Strategic implementation and development of Best Available Techniques in Danish Crown

Master thesis in Environmental Management and Sustainability Science

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Synopsis:

The purpose of the master thesis is two-folded. First, to analyse the policy implementation of Best Available Techniques (BAT) in Danish Crown through interviews, and suggest recommendation to achieve sufficient use of BAT in the organisation through strategic adaptive management and implementation of strategies based on effectual reasoning. Secondly, assessing how Danish Crown can benefit from partnerships and moving focus from products to systems based on Product-Service System. Interviews are conducted with project managers from Danish Crown, their technology suppliers Frontmatec and Multivac, the Danish Environmental Protection Agency, Danish Meat Research Institute and the Danish Society for Nature Conservation, and are based on the three characteristics that actors possess and could change the course of the policy; motivation, resources and cognition. Network theory is used to describe how Danish Crown interact with the different actors and how this can lead to changes in the policy implementation. Lastly this thesis presents a tool to calculate the Total Cost of Ownership to support the implementation of BAT in Danish Crown, and help assess if technology suppliers are presenting Danish Crown for the best environmental alternative equipment.

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Preface

This master thesis has been conducted on the 4th semester on the Master program Environmental Management and Sustainability Science, in the Department of Urban, Energy and Environmental Planning at Aalborg University from February 2019 to June 2019. Arne Remmen, Professor in the Department of Planning and Henrik Riisgaard, Teaching Associate Professor in Department of Planning has been supervising the master thesis.

The report has been edited using Latex. NVivo has been used for the coding of the interviews. Abbreviations are located in the beginning of the report so the reader can refer there for any unintelligible symbols. Moreover, the tables and figures included in the report are numbered according to the corresponding chapter. Lastly, a Google Drive link with the TCO-tool, audio-files from interviews and all appendixes is provided. It can be found by clicking here.

The authors would like to thank Arne Remmen and Henrik Riisgaard for the continuous support, the helpful comments and the constructive discussions throughout the writing process. A word of gratitude to Charlotte Thy, Sustainability Director in Danish Crown, thank you for the support in this period and for allowing us to get a glimpse of what is happening behind the curtains in Sevilla. We would like to thank all the people we got to interview during our master thesis, so thank you to Ole Pontoppidan (former DMRI employee), Tanja Smetana (the Danish EPA), Ulla Ringbæk (the Danish EPA), Per Tage Jespersen (Danish Crown), Erik Skovgaard Møller (Danish Crown), Claus S. Nielsen (Danish Crown), Niels V. Juhl (Danish Crown), Jens Peter Mortensen (Danish Society for Nature Conservation), Martin Petersen (Multivac) and Karsten Nissen (Multivac) and Henrik Andersen (Frontmatec). thank you for your time, the pleasant meetings and sharing your knowledge on the subject with us. Lastly, we would like to give a special thank you to Niels V. Juhl, Vice President from Danish Crown, and all chief engineers from Danish Crown who participated in the chief engineer meeting on Friday 24th of May 2019 in Randers, for allowing us to present our work and TCO-tool and for the inputs and constructive feedback.

Abstract

Environmental approvals for companies in Europe are regulated by the Industrial Emission Directive, which uses the concept of Best Available Techniques (BAT) to set requirements for the equipment used in the industry. Danish Crown is one of the companies that have to comply with the requirements set in the Industrial Emission Directive. The implementation of BAT requirements in Danish Crown could be more effective, because they rely on their technology suppliers to document that the equipment they purchase comply with the BAT requirements. The technology suppliers are however not able to provide Danish Crown with the required documentation.

Interviews with the actors involved in the process of developing and implementing BAT regulation are used to analyse the characteristics of the actors and discuss how these affect the process. The characteristics used in the analysis are based on the contextual interaction theory, which uses the three characteristics *cognition, motivation and resources* and the structural context surrounding the policy process, to analyse how the different actors affect the policy process and which options they have to change the course of the policy process. The structural context is analysed based on network theory, with a focus on the relation between the actors involved in the policy process. How the policy process could be changed to improve the implementation of BAT requirements is discussed based on Strategic Adaptive Management strategies and Effectual Reasoning. New suggestions for BAT conclusions that could be developed to create social, environmental and economical value are also discussed to clarify the possibilities a improved collaboration between the actors in the value chain could lead to.

In the development of BAT conclusions the actors motivation, cognition and resources creates a situation where the actors who want circular economy aspects in the BAT requirements do not have the resources to change the policy process. The focus from Danish Crown is on avoiding any requirements made by actors from outside the industry which they are not able to comply with, while the Danish EPA focus on requirements that could benefit Danish companies. In the implementation of BAT, Danish Crown would like to be more ambitious than the requirements set in the BAT conclusions and are motivated by reducing their operation costs. The technology suppliers have limited to no knowledge about BAT, but focus on the factors which could give them a competitive advantage. It is suggested that Danish Crown use total cost of ownership assessments in their procurement process, as this could give them a better basis for collaborating with their suppliers and make decisions. The suggested BAT conclusions focused on value chain aspects could create economic, social, and environmental value, if the interaction between the actors are improved.

Dansk resume

Miljøgodkendelser til virksomheder i Europa er reguleret af direktivet for industrielle emissioner, som anvender konceptet Bedst Tilgængelig Teknik (BAT) til at opstille krav for det udstyr der bruges i industrien. Danish Crown er en af de virksomheder som skal leve op til de krav der stilles i direktivet for industrielle emissioner. Implementeringen af BAT i Danish Crown er problematisk da de er afhængige af, at deres teknologi leverandører kan dokumentere at det udstyr de levere til Danish Crown, lever op til de relevante BAT krav. Denne dokumentation er teknologi leverandørene ikke i stand til at give Danish Crown, da deres viden om BAT er minimal eller ikke eksisterende.

De aktører der er involveret i udviklingen og implementeringen af BAT reguleringen er interviewet. Interviewene bruges til at analysere aktørernes karakteristika og baseret på det, diskutere hvordan de forskellige aktører påvirker processen. De karakteristika der bruges til at lave analysen, er baseret på contextual interaction theory, som bruger de tre karakteristika *motivation, kognition* og *ressourcer* samt den strukturelle kontekst omkring processen, til at analysere hvordan aktørerne påvirker processen. Teorien bliver også brugt til at diskutere hvilke muligheder aktørene har for at påvirke udfaldet af processen. Den strukturelle kontekst analyseres ud fra en netværks teori som fokusere på relationen mellem aktørerne i processen. Strategic Adaptive Management strategies og Effectual Reasoning bruges til at diskutere hvordan processen omkring udviklingen og implementeringen af BAT kan ændres, så implementeringen af BAT kravene kan forbedres. Nye forslag til BAT konklusioner som kunne føre til social, økonomisk og miljømæssig værdiskabelse diskuteres ud fra produkt-service system begrebet, for at gøre det klart hvilke muligheder et forbedret samarbejde mellem aktørene i Danish Crowns værdikæde kunne medføre.

I udviklingen af BAT konklusioner skaber aktørenes motivation, kognition og ressourcer en situation hvor de aktører der vil inkludere aspekter som cirkulær økonomi i BAT konklusionerne, ikke har ressourcerne til at gøre det. I udviklingen af nye BAT konklusioner fokusere Danish Crown på, at der ikke skal komme nogle fra udenfor industrien og lave krav som de ikke vil være i stand til at overholde. Miljøstyrelsen fokusere samtidigt på at udvikle kravene på en måde så de gavner danske virksomheder. I implementeringen af BAT vil Danish Crown gerne være mere ambitiøse end de krav der er sat i BAT reguleringen, da de er motiverede af at reducere deres produktionsomkostninger. Deres teknologileverandører har begrænset eller ingen viden om BAT og motiveres kun af de faktorer som kan give dem en konkurrencefordel. I diskussionen foreslås det, at Danish Crown laver en vurdering af totalomkostningerne ved at købe en teknologi, hver gang de køber nyt udstyr. Det kunne give dem et bedre grundlag til at samarbejde med deres leverandører om at begrænse de løbende udgifter, heriblandt deres miljøomkostninger. De foreslåede BAT konklusioner som foksuere på værdikæde perspektivet kunne skabe økonomisk, social og miljømæssig værdi, hvis interaktionen mellem de forskellige aktører i værdikæden forbedres.

Abbreviations

AEL	Assosciated Emission Levels
BAT	Best Available Technique
BATAEL	Best Available Technique Associated Emission Levels
BREF	BAT Reference Document
CIT	Contextual Interaction Theory
DC	Danish Crown
DN	Danish Society for Nature Conservation
EEB	European Environmental Bureau
EIPPCB	European IPPC Bureau
EMS	Environmental Management System
EPA	Environmental Protection Agency
FDM	Food, Drink and Milk BREF
KPI	Key Performance Indicator
PSS	Product System Service
SA	Slaughterhouse and Animal By-product BREF
SSCM	Sustainable Supply Chain Management
TCO	Total Cost of Ownership
TWG	Technical Working Group

Contents

Problem Analysis 1

1.1 Environmental regulation and cleaner technology

First time 'cleaner technology' was introduced in Denmark was in 1983 by the Environmental Protection Agency in their report on recycling and clean technology (Remmen et al., 2015). In Denmark the definition of cleaner technology was broadly defined by the Ministry of Environment and Food in 1992 as: *"the pollution and waste, as a result of the manufacturing, use and disposal of products, is sought to be eliminated or limited as close to the source as possible. This means that one changes the product or the manufacturing process so that the overall load on the environment from the society's material and substance cycles is reduced as much as possible"* (Remmen et al., 2015). The first cleaner technology programs were issued in 1986 in Denmark (Remmen et al., 2015). The focus was on the development of cleaner technology solutions in the production process. The focus later shifted towards environmental management and industry trade, where improvements were identified and conducted continuously in the organisation. Cleaner technology programs had the intention to stimulate organisations to do more preventive environmental efforts and develop new technologies as foundation for the environmental regulations (Remmen et al., 2015). Before organisations focused on methods for preventing pollution, they focused on end-of-pipe solutions, cf. figure 1.1.

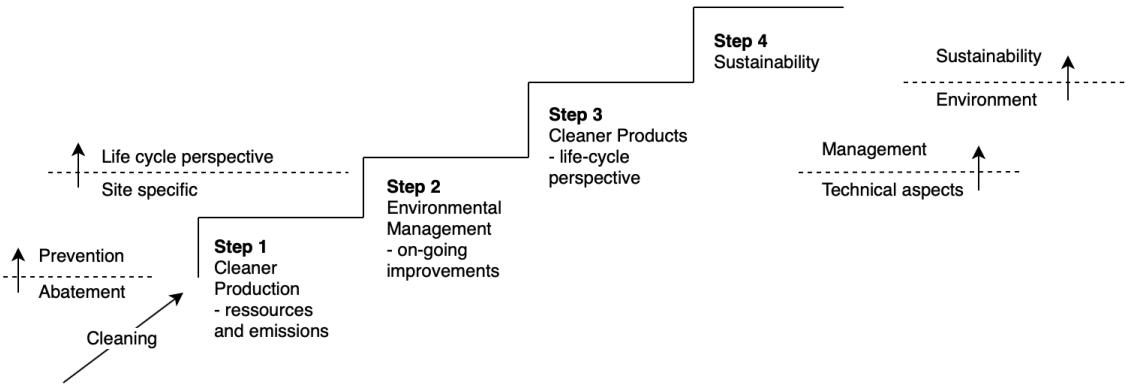

Figure 1.1: The industries environmental efforts, inspired by Remmen (2001).

The introduction of the cleaner technology mindset has had an effect on traditional environmental regulation. In the 1990s, environmental regulation was renewed to stimulate more directly the prevention rather than end-of-pipe technologies (Remmen et al., 2015). Businesses began to gain control of visible, local and significant sources of pollution, and more focus was then placed on other environmental issues that were more global, diffuse,

and complex (Remmen et al., 2015). There was a need to regulate at other levels, such as the EU and other international bodies, beyond the efforts of the national authorities (Remmen et al., 2015). The technological knowledge base for environmental regulation of production regulated by EU was developed.

The idea was to change and revise the regulatory framework in the Environmental Protection Act in a way that the rules gradually reflected the development of cleaner technology (Remmen et al., 2015). Cleaner technology should be disseminated by being a central aspect of environmental permits for industries.

In 1991, cleaner technology became the fundamental principle with the change in environmental protection law. Section 3 of the Act states that the administration thereof must be based on what is achievable through the use of least polluting technology. In 1999, the concept was changed to Best Available Techniques (BAT) as a result of the IPPC directive - Integrated Pollution Prevention and Control (Remmen et al., 2015). The IPPC Directive (96/61/EC) was included in the new, complex and holistic framework legislation under the European Community's Fifth Environmental Action Programme, adopted in 1993 (Fatta et al., 2003). The Fifth Environmental Action Programme was different from the previous action programs as it sets long term objectives and focused on a more global approach with the title 'Towards Sustainability' (European Commission, 2005). The Fifth Environmental Action Programme stated that one of its objectives was: *"improved management and control of production processes including a system of licensing linked to integrated pollution prevention and control"* (European Commission, 1993). The IPPC Directive was an important milestone in the environmental legislation, as it sets a flexible and integrated framework for environmental regulation of a wide range of the most polluting industrial activities (Fatta et al., 2003).

1.2 From single medium regulation to sustainable development

Prior to the IPPC, emissions from industrial processes were subject to single medium regulation covering releases to air, water or land (Nicholas et al., 2000). Already in the mid 70's it was highlighted that this approach was not effective for minimising the total impact of the pollution on the environment, as one form of pollution can transfer impacts to another medium (Nicholas et al., 2000). It was recommended that an unified pollution inspectorate should be established to ensure that the release of pollutants to air, water and land caused the least environmental damage overall by choosing the Best Practicable Environmental Option later known as BAT. (Nicholas et al., 2000). The IPPC adopted some of the fundamental concepts, notably the requirement for an integrated site-specific approach to pollution control and a much wider assessment of the processes, and including whole installations rather than individual processes, and covering more environmental impacts (Nicholas et al., 2000). In addition to the integrated control of emissions to air, water and soil, IPPC considers energy efficiency, use of raw materials, off-site waste disposal and site restoration (Nicholas et al., 2000). Moreover, IPPC focuses on the processes upstream of the effluent discharge, favouring reduction of pollution rather than end-off pipe solutions. Therefore, IPPC goes beyond emission-focused systems and single medium

approaches to a more wider scope of industrial pollution control, cf. figure 1.2.

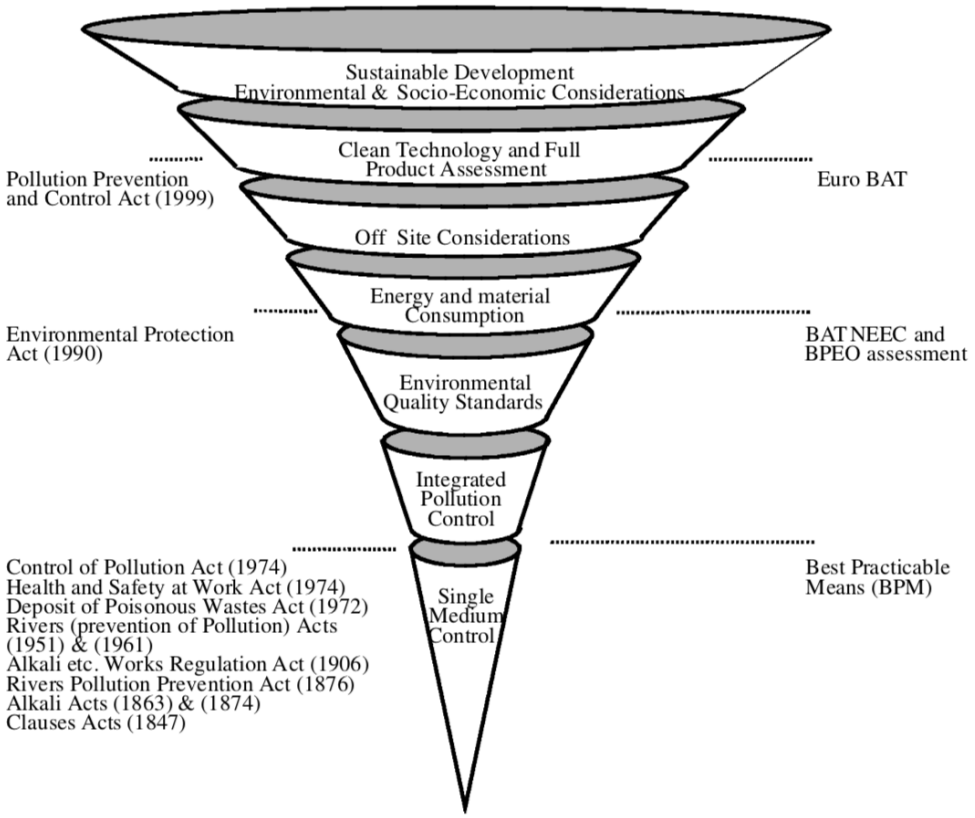

Figure 1.2: The widening scope of industrial pollution control (Nicholas et al., 2000)

However, BAT is still in-line with the recipient-oriented environmental regulation based on emission values, limit values and rules. The public translates environmental knowledge into rules, for example in the form of standards that define the technological development tracks (Holm, 1997). Holm (1997) believes this entails, among other things, the risk of locking the production in a particular development track that prevents technological renewal. Huybrechts et al. (2018) argues that BAT-based permit regulations can potentially act as a driver or as a barrier for implementation of circular economy.

1.3 Best available techniques in the Industrial Emission Directive

In 2010, the IPPC directive was replaced by the Industrial Emission Directive (IED) which has extended and reinforced the role of BAT (Evrard et al., 2016). The overall goal of the IED is *"to prevent, reduce and as far as possible eliminate pollution arising from industrial activities in compliance with the 'polluter pays' principle and the principle of pollution prevention"* (European Commission, 2010).

The purpose of the directive is, among other things, to ensure a more coherent approval process for polluting companies. Besides replacing the IPPC, the IED merged and replaced the following six directives (Ibáñez-Forés et al., 2013):

- large combustion plants
- waste incineration
- solvent emissions
- titanium dioxide (three directives related to disposal, monitoring and surveillance and programs for pollution reduction).

As mentioned, the IED strengthened the application of BAT in the EU across a range of sectors, also establishing Emission Limit Values for different polluting substances (Ibáñez-Forés et al., 2013). According to Article 3(5) of the IED, Emission Limit Values means the mass, expressed in terms of certain specific parameters, concentration and/or level of an emission, which may not be exceeded during one or more periods of time (European Commission, 2010).

Article 3 of the IED defines BAT as *"the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole"* (European Commission, 2010). The meaning of the three words are:

- **Best**: The technique considered *"the most effective for achieving a high general level of protection of the environment as a whole"* (European Commission, 2010).
- **Available**: The technique considered is *"developed on a scale which allows an implementation in the industrial sector, under economically and technically viable conditions"* (European Commission, 2010). The condition takes into account the cost and advantages, whether or not the techniques used or produced within the given member state, and if it is reasonably accessible to the operator (Evrard et al., 2016).
- **Technique**: Includes both the *"technology used and the way in which the installation is designed, built, maintained, operated and decommissioned"* (European Commission, 2010). It means that technique is not only limited to a pollution abatement device but also includes management approaches such as environmental management systems (Evrard et al., 2016).

Industries within the scope of the IED can use BAT Reference Documents (BREF) to identify BATs and their associated emission levels. The BREFs are a series of reference documents that cover the industrial activities listed in Annex 1 in the IED. BREFs provide descriptions of a range of industrial processes, their respective operating conditions and emission rates (European Environment Agency, 2019). The creation and revision process of the BREF documents, is denoted as the Sevilla Process. The aim was to reach a three-year revision process to improve the accuracy of the BREF (Huybrechts et al., 2018), however the process have been longer than expected. This process is a response to the requirement stated in article 13 of the IED to set up an information exchange while creating or revising the BREF documents (Huybrechts et al., 2018). It is coordinated by the European IPPC Bureau (EIPPCB) based at the Joint Research Centre in Seville (Spain).

The IED is an integrated approach, where authorities would need to weight non-local and transboundary effects, such as global warming and acidification, against effects on the

local environment (European Commission, 2010). They also need to weight the costs, as well as the advantages of pollution prevention and control to make sure they are up to date with the latest developments of BAT (European Commission, 2010). These decision processes are complex and need a significant knowledge base of the industry, which lead to the establishment of the EU exchange of information on BAT.

The Sevilla process for determination of BAT is a stakeholder process between member states, environmental NGO's and the concerned industries (Huybrechts et al., 2018). The process is based on information exchange, evaluation, and consensus building on available techniques. The strength of this form of regulation is that it is possible to integrate the specific knowledge of products and processes and the structural conditions for the implementation of new concepts, and helps to establish a common agenda in relation to the environment (Holm, 1997). However, the interactive form also contains the risk that specific interests and dominating development tracks maintain the development within narrow environmental and technological limits (Holm, 1997).

By the end of the Sevilla Process the BREF Documents are developed, and are applicable for different industrial activities under the scope of the IED (Huybrechts et al., 2018). The European Commission lays down rules and guidance for data collection, drawing up of the BREF document and quality assurance. Each BREF describes applied techniques, emissions and consumption levels, techniques considered in the determination of BAT as well as BAT conclusions and any emerging techniques (Huybrechts et al., 2018). There is a total of 34 BREF documents under the IED and its predecessor, the IPPC Directive (Miljøstyrelsen, 2019). There are 3 BREF documents addressing cross-sectoral issues such as cooling, storage, energy efficiency, denoted as the 'horizontal' BREF document, while the remaining 31 BREF documents address a specific industrial or agricultural sector or activity, called the 'vertical' BREF documents (Miljøstyrelsen, 2019; Huybrechts et al., 2018).

The industrial sectors concerned with the implementation of BAT is listed in Annex 1 in the IED. A distinction is made between industries listed in Annex 1 and 2, respectively, in the Executive Order on permits (Remmen et al., 2015). Annex 1 industries are subject to full individual permit, while Annex 2 industries are under a simplified system (Remmen et al., 2015). Annex 1 represents about 50,000 installations within Europe from various industrial sectors e.g. food, drink and milk, wood-based panels, sanitary landfills etc (Evrard et al., 2016). One of such industries is Danish Crown. Danish Crown is a Danish internationally oriented food company with slaughtering business, processing and sales of primarily pork and beef (Danish Crown, 2019b). Through a number of subsidiaries, the Group is widely represented in the food industry with various food products (Danish Crown, 2019b).

1.4 Issues in the implementation of BAT in Danish Crown

In the spring of 2019, a revised version of the BREF document concerning Food, Drink and Milk (FDM) industries will be published, and because Danish Crown is an Annex 1 industry in accordance to IED, their environmental approval shall be reviewed in accordance with the new BREF. In addition to the FDM BREF, Danish Crown is participating in the technical working groups for the revision of the Slaughterhouses and Animal By-products

BREF. The revision process started this year. After the revision process, the BAT conclusions are legal requirements which industries must comply with. Therefore Danish Crown must document the implementation and use of BAT. This can be done, among other things, by using BAT checklists, which are translated BAT conclusions that are relevant to the industry. These checklists are submitted alongside the environmental permits to the Danish Environmental Protection Agency (EPA), see checklist in Appendix A. In addition to documenting BAT implementation when new revised BREF documents are published, Danish Crown must also document the use of BAT when applying for new environmental approvals or when changing production equipment that has a significant impact on the environment.

Danish Crown rely on their suppliers to comply with BAT and document the use of BAT. In 2012, during the building of the new pig slaughterhouse in Holsted, Danish Crown decided to make their first big initiative to collect all BAT documentation from their technology suppliers. The results from the initiative back in 2012 was unsatisfying. Danish Crown experiences that their suppliers could not provide them with the correct and sufficient information to document the use of BAT. Typically, the technology suppliers had a limited understanding of BAT, as they only looked at environmental parameters such as energy and water. Therefore, Danish Crown faces a challenge when buying new equipment, to be presented with the best environmental alternatives. Since the Holsted-project, Danish Crown has not in the same extent tried to document BAT with their suppliers. Danish Crown seek to improve on this effort as BAT is legal requirements, but also gives the ability to optimise production. Therefor, this master thesis seek out to answer how Danish Crown can improve the implementation of BAT in the organisation. Currently, research is conducted on the improvement in the determination of BAT, but there is no research assessing the implementation practices on BAT.

In addition to assessing improvement practices for the implementation of BAT, this master thesis also sets out to answer the questions of why value chain aspects was or was not considered in the determination of BAT. It is also discussed how the inclusion of value chain aspects in BAT conclusions could create value for the social, environmental and economical bottom-line in Danish Crown. As mentioned earlier, Huybrechts et al. (2018) suggests that BAT regulations can potentially act as a driver or as a barrier for implementation of circular economy. Whether BAT will act as a driver or as a barrier depends on how up- and downstream activities are considered in the way BAT is developed and implemented at the installation level.

1.5 Existing research on Best Available Techniques

The research on BAT is mostly focused on the method used to identify the techniques that are defined as BAT. At the moment, no study that have analysed BAT regulation from a company perspective or from a social interactive context.

In a literature review of studies on BAT, 10 articles which focus on how LCA could be included in BAT were identified and only one article focused on BAT and circular economy. In the article by Huybrechts et al. (2018) they conclude that in the determination of BAT the consideration of value chain aspects are not considered systematically. Huybrechts

et al. (2018) proposes a systematic assessment of relevant cross-sector effects in the BAT determination. In addition they propose to include value chain BAT in the selection of BAT, i.e. techniques that can be implemented in the sector but will realise an environmental benefit elsewhere in the value chain. Collaboration with the upstream and downstream actors in the value chain can be considered as a generally applicable value chain BAT for all sectors. Further research is needed to determine how the "concepts/proposals" can be incorporated in the existing methods for determination of BAT at sector level.

Huybrechts et al. (2018) uses BREF documents as an information source. However, they suggest as an alternative or complementary information source, interviews with BREF authors and experts or stakeholders involved in the information exchange on BAT (members of technical working groups). They mentioned interviews as being beneficial because the drawback of using BREF documents as information source, is that they provide good insights into the question if and how the value chain aspect was considered in the BAT determination process, but not (always) into the question why the value chain effect was or was not considered.

Whether BAT based permit regulations will effectively act as a driver or barrier for greening of global value chains, will not only depend on whether or not value chain aspects are considered in the determination of BAT, but also on how the BAT implementation practices with respect to value chain aspects can play in the successful implementation of Sustainable Supply Chain Management and Circular Economy (Huybrechts et al., 2018). It was outside the scope of the paper, but was suggested as a topic for further research on the role that environmental laws and regulations, in this case BAT-based permit regulations.

With a starting point in the issues experienced by Danish Crown in their implementation of BAT and building on top of the existing research, this study focus on how the implementation of BAT regulation could be improved and suggest new possible BAT conclusions for the meat industry.

Problem Statement 2

In chapter 1 it is highlighted that the implementation of Best Available Techniques (BAT) is insufficient in Danish Crown and that there is no systematic consideration of value chain aspects in the development of BAT. This leads to the main research question.

Research question

How can the implementation of BAT be improved in Danish Crown when buying new equipment, and which new BAT conclusions could create value for the social, environmental and economical bottom-line in Danish Crown?

Sub-questions

The main research question relates to the desired situation and vision. In order to answer the main research question, the first three sub-questions are aimed at describing and analysing the current implementation practice and BAT development process. The last two sub-questions are action-oriented and sets out to answer how to achieve the desired situation.

1. What is the current process of developing and implementing BAT?
2. Which actors are involved in the development and implementation of BAT, and how do their characteristics and relations affect the policy process?
3. How could the characteristics of the actors involved in the BAT development process, be used strategically in the development of new BAT conclusions?
4. How could Danish Crown succeed in their strategies to improve the implementation of BAT in Danish Crown?

Research design and structure 3

This thesis adopts an effectual reasoning approach to the research, cf. 3.1. Effectual reasoning is a fluid process, and there is no clearly-defined goal in the beginning, this approach allows the goal to emerge out of the process. Effectual reasoning resembles *action research*, as both research strategies adapts circular actions and reflections. In action research a problem is firstly defined, secondly turning the problem into questions, then finding sources of knowledge, gathering information and data, sort the information and lastly, ask new questions.

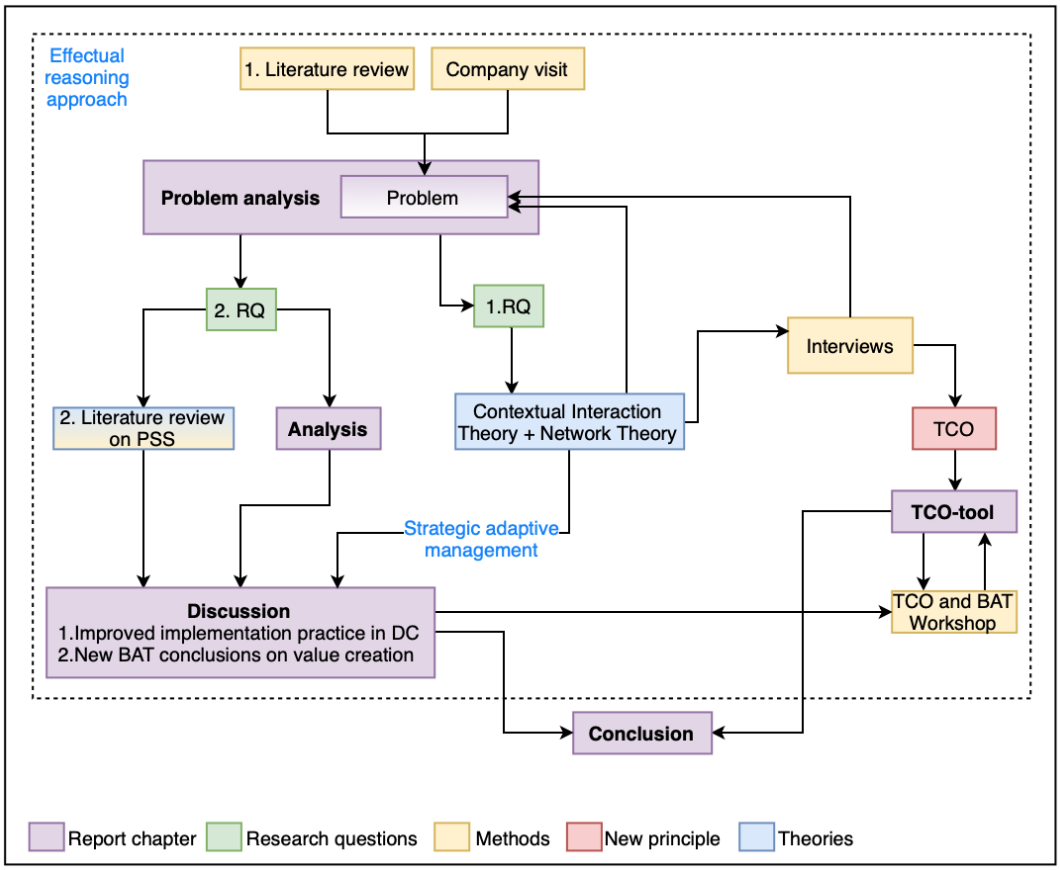

Figure 3.1: An overview of the research design.

The same research approach is taken in this master thesis. Firstly a problem is identified after a literature review and a company visit in Danish Crown. Secondly, the problem is turned into research questions (1. RQ).

Two theories is found to help understand and answer the research questions. Using theoretical tools to answer on a wonder/or puzzling fact, made from an observation, that does not match the researchers' prior knowledge, is also known as *abductive reasoning.*

The two theories used in the thesis is 1) Contextual Interaction theory, which is a policy implementation theory, and 2) Network theory. Network theory is used to identify which actors to interview, and Contextual Interaction theory is used as an analytic framework to formulate interview-questions, based on the actor characteristics that could change a policy process. In order to gather information and data, actors involved in the development and implementation of BAT are interviewed. After information is sorted new questions emerge. New research questions (2. RQ) are formulated, as new information, issues and company needs are discovered, such as Total Cost of Ownership, cf. 3.1. To fulfil this company need, a TCO-tool is developed to support BAT. A workshop on TCO and BAT is conducted to introduce Danish Crowns employees to the tool and get improvement feedback. Identifying a need and then meeting that need is in accordance to the effectual reasoning approach.

After formulating the second research questions (2. RQ) the process is then repeated. This means a second literature review is conducted, and this time on the Product-Service System framework to discuss *how new BAT conclusions could create value for the social, environmental and economical bottom-line in Danish Crown.* The 2. RQs also aim at analysing and describing the current implementation practice in Danish Crown in order to suggest *how Danish Crown can improve implementation of BAT.* Suggested improvement practices are based on Strategic adaptive management, which is an element in the Contextual Interaction theory. Principles from effectual reasoning is also used to assess how Danish Crown can become successful when implementing strategies. Effectual reasoning is used in two ways in this master thesis. The first one is in the research approach. The second is using principles from the theory to suggest how Danish Crown can continue the work in the future.

Principles from the Product-Service System framework, Strategic adaptive management and results from the analysis is used in the discussion, in order to answer the main research question, cf. 2. Highlights from the discussion is used to feedback into the workshop on BAT and TCO. Lastly, a conclusion is written on the highlights from the analysis and discussion and the TCO-tool.

Chapter outline

The master thesis proceeds as follows. In chapter 4 is the theory, and in the first section 4.1 the theoretical framework for understanding a policy process is presented and discussed. In the second section 4.2 the theoretical framework for strategies and actions: adaptive management strategies and effectual reasoning is presented. The last section is 4.3, where the Product-Service System (PSS) framework and barriers for implementing a PSS framework is described. In chapter 5 methods used in the thesis is explained; interview 5.1 and workshop 5.2. Chapter 6 is the analysis. The analysis is split into two tracks: 1) development of BAT 6.2 and 2) implementation of BAT 6.3. The two sections are focused on actor analysis based on the three characteristics: motivation, resource and cognition. The discussion in chapter 7 consist of three sections. In ection 7.1 BAT benefits and limitations is presented, section 7.2 is on including circular economy considerations in BAT,

and in section 7.3 it is discussed how to improve BAT implementation practices in Danish Crown. Lastly, the applied theories and methods throughout the study are discussed in section 7.4 and 7.5. The tool for assessing total cost of ownership is in 8. Chapter 9 concludes on the improved implementation practices of BAT in Danish Crown and new BAT conclusions to create value for social, environmental and economical bottom-line in Danish Crown.

Theory 4

The problem statement has a focus on two different, but still related questions. The first question is focused on the implementation of BAT in Danish Crown while the second question focus on the development of new BAT conclusions. The common thing for both questions is that they point towards a future scenario which require action from the involved actors. One part of the theoretical framework is therefor focused on action, and how actors can use strategies to affect a policy process. To understand how different actors are involved in, and affect the policy process of BAT, another part of the theoretical framework focus on the factors which are relevant for a policy process. This theory is used to analyse both the development- and implementation process of BAT regulation. The development of new BAT conclusions which could create triple bottom line value for Danish Crown, is based on the product-service system framework.

4.1 Theoretical framework for understanding a policy process

Policy processes are described in multiple theories with differing focus. Multi Level Governance theory focus on the development of policy by asking questions such as: Who are the actors? How do they interact? Is influence moved from the government? These questions could be relevant to ask in the analysis of the development of BAT regulation, but the focus of this study is wider than only the policy development process, because the actors behaviour in the implementation process also is of interest for this study. Institutional theory focus on the social structures that have an effect on how actors behave, and what the rules determining this behaviour are. It could to some degree be used to analyse the issues occurring in the BAT regulation implementation process, as it could be used to identify why the actors behave in the way they do. However, because the focus of this study is on policy implementation it is chosen to use a policy implementation theory. In section 7.4, it is discussed how the use of the other suggested theories could add to the study.

4.1.1 Overall framework of Contextual Interaction Theory

Policy implementation theory is in general used to improve policy implementation by offering knowledge about which factors influence the success of policies, by explaining the gap between policy intent and policy action (O'Toole Jr, 2004). Contextual Interaction Theory (CIT) is a policy implementation theory which mainly have been developed and used as a framework to assess why policies concerning water governance are successful or

not. It has not been used in this kind of study before, but it is assumed that the factors influencing the policy process are the same.

Contextual Interaction Theory is used as a framework for this analysis because it looks at a policy process as part of a social interaction process and not as a mechanism. The central characteristics of each actor involved in the process can based on this framework be used to explain the course and results of a policy process (Bressers and de Boer, 2013). It is argued by Owens (2008) that the theory has distilled the options down to three variables, which makes it simple to use, but at the same time it represent a realistic take on the interaction process.

4.1.2 Factors influencing a policy process

The key characteristics of an actor are identified based on three core factors; resources, cognition and motivation. Resources are an actors capacity to act and its power in relation to other actors. Motivation is what drives the actors to behave the way they do and cognition is the information which the actors see as the truth and through which they interpret a situation. It is these characteristics that partly determine how each actor contribute to a process, because actors are also influenced by the course and the experience they gather from the policy process and their characteristics can therefor change gradually over time (Bressers and de Boer, 2013). The actors in a policy process can both be people and/or organisations. If the actors involved in a process are organisations, then the resources, motivation and cognition should be identified for the organisation as a whole and not for each individual. (Bressers and de Boer, 2013)

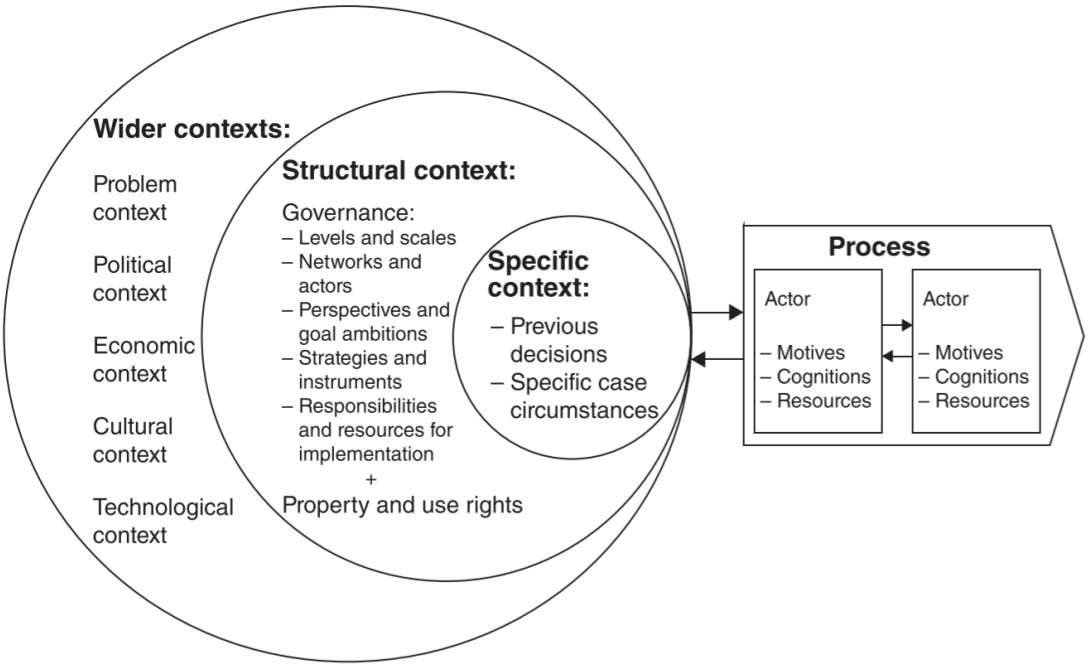

Figure 4.1: The different layers of contextual factors and the policy process (Bressers and de Boer, 2013).

The three key characteristics are influenced by the context the policy process is happening

within. This context is in CIT divided into three layers. The first layer is the case-specific context, which includes the case history, e.g. previously made decisions. In this layer are also the specific case circumstances. The second layer is the structural context with the elements of governance; levels and scales, networks and actors, perspectives and goal ambitions, strategies and instruments, and responsibilities and resources for implementation. This layer is more stable than the case specific layer, as it is not influenced in the same way by the policy process. Another difference between the specific context and the structural context is that the latter does not differ from case to case. The structural context will however gradually change in processes larger than the case specific processes. The last layer is the wider context layer where the cultural, economic, political, and technological process is included (Bressers and de Boer, 2013). This layer will not be addressed directly in the analysis.

4.1.3 The structural context of policy implementation

In this study, the focus in the analysis of the structural context is on the network and actors. Network theory is used because it moves the focus of the analysis from the company to the company in its context, understood as the relations that the company forms as part of its productive activities (Holm, 1997). Network theory is used to explain which relations Danish Crown enters into and the selection of actors in the various networks that are relevant for BAT development and implementation. Furthermore, the company's ability to develop and change their technological and organisational base is crucial to their competitiveness and survival (Holm, 1997). Innovation is an interactive process where the company exchanges knowledge and experiences in the network that it is part of. This study is therefore not limited to the company but also looks at the company's relations.

The company is viewed from a technical and economic perspective. As an actor, the company tries to optimise its operations to ensure the greatest possible return. The choice of technology and production and market strategy is also subject to this rationale. However, it is important to emphasise that the choice of technology is subject to a technical rational, but also a social situation. It is therefore important to analyse how and why a company chooses a particular technological system in order to be able to discover how the choices can be influenced in a more sustainable way. (Holm, 1997).

The network theories emphasise the social content in companies' relations. Relations create *reciprocity*, *interdependence*, *loose links*, and *power* (Holm, 1997). The single transaction (buy-sell) is not seen in isolation, but as part of a sequence over time. It creates the preconditions for subsequent transactions by creating *reciprocal* expectations. *Reciprocity* is therefore the prerequisite for and the strength of the relation (Holm, 1997). The *interdependence* is built up by the actors' interaction in long-term relations. It is knowledge about each other, adaptation to each other, and investments (Holm, 1997). Relationships are therefore difficult to resolve. Relations represent structured benefits in terms of the development of common codes that facilitate the communication and exchange of information and represent a real investment (Holm, 1997). In the event of an outbreak, this will be lost. The benefit of this relation grows over time, making companies less likely to respond to radical changes in their surroundings (Holm, 1997). However, network relations still need to be characterised as *loose links*, as the actors in the network possess

an autonomy, as they are not locked in the same specific exchange relation as within a company (Holm, 1997). The network relations also have a stability that can form the framework for the development of interaction and exchange of information, whereby the network reduces the systematic uncertainty of the market (Holm, 1997). *Power* relations are the actors' control over resources. The resourceful actors will be the most powerful actors in the network, which creates a need to engage in the network.

Actors can be described by three dimensions: 1) the activities they perform and control, 2) the resources they control and 3) the knowledge they have about activities, resources and other actors in the network (Holm, 1997). For the individual actor, it becomes an objective to expand this basis by improving its position and expanding its control over the network, for example by gaining control over strategic activities and resources in the network (Holm, 1997).

The network is emphasised not only as a technical-economic structure but also as a social structure. The network will thus establish a strong binding of the actors' space for action (Holm, 1997). At the same time, development and change in network relations will be a decisive tool for initiating new and environmentally oriented development tracks (Holm, 1997).

The company is part of many networks with different significance and knowledge content, and where the relations change over time. Holm (1997) divides into three main types of network: *business*, *development* and *regulatory*, cf. 4.2.

The division is based on the difference in the dominant dynamics that impose and develop the networks. Common to them is that an interaction is established in the relation, which determines the company's development and potential for change. As shown in the figure 4.2, some actors will appear in several networks. The companies' relations with suppliers and customers will primarily be determined by business activities, but relations with these actors and their resources will at the same time be essential preconditions for the companies' development potential.

Holm (1997) argues that the network perspective maintains a holistic view that not only focuses on a single relation but the network as a unified structure. Holm (1997) continues; *network perspective is important as the company will be influenced by the overall network of relationships, the structure of these relationships, and the relative importance of the networks.*

Holm (1997) distinguishes between environmental conceptions and their environmental interactions. Environmental conceptions is understood as *the company as an actor that interprets external and internal conditions and opportunities.* It is this interpretation that determines the company's action horizon and priorities. The actor perspective is therefore important, because it uncovers the company's readiness for change, its strategies in the environmental field, and its knowledge of possible solutions.

However, environmental conceptions are largely determined by the company's environmental interactions. Here, a structural perspective is placed on the company, as the focus is on all relations where there is an environment-related interaction and information exchange. Holm (1997) argues that this is an important consideration because the company's

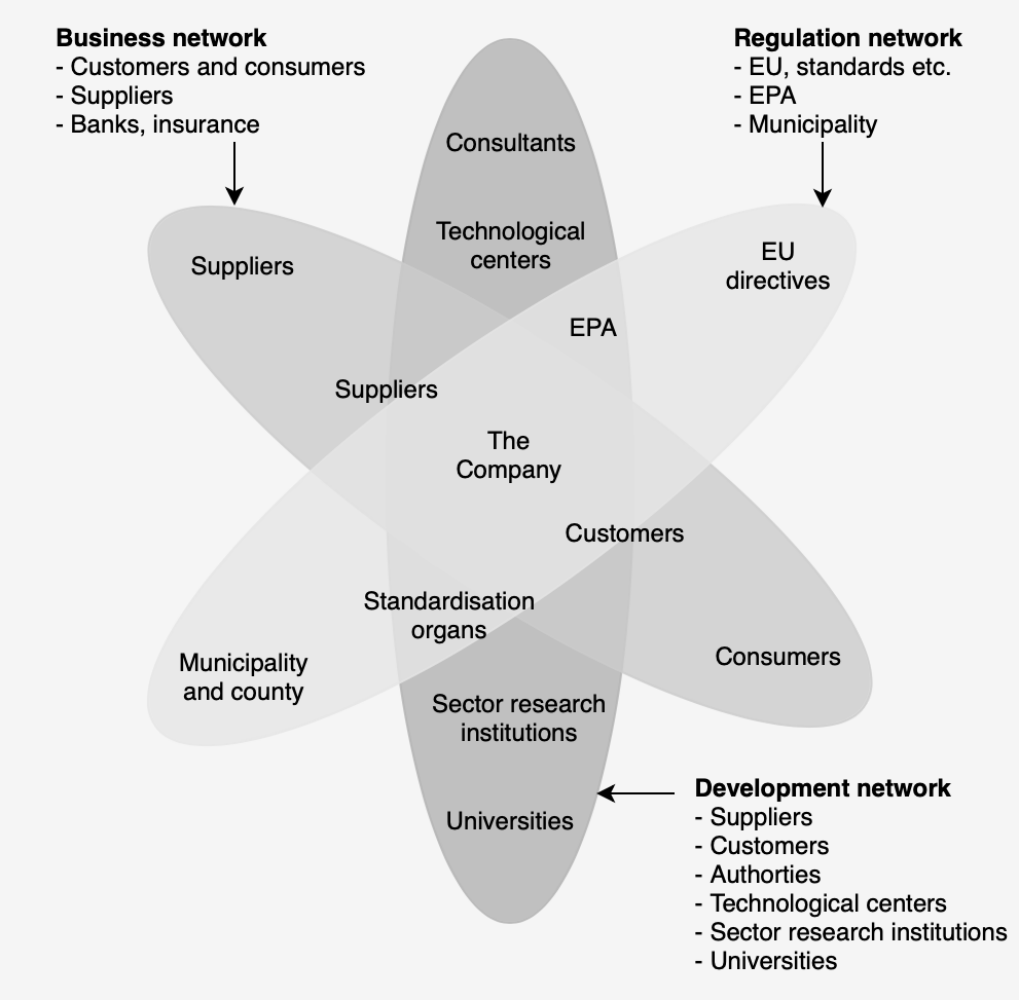

Figure 4.2: The company's network relations - selected networks important for the company's environmental space for action (Holm, 1997).

relations largely define the space for action.

In this study, the actor- and the structural perspective are integrated into the analysis. This is done because restructuring processes involve many actors with different environmental conceptions. A crucial focus is to analyse how in the field of technological systems dominant environmental conceptions are developed, which decisively determines the development track.

4.1.4 Main points

- Implementation policy is used to explain the gap between policy intent and policy action
- Actors contribution to a policy process can be explained by the three characteristics; resources, cognition and motivation.
- The actors are influenced by the context the policy process is happening within.
- Network theory moves the focus of the analysis from the company to the company in its contexts.

- Choice of technology is subject to a socio-technical rational depending on the competences and knowledgde of the actor as well as the organisational context.
- Relations create reciprocity, interdependence, loose links, and power.
- Actors are considered in three network dimensions: business, regulation and development, where the type of relations and interactions are different.

4.2 Theoretical framework for strategies and actions

Both an improvement of the implementation of BAT and the development of new BAT conclusions require actions from the involved actors. Suggestions for how the suggested improvements can be achieved are based on the following two strategic approaches.

4.2.1 Adaptive management strategies

If the course of a policy process is unsatisfying for an actor, it is possible for that actor to try and change the course of that process. Adaptive management strategies could be applied to make this change. These strategies could be aimed at changing the specific context of a policy process, which could be done by adding new actors to the process and thereby creating better networks, or by creating new arenas. A new arena could be a new meeting point like a working group, committee, etc. Another strategy could be to introduce new information and thereby changing the cognition of the actors, or to create motivation by offering resources. A last strategy could be to gain new resources or power. (Bressers and de Boer, 2013)

These strategies answers the question of *what* an actor can do to change the course of a process. The approach to implementing these strategies is also relevant for the success of the chosen strategies. One theory that tries to answer the question of *how* an organisation can be successful with its strategies is "Effectual Reasoning".

4.2.2 Effectual reasoning

Unlike causal reasoning where planning and prediction of the future is the key, effectual reasoning is about execution. Effectual reasoning is based on the way successful entrepreneurs work.

The starting point for an entrepreneur is imagining what they can do based on three categories of means: Who they are, what they know and whom they know (Sarasvathy, 2001). This is the Bird in Hand principle. From this point entrepreneurs would look at their abilities. Another similarity for entrepreneurs is that they apply some common principles of reasoning, that is in contradiction with causal reasoning, Table 4.1.

Causal reasoning	Effectual reasoning
Expected return	Affordable loss
Competitive analysis	Strategic partnerships
Pre-existing knowledge and prediction	Leveraging of contingencies

Table 4.1: Principles of reasoning for causal and effectual reasoning (Sarasvathy, 2001).

The Affordable Loss principle is to put a product on the market with as few expenses (time, money and effort) as possible (Sarasvathy, 2001).

Strategic partnerships, or the Crazy Quilt principle, is to make partnerships as early as possible, instead of focusing on the potential competition within a market. This is where entrepreneurs cooperate with partners they can trust. Together with affordable loss this means that a company can secure commitments from their partners before investing capital in the project (Sarasvathy, 2001).

The Lemonade principle, is where entrepreneurs will look at how to leverage contingencies - to realise that not all surprises are bad, and that they can be used as input to a new venture.

The fifth principle is the Pilot-in-the-plane principle, where all previous principles are put together. The logic behind this principle is that *to the extent that we can control the future, we do not need to predict it*(Sarasvathy, 2001). Entrepreneurs do not act like there is a certain future to be discovered, but they do act as if the future is created from the strategies used by the actors (Sarasvathy, 2001). They can however control some of the factors which determine the future.

Effectual reasoning is especially effective in domains where there is a new market and a new product (Sarasvathy, 2001). However according to Svensrud and Åsvoll (2012) effectuation is *almost as important for opportunity practice in large corporations as for start-ups*. Their study focus on whether effectuation strategies should be used by corporations or not and, if it should, how it could be used. They conclude that the value of effectuation strategies in corporations decreases as the opportunity grow. Halfway through the growth of an opportunity the effectuation strategies and causation strategies are equally valuable, but after this point causation strategies are more valuable. As it is difficult to be a big company and innovative at the same time, they argue that a corporation should identify which of their employees have the most tacit knowledge and then let these employees identify, create and exploit opportunities. Managers should also use gut feeling when evaluating opportunities - especially when evaluating those opportunities that hold a lot of uncertainty (Svensrud and Åsvoll, 2012). Large corporations should also arrange more experiments in their search for opportunities, to assure a higher rate of success (Svensrud and Åsvoll, 2012).

4.2.3 Main points

- An actor can change the course of a policy process by; adding new actors to the process, creating new arenas, introducing new information, gaining new resources.
- The starting point of a atrategy based on effectual reasoning is to answer the question; who am I, what do I know, and who do I know?
- Partnerships, leveraging of contingencies and controlling some factors could lead to a successful strategy.

4.3 Product-service system framework

Recommendations for how sustainable value creation could be integrated in new BAT conclusions are suggested in chapter 7. Some of these suggestions are based on the product-service system (PSS) framework.

Product System Services is by Goedkoop et al. (1999) described as *a marketable set of products and services capable of jointly fulfilling a user's need.* Mont (2002) elaborates the term further and defines PSS as *a system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs and have a lower environmental impact than traditional business models.* For the consumer this mean buying a service instead of a product, to fulfil the same function as a product would (Mont, 2002). For the producers and service providers this means a higher responsibility of the products entire lifecycle, involvement of the costumer and design of closed loop systems (Mont, 2002).

Product Service Systems could mean that the property rights change in some cases and that more attention will be given to the use stage in a products life cycle (Mont, 2002). Using PSS allows companies to identify new market opportunities and trends, and to stay competitive as the markets change. The concept could also lead to incremental innovations (Mont, 2002). For a producer a PSS could mean that it is possible to:

- Attach additional value to a product by adding new services to it.
- Base a growth strategy on innovation.
- Improve relations with consumers as the communication about preferences and flow of information will increase.
- Improve the value for customers because of the added services.
- Turn take-back schemes into a competitive advantage.

For the consumer PSS means they get presented with a greater diversity of services like maintenance and repair services, payment schemes, etc. (Mont, 2002). The consumer get added value because of more customised offers and higher quality products/services (Mont, 2002). The consumer could also be relieved from the responsibility of ownership, as the producer will own the product (Mont, 2002). The use of a PSS could amplify the development towards dematerialisation, as the consumer pays for a service instead of a product (Hinterberger and Luks, 1998).

Overall there are 3 categories of PSS. The first is a product oriented category, where the main item is the product with some extra services connected to it. The second is where the producer keep the ownership over the product, while the customer pays to use it and not for its possession. In the third category, the actors agree on the outcome, without any or with very few predetermined conditions (Annarelli et al., 2016). The main elements of a PSS are:

- A system that consist of various combinations of products and services.
- At the point of sale, a service is the personal assistance, financial schemes, explanation of product use and marketing.
- Maintenance services with the goal of prolonging the lifetime of a product through maintenance and upgrades.

- Closing the product material cycle by offering take back schemes with the goal of using old parts in new products and recycling materials that cannot be reused.

(Mont, 2002)

For a PSS to be successful it is necessary that the manufactures extend the responsibility outside those life cycle phases that are usually the responsibility of the manufacturer (Mont, 2002). Because of this extended responsibility information from the use phase can easily be transferred to the design and production phases, which make the whole system more responsive to changes in the market and thereby also stimulate innovation (Mont, 2002). Information management will therefor also play an increasingly important role in improving organisational efficiency and also for communication with the customer (Mont, 2002). It could be necessary to create new networks in order to develop the PSS. These could be research networks, sector networks or information sharing networks (Mont, 2002). In a PSS the goal is not to sell as many products as possible, but to have as strong a relationship as possible, with the most profitable costumers (Wise and Baumgartner, 2000).

Product Service Systems are not necessarily more sustainable than a traditional manufacturing industry. There could however be an incentive for the producer to reduce the resource use in the use phase of the product, if the producer will be paying for the resource use in this phase. A PSS could also encourage the producer to increase the reuse-ability and recycle-ability of the product (Mont, 2002). If they do that, producers could decouple economic growth from environmental pressures, while they still satisfy the consumers needs (Annarelli et al., 2016). To understand the value created in a system perspective a value proposition was developed by Kristensen and Remmen (2019). The framework (Figure 4.3) is built on the three aspects of PSS; product, service, and system, and divided into the three core dimensions for sustainability defined by Bocken et al. (2015); economic, social and environment as well as a key theme identified in the article; interaction. The purpose of the framework is to present the differences between a traditional sale, a sale including services and a system designed to include both services and products.

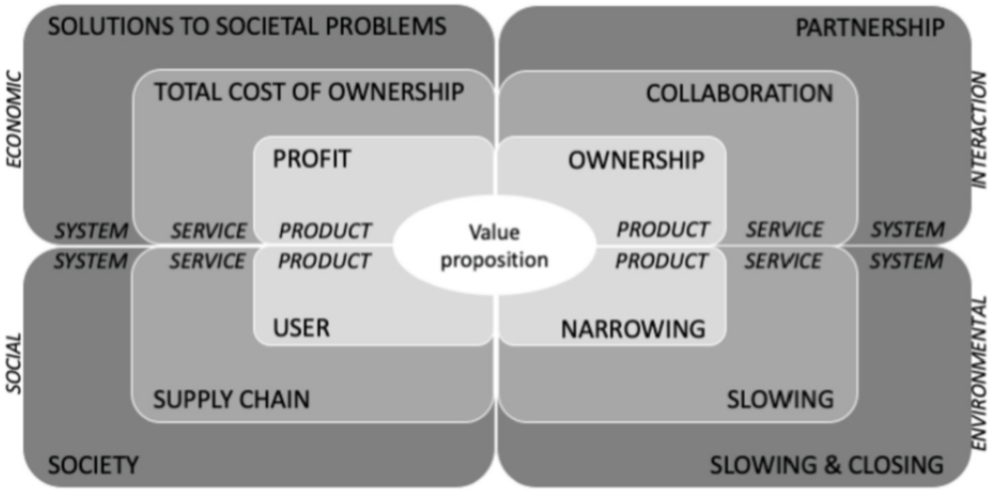

Figure 4.3: The value proposition framework developed by Kristensen and Remmen (2019)

4.3.1 Barriers for implementing a product-service system framework

A range of barriers for implementing a PSS have been identified in the literature. One barrier is that it could be difficult to develop alternative use scenarios, as a PSS could include elements situated between the production and use of a product (Mont, 2002). It could therefor be necessary to involve several stakeholders in designing the system.

Another barrier is that a PSS rely on that there is a social system that can support the system (Mont, 2002). If this is not the case, then it will be necessary to create a new infrastructure or network that could support the system.

A third barrier is connected to the close cooperation that is necessary between the producer and consumer. The success of the system depends on cooperation between the actors (Mont, 2002). If the actors included in the network does not have the power or influence to change events, then the system will not be successful. The transparency and information sharing between actors, and trade-offs also influence the success of the PSS.

Changing the source of profit could also be a barrier for producers. The problem lies in the change from a short term profit realisation at point-of-sale to a medium to long term realisation at point-of-service. If a company decides to change into a PSS it will have to change three elements in its business model: key activities, key ressources and customer relationships (Barquet et al., 2013). The change towards a PSS would therefor require that the company set up a new structure for developing services, training employees and rethinking how the company handles its relations with customers (Barquet et al., 2013). This change would affect many parts of the company, e.g. distribution channels, value proposition, cost structure, key partners and revenue streams (Barquet et al., 2013).

A barrier identified by Stoughton et al. (1998) is the resistance by producers to extend their involvement with a product beyond point-of-sale. The reorientation of companies towards a PSS requires that the corporate culture and market engagement change fundamentally. This requires time and resources to facilitate and could be met by psychological barriers within the company (Mont, 2002; Barquet et al., 2013).

4.3.2 Main points

- A product-service system is a system of products and services deigned to be competitive and satisfy customer needs with a lower environmental impact than traditional business models.
- A product-service system is not necessarily more sustainable than traditional business models, but it could lead to social, economic and environmental value creation.
- Changing from a traditional business model to PSS will require that the six barriers for its implementation are resolved in the companies.

Methodology 5

5.1 Interview

As a part of this project ten expert interviews are conducted. The interviews have different purposes; gaining knowledge, collecting different viewpoints and understandings of BAT, and discussing the benefits and drawbacks of using BAT to limit industrial emissions and identifying the issues in the development and implementation of BAT.

Presentation of experts interviewed

Interviews are conducted with four different actors to extend the study beyond the case company to include technology suppliers, authorities, non-governmental organisations (NGOs) and consultants. This network arrangement allows the researcher to understand which actors are driving, supporting or hindering the process. The four different actors interviewed is; 1) Danish Crown, 2) The Danish Environmental Protection Agency, 3) The Danish Society for Nature Conservation, and 4) Danish Crown's technology suppliers Frontmatec and Multivac.

Consultant: Danish Meat Research Institute

- The first person to be interviewed is Ole Pontoppidan. His educational background is as a construction engineer, but he is retired now. He has previously worked as a consultant at Danish Meat Research Institute (DMRI). He is interviewed as an expert outside the network arrangement, as he does not have influence any longer. DMRI is a knowledge-center within research and innovation of animal foodstuff. Specialists in DMRI develop solutions for the international meat industry and provide consultancy both nationally and internationally. Ole Pontoppidan was the consultant hired by Danish Crown in 2012 to obtain BAT implementation from technology suppliers during the development of a new slaughterhouse in Holsted. He is chosen because he has knowledge about how Danish Crown retained BAT documentation from their suppliers in Holsted. In addition, Ole Pontoppidan was in the technical group in Sevilla representing the meat industry and has extensive knowledge of the political process. He has however been retired for a couple of years and is not up-to date on the current process. The aim of the interview is to gain knowledge about the process of gaining BAT documentation in Holsted and to which degree suppliers are aware of BAT, and also to discuss the effectiveness of BAT.

Authority: Danish Environmental Protection Agency

- Tanja Smetana is a biologist from the Danish EPA. She handles tasks related to

approval and supervision in accordance with he Environmental Protection Act for a number of large companies. She is chosen because she has knowledge about how authorities supervise BAT and how companies relate to BAT. The aim of the interview is to gain knowledge about the current supervision process with special focus on what requirements they set for companies and the impact of BAT.

- Ulla Ringbæk is a functional manager from the Danish EPA. She deals with overall environmental regulation of companies and specific business areas. They are responsible for the development and preparation of regulative guidelines, among other things, promoting BAT for pollution constraints. Ulla Ringbæk has worked with BAT for many years and is part of the partnership program for BAT in Denmark. She has knowledge of the political and legal process of BAT. The aim of the interview with her is to gain knowledge about the political process and discuss the benefits and drawbacks of using BAT to regulate industrial emissions.

Company: Danish Crown

- Per Tage Jespersen is a project manager from the technical department in Danish Crown. He has a background as a mechanical engineer and has been working in Danish Crown for 5 years. He is in his daily work confronted with BAT when buying new equipment or when replacing existing equipment for the production sites. He has knowledge about the process of buying new equipment and which parameters are used to assess the options, and is also in contact with the suppliers. The aim of the interview is to gain knowledge about the most important parameters when buying new equipment, which requirements Danish Crown sets for their suppliers, and also discussing benefits and drawback of using BAT in the project phase. Moreover, gaining knowledge of the process and to which extend BAT is used when buying new equipment.
- Erik Skovgaard Møller is project manager from the technical department in Danish Crown. He has a background as a civil engineer and has been working in Danish Crown for three months. He was recently introduced to BAT and has been working with BAT in a recent project where he bought new washing machines to the production site in Sæby. The aim of the interview was to gain knowledge about the process of discussing BAT with suppliers, the understanding of BAT and discussing benefits and drawback of using BAT in the project phase.
- Claus Skodborg Nielsen is an environmental specialist from the technical department in Danish Crown. He has been working in Danish Crown for more than 25 years. He has been active in the work with BAT as the project managers in DC have to consult with the environmental specialists when they purchase equipment that requires a BAT assessment. He has been an active part of collecting BAT documentation from suppliers during the Holsted project in close dialogue with Ole Pontoppidan. He has also prepared BAT checklists in DC. The aim of the interview is to gain knowledge about the process of seeking environmental approvals in DC and supervision of existing production plants. Furthermore, to understand the trade-offs when making a decision when purchasing equipment.
- Niels Valdemar Juhl is vice president for the technical department in Danish Crown. He has the main contact with suppliers both nationally and internationally, works with large projects, and all project managers in the technical department consult with

him. He is in a different position compared to the other interviewees from Danish Crown, as he is part of the management and he can therefor influence the overall decisions and strategies used by DC. He is interviewed because he has knowledge about what can be done in regards to their suppliers.

- Charlotte Thy is the Sustainability Director in Danish Crown. She is not formally used, hence no transcripts and audio files. However, several meetings are held together with her where the main focus was on the process of determining BAT and BAT implementation practices in Danish Crown.
- Mette Schulin-Zeuthen is an environmental specialist from Danish Crown working with Green Accounts. There is no formal interview conducted with her, hence no transcripts and audio file. Some questions are aimed at her, for example gaining knowledge on how many investment projects had undergone a cleaner technology assessment.

Suppliers: Multivac and Frontmatec

- Martin Petersen is the Managing Director, and Karsten Nissen is the Service Manager of the German company Multivac, which work with packaging solutions for food products of all types. The company is the main supplier of vacuum packaging solutions for Danish Crown. Multivac is chosen for interview because they have have started different initiatives to promote sustainability, e.g. developing a recycle packaging solution. Martin Petersen and Karsten Nissen have knowledge about the cooperation between Multivac and their costumers and how Multivac work with sustainability and TCO. The aim of the interview is to gain knowledge of how suppliers work with sustainability.
- Henrik Andersen is the CEO of Frontmatec, which is a Danish company developing customised solutions for automation in food industries and other hygiene sensitive industries. Frontmatec is one of the largest technology suppliers to Danish Crown, and therefor chosen to be one of the suppliers to interview. Henrik Andersen is chosen because he has knowledge of how Frontmatec works together with their customers and because he can give an insight into how much knowledge technology suppliers have about BAT. The aim of the interview is to gain knowledge of how suppliers understand and work with BAT.

NGO: The Danish Society for Nature Conservation

- Jens Peter Mortensen is an environmental policy advisor working in The Danish Society for Nature Conservation. Jens Peter Mortensen works with environmental approvals and assessments of companies. Circular economy and prevention plays a central role in his work. He is interviewed because of his role in the development of BREF documents, as he participates as a technical expert and representative for the European Environmental Bureau (EEB) in technical working groups set by the EU Commission for waste incineration and treatment, food industry and others. He has central knowledge of the Sevilla Process and an actor without any economic interest. In addition, Jens Peter Mortensen assist DN's local departments with cases concerning industrial companies and participates in many committees in the Danish EPA on the future environmental regulation of companies on industry regulation such as BREF notes (Naturfredningsforening, 2019). The aim of the interview was also to

gain knowledge on how to ensure more sustainability in the BREF documents and ability of introducing more circular economy considerations to the BREF documents.

5.1.1 Overview of interviewees

Interviewee	Title	When	Time	Form	Keywords
Ole Pontoppidan	DMRI, retired	27th February	00:50:58	Skype	DMRI, Holsted, BAT, suppliers
Tanja Smetana	Danish EPA	7th March	01:18:45	Face to face	Oversight
Ulla Ringbæk	Danish EPA	11th March	00:31:06	Skype	Oversight, BREF
Per Tage Jespersen	Danish Crown, Project Manager	1st March	00:21:21	Face to face	Implementation of BAT
Erik Skovgaard Møller	Danish Crown, Project Manager	7th March	00:28:14	Face to face	Implementation of BAT
Claus Skodborg Nielsen	Danish Crown, Environmental Specialist	13th March	01:08:48	Face to face	Environment, BAT
Niels Valdemar Juhl	Dansih Crown, Vice President	14th March	00:33:19	Face to face	Procurement, TCO
Jens Peter Mortensen	The Danish Society for Nature Conservation, Environmental policy advisor	20th March	00:59:45	Skype	NGO view on BAT, Circular economy
Martin Petersen and Karsten Nissen	Managing Director and Service Manager, Multivac	25th March	01:15:00	Face to face	Suppliers view on BAT, TCO
Henrik Andersen	Frotmatec, CEO	28th March	00:25:05	Skype	Suppliers view on BAT, TCO

Table 5.1: Persons interviewed

All interviews are conducted in Danish and all transcripts are in Danish, cf. Appendix A.1. Passages from the interviews used to quote directly in the thesis are translated and referred back to the original passage. All passages are aimed to translate so meaning in expressions and concepts are kept.

5.1.2 Structure of the interviews

In preparation for the interviews an interview guide is developed. It is based on semi-structured interview with open-ended questions. The questions are alternated before the interview to fit the persons profile that is interviewed. Prior to the interviews with technology suppliers a news search of the company is made using Infomedia. Questions are changed concurrently with gained knowledge during the interviews.

The questions are based on the three key characteristics from the Conceptual Interaction Theory. The first characteristic is motivation which is what drives the actors to behave the way they do, where questions are aimed towards the current process, what they use the BAT documentation for, and what could promote an active approach to BAT. The second characteristic is cognition, which is the information which the actors see as the truth and through which they interpret a situation. Here the questions are based on the understanding of BAT. The third characteristic is resources, which is an actors capacity to act and its power in relation to other actors. These question are based on the actors role in the process, how they document BAT and which requirements they are setting, also what are their abilities to affect an actor and what are their role in the development and implementation of BAT. The interview guides can be seen in Appendix A.2.

The interview guide is a semi-structured frame used as a guideline to insure all subject are covered, however a semi-structured frame allows the interviewer to elude from the script if interesting viewpoints, statements or information are raised. The reasons why semi-structured interview is conducted is because respondents can answers questions in as much detail as they like, it encourages an informal atmosphere where respondents are open and honest. In addition, it allows more valid information about the respondents' values and opinion to be obtained, especially how people explain and contextualise these issues. Moreover it allows the interview to be flexible and change direction as the interview takes place and limits the researchers own bias. However, the disadvantages of conducting a semi-structured interview is that it is time consuming resulting in fewer interviews, it is difficult to compare as the interviews are unique. Moreover, the respondent could steer the conversation away from what the researcher have in mind.

Answering the problem statement requires an analysis of the current process of implementing BAT which is not present in literature nor is the different actors' understanding of BAT. Therefor it is necessary to gain knowledge from different actors involved in the process during interviews in order to map out the challenges and suggest improvements. In this case open-ended questions are favourable as they provide the researcher with a rich array of information and may suggest additional alternative perspectives. In addition, it allows the respondent to answer based on his or hers personal frame of reference.

Ensuring interview quality

In order to ensure interview quality the interviews has been recorded and transcribed then sent to the respondents for correction of any misunderstandings and supplements. Furthermore, questions are formulated to ensure that they are objective and do not affect the response of the interviewees. In order to make the data more transparent the interviews are enclosed in Appendix A.

During the interviews pauses are used to encourage the interviewee to elaborate on what they have said, before the interviewer ask a new question. This is done to extract as much information from the interviewee as possible without pressuring them by asking new questions. In addition, by repeating a question by rephrasing the question may secure credibility of the answer. Repeating a point given in an answer can also help underline the statement, and often the interviewee feels the duty to elaborate.

Transcribing interviews

Methods of recording interviews for documentation and later analysis include audio recording. Recording interviews and later transcribing ensure that the interviewer can actively listen. Moreover, relying on memory may work as a selective filter, not only as a bias, but also retaining meanings that are essential for the topic and purpose of the interview (Kvale, 2008). During the interview short notes are made but eliminating extensive notes, as this can be distracting and interrupt the free flow of conversation (Kvale, 2008).

An instruction guide to transcribe interviews was made to ensure linguistic cross-comparisons among the interviews, as there is more the one transcriber (Kvale, 2008). The statements are therefor transcribed verbatim and word by word. Long pauses are included as '...' and beginning sentences that got rephrased are also included. If interviewees refer to documents for example laying on the table, then this is made clear in the transcriptions. Moreover, in the transcriptions it is added which document the interviewee is referring to in order to help the reader to understand the context. However, no 'mh-s' was transcribed. Interviews were transcribed relatively shortly after the interview was conducted, to ensure one remembers what was said. In doing so, one can get deeper into the material by transcribing it, and often good ideas for the analyses arise in this phase. The chosen transcription strategy is very simple, as it is crucial to maintain the meaning of the matter. Emphasis in intonation and emotional expressions such as laughter and sighing is not included in the transcriptions, because the primary purpose of the transcriptions was for own use to analyse and code in NVivo. The audio files are also uploaded and documents the interviews, where several nuances are included such as laughter, sighing, long breaks, interruptions, and voice levels. These things, if included, may have a subjective interpretation of the meaning of the matter. In addition, there may be other linguistic phenomena such as irony that may be incomprehensible outside the context that the interview interaction originally formed (Brinkmann and Tanggaard, 2015).

5.1.3 Analysing the interviews

To ensure that the answers are comparable all the interviews are structured in the same way based on the three characteristics described in the contextual interaction theory, which is motivation, cognition and resources. This enables categorising statements when analysing the interviews to examine the attitudes, feelings and motivations from different actors involved in the process of BAT implementation and development. The theoretically reflected reading of the interviews enables to develop rich meanings (Kvale, 2008). Moreover, it brings out the connections and structures which are significant to the research project. Transcripts are read and re-read in order to establish a close familiarity with the data (Kvale, 2008).

NVivo

In an effort to structure the data gained from the interviews, the transcriptions are coded using the program NVivo. The coding is made using nodes that are based on themes and persons mentioned in the interviews and on the three factors from the CIT theory. The

nodes can then be analysed by combining nodes manually or by combining them based on attributes.

5.2 Workshop

To strengthen the implementation of BAT in Danish Crown it is decided to make an internal workshop focusing on how to integrate Best Available Techniques in a tool to calculate the Total Cost of Ownership (TCO). The workshop gives Danish Crown the opportunity to kick start their effort in using BAT and TCO when buying new equipment, and could enable a better comparison of different technology suppliers on a more systematic and holistic basis. The goal of the workshop is to educate the chief engineers at Danish Crown on BAT and TCO, suggest improvements in the implementation practice, present the TCO-tool and get inputs, and lastly change the way Danish Crown think about BAT. The result of the workshop is a TCO-tool that Danish Crown can use with their suppliers to find new ways to collaborate on BAT and sustainability, cf. Appendix A.

5.2.1 Participants in the workshop

Participating in the workshop is chief engineers from Danish Crown, who are chief executives on the factories. Vice President in Danish Crown Niels V. Juhl and Brian S. Kristiansen who is Senior Maintenance Manager also participate. A total of eight employees from Danish Crown participate in the workshop.

Name	Work title
Niels Valdemar Juhl	Vice President
Philip Bojtas	Manager, Engineering
Martin Bo Nielsen	Manager, Engineering
Christian Storgaard Frederiksen	Manager, Engineering
Nicolai Sørensen	Manager, Engineering
Anders Vinther	Manager, Engineering
Tommy Hjorth	Manager, Engineering
Brian Senger Kristiansen	Senior Maintenance Manager

Table 5.2: Participants in the workshop

As mentioned, chief engineers are the chief executives in the Danish Crown factories. They work with daily operations and are largely involved in projects and procurement. On the factories, they are responsible for the economy. They can also initiate investment projects. They keep updated of the latest technologies in the slaughtering industry and participate in International Frozen Food Association fairs.

5.2.2 Setting of the workshop

The internal workshop is held at Danish Crown in their headquarters in Randers 8950, Marsvej 43. The workshop is conducted during a chief engineering meeting on Friday the 24th of May 2019 at 9:15 to 9:45 AM. In the room where the workshop is held, there is an whiteboard, a flip-over board and a long table where participants sat on both sides, see picture below 5.1.

Figure 5.1: Emil Pedersen presenting the Total Cost of Ownership tool to chief engineering meeting in Danish Crown, Randers.

5.2.3 Design

The total time span of the workshop is 30 minutes, where the first 10 minutes are spend on presentation and the last 20 minuets for the discussing and interactive part. In the presentation the challenges discovered during the analysis are presented. Then explaining what BAT is and why it is important. Some of the participants know of BAT, but do not use it. However, all of the terms used during the workshop are terms which the participants are familiar with. Afterwards, explaining what TCO is by using an illustration of an iceberg, and discussing different factors that might affect the TCO of equipment, and why it is important to calculate TCO. Then describing how BAT and TCO are connected. Later showing how to implement the TCO-tool in Danish Crown through three steps suggested by the Miljøstyrelsen (2015). Next presenting the TCO-tool and how to compare the results using diagrams. The presentation is approximately 10 minutes. The last slide is aimed at getting the participates to come with inputs by preparing questions they could discuss among themselves, this take approximately 20 minuets.

Workshop materials

Different materials are used during the workshop. A *slide show presentation* in Power point is prepared before the workshop, cf. Appendix A. During the presentation there is a interactive element, where participants are encouraged to mention different hidden costs when purchasing equipment. The participants' suggestions are written down on the *paper flip-over board* next to the screen. The participant has three minutes to get as many hidden costs written on the paper flip-over board, before a more extensive list of hidden

cost is revealed on a slide on the screen. When presenting the TCO-tool on the screen, the participants are handed a *A3-paper of the TCO-tool*. The participants discusses from the prepared *case-example*, (fictitious costs assigned to three different alternative equipment), which equipment has the best TCO-price and how come. The activities and tasks are aimed at helping the participants understand BAT in accordance to TCO and how to work with the TCO-tool. Additionally, the activities focus on giving the participants insight into how BAT and TCO can be used when purchasing equipment, and how that can be used to document BAT.

On the last slide in the presentation there is different questions leading up to a discussion round. Participants were to discuss the following questions:

- Could you imagine using the TCO-tool next time you buy equipment?
- Does it make sens in the way your procurement process is to day?
- Would it be possible to get information that is needed to make the calculation?
- Is there any costs we might have missed when constructing the TCO-tool?

The aim of the last part of the workshop is getting them to understand the TCO-tool, getting inputs to finish the TCO-tool, and figuring out if there is a need that is being filled through the use of the TCO-tool.

5.2.4 External workshop

Because of time constraints there is no time to make an external workshop. The aim of the external workshop is to strengthen the relations between Danish Crown and their suppliers focusing on BAT, TCO and sustainable solutions. The participants are a mix of employees at Danish Crown, representatives from technology suppliers, DMRI, and ISS workers (cleaning company).

The workshop could give Danish Crown the opportunity to kick start new partnerships with their technology suppliers and together with them, find new ways to collaborate on BAT and sustainability. The goal of the workshop is to educate the technology suppliers and technical staff and procurement in Danish Crown about sustainability principals and tools, and change the way Danish Crown and technology suppliers think about BAT. The result of the workshop could be a paper that sets up guidelines for the future partnership between Danish Crown and their suppliers.

Development and implementation of Best Available Techniques 6

The first section of the analysis consist of an description of the process of developing and implementing BAT, a description of the different actors involvement in the different stages, and lastly analysing which network Danish Crown forms part of in the development and implementation of BAT. The second part of the chapter is split into two sections. The two sections are using the same approach to analysing different actors' motivation, resources and cognition. Section 6.2 consist of an analysis of the actors' motivations, resources and cognition in the development of BAT and section 6.3 in the implementation of BAT. The analysis is two-folded focusing firstly on the development and then the implementation, because it is argued that *the implementation game is often more defensive than the game during the policy formulation, where the actors are more concerned with what they can achieve individually, while during implementation they are more concerned with avoiding inconveniences* (Winther, 1994). This implies that actors may have different motivations, resources and cognition in the development and implementation process. Sections 6.2 and 6.3 end with identifying potentials and drawbacks in the BAT development and implementation process. Section 6.4 is a summary of the findings, where a table is presented to summarise the different actors' motivations, resources and cognition in the development and implementation of BAT.

6.1 The process of developing and implementing Best Available Techniques

As mentioned in chapter 1, BAT stems from cleaner technology where the intention is to do more prevention rather than focusing on end-of-pipe technologies, and develop new technologies as foundation for the environmental regulations. The Industrial Emission Directive, former known as the IPPC Directive, is an important milestone in the environmental legislation, as it sets flexible and integrated framework for environmental regulation of a wide range of the most polluting industrial activities. BAT regulation is determined in an EU process denoted as the Sevilla Process. The process is based on information exchange, evaluation, and consensus building on available techniques among different stakeholder.

During recent literature, Evrard et al. (2016), found that methods for determination of BAT exist at two levels: *methods to determine BAT at the level of an industrial sector,*

and methods to apply BAT at the installation level. Evrard et al. (2016) suggest that these methods were developed in different frameworks, specific contexts, different decision processes and have various objectives. This study recognises and works within these two levels, the development and the implementation of BAT, to analyse the different actors in that given process. Moreover, identifying Danish Crowns possibility to influence the BAT process by describing the process (cf. 6.1.1), and analysing Danish Crowns relations with the involved actors when developing and implementing BAT.

Firstly, the development of BREFs is defined in an official framework named the Sevilla process. Actors involved in the Sevilla Process are Member States, the European Commission, relevant industries and environmental NGOs, gathered in a Technical Working Group (TWG). During the process decisions are made based on a consensus among the different actors involved. Information exchange among the actors are essential to produce a document which is applicable and contribute to reduce the industrial pollution in EU. therefor, BATs encompass two areas: a development area with the Sevilla Process, and an implementation area with the contribution of national application of BATs by industries and environmental authorities, cf. Figure 6.1.

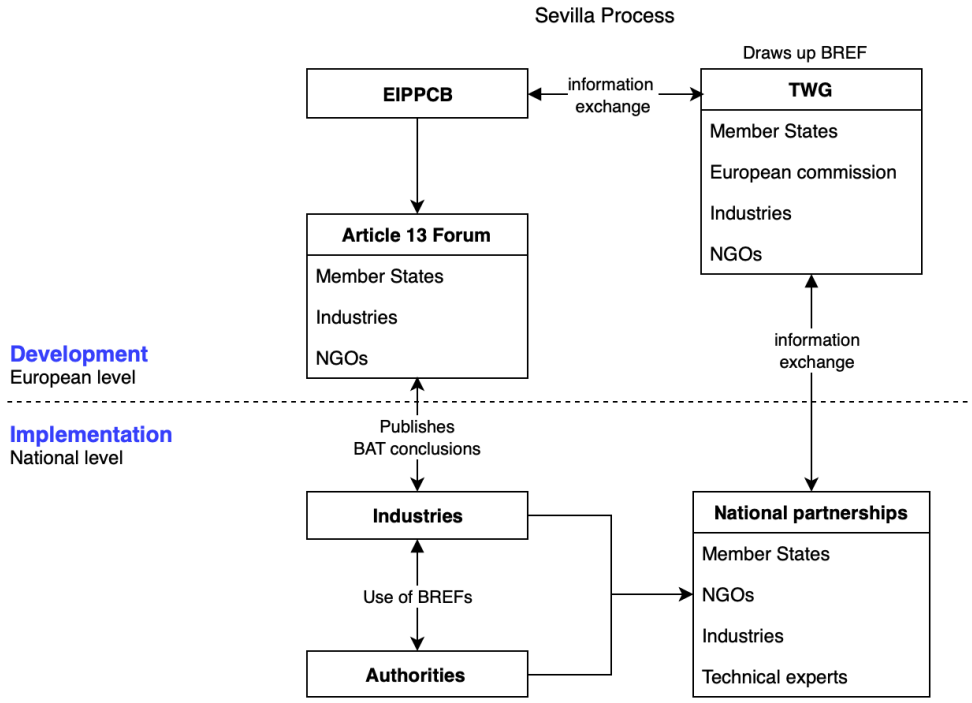

Figure 6.1: Process of developing and implementing BREF. Modify after Evrard et al. (2016). EIPPCB is short for European IPPC Bureau and TWG is Technical Working Group.

6.1.1 The Sevilla Process

The Sevilla Process can be described in six steps. The first step is *the reactivation of the TWG and call for wishes.* This step aims at collecting the TWG members' wishes for the future document: scope, nature of data collection, environmental indicators, structure, etc.

The second step consist of a *kick-off meeting*. This step aims at defining the agenda for the revision. In this step sector-specific templates are developed to be used to collect data within existing installations, cf. European Commission (2012) sections 4.6.2.2 and 5.5. A template for gathering plant- and installation specific data contains these main types of environmental performance and operational data; consumption of raw and auxiliary materials/feedstocks, water use, energy use, emissions to water, emissions to air, residue/waste, other information such as installation year, types of production processes etc. (European Commission, 2012). Data in the templates become the criteria for the assessment of the techniques.

The third step is *collecting data*, where the template(s) are sent to the installations selected by the TWG members and approved by their Member State. TWG members are responsible for uploading all the information they have collected and submitted for the BREF drawing up or review process onto the official database BATIS (European Commission, 2012). BATIS is a web-based software application set up to facilitate the information exchange on BAT (European Commission, 2012).

Technical and economic data are gathered to ponder the feasibility of techniques and BATAELs (BAT Associated Emission Levels) are defined to give consistency to the choice of BATs derived from the existing installation performances (Evrard et al., 2016). Article 3(13) of Directive 2010/75/EU defines BATAEL as *the range of emission levels obtained under normal operating conditions using a best available technique or a combination of best available techniques, expressed as an average over a given period of time, under specified reference conditions* (European Commission, 2010).

Step four includes the *drafts* where the EIPPCB uses the information collected to draft the BREF document. If consensus on environmental benefit of a technique and its overall performance level is reached among the experts, then the technique is considered BAT.

Step five is the *final meeting* where discussion is focused on "BAT conclusions". Here consensus has to be obtained on the emissions and consumption of the sites covered by the templates and each BATAEL is determined in accordance to existing installations (Evrard et al., 2016). If consensus cannot be reached, it is possible to write a "split-view" to be included in the remarks in the BREF if accepted by the EIPPCB.

Lastly, step six is the *final draft* sent to the TWG members for validation by the Member States and the European Commission. The validation process is set out by the Article 13 Forum that gives a formal statement that the document is overseen and can be made publicly available.

The European IPPC Bureau

The European IPPC Bureau (EIPPCB) main purpose is to coordinate the information exchange in the Technical Working Group (TWG). EIPPCB also manages the whole revision process, collects and verifies data and conducts an independent analysis to define BATs (Evrard et al., 2016). The EIPPC is an output oriented team which produces BREF documents. When finished, the documents and BAT conclusions are received by the Article 13 Forum (European Commission, 2016) .

Article 13 Forum

The European Commissions Article 13 Forum is a steering committee for the BREF/BAT work. As part of this it sets out the validation process before the conclusions are translated and published in the Official Journal of the EU for Industries and Authorities to implement. Article 13 Forum consist of Member States represented by the national authorities, relevant industries and NGO's. Ulla Ringbæk from the Danish EPA represent Denmark and the industries are represented by their trade organisation. Danish Crown is part of the trade organisation *The Liaison Centre for the Meat Processing Industry in the European Union (CLITRAVI)*. The organisation aims to represent the interest of the European Meat Processing Industry. Danish Crowns sustainability director Charlotte Thy has represented Clitravi in the Food, Drink and Milk (FDM) BREF. Lastly, the NGOs are represented by the European Environmental Bureau (EEB) which is the umbrella organisation for European environmental organisations in Europe. The Danish Society for Nature Conservation is a member of EEB.

Technical Working Group

Members of the Article 13 Forum nominate the people who take part in the meetings in the Technical Working Group. The TWG consist of experts that ensures a transmission of relevant information to the EIPPCB, comments on the proposals and participates in the TWG meetings in order to determine BAT (Evrard et al., 2016). Members of the Technical Working Group consist of the European Commission, and people nominated from the national environmental authorities. In Denmark people from the Danish EPA are nominated to participate. Tanja Smetana from the Danish EPA has been sitting in the TWG. Most importantly is to nominate people that has the right kind of knowledge. In addition, the industry organisations nominate those who sit at the offices in Brussels, or from national industrial organisations or from individual companies. Charlotte Thy from Danish Crown has been part of the working group for FDM, as representative from Clitravi. Jens Peter Mortensen from The Danish Society for Nature Conservation has in some cases represented the EEB (Mortensen, 2019).

6.1.2 Procedure of using BAT in environmental approvals

As mentioned in Chapter 1, BAT is implemented in the environmental approval companies mentioned in annex 1 in the *Approval Order (Godkendelsesbekendtgørelsen)* have to apply for, in order to operate in Denmark. The environmental approval is given by either the Danish EPA or the municipal that the company is operating in. Danish Crown gets their environmental approvals from the Danish EPA. The environmental approval has to be given before the business is established or changed. After the business has started its operations the Danish EPA will do environmental inspection of the business. This oversight is made to ensure that the business obey the environmental limits set out in the environmental approval.

National partnerships

In Denmark, the Danish EPA arranged partnership meetings for those BREF documents that are important for Denmark. The Danish EPA make partnerships and invite

concerned companies, organisations, municipalities and technical experts. Danish Crown has been an active participant in the partnership meetings for FDM and now also for the 'Slaughterhouse and Animal By-product' BREF. Not all actors participate actively in the partnership meetings but follow the process via e-mail (Ringbæk, 2019). All have the possibility to participate, however there can be some reasons related to resources that they can not participate (Ringbæk, 2019). In addition to resources, it is sometimes difficult to make the link to "what's in it for me" (Ringbæk, 2019). This is a typical problem in relation to the technology suppliers. For that reason they are often not present in the partnerships. However, the role of technology suppliers in the partnerships will be discussed in more detail in later sections. Besides Member States' representatives, NGOs, concerned industries there are some consulting engineers in some of the partnerships, e.g. Alectia which is a great player in the water and food area, has a lot of knowledge within these areas (Ringbæk, 2019).

Industries and Authorities

The Member States have four years from the day the BREF documents are published, until it should be reflected in the environmental approvals and the industries have to live up to the requirements (Ringbæk, 2019).The industries together with their suppliers are the ones who must ensure that their technology is BAT.

6.1.3 Danish Crown's BAT network relation

Following the process of developing and implementing BAT it is relevant to interview Danish Crown, Frontmatec and Multivac, the Danish EPA, The Danish Society for Nature Conservation (DN), and Danish Meat Research Institute (DMRI), Figure 6.2. The different actors are interviewed to represent the different networks in which Danish Crown forms part of in the BAT work.

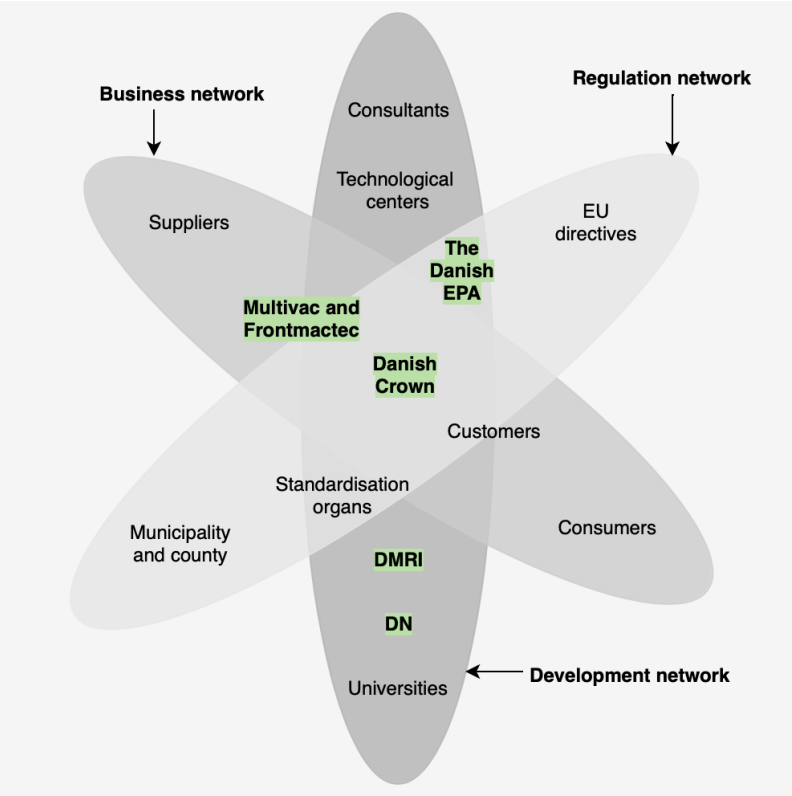

Figure 6.2: Danish Crown's actor network relations in accordance to BAT. The actors interviewed are marked green. The DN refers to the Danish Society for Nature Conservation.

In accordance to the network theory Danish Crown is the industry which forms interactive relations with DN and DMRI in the development network, Multivac and Frontmatec in the business network, and lastly the The Danish EPA in the regulative network. The relation between Danish Crown and technology suppliers Frontmatec and Multivac is a buyer-supplier relationship. Knowledge and money are being transferred within this network. Danish Crowns relation with their technology suppliers will primarily be determined by business activities, but relations with these actors and their resources will at the same time be essential preconditions for the companies' development potential. The technology suppliers possess an autonomy, and can propose BAT candidates and enter into the regulative network by affecting what is considered BAT.

The network theory, section 4.1.3, defines that relations create reciprocity, interdependence, loose links and power. In some cases Danish Crown uses the same technology suppliers for many years, they do so to ensure the same quality of their equipment. By using the same suppliers multiple times this create reciprocal expectations. Interdependence is built by the actor's interaction in long-term relations, making the relationship less likely to resolve and less likely to respond to radical changes in their surroundings.

The relation between Danish Crown and the Danish EPA is of a regulative order, where the Danish EPA are conducting inspections and making sure Danish Crown is meeting the BAT requirements. There is also knowledge sharing as the Danish EPA formulate instructions on BAT requirements from Sevilla. Moreover, the Danish EPA carries out a number of

projects in regards to cleaner technology and BAT, in some cases they collaborate with Danish Crown. The Danish EPA produces knowledge making them also a part of the development network.

Danish Crowns relation with the Danish Society for Nature Conservation (DN) will primarily be determined by research and development activities. Danish Crown can collaborate with the DN in Sevilla, where they exchange information and knowledge. They can develop alliances to get more influence and power over the BAT work. Danish Crown and the DNs relation are defined by loose links, as the both posses autonomy and only collaborate if they have a common interest. They are not locked in the same specific exchange mechanism. In addition, the DN through their work affects the regulation. Danish Crown have collaborated with the DN when seeking an environmental approval to ensure that they do not send in a complaint.

DMRI is a sector research institute they are a part of the development network. Danish Crowns relation to DMRI is primarily research and development activities where knowledge are being transferred. Danish Crown have used consultants from DMRI during the BAT work. In the 1990's, DMRI carried out a number of projects supported by the Danish EPA and also by the industry in regards to introducing cleaner technology in the slaughterhouses. At that time DMRI gained a lot of new knowledge. A representative from DMRI was also appointed by the industry to participate in the Technical Working Group in Sevilla. DMRI had a greater impact than other advisers because they are a branch institute and have firmer and daily contact with people on the shop floor.

6.2 Actor characteristics in the development of Best Available Techniques

This section analyses the difficulties in developing BAT based on the CIT theory. This is done, by looking at how different actors are involved in the development of BAT, and their motivation, resources and cognition in relation to the development of BAT. The actors analysed is the Danish EPA, Danish Crown, Technology suppliers and The Danish Society for Nature Conservation. The last section analyses the potentials and drawbacks of developing BAT.

6.2.1 Danish Environmental Protection Agency

The Danish EPA operates within the regulative network as both a regulatory actor and a inspection actor. Both actors are present in the development of BAT. The regulatory actor in the Danish EPA, is Ulla Ringbæk who works in the unit that deals with the environmental conditions of businesses. They make the rules and guide municipalities and industries. Part of their working field is to manage the rules in the Environmental Protection Act on approval of industries and rules on supervision of industries. In this context, the IED and the BREF/BAT work. They work with both the development of what is BREF/BAT at the European level, but also how it is realised afterwards. In regards to the development they get assisted by the inspection unit in the Danish EPA, who have better knowledge of the individual sectors. Therefor, Tanja Smetana from the Danish EPA, who supervises BAT in Danish Crown, has been involved in making BAT conclusions in the Food, Drink and Milk (FDM) BREF and also now in the Slaughterhouse and Animal By-product (SA) BREF.

Motivation

The Danish EPA enforce the legislation on the environmental protection that is to ensure clean air, water and soil and good living conditions for people, animals and nature. The motivation of the Danish EPA is to ensure that rules in The Environmental Protection Act are obeyed.

> *Our primary interest is to manage the environmental protection and secondarily to pay regard to Danish companies.* ((Ringbæk, 2019), [00:15:51.29])

> *We would like to put some green marks and ensure that this would give some advantages to Danish companies. It does not matter that we make BAT conclusions that give Haldor & Topsøe a huge boost in the market, especially if it is a market where all Danish companies long ago live up to it. This is about giving all companies in Europe equal conditions. If we in Denmark have been good at setting environmental protection requirements, then this is helping to lift the other Member States, repaying the Danish companies.* ((Ringbæk, 2019), [00:15:51.29])

Before entering into this work, Denmark was convinced that everyone else in Europe should live up to the Danish level. However, in some areas Denmark was not as good as they thought. (Ringbæk, 2019)

Resources

The Danish EPA has different resources in the development of BREF documents. They among other things have the ability to participate in the different working groups in Sevilla, this gives them an ability of influencing the rules and look after Denmark's interest.

(...) Article 13 Forum is a kind of steering group and we participate in the Seville process in all the working groups that are relevant to us. In the beginning we only participated in those who were relevant to Denmark, i.e. we excluded those where there were no Danish companies. We no longer do this because we have discovered that in some contexts there is a discussion that becomes normative for something that comes in some later BREFs. ((Ringbæk, 2019), [00:04:40.12])

Besides participating in different working group in Sevilla, Ulla Ringbæk sits in the Article 13 forum representing Denmark. In this Forum the members are able to consult the European Commission and nominating the danish participants.

The Forum (Article 13) is presented with the work program and has the opportunity to speak and comment on their order. It is not us who decides. It is the Commission that decides, but we can advise. We start a job and it is my job to find the Danish participants for that work. ((Ringbæk, 2019), [00:03:03.10])

The Danish EPA can also create national partnerships and invite concerned actors.

For those BREFs that are important to Denmark, whether it is intermediate or high level, we make partnerships and invite affected companies, organisations and municipalities in the partnership, where one can follow and regularly discuss the things that are being put up (in Sevilla). So when something has happened and something important comes from Sevilla, we tell the partnership that there are some things, and what does Denmark think about it. Then we can introduce it in the partnership and ask if there are anyone who has point of views on this. ((Ringbæk, 2019), [00:24:45.16])

In the national partnerships, the Danish EPA has difficulty in attracting technology suppliers. Besides not knowing who to invite (Smetana, 2019), it is difficult to make the connection to *"what's in it for me"* (Ringbæk, 2019). During the recent revision of the FDM BREF document, they wrote a small letter, that the Danish Environmental Technology (industry association for Danish environmental technology companies) to use in their newsletter. This attempt did not attract technology suppliers (Ringbæk, 2019). The Danish EPA would like to bring technology suppliers into the partnership meetings Smetana (2019); Ringbæk (2019). They do not share this attitude with Danish Crown, who has bad experiences with some technology suppliers who have been involved in partnerships, the reasons will be discussed in later sections.

Cognition

The Danish EPAs motivation is the environmental protection. They see BAT as an important element in the environmental protection to ensure that industries do not emit more than necessary by implementing best available state-of-the-art technology (Smetana, 2019).

But there is also something about the whole principle of reducing at the source, that one doesn't just say "we can do it, so let's just emit" no, you do not necessarily have to, right? You do not necessarily have to increase your noise up to your noise limit, you have to try to keep it down to the extent you can. (...) something else is, there has also come environmental management in (BREF), as BAT 1. In the FDM we have at least argued that it has to be included, and that it also include action plans for odour and noise. So you always have a plan for how to handle these things, so that you always make sure that you do not just let it all go... ((Smetana, 2019), [00:49:31.20])

In addition, Ulla Ringbæk believes that sustainability considerations are important. However, it is also important to ensure the community is not exposed to pollution from industries. She understand BAT as being important in terms of limiting noise, waste and smoke, to ensure good local conditions. She also adds that they are working on resource efficiency including a circular economy perspective in the BREF documents.

One does not exclude the other. It is really good to see it in a life-cycle perspective, but the local community that has an industry is not prepared to have all kinds of smoke, noise and waste poured in the head because the industry is allowed to pollute because one has chosen to do so, and because efforts are made elsewhere in their chain. So in reality it is something that complements each other. We also try to get resource efficiency into the BREF documents. Well energy efficiency, we are working to get them to map their environmental conditions. Get things under control. It is all something that can be used in circular economy perspective. ((Ringbæk, 2019), [00:27:42.05])

Tanja Smetana from the Danish EPA Companies believe that some sectors have greater benefit from BAT than others, these industries are among other power plants and waste incineration plants, where much concern is on the discharges from environmental substances such as heavy metals. She however believes that the revision process allows for some things to be discussed and sharpened.

I want to say that I think this revision process is important, it is also important for the slaughterhouses because every time we go through these revision processes, there are some things that pop up, industry people and authorities from all over Europe are sitting (at the meetings), and some new stones are constantly being turned, I think. Well, we may have turned many of the same stones that we turned last time, but you might get a little more sharp on some things, which can be addressed and regulated. ((Smetana, 2019), [00:49:31.20])

The Danish EPA is positive about the BAT work and believes that it is a key element in environmental protection.

6.2.2 Danish Crown

Danish Crown is in the business network. They have knowledge of the industry processes and technology and in direct contact with technology suppliers. Danish Crown participate actively in the national partnerships for FDM and SA. Danish Crown's sustainability director Charlotte Thy has been sitting directly in the TWG for FDM representing Clitravi and in the Article 13 Forum. Danish Crown has a lot of in-house knowledge but also use consultants from their knowledge network such as Ole Pontoppidan from Danish Meat Research Institute (DMRI). When the EU started making BREF/BAT notes for slaughterhouses and production plants, Ole Pontoppidan was appointed by the industry to be their representative in the technical working group on slaughterhouses.

Motivation

Danish Crown is involved in the process of developing BREF documents. Their motivation is to ensure that no rule are made by anyone that do not understand the industry.

> *(...) they feared that the (BAT conclusions) would be made by someone who did not understand things. And then one could end up with something that do not have grounds in reality. So that was the argument that the industry through the institute chose to go very actively in and make the actual BREF for Slaughterhouses and Animal By-products.* ((Pontoppidan, 2019), [00:05:55.27])

Danish Crown has for many years been working on resource efficiency in their production plants. Danish Crown's vice president Niels V. Juhl therefor says that it was natural for them to participate in the process and ensuring influence in the legislation.

> *The Danish slaughterhouse industry has always looked a lot on consumption, ever since 30 years ago or more, where I started, to reduce its consumption. Partly on what we had, but also what we bought. (...) So, therefor, it is natural that we also participate in such a BAT collaboration, in the preparation of the BAT notes and made something to send to Seville (...) And be a part of that, so no one came up with something completely obscure. We helped to characterise the whole process. So it is a natural part of our way of thinking. In the overall, work to reduce our costs all the time. We can do so little about the salary, but we can do even more with what we consume.* ((Juhl, 2019), [00:11:41.24])

Danish Crown's primary motivation has been to ensure that no unreasonable BAT conclusions were made. Furthermore, Danish Crown has been optimising their production for many years and therefor hoped that this will give them a competitive advantage.

Resources

Internally in Danish Crown they have technical experts with knowledge about the slaughterhouse processes and food production. In some cases Danish Crown use consultants

from DMRI. Ole Pontoppidan together with employees from Danish Crown was a major supplier of input for the first edition of BREF for slaughterhouses. The person in charge in Seville was on a participatory review at Danish slaughterhouses, led by Ole Pontoppidan and Danish Crown employees, where the Danish EPA also participated in a review (Pontoppidan, 2019).

Danish Crown have the ability to participate in the BAT development process by sitting in technical working groups in Sevilla. In Sevilla companies are not directly represented, but are represented via their trade organisation. Danish Crown's sustainability director Charlotte Thy has been representing their trade organisation Clitravi. In Sevilla they co-ordinate in the Danish partnership to look after Danish interests.

Danish Crown is an active participator in the development of BAT and therefor contributes to providing information on the company's environmental performance. The collection of data begins after the kick-off meeting. The concerned companies can upload information on the Commission's intranet and the official database called *Batis*. Companies are encouraged to upload information, in order to identify the European level.

When 50-100 companies have provided information on emissions on the same parameter, they draw up a curve and identifies where the level is. If there are one or two that are extremely low it is assumed that there must be something special that applies. Those who are extremely high do not have any influence on what is BAT. They later have to lower their emissions to meet BAT requirements. It is important to participate in the data collection because BAT levels are are identified based on that data. The company can also get their information inserted and later see where they are in relation to BAT. (Ringbæk, 2019)

Cognition

The understanding of BAT in Danish Crown is that there are some requirements that can affect the company and they must therefor ensure that they can comply with them and not be made by someone who does not understand the industry. This is also the reason why Danish Crown has entered the work on preparing BAT documents.

The directive says you have to live up to BAT. They (Danish Crown) know that and you can not get around that. They think it is a great way that we offer them a collaboration on what BAT is, so we can get some conclusions that will be easiest to live with for them.
((Ringbæk, 2019), [00:23:52.02])

In general, the understanding of BAT is that it is EU requirements that all industries must comply with. Therefore, it is important for Danish Crown, in cooperation with their suppliers, to ensure that the BAT requirements are met, as they are also stated in the environmental approval. Danish Crown want their suppliers to present them for BAT equipment, use BAT as a sale or competition parameter and provide the sufficient BAT documentation. Danish Crown must, in cooperation with their suppliers, meet the requirements. They are therefor interested in educating their suppliers in thinking in BAT and ensure they can document BAT considerations.

Moreover, Danish Crown understand BAT as preventive technologies. Because Danish Crown is a company that focuses on their bottom line, end-of-pipe solutions rather than preventing a pollution or emission is not considered as favourable by Danish Crown, as it is considered to be a wasted resource and source of income for the company. Therefore, Danish Crown shows frustration when suppliers of end-of-pipe technologies present their products on BREF forums.

6.2.3 Technology supplier

Technology suppliers are operating within the business network. The suppliers interviewed was the German-owned company Multivac, which has a Danish department in Vejle, and Frontmatec. Multivac provide complete packing solutions for Danish Crown. The department in Denmark do not work with BAT and have no knowledge of BAT. If they are to deliver BAT documentation on BAT, they ask for documentation from the headquarters in Germany. Frontmatec is the only supplier that can deliver a complete slaughterhouse plant and is Danish Crown's largest supplier. Frontmatec has very limited knowledge about BAT and does not use BAT in relation to Danish Crown, but uses it internally.

Motivation

The two suppliers do not use BAT in negotiations with Danish Crowns project managers and do not use it as a selling parameter or competitive parameter. Frontmatec would use BAT if they thought it could give them a competitive advantage:

> *(...) we use it actively where we believe we have a competitive advantage of using it, or if it is a legal requirement. And where we have a competitive advantage it is when we can argue that our equipment has a higher cleaning friendliness than others.* ((Andersen, 2019), [00:09:59.08])

Frontmatec could be interested in participating in the preparation of the BREF documents or participating in the partnership meetings held by the Danish EPA, but it has not been a major focus area for them. Their focus is on clean-ability and water consumption, which is included in the BREF documents:

> *(...) I do not think that it has been a huge focus area in-house, you can probably also sense that. In this we have been as subcontractors. (...) It is a focus area that it helps with water consumption and clean-ability, it lies in continuation of something that would otherwise be a reasonable design criterion. Otherwise, we have spent money on what we can get money for.* ((Andersen, 2019), [00:22:27.12])

Multivac has no understanding of what BAT is. During the meeting, Multivac was interested in knowing whether, by BAT regulation, Danish Crown can choose either a 'mercedes' over a 'volkswagen', mercedes referers to be the better technology and the volkswagen may be cheaper but it works. They believe they can provide both solutions for their packaging equipment, but that Danish Crown often looks at the purchase price. At present, with the BREF documents, it is not possible for the regulator to say *"you should*

choose one technology over the other". The regulators manage the external environment and if the company does not exceed the limit values, then the company itself decides which technology they buy (Smetana, 2019). It is only when the company exceeds the limit values that the authority can send an order that the company must reduce the pollution. After Multivac became aware of it, they did not show much motivation or interest in the BAT work. They also believe that their contribution to the production line at a slaughterhouse is relatively small and that their technology has little effect on the external environment.

Multivac believe they sell top-class technology, but are not interested in turning their technology into a BAT candidate. The reason is that they do not think they can influence anything. Furthermore, they are not interested in participating in national partnerships, unless it is an initiative that come from their headquarters in Germany.

Resources

Despite the fact that the two suppliers are not part of the development of the BREF documents, they do have the opportunity to participate in different forums. The suppliers have a great knowledge of their products. They can, among other things, enroll their technology to be considered as a BAT candidates and perhaps ensure a sales and competitive advantage or leading market position. They can do this by displaying good environmental parameters on their equipment. There may also be a financial benefit to the supplier of technology equipment:

> *Can you do something that the others cannot, then you have a great advantage here because we can play it into the process and say "well listen, here we stand with some technical devices and some installations whatever it is, some cleaning technology that performs great and it has been tested all around, and there is actually someone who runs it". Then we will probably go in and say it is BAT, and then you have a cash advantage and an export opportunity etc.* ((Smetana, 2019), [01:06:01.14])

There are examples of a technology supplier entering into the BREF development where it had economic benefits:

> *Haldor & Topsøe got an additional sale on a catalyst because of a specific BAT conclusion. They are some of those who can supply this equipment to reduce air pollution.* ((Smetana, 2019), [00:13:39.11])

Another example is in connection to the recent FDM process. There was a company called Enerdry, which makes steam drying plants, which among other things are installed on Danish sugar factories, where conventional coal-fired boilers are usually installed. The principle of this steam-drying plant is that it utilises its own flows in a way so that nothing comes out of the steam drying plant, that is, no smell, water or air currents. Enerdry entered the process and provided documentation and data. The new BAT conclusions in FDM will include steam drying as being BAT. In this way, they have secured a strong market position. They will also stand as a source in the BREF document and in the

reference list, in this way people will know who they are. They can use it as advertising and in marketing and use it as a competitive advantage. ((Smetana, 2019), [01:08:12.22])

According to Mortensen (2019) it is important that the right suppliers are involved in the process because they can influence what is stated in the BREF documents:

> *Unfortunately if we have technology suppliers that have got the decisive power for the BREF note work, then the BREF note is very much focused on end-of-pipe measures and it has been difficult to work against that. I believe there is a great task in educating suppliers and thinking differently.* ((Mortensen, 2019), [00:44:08.05])

Mortensen (2019) believes that some of the things that have caused the suppliers to think differently are the projects that dealt with the waterless dairy production or food industry. These projects gave the suppliers the task of creating the technical systems for closing the loops inside the production.

Cognition

Frontmatec understands BAT as looking at the discharge of waste water and reducing the consumption of electricity and water. They work with this indirectly when they focus on the cleaning-ability of their products. Frontmatec uses BAT internally in the way they access their own production facility, but do not use it in the way they sell their products.

Multivac's department in Denmark has no knowledge of BAT. Martin Petersen, Managing Director of Multivac's Danish department, first time hearing about BAT was in the e-mail sent ahead of the interview.

6.2.4 The Danish Society for Nature Conservation

Denmark's largest NGO is the Danish Society for Nature Conservation. Their purpose is to protect nature and to provide the public access to nature. They are part of the knowledge network where they work with local conservation projects and on international level with lobbying. The Danish Society for Nature Conservation is a member of an umbrella organisation in Brussels, called the European Environmental Bureau, which handles the interests of European environmental organisations.

Jens Peter Mortensen works for the Danish Society for Nature Conservation and works with environmental regulation of industry. He has knowledge of how different companies work, how to measure emissions, make mass balances etc. (Mortensen, 2019). He sometimes participates as a representative of EEB in Seville, where he participates in the development of the rules for BAT and technical rules in relation to environmental approvals.

Motivation

Jens Peter Mortensen has been involved in an organisation called *Impel*, in which working groups have discussed how BAT should be used, and how to ensure implementation etc. There has been shared attitudes, but Jens Peter Mortensen believes that as an environmental organisation their motivation is in relation to the environmental impacts of the surroundings.

(...) some have been very happy about BAT because they believe there are similar requirements, but there are also many who think it is bad because it removes the focus from the environmental impact to one's competitive conditions instead. As an environmental organisation, one does not care about the conditions of competition, but one is very interested in the environmental impacts on the surroundings. ((Mortensen, 2019), [00:35:11.06])

The Danish Society for Nature Conservation's motivation for entering into the BAT development is because they saw an opportunity to influence the rules.

In fact, we worked with it by trying to influence the rules, which came from BAT and we chose first to participate in what was called Article 13 Forum, which was where the rules for enrolling BREF notes were established. ((Mortensen, 2019), [00:02:41.02])

In 2011, the Danish Society for Nature Conservation prioritised that they could not work with all BREF developments because some are not relevant to Denmark, so they decided to focus on power plants, waste incineration plants and waste treatment facilities. However, with the latest revision of the FDM BREF document, they saw the possibility of working with circular economy.

(...) When we got a little further into the work, we also prioritise the Food, Drink and Milk BREF note. We did this because we saw an opportunity for working with circular economy in the Food, Drink and Milk BREF note, which was not really possible in the others and therefor we pulled more and more out of the BREF notes for the large power plants and waste incineration plants and waste treatment plants. ((Mortensen, 2019), [00:02:41.02])

Jens Peter Mortensen has since the latest revision of FDM withdrawn from the work of BREF documents. In FDM they managed to get more circular economy into the BREF note, but the industries did not report data on the official database Batis. Instead it was the national authorities who reported in the data, which made it impossible for the NGO's to identify which company were behind the data. That was dissatisfying for the NGO and led to them loosing their motivation to participate in the BAT work. DNSC is very critical towards BREF and is dissatisfied with the way limit values are selected. They do not think that BAT is something that moves the sustainable agenda.

Resources

As a Danish environmental organisation, the Danish Society for Nature Conservation has the opportunity to participate in technical working groups in Seville. Because of their size, they have been an active participant in the development. Jens Peter Mortensen has been a member of Article 13 Forum. During the latest revision of the FDM BREF, the Danish EPA convened the stakeholders who are in Denmark to prepare for working on new BAT rules. During this revision process, Danish Crown and DN were invited. They came to sit in the same group with Arla and Danish Agriculture and Food Council.

Arla, Danish Crown and Danish Agriculture and Food Council and the Danish Society for Nature Conservation, found out that we had a common interest in getting the circular economy or the considerations that are in the circular economy put into the BREF notes. So we came together to find out how we should try to influence the EU process (...). We did this by instead of formulating emission requirements as concentration levels, we instead formulated emission quantities per input of raw materials per unit of time, and the data were, after all, some that the companies already had, but which they usually do not state. ((Mortensen, 2019), [00:02:41.02])

The Danish Society for Nature Conservation were endowed with large and strong industries. They had a common interest and could therefor make an alliance. Jens Peter Mortensen was appointed by the EEB as a representative and was able to present a presentation in Seville on circular economy. Similarly, they ensured that Danish Crown, Arla and Danish Agriculture and Food Council represented different European trade associations and represented some different industries.

(...) we were really reasonably well prepared, we actually did a common presentation, but it was agreed that it was me who had to report it because I am as an environmental organisation, we are the only ones who have no financial interest in formulating certain specific terms in a particular way. So, therefor, if Danish Crown had been out and said the same thing, it would not have had the same credibility as when an environmental organisation says the same. So that was something of the strategic set up. ((Mortensen, 2019), [00:02:41.02])

The different actors do not always work together, but they do where there is a common interest. In this way, Jens Peter Mortensen believes that it is easier to talk about their disagreements. The other thing is, if you want to change something that applies both in Denmark and in the EU, you need some alliances, which will make it easier to get something through. In the latest revision of FDM BREF, Jens Peter Mortensen says that it turned out that their alliance was not strong at EU level, there were some much larger and stronger companies that decided how to shape the BREF rules.

Cognition

Jens Peter Mortensen still follows the work but no longer participates actively because he finds it uninteresting and theoretical:

It is all about doing everything in the same way everywhere, firstly I do not want that for the companies and for the environment, and secondly, it is impossible. Because one should not believe that same demands give the same discharge conditions. (...) so putting up same demands on to give same competitive conditions is nonsense. In this way, the BREF notes are in fact something theoretical and furious uninteresting. ((Mortensen, 2019), [00:02:41.02])

In addition, Jens Peter Mortensen believes that BREF is not something that contributes to sustainability. One of the reasons is that he sees a lot of suppliers of end-of-pipe technology using BREF to sell their solutions.

(...) this has been especially the case at waste incineration plants, and this is because there is a huge business in selling, at least to, waste incineration plants and power plants because they are publicly funded and they can become extremely large those types of plants (...). When the industry from power plants and waste incineration plants is the dominant industry in relation to the preparation of the BREF notes, it will be their concepts that also applies to FDM. And then there will be a lot of focus on what they are looking at, and they especially look at cleaning technical measures (...) Unfortunately, if we have technology suppliers that got the decisive power on the BREF note work, then the BREF note will be very much focused on end-of-pipe measures, and it has been difficult to work against that. ((Mortensen, 2019), [00:44:08.05])

Mortensen (2019) believes that focus should be on the concrete environmental effect instead of using the BREF note because it prevents the process optimisation and the possibility of closing the circuit.

In other words, there needs to be circular economy. But I just do not think it is possible to get it through. I do not believe BAT... BAT will not lift it. It is the power of the black industries in Europe it is too big to ever get it through. ((Mortensen, 2019), [00:51:42.19])

Mortensen (2019) therefor thinks that the BREF work is outdated, it is not possible to get circular economy into the BREF documents, and there are some resourceful players in the development of the BREF documents, which will have the greatest influence on the output.

6.2.5 Potentials and drawbacks in the development of BAT

There are various potentials and drawbacks in the development of BAT. The BREF process includes different actors with different knowledge which creates a wider foundation for making decisions (Smetana, 2019). The decisions are therefor taken on a well-founded and well-considered basis. The Danish EPA also believes that BAT has the potential to reduce emissions at the source and ensure that the industries do not emit more than necessary (Ringbæk, 2019). In the new BREF documents, environmental management is introduced, which ensures that the companies have a action plan regarding noise and odour.

However, BAT is based on consensus policy, which makes it difficult, and according to Mortensen (2019), impossible, because different actors have different ways of doing things, and attitudes and interests. The document is about doing everything in the same way everywhere in Europe. This is something Mortensen (2019) points out to be problematic. He believes that the same rules do not give the same discharge conditions and that it will not be good for either the companies and the environment.

The development of BAT is controlled by resourceful actors in Europe. This is one of the reasons why circular economic considerations cannot be put into the BREF documents

as mentioned above. The BREF documents do not drive sustainability and innovation, because the BREF conclusions are minimum requirements for industries to comply with. Some BAT conclusions become legal requirement after the revision of the BREF document, which makes the industries hesitate even more with what they enroll as being BAT and putting in the BREF document.

Another thing that affects the development is which actors are involved in the process. BAT is from a cleaner technology era, where environmental protection began to deal with prevention rather than cleaning from a pollution. However, many suppliers of end-of-pipe technologies are still involved in the BAT process. This is especially happening in the BREF documents for waste incineration and power plants which affects the other BREF documents because the industry's concepts are dominating and becoming normative in other BREF notes (Mortensen, 2019). This tendency for something to become normative in other BREF documents is something that the Danish EPA can recognise, and it has therefor been pressured to participate in the development of all BREF documents even though some of them are not relevant for danish companies. Ringbæk (2019) from the Danish EPA says that Denmark has decided to participate in all technical working groups but at different levels.

In addition, it is difficult to get the technology suppliers involved. This is partly due to the BREF documents length, and the document being abstract and inaccessible to most people (Pontoppidan, 2019). It also takes long time to prepare the documents and they never reach the deadline of three years of developing and four years to implement the BAT conclusions in the industry.

6.3 Actor characteristics in the implementation of Best Available Techniques

As described in Chapter 1, Danish Crown experience some difficulties when they work with BAT because their suppliers are not able to give the documentation that Danish Crown requires of them. Based on the CIT theory this section answers the question of why Danish Crown experience difficulties in their efforts to use BAT actively in their purchase of equipment, by analysing how the different actors work with BAT and their cognition, motivation and resources in relation to the implementation of BAT.

6.3.1 Danish Environmental Protection Agency

In an application for environmental approval a company has to consider the BAT conclusions (Smetana, 2019). The Danish EPA has different ways of making sure that the applicant has considered all the conclusions, e.g. checklists and dialogue. In the supervision of Danish Crown they use a checklist, that list all the conclusions and Danish Crown can fill out if the BAT conclusion is *implemented, partly implemented, not implemented* or if the BAT conclusion is *not relevant* in this case. For each conclusion that is not *implemented*, Danish Crown has to give an argument for why they have chosen not to implement the specific conclusion. Besides the checklist the agency also have a ongoing dialogue with the companies, where they can discuss different issues before they turn into problems.

Motivation

The Danish EPA works with BAT because it says in the Approval Order (Godkendelsesbekendtgørelsen), that the companies should consider BAT when applying for an environmental approval (Ringbæk, 2019). It has previously been a guideline for the agency that they could base their assessment on, but because the BAT conclusions will be binding when the new BREF documents are adopted, the agency has to be more strict in their assessment:

> *(...) because we now get some binding BAT conclusions (...), then it will be more difficult to diverge from the conclusion, because the argumentation for why you diverge will have to be much stronger. It will set higher requirements for us and the companies.* ((Smetana, 2019), [00:04:03.20])

The motivation for the Danish EPA to work with BAT comes from the regulation and this motivation increases as the requirements in the regulation become stricter.

Cognition

When giving environmental approvals the Danish EPA distinguish between the big automated slaughterhouses and the smaller more manual slaughterhouses (Smetana, 2019). In the automated slaughterhouses the pigs are very similar and have approximately the same weight, while the smaller slaughterhouses handles pigs of various sizes. The equipment used in the process is therefore also different. This means that the best available techniques (BATs) depends on the size and the systems used in the slaughterhouse

(Smetana, 2019). For the Danish EPA BAT is therefore different depending on the function of the slaughterhouses.

The EPA's of Europe have different views of how BAT should be implemented. The Industrial Emission Directive (IED) gives the EPA's some general guidelines and limit values, but it does not dictate how the EPA's should implement it. The method used by the Danish EPA is based on their own view on, how a well functioning inspection should be conducted. This is not something the Danish EPA view as a problem:

> *It is the suppliers problem, if he want to sell his product here in Denmark, he has to figure out that it is different here.* ((Smetana, 2019), [01:01:25.19])

In their view it is the responsibility of the companies to adapt to the national inspection, even though this could lead to differences in how the companies are regulated in Europe.

Resources

Internally in the Danish EPA they have experts with knowledge about the most relevant environmental pollution like smell, noise, air emissions, etc. Some areas, like the more technical aspects of a production and the calculation of emissions, they do not have the adequate knowledge internally in the agency, so there they rely on the companies or consultants to do that part of the work (Smetana, 2019).

The Danish EPA does not have the authority to give fines or other penalties. If a company exceed their emission levels the Danish EPA can impose that they have to obey to the emission levels. Through a dialogue the EPA try to help the company bring down their emissions, but if the company does not deliver any acceptable results, then the EPA has to report the company to the police. The police can then give fines and other penalties to the company until the issue is brought into order. (Smetana, 2019)

When a company wish to expand or make any changes to the production facility, which could lead to an increase in the emissions from the facility, the EPA can demand that the company make a measurement of the pollution. They do it to ensure that the company will not exceed any emission limits. In this way they can force the company to deliver documentation needed to ensure that the emissions are within the agreed limits.

Supervision with companies is based on a continuous dialogue, where the agency get an impression of how the companies work with these issues and how willing they are to implement new solutions. As mentioned above, the EPA also uses a checklist in some cases to ensure that a company has considered all BAT conclusions.

If a company want or need to bring down their pollution, the EPA is not allowed to tell the companies which supplier is able to deliver the needed technology. They can tell the company that there is technology available on the market that can bring down their pollution and give examples of who has implemented BAT.

The EPA is aware that they should not force the companies to make huge investments, if the environmental gains are not proportional to the costs. It is a balance for the agency of pushing the companies to perform better environmentally and at the same time not

pushing them too hard and thereby make it too difficult to run a healthy business in Denmark. In some cases the agency can diverge from the rule of having to implement the conclusions within four years, if it is evaluated that it will be too difficult for the company to do it within the given time frame. This gives them some flexibility in the process of giving environmental approvals. The EPA prefer having this dialogue with companies, because then they can cooperate with the companies to find the best solutions to an issue.

6.3.2 Danish Crown

Best Available Techniques is used by Danish Crown when they purchase new equipment for their slaughterhouses. Even though it is not a legal requirement to use BAT every time new equipment is bought, Danish Crown has made a promise to the board of directors that they should make a BAT assessment of a product before they purchase it (Juhl, 2019).

When Danish Crown buy new equipment they include actors with different interests in the specific project. Depending on the scale of the project they set a team that has the qualifications to work on the project (Juhl, 2019). When the team is set, they look at what the equipment should be able to do, and then they search for companies that can deliver equipment that fulfil the requirements. Based on the initial search they make a tender specifying the requirements for the equipment. According to Juhl (2019) they never set limit values on how much energy, heat, etc. the equipment is allowed to use. When they have received the offers from different suppliers they compare them based on price of purchase and installation. They also want to compare the products based on the *total cost of ownership*, but so far there are very few examples of doing so:

> *The challenge is to remember it (..) Too many times, the person [project leader] rushes through with his tasks, and then when he sees something like this [BAT, TCO], he thinks it is just a disturbing element and then he continues forward.* ((Juhl, 2019), [00:18:00.11])

Danish Crown have a *engineering handbook* which describe how an ideal process should be, but according to Tage (2019) it rarely happens that they follow all the steps in the book. Often they only use fragments of the book, and it is rare that they use the part of the book concerning BAT. If the handbook is followed then the environmental specialists in DC should be included in the project group with responsibility of implementation of BAT, waste water licenses, etc. (Nielsen, 2019). Even though they do not work as systematically with BAT as described in the handbook, then they still think about it:

> *(..) but on the other hand you do it a little bit anyway because you think about, if this is the correct method or if they should use another method.* ((Tage, 2019), [00:04:27.01])

The ambition from Danish Crown is however to use BAT in a systematically way, so they can be sure that they always get presented with the best available technologies on the market (Juhl, 2019).

Resources

Danish Crown requires that their suppliers inform them about how much the equipment uses of water, heat, pressurised air, etc. in order for them to be able to dimension the resource supply correctly to the equipment. The suppliers thereby guarantee that their equipment does not use more than the guaranteed amounts (Juhl, 2019). Danish Crown has not made requirements for the equipment to be BAT (Tage, 2019) and therefore the suppliers have not focused on it. If Danish Crown had used their position as customer to set requirements to the suppliers, then their focus on BAT would increase:

Interviewer: Which requirements do you set for BAT? You say they [the suppliers] don't have a feeling for BAT, but do you set requirements for them?
Tage: No, and they are behind on this in my opinion (...). We have not been good at setting these requirements and therefore the suppliers do not want to use any energy on it. ((Tage, 2019), [00:11:15.18])

They have however in some cases where the resource use have been too big in their opinion, asked the supplier if they could change their design, e.g. modify the equipment to use energy instead of pressurised air (Tage, 2019) or reusing the cleaning water in a smarter way (Møller, 2019). In those cases Danish Crown has taken the initiative and in cooperation with their supplier developed new solutions. The suppliers do not themselves have different solutions with different environmental impacts (Møller, 2019).

Danish Crown can influence their suppliers and push them towards making more sustainable technologies. The engineers at Danish Crown have experienced that their knowledge about the technology is almost as comprehensive as the suppliers knowledge when it comes to the use of the technology (Møller, 2019). The cooperation between Danish Crown and the supplier could be beneficial for both, because Danish Crown get a better technology, while the supplier get valuable knowledge about how their product is used and what their costumers want. Møller (2019) explains that he was part of a cooperation with a supplier of washing machines that was initiated by Danish Crown, where he went to see a functioning washing machine. As they stand and observe the machine they realise there is a possibility for optimisation of how the water is reused. This hands-on approach led to the development of a new section for the washing machine that could recycle the water more efficiently. This process is only possible because the engineer had time to go into dialogue with the supplier, which Møller (2019) also points out:

(...) what kills the process concerning sustainability is, if the process moves forward too fast. It is important to know the methodology as well as you know the back of your hand, so you make the right considerations automatically. (Møller (2019), [00:27:14.24])

Danish Crown has in one case tried to include BAT in their requirements for the suppliers. In 2014, when they built a new slaughterhouse in Holsted, they included, as a requirement in their tender, that the equipment should be BAT in accordance to the relevant BREF (Nielsen, 2019). However, even though it was part of the contract, many of the suppliers were not able to deliver the required documentation and according to Pontoppidan (2019) it was not easy to get the needed documentation:

I tried to be forthcoming and help a bit by explaining them, but it didn't always help. Some were able to do it and some were not able to. Unfortunately the latter were in majority. (Pontoppidan (2019), [00:47:36.22])

Having BAT as a requirement in the contracts did not help Danish Crown in their effort to make sure that the equipment they purchase is BAT. The main reason for this could be, that there was not included any possibility of sanctions in the contract for the part concerning BAT (Pontoppidan, 2019). The suppliers therefore still focused on those parameters where they could risk having to pay a penalty, like complying with the time schedule and deliver at the agreed price.

Danish Crown had expected that the suppliers were able to document that their technology was BAT, but that was not the case. They tried to help the suppliers, but nothing really helped, as pointed out by Nielsen (2019):

So what came out of it documentation wise, about how they comply with BAT, is very very limited when talking about equipment. (Nielsen (2019), [00:04:17.14])

Many of the suppliers did not know that the BREF documents existed and some said that they had never experienced this kind of documentation requirements from any other company (Pontoppidan, 2019). The equipment Danish Crown bought was BAT, but the suppliers were unable to document it (Pontoppidan, 2019).

As part of Danish Crowns effort to get their suppliers to document that their equipment was BAT, they send out the same checklist as they use to document their own implementation of BAT towards the EPA. This checklist was used in the hope that the documentation could be a bit more formalised, and also in the hopes that the suppliers could take more responsibility (Pontoppidan, 2019), but it was only somewhat useful, because many of the suppliers crossed out *not relevant* all the way down, without really considering each individual conclusion (Pontoppidan, 2019).

Cognition

Some BAT conclusions are directed at how Danish Crown should organise their production facilities. In their new slaughterhouse in Holsted, Danish Crown implemented a BAT conclusion regarding the floor gratings which dictated that the holes in the floor gratings should be 6 mm wide. After Danish Crown had installed these floor gratings they realised the holes got plugged immediately. They have afterwards decided to replace the floor gratings and now use floor gratings with holes at a size where only knee caps and larger bone fragments that could block the pumps do not go through. This has led to a small increase in the amount of sewage, but that was acceptable for Danish Crown, because the workers in the slaughterhouse would pull up the floor gratings when they got plugged. The argument was that it was better with floor gratings with bigger holes, rather than having floor gratings with smaller holes that get plugged and then pulled out (Nielsen, 2019). This was seen as a internal issue at Danish Crown which was handled without including the EPA in their decision.

Danish Crown can diverge from the BAT conclusions because the Danish EPA only supervise the external environment and rarely enters the production facility. Generally there is a continuous dialogue between Danish Crown and the Danish EPA. This has been a priority for Danish Crown as they would rather solve the problems before they get fined or sanctioned. Danish Crown uses the checklist as documentation for their implementation of BAT. So far they have only been challenged once or twice regarding some of the conclusions that they have not been implemented. When it happens they have been able to use the argument that their facilities are old and therefore it is not possible to implement all BAT conclusions:

(...) the argument have always been, except for Holsted, that it is existing processing facilities, that were built in another time, and there it is not certain that we can comply. ((Nielsen, 2019), [00:53:05.11])

The problem for Danish Crown regarding to BAT is therefore not from difficulties regarding their environmental approval. The problem originates from their ambition to use BAT every time they purchase new equipment from technology suppliers.

In those cases where Danish Crown have tried to use BAT as an active part of their purchasing process they have been met with resistance and despair from their suppliers, which meant, that it was a struggle for Danish Crown to get the documentation they wanted from their suppliers:

It was an impossible process and what made it impossible was that nobody besides us have made these requirements. Our competitors do not have these requirements even though it is an EU regulation (...). ((Juhl, 2019), [00:03:52.15])

Danish Crowns experience with BAT is that it is difficult because their suppliers do not know what BAT is and have no understanding of why Danish Crown want to focus on it. This does not mean that the suppliers do not want to listen to the demands and requirements from Danish Crown. As mentioned previously there are many examples of cooperation between Danish Crown and their suppliers regarding optimising the resource use of equipment. This willingness to cooperate have however not been there, in those cases where Danish Crown wanted the suppliers to document that their equipment is BAT.

Motivation

Danish Crown wishes to use BAT actively because it can help them bring down their operation costs (Juhl, 2019; Nielsen, 2019). In the coming years the BAT conclusions will become binding which also motivates Danish Crown to focus more on this subject (Nielsen, 2019). Lastly Danish Crown also see a potential for using it in their communication and marketing (Nielsen, 2019).

For Danish Crown it is a question of possible savings in the long run, when they consider equipment that is defined as BAT. The concern is that the equipment is too expensive compared to the possible savings in the long run. It is also tempting for the project

leaders to purchase the cheaper equipment because it is easier for them to stay within their budget, even though it could be more expensive in the long run:

In order to stay within a investment budget, it is tempting to purchase the cheapest option, which might not be as good on consumption-side in the long run. (...). It is very typical. Both here and in the rest of the world. ((Nielsen, 2019), [01:04:42.16])

Within Danish Crown there are these two contradicting motivations where the first one is about seeing the purchase of equipment as a long term investment, that could help bring down the production cost in the long run, while the other motivation is about staying within an investment budget without considering the long term costs of the investment. It is a dilemma for the company, because they have limited economical resources for investments in new equipment, but at the same time they want to bring down their production costs (Nielsen, 2019).

Tage (2019) argues that in many cases it does not make sense for them to do it, because they as part of the negotiations with the suppliers, discussed which standards they have to comply with in order to supply Danish Crown with technology. Requirements for water usage, electricity, etc. have also been decided before hand in most cases, so according to Tage (2019) there is not much the engineers can do:

If you have a washing station or another project where the things are given beforehand, like water pressure and usage (...) then there is not much we can do. (...) but I think if I were involved in a project that uses a lot of energy, then I think I would have paid more attention to it. (Tage (2019), [00:06:55.05])

The most important requirement in the contract with the supplier is that they can deliver the demanded capacity in relation to the production flow (Møller, 2019). The physical boundaries and other practical issues, like easiness of cleaning and an ultimate requirement for the noise to be below 82 db are also set in the contract (Møller, 2019).

6.3.3 Technology suppliers

The technology suppliers' knowledge of BAT is limited. The interview with Multivac, started with an explanation of what BAT is and how it can be used. At Frontmatec they know what BAT is but do not use it in the development of their technology.

We do of course try to chose parts with a high technical quality, but I cannot say that BAT is a integrated part of that. ((Andersen, 2019), [00:08:11.22])

In the development of technology they focus on the veterinary standards that dictate the easiness and safety of cleaning the equipment (Andersen, 2019). Both Frontmatec and Multivac believe that their equipment use a relative small amount of energy, therefore they do not focus on energy use in their technology development (Andersen, 2019; Petersen and Nissen, 2019). Andersen (2019) explains that they indirectly work towards developing their technologies to be BAT, but they do not use BREF documents to see, what have been

defined as BAT in their category. This makes it difficult to document that their technology is BAT based on the checklist with BAT conclusions. Pontoppidan (2019) mentions an example of a supplier that had developed a new method to reuse water in the process. The supplier knew that the technology reduced the amount of pollution, but he did not realise how that could be used to promote the technology. Working with BAT is not something any of the suppliers have considered in the development and promotion of their technology.

Motivation

The suppliers are not motivated to work with BAT at the moment, because it does not give them any competitive advantage. The reason is that when they sell their equipment to companies like Danish Crown, the focus is on price, quality, delivery time and hygiene (Tage, 2019).

This was also the case when Danish Crown as part of the construction of the slaughterhouse in Holsted, required the suppliers to document that their technology was BAT. Even though the suppliers had signed a contract where they were required to deliver the documentation, most of them chose not to do it, or deliver inadequate documentation. The reason was that the contract did not set any possibilities for penalties for the suppliers, and therefore the suppliers focused on staying within the budget and time schedule. On top of that, the requirement for documentation was put forward as part of the contract, which meant Danish Crown did not have any possibility to make any changes to the equipment, if the documentation showed that the technologies used in the equipment was not BAT.

What could motivate the suppliers to work actively with BAT would be, if it could be used to promote their product as being better than the competitors, or if there is a legal requirement to use it (Andersen, 2019). The possibility of using it as a competitive advantage rely on that the costumers have to use BAT to set requirements for the equipment. If the companies begin to set requirements based on BAT, it could motivate the suppliers to focus on BAT (Tage, 2019).

Cognition and resources

Because the suppliers have limited knowledge about BAT, their cognition of BAT and resources to work with BAT is difficult to analyse. What was made clear from the interviews were, that when the suppliers think about what makes their product better than the competitors product, then they compare it on price, quality and easiness of cleaning and to some degree also power use. They do not think of it as a list of conclusions or minimum requirements, that they should be able to document. All the suppliers have a budget for developing the technologies, but at the moment they do not use any resources on working with BAT. At the same time, both of the interviewed suppliers do not think of their technologies as having a significant environmental impact and does therefore not think it is relevant to focus on in a sale situation.

6.3.4 NGO

When an environmental approval is given to a company in Denmark, the Danish Society for Nature Conservation (DN) are interested in what the effects of a production facility

will be for the surrounding environment. They go through the environmental approval and if they think there is a problem they can either make a complaint or go into dialogue with the company

Ressources

The Danish Society for Nature Conservation has a secretariat with approximately 65 employees working on different subjects. Out of these 65 only one person work with the environmental approvals given to the industry. Besides the secretariat the society also have 98 local departments where volunteers follow the local environmental and nature plans in the municipalities. All plans regarding the environmental protection law (Miljøbeskyttelsesloven) have to be signed by the secretariat, which mean they could have an overview of what all danish companies produce and how much they pollute. They do however not have the resources to keep track of all companies in Denmark.

As mentioned before DN has the opportunity to make a complaint about an environmental approval. Companies are therefore interested in including DN in the initial environmental impact assessment, where it is decided whether it is possible or not to place a production facility in the wished location. If DN cannot accept the location because the pollution will be too big for the surrounding environment, then the company can cooperate with DN about finding a solution that is acceptable for both parties and thereby avoid the risk of getting a complaint after the investment has been made. This power can DN use to push the company to produce in a more sustainable way.

Motivation

For DN the motivation to work with BAT and environmental approvals is to make sure the effects on the local environment are minimised (Mortensen, 2019). The argumentation in their complaint is based on an assessment of, if the local environment can handle the pollution.

Cognition

The Danish Society for Natural Preservation does not see BAT as cleaner technologies, where it is the companies pollution that is most important, but as minimum requirements for companies, where it is the companies' competitiveness that is most important. At the same time they think this approach is very theoretical and uninteresting:

> *The conditions [for the companies] are different in relation to when you invest, when you write of debt - the economical rhythm is different. The surroundings conditions, cost of workforce, etc, all those those things are different. The idea that setting the same requirements for companies, should give equal competition is therefore nonsense.*
> ((Mortensen, 2019), [00:35:11.06])

They are critical of BAT and when they approach companies to talk about sustainability they choose not to use the term BAT, because it is perceived differently. The term *circular economy* is used instead because it is easier for the companies to understand (Mortensen, 2019).

Their view on the supervision is, that it has been reduced to a checklist. They do not follow the work because they are not interested in working with the BREF notes (Mortensen, 2019).

Despite the fact that Mortensen (2019) believes that working with BAT is uninteresting in an environmental sense, he also believes that it has a great effect in relation to discussing environmental approvals and what environmental approvals must contain. He therefore believes that it is important to consider BAT, otherwise he argues that *it will be to look away from the reality that is out there* (Mortensen, 2019).

6.3.5 Potentials and drawbacks in the implementation of BAT

BAT is not checked by the EPA in their inspection with the factories. In its current form BAT is used as a checklist to ensure that companies have considered different environmental aspects of their production and as a point of departure in the dialogue between the Danish EPA and Danish Crown. It sets out minimum requirements for companies, that could push some companies to perform better environmentally, but for Danish Crown it has not pushed them to perform more environmentally effectively. BAT is not relevant in their efforts to continuously improve their environmental performance as they have implemented the relevant conclusions. therefore BAT does not hold a potential to move Danish Crown in a more environmental efficient direction.

In the coming BREF for Food, Drink and Milk associated emission levels (AEL) are used as limit values for emissions per amount of raw material. These BAT conclusions will also become binding. This will make it easier for the authorities to hold supervision with a production facility as they can monitor the emissions from a facility fairly easy. But there are also some concerns regarding this new element of BAT. One concern is that AELs does not adequately take into account that some products that have a close resemblance could be the result of different processes. An example is the sausage production. In this category there is a significant difference between how the different products are made, e.g. a salami and a frankfurter (Pontoppidan, 2019). Another aspect in the meat processing sector is that the AELs could become limiting towards an effort to bring as much of the resource up to a human consumption level. This is because the process required to achieve a higher degree of human consumption could be resource intensive, and thereby bring the emissions from the production above the limits set by the AELs. The company would therefore not be allowed to do it, even though it in a life cycle perspective could make sense to use this process, because it would lead to an increase in the utilisation of the resource.

6.4 Summary of actor characteristics

The motivations, resources and cognition of each actor are summarised in this section and presented in Table 6.1 and 6.2.

The development of BREF documents is affected by the actors motivation to participate in the work. The Danish EPA seek to give Danish companies an advantage and push towards more sustainability. Danish Crown wants to ensure that the conclusions make sense when they are to be implemented in their production facilities. The DN push for reducing the environmental impacts as much as possible while the suppliers try to have their technology

put in as a reference for a BAT conclusion. At the same time there are actors from other nations with their own interests. The different motivations pull the BAT conclusions in different directions.

The actors influence on the BREF documents depend on their ressources to participate in the process. The actor with the most ressources will have the biggest influence on the process. The Danish EPA can participate in the working groups, create national partnerships and represent Denmark in Article 13 Forum. Danish Crown and the suppliers can participate in these national partnerships where they have the opportunity to present their knowledge about the sector to the Danish EPA. For the suppliers this is also where they have the opportunity to bring their technology in play as a BAT candidate. Danish Crown are represented in the technical working groups in Sevillia by their trade organisation *Clitravi*, where the NGO's also can participate. The ressources of the single actor to affect the process increases if they form alliances where they seek to pull the BREF documents in the same direction.

How many ressources each actor want to invest in the process and their motivation to take part in the process is based on their cognition of BAT. For the Danish EPA BAT is a key element in the effort to protect the local environment. To Danish Crown BAT is an EU requirement mostly focused on preventative technologies. DN think BAT focus too much on end-of-pipe solutions, that it is outdated and that it is theoretical and uninteresting. The suppliers knowledge of BAT is limited and they do not see it as relevant to them.

		Motivation	Ressources	Cognition
Development	Danish EPA	- Ensure compliance with the rules in The Environmental Protection Act. - Give Danish companies an advantage. - Reducing environmental emissions.	- Have the ability to participate in the different working groups in Sevilla. - Representing Denmark in the Article 13 forum. - Can create national partnerships.	- Industries should not emit more than necessary. - The local environment is important. - BAT is a key element in the environmental protection.
	Danish Crown	- To ensure that no rule are made by anyone that do not understand the industry. - Hoped that it would give them a competitive advantage.	- They have technical experts with knowledge about the slaughterhouse processes and food production. - Has represented the trade organisation Clitravi in the TW in Sevillia.	- BAT are EU requirements that all companies must comply with. - BAT are preventive technologies.
	DN	- Reduce environmental impacts. - Opportunity to influence the rules. - Have to be relevant in Denmark.	- Can participate in the technical working groups in Sevillia. - Can cooperate with companies if they have the same agenda.	- BAT is theoretical and uninteresting. - Too much focus on end-of-pipe solutions. - BAT is outdated.
	Suppliers	- They use BAT if it can give them a competitive advantage.	- They can get a reference to their technology in BREF documents. - They can participate in the national partnerships.	- BAT is reducing wastewater and ressource use.

Table 6.1: Motivation, ressources and cognition in the development of BAT for the Danish EPA, Danish Crown, the Danish Society for Nature Conservation (DN) and technology suppliers.

Some of the characteristics of the actors change after the BREF documents are developed. In the implementation phase the actors focus change away from trying to affect the BAT conclusions and instead focus on how they can use them. The motivation for the Danish EPA is to ensure that environmental approvals are based on BAT as it is required by the law. For Danish Crown the motivation to use BAT is to decrease ressource consumption and operational costs. BAT is however not the first priority. When they purchase equipment there are some requirements, e.g. production capacity and noise, that have bigger influence on what equipment they choose to purchase. The project leader in charge of buying equipment have a limited budget to purchase equipment for and therefore the

purchase price also affect which supplier Danish Crown choose. The motivation for DN is to minimise the environmental impacts on the local environment. When the suppliers deliver equipment to Danish Crown they are motivated by the requirements set by Danish Crown to develop their equipment to fit the requirements. Danish Crown have been successful with motivating the suppliers, when they collaborate with them on developing a new solution. After the contract is signed the suppliers are more focused on staying within their budget and time schedule.

The ressources available to the actors determine how much they are able to do with BAT. The Danish EPA determines the levels set in the environmental approvals, and they have the possibility of reporting companies that does not obey the requirements to the police. If they are unsure if a company obey the requirements, they can require the company to document that they are within the limits or initiate a dialogue with the company. If a company does not obey the requirements, the Danish EPA can report the company to the police. DN have volunteers that study many of the environmental approvals to identify issues that they should complain about. Companies want to collaborate with DN because then they can avoid those complaints. Danish Crowns ressources to implement BAT are that they can set requirements for the companies and collaborate with them. They have been succesful in their collaboration with suppliers when there have been time for developing new solutions that benefit both Danish Crown and the supplier, but they have also experienced that the suppliers have not been able to fulfil the requirements. In one case where Danish Crown required the suppliers to document that their equipment was BAT, the suppliers were not able to deliver what they had promised. The reason is that some suppliers do not know what BAT is and the rest do not think of BAT when they develop their equipment.

Danish Crown see BAT as a tool they can use to bring down their operational costs and ressource use and they have an ambition to use it every time they buy new equipment. DN see BAT as minimum requirements that do not push the companies. The Danish EPA see BAT as different things depending on the size and operation of the production facility.

		Motivation	Ressources	Cognition
Implementation	Danish EPA	- Environmental approvals must be based on BAT.	- Expert knowledge of environmental issues. - Can not give fines, but impose that the companies should obey the emission levels. - Can report the companies to the police if they do not obey the emission levels. - Can require documentation from companies - Cooperate with companies.	- BAT is different for a automated and manual production facility. - It is not a problem that the inspection of BAT is different around Europe.
	Danish Crown	- Decrease ressource consumption and operation costs	- Can set requirements to the suppliers.	- It is possible to diverge from BAT conclusions if they cause too much trouble.
		- The most important requirements are capacity and limit value requirements.	- Can cooperate with suppliers and push them towards developing more sustainable technologies. - Have comprehensive knowledge about how the technology is used	- They have an ambition to use BAT every time they purchase new equipment.
	DN	- The effects on the local environment should be minimised.	- Have volunteers going through environmental approvals. - Can make complaints about environmental approvals. - Companies want to cooperate with them.	- BAT is minimum requirements.
	Suppliers	- They want to stay within budget and time when delivering equipment. - Requirements from customers.	- They do not use any ressources on BAT.	- Their knowledge of BAT is limited or non existing.

Table 6.2: Motivation, ressources and cognition in the implementation of BAT for the Danish Environmental Protection Agency (EPA), Danish Crown, the Danish Society for Nature Conservation (DN) and technology suppliers.

Suggestions for new BAT conclusions and improved implementation practices 7

The benefits and limitations of Best Available Techniques (BAT) as a regulatory tool to reduce emissions from industries is discussed in the following chapter. In section 7.2, it is described how Circular Economy (CE) considerations have been included in BAT documents, and how new BAT conclusions can include CE considerations. Moreover, assessing how Danish Crown can benefit from partnerships and moving focus from products to systems based on Product-Service System. In section 7.3, it is described how Danish Crown implements BAT in their organisation. It is further discussed how Danish Crown can ensure good implementation practices of BAT and TCO through Adaptive Management Strategies and principles from Effectual Reasoning. Lastly, in sections 7.4 and 7.5 theories and methodologies used throughout the study are discussed.

7.1 Benefits and limitations of Best Available Techniques

There are various benefits and limitations in BAT as a regulatory tool to reduce emissions from industries, the discussion is based on empirical knowledge from interviews and literature on BAT.

Knowledge do not necessarily lead to realisation and change in action

A number of articles point at different benefits of BAT. Ibáñez-Forés et al. (2013) argues that BAT plays a key role in the improvements of the industrial sustainability through higher energy efficiency, reduced pollution and related environmental and economic benefits. This statement is supported by Ringbæk (2019), she argues that BAT is important to manage the environmental protection and that it ensures a good environment for the local society.

However, Ibáñez-Forés et al. (2013) presents a methodology based on Life Cycle Assessment (LCA) to guide the selection of candidate BAT options for targeting hotspots in a given industrial installation and sector. Ibáñez-Forés et al. (2013) do not recognise implementation issues, as more information do not necessarily lead to realisation and action.

Moreover, Giner-Santonja et al. (2012) argues that one of the most powerful tools for the promotion of eco-innovations is IPPC Directive (now IED), as it establishes a procedure

for authorising the activities listed in Annex 1, so that the owner of a new facility must request permission from the competent authority. However, Giner-Santonja et al. (2012) continues stating that BAT is a decision to be made by the competent environmental authority, who must evaluate different BATs, but there is no specific assessment method for a better implementation of the IED approach, this argument is supported by the project group. Therefore, Giner-Santonja et al. (2012) proposes a decision-making process for assessing BAT based on Analytic Network Process. The Analytic Network Process represents a decision-making problem as a network of criteria and alternatives grouped into clusters and are given priority by the decision-makers. Giner-Santonja et al. (2012) recognises that there is an implementation issue, but suggests that more information and knowledge in the determination of BAT could lead to better implementation. However, more information in the determination of BAT would not necessarily lead to improvements in the implementation procedure. The literature on the selection of BATs disregards this point and tries to gather the full information to identify BAT (Bréchet and Tulkens, 2009). The project group depart from this literature by acknowledging that policy implementations are not a mechanical process but social interactions that can be influenced by actors.

Implementation issues in industries

There is no systematic method to assess the implementation of BAT in industries. Mortensen (2019) believes that the different understanding of BAT among the authorities and the industries leads to different implementation of BAT. Thy (2019) explains that in some places in the EU, BAT implementation is rigid, while some where else it might be more based on dialogue between the authority and industry. This also depends on the inspectors because some authorities believe that BAT is good, while others do not look as positive on it (Mortensen, 2019). Pontoppidan (2019) also believes that the implementation of BAT in the industries is weakened by the fact that the BAT documents are long and technical, and sometimes under 10% of the document is relevant to a particular industry.

Levelling of the playing fields

Smetana (2019) argues that BAT benefits are that it reduces pollution at the source. She continues stating that BAT is a business regulatory tool, which ensures that industries do not emit more then necessary, i.e. all EU industries are regulated under the same minimum requirements, this principle is known as *levelling of the playing fields*. Smetana (2019) also mentions that BAT is EU-level policy where technical experts from the industries are participating, and they can contribute with knowledge on environmental solutions. However, this can also cause power asymmetry, as larger industries can gain more control and influence the determination of BAT. Moreover, larger industries have more resources to participate in the determination of BAT, where smaller industries do not have the same resources and therefore do not know what to expect.

For example, Mortensen (2019) mentions that he in the recent revision of the Food, Drink and Milk BREF thought by making an alliance with Arla, Danish Crown and Danish Agriculture & Food Council could get more CE considerations put into the BREF document. However, even though these companies are large in Denmark does not mean they are large in the EU (Mortensen, 2019).

Moreover, Mortensen (2019) explains how end-of-pipe technology suppliers are using BAT to 'sell' their equipment to waste incineration plants and power plants that are publicly owned, as these are financed thought the taxes and can become large. These end-of-pipe concepts will then be norm setting for other BREFs (Mortensen, 2019; Ringbæk, 2019). This is a risk also pointed out by Holm (1997), as integrating the direct producers into a dialogue and negotiation procedure can contain the risk that specific interests and dominating development tracks maintain a narrow technological development.

Mortensen (2019) also argues that the surrounding environment is an important aspect, as BAT is command-and-control regulation, which makes the same requirements for all industries everywhere in EU, so levelling of the playing fields. Mortensen (2019) points out that this is neither good for the environment nor the industries. This is also supported by Giner-Santonja et al. (2012), arguing that in the establishment of Emission Limit Values based on BAT, *does not take into account the technical characteristics of the installation concerned, its geographical location and local environmental conditions.* Bréchet and Tulkens (2009) also argues that from a theoretical perspective it is well-established that command-and-control regulation is inefficient under imperfect information, that is, when industrial plants are numerous and heterogeneous. This is particularly relevant in the IED as it covers multi-pollutants over 55,000 industrial plants.

Setting limit values to optimise production

BAT is a normative regulation that is an extension of the recipient-oriented environmental regulation based on the emission values, limit values and directions.

Mortensen (2019) comments on the disadvantages on setting requirements based on concentration values. Because when optimising the process based on BAT regulation it is recommended to reduce the water consumption. When water consumption is reduced so much that a highly concentrated and thick organic material is left, then the concentration value per m^3 will be too high and will not meet the limit value for discharge. Mortensen (2019) therefore believes that the existing BREF notes have some concentration limit values which can limit water savings on the production sites, and also prevent the possibility of closing the loops, because it will be best to take the organic material and use it in energy production.

BAT regulation sets minimum requirements for all industries, which makes it easier for authorities to conduct supervision on BAT implementation. However Pontoppidan (2019) shares his concerns on this subject. As the emission limit values can become one-sided and hinder sustainability, for example something that can drive sustainability in the meat production industry is to utilise all parts of the animal as high up in the value pyramid as possible, in other words use it as human consumption, and by-products not fit for human consumption can be used in the energy production (Pontoppidan, 2019; Cerimagic, 2019), this could require more energy or water consuming activities which is contradictory to BAT, where the focus is on lowering resource consumption.

Pontoppidan (2019) points out that it is difficult to make general BAT conclusions for a sector as products and processes are different. When simplifying it too much so that the supervision from authorities are easier it can become one-sided (Pontoppidan, 2019).

Life-cycle based considerations in Best Available Techniques

Some interviewees point out that BAT permit regulations are antiquated and troublesome. Moreover, a number of articles Nicholas et al. (2000), Laso et al. (2017), Ibáñez-Forés et al. (2013) points that the BAT regulation need to develop methods to incorporate life-cycle based consideration into BAT.

Nicholas et al. (2000) suggest that new tools are needed to get the full impact assessment of an installation, so that the determination of BAT can be assessed on an integrated and holistic basis. They argue that life-cycle approaches can be used both to provide an integrated assessment of environmental impacts and to include some of the wider considerations required by the Industrial Emission Directive (IED). Laso et al. (2017) also argues that LCA is ideally suited to that type of integrated and holistic assessment that is required by the IED to assess the different techniques that are being considered as BATs.

This has also been recognised by other authors. Ibáñez-Forés et al. (2013) points out that BREFs often include a myriad of BAT options making it difficult to choose amongst the alternatives as different factors determine the viability of a BAT for different companies. Ibáñez-Forés et al. (2013) argues that there is a need for methodologies and tools to help companies select BAT that are appropriate for their conditions, while at the same time complying with the IED. They continue stating that BAT must protect the environment as a 'whole', but the IED do not require Life Cycle Assessment (LCA) to assess environmental performance. Therefore, the full life-cycle emissions and impacts are not considered and there can be shifting of environmental burdens up- and downstream from the installation.

Ringbæk (2019) argues that life-cycle perspective is a good aspect, but that the local community is not prepared to accept industry pollution because efforts are made elsewhere in the chain. However, one does not exclude the other. On the contrary a life-cycle based and holistic approach can improve the level of sustainability and selection of the most appropriate BAT for different sectors, as the scope is expanded.

Circular Economy considerations in Best Available Techniques

In addition to LCA considerations, only one article mentions BAT and Circular Economy (CE) in the same subject field. Huybrechts et al. (2018) investigates how BAT-based permit regulations can potentially act as a driver or as a barrier for greening global value chains and for implementation of Sustainable Supply Chain Management and CE. In the paper, Huybrechts et al. (2018) investigates how up- and downstream activities have been considered in the determination of BAT in the Sevilla process by analysing four different BREFs and identifying value chain considerations. The case studies show that in the Sevilla process there are examples of value chain aspects considered. However, it is not a systematic practice, and it is not explicitly required by the available methods for determination of BAT (Huybrechts et al., 2018).

BAT however shares some of the principles of CE, this principle is narrowing. Narrowing resource loops can be achieved by increasing resource efficiency by using fewer resources per product which is aligned with BAT. BAT is product-focused and focused on production optimisation, and less focused on service (slowing) and system (slowing and closing), so

how to incorporate more CE service and system considerations in BAT will be discussed further in section 7.2.

Some interviewees (Pontoppidan, 2019; Mortensen, 2019) also point out that CE considerations are important, in the way limit values are formulated, to limit contradictory actions towards sustainability and avoiding that end-off pipe solutions are dominating the BAT work.

7.1.1 Summary of the benefits and limitations of Best Available Techniques

Benefits

- BAT is a policy tool to regulate industry emission and seek to do so in an economically feasible way.
- All EU industries are regulated under the same minimum requirements under the principle levelling of the playing fields.
- Ensuring good local environmental conditions.
- Well established framework where several technical experts are involved in the development of BAT.
- Knowledge is being shared from the different actors to solve environmental issues in regards to the production.

Limitations

Consensus policy and powerful actors

- Some suppliers see the possibility to 'sell' their products to large publicly owned facilities that are financed by taxes e.g. waste incineration plants.
- Difficult to insert CE considerations if powerful actors are not interested as they have a lot of influence in the BAT process as it is consensus policy.

Command-and-control regulation

- BAT permit regulation is command-and-control regulation where all industries has to comply to the same minimum requirements, this is neither good for the industries nor the environment.
- Command-and-control regulation is inefficient under imperfect information.
- More information in the determination of BAT will not necessarily lead to realisation and action.
- Difficult to make general BAT conclusions for a sector as products and processes are different.

Implementation issues

- There is no assessment method for a better implementation of the IED approach.
- Difficult to choose amongst a myriad of BAT options as different factors determine the viability of a BAT for different companies.
- Simplifying BAT requirements too much, so that the supervision from authorities are made easier, can become one-sided and insufficient.

- BAT permit regulation is perceived differently in the Member States, where some use BAT in a rigid way, while others use it in dialogues with industries.
- Actors have different cognition and not a common one. Therefore the BAT implementation practices are different in EU.
- BREFs are long and technical documents that rarely are being read.

Focused on production optimisation

- Silo thinking and do not include life-cycle perspectives.
- There is no systematic practice or method to assess up- and downstream activities in the determination of BAT.
- BAT is narrowing resource loops and to some extend slowing down, but not so much closing. The focus is mainly on the product and not service and system considerations.
- The aim of reducing energy and water could hinder closing loops, as some processes are energy-intensive in order to limit waste and get products higher in the value pyramid.

One of the limitations of BAT is that it is focused on products and production optimisation, and there is no systematic method or practice to assess value chain aspects and slowing and closing resource loops. How to include circular economy consideration is discussed in the next section.

7.2 Including circular economy considerations in Best Available Techniques

Because of its role as environmental regulation, BAT based permit condition can act as a driver for circular economy. This section discusses the possibilities for including circular economy aspects in BAT regulation, including a discussion of how Danish Crown would be affected by these new aspects.

7.2.1 Value chain perspective

Huybrechts et al. (2018) concludes that in the Sevilla process, aspects of value chain are not systematically considered in the development of BAT. In the article, three strategies to a systematic considerations are proposed: 1) consideration of relevant 'cross-sector effects', 2) determination of 'value chain BAT', and 3) selection of a 'collaboration with up- and downstream partners in the value chain' as a general value chain BAT for each sector.

The article does however not answer the question of *why* value chain aspects are not considered in BAT development. From the analysis in chapter 6 it is concluded that the actors involved in the development and implementation of BAT have different motivations for working with BAT, different cognition of BAT, and different resources to use on BAT.

Cross-sector effects

The first strategy proposed by Huybrechts et al. (2018); consideration of relevant 'cross-sector effects', is suggested as a method to avoid unintended environmental effects in other

parts of the value chain. This should reduce the risk that BAT could become a barrier for greening value chains. In the article, cross-sector effects are defined with inspiration from the similar expression cross-media effects. The only difference between the two expressions is the place where the effects are occurring, and it can therefore be considered to be as relevant (Huybrechts et al., 2018). In the revised BREF document for Food, Drink and Milk Industries, environmental performance levels for energy consumption and waste water discharge are presented (European IPPC Bureau, 2018). In the interview with Pontoppidan (2019), the possible drawbacks of this method was discussed. He argued that these limits could become a barrier for sustainability if they were set without taking into account the differences in production processes and thinking of the whole life-cycle of the meat. In a life-cycle perspective focus should be on using as much of the meat for human consumption instead of pet food or biogas (Pontoppidan, 2019). A cross-sector approach, where the environmental effects from other activities along the value chain are considered when deciding what should be BAT, could, because of its life-cycle perspective, be a useful method for avoiding any unintended barriers for sustainability. A possible BAT conclusion, that could lead to reduced environmental impacts upstream in Danish Crowns value chain, is a BAT conclusion regarding the amount of product used for human consumption. The BAT conclusion could specify a certain percentage of the raw material which should be used for human consumption. This suggestion could be difficult to implement in the regulation because some companies, which do not have as big a retail network as Danish Crown, would struggle with complying with such a conclusion, as they do not have the same possibilities to sell their products on different markets.

Value chain BATs

The second strategy; determination of 'value chain BAT', is suggested as a systematic approach to determine techniques that can be implemented in one activity in the value chain to give an environmental benefit in another activity in the values chain (Huybrechts et al., 2018). A value chain BAT should not only be determined as BAT for the activity where the environmental effect occurs, but also where the technique has to be implemented (Huybrechts et al., 2018). An example is a conclusion in the Slaughterhouse and Animal By-product (SA) BREF regarding the feeding of pigs prior to slaughter, where it is recommended not to feed the pigs 12 hours prior to slaughter, as a way to reduce the amount of manure produced (Huybrechts et al., 2018). Value chain BATs are also relevant in the value chain for equipment, as the decisions made by the suppliers upstream have influence on the resources used by Danish Crown downstream. The issue for Danish Crown has also been that some of the BAT conclusions regarding their equipment is not something that they have direct control of. They rely on their suppliers to comply with BAT and document the use of BAT, which require them to have a collaboration about it. Danish Crown has however not been successful in facilitating a collaboration around BAT, which indicate that it could be necessary to make BREF documents for the suppliers to secure a successful implementation of the BAT conclusions aimed at Danish Crown. In the discussions with employees at Danish Crown, another example of a possible value chain BAT, was brought up. The example concerned plastic conveyor belts which are changed on a regular basis by Danish Crown, which generates a relatively big amount of plastic waste. Danish Crown is not able to recycle this plastic waste because they do not know what plastic has been used in the conveyor belts. It was therefore suggested by the employee

at Danish Crown that the information of which materials have been used in the product should be stored in the product. This could make it easier for Danish Crown to recycle the plastic and thereby reduce their resource use. Another example of a possible value chain BAT could be to set a requirement for Danish Crown concerning the packaging materials for their final products. At the moment the packaging material cannot be recycled by the consumers, but there are new packaging solutions available which make it possible for the consumers to recycle a bigger amount of the packaging. The new packaging solution is made of a cardboard box with a thin plastic film. The amount of plastic used for this packaging is reduced and the cardboard can be recycled. The solution is however assessed by Danish Crown to be too expensive, but it is available at the market.

Collaboration with up- and downstream suppliers

The third strategy; collaboration with upstream and downstream partners in the value chain, is suggested by Huybrechts et al. (2018) as a general value chain BAT for each sector, which could be implemented in the BAT conclusion regarding environmental management system. Collaboration between the technology suppliers and Danish Crown has previously led to improvements in the performance of equipment. The relation between actors in the value chain also play an important role in the value proposition framework by Kristensen and Remmen (2019) presented in section 4.3.

7.2.2 Product-service system as framework for new BAT conclusions

Interaction between the actors in a value chain are necessary to realise the potentials of a Product-Service System (PSS) (Kristensen and Remmen, 2019). When moving from a product dimension to a service or system dimension the interaction between actors play an increasingly important role. If collaboration with upstream and downstream partners is included as a value chain BAT in the general BAT conclusions on Environmental Management System, it could make it possible to realise other elements of PSS.

Interaction

In the value proposition framework by Kristensen and Remmen (2019), the interaction dimension goes from ownership to collaboration to partnerships. For each of the dimensions, a variety of initiatives within the economic, social and environmental dimensions are possible.

In the product dimension the interaction between Danish Crown and the technology suppliers is limited to the transfer of ownership of equipment based on traditional supply chain management. This limits the interaction between the supplier and Danish Crown to be a discussion of price and installation costs.

In the service dimension the focus move from transfer of ownership to collaboration and sustainable supply chain management. The focus of this collaboration could be on optimising service life by focusing on quality, repair and maintenance (Kristensen and Remmen, 2019). Danish Crown has in some cases collaborated with their suppliers, where they have succeeded in optimising the equipment, but there are also many examples of Danish Crown not taking the time to go into collaboration with their technology suppliers.

The step from product dimension to service dimension has given Danish Crown good results previously. If Danish Crown go into collaboration with their suppliers in all projects, it could help Danish Crown in their effort to reduce their resource use and operational costs.

In the system dimension focus changes to delivering functionality instead of a product. For Danish Crown this means, they go from buying equipment that solves a specified task to buying a function that fulfils Danish Crowns needs. This would require Danish Crown to form partnerships with their technology suppliers where they can rethink the purpose of the equipment in an effort to create solutions to societal issues. The suppliers role will change from being technology supplier to consultant at the same time as they still provide Danish Crown with innovative solutions. This change will require that the suppliers gain new competences regarding the production facility and how they could go into co-creation with the users of their equipment (Kristensen and Remmen, 2019).

At the moment, Danish Crowns relation with technology suppliers is in the product dimension where focus is on the change of ownership, and only in some cases in the service dimension. There are no examples of Danish Crown going into partnerships with their suppliers. If Danish Crown chooses to go into collaboration with their suppliers and form partnerships, it could lead to new possibilities and solutions to issues Danish Crown has. Based on the three core dimensions of sustainability, the following sections will discuss the possibilities the PSS framework could give Danish Crown.

Environment

For the environmental aspect in the PSS framework, the focus of the product dimension is on narrowing resource flows, e.g. reducing water and energy use or waste streams. Most of the current BAT conclusions in the FDM and SA BREF documents are focused on this aspect of the environmental impacts, but if the interaction between Danish Crown and their suppliers strengthen and turn into a collaboration or partnership, it could be possible to change the focus of the BREF documents to also include other environmental aspects.

In the service dimension the aim is to slowdown the resource flows. In the case presented by Kristensen and Remmen (2019), slowing down resource flows was achieved by designing for durability, by maintenance and repair, and by increasing the average lifespan of products. It could be argued that designing for durability is the technology suppliers responsibility, as they are designing and producing the equipment. A collaboration between the supplier and Danish Crown could on the other hand increase the suppliers knowledge of how the equipment is used, and give them valuable information about which parts breakdown first, and where they can improve the design of their equipment to last longer. Maintenance and repair is, in the product dimension, the responsibility of Danish Crown, but in a service dimension the responsibility could change to the supplier. If the supplier has the responsibility for maintaining a product during its lifetime, it will give the supplier an incitement to construct the equipment in a way, which make it easy to maintain. Increasing the average lifespan of equipment could slowdown the resource flow for equipment significantly, as the need for new equipment will be reduced. Value chain BAT conclusions aimed at slowing down resource flows could include the following aspects: guaranteed lifespan, design for durability, easy maintenance and repair, or guaranteed

minimum maintenance and repair of equipment over a longer lifespan.

In the system dimension the aim is to slowdown and close the resource flows, which in the case presented by Kristensen and Remmen (2019) was achieved by modular design, take-back systems, design for dis- and re-assembly, and by increase of reuse, refurbishment and recycling. These different solutions rely on a partnership between Danish Crown and their suppliers, as the success of the implementation of these solutions rely on both of them taking responsibility. Equipment with a modular design could be used by Danish Crown for gaining more flexibility in their production. This could be necessary to respond to changing consumer demands. Take-back systems combined with a variety of the other solutions could hold the potential of closing the resource flow used to produce equipment. Especially for equipment with a relative short life time, like conveyor belts, take-back systems combined with refurbishment could be an important solution to close the resource flow. Solutions based on dis- and reassembly, reuse and recycling also hold the potential to close the resource loops, but rely on partnerships between the technology suppliers, Danish Crown and a recycling facility. New value chain BAT conclusions aimed at closing resource flows could include the following aspects: take-back systems, modular design, design for dis- and reassembly, increase of reuse and recycling, and refurbishment.

Social

In the product dimensions the social aspect is focused on the user of the equipment, e.g. the design of the equipment (Kristensen and Remmen, 2019). Design considerations for Danish Crowns suppliers is related to the efficiency of the equipment, but also on how any human interaction is integrated in the production process.

In the service dimension focus is on the supply chain. The change in responsibility for the maintenance and repair of the equipment means that the employment of service personal will change from Danish Crown to their technology suppliers. Having the equipment maintained by the supplier could benefit Danish Crown in a few ways. First of all, they would not be responsible for maintaining all of their equipment themselves which mean they could reduce their own costs for maintaining equipment. Second, the need for specialised knowledge on maintenance of equipment within Danish Crown is decreased. Having the equipment maintained by the supplier could also mean an increase in the quality of the maintenance, as the supplier has expert knowledge of the equipment. A value chain BAT conclusion regarding easy maintenance and repair could therefore also affect the social dimension.

In the social system dimension focus is on society. The value created in the service dimension for Danish Crown could be in the form of an improved work environment for the production facility workers. This would again require that Danish Crown and their technology suppliers form partnerships to create solutions that increase the social value. Designing improved working environments could require new competences for the suppliers regarding designing a healthy working environment. A value chain BAT conclusion on collaboration with upstream and downstream actors could thereby indirectly lead to an improved work environment, if Danish Crown and their technology suppliers decide to focus on that aspect in a partnership. Besides the environmental benefits, collaboration and partnerships could thereby also create value in the social value proposition.

Economic

In the product dimension in the economic value proposition focus is on profit. In the transfer of ownership from the supplier to Danish Crown the focus is on product price. Investment cost are also relevant in the light of BAT, as the *availability* is partly determined by the price of the equipment. It could be argued that the *availability* should encompass more than just the investment cost, if the value chain BATs suggested above are implemented in the coming BAT conclusions. As the focus moves from a product dimension to a service dimension, the investment changes from a one time investment to an ongoing subscription to a service. The subscription could include a basic cost as it is seen in some leasing deals.

In the service dimension, focus is on Total Cost of Ownership (TCO), service contracts and efficient use of product (Kristensen and Remmen, 2019). In the transfer of ownership, the focus is on the equipment's expected lifetime, the costs of maintenance, expected repairs, spare parts, etc. TCO was highlighted by Juhl (2019), as something Danish Crown has the ambition to do. It is also in alignment with their motivation for reducing production costs. Service contracts could also be a way for Danish Crown to avoid unforeseen expenses, as the costs for maintenance and repair will be included in the service contract made with the technology suppliers. It could be argued that in the service dimension, the *availability* of equipment should depend on the total costs of owning the equipment when all relevant aspects are taken into account instead of only the cost of investment.

In the service dimension, the economic focus is on solutions to societal problems and functionality (Kristensen and Remmen, 2019). The transfer of value is based on a functionality provided. For Danish Crown and their suppliers it could mean that Danish Crown would pay the technology supplier for a service, e.g. to wash vessels used for transporting meat. Danish Crown would then pay the technology supplier a fixed price for each washed vessel. For Danish Crown, this could mean low initial costs and that the risks will be given to the technology supplier. On the other hand Danish Crown would not own the equipment they use in their production, which would make them more dependent of their suppliers. The *availability* of a technology will in the service dimension, depend on the price of each produced unit.

7.2.3 Development of new value chain and circular economy BAT conclusions

Value chain aspects have not been considered systematically in the development of BREF documents (Huybrechts et al., 2018). Circular economy aspects have to some degree been considered in the development of BAT (Mortensen, 2019), but the aspects presented above have not been looked at previously. The aspects considered in the development of BREF documents are those the different actors involved in the development of BREF documents find relevant. This could explain why aspects of value chain and circular economy are not considered.

The analysis of the actors motivation show that the Danish EPA and DN are motivated by reducing environmental impacts. The Danish EPA is however mostly focused on the local emissions. In the development of BAT, Danish Crown and the suppliers are not motivated

by reducing environmental impacts. DN is therefore the actor that has considered CE the most. Their resources to work with the development of BREF documents are however limited compared to the other actors. At the same time, the motivation by Danish Crown, and presumably also other companies, is to ensure that no rules are made by actors from outside the industry.

Including considerations of CE and value chain in the development of BREF documents, would require that the actors involved in the development of the documents are motivated to work with the subject. The Danish EPA and DN are both motivated, in the development of BREF, by a wish to reduce the environmental impacts. For them to start working with CE, it would require that they see it as a method to reduce the environmental impacts. For Danish Crown and the suppliers to work with it, they would have to see it as a competitive advantage.

Danish Society for Nature Conservation is the actor who is most likely to take the lead in including CE and value chain in the development of BAT conclusions, as it is most within their motivation. They do however not have the necessary resources to force these aspects into the BAT conclusions alone. There need to be more resources behind the suggestions, which could either be done by increasing DNs resources or by involving new actors that have more resources than DN. Because DN is limited in its ways to gain resources, the most realistic way to gain more resources is by engaging with other actors in the process. The most resourceful actors which DN could go into collaboration with, is Danish Crown and other big companies. One way to get other actors to work on the subject is by changing their cognition. According to the adaptive management strategies presented in section 4.2.1, the cognition of actors can be changed by providing them with new information. Danish Crowns cognition can thereby be changed if they receive new information, which in return could change their motivation when working with the development of BAT. However, it is worth mentioning that new information do not always lead to realisation, a change in behaviour acquires incentives. The arguments that could change Danish Crowns cognition of these suggestions for BAT conclusions, would have to convince them that the new BAT conclusions could give them a competitive advantage and that it could help them with decreasing their resource consumption and production costs.

The technology suppliers are motivated to participate in the development of BAT conclusions if they think it could give them a competitive advantage. The suggested BAT conclusions could give the suppliers a competitive advantage, if they collaborate with Danish Crown on developing the new techniques required. This could give both the suppliers and Danish Crown a competitive advantage, as they would be in the front of the development and have temporary monopoly on the new techniques. The Danish EPA would also support this collaboration, as they are motivated by giving Danish companies a competitive advantage. If all four actors are motivated to work on implementing the suggested BAT conclusions in the upcoming BREF documents, then they could have enough resources to influence the policy development process.

7.2.4 Summary of new BAT conclusions and the affect of product-service system in Danish Crown

The possibilities for BAT based permit conditions to act as a driver for circular economy and triple bottom line value creation are summarised in this section.

Six new BAT conclusions are suggested based on a discussion of how the value chain BAT considerations presented by Huybrechts et al. (2018) could be used by Danish Crown and from a discussion of which possibilities the value proposition by Kristensen and Remmen (2019) could give Danish Crown.

1. BAT conclusion could specify a certain percentage of the raw material which should be used for human consumption.
2. A BAT conclusion to ensure that information on the optimisation of resource use is shared with the value chain.
3. A BAT conclusion to ensure that the packaging material used by Danish Crown can be sorted by the end consumer in the households and recycled.
4. Value chain BAT conclusions aimed at slowing down resource flows could include the following aspects: guaranteed lifespan, design for durability, easy maintenance and repair, or guaranteed minimum maintenance and repair of equipment over a longer lifespan.
5. New value chain BAT conclusions aimed at closing resource flows could include the following aspects: take-back systems, modular design, design for dis- and reassembly, increase of reuse and recycling, and refurbishment.
6. A BAT conclusion to ensure collaboration with upstream and downstream partners in the value chain.

At the moment it is difficult to say with certainty if any of the suggested BAT conclusions could lead to lower resource use and production costs for Danish Crown. However, the first BAT conclusion would most likely lead to a competitive advantage, as Danish Crown has a high level of utilisation of their products (Cerimagic, 2019). BAT conclusion 3 would likely lead to increased costs for Danish Crown as it would require Danish Crown to change their operations and use more expensive materials than they do today (Petersen and Nissen, 2019). In this case they have to eliminate the use of black plastic packaging which can not be detected in the current recycling plants which leads to the plastic being incinerated. Instead of the black plastic they can use a cardboard material with a thin film. The film which is in contact with the meat can be removed in the end-user phase, leaving the cardboard to be recycled. BAT conclusions 2, 4, 5 and 6 could on the other hand lead to lower costs for Danish Crown as they would be able to reduce their costs for waste and maintenance and lower their investment costs.

A product-service system approach could for Danish Crown give a variety of options for improvements. Based on the value proposition by Kristensen and Remmen (2019), it is assessed that a product-service system could open up for the possibilities in Table 7.1.

	Product	**Service**	**System**
Economy	- Profit - Focus on price of equipment	- Total cost of ownership - Focus on expected lifetime, cost of maintenance and expected repairs, spareparts, etc. - Service contracts - Avoiding unforseen expenses	- Transfer of value is based on funcionallity - Pay the technology supplier for a service - Payment per produced unit - Low initial costs and the risks will be given to the technology supplier
Social	- Use of equipment - Design of equipment - Human interaction with equipment	- Employment of maintenance personel will move to the technology supplier - Reducing costs for maintenance for Danish Crown - Decreased need for specialised knowledge in Danish Crown - Increased quality of maintenance by the supplier	- Improved work environment for production facility workers - New competences for the suppliers regarding designing a healthy working environment
Environment	- Narrowing resource flows - Reducing water and energy use - Reducing waste streams	- Slowing resource flows - Designing for durability and increased lifespan - Easy maintenance and repair - Exchange of performance information	- Modular design creating more flexibility in production - Take-back systems and refurbishment of equipment
Interaction	- Transfer of ownership - Traditional supply chain management - Discussion of price and installation costs	- Collaboration on improving design of equipment - Sustainable supply chain management - Optimising service life - Focus on quality, repair and maintenance - Reducing resource use and operational costs	- Delivering functionality - Partnerships with technology suppliers - Rethinking the purpose of the equipment - Suppliers role changes from being technology supplier to consultant - New competences for suppliers

Table 7.1: Possibilities for how a product-service system could affect Danish Crown.

7.3 Implementation practices of Best Available Techniques in Danish Crown

The findings in the analysis in this report show that there is a communication barrier between Danish Crown and their technology suppliers when discussing BAT. The technology suppliers do not know what BAT is and the rest do not think of BAT when developing their equipment. There is a need for collaboration between Danish Crown and their technology suppliers if they should be successful in their effort to use BAT every time they buy new equipment, because they rely on their suppliers in order to find the most sustainable solutions.

Currently, Danish Crown has BAT in the their Code of Conduct with Suppliers. It states that; *suppliers should present Danish Crown for the most environmentally and climate friendly alternatives and solution. Equipment to be used in Danish Crown production must live up to BAT requirements.* (Danish Crown, 2019a).

In addition to the Code of Conduct with Suppliers they also have BAT written in their Project Handbook, which is a guideline for project managers to follow when buying new equipment. Here it says that: *In connection with obtaining quotes from suppliers, a technology assessment is carried out on the project.* The assessment is made on the basis of their Cleaner Technology Assessment table, where there are a number of 'project assessment themes' cf. Appendix A.3. The purpose of the technology assessment is to compare and evaluate different equipment from different suppliers, and to be able to choose the best solution for Danish Crown. The completed table is also used as documentation for Cleaner Technology Assessment because it is necessary for the approval authority to have documentation that the choice of plant and production methods has been made on the basis of the principles of BAT. The Project Handbook also states that the table must always be used on systems and installations where there is resource consumption, even in cases where there are no alternative plant/production methods, but where it can be assessed whether energy-saving investments must be made on the equipment. However, project managers rarely use the table when doing the assessment of cleaner technology.

Danish Crown conducts CAPEX (Capital Expenses) projects, which are investment projects over DKK 50,000, where there is an obligation to purchase the equipment at the expiration of the agreement. CAPEX projects can be prepared by project managers in Randers or local project managers on the factories such as the chief engineers. CAPEX projects need to implement a cleaner technology assessment. Danish Crown has made a Key Performance Indicator (KPI), where a collection of registered CAPEX projects is established, which states that the Cleaner Technology Assessment table has been used and that an evaluation of alternatives has been made. The Environmental, Safety and Health (EHS) managers at the factories collect information from local project managers, as well as project managers from Engineering in Randers, who have projects at their factory. The total number of new projects in the quarter, as well as the number of projects with completed cleaner technology assessment, are recorded on a dedicated table on the 'Environmental-Portal'. Target value for environmental assessment on CAPEX projects must be at least 80%, the KPI was established in 2017. The data collection has been inadequate, as the EHS managers must collect the information which makes the process

very slow. In addition, CAPEX projects with implemented cleaner technology assessments are very low. For example, for 2018-19 for the slaughterhouse in Rønne there was only one CAPEX project that included cleaner technology assessment among the total of eight CAPEX projects (Schulin-Zeuthen, 2019).

The current Cleaner Technology Assessment table is not efficient and are not being used in-house. Project managers are confused about its purpose, they do not understand it and can therefore not use it when talking to their suppliers. There is a need to incorporate the cleaner technology assessment table differently, and it needs more guidance (Thy, 2019).

7.3.1 Integrating BAT in a TCO-tool for Danish Crown

The cleaner technology assessment table for projects is confusing (Thy, 2019). The tables purpose is it to assess the implementation of BAT, but there is a category saying 'according to BAT', referring to the BAT checklist with BAT conclusions, cf. Appendix A.4. In practice, the table has not been used, in the very best case it is simply used as a proof that more offers have been obtained (Thy, 2019). Having a category called 'according to BAT' and then having categories in the assessment tool such as: energy consumption, water consumption, waste water production, waste production, noise, cleaning friendliness, chemical consumption etc., makes it very confusing, as project managers and suppliers would think this is not BAT, and that BAT is the checklist. BAT would therefore be downgraded to a checklist.

In the Cleaner Technology Assessment table no units are stated. The idea is that table is sent to the suppliers to be filled out. They state if the resource consumption is high, mid or low. It is difficult to assess the different alternatives against each other because there is no established weighting method. In the Cleaner Technology Assessment table the economy is also a separate category, referring back to the Project Handbook.

The Project Handbook describes that financial management must be made for all investments. Project managers are responsible for carrying out the financial management. A financial management is made for all projects in Danish Crown's standard spreadsheet. In connection with the investment application, the spreadsheet is divided in the following main items: building work, machine and process plants, technical installations and project costs. In addition, an inventory must be made of possible increased energy and water buildup, increased operating and maintenance costs, etc. This can be done in the financial management tool. The worksheet is used in the start of the project for budgeting and later to the actual financial management of the project.

Currently, projects do not focus on Total Cost of Ownership (TCO) even though they should, according to Danish Crowns Vice President Juhl (2019). However, there is a basic problem; which is that the purchase price and operation costs are not in the same department:

> *You can say that there is an increasing focus on what things also cost in operation and maintenance. One can then say, if you have to give a tip to Danish Crown, then I think that they think budget in the investment budget as one thing, and operation and maintenance budget is something else. It is not often that the same people who are*

responsible for it. So the question is whether they think about it. They perhaps think in TCO, but in practice when it goes into operation, then it is different boxes. ((Andersen, 2019), [00:13:02.24])

Therefore, it is recommended that costs lie in the same department, and that the communication is sharpened between procurement and operations department.

There has been a clash between these two departments (Nielsen, 2019). Especially in recent times, where Danish Crowns procurement has to save 650 million DKK from the total purchases, and the chief engineers at the factories (the operations department) is given the responsibility if there is a production shutdown, because procurement has chosen to buy a machine that works poorly but was cheap in purchase price (Nielsen, 2019). In this context, it is proposed to increase focus on TCO in the investment projects but also because TCO is something Danish Crown has promised their board of directors (Juhl, 2019).

Doing a TCO assessment will include an assessment of the costs related to the environmental costs and can therefore be seen as a way to assess and document which equipment is BAT.

Environmental costs are a part of the TCO calculations. Economy can therefore be used as the weighting method for BAT. In this way one can clarify how cleaner technology assessment should be included as an assessment parameter in the choice of equipment/solution. In this way, it is made clear that BAT is about getting influence on the choice of equipment and that it is not just about being able to present a documentation that an assessment has been made. A TCO-tool which supports BAT is much needed in Danish Crown as they have not yet developed one, and integrating BAT can help different actors in Danish Crown understand BAT and implement it.

The weighting of environmental impacts in TCO, is based on the costs to the company of the environmental impacts. This can be problematic as the relative cost of environmental impacts not necessarily is related to the relative impacts by an emission. On a societal level it is possible to adjust the cost of these impacts by creating taxes that are relative to the impacts. Because these taxes will affect the competitiveness of companies, it would be necessary to implement similar taxes in the rest of the EU. At the same time, putting a price on the environmental impacts makes it possible for the project leader to compare the environmental costs with the other costs of new equipment and thereby make an assessment of how much a piece of equipment will cost the company in the long run. This will include an assessment of how the environmental costs of a equipment can be brought down.

In 2011, Danish Crown started a project called 'Environment with Bottom Line' (Miljø med Bundlinje). The purpose of the project was to make the environmental work visible, and meet different actors on their home ground by talking economy. There was a lack of focus on environmental costs which the environmental department in Danish Crown wanted to do something about. The project was suspended because they failed to get the message out. However, the idea is the same as for this project.

During the project 'Environment with Bottom Line', it emerged that Danish Crown's total

environmental costs are DKK 148 million. A 5% reduction in total environmental costs would therefore mean DKK 7.4 million in lower costs and thereby greater profits. Similarly, if one had to generate 7.4 million in pure surplus of the primary operation, then Danish Crown had to sell for DKK 246 million to generate the same surplus contribution. These figures must be read with caution, as these calculations were carried out in 2011. However, the principle is the same. If Danish Crown focuses on their environmental costs, they can save a lot of money.

7.3.2 Strategic adoption of BAT in Danish Crown

Following the findings in the analysis, Danish Crown has a lot of focus on the investment budget and the time to complete the project. Their motivation after an investment contract is signed is to stay within the budget and time schedule. Often, the budget is made from the cheapest technology, which makes technology suppliers focus on price and time, because if they go over time, they can get fines and if they go over budget then a new investment application must be made, which also takes time.

In addition, Danish Crown recommends in their Project Handbook that a table has to be prepared per category (from the Cleaner Technology Assessment table), which is then sent to their suppliers for completion. Danish Crown is therefore dependent on technology suppliers presenting them for the best available technology. However, they cannot expect the suppliers to present them this information without demanding it, and as of now Danish Crown rarely discuss BAT with their suppliers, in spite of it being in their Project Handbook and in the Code of Conduct with Suppliers. However, this can be improved by partnerships and dialogues with their technology suppliers, so Danish Crown can ensure that they are being presented for the best environmental equipment. It requires that Danish Crown has an internal understanding of BAT principles and that they demand this information from their suppliers and follow-up on the information given.

Danish Crown can strategically change the course of the BAT implementation practice. How to do so, is suggested through the theory of Strategic Adaptive Management presented in the Contextual Interaction Theory, where it is suggested how an actor can change the course of a process by changing the specific context of the process.

New actors

The theory suggest to add new actors to the process and thereby creating better networks. Findings in the analysis suggest that Danish Crowns technology suppliers are not involved in the BAT implementation practices. Danish Crown are very focused on purchase price and time schedule of the project. The technology suppliers agree, as this is the parameters they are assessed on, alongside cleaning friendliness. Sustainability considerations are very new to the technology suppliers, because Danish Crown are not demanding it. Because Danish Crown has not demanded it enough, their technology suppliers has no or a limited knowledge on BAT principles.

Danish Crown does not effectively use BAT in their organisation when buying equipment, and therefore refrains from talking about it with their suppliers. It takes time to make these considerations and assessments, and the project manager must therefore have the

right team from the start of the project, so BAT assessments are not skipped to comply with the deadline. This means that the project manager need to include actors with the necessary knowledge, for example involving the environmental department in the case of waste water production or waste production.

However, the opposite case applies for TCO. Here the technology suppliers focus on TCO, but Danish Crown has little to no focus on this in their own projects.

In addition to strengthening communication with suppliers and Danish Crown's project manager, they must also secure good communication in Danish Crown across the departments. Which means the communication wall between the procurement and the operations department must be breached. When purchasing new equipment, procurement must inquire with the operations department and vice versa. The Danish Environmental Protection Agency suggest a three step model on how to include TCO in the procurement.

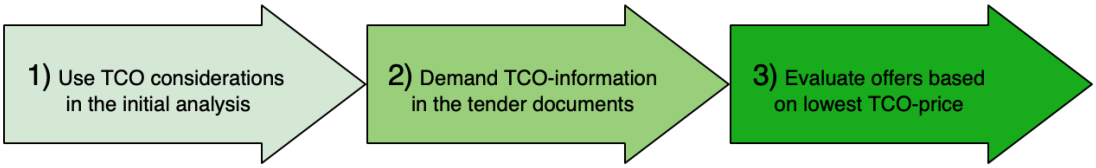

Figure 7.1: 3 steps to implement Total Cost of Ownership in Danish Crown, based on model from Miljøstyrelsen (2015)

The three steps to implement TCO is defined by Miljøstyrelsen (2015):

- **Step 1)** Consider cost drivers in the initial analysis. Examine the product solutions impact on the usage context. Involve indirect costs, e.g. longer working hours.
- **Step 2)** Make requirements and criteria in the tender documents for cost drivers. Request information for the TCO calculation in the tool in the tender documents (TCO-tool, cf. Appendix A.6).
- **Step 3)** Use the tool to calculate TCO prices and compare offers. Evaluate by lowest TCO-price.

The tool must be completed on the basis of a talk/guarantee from the suppliers. By developing a tool, such as the TCO-tool, where BAT is an integrated part and is stated in monetary values, more actors can get involved in the process, as the understanding increases.

In addition, Miljøstyrelsen (2015) has identified how to use TCO in a basic initial analysis, where they have learned that it is relevant to get the management's support from all parties involved. There must be a cooperative effort from all professionals involved, and there must be a dialogue between all actors (Miljøstyrelsen, 2015). This is also in line with *interaction* from the value proposition by Kristensen and Remmen (2019).

New arenas

The second suggestion in the Strategic Adaptive Management is to affect the implementation process by creating new arenas, such as new meeting points like working

groups or committees.

In the analysis, two different communication barriers are identified. The first is between the procurement in Danish Crown and the operations department in Danish Crown. The other is between the project managers and suppliers when it came to discussing BAT. There is therefore a need for knowledge sharing and collaboration between these actors. For project managers and suppliers, it is important to enter into partnerships, which has proved to be an advantage when project managers have made projects where the dialogue has been ongoing with the suppliers. Moreover, it is important that Danish Crown sets up the right team from the start of the project, with the necessary knowledge, before making an investment project. Project managers, Danish Crown employees with relevant knowledge for that particular project and suppliers should enter into a working group when buying equipment.

In relation to developing BAT, it has also been identified that it is important to make a systematic consideration of value chain aspects in the determination of BAT by collaborating with up- and downstream partners in the value chain. Here it could be an advantage to do workshops where Danish Crown, and other industry sectors such as Tican, technology suppliers, the Danish Environmental Protection Agency, the Danish Meat Research Institute and the Danish Society for Nature Conservation participated. This was the projects initial aim, but because of time restraints this was not possible.

New information

The third suggestion is to introduce new information and thereby changing the cognition of actors, following the analysis where it is identified that there is a different cognition of BAT among the actors, and therefore a need for a common understanding. The current cleaner technology assessment table used in Danish Crown does not explicitly explain BAT requirements and there are no units attached to the categories, which make it difficult to assess equipment based on the different categories. This makes it inaccessible for project managers which view it as irrelevant in connection to price and time schedule. The cleaner technology assessment table is not understandable and the project managers could therefore not use it together with the their suppliers. It is important to educate the suppliers on BAT, as they do not consider sustainability. This is new to them, but Danish Crown should demand it.

In this project, a common understanding of BAT by Danish Crown and their technology suppliers is suggested. It could be obtained by viewing BAT in connection to TCO. Moreover, the TCO-tool can be used for the argumentation to present to the authority of using one technology instead of the other.

New motivation

The fourth suggestion is to create motivation by offering resources. Technology suppliers produce equipment that they know they can sell. If a buyer is interested in equipment with a better sustainability profile, some suppliers will produce that type of equipment. However, the technology might become more expensive reflected in the purchase price. Henrik Andersen, CEO of Frontmatec, says that they are producing what they can get

money for (Andersen, 2019). Danish Crown is willing to pay more for the equipment, but the TCO price must be lower. This is because Danish Crown is a company where black numbers on the bottom line are important. Niels Juhl, VP for Danish Crown says: *"(...) if the TCO looks sensible within the depreciation period, which is either five or ten years, sometimes a little more, (...), then they can take more for their equipment"* (Juhl, 2019). In this case, money will be a resource that can create a motivation.

Another resource that can create motivation is knowledge. Among other things, BAT has not been discussed by project managers in Danish Crown and their suppliers, because they have not understood it or did not understand its purpose fully. Making a TCO-tool that supports BAT can make it easier to understand BAT. In this way one can get more actors involved.

New resources or power

As of now the BAT implementation and TCO is of a normative nature, it is written in the Project Handbook, it is in the Code of Conduct with Suppliers, there are BAT checklists and a Cleaner Technology Assessment table, but this has not been sufficient. However, putting the suggested TCO-tool in the audit program, could give it a regulatory nature, forcing the project managers to obtain the data before choosing a supplier.

7.3.3 Ensuring TCO and BAT implementation in Danish Crown

This project has been conducted in accordance to an effectual reasoning approach. The effectual reasoning theory identifies the means for *how* an organisation can be successful with its strategies. In this section it is proposed that Danish Crown in the future choose the same approach to implementing strategies. The recommended strategic approaches is based on the five principles of effectual reasoning, described in section 4.2.2.

Based on effectual reasoning, Danish Crown should start with the means they have and from this point they should look at the possible goals. Firstly, in accordance to the Bird in Hand principle, Danish Crown should start with *who they are*, *what they know*, and *who they know*. In this sense, they should educate the procurement on TCO and BAT and establish a communication between procurement and their operations department. This initiative must have a management support, and the project managers must secure knowledge from all relevant actors in the organisation. Juhl (2019) from Danish Crown says that they have been forced to reject investment projects because no alternative offers was included. These are points that they have promised their board of directors that they adhere to when making projects. In this way, the company looses money because they waste time. Juhl (2019) suggest that this can be solved when putting up the right team from the start of the project. This also means that they have to take more time for the projects. According to Møller (2019) project manager from Danish Crown; *"what can kill the process of sustainability it is if the process goes too fast"*.

In addition to strengthening communication within Danish Crown, they must also educate their suppliers in BAT and discuss TCO when purchasing equipment. Danish Crown can start with the suppliers that they buy a lot of equipment from, and large suppliers who have the opportunity to invest in sustainability initiatives. For example, Danish Crown is

one of Frontmatec's five largest customers in the world (Andersen, 2019). According to Andersen (2019), Frontmatec does not have any dominating customers, i.e. customers over 10% of their total turnover, but a large and good customer will receive better treatment than a bad costumer.

Secondly, in accordance to the Affordable Loss principle it is important for Danish Crown to not focus on possible profits, but on the possible losses and how they can minimise these losses. So instead of implementing a very costly leasing system they should discuss the possibilities of such with their suppliers. In the same way they should define different product areas that they want to make TCO calculations on, they should identify the cost drivers for such equipment and assess if they can gather the sufficient data from their suppliers. They can complete case studies with their suppliers. In addition to establishing case studies where they can share knowledge, it is also suggested that Danish Crown create partnerships, and ongoing dialogues with their suppliers. By doing so this will not cost a lot of money, however it will take time, but by doing so they can gain experiences and identify the possibilities before investing in projects, this is also in accordance to the Lemonade principle. Based on the Lemonade principle Danish Crown will look at how to leverage contingencies and surprises are not necessarily seen as something bad, but as opportunities to find new markets.

Through a dialogue with their suppliers, Danish Crown has discovered contingencies that gave new opportunities. Møller (2019) explains how they went to see a washing station, where they, together with the supplier, had an ongoing dialogue, which led to making improvements in the form of recirculating the water. This example occurs when the project manager has the opportunity to share knowledge with the supplier. The washing station project succeeded because it was not time-restricted. This is also an example of, to make knowledge sharing, networking, involvement and synergy. In this way more emphasis can be put on the possible losses and how to minimise those losses. Creating new arenas allow for partnerships where the dialogue can be open and honest, and those involved can identify improvement potentials. Also cooperating with suppliers Danish Crown can trust, can limit the affordable loss by giving pre-commitment, this principle is called the 'Crazy Quilt' principle.

Moreover, Danish Crown has a lot of in-house knowledge to support both BAT and TCO considerations, however they are missing tools to assess these principles in a systematic way when buying equipment. During this project, the project group has developed a TCO-tool that support BAT. BAT is denoted as the environmental impact costs that must be reduced. The project group suggests that there is a need for further dissemination of the TCO tool in Danish Crown and for an evaluation of the tool where experience is collected. In addition, it is necessary to use the tool by preparing cases to evaluate the tool's effect. Due to time constraints the project group did not have the possibility of completing the case study. According to the 'Bird in Hand' principle, suppliers that Danish Crown have a good knowledge about are selected, and according to the 'Crazy Quilt' principle, select suppliers that Danish Crown trusts and have a good relationship with. Finally, the TCO-tool is developed for new product areas where different cost drivers can be identified.

According to the Effectual Reasoning theory there are four basic principles, these principles can be applied so an organisation can become more successful with their strategies. The

fifth principle is the Pilot-in-the-plane and in this stage all the four previous principles are put together. This principle suggest that Danish Crown can not predict the future, however they can control some of the factors which determine the future. When following the four first principles, then Danish Crown will have a good prerequisite for gaining control over the future. In this context, Danish Crown is engaged in the places where they can have influence. For example, it can be the partnership meetings organised by the Danish Environmental Protection Agency and participate in the Seville process, in this way they can make sure that nothing is put into the BREF documents that does not make sense. If Danish Crown enters into partnerships with their suppliers, they also have the opportunity to investigate their intentions or approach, making them more likely to influence the process and controlling the future.

7.3.4 Summary of the strategies to efficient implementation of BAT in Danish Crown

The cleaner technology assessment table is confusing and not used. Total cost of ownership assessment can be used to calculate and weight the environmental impacts. This approach could create a sharper focus on the environmental costs and make them easier to relate to.

A number of strategies are presented for how Danish Crown can change the course of BAT implementation:

Internal organisational changes

- Educate suppliers in BAT.
- Involve technology suppliers in the implementation of BAT.
- Discuss TCO when purchasing equipment.
- Make sure the time-plan for a project includes enough time to go into collaboration with suppliers.
- Implement TCO considerations in the procurement process.
- Educate the procurement team on TCO and BAT.
- Involve environmental department in the BAT assessment.
- Establish communication between procurement and operations department.
- Add the TCO-tool in the audit program to make sure it is used.
- Accept a higher investment cost, if the TCO assessment indicates that it will be the best choice in the lifetime of the equipment.
- Focus on reducing losses instead of possible profits.

Value chain collaboration

- Make a workshop with up- and downstream partners in the value chain.
- Create partnerships with technology suppliers about the development of better equipment.
- Start of by collaborating with suppliers that Danish Crown have a good relationship with and trust.
- Use TCO assessments as a basis for communication with suppliers and authorities.

7.4 Discussion of the applied theories

In the selection of theories a range of different theories were investigated. Early on in the project it was identified that the analysis should be focused on the question of why the actors are not able to implement BAT in a satisfying way. This meant that the focus of the analysis and the theory should be on the actors and their actions.

Contextual interaction theory

In this project Contextual Interaction Theory (CIT) is used to analyse the actors characteristics and how that affect the BAT policy development and implementation process. There were however some difficulties in the application of CIT theory to this case.

The distinction between *cognition* and *motivation* is clear in the theory, but in the reality it can be difficult to analyse whether an actor make his choices because of his cognition or because of his motivation. It could be argued that the motivation to act in particular way also is determined by the actors cognition of a situation. An example of this is Jens Peters argumentation for not working with BAT anymore within the FDM sector, because the sector is heading in the right direction. His motivation for working with this subject is non existing because of his cognition of the situation. In reality it can therefore be difficult to make a clear distinction between what is *cognition* and what is *motivation*.

Some aspects are not covered by the three characteristics used to describe the actors. In the interviews there are questions under the category 'Others' that are used to understand the actors, but which does not fit under any of the other characteristics. These questions are focused on *what* the actors do and *why* they do it without being clearly within motivation or cognition.

Network theory

The network theory is useful in the analysis of the actors relation to each other and to analyse what kind of transaction that is happening between the actors. The theory present some concepts, like interdependence and reciprocity, that can be used to describe the relations. It is however difficult to place all the actors within the model. Some of the actors role and relations change when the circumstances change. An example is Danish Crowns relations with the Danish Society for Nature Conversation, which changes depending on if the relation is described for the situation in the development of BREF documents or in the implementation of BAT.

Theories for further research on the subject

Different theories focus on actors and their actions and could be used in further research within the topic. The use of some other theories would have given the possibility to discuss some aspects further.

Institutional theory focus on the social structures that have a high degree of resilience and the effect those have on how the actors behave. The theory can be used to answer the questions what are the rules and what makes actors behave the way they do? These

questions are relevant for this project, but some relevant aspects, like power, are not answered by these questions.

Multi-level governance could also be relevant to look further into as BREF documents are made in an arena with many different actors, who all try to influence the process. These actors, like the Danish EPA, DN and Danish Crown each hold some competences for policy making, which they use in the negotiations. Multi-level governance theory could give a better knowledge of the policy development process of BREF documents by answering the questions: Who are the actors? How do they interact? and is influence moved from the government?

There is an overlap between the network theory and multi-level governance as both theories tries to answer the questions: Who are the actors and How do they interact? BAT is command-and-control regulation where the public sector translates environmental knowledge into rules, by defining the technological development tracks, while collaborative BAT and TCO suggested in the project is multi-level governance. Hence, multi-level governance could be used to analyse *institutional arrangements for the implementation of structural funds in cohesion policy, uncovering diverging formal and informal rules at national and supranational level to explain multi-level tensions* (Stephenson, 2013).

Discourse theory could be used to answer the questions of; How does the different actors talk about the issues? Does the language and terminology include and exclude certain perspectives? This could be used to investigate if any of the actors try to control the discourse around BAT regulation and which effect that have on how it is perceived by other actors.

7.5 Discussion of the applied methods

The methods used in this project give adequate knowledge for answering the problem statement. There have however been some issues that could affect the conclusions. These will be discussed in this section.

7.5.1 Interviews

When choosing experts for the interviews there were some limitations in who were available for interview. It was especially in the search for suppliers who were willing to participate in an interview there were issues. In the initial contact with possible interviewees all of the people approached refused to participate in an interview, which meant there was a need for a new approach towards the suppliers. Therefore the suppliers were contacted again, but this second time the contact were through Juhl. This affected the suppliers willingness to participate in the interviews, but it could also have affected the suppliers answers to the questions, that they know that Juhl is interested in the results from the interviews and the project. The same conditions are true for the interviewed persons from Danish Crown who know that the project is supported by their bosses. They could therefore express more positive opinions about BAT than they would, if their bosses attitude towards BAT was different.

There is also a risk that the interviewers influence the answers given by the interviewed

person, by only asking follow-up questions or by indicating more positive in another way, when the subject brought up is of interest to the interviewers or when confirming their own opinions.

7.5.2 Workshop

The workshop was time-constrained to last approximately 30 minuets. This is short for a workshop, and it did not allow the facilitators to do much interactive exercises with the participants. Additionally, the room was small and there was no floor space as all of the participants were sitting on a long table in the middle of the room facing the presentation screen. The room and the set-up did not allow for interaction. The room was arranged in such a way that the facilitators' role was to present and talk and the participants' role was to listen.

There was not given any information about the workshop to the participants prior to the workshop, hence they were not prepared. If they were given information prior to the workshop, it could have allowed them to prepare and the facilitators could have got more input and less time could have been spend on the presentation.

7.5.3 Effectual reasoning approach

It was also a challenge to base the method on effectual reasoning as the method was unlike the methods previously used by the researchers. The challenge have been, that there normally is a goal to focus the work and process towards, but in effectual reasoning the focus is on the things already available and what can be done with them. It could also be argued that there in some cases always will be a clear goal from the beginning of a process. In this case a report with a certain content, extent and time frame. Basing the work on effectual reasoning did however open up for new possibilities during the project, e.g. the TCO-tool and the meeting with the chief engineers.

Tool for assessing total cost of ownership

8

In chapter 7 it is suggested that Danish Crown should make an assessment of the Total Cost of Ownership (TCO) for equipment as part of their procurement process. A tool created by the project group for making a TCO assessment and which can be used by Danish Crown in their procurement process, is presented in this chapter.

8.1 Process of developing the Total Cost of Ownership tool

The TCO-tool is developed in a spread sheet in Excel and can be found in appendix A.6.

The first version of the TCO-tool consisted of category expenses based on TCO-tools from the Danish Environmental Agency, found on their website (Miljøstyrelsen, 2019), and on the environmental impact categories from the Best Available Techniques (BAT) documents. After presenting the first version of the tool to the chief engineering meeting in Danish Crown, inputs and feedback lead to a second version of the tool. During the meeting hidden expenses that could have an effect on the total cost of ownership of equipment was discussed. These hidden expenses is product quality, give-away saving, costs in relation to changing supplier, and expected planned stops. These hidden expenses was not included in the first version of the TCO-tool but are included in the final version of the TCO-tool.

8.2 Overall framework of the Total Cost of Ownership tool

The TCO-tool is created as a table which make it possible to compare different alternatives on several factors. These factors are divided into four overall categories; one-time expenses, yearly expenses, expenses related to consumption, and production capacity. For each factor there is a cost related to the equipment. These costs are summarised in the following way, to calculate what the total cost of ownership will be per produced unit for each alternative:

(One-time expenses + total yearly expenses) / Total expected production = Expenses per produced unit

Expenses per produced unit + Expenses related to consumption per unit = Total expenses per produced unit

The calculations are explained in further detail below.

Production capacity

The final result in the TCO-tool is presented in two ways. The first way to present the result is as the costs related to the production of one unit. The other way is to present the results as costs per year of owning the equipment. It is chosen to present the results in two ways, because the tool is designed to be used for different kinds of equipment, where it changes which result will be relevant to use.

The production capacity is calculated by the formula:

*Production capacity at full production time (amount) * expected planned stops (%) * expected breakdowns (%) = Expected production capacity (amount)*

The total expected production is calculated using the following formula:

*Expected production capacity (amount) * Lifespan (years) = Total expected production*

Production capacity at full production time is the amount of products the equipment could produce if it was in operation for a year without any stops. Expected planned stops are the stops that are necessary for maintenance and for changing tools in a production. Expected breakdowns are the production stops which are not planned. These different factors are included as they could have a relatively big impact on the production after installation and is something Danish Crown focus on.

One-time expenses

The costs related to the purchase and installation of the equipment are one-time costs. This category covers the price of the equipment, installation and development costs, administration costs related to the changes made, costs related to change of supplier, costs for supportive infrastructure, costs for upgrades, costs at end of life for the equipment, and work environment. It could be argued that work environment should be in yearly expenses, as a healthy work environment could reduce the yearly costs for personal and possibly also increase the productivity. However, in this tool it is chosen to put work environment, which in the tool only includes the noise from equipment, under one-time expenses because it represent the costs of bringing the noise from the equipment under the 82 dB limit value set by Danish Crown. If the noise from the equipment is below 82 dB the costs will be zero, but if it is above 82 dB then the costs will be, how much extra it will cost to make the necessary precautions to reduce the noise to below 82 dB. Noise is divided into internal and external noise contributions. Internal noise contribution is in the production and can affect employees and the working environment. The external noise contribution is outside the production facility and can negatively affect the wildlife and people in the community. The noise contribution limit for internal noise is 82 dB, and the limit value for external noise contribution depends on the area, if it is residential area, the limit value is lower than industrial area.

Yearly expenses

The running expenses that are independent from how much the equipment is used, are in the category called yearly expenses. The factors in this category are costs for maintenance and repair, insurance, salary for workers, and costs related to the cleaning. It could be argued that costs related to cleaning depends on the use of the equipment as equipment which is used more will become dirtier. However, in the tool it is chosen to put it in the yearly expenses, as it is assumed that the cleaning happens at a certain interval, e.g. once a day. Putting it under expenses related to the use of the equipment would therefore complicate the calculations unnecessarily.

Costs related to cleaning are calculated using the formula:

*(costs for electricity + costs for water + costs for chemicals) * Number of cleanings per year = yearly costs for cleaning*

The total yearly expenses are calculated using the following formula:

*Yearly expenses (DKK) * Lifespan (years) = Total yearly expenses*

Expenses related to the consumption

The expenses that depend on how much the equipment is used is in this category. The factors in this category are operating costs, environmental costs, and materials for production. This category is where the expenses related to BAT is calculated.

The costs are calculated from the resource use per produced unit, e.g. 3 m^3 of water per produced unit and the cost of each resource:

*Resource use per produced unit * Resource cost = Expenses related to consumption per unit*

The consumption factors in this category is based on the environmental impacts from the BAT documents which is energy efficiency, water consumption, gas and fuel consumption, waste water production, and waste production.

8.3 Limitations in the Total Cost of Ownership tool

In using the tool it could become difficult for a project manager to collect all the data necessary to fill out the table. It could therefore be necessary to make assumptions about those factors where no data is available. These assumptions could be based on previous experiences with the supplier or generic data.

When using the tool the product area should be defined and determine associated cost drivers. However, it may be challenging to determine cost drivers before the commissioning of the product.

One aspect which is not included in the TCO-tool is that the costs for maintenance and repair likely will increase over time. In the beginning of the lifetime of the product the expenses could therefore be lower than assessed in the tool and higher ind the end of the products lifetime. This aspect could be included in the tool by making an assumption about how much the costs for maintenance will increase per year. It could thereby be included in the assessment, if the user of this tool finds, that it is an important aspect. However, it is not included in this version of the tool, because it would be based on unqualified assumptions.

Another aspect which is not included in the TCO-tool is that the costs for changing supplier only exists the first time a piece of equipment from one supplier is switched to equipment from another supplier. This aspect could be relevant if there are multiple pieces of the same equipment at a production facility, but only one need to be replaced at the moment when the assessment is made. In a TCO assessment where the costs of changing supplier is included, it could show that it would not be economical feasible to change supplier because the costs of changing supplier will be bigger than the possible savings. But because the cost of changing supplier only will be there the first time, it could be possible that if all the equipment is changed to the new supplier, then it would be feasible. This aspect could be handled by making a TCO assessment for changing all the equipment even though it at the moment of the assessment, only is one piece of equipment need to be changed.

Conclusion 9

Development of BAT conclusions happens in the Sevillia process, where member states, the European Commission, relevant industries and environmental NGO's are gathered in Technical Working Groups to write BAT reference documents. The Sevillia process consist of six steps, where the first is to collect wishes for the future document. The second step is to define the agenda for the revision, the third step is collection of technical and economic data from Member States to ponder the feasibility of techniques and BAT Associated Emission Levels. The last three steps are to formulate a draft, reaching consensus on BAT conclusions and sending the final draft to the members of the Technical Working Group. After the BREF documents have been published, the Member States have four years until the BAT conclusions should be reflected in the environmental approvals given to companies.

The motivations of the actors involved in the development of BAT conclusions pull the process in different directions. Danish Crown is motivated by making conclusions which also will make sense when they are implemented in their production facilities. The technology suppliers are motivated by the chance of getting their technology as a reference in the BREF documents. The Danish EPA and DN are both motivated by reducing environmental impacts, but the EPA is also motivated by giving Danish companies a competitive advantage. The resources of each actor determine how big an influence they could have on the final BAT conclusions. The actors cognition of BAT determines their motivation to participate in the development of BAT conclusions and how many resources they want to use on it. Danish Crowns relations to the other actors are also affecting the policy process.

The different motivations, resource and cognition of the actors in the development of BAT, could explain why aspects of value chain and circular economy are not included. In order for BAT based permit conditions to act as a driver for circular economy and triple bottom-line value creation, six new BAT conclusions are suggested:

1. Higher utilisation of produced products to limit waste generation and down-grading of valuable resources.
2. Share information in the value chain to optimise resource use.
3. Altering packaging material to ensure recycle-ability at the end-user.
4. Include more of slowing down resource flows e.g. designing equipment for durability and easy-maintenance and repair.
5. Include more principles from closing resource loops e.g. take-back systems, increase reuse and recycling.
6. Collaboration with upstream and downstream partners in the value chain.

At the moment it is difficult to assess whether the suggested BAT conclusions could lead to lower resource use and production costs for Danish Crown. However, it is assumed that BAT conclusions 2, 4, 5 and 6 could lead to lower costs for Danish Crown as they would be able to reduce their costs for waste and maintenance and lower their investment costs. Danish Crown could therefore be motivated to include these suggestions in the development of BAT conclusions. The Danish EPA and DN could also be motivated to include these conclusions in the development of BAT as they could lead to reduced environmental impacts.

In the implementation of BAT the motivation affect how willing the actors are to work with BAT. The Danish EPA are motivated by the law stating that the environmental approvals must be based on BAT. Danish Crown want to work with BAT because it represent a possibility to decrease their operational costs and decrease their environmental impacts, but at the same time they are more motivated by staying within an investment budget and reaching timelines. The main focus in a procurement process is therefore not on BAT. However, not including total cost of ownership of equipment could lead to increased operational costs. The implementation procedure in Danish Crown is not sufficient, as the current tables and checklist to assess cleaner technology and BAT is not used actively by project managers. At the same time the project leaders do not talk about BAT with their suppliers and thereby not motivating them to work with BAT. Additionally, when purchasing equipment they do not calculate for the Total Cost of Ownership (TCO) of the equipment, because the project managers and procurement are subject to a budget and are limited by a purchasing price and time-schedule. Moreover, there is a communication barrier between the procurement department in Danish Crown and the operations department hindering the use of TCO.

Danish Crown has to educate their suppliers on BAT to ensure implementation, because they rely on their suppliers to comply with BAT and document the use of BAT. Danish Crown also need to involve technology suppliers in the implementation of BAT through collaborations, and make sure the time-plan for a project includes enough time to go into collaboration with suppliers. TCO considerations should be implemented in the procurement process and educate the procurement team on TCO and BAT, as well as educating the project managers and operations department. A communication between procurement and operation should be established.

In order to strengthen the communication and implementation of BAT, we have developed a TCO-tool which supports BAT is developed. BAT in the TCO-tool is measured as environmental costs, focusing on reducing losses instead of possible profits. This tool can be used to compare different equipment to ensure suppliers are presenting Danish Crown to the best environmentally available technologies. It is suggested that Danish Crown 1) use the tool in the initial analysis in the project period, 2) demand TCO-information in the tender documents and 3) evaluate offers based on the lowest TCO-price. The TCO-tool could be added to the audit program to make sure it is used and all data is collected in order to assess alternative equipment before purchase. The developed TCO-tool is not product specific but general. When using the tool, the product area must be defined and associated cost drivers. During time-restraints no case study has been made in which the tool is used, therefore the tool's effect cannot be validated.

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Appendix A

The appendix to this report is located in a Google Drive folder. To see the complete appendix click here.

It is also possible to go to each individual appendix by using the links in the following sections.

NB All appendix is in Danish.

A.1 Interview transcripts and audio files

During the project period 10 interview are conducted. Only one interview was not recorded. The interview was with Multivac in this case there is a summary of the interview.

To see the transcripts click here.

To listen to the audio files click here.

A.2 Interview guides

An interview guide is prepared to every single interview. Questions in the interview guide is changed in every single interview to target the specific interviewees' knowledge-field. Moreover, questions is changed as more knowledge was obtained by the project group. All of the interview guides are collected in one document.

To see the interview guides click here.

A.3 Cleaner Technology Assessment table

This tool should be used by project managers in Danish Crown to assess cleaner technology in projects.

To see the Cleaner Technology Assessment table click here.

A.4 Best Available Techniques Checklist

Example of a checklist used by Danish Crown when assessing BAT implementation. Danish Crown attaches completed checklist in the environmental approval for the Danish EPA.

To see the BAT checklist click here.

A.5 Slide show on BAT and TCO

The slide show is used to present BAT and TCO on the chief engineering meeting on the 24th of March in Danish Crown, Randers.

To see the slide show presentation click here.

A.6 Total Cost of Ownership tool

A tool created for Danish Crown to calculate the Total Cost of Ownership when purchasing equipment. The tool is made in a spreadsheet in Excel.

To see the TCO-tool click here.