IED).

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1. **Summary**

In the SOER (State and Outlook Environmental report) from 2015 the EEA (European Environmental Agency) analyses the implementation of the environmental policy agenda in the EU. The conclusions in the report is that there is a need for transformative systematic changes to reach the ambitious environmental goals set for the EU in 2050.

With this as a background the Swedish Environmental Protection Agency in January 2017 launched a pilot project with the objective to investigate how to increase the impact of emerging techniques (ET) within the European Commission’s work with the Industrial Emission Directive (IED). The Swedish EPA is the responsible agency for the Swedish involvement in this process and the objective with the pilot was to mirror some of the actions suggested in the report *Supporting information exchange on new facilities and the development and identification of emerging techniques in the context of the IED* published by the international consulting firm ICF International in 2014.

The main idea with the pilot project was to involve new types of stakeholders in the revision process of the Best Available Technique Reference Documents (BREF) within the IED to increase the impact of ETs in this process. The project consisted of mainly three parts: mapping of stakeholders, designing of a questionnaire specific to ETs and to contact stakeholders asking them about potential techniques. Four types of stakeholders were mapped: universities, research institutes/research programs, suppliers and science parks. During the second part of the project a questionnaire specific to ETs was developed with the aim to gather standardized information about the techniques enabling the development of a format to consistently describe ETs in the BREFs. The purpose with the questionnaire was to gather sufficient information to satisfy the requirements in the implementing decision 2012/11/EU. The last part of the project mainly consisted of contacts with the mapped stakeholders where they were asked to fill in the questionnaire describing potential ETs.

The findings from the project suggest that using TRL as a concept to estimate the level of maturity of ETs worked well since many of the contacted stakeholders were aware of this concept. Many stakeholders also showed an interest in the IED and expressed that regulatory requirements drives the demand for their products. Other findings and learnings during the project suggests that the questionnaire needs to be iterated and further improved to avoid confusion among stakeholders. Experienced challenges in the information exchange process were related to the gathering of economic data about the techniques both in early and late stages of development due to unavailability and/or confidentiality.

Based on the experiences from the pilot some actions to improve the process and information exchange with the stakeholders are suggested. These include developing a detailed framework based on TRL and the concepts and definitions in the IED to classify ETs. An iteration of the questionnaire and the way this is distributed to the stakeholders to improve the process and information exchange is also needed. An improved questionnaire would also enable the implementation of a portfolio model as a format to map the ETs based on their level of maturity and feasibility potential.
2. Emerging Techniques pilot project

2.1. Introduction

2.1.1. Background

Considering the conclusions from the SOER (State and Outlook Environmental Report) from 2015, the Swedish Environmental Protection Agency (Swedish EPA) has decided to increase the focus on innovation to accelerate the work towards the Swedish environmental objectives and the international sustainability goals.

As a part of the work with industrial innovation, the Swedish EPA launched a pilot project in January 2017 related to the agency’s involvement in the European Commission’s work with the Industrial Emission Directive (IED). The Swedish EPA is the responsible public agency for the Swedish involvement in the work with Directive 2010/75/EU (IED). The objective with the pilot was to involve new stakeholders in this process and highlight new techniques with potential to reduce environmental impact from industrial installations. The purpose was to find a systematic and structured way of doing so and to better achieve an added value with emerging techniques in the IED BREF-work and try to find the transitions needed for the relevant industry sectors in regards to the SOER findings. The pilot was conducted during 2017. In 2018, the work was complemented with interviews regarding how to better implement Emerging Techniques.

2.1.2. IED and ET

Directive 2010/75/EU (IED) works as a framework for granting permits and to carry out control of industrial installations within the EU. Through the application of Best Available Techniques (BAT) the directive aims at preventing and reducing emissions from industrial installations as well as reducing the use of resources and preventing waste. Techniques that have been proven to be technically feasible and economically viable within a specific sector and which are considered to be the most effective in order to achieve a high level of protection of the environment are considered to be BAT. 4

These techniques are an important part of the so called Best Available Technique Reference Document (BREF). The BREF for a specific industrial sector includes information about the sector in the EU, the techniques and processes that are currently used in this sectors, emission and consumption levels, potential techniques to be considered in the determination of the BAT and finally also information regarding emerging techniques (ET). 5


Implementing the IED is an important part of the EU’s work towards achieving the environmental policy objects regarding pollution to water, air and soil but also the use of natural resources and the prevention of waste.

As mentioned above, the directive also describes ETs to further support innovation and enable a higher level of prevention and protection of the environment. The formal definition of ET can be found in the IED 2010/75/EU:

Article 3(14) of Directive 2010/75/EU defines an ‘emerging technique’, as a novel technique for an industrial activity that, if commercially developed, could provide either a higher general level of protection of the environment or at least the same level of protection of the environment and higher cost savings than existing best available techniques.

The focus of the Swedish ET pilot has been to map stakeholders potentially developing these types of techniques and map potential ETs related to the ongoing revision process of the BREFs related to the textile and chemical sectors.6

2.1.3. The Seville process

The European Commission aims at revising the BREFs every 8th year and this revision process has been formalised through the so called Seville-process. The work is organised by the European IPPC Bureau in Seville. They start the process through the activation of a Technical working group (TWG). In the TWG, the European Commission participates and experts from member states, the specific industry sector and related non-governmental organizations promoting environmental protection. The next step of the process is Call For Initial Positions and the submission of Initial Positions. This is followed by the Kick-Off meeting in Seville with the TWG which is followed by an information exchange between the Bureau and the Member States, the industries concerned and non-governmental organizations promoting environmental protection. This includes companies running industrial installations where data is gathered regarding currently used techniques and the related emissions levels, as well as consumption data regarding energy, water and raw materials. The information gathering also includes visits to the industrial installations. The EIPPC in Seville then writes a first draft of the BREF which is sent to the TWG for feedback. The TWG is then gathered for a final meeting before the final draft of the BREF is written and then discussed at an Art.13 forum meeting in Brussels before being adopted by the European Commission according to Article 75.7

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6 ICF International, 2015, Supporting information exchange on new facilities and the development and identification of emerging techniques in the context of the IED, p.1

2.1.4. The ICF report and the European Commission's ET workshop in 2014

In 2014 the consulting firm ICF delivered a report to the European Commission called *Supporting information exchange on new facilities and the development and identification of emerging techniques in the context of the IED*. This report was the result of an inquiry from the European Commission based on the concern that the information exchange related to ET had received less attention in the then recently finished BREF revision processes. ICF conducted research among member states and several different European stakeholders trying to find examples of current information exchange processes and possibilities to link ongoing innovation initiatives to the BREF process.

Based on the findings from these activities, ICF published a list of actions outlining potential steps to consider to increase the focus on ET and improve the information exchange in the BREF process regarding these novel techniques.\(^8\)

<table>
<thead>
<tr>
<th>Action number</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.</td>
<td>Clarify the definition and purpose of the term ET and introduce the definition of CET(^9)</td>
</tr>
<tr>
<td>2.</td>
<td>Adopt a questionnaire specific to ETs</td>
</tr>
<tr>
<td>3.</td>
<td>Adopt a systematic approach to consistently describe ETs in the BREFs</td>
</tr>
<tr>
<td>4.</td>
<td>Adapt the BAT questionnaire to capture specific information on CETs</td>
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<tr>
<td>5.</td>
<td>Ensure that ETs and CETs are discussed in TWG meetings</td>
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\(^8\) ICF International, 2015, *Supporting information exchange on new facilities and the development and identification of emerging techniques in the context of the IED*. Executive Summary: p.5-6

\(^9\) Cutting Edge Techniques
6. Consult with governmental organizations outside Europe (e.g. USA, China, Japan)
7. Increase awareness of BREFs existence and of their objectives among additional key stakeholders, emphasizing in particular the role of the ET chapter and of CETs in the BREFs
8. Ensure active participation of additional stakeholders in TWG (ETs)
9. Ensure direct involvement of particular key stakeholders (CETs)
10. Continuous screening for information on ET and CETs. More frequent collection of information
11. Rating and regularly updating information on the commercial readiness and sectors possibly applying ETs and CETs. Keeping track of ET development will improve accuracy on estimation for commercial availability
12. Structure and publish the collected information on ETs and CETs (for example establishing ‘live’ documents or portals). This may motivate involvement of technology developers

The findings from the ICF report and the European Commission workshop in 2014 has been the basis for the Swedish ET pilot project.

2.1.5. Objectives of the pilot

The overall objective of the Swedish ET pilot has been to gather experience regarding a potential process to be used to increase the focus and impact of ET in the work with IED by:

1. involving new stakeholders in the Seville process and highlight new techniques with potential to reduce environmental impact from industrial installations
2. finding a systematic and structured way of doing so
3. better achieving an added value with emerging techniques in the IED BREF-work and trying to find the transitions needed for the relevant industry sectors in regard to the Swedish environmental objectives and the SOER-report findings.

This has been done through mirroring some of the actions listed in the ICF-report. The mirrored actions are:

1. Clarify the definition and purpose of the term ET
2. Adopt a questionnaire specific to ETs
3. Adopt a systematic approach to consistently describe ETs in the BREFs
4. Increase awareness of BREFs existence and of their objectives among additional key stakeholders, emphasizing the role of the ET chapter

To reach the project’s objective, three major steps have been conducted: mapping of potential relevant stakeholders, creating a standardized questionnaire specific to ET and contacting the mapped stakeholders. These will be further elaborated on in the upcoming sections. CET, Cutting Edge Techniques, was not further investigated, as
feedback from stakeholders in the 2014 Emerging Techniques workshop meant that CET does not have any clear definition like ET, and that it would be better to use ET together with TRL, technology readiness level, instead.
2.2. Part 1 – Mapping of stakeholders

The Swedish EPA is the responsible agency for the Swedish involvement in the revision process of the BREFs, apart from BREF IRPP. Before the TWG is activated in the Seville-process, the Swedish EPA gathers stakeholders in a Swedish reference group. These reference groups have traditionally mainly consisted of people representing organizations running industrial installations in the related industrial sector as well as county administrative boards and other competent authorities. The aim of the reference group is to provide information regarding currently used techniques in the sector, important environmental aspects and to be a contributing part in the Swedish involvement in the BREF revision process. This reference group is an important part of the information exchange during the whole BREF-process.

One of the important actions that this pilot aimed at mirroring was to increase the awareness of BREFs existence and the role of the ET chapter among additional key stakeholders but also to include more stakeholders in the BREF process. That is why the first step in the pilot project was to map and gather information regarding new types of stakeholders which potentially could be involved in the development of ETs. The stakeholders were chosen based on their main activities and their relevance for the chosen BREFs, i.e. chemicals and textiles industry sectors.

In the report from 2014, ICF categorized the stakeholders that at the time, either were or potentially could be connected to the information exchange process related to the IED, into a couple of different types. These types were: technique users, industry associations, technique developers (such as providers of equipment in both early and late stages of development i.e. suppliers), supporters of technique implementation (such as technical consultants, permit writers etc.) research project communities and others. Based on this classification and after some modification of the classification, four main types of stakeholders were chosen for the Swedish ET pilot: universities, research programs/research institutes, suppliers and science parks/incubators. The mapping of the stakeholders was conducted using currently known innovation channels that the Swedish EPA has used in other innovation related projects. Experts at the Swedish EPA with knowledge in the industry sectors were also asked for suggestions of potential relevant stakeholders.

Below is a further description of the chosen groups of stakeholders and a short description of their relevance for the pilot project:

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10 The Swedish Board of Agriculture is responsible for BREF IRPP (Intensive rearing of Poultry and Pigs).
11 ICF International, 2015, Supporting information exchange on new facilities and the development and identification of emerging techniques in the context of the IED. p.142
Table 2 Overview of included types of stakeholders

<table>
<thead>
<tr>
<th>Type of stakeholder</th>
<th>Short description and reason for inclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universities</td>
<td>Many of the important researchers in Sweden are located at the universities and universities are therefore of great importance in the gathering of information related to ET.</td>
</tr>
<tr>
<td>Research institutes/innovation programs</td>
<td>An important hub for researchers and are often involved in research projects together with the industry. Strategic innovation programs funded by Swedish governmental agencies are often based and conducted through deep cooperation with these types of research institutes.</td>
</tr>
<tr>
<td>Suppliers</td>
<td>Suppliers of technical solutions to industrial installations have been included in this project because of their role in delivering new products or services which could improve the performance of the industrial installations and thereby contributing to reduced emissions, resource efficiency, waste reduction etc.</td>
</tr>
<tr>
<td>Science parks/Incubators</td>
<td>Science parks are important hubs for start-ups and of that reason also interesting to include in the project based on the possibility of finding start-ups/suppliers working with innovations in connection with industrial installations and industrial applications.</td>
</tr>
</tbody>
</table>
2.3. **Part 2 – Creating the questionnaire**

The second major part of the project was related to the following actions specified in the ICF report: clarifying the definition of ET, establishing a questionnaire specific for ETs and to adopt a systematic approach to consistently describe ETs in the BREFs. The questionnaire was designed to accomplish a mirroring of these actions and to standardize the information gathering regarding ETs.

2.3.1. **Background to the design of questionnaire**

In the report from 2014, ICF highlighted that an issue in the current process to gather information about ET was that the gathered information about the techniques was insufficient in relation to the guidelines provided in the implementing decision 2012/119/EU of the IED\(^{12}\). The starting-point when designing the questionnaire for ETs was therefore the specification of the required information in this implementing decision which states that:

- As a minimum, information for each emerging technique will include its description, its potential performance compared to existing best available techniques, a preliminary cost-benefit estimate, and an indication of the timescale of when the technique might become commercially ‘available’.\(^ {13} \)

A challenge identified in the ICF report was that the collection of data is complicated by the fact that many ETs have not been tested in industrial applications or at least to a very limited extent. Some of the techniques may still be at research level and data regarding for example economic performance might therefore be difficult to estimate or the stakeholders might be unwilling to share such data to keep the competitive advantage of possessing the technique.\(^ {14} \) ICF also stated in their report that TRL is the most commonly method to classify technology development. ICF suggests that using this approach would improve the classification of different techniques in more specific levels of maturity when working with ETs in the BREFs.\(^ {15} \)

When designing the questionnaire, a framework developed by a research group within the research program Framework conditions for innovation towards sustainability initiated by the German Federal Ministry of Education and Research\(^ {16} \) was used as inspiration. The main objective of this research group was to develop an indicator system allowing to evaluate sustainable effects of innovations. This system was based on the concept of Sustainability Innovation Scorecard and consisted of three different modules. The first module was related to how different drivers of influence, such as regulatory framework, market pull and technology push and societal drivers, affect the diffusion of innovations. The second module aims at describing how a certain innovation contribute to improve sustainable development where the contribution is

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12 ICF International, 2015, Supporting information exchange on new facilities and the development and identification of emerging techniques in the context of the IED, p. 14
14 ICF International, 2015, Supporting information exchange on new facilities and the development and identification of emerging techniques in the context of the IED, p. 15
15 ICF International, 2015, Supporting information exchange on new facilities and the development and identification of emerging techniques in the context of the IED, p. 19
evaluated from an environmental, economic and societal perspective. Finally, the third module aims at evaluating the life-cycle stage of the innovation and mapping potential barriers for implementation. The innovation is then placed in a portfolio model based on the previously gathered information.

In the Sustainability Innovation Scorecard described above, a quantitative scale is used to evaluate the impact of the innovation on the three sustainability dimensions. The provided arguments for this choice is that the sustainability contribution of evolving innovations in early development stages have not been proven in practice and the indicator system therefore aims at showing the potential of certain innovations. The authors also mention that the use of a “low-medium-high” scale avoids the development of normative or value judgement for each individual innovation and sustainability factor which is avoided by the use of this more general, qualitative approach.

2.3.2. Design and layout of questionnaire

The information requirements specified in the implementing decision together with the recommendations in the ICF report constituted the foundation for the development of the questionnaire. The mentioned Sustainability Innovation Scorecard was used as an inspiration in developing the structure of the questionnaire. As ICF suggested, the technological readiness level (TRL) was used to estimate the development stage of the ETs. The stakeholders were asked to place the techniques at the TRL which they found most appropriate. To tackle the concerns raised in the ICF report regarding the potential difficulty to gather economic data about the techniques, a qualitative scale was used to estimate the potential cost savings accomplished by the implementation of the technique.

The questionnaire was designed and built in Excel using User forms to enable an easy way for the user to enter data. The challenge in this step of the pilot project was to design a questionnaire that would provide sufficient information regarding the ETs without making the questionnaire too complicated to answer for the stakeholders. Another key element that was considered during the development process of the questionnaire was that these stakeholders might not be aware of neither the concept of BAT, currently existing BATs or the BREF process.

The purpose with the questionnaire and the choice of platform was to evaluate the different techniques in a consistent way. Like in the Sustainability Innovation Scorecard described earlier, the questionnaire was designed to create a score for the innovation based on the provided information in earlier sections of the questionnaire. This score aimed at enabling a classification of the different techniques based on their level of maturity and their feasibility potential which could be seen in Figure 2. In the project, the information gathered from the stakeholders was not sufficient to accurately place

![Figure 2 Portfolio model to map ET](image)
the techniques in the portfolio model. The reasons for this and how to tackle these difficulties will be discussed in Section 2.7 Future steps.

To meet the information requirements in Annex III regarding ET the questionnaire was divided into four major parts:

1) **General information regarding the technique**
   Data was gathered regarding the organization behind the technique, applicability, market name, examples of demonstration installations testing the technique.

2) **Development stage**
   In this part, the stakeholders are supposed to assess their technique based on the TRL-scale. The purpose is to get an idea of the maturity of the technique.

3) **Environmental performance**
   This part of the questionnaire aimed at gathering data regarding the potential environmental performance of the different techniques. Major information areas were: type of technique (end-of-pipe or in-process), main environmental aspects addressed by the technique and positive environmental effect in different life-cycle steps. The questionnaire focused both on general environmental aspects included in the selected BREFs but also on environmental aspects highlighted as in great need of ET according to interviewed Swedish EPA experts in the textiles and chemicals industry sectors.

4) **Economic performance**
   This part of the questionnaire gathers data regarding the basic economic information related to the implementation of the technique. Information such as the potential size of the investment, any potential additional costs incurred by using the technique and information regarding potential cost savings that could be accomplished by using the technique was gathered.

These four parts were also the main headlines in the format used to describe the techniques. In the pilot project, this questionnaire was used as the main source of data regarding the emerging techniques. However, in a future process, the gathering of data could be divided into two parts. First an initial survey to scan for the techniques with highest potential from an environmental perspective. In the second step, some chosen especially promising techniques can be further investigated in a more detailed questionnaire. This will be further discussed in Section 2.7.1.1.
2.4. Part 3 – Contacting stakeholders

The third step in the project was to contact the mapped stakeholders. The initial methodology used was to contact the stakeholders by telephone and describe the objective and purpose of the project. The stakeholders were asked to describe the activities and projects they are currently working with to get a deeper understanding of their area of expertise and ongoing projects. The stakeholders were then asked if they had any ideas of potential emerging techniques within the chosen BREFs and if they were willing to participate in a phone interview. If they accepted, a meeting was scheduled. During this meeting the representatives of the stakeholders together with an interviewer from the Swedish EPA filled in the questionnaire.

This was a very time-consuming way of working and to speed up the process the methodology was changed after approximately half the time. Instead of asking the stakeholders to fill in the questionnaire together with the interviewer from the Swedish EPA, the interviewer used the questionnaire as an interview guide. The stakeholders were still contacted by phone and the questionnaire was then used as a guideline for the interviewer from the Swedish EPA to conduct the interview.

Some stakeholders have also been contacted by e-mail. This has especially been the case when they have not been reachable by phone. They have then received a short description of the project and what types of techniques that are of interest. The stakeholders have also been asked if they know of any other point of contact with knowledge of relevance for the project. Generally, the frequency of answers was lower using this way of contacting the stakeholders compared to contacting them by phone. The quality of the answers was also more varying where some stakeholders just answered with very brief information.
2.5. Findings

The major findings from the ET pilot are summarized below. These findings will be further discussed and elaborated upon in the discussion section of the report.

2.5.1. Clarify the definition and purpose of the term ET
- TRL is a well-known concept among the chosen types of stakeholders
- Some stakeholders may have varying interpretation of the different TRLs
- There is a need to further specify the TRLs and create guidelines for mapping of techniques to improve the fit of TRL to the IED process and definitions

2.5.2. Adopt a questionnaire specific to ETs
- Overall the questionnaire has worked well and it has been a valuable tool in standardizing the gathering of data
- Important to provide relevant information regarding the BREFs and the purpose with the questionnaire before sending this to the stakeholders – the data gathering needs to be coordinated with general information about the IED
- The challenge of properly comparing ETs to existing and new BATs in the questionnaire needs to be further addressed
- Some parts in the questionnaire, such as the definition of technical risk and how to quantify potential cost savings incurred by implementation of a new technique, need to be more clearly defined to avoid the possibility of misinterpretation
- Difficult to quantify economic benefits of techniques with low TRLs
- Information is sometimes classified which complicates the description of the techniques and their performance

2.5.3. Adopt a systematic approach to consistently describe ETs in the BREFs
- The questionnaire provides a valuable foundation for a format to describe the techniques
- This format has worked well and covers the suggested areas of information in Annex III of the IED

2.5.4. Increase awareness of BREFs existence and of their objectives among additional key stakeholders, emphasizing in particular the role of the ET chapter
- Many stakeholders have shown a great interest in the BREFs and the ET chapter
- Some stakeholders have expressed that regulatory requirements drive the demand for some of their products and therefore consider the BREFs as a market potential but also to receive funding for further research or development
- More extensive information regarding the BREFs and the Seville process is needed to further improve the awareness about the IED among these types of stakeholders
- It is a challenge to reach the people with the specific knowledge in the desired area
2.6. Discussion

This pilot has resulted in several key learnings which are important to consider when continuing the work with ET within the IED BREF work. The discussion is structured around the findings described above and is divided into categories based on the chosen mirrored actions from the ICF report. In the end of the section some general findings not immediately related to the mirrored actions are discussed.

2.6.1. Clarifying the definition and purpose of ET

2.6.1.1 TRL to determine level of maturity

The use of TRL proved to be a suitable tool to discuss the maturity level of the techniques with the stakeholders and many of those contacted were aware of this concept. Most of the stakeholders also had an idea about which TRL their technique belonged to. However, the described techniques may have different areas of application and the TRL-level may therefore vary depending on the type of application. This makes it more complicated to specify a general level of maturity for the technique. To reach an even more standardized way of assessing the maturity of ETs it is necessary to have a framework where the maturity is determined based on the specific area of application.

Another learning from the project was that the interpretation of the TRL for a specific technique might vary depending on the type of stakeholder. As an example, one of the contacted researchers expressed that they considered their technique being at a specific TRL while their industrial partner, also involved in the research project, had a significantly different idea of the TRL. To improve the classification of the ETs it is necessary to handle these types of differences among different types of stakeholders.

2.6.2. Adopt a questionnaire specific to ETs

The general impression is that the questionnaire has worked well and that it has been a first step in standardizing the information exchange regarding ETs in the BREF-process. This is something that ICF highlights as an important factor to increase the impact of ETs in the BREFs. Developing the questionnaire in Excel is not a very complicated process when the information to include and the overall structure has been set. Using User Forms also makes it possible to provide some explanations of the different parts of the questionnaire to the user which helps the information gathering.

Another important learning from the pilot is that in order to get the best possible value from the use of the questionnaire, the stakeholders need to be informed about the BREFs and the meaning of ET before being sent the questionnaire. If they have this type of information it is easier to get more accurate and from an IED perspective relevant information. During the ET pilot, the stakeholders were first informed briefly about the IED and the ET chapter over phone and in those cases where the stakeholders participated in an interview, these topics were further described.

Another experience from the pilot was that some parts of the questionnaire caused confusion and risk of misinterpretation among the stakeholders. For example, the stakeholders were asked about the potential technical risk with the technique, additional costs incurred by the implementation of the technique and the potential barriers and drivers for implementation of the technique. These questions caused some concerns
among the contacted stakeholders. The concerns were mainly related to a need of further clarification of the meaning of technical risk and drivers/barriers for implementation. Some stakeholders also expressed that they felt unsure about providing an estimate of additional costs since that is very dependent on the specific conditions at the industrial site. If these questions are still to be included in the questionnaire they need further clarification. How this could be done will be discussed in the section about future development of the process.

ICF mentioned in their report that economic data for these types of evolving techniques might be unavailable due to lack of tests at full scale operational level. The same concern was expressed by the German research group working to develop a Sustainability Innovation Scorecard. During the ET pilot is was discovered that this type of information was indeed sometimes difficult to gather, even though the qualitative approach and design of the questionnaire aimed at avoiding these types of difficulties. The experience from the pilot is that it is easier to quantify environmental performance in terms of for example energy savings or emission reductions early in the development of the techniques while financial information regarding investment and operational costs are harder to specify in early development stages. When it comes to the information gathering regarding techniques with high TRLs this means other challenges, such as the fact that for example data regarding economic performance of techniques is sometimes classified. These factors complicate the information exchange and needs to be further addressed when iterating the questionnaire and the information exchange process with the stakeholders. How this could be done will be further described in the section 2.7.1.4.

2.6.3. Adopt a systematic approach to consistently describe ETs in the BREFs

The format which has been used in this pilot to describe the techniques was based on the main parts of the questionnaire namely: overall description, applicability, development stage, environmental performance and economic performance. The gathered information in the questionnaire was summarized under these headlines to reach a consistent way of describing the ETs. This format worked well but the level of detail in the description depends on the information received through the questionnaire. However, after having presented the results of the ET pilot for the Swedish reference groups (consisting of companies affected by the chosen BREFs for the chemical and textile sector) the feedback has been that some of the descriptions of the techniques (from some of the ET suppliers) have been too selling. It is important in the future work with ET to make sure that the descriptions are more neutral to be accepted by the companies running the industrial installations. Potential actions to accomplish this, are described in Section 2.7.1.

During the project an outline to a portfolio model was designed to map the techniques based on their level of maturity and their overall performance. The purpose of this portfolio model was to visualise the potential of different techniques but also to be able to compare the different techniques in relation to each other. However, since some of the information that constituted the basis for the mapping of the techniques was hard to receive, the model did not work as planned. It needs to be improved and adjusted so it can handle potential lack of information related to some areas of the performance of techniques and still keep its evaluation accuracy. Yet the use of a portfolio model would
really mean a systematic approach to describe the ETs and visualize the potential of different ETs.

2.6.4. Increase awareness of BREFs existence and of their objectives among additional key stakeholders, emphasizing in particular the role of the ET chapter

The experience from this pilot project is that many of the stakeholders are interested in the IED and the ET chapter. Several of the stakeholders have expressed that regulatory frameworks drives demand for their products and the regulation of emissions in the IED is therefore of great interest to them. The stakeholders have briefly been informed about the BREFs and IED when contacted, however to further improve the awareness and their potential to contribute to the process more information need to be provided to them. Some suggestions of how this could be done will be described later in the report. To use the interest among these stakeholders constitutes a great potential to accelerate the work towards the European environmental goals constitute and would be a major argument to increase the focus of ET in the BREF-process.

2.6.5. General learnings

2.6.5.1 Mapping of stakeholders and stakeholder interaction

What has also been learnt during the project is that the outcome of the contact with the stakeholders depends on the level of information about their activities that is gathered before the contact. During the pilot, the initial mapping of the stakeholders was conducted on a general level where the stakeholders were chosen based on an overview of their current research or brief description of their main products. However, no further mapping of specific research projects and their potential applicability as ETs was conducted.

The initial part of the conversation with the stakeholders aimed at getting a deeper understanding of the specific projects that they were currently involved in and potential solutions they were developing. To get this deeper understanding, general open questions were asked about the stakeholders ongoing activities and about their knowledge of any potential relevant techniques. These types of questions tend to give open answers which are sometimes hard to fit in the format of ETs according to the requirements in the implementing decision. The advantage was that they give stakeholders an opportunity to provide an overall picture of the ongoing research. This is a good way to eliminate the risk that any potential projects or techniques are excluded.

However, the main issue is that it does not provide sufficiently detailed data regarding the specific techniques and their applicability. One way to get around this problem is to map specific projects that the stakeholders are involved in before contacting them. In those cases, it is easier to find out more specific information regarding their techniques and that information will then be more valuable from an IED perspective. However, the risk with this approach is that important information regarding other projects is left out.

Another key learning when it comes to communication is that the techniques that are of interest for the ET chapter in the BREFs are not always new techniques in the sense that they are newly discovered in the research or industry community. Instead the potential
ETs might be such where the theoretical result has been known for a long time but it has not yet been industrially implemented. These types of techniques might often be forgotten if stakeholders are asked for ETs since they interpret the term as techniques that have to be new in a sense that they are currently researched or discovered.

The contacted suppliers have been asked about their current product and technique development. This communication has mostly resulted in answers related to products that are recently demanded by the customers. Most often these products are demanded due to new legislation. However, the technique in itself is not emerging according to the definition in IED since it has already been commercialized. The conclusion from the pilot project is that suppliers are also valuable in the process of gathering BAT or candidate BATs then in the information process regarding ET.

2.6.5.2 Reaching the people with the relevant knowledge

Another learning during the pilot project was that reaching the people with the specific knowledge relevant for a specific field within the chosen BREFs is a time-consuming process. The research community is for example very specialized and is not organized around the industrial processes. Reaching the specific department or researcher at the universities or the research institutes with the knowledge in for example certain types of catalysts requires several points of contact before reaching the most appropriate person. The experience from this pilot is that creating this type of network of people is a time-consuming process and unfortunately constitutes a barrier for including these new stakeholders in the BREF-process.

2.6.5.3 Areas in need of increased focus

During the project, stakeholders have highlighted some environmental issues that are in need of increased focus by the regulatory system. One of these issues is the water management at industrial sites. Water scarcity is a growing problem within some Member States in the European Union17 and many industrial sites consume large quantities of water. One of the contacted stakeholders from the universities highlighted that tougher regulatory requirements are necessary in order to increase the focus on this important environmental issue at the industrial sites. The IED could possibly play a more important role in this work since one criterion for determining BAT is the consumption and nature of raw materials including water. The ET chapter in the BREFs could be a possibility to highlight techniques which could reduce the water consumption at industrial sites.

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2.7. Future steps – Developing the process

Based on the presented findings a couple of potential actions that would improve the process and increase the value of an intensified information exchange process regarding ETs will be described.

2.7.1. Clarifying the definition and purpose of ET

Based on the findings from the ET pilot in Sweden, the first suggestion regarding clarifying the definition and purpose of ET is to develop a detailed framework specific to the IED process and the definitions used in this context to improve and standardize the classification of ETs in the BREF process. This framework should be based on TRLs where each level is defined by the status of specific actions or activities. In the framework and questionnaire used in the so called Innovation Radar initiative (a project conducted by JRC to map innovations with high potential in ICT FP7, CIP & H2020 Projects)\(^\text{18}\) the stakeholders were asked questions with pre-decided answers (done, planned in project, not planned, desirable) about activities such as feasibility study, pilot and prototyping. Each answer gave a score in one of the three sub criterions used to assess the innovations. Applied in the information gathering and assessment of ET, this would be an efficient way of structuring the framework and to decide which TRL a specific ET belong to. It would also help in categorising the techniques based on a quantitative method.

When it comes to clarifying definitions, it would be a good idea to transfer the definition of ET as a technique that in the “near future might become BAT” into an actual timeframe which should be included in the classification of the TRL. It would also be beneficial to describe the term “commercially developed” in relation to how BAT is used in the IED context, specifying for example how many industrial installations that need to have adopted the technique in order to consider it “commercially developed”. It may also be the case, that a technique is well established within one industry sector, but not the other. The clarification of commercially developed would improve the process of estimating the maturity and readiness level of the techniques and make the estimation more consistent. Clarifying the definitions of high TRLs and adjust them to the IED context would improve the effect of ET and provide a better overview of the maturity of these techniques. Such a framework would also help in distinguishing between ETs with high TRLs and candidate BATs. However, ETs with low TRLs are recommended to be included in the BREF as well, since many of the ETs will be interesting as they have very high development rate and thus will also become BAT in the near future.

The next suggested action is to let an observatory determine the TRL. During the pilot, the stakeholders have been asked to estimate the TRL of the ETs and as has been discussed the interpretation of the different readiness levels might vary depending on the type of stakeholders. These types of stakeholders might also have a different opinion regarding the TRL compared to the organizations running the industrial installations. To avoid these discussions, it is recommended that the estimation of the

TRL is done by an independent observatory and not by the stakeholders themselves. Using this independent resource to evaluate the ETs would also be helpful in getting more neutral descriptions of the techniques. Looking at the Innovation Radar initiative, external experts were commissioned by DG Connect who reviewed the answers regarding the innovations and made the assessment of their potential.\textsuperscript{19} To let an observatory determine the TRL in the IED context is also necessary to reach a standardized classification of ETs since it requires people with knowledge in both the innovation and the IED framework to do the classification. It also means that enough information needs to be collected in the questionnaire to enable this consistent TRL classification of ETs.

The last suggested action is to use intervals to classify the different techniques based on their level of maturity when it is difficult to determine a specific level. Based on the experience from this pilot, using intervals would make the classification of techniques easier since it is sometimes hard to place a technique in a specific TRL while it easier to determine whether a technique is in the range 0-2 or in 8-9.

\textbf{2.7.1.1 Adopt a questionnaire specific to ETs}

The questionnaire which was developed to gather data about the ETs in this pilot was a first step in using a specific questionnaire to ETs. However, with the experiences gathered from the pilot project there is a need to further improve both the questionnaire itself but also how it is distributed to the stakeholders.

Regarding the questionnaire itself there were some parts which confused the contacted stakeholders. These were mainly the questions related to the technical risk of the technique, the potential additional cost incurred by implementing the technique and the potential barriers or drivers for implementation. Also in this case it would be beneficial to clarify these concepts by asking questions about specific actions or activities that either have been conducted or not. For example, if a feasibility study in a production environment has not been conducted the independent observatory could determine that the technical risk is high.

Since the additional cost incurred by implementing a new technique or the cost savings the technique could accomplish were hard for the stakeholders to quantify, the financial potential of an ET could also be determined in another way than specifying actual numbers. An alternative cold also in this case be to determine the financial potential using specific actions or activities. In the Innovation Radar initiative\textsuperscript{20}, the market potential of the mapped innovations was determined by letting the stakeholders answer statements about the degree of innovation exploitation, external bottlenecks and needs of key organizations. This information enables an assessment of the innovation’s potential to reach the market which also provides an indication of the financial potential without specifically quantifying cost savings. In the context of mapping ETs, these types of measures would be an appropriate way of avoiding the issues with quantifying financial data.

Another step to improve the accuracy of the questionnaire would be to create a guide that describes the steps in the questionnaire. Mostly the questionnaire needs to be self-explanatory but the guide would contribute with clarification for details that could be misunderstood. It is also important that the questionnaire is adjusted for the specific BREF which is to be reviewed. The reason for this is simply that the manufacturing processes in different industrial sectors are very different and to capture potential environmental or economic effects of the implementation of ETs the questionnaire needs to be adjusted for the specific BREF. Of course, the overall structure of the questionnaire does not need to be changed, however to get the most value of the information exchanges the details in the questionnaire need to be adjusted.

The next suggested action is more related to the distribution of the questionnaire. A potential action to improve the process in this regard, is to use a step-wise approach in gathering information about the techniques. This approach would consist of mainly two stages:

1. **Survey – finding potential techniques**
   The first stage would focus on gathering ideas about potential techniques. This would be done through a survey that is sent to the stakeholders. The survey would be sent together with information regarding the IED, the BREFs and the types of techniques that are of interest. The survey would include some questions which makes it possible to estimate the relevance of the techniques for a specific BREF. The main idea with this step is to get a list of potential techniques and make an initial assessment of them and then move on to get more detailed information about the techniques which seem most interesting and have the potential to improve environmental performance the most or contribute with the greatest cost savings.
   First of all, the techniques with the most promising environmental performance should be identified since the environmental performance is often known (at least in lab scale) in early faces of the development process.

2. **Questionnaire – mapping and understanding the techniques**
   The second stage in the information gathering would be to send the more detailed questionnaire to the stakeholders which in the survey pointed out the most interesting techniques.
   The purpose with using this step-wise approach would be to streamline the process of distributing the questionnaire to the stakeholders and eliminate the time-consuming process of calling all the stakeholders. Of course, there is still work to be done in assessing the incoming suggestions of techniques in the survey but hopefully the workload could be reduced compared to the tested process in this pilot.

2.7.1.2 **Adopt a systematic approach to consistently describe ETs in the BREFs**

The format that has been used in the pilot project has consisted of different headings under which the gathered information from the questionnaire has been summarized. This format has worked well. However, to improve the systematic and consistent description of ETs it is suggested to iterate the format and perhaps try to reach an applicable portfolio model which maps the different techniques. This was something
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that Feess et al.\textsuperscript{21} did in their Sustainable Innovation Scorecard and an outline to such a model was created during this pilot project based on the gathered information in the questionnaire.

Again, the evaluation criteria which constitute the basis of the mapping of techniques in such a portfolio models needs to be summarized in a framework specific for the IED application. An important factor to consider when using such a model is to make sure that for example the estimation of the maturity of the techniques is done in a consistent way (which has been suggested above). It is also important to further develop the questionnaire to make sure that the gathered data about the techniques is relevant and quantifiable enough to constitute a foundation for this type of mapping. Also in this aspect, inspiration could be gathered from the JRC report regarding how to practically do this. The first step would be to develop the questionnaire according to the suggestions described above with clear actions that shows the phase of development and the financial potential for the ET. It is also important to give each action in the questionnaire a pre-decided contribution to the scoring of the technique enabling a quantitative assessment of ET (see Figure 3 below).

In the JRC report, three different sub criterions were used to assess the innovations: Innovation Readiness, Innovation Market Potential, Innovation Management. The arithmetic mean of the sub criterions formed the final metric called the Innovation Potential Indicator (IPI). This metric was then normalized and by using the mean and standard deviation of all the scores of the assessed innovations JRC reached a statistical categorisation of the innovations (see picture below).\textsuperscript{22}

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In the IED context, the following three sub criterions could be used to do a quantitative assessment of ETs: ET readiness (TRL and time to implementation), ET market potential (type of technique, external bottlenecks, technique exploitation) and ET environmental performance (emissions reductions, increased resource efficiency etc.). Based on an average of the three sub criterions a categorisation of ETs in three levels, high, medium and low potential ETs could be accomplished where for example ETs with medium and high potential are included in the BREF. This would also answer the concern highlighted in the ICF Report regarding the lack of transparency when it comes to which ETs that have been included in the BREF and which that have been excluded.

2.7.1.3 Increase awareness of BREFs existence and of their objectives among additional key stakeholders, emphasizing in particular the role of the ET chapter

A suggestion based on the experiences from this pilot related to this action would be to add information material about the BREFs in the first phase of the mapping of potential ETs described above. Sending an initial survey together with information material about the regulatory framework would increase the awareness of the IED and the ET chapter. This would also mean that the stakeholders get a better sense of what types of techniques that are of interest. The main challenge in working with this action is to create an information channel to the stakeholders. To accomplish this, an easily understood information material regarding the BREF review process and especially the ET chapter should be developed. This information could follow the initial survey and later also the questionnaire to provide the stakeholders with some deeper knowledge regarding the IED and how these new types of technologies fit in this legal framework. Another way to accomplish this and to keep these new types of stakeholders updated would be to create a ET network with stakeholders related to ET. This network would feed in ideas to the BREF-process and provide valuable information regarding techniques at different TRLs. Developing this type of network would also enable an improved use of the showed interest in the IED framework by these types of stakeholders and would provide additional input of solutions that would accelerate the work towards the environmental goals.
2.7.1.4 How to improve the data gathering related to the comparison of ET to BAT

An important learning from the pilot is the need of further improvement of the questionnaire to gather data enabling the comparison of ET with existing or potential new BATs. The developed questionnaire aimed at gathering sufficient data to enable such a comparison of the techniques with the BATs in earlier BREFs. However, as mentioned earlier the information gathering regarding for example the economic performance of the techniques makes this comparison a complicated task due to unavailability or confidentiality. Another factor to also consider is that these types of stakeholders in many cases are unaware of current BATs which makes it unfeasible to ask them to compare their techniques with BATs. However, if an independent observatory should conduct the evaluation of the emerging techniques, this group will have knowledge in the current BATs and their environmental performance. Hence it should be possible for this group of people to perform a comparison of the environmental performance between the emerging techniques and the current BATs based on the collected information regarding the ETs. An additional aspect that should be considered in the design of the information gathering process is to focus the questions on the environmental issues that are of greatest importance. In the conducted pilot project, some of these issues were highlighted through initial interviews with experts at the Swedish EPA in the investigated sectors. However, to make the information gathering more time efficient and to really enable a comparison of ET to BAT, the selection of key environmental issues should be even more rigorously performed.
2.8. Implementation of Emerging Techniques

Some interviews have also been conducted with industrial installations which participated in the reference groups. The purpose with theses interviews was to get an understanding of what support and contribution from the governmental agencies that would be needed for the found techniques to be implemented. Some differences in the answers could be seen depending on size and industry. From the textiles sector, some installations said that they are not implementing any new techniques and therefore did not have any suggestions regarding how an improved collaboration or financial support from governmental agencies could help them in this process. Other argued that when doing these types of expensive investments, it is necessary that the machines and techniques have been tested in the environment and with the material which that specific installation is working with. This is of high importance since the down time in the production and quality risks related to changes in the manufacturing process need to be mitigated and kept to a minimum.

Furthermore, financial support was expressed as something that could be valuable together with information and education that actually concerns the organisation and the production itself. Some installations emphasized that the financial support should be directed so that it actually has an impact in the individual organisations. It was expressed that earlier efforts had mostly resulted in educational meetings with information too far away from the everyday issues that the installations are facing. Furthermore, it was stated that some platform where no-how regarding new techniques would be of interest for the installations.

A third need that the installations mentioned, was to get assistance in the application process for permits. It was stated by some installations that the administrative process was too challenging but also that the time to get an application granted varied heavily between different public agencies. The main issues identified, also concerned which information to provide in the application process. Additionally, in one interview that was conducted with a representative from a municipality, it was concluded that from their experience when installations are testing new techniques, they do not know all the parameters in advance. This means that when techniques are coming from the research phase and will move to the implementation phase, all the parameters in terms of emissions to air, water and soil are not known. This requires flexibility and tight communication between the representatives in the municipality and the installation.
2.9. Conclusion

This pilot has been a start in the process of finding a way to increase the focus and impact of ET within the IED. The objective with this pilot has been to mirror some of the actions stated by the European Commission and the international consulting firm ICF in a common workshop from 2014. The purpose with mirroring these actions has been to gather experiences regarding a potential process to include more stakeholders in the revision process of the BREFs. During the project new stakeholders have been mapped and contacted and a questionnaire specific for gathering information regarding ETs has been developed.

The findings from the project indicates that there is an interest among these new stakeholders in the IED and the BREF process since they notice that regulations implemented through for example IED drives demand for products and stimulates funding for research. This interest needs to be taken care of by the agencies working with the regulatory framework in order to accelerate the work towards the environmental goals. Further, the experiences from the pilot project shows that the involvement of these new types of stakeholders unfortunately is a time-consuming process which needs to be iterated and improved in order to be feasible to implement. There is also a need to improve the developed questionnaire to clarify some of the aspects which the stakeholders experienced a bit confusing. Some challenges in the information exchange process that also need further attention are to handle the fact that some information, especially regarding the economic performance of the techniques is sometimes unavailable due to early stage of development of the technique or because the information is classified.

The future actions needed to address these challenges are to further develop the format designed in this pilot to consistently describe ETs in the BREFs. Reaching a portfolio model enabling a visualization of the techniques and their performance but also a comparison of different techniques would be beneficial for the impact of ET. It is also necessary to develop the concept of TRL and outline a detailed framework adjusted to the IED context which translates terms and definitions in the directive to a classification framework that could be adopted to ETs.
3. References


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