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Middle-out approach to planning of Eco-industrial park

Case of GreenLab Skive

Master thesis

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    - Michael Rønning Dalby, a business manager and a head of E.ON biogas activities

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1 Introduction

1.1 Industrial Symbiosis and its planning

Within the rapid economic and population growth globally, the demand for resources and utilities consumption has been growing constantly. The rising production operations and consumption level burden the nature capacity for resources provision and regeneration. The increasing number of industries have a huge impact on the environment starting from the resources extraction, transportation till the end of production and transportation of end materials and products. For example, increased number of emissions to air, depletion of natural resources, increased use of water sources and their pollution, extreme use of electricity and heat, generation of ample industrial waste in the end. These issues have been addressed in Kyoto Protocol and in other subsequent meetings and commission reports on sustainable development with the goal to develop sustainable solutions in industrial sector (UN, 2011).

Symbiosis of industrial, business operations has been argued to be one of the solutions for sustainable production and consumption (Lehtoranta et al.,2011). Industrial symbiosis has been described by Chertow (2004) as a system that engages businesses to competitive benefit involving physical exchange of materials, water, energy and by-products. The key for Industrial Symbiosis is collaboration on exchanges and synergy provided due to geographic proximity. It integrates natural ecosystem traits into its practice through the by-products, water and energy exchanges among the companies and attempts to develop closed loop of resource exchange (Lowe, 2001; Chertow, 2004). Aside the environmental benefits, it attempts to provide social and economic benefits to the community and businesses (van Berkel, 2006). Industrial symbiosis can be developed among two companies (bilateral by-products exchange), or one company can be the only provider of by-products and services to others (service exchange), or it can be a network with multiple exchanges (network exchange) (Sterr & Ott, 2004). Industrial symbiosis[1] can also be developed in a smaller scale, e.g. within the borders of industrial park, which is then called eco-industrial park (EIP) or in a broader scale, e.g. within the borders of the city, municipality, region and country (Chertow, 2004) (see Annex 1).

Indeed, industrial symbiosis does not appear fast, it requires concrete actions towards its realization. It requires consideration of all related aspects, e.g. its integration with the urban development, with its economy, with national development policies and with social and company needs. Especially in a specified area or in EIP, it requires proper *land use planning* to assess the potentials of the area according to the mentioned aspects and form the basis for the physical plan of the area. It is one of the primary steps in the realization of industrial symbiosis. Land use planning of industrial symbiosis possesses a comprehensive nature, thus, the planning[2] has to consider multiple sectors, e.g. land use, transportation, facilities, environment, infrastructure of the area, housing, community (Conticelli & Tondelli, 2014). Planners of industrial symbiosis have a task to account for

[1] There are many other terms of Industrial Symbiosis that are used equivalently to the main term “industrial symbiosis” (see Annex 1). However, this thesis focuses on the symbiosis in a certain park, thus, the term “eco-industrial park” the best describes the industrial symbiosis here. It will be used along with “industrial symbiosis”.

[2] The word “planning” here equals to the “land use planning”.

multiple attributes and to generate sustainable solutions for the area and to make the symbiosis work for sustainable development (Lowe, et al., 1996). Nevertheless, the planning of industrial symbiosis is not only managed by planners, but also dependent upon the inclusion of other related stakeholders due to its comprehensive nature (Côte & Cohen-Rosenthal, 1998). This thesis concerns the way the planning is approached by stakeholders, and the features of the approach taken for planning.

1.2 Planning approaches of Eco-industrial Parks

Land use planning of industrial symbiosis has been mainly studied from the perspective of land use planning and design strategies and elements, sustainable use of the area in EIP (Lowe et al.,1996; Lowe, 2001; Verguts et al.,2010; Conticelli & Tondelli, 2014; Roberts, 2004; Oh et al.,2005). Despite the multiple recommendations on land use planning of EIPs, *the way it has been taken to approach these planning strategies in relation to the stakeholders varies from one case to another*. Early studies on planning approaches indicate two approaches: top-down and bottom-up approaches to planning (Côte & Cohen-Rosenthal, 1998; Chertow, 2007; Desrochers, 2001; Leo, 2011; Chertow & Ehrenfeld, 2012). Costa & Ferrão (2010) made a comprehensive summary of these two approaches and stated that top-down approach to planning was characterized by governmental initiative to form industrial symbiosis; governmentally centralized decision-making; some level of exclusion of interests of stakeholders having less legitimacy. On the other hand, bottom-up approach was characterized by bottom-led initiative to industrial symbiosis, decentralization of decisions and actions.

These studies on planning approaches cover the land use planning interlinked with the actions taken before the land use planning to give the comprehensive view of how the planning can be approached by stakeholders; how these two approaches influence the implementation of industrial symbiosis; how the planning depends on the context factors, e.g. political, national, social context of the area. However, pre-reviewed literature has not revealed the deep analysis of the system of land-use planning of EIP, in which land use regulations, subsequent plans for EIP and how these procedures were approached were given. Mainly, the studies are given as a general overview of planning procedures without the detailed exploration of land use regulations, land use plans and connecting the actions, stakeholder interaction to them.

Nevertheless, the studies revealed that the top-down approach to the planning of EIP has often led to the failure, while bottom-up planning resulted in longer performances of EIP (Mirata, 2004; Gibbs & Deutz, 2005; Chertow, 2007). These studies generated the new concept that middle-out approach to the planning of EIP can be a prominent approach for successful planning of the industrial symbiosis (Costa & Ferrão, 2010). On the other words, middle-out approach to planning was studied as collaborative systematic planning of EIP, which possesses the same meaning. However, the term “middle-out” was also used to describe not only the planning but also further collaborative development phases of EIP, thus, linking the collaborative planning with further actions Costa & Ferrão, 2010). This thesis uses the term “middle-out” to emphasize that the collaborative planning is embedded and influences the following development phases of EIP. However, the studies on middle-out or collaborative planning are not in abundance as for the top-down and bottom-up approaches and are mostly argued in scientific or theoretical basis. This is mainly due to its recent appearance in the knowledge about the planning approaches of industrial symbiosis (Terway, 2007; Costa & Ferrão, 2010; Massard, 2012). Therefore, the middle-out approach needs to be investigated

more in its practical implementation to better understand its characteristics and actual performance in the field. Moreover, the role of middle-out planning for stakeholders, i.e. its influence on the stakeholder actions and their perception on middle-out planning is crucial to investigate to develop the knowledge about the middle-out approach, so that it can stand along with the knowledge existing for top-down, bottom-up approaches and contribute to the knowledge given for planners on how EIP can be approached.

1.3 Middle-out approach to planning of Eco-industrial park through the case study

To contribute to the mentioned knowledge gap on land use planning of EIP and middle-out approach to planning, this thesis aims to study one practice of middle-out planning of EIP, its planning system, i.e. land use regulations, plans, stakeholder interaction within the planning procedures, so that the information about the planning is covered utmost. It aims to contribute to the knowledge about the middle-out planning of EIP and to socialize aspiring planners into a professional community through understanding the planning issues, grasping the context in which it appears, and understanding the inner dynamics of institutions and interconnections. The study of planning practices will give the insight into what to change, improve and what the best to take from planning knowledge (Friedmann, 2008).

Moreover, not planning *of* EIP, which implies considering the synergies as a network to achieve the organizational aims, is considered here, the main focus is planning *for* industrial symbiosis, in which the study of the role of middle-out planning in EIP is considered. Disclosing the role of planning in industrial symbiosis would show how the middle-out planning approach influence the stakeholders engaged in planning.

This thesis aims to:

1. explore one practice of planning of EIP from the perspective of characteristics of middle-out approach to planning.
2. to understand the role of middle-out approach in planning of EIP.
3. to understand its influence on the engaged stakeholders.

The research is grounded in Skive Municipality, Denmark. Denmark planning system is unique with its traits of the middle-out planning. From multiple sources, it was argued that the planning system in Denmark can be characterized by decentralization of the planning, framework control and public participation, corporate approaches to plan-making, use of plans as legally binding controls on future environmental change (Edwards, 1988; Interreg III, 2012; Enemark, 2016). It considers both the needs and interests of society with respect to the environment (Enemark, 2016). It incorporates comprehensive planning at national, regional and municipal levels, thus, allowing interdisciplinary collaboration and structured management of planning (Galland & Enemark, 2012).

The industrial symbiosis is not a novelty in Denmark planning practices. Industrial Symbiosis in Kalundborg municipality has evolved through the business initiatives, and consequently, has led to the dynamic process of government and industries interventions (Chertow, 2007). There are multiple factors that have positively influenced and generated the flexibility in planning of eco-

industrial network in Kalundborg[3] (Chertow & Ehrenfeld, 2012). Nowadays, another planning of industrial symbiosis is in progress in Skive Municipality. In a recent decade, the municipality and businesses and other actors have been planning the industrial symbiosis in a business park named GreenLab Skive with a goal to develop energy exchanges. The vision is to develop sustainable city Skive with the first energy bank in Europe, which is going to be totally carbon neutral by 2029. Moreover, the park is aimed to become innovation and research hub for professionals and researchers, and to encompass the recreational features into its landscape. Less than a year ago the park has opened its doors to start the construction of energy sources for exchanges (Energifonden, 2017).

The difference between Kalundborg IS and the aiming industrial symbiosis in Skive is that Kalundborg IS has evolved spontaneously, while Skive has been planned collaboratively through the constant interaction among engaged stakeholders. The planning of GreenLab Skive follows the regulations of Planning Act of Denmark: national, municipal and local planning. Indeed, it differs with the development of Framework Local Plan before the local planning by companies that was dedicated to allocate all companies in a designated business park (Enemark, 2016). This approach required the engagement of multiple stakeholders in planning to find better solutions for planning. Moreover, it involved citizens into each planning procedures of the area (Municipality, 2016). Now the turn is on local business planning. The planning of GreenLab Skive entails the characteristics of middle-out approach wherein multiple actors are interactively engaged to make better decisions for planning (Municipality, 2016).

The study of planning practice of GreenLab Skive connects it with the theories in middle-out planning and it will contribute to the theories of middle-out planning. The study unleashes the characteristics of middle-out planning and attempts to understand the role of middle-out planning for actors and its effect on actors in a case of GreenLab Skive.

1.4 Research question

Finalizing the above information, there emerge two research questions:

1. What characterizes planning of GreenLab Skive as middle-out approach?
2. What role does the middle-out approach to planning of GreenLab Skive play for the actors involved in planning?
3. How did the middle-out approach to planning influence engaged stakeholders of GreenLab Skive?

By these questions, the planning of GreenLab Skive will be documented. The first question explores the case with the focus on the characteristics of middle-out approach described in multiple researches and its reflection in the case study GreenLab Skive. It aims to contribute to the first research objective. The second question attempts to examine the role of middle-out approach to planning of industrial symbiosis, and thus, to contribute to the second research objective. The third research question explores the effect of middle-out planning on the stakeholders engaged in planning of GreenLab Skive to contribute to the third research objectives.

[3] In Kalundborg, the initiated industrial symbiosis has been expanded into eco-industrial network, which performs in a regional scale (Gibbs & Deutz, 2007).

To answer the research questions and reach the objectives, the thesis first starts with describing the methodology used to answer the research questions in section 2. Methodology sheds the light into research method, design and gives the information about how the data was collected to further analyse the case study according to the theories. After, the theoretical framework is described in section 3. The related theories as planning approaches of EIP, stakeholder engagement theory and stakeholders in planning of EIP are explored. Section 4 explains the context of the case study by looking into the Danish planning system that influences the approach that can be taken to planning of EIP, and also by describing the planning procedures of GreenLab Skive. Section 5 is Analytical framework, in which the analysis of the gathered data is provided. Section 6 is Results and Discussion that connects the analysis of the data with explored theories and forms the results of the research. The final section 7 is Conclusion that summarizes the research and gives suggestions for future research areas. The thesis ends with providing the Annexes that are complementary information for the research and with References to show the list of used literature.

2 Methodology

This section describes the methods that were used to answer the research questions. It consists of research method that explains the general research approach and of research design that structurizes research elements and discloses the way how the research questions will be answered.

2.1 Research method

The research on characteristics of the middle-out approach in the park planning and its role and influence on stakeholders is exploratory. Since the case is new in a research area, the thesis aims to explore the case with an intention to disclose the research questions, but full answers cannot be provided due to the lack of academic knowledge about the role of middle-out approach in planning. Indeed, the exploratory research aims to form the basis for future potential research design and methodology to investigate the research questions and the case.

On the other side, the grounded theory is used as an inductive qualitative method to explore the case and to generate the new area of studies on middle-out planning. The reason to use a grounded theory in this research is based on the issue that the pre-reviewed articles has not revealed the studies about the role of middle-out approach for and its influence on the stakeholders. Therefore, there is no grounded knowledge about this. These could be disclosed through the viewpoint of engaged stakeholders, e.g. through the interviews. In grounded theory, the data collected is reviewed and coded into concepts and categories, which then form a basis for a new knowledge (reference).

In this research, the data on GreenLab Skive was collected using qualitative research tool, i.e. the interviews with engaged stakeholders, and then coded and analysed with the aim to:

- explore the characteristics of middle-out planning
- explore the role of middle-out planning for stakeholders
- explore its influence on stakeholders

2.2 Research design

Figure 1 Research design

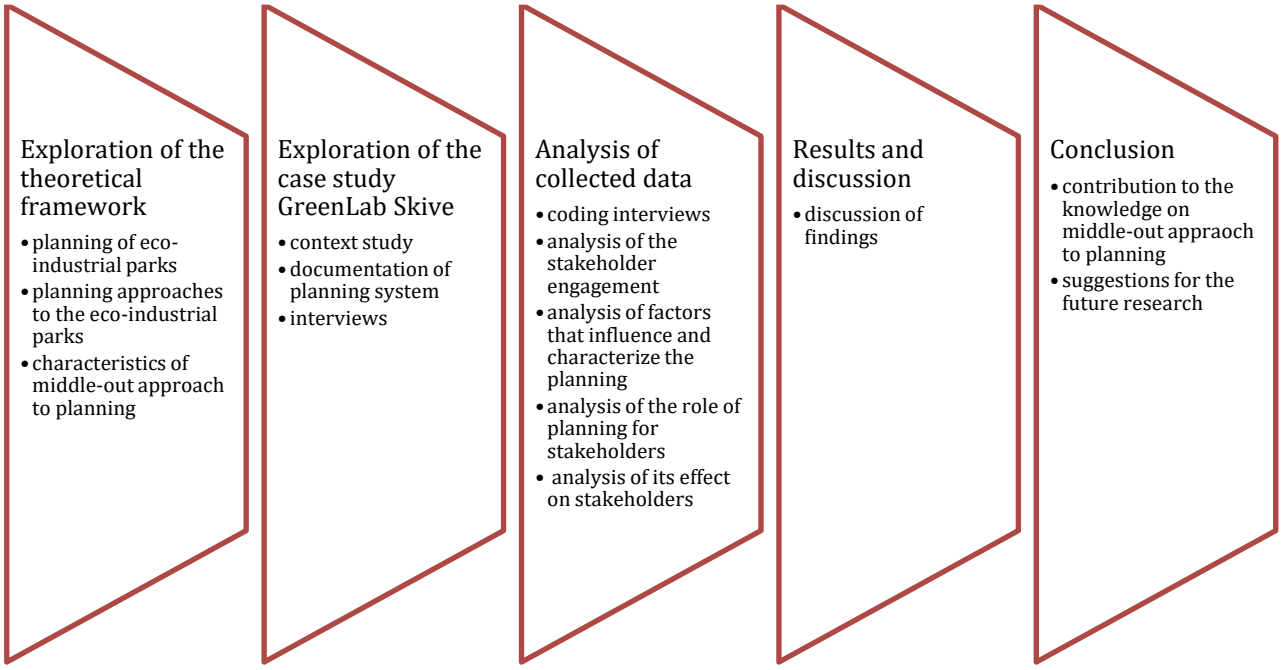


Figure 1 shows the research design, which attempts to answer the research questions. First, the exploration of the theoretical framework was necessary to give the insight into the planning of EIP, planning approaches and what characterizes the middle-out approach to planning. These were necessary to form the foundation for the exploration of the planning of GreenLab Skive from the perspective of middle-out approach.

Next, the case study GreenLab Skive was explored through the context study, in which the information about the planning the planning of GreenLab Skive was gathered, then it was documented in a chronological way. Moreover, the interviews with engaged stakeholders were carried on to disclose the characteristics of middle-out approach and its role for stakeholders from the primary data.

After, the collected data in interviews was coded in relation to the theories and analysed from the perspective of stakeholder engagement in planning to understand their role and interaction with each other. Additionally, the factors that influence the planning and disclose the approach to planning, the role of planning and its effect on stakeholders were analysed to impend to the research questions.

The results of the analysed data were then discussed in relation to the theories, and the research was concluded including the suggestions for the future research.

2.3 Data collection

2.3.1 Literature review

The research starts with the extensive search of academic literature in *AAU online library,* which discloses multiple access to the online platforms like *Science Direct, Research Gate, Sage Journals, Taylor & Francis*, *ProQuest Dissertations and Theses.*

The used key words were “planning of industrial symbiosis”, “planning of eco-industrial parks”, “stakeholder engagement in industrial symbiosis”, “stakeholder engagement in planning of eco-industrial parks”, “planning approaches of eco-industrial parks”, “top-down planning of eco-industrial parks”, “bottom-up planning of eco-industrial parks”, “top-down, bottom-up industrial symbiosis”, “middle-out approach to planning of eco-industrial parks”, “collaborative planning of industrial symbiosis”, “eco-industrial parks and collaborative planning”.

The criteria for selection of papers were: filtering by key words, looking to the papers that use stakeholder theory, organisational development theory, governance theory, social networking theory, communicative planning theory in their research.

The academic papers were from the Journals such Journal of Industrial Ecology, GeoForum, Habitat International, Journal of Cleaner Production, Journal of Environmental Management, The Town Planning Review.

The approach to the literature review started with the planning of EIPs to generally understand what the planning stands for, and then was continued by planning approaches to EIP to explore how the planning was approached by stakeholders. Different approaches to planning of EIP, i.e. top-down, bottom-up, middle-out approaches could be compared, and their characteristics explored. This was done to better understand the difference of middle-out approach to planning from top-down and bottom-up approaches in its general concept and characteristics.

The literature review contributed towards generating the theoretical knowledge to answer the first question and to form the basis to explain the planning in the case study GreenLab Skive from the middle-out perspective. Through the careful analysis of the academic literature, the second question about the role and effect of middle-out planning on stakeholders emerged.

2.3.2 Context Study

Context study is a study of the documents, papers by summarizing these papers to generate the state-of-the-art for the case study (Jørgensen, 2011). Since the case study GreenLab Skive and its planning approach has not been investigated yet, the literature was gathered in a form of official documents from associated entities engaged in the planning of the business park. The list of documents is provided in the Annex 2.

These documents were collected because they were direct sources of planning of GreenLab Skive, and together they give the comprehensive view on the planning system of GreenLab Skive, its relation with environment, municipality, businesses and community. The data from these documents were synthesized and used in a section of case description as for the chronological description of planning procedure and for the general explanation of the case, and they formed the basis for interview questions.

2.3.3 Documentation of the planning system of GreenLab Skive

After gathering the information from different entities associated with planning of GreenLab Skive, the data was synthesized to constructively document the planning system[4] of GreenLab Skive. The planning system of GreenLab Skive was documented in a such way to facilitate the analysis of middle-out planning approach. The documentation was also important for further researches on GreenLab Skive to have a systematic overview of planning procedures at different levels. Thus, it was done in a chronological way with inclusion of planning procedures, stakeholders engaged in each planning procedure, outcome of planning and executed land-use plans. The validity of the chronological scheme was also checked by the interviewed planners, as well as new data was added by planners.

2.3.4 Interviews

After documentation, the case study was fulfilled through the interviews with associated stakeholders. Since the case is new and planning is still in progress, there was a possibility to carry on the interviews with associated stakeholders. Purpose of the interview was:

- to disclose the middle-out approach to planning through the viewpoint of stakeholders
- to explore the role of middle-out planning for and its effects on engaged stakeholders.

Moreover, interviews could complement the history of planning of GreenLab Skive, since the questions were also related to the different actions related to planning. It emphasized on the role of stakeholders in different planning procedures and actions; the networking in planning; advantages and barriers of planning; the influence of middle-out planning on stakeholders.

The relevant actors for the interview were identified with the aid of literature study and its documentation. The interview was semi-structured and held in a form of face-to-face conversation and phone conversation. The interviews were recorded using the portable recorder and transcribed in NVivo software.

The performed interviewees were:

- Steen Harding Hintze, CEO of GreenLab Skive under EnergiFonden Skive, which is a business fund aiming to boost green business development
- Vivi Mathilde Hjortsø, coordinator of the planning of GreenLab Skive
- Merete Møller, planner of GreenLab Skive
- Michael Rønning Dalby, a business manager and a head of E.ON biogas activities

The first interview was carried out with Vivi Mathilde Hjortsø and Merete Møller in the planning department of Skive municipality. It was facilitated by Lone Kørnøv, head of the Danish Centre for Environmental assessment. The second interview was with Steen Harding Hintze in the office of GreenLab Skive in Skive municipality. These interviews were carried out on the 8 May, 2018. The third interview was with Michael Rønning Dalby, a business manager and a head of biogas activities in E.ON, on 23 May, 2018.

[4] According to Oxford Dictionary a system is 1) a set of things working together as parts of a mechanism or interconnecting network; 2) a set of principles or procedures according to which something is done (University, 2010). Additionally, a procedure is defined as a series of actions conducted in a certain order or manner (University, 2010). Thus, the planning system can be a set of planning procedures working interconnectedly and in an organized way to achieve a desired result.

The rationale for interviewing these stakeholders:

- the CEO of GreenLab Skive:

The CEO was the one of the main actors managing the realization of GreenLab Skive and eventually engaged in planning of the business park. The interview could provide with the data related to the pre-land use planning, explain the planning from the viewpoint of primary stakeholder engaged in planning, without the responsibility to generate the plan but who could shape the planning.

- Coordinator of planning and associate planner:

They were one of the essential stakeholders directly engaged in planning: gathering the information for comprehensive understanding, evaluating the area and generating the land use plans. Interviewing them was crucial because they could provide with more and detailed information on planning, explain the internal dynamics in planning from the viewpoint of primary stakeholders.

- Company representative, E.ON providing with biogas plant and operation.

Company representative was essential to interview to understand the planning from the perspective of stakeholder whose facility implementation depends on the land use planning. The E.ON. could provide with the data related to the pre-land use planning.

The questions were prepared for each stakeholder in a line with his/her field of responsibility. The interview questions were focused on:

- the role and actions of engaged interviewees in planning procedures
- stakeholder interaction in planning
- their perception about the role of planning for GreenLab Skive
- the lessons learnt from the planning

The result of these interviews was then coded, synthesized and analysed to disclose the research questions.

3 Theoretical framework

This section explores theoretical knowledge used for this research. It first explores an industrial symbiosis in a form of EIP as an object disclosed from various characteristics of land use strategies to better understand what the planning aims for. Then it studies stakeholder engagement in planning to reveal how stakeholders can be influenced from one to another, then it studies top-down and bottom-up approaches to the planning of EIP based on the way stakeholders are engaged in the process. At the end, it sheds the light into the success factors for the planning of EIP and explores the novel approach to planning, which is middle-out approach.

3.1 Planning of Eco-industrial Parks

Eco-industrial park is an industrial park, where the waste products and materials as well as excess energy and wastewater of one company serve as an input for another company, and the mutual exchange of these products is provided (Lowe, et al., 1996). The EIP does not necessarily aim to cover all possible exchange products, the exchange can be oriented towards single resource, or multiple one; solid by-products or energy, wastewater exchanges. EIPs can be generated in a greenfield, in untouched area for future businesses, or in a brownfield by restructuring the existing industrial park (Sterr & Ott, 2004). Regardless the type of EIP, it requires the land use planning to

enable the industrial symbiosis, so that the natural environment is not jeopardized by company activities, companies and local community benefit from generated exchanges, and the industrial site is a model of sustainable industrial ecosystem. According to Conticelli & Tondelli, 2014, the main attributes, which differentiate these parks from conventional business or industrial parks are a greater environmental quality of the layout management, specified facilities for companies and human resources, complementary environmental and technological infrastructures and integrated management of the industrial park.

Creating an industrial park as a symbiotic ecosystem and increasing its self-sufficiency means altering linear model of material flows into self-contained systems. It means creating an effective symbiotic network among companies, e.g. creating mutual production, distribution, pollution treatment network (Ohet al.,2005). Planning of the industrial park for these activities is a primary step to physically determine the suitable allocation of companies, landscape layout, type of buildings, networking potentials, transport facilities for more sustainable operations and sustainable impacts. Planning of EIP is therefore comprehensive so that it involves the planning of multiple sectors (Roberts, 2004).

According to Grant (2000), planning of EIP shall aim for sustainable planning and represent, the utmost of urban and environmental design; pedestrian-friendly compact places, comprehensive open-space systems, high amenity values, energy-efficient buildings and layouts. Conticelli & Tondelli (2014) explore the need to improve site accessibility and reduce traffic congestion. They also agree on considering 1) integration of the park with natural ecosystem, e.g. identifying the capacity of the area according to the defined limits; preserving indigenous vegetation; maintaining natural storm water drainage; reducing air pollution; 2) green design for better environmental performance, e.g. design of energy-efficient sites and buildings; storing and exploiting excess heat; recycled use of wastewater; design of multi-functional buildings. They argue on the importance of applying European Strategic Environmental Assessment (SEA) as a tool for the assessment of the most suitable conditions for better environmental performance. Strategic environmental assessment means an assessment of environmental, social implications of development policies, plans and programmes to generate more sustainable solutions. It aims to affect decision-making, improve the governance and foster the institutional reform.

The studies on planning strategies are vast in number. However, implementation of all these strategies to planning vary according to the context they emerge and the strategies that were developed in one are sometimes not applicable to another, but the industrial symbiosis could still emerge. Indeed, these strategies show the best potentials of EIP planning. Consideration of these strategies can foster the planning towards sustainable planning, but it does not necessarily limit the implementation of industrial symbiosis.

However, the fact is that planning requires complex tasks to be accomplished due to its comprehensive nature. Therefore, the planning of IS does not position only planners into this responsibility but requires the involvement of multiple stakeholders to facilitate and enhance the planning.

3.2 Stakeholder theory

First, it is relevant to study stakeholder theory to reveal the role of stakeholders in shaping the planning of EIP in relation to their legitimacy. The most commonly known definition of stakeholders is created by Freeman (1984):

"Stakeholders are … any group or individual who can affect or is affected by the achievement of the organization's objectives…".

However, there were still discourses on who to claim as a stakeholder, since this could include living and non-living entities, e.g. natural environment, mental constructs such as respect for past or future generations (Starik, 1995), (Hubacek & Mauerhofer, 2008). The debate led to the question defining what a legitimate stake is. Legitimacy and stakeholder interests have defined stakeholders as "persons or groups with legitimate interests in procedural and/or substantive aspects of corporate activity" (Donaldson & Preston, 1995), and "persons or groups possessing one or more of three relationship attributes: power, legitimacy, and urgency" (Mitchellet al.,1997).

Besides these, stakeholders are also defined by their degree of dependence, loyalty, fairness and reciprocity (Fassin, 2012). There are stakeholders with higher or less influence in decision-making and actions, and stakeholders with higher or less importance in their demands and interests. (Grimble & Wellard, 1997). Some stakeholders can have more normative legitimacy, some can have self-proclaimed legitimacy; some can be more dependent from others and their decisions, some can be independent; some can have mutual influence; some can have one-directed influence (Fassin, 2012). This is how the interests and needs of stakeholders can be affected, and in the case of less influence and power, one stakeholder can be suppressed, the interests can be neglected.

Therefore, when stating the planning strategies that were mentioned for industrial symbiosis, the stakeholder engagement in planning can vary by its attributes. Some stakeholders can be passively engaged, some more active and with more power and influence. Even though, the engagement means enhancing a stake of stakeholders and ensuring participation and consideration of interests in decision-making, the stakeholder engagement can be speculated in planning for sustainable development.

3.3 Planning approaches of Eco-industrial Parks

3.3.1 Characteristics of top-down approach

Despite the careful studies on what is needed to plan in the EIP for its sustainable performance, the approach taken to land use planning of EIP varies by the way the planning of industrial symbiosis is taken by stakeholders (Chertow, 2007). Study of approaches to plan the EIP are vast in number (Baas & Boons, 2004; Heeres et al.,2004; Gibbs & Deutz, 2005; Costa & Ferrão, 2010; Zhang et al.,2010; Chertow, 2007; Chertow & Ehrenfeld, 2012). The main division occur between top-down and bottom-up approaches to planning of EIP (Chertow, 2007). Planning of EIP mainly covers the phase before the land use planning, which is about the idea generation, visioning, recruitment, and land-use planning itself.

Top-down approach can be also named planned EIP was characterized by Chertow (2007) as a conscious effort of governmental institutions to determine the industries, to plan and allocate them in the EIP. The main feature of top-down approach is that the government is the main stakeholder having a power, importance and influence on decisions regarding the planning. Other stakeholders mostly have less influence on decision-making, even if they possess some legitimate stake to planning and establishment of industrial symbiosis. Indeed, the government is willing to plan the EIP because of the potential benefits that it can generate to the national economy and to the economy of the area, as well as it can reduce the environmental impact and improve the social

conditions of the area (Gibbs & Deutz, 2005). Thus, sustainability with economic interest combined with environmental and social benefits is one of the core drivers for government to start planning the symbiosis. However, study of some practices showed that the environmental benefits that could be derived from the by-product exchange sometimes triggered the government to force the businesses to generate the exchanges that were not economically beneficial for companies. Such actions resulted in a soon termination of the exchanges due to the negative revenue (van Berkel, 2006). Gibbs et al. (2005) have investigated 63 governmentally initiated EIPs in US and Europe and has concluded that 19 of them failed due to the lack of trust and consensus within the firm interactions; lack of close relationship among stakeholders; lack of communication. Chertow (2007) added that the lack of proper managerial knowledge; only dependence on public funding led to the termination of top-down models of EIP. Heeres et al. (2004) argued that the endeavour to plan EIPs by the government of US was cancelled due to change in political party that de-priortized the industrial sustainability plan of the previous party.

Despite the failures mainly observed in planned EIPs, this approach was argued to possess some advantages that are also crucial for the planning of EIP. These advantages are part of factors[5] that can lead to the successful planning of EIP:

- political support of the vision that can lead to the necessary financial support and can shape environmental regulations for the benefit of establishing the industrial symbiosis (Albino, et al., 2015).
- established management entity recruits the industrial symbiosis, facilitates and communicates with stakeholders that can assist in planning (Doménech & Davies, 2011).
- established anchor tenants or symbiosis champion, a major company providing multiple exchanges can be part of a management body that facilitates the issues in supply chain and assists in communicating with businesses (van Berkel, 2006).

Moreover, it was also argued that the reasons for failures were not always true for each case, and the top-down planning of EIP varies from one country to another (Gibbs & Deutz, 2005). For example, in a case of UK, National Industrial Symbiosis Programme succeeded due to strategic management, generated trust, good communication with businesses and diverse networking at national scale (Gibbs, 2009). There are many other practices of EIP that were planned in top-down approach and have been currently operating successfully (Mirata, 2004; Gibbs et al., 2005; Zhang et al., 2010; Yu et al., 2014).

3.3.2 Characteristics of bottom-up approach

Apart from top-down there is another approach, which is opposite for the governmental approach - bottom-up approach to the planning of industrial symbiosis, which is also named unplanned or self-organized EIP. It implies the emergence of by-product, services exchanges because of the initiative of private actors to generate economic benefit from such exchanges (Chertow, 2007). Desrochers (2001) stated that the businesses play a major role in decision-making towards the planning of industrial symbiosis also because in the beginning the governmental intervention is not considered. Chertow & Ehrenfeld (2012) explored the reasons for emergence of bottom-up approach and concluded that it was triggered due to growing costs of the waste disposal, resource security and scarcity, regulatory pressure. They also described the evolution of unplanned EIP that

[5] According to the Oxford Dictionary, “factor” is a circumstance, fact, or influence that contributes to the result

was developed from the bottom-led initiatives. They discovered that the sustainable performance of by-product exchanges was not considered in the beginning, but it could get unfolded within the operational time of exchanges. When sustainable impacts were unfolded, the symbiosis was known to other entities and reached the attention of public institutions and researchers. In the case of bottom-up approach to planning, there was no area boundaries for the planning of by-product exchanges in the beginning, therefore, the symbiosis could be developed within the boundaries of the industrial park or in a broader "virtual" (regional) scale.

This approach to the planning of EIP has been concluded to be more successful since most of self-organized industrial symbiosis has passed the market test within a time and in most of them, there is a clear trust among companies, and a support from public institutions emerged within a time (Chertow & Ehrenfeld, 2012). Moreover, Chertow (2007) argued that the businesses saw more opportunities for by-product exchanges than the state institutions could, and planning, therefore, could be more feasible. This was because the private managers coordinating the symbiotic relations were familiar with internal management and technical specifics of the company and could trustfully coordinate the business interactions. Moreover, Bass and Boons (2004) explained the success of bottom-up planning that there was a knowledge exchange during the evolution of unplanned EIP that strengthened the opportunities for further exchanges and the strategic vision and collaborative actions were deeply rooted into the networking of businesses in the final stage of discovering sustainable performance.

All above, the factors that led to the successful planning of EIP in a case of bottom-up approach were:

- looking for economic benefit from the beginning
- knowledge generation on how to manage the planning of EIP
- businesses can explore more exchange opportunities because of knowing the businesses from the inside
- trust among businesses
- close collaboration of businesses
- strategic vision of sustainability that establishes within a time
- intervention of public institutions within a time

Regardless the conclusion of most researchers that the bottom-up approach results in more successful implementation, there are barriers that exist for bottom-up approach to planning of EIP and that can hinder the planning. These are the limited financial support to plan and implement the by-product exchanges in the beginning because the planning can totally depend on the private budget; dependence on the environmental regulations that can be stringent and limit the symbiosis opportunities (Desrochers, 2001).

Nonetheless, for the studies on bottom-up planning, it was difficult to explore more detailed land use planning, because the symbiosis is usually uncovered later in a stage of expansion and discovery of their sustainable performance. The details on land-use planning, therefore, could be mostly vanished within a time.

3.3.3 Stakeholder engagement in planning approaches

There are subsequent differences in the characteristics of two approaches. The common aspect is that they both possess the features that can lead to the successful planning of EIP. Another difference lies on the engagement of stakeholders in the planning of EIP, on their role and influence

on decision-making. The way the stakeholders engaged in planning triggers the challenges that exist in top-down and bottom-up approaches, but also enforces the factors that can positively influence the planning. During the literature review, it was identified that authors such as Lowe et al. (1996), Desrochers (2001), Lowe (2001), Mirata (2004), Verguts et al. (2010), Costa & Ferrão (2010), Alashpekova & Kørnøv (2018) studied the stakeholder interaction in planning of EIP [6].

Lowe et. al (1996) and Lowe (2001) gived the comprehensive picture of responsbilities assigned to the stakeholders in planning of EIP. The author includes each stakeholder that can be involved in planning from the bottom to the top actors. These researches did not investigate the stakeholder interaction and the approach that could be taken by stakeholders. Indeed, these researches were the starting point for the investigation of stakeholder engagement in top-down and bottom-up approaches. The list of stakeholders engaged in planning of EIP are:

- Public-sector government: city, municipality, regions, state authorities
- Core project team
- Company representatives
- Educational institutions
- Environmental organizations
- Planners
- Architects, engineers and developers
- Community

Desrochers (2001) described the stakeholder engagement in bottom-led initiative, the role of public institutions, government, companies, planners and facilitator of the dialogue among businesses. The author pointed the importance of facilitator or mediator who would communicate the businesses and would be the private actor so that the planning is not limited with the governmental vision.

Mirata (2004) explored the top-down planning of EIP in UK and concluded the challenges faced by stakeholders in their interaction. The author stated the challenge of finding the businesses as one of the main ones. Verguts et al. (2010) described the planning from the perspective of businesses and management body, who facilitated the recruitment and communication among stakeholders. The research concluded that the changes in the industrial symbiosis would occur within a time and proper management team that would facilitate these changes was needed. Costa & Ferrão (2010) studied the stakeholder engagement in both approaches: top-down and bottom-up and generated a comprehensive view of the divergence of two approaches in engaging stakeholders into planning of EIP. This study showed that the government and public institutions were major decision-makers in the top-down planning of EIP and other stakeholders were entitled to inform, give the feedback information to the public institutions. On the other hand, they had less legitimacy in the bottom-up planning, and businesses were the main decision-makers and other stakeholders assisting in and supporting the planning needed to give the feedback information to businesses. Alashpekova & Kørnøv (2018) studied these differences by exploring the international experiences in planning of EIP.

According to these researches, the summary of stakeholder engagement in relation to the top-down and bottom-up approaches to planning of EIP is provided in Annex 3.

[6] These studies are only defined during the literature review for this research. There could be more studies on stakeholder engagement in planning of EIP and in relation to the top-down and bottom-up approaches, which were not discovered by the author.

The different approach to the inclusion of stakeholders to the planning of EIP and the fact that these approaches to the engagement of stakeholders influence the successful implementation of planning, the researchers explored how to achieve the proper planning of EIP through the stakeholder engagement and what was needed for proper performance of planning by stakeholders.

3.4. Combining two characteristics: success factors for planning

Top-down and bottom-up approaches possess the factors that positively influence the planning of EIP, but they also face challenges in planning. Most researchers agree that the proper application of these factors in planning procedures can lead to the subsequent implementation of EIP (Cohen-Rosenthal, 1998; Gibbs & Deutz, 2007; Doménech & Davies, 2011; Côte & Walls & Paquin, 2015). They are formed according to the studies on barriers and potentials of EIP, planning approaches that disclosed the features of each approach and the reasons for their successful outcome, which were given in a section 3.3.1 and 3.3.2. Besides these given factors, there are other factors explored by researchers that are also essential for success of the EIP planning (Albino et al., 2015; Changhao & Kai, 2015; Europe Interreg, 2017).

The list of success factors are:

- common goal/shared vision
- trust
- constant communication
- knowledge sharing
- policy instruments
- anchor tenant/symbiosis champion
- diversity of exchange networks
- public participation
- political and financial support
- strategic vision

1. Common goal/shared vision

Doménech & Davies (2011) argue that a sense of commonality among stakeholders is essential for the EIP planning. Sense of commonality means having a common goal or, in other words, shared vision about the purpose of planning of EIP. They argue that the sense of commonality strengthens the planning process by creating stronger cohesion among stakeholders.

2. Trust

The lack of trust has been argued to be one of the dilemmas in establishing communication with businesses for industrial symbiosis (Baas & Boons, 2004; Gibbs & Deutz, 2005; Chertow, 2007). Trust of businesses to another businesses, to planning actors is crucial to make the businesses cooperate. Additionally, trust among planning actors is also essential to properly plan the EIP (Verguts et al., 2010; Doménech & Davies, 2011)

3. Constant communication

The different practices of top-down and bottom-up approaches has mostly revealed that the frequency of communication increases because of the necessity to cooperate and to generate new synergies, to find solutions with the aid of research, environmental organizations (Gibbs et al., 2005; Oh et al., 2005; Bass, 2011). They argue that the communication has to be frequent and fair among stakeholders to keep the feeling of commonality and trust. However, the frequent communication does not always ensure fair consideration of interests and views (Herczeg & Akkerman, 2014; Costa & Ferrão, 2010). Therefore, the communication has to go with collaboration wherein the interests of others will be taken into account (Harris & Pritchard, 2004; Desrochers, 2001).

3. Knowledge sharing

Stakeholders engaged in the development of IS shall share their knowledge, e.g. social, technical, environmental, etc. to further use it for the achievement of successful operations. It improves the managerial structure of the symbiosis and strengthens the interaction between stakeholders (Doménech & Davies, 2011). Knowledge sharing gives more ideas for planning of the industrial symbiosis, and better solutions for planning can be determined.

4. Policy instruments

Influence of governmental incentives, subsidies, regulations on the planning of eco-industrial park is tremendous. The policy instruments can either hinder or facilitate the planning, and in the case when the planning is mostly dependent on private actors, it can be difficult to reach the governmental regulations (Chertow, 2007). To provide the successful operation of industrial symbiosis, it is important that policy instruments are not stringent to challenge eco-industrial development.

5. Diversity of exchange network

Diversity of exchanges in a network is argued to be another factor that influence the industrial symbiosis. Planning is developed with regard of the companies that will be situated in a park, and the diversity increases the potential of the EIP for the long-term operation. Diversity of the exchanges also gives more ideas for planning. Moreover, Doménech & Davies (2011) argues that the network diversity can ease the case when one firm is withdrawn from the symbiosis, so the other company can substitute the previous one, and the exchange can be renovated.

7. Anchor tenant/symbiosis champion

Symbiosis champion reflects a firm or couple of firms that have the highest potentials for multiple exchanges and possess major interest in the establishing the symbiosis. Having a symbiosis champion can be a reflection point for stakeholders to plan, design the area and to develop the companies in regard with the placement of the symbiosis champion (van Berkel, 2006).

8. Public participation

From the studies of multiple practices, it is seen that the communities are mostly neglected in planning of industrial symbiosis (Desrochers, 2001; Gibbs & Deutz, 2005; Costa & Ferrão, 2010). However, as practices of actions towards sustainable development show the community

engagement can contribute to the innovative solutions, empower the community and increase their resilience (Aigbe, 2011; Doménech & Davies, 2011). Citizen's knowledge, suggestions, concerns and visions can shape the decisions towards the planning of EIP, assist other stakeholders in planning so that the community interests are considered (Chopra & Khanna, 2014; Conticelli & Tondelli, 2014).

9. Political and financial support

The financial support is a foundation for the success of any project. The sufficient finances also entail the successful management of planning, and in a case of eco-industrial development financial support has to be sufficient for a longer run, and as practices show, it can be provided by any stakeholders.

10. Strategic vision

Strategic visioning has been argued to be insurmountable for the planning of EIP because the planning of EIP requires complex efforts and consideration of actions in a strategic way, thus, in a way that the subsequent actions and development scenarios are accounted, innovative solutions are welcomed. Strategic visioning is crucial when taken actions for sustainable development that requires multiple considerations (Desrochers, 2001).

3.5. From success factors to the new planning approach

Lack of these success factors has led to the multiple failure of planning of EIP and to the challenges in planning. Moreover, Mirata (2004) argues that context factors, as mentioned governmental regulations, and along with political, social and economic factors can influence the planning of EIP. Mirata (2004) reports that the context factors that affect the planning of EIP and success factors can be shaped through the conscious intervention of various actors to coordinate, guide and facilitate the stakeholder intervention. Such broad studies revealed another concept from the perspective of planning approaches, which is called middle-out approach.

Costa & Ferrão (2010) argue that the middle-out approach to the planning of EIP entails some characteristics of the bottom-up approach, in which the decision-making includes multiple actors and is *decentralized.* Besides that, the middle-out approach aims for the *collaborative* planning since very beginning. Faehnlea & Tyrväinen (2013) argue that the collaborative planning involves these mentioned factors as *knowledge sharing and communication* into its key principles. It also induces the following principles into its foundation.

- *Meaningful involvement,* which means the inclusion of stakeholders to take actions and ensuring the equal participation for any actor involved. This is bounded with *public participation,* which was mentioned above. This also contributes to *knowledge generation, improvement of the governance and collaboration*. In other words, meaningful involvement means *full and fair stakeholder engagement* to the planning of EIP, wherein the interests of stakeholders are considered, the *influence of one stakeholder does not halt the importance of another stakeholder.*

- *Functioning governance***.** Governance, here, implies the coordination between departments and institutions or even several municipalities for the planning of EIP. This is highly important since it can facilitate the *collaboration both horizontally*, i.e. national, regional, local level *and vertically,* i.e. inclusion of multiple stakeholders for planning, to provide an effective planning.

Some practice of middle-out planning was studied from the perspective of stakeholder interventions in the development process, some discusses eco-industrial development from the view of collaborative planning of material exchanges (Costa & Ferrão, 2010) (Gábor Herczeg, 2014) . There are many other studies on how the social networking has to operate for successful performance (Lowe, 2001) (van Leeuwen, et al., 2013). In general, the stakeholder role in middle-out planning is provided in the Annex 4.

The middle-out planning is about mutual influence on decision-making, in which the legitimacy of stakeholders are not hindered, one stakeholder does not suppress the other. It is about collaborative way of taking actions wherein the interests of all stakeholders at national and local scale are considered. Costa & Ferrão (2010) argue that the middle-out approach contributes towards more innovative solutions, community empowerment, closer relations among stakeholders wherein the conflicting interests can be resolved and context factors can be facilitated. Moreover, this approach aims to generate success factors from the very beginning of the planning of EIP. Therefore, the middle-out approach possesses more benefits to succeed than top-down and bottom-up approaches.

However, this approach was developed as a concept for planning of EIP, but there are not enough studies on the practices of middle-out approach to planning of EIP because of its novelty in a theoretical basis. Moreover, more research is needed to understand what characterizes the middle-out planning and approach from the argumentation of stakeholders is necessary.

4 Case description

This section explores the planning system of the case study GreenLab Skive. First it studies the planning system of Denmark to shed the light into on how the land use plans are approached in a country and on characteristics of Danish planning system. Then it explores the planning system of the case study GreenLab Skive from the information found in the official documents by systematizing them in a chronological order so that the connection between each step is noticeable.

4.1 Danish planning system

Exploring Danish planning system is a primary step because it reflects the governance of planning and forms the framework for the planning of case study GreenLab Skive. The approach to planning of a certain asset primarily depends on the established system of planning. It sets the boundaries on what and how the planning can and cannot evolve. Therefore, there is a strong link between approach to planning of industrial symbiosis and the governmental planning system.

Danish planning system shifted from the development control, which had the political clout, to the facilitation and management of economic growth since 2007 (Enemark, 2016). Galland (2012) positioned this shift as the one to follow the growth and competetitiveness demands posed by

global development trends. The idea was to use spatial planning as a platform and strategic tool to pursue local development according to the regional strengths and potentials (Galland, 2012). In this regard, more responsibility and authority have been dedicated to the national and local authorities than it was before to link the municipal interests with national vision (Galland, 2012).

The paper Interreg III (2012) and OECD (2017) about the spatial planning of Denmark best describe the Danish planning system. These papers are used to describe the vetical integration of the Danish planning system.

The responsibility of the national Level planning is to facilitate the planning and monitoring the local-level planning and preparing *national reports, directives and legislations*. The national authority can apply veto to municipal plan proposals that contradict to the national interests.

At regional level, regional councils were left with some responsibility. The administrative regions are now in charge of producing *strategic spatial development plans*, which envision the purpose of cities, towns, rural districts and small towns. The regional spatial development plans are visionary and advisory plans for municipalities and local communities and have no enforceable land use regulation.

Regional council publishes the proposal for the regional plan during the first half year of the 4-year regional and local election period. During that period the municipalities prepare the municipal strategies for planning. These two processes are interlinked and the close dialogue between regional and municipal council can produce the synergy.

At the municipal level, the Planning act of 2007 has strengthened the strategic aspect of municipal planning and the interests of local communities in municipal planning.

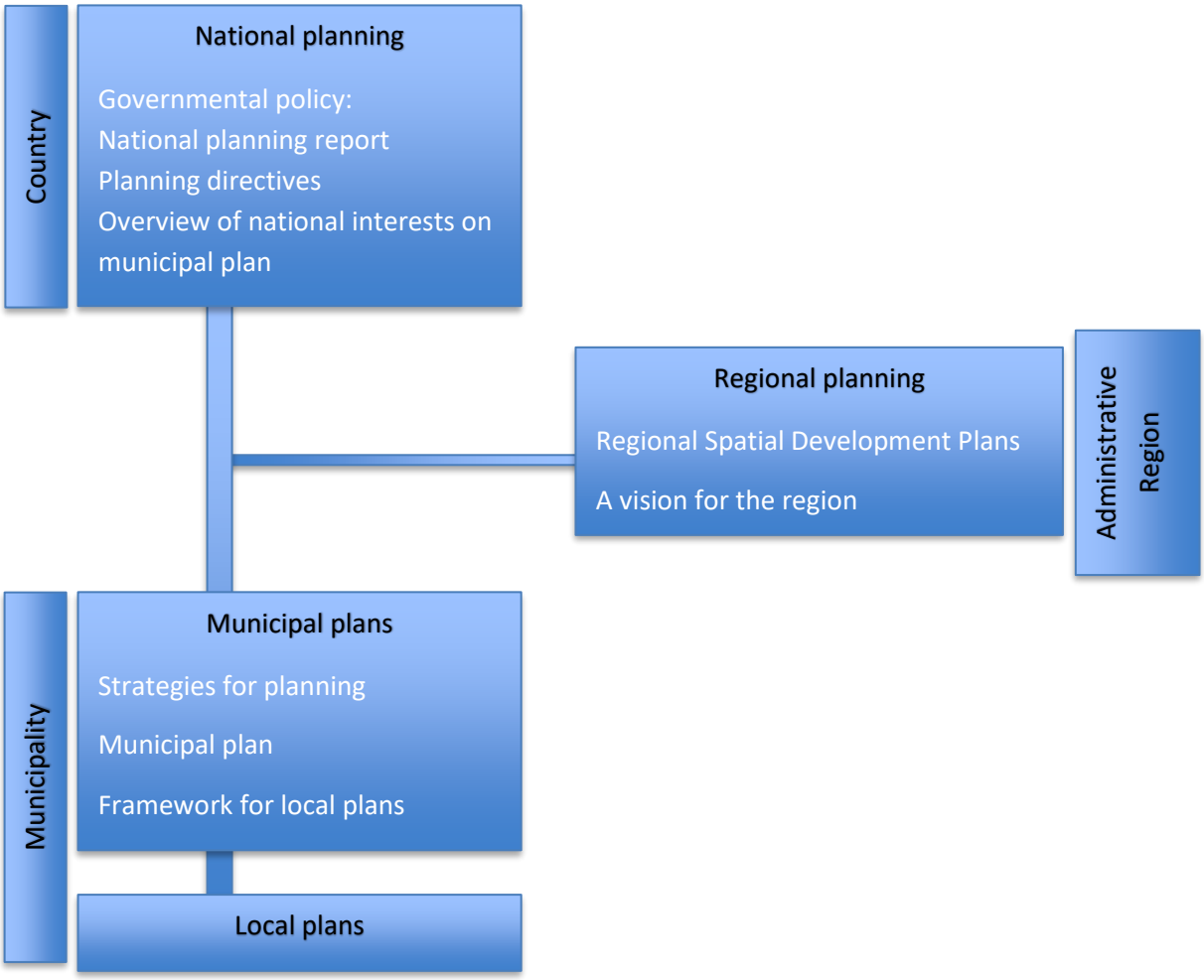
Municipal planning includes developing:

- *strategies for planning* can be exclusively focused on the strategic land use planning, but can also include more general municipal strategies for economic and social development.
    - The municipal council publishes a strategy within the first 2 years of the municipal election period (4 years).
- *municipal plan* is a comprehensive land use plan with important strategic elements for the development of municipality. It sets the overall targets and guidelines for the individual municipality's development for a period of 12 years. It may not contradict to the future vision described in the regional spatial development plan; national planning directives; a Natura 2000 plan and related action plans; and water resource plan.
    - Every 4th year the municipal council determines whether a new plan is needed or the current shall be changed.
- *framework for local planning* links the local planning with the competences of municipal council in preparing the local plans. It is developed for individual areas to describe what these areas can and shall follow for a certain development to reach the municipal objectives. It also illustrates the future opportunities for these areas. Moreover, it is not a mandatory plan for every local area, the areas need to possess some economic and social benefits at regional and national level.

Local level plan is the most detailed plan that stipulates how land may be developed and used. Local plan is legally binding for property owners. It can ensure that various interests in the local plan area are discussed. It is flexible and framed by municipal plan. It may regulate multiple factors on the size, use and location of buildings, roads, architectural features of the area.

A general scheme of vertical integration of Danish planning system is given in a figure below.

Figure 2 Planning system of Denmark. Vertical integration



From this vertical integration that was described above, it can be noticed that the planning responsibilities are *decentralized* to municipal planning with the 4-years municipal strategy and plan adoption period, that gives higher responsibility to municipal planning authorities to navigate the planning and to engage in a close dialogue with regional authorities.

Moreover, the *systemic approach* to plans, e.g. municipal plans, framework local plan, local plans allow better elaboration of the land use planning. It also ensures complete information to everyone about the land use, objectives and perspectives taking into account the main function of the area for national economy and society.

Horizontal coordination in planning is required by the Planning Act of Denmark (OECD, 2017). Municipal plans generally consider multiple themes and policy sectors in a comprehensive way. These require engagement of a number of actors to contribute towards the formation of municipal plan.

One of the aspects of horizontal integration of actors is that *public participation* is highly ensured by the Planning Act at municipal, regional, national levels (Galland, 2012). The proposals on the national report and directives, municipal strategies and plans are published via different sources, and property owners, neighbours, NGOs, public authorities have at least 8 weeks to submit

concerns, comments, proposals or protests. There are minimum rules on public participation. The planning authority decides whether it should arrange meetings, create working groups, electronic citizens' panels or use other tools to engage public in planning. Indeed, the public participation, e.g. in the case of meetings can be facilitated by different stakeholders (Interreg III, 2012).

Moreover, to ensure the *transparent information sharing*, the Danish planning system also ensures the open access to the plans and data on land use, nature and environment in their webportal.

The Danish planning system ensures the *functional governance* of the planning, in which it promotes the *close collaboration* in vertical and horizontal scale.

4.2 Case study GreenLab Skive

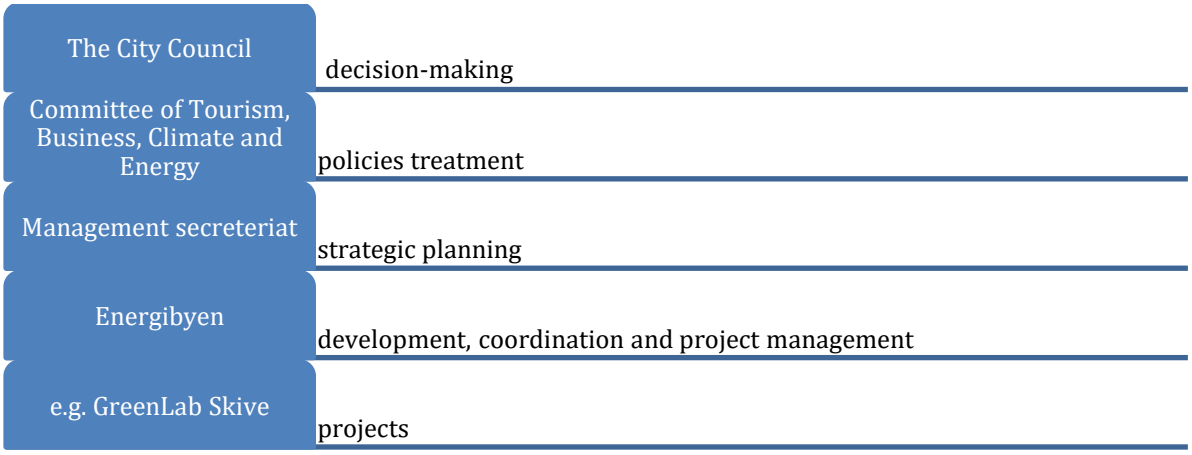
4.2.1 Pre-land use planning

Pre-land use planning includes the reasons of initiating the industrial symbiosis in a business park named GreenLab Skive and idea generation.

The case study GreenLab Skive is located in Skive municipality, Central Denmark region. Skive municipality has been invested in renewable energy since 70's and 80's when the prices for the fossil fuels have considerably increased and the national strategy started to encourage the development towards becoming fossil free country by step-wise changes. According to the data from the Skive Municipality (2016) and Energibyen Skive (2016), Skive Municipality was first with geothermal energy, energy innovations and low energy homes. In the 90s and in the 00's major investments were made in municipal solar cells and energy savings in own municipal buildings in the form of after-insulation, optimization of climate screens and technical installations as well as general energy efficient measure. In the beginning of the economic crises in 2008 with considerable increase in market prices for fossil fuels, Climate and Energy Minister proclaimed three municipalities Copenhagen, Skive and Kolding to be one of the first energy cities in Denmark. Thus, Skive municipality was the one of the municipalities taking the lead to be first energy bank in Denmark and in Europe, and to be fossil free by 2029.

The organizational structure of municipality and responsibilities related to the energy sector are given below (Skive, 2016):

Figure 3 Organizational structure of Skive municipality for energy sector



"EnergiByen Skive" or "Energy City Skive" Skive was established as an independent department under the Technical Council of Skive Municipality (Skive, 2016). The EnergiByen Skive works to ensure that the projects aiming to contribute to the goal of municipality to be CO2 neutral by 2029 are well coordinated and facilitated. Since 2008, the municipality of Skive has developed several major projects that have meant that it has taken the lead position in Denmark when it comes to conversion of energy, heat supply and use of solar cells, biomass and biogas in energy system (Skive, 2016).

The project GreenLab Skive started with the idea of developing power to gas facility among HMN Naturgas, developing and managing biogas facilities and Skive Municipality in 2012. Later, the energy policy settlement adopted in March, 2012 described the potentials of Skive Municipality as with significant growth in wind power generation, and the balancing source natural gas was necessary to balance the energy generation. This settlement created the basic prerequisite for initiating the project (Municipality, 2012).

Later this year, HMN Naturgas and Skive municipality agreed to launch the project, GreenLab Skive (Municipality, 2012). The vision was to establish a ***business park*** as a future energy and resource partnership area, where companies balancing energy systems through collaboration in an ***energy symbiosis*** can demonstrate and develop future energy technologies in a test and production centre (Municipality, 2012). To make it real, the area at Kåstrup, north-east of a town of Skive, near to the town of Odense has been chosen due to its already established energy cluster with wind turbines and heat and electricity transportation pipelines crossing the area (Municipality, 2016). Moreover, the greenfield was available for the consideration for future perspectives and now consists of the area of 69 ha (Municipality, 2016).

The park combines three operations in one system:

- renewable energy sources
- electrolysis
- biogas production

Sources of energy supply will be wind turbines, heat pumps, PV panels, combined heat and power engines. Facilities for biogas production will be built with the potential to upgrade the biogas to methane, and facilities for electrolysis will be developed as well. Moreover, the grids for natural gas, heat and electricity will connect the facilities (Assessment, 2017) .

4.2.2 From the Municipal Strategy to the Municipal plan

This section shows how the discussion among different stakeholders was initiated to start planning of the energy symbiosis from 2012, how the GreenLab Skive was officially considered in municipal Climate and Energy strategy, 2013 and in a comprehensive Municipal Plan 2016.

The GreenLab Skive was officially entered into the list of projects that could have tackled the climate change and rising CO2 emissions. This was included into Climate & Energy Strategy 2029 of Skive Municipality (Municipality, 2013) .

These actions formed the conditions to start the planning, e.g, engaging planners and designers. Thus, there was a meeting in March, 2014 with Energibyen to first explain the vision and the anticipated spatial plan of the industrial site (planner, 2018).

"They (Energibyen) asked us to do the planning. They had a project; do the planning, make it possible that they can bring this in…… They explained work packages and the way they saw, the way they thought planning was supposed to be" - municipal planners of GreenLab Skive

The second meeting was between planners and the Ministry of Environment, wherein they discussed who would make planning for the area and agreed that it was better if Municipal planners take the responsibility for planning (planner, 2018).

The management of the development of GreenLab Skive required the private actor to recruit, manage the ongoing process and communicate with various actors who could support the development of GreenLab Skive (Municipality, 2012). This responsibility was dedicated to Energifonden Skive, which is a business fund organization aimed at raising the general knowledge of climate, energy and environmental issues in the municipality of Skive (Skive, 2012)

Later, the visual design of the site was provided by the private company. The societal aspect of the park was required to be taken into account, as well the spiral vision of the site should have been eventually present.

Thus, having the municipal planners assigned the task to plan the area, visual design of the area was prepared, the *Masterplan of GreenLab Skive* was ready to be adopted in 2015, in 3 years after project initiation. This was the essential document for stakeholders to form the platform for dialogue. It consists the information about the location of the park, architectural vision, various purposes of the park, e.g. educational and research, recreational, and future touristic site. It also shows the organizational structure, investment and risk assessment of the park as well as its future effects. It describes the planning of GreenLab Skive as following:

"Architectural vision of GreenLab Skive is to shape and plan a physical area so that the individual building complexes in GreenLab Skive are built into a designed landscape. An area must be created in which production, architecture and landscape constitute an architectural whole that demonstrates that a high-tech production center can be developed and function in line with the landscape and environmental considerations, thus contributing to sustainable development" (Skive, 2015).

Public meetings were also held in the first phase to inform citizens on future vision and further development of the area (Municipality, 2015).

Municipal Plan (Kommuneplan 2016-2028) is a comprehensive plan and it covers many

sectors such as urban development, business, tourism, the landscape - the open country, energy and climate, infrastructure. The municipal plan establishes general guidelines and frameworks for, inter alia, physical development of the municipality. It includes the information about GreenLab Skive considering its Masterplan. GreenLab Skive is adjacent with the business development sector of the municipal plan, as well as considered in agricultural land reduction, and in strategic environmental assessment of the municipality as a whole (Municipality, 2016).

In accordance with the Law No 939 of 03/07/2013 on Environmental Assessment has to be conducted in preparation of Municipal plan. The EA was performed in parallel with the planning process, and the EA had a major importance. The environmentally evaluated themes were:

- GreenLab Skive
- BigBlue
- Windmills
- Transport centre
- Glyngøre Sea port
- Framework Area

This was a *strategic environmental assessment (SEA) of GreenLab Skive in 2016* (Municipality, 2016). According to the document on SEA of municipality (2016), this SEA focused on complementing and shaping plans, programmes, and looking for wider picture of the area and making more strategic long-term evaluation. Danish Centre for Environmental Assessment (DCEA) assisted in SEA development. SEA evaluated the alternative placing of GreenLab Skive; general assessment of environmental impacts; positive and negative outcomes; options for optimizing different activities and their influence on climate; evaluation of how much wind energy is necessary for GreenLab Skive. It showed the planning issues related to the societal and environmental impacts e.g. flora and fauna, land, landscape, water, population; health; housing; heritage. LCA was also carried on by researchers of Aalborg University to assess the carbon footprint of the park, alternatives for biogas production and to support the Municipality in developing the GreenLab Skive (Pizzol & Kørnøv, 2016).

There were public meetings with citizens to inform, explore the concerns in relation to the societal and environmental impacts; business seminars where Ministry representatives, regional authorities, businesses, planners, Energibyen Skive representatives, Energifonden Skive could have a discussion table for the holistic outlook and for the discussion of the state-of-the-art and future actions (Municipality, 2016).

All of these led to the conclusion that further detailed Framework Local Plan (Rammelokalplan) was needed for detailed planning information and evaluation of the area and the SEA of the area is necessary for potential solutions and options, design and settlements in the industrial area.

Thus, the first phase, which is about the first contacts, meetings, inclusion in Climate & Energy Strategy, adoption of Municipal plan and SEA included in the municipal designation, gives the impulse for the second stage.

4.2.3 Development of the Local Framework Plan

This section is about the narrowed level of planning, which was concluded to be *Framework Local Plan* (FLP). FLP served as a junction between Municipal plan and local plans for businesses. The main actors developing this plan were planners of Skive Municipality. However, the planners did not know in the initial stage that the planning would go to the direction of developing Framework Local

Plan (planner, 2018).

The FLP consisted of the different objects of planning; its zoning status, conditions for road construction, site preparation, technical installations; sewage and wastewater conditions; windmills; electricity, heat supplies; parking; low-energy buildings. This was more detailed planning of different objects, alternative options and settled limits to planning. Environmental assessment, i.e. impact of planning the ecosystem and public opinions were also incorporated into the plan (Municipality, 2016).

Before the FLP, Strategic environmental Assessment of the area was performed in integrated decision-centred way by DCEA. SEA helped to account for the environmental and societal aspects of planning, and therefore to make FLP more detailed. Nature regulations, limits were given, development options were advised as well as a dialogue with citizens were held in SEA (Kørnøv, 2018).

The interaction of planners with DCEA even continued after DCEA concluded the SEA. As planners stated they needed help and they did not have a lot of experience, and they did not want to make an error (planner, 2018).

Developing FLP required a year from 2016 till the beginning of 2017. The FLP formed a ground for local businesses to develop their own local plan and EIA.

4.2.3 Development of the Local Plans

After approval of FLP, the business park was soon announced officially open for companies to start constructing facilities. The first company was E.ON that focuses on biogas plant development (Municipality, 2017). The company started with planning of its designated area. In late 2017, Local Plan 275 was adopted by Skive Kommune on technical specifics for planning of the biogas facility. It states the requirements for local planning that it shall follow the boundaries and suggestions stated in FLP (Municipality, 2017). It was known from the interview that the local planning of E.ON. was supplemented by the consultancy that assisted in planning. Planning, in general, was conducted by E.ON (E.ON, 2018). The EIA of the company area was also performed. The difference between EIA and SEA was that there were less scope on alternatives; more scope on the assessment of remedial and preventive measures and fewer environmental conditions involved (Kørnøv, 2018).

From the interview with planners it was known that the public hearing was performed not the public meeting, because the meetings were already done during the phase 1 and 2 and the major visions and concerns were known. Public hearing was supplementary to inform citizens on the construction of biogas plant, and to gather the concerns again so that to know if they have been facilitated and if there was any need to facilitate the citizens' concerns additionally. Public hearing has been recently conducted for wind turbines and biogas plant

Developing the local plans for businesses is the final step in planning system, when the planning reached the private companies who would make the physical construction and who would have to do the local planning of their area taking the advices and support from the Municipality in their municipal and FLP, SEAs.

Overall, the planning system of the park GreenLab Skive for energy symbiosis followed the planning procedures induced by the Danish planning system. The summary of planning procedures is given in Annex 5.

5 Analytical framework

The interviews played the major role in the analytical part of this research, they could disclose the perception of interviewees about the development of GreenLab Skive, how the planning went, what obstacles they faced and what benefits they have seen so far, what was new, what they thought about the approach taken to planning. While the survey complemented the information given by the interviewees and strengthened several points in the research. The analysis of qualitative data is given below. The analysis was conducted in such a way to explore the research questions.

5.1 Data Classification

After face-to-face and phone interviews, the gathered data were coded, which meant they were classified according to the common pattern and trends. This eased the reading of data for the analysis. More details about coding is given below. The priori coding was used in these interviews because the data was available to code according to the theoretical framework as well as other data with common traits could be found that could be analysed. Similar classification could be given for each interview. The difference in coding can be also observed because of the different engagement of interviewees in planning, and some information could be better provided by planners than by CEO and E.ON representative, and vice versa. The coding result can be found in the Annex 6.

5.2 Data analysis

5.2.1 Why GreenLab Skive

The coordinating organization Energifonden was the main actor inspiring the companies to join the project. The interviewed E.ON head of biogas activities could disclose the main driver for joining the energy symbiosis.

Table 1 Drivers for GreenLab Skive

Stakeholder	Encouragement	Quotes from interviews
Energifonden	- facilitating the business interactions to generate the mutual benefit for them	*"do you want to have a business that can create growth for you? We know somebody would like to invest in that" "we want to facilitate and try to make your dreams come true"* (CEO, 2018)
E.ON	- high interest in sustainable development in Municipality, which is also a core business of the company - Future economic benefits	*"We found out that there is also a clear intention to do a symbiosis. So making more interest in business opportunities for the biogas plants made us look into this area" (*E.ON, 2018) *"I expect that that benefits would come from the interaction between the different companies for energy streams and waste streams" (*E.ON, 2018)

It is seen that that the market incentives were one of the core drivers to encourage businesses to join the energy symbiosis. Indeed, for E.ON the shared value was also crucial.

5.2.2 Stakeholder engagement

From the beginning of the project there was observed that the planning required multiple stakeholders in different planning procedures. During the interview, following stakeholders were mentioned and discussed:

- Energibyen/Energifonden
- Ministries
- Municipality
- Planners
- Aalborg University
- Danish Centre for Environmental Assessment
- Companies
- Citizens
- Consultancy for planning
- Architects, designers

The **Energifonden** played a crucial role in engaging the stakeholders. CEO stated about their responsibilities:

"We are actually facilitators as a platform here and that is actually the recipe for us here, meeting companies, really trying to understand what they want to do and then try to make it happen together with them sitting."

"...And then the next company will come. They need some more heat, need some more electricity. And we facilitate that…..We play a role as a GreenLab Skive that they cannot do on their own. We call it an enabling platform, an enabling platform. That's what we describe us"

"We said to businesses, we want to facilitate and try to make your dreams come true"

Planners also stated that the CEO aimed to facilitate the dialogue with planners and tried to understand what they needed and tried to assist in that. CEO was the main communication body between planners, Ministry representatives, companies, research institutions as well as engaging citizens. E.ON head of biogas activities, Michael Dalby, also stated the facilitation by CEO that was crucial for them and the team of GreenLab Skive "*tried to find solutions which would fit to everybody's plan, and they all tried to find out how they can work together*".

Thus, the team of GreenLab Skive has been acting from the middle of cooperation listening to companies will, attempting to communicate the needs of planners and citizens, attempting to gain support of Ministries, and attempting to develop cooperation for research and investigation.

From the perspective of planning, the team of GreenLab Skive has been working to refine the view, to generate the idea how to create an area for the houses and how they can fit into the area. One of the contributions was generation of the MasterPlan that has outlined the vision of the

area. They have been communicating the next steps of planning, and responsible for bringing the FLP and local plans together.

The **City Council** here as the CEO stated approved the MasterPlan and the project could go further and the financial support was also given:

"After we established the master plan, we went to the municipality board and got the grant to start the process of the construction and, and forming the partnership".

The role of Municipality was characterized as making a project as "spin-off" of the municipal strategy.

As known, the **Ministry of Environment**? is a national entity that approves or rejects the plans, and having their support and approval is detrimental step in project development. As Steen Harding stated ministerial political support was crucial for them, because the GreenLab Skive was also a project of national interest, and they could bring the ministers into the office and generate trust among them.

Planners also noted that the contact with the Ministry and their support throughout the process was detrimental. Planners had a direct meeting with the nature department of the Ministry of Environment to decide on who had to plan the park. The result of these meetings was the agreement between Nature department (....in Danish) of Ministry of Environment and municipal planners that the latter one would make the planning of the area because the municipality was closer to reach by companies and the communication with businesses and other organizations would go easier. This decision was a starting point for planners. The Ministry was also very helpful to guide planners if needed and there was a task force, which was Ministry representatives having a specific task to support local municipalities in the planning related to windmills and biogas plant. This direct communication was necessary to dissolve uncertainties on who had to plan the park.

However, planners also mentioned that in some cases, they needed to adjust the planning according to the national interest. Thus, the Ministry was both supportive and controlling the actions.

Planners then played a major role in making the land use plan for GreenLab Skive. The **companies** were essential for planning, since knowing the companies that would be aiming to develop their facilities, could actually facilitate land use planning. However, as planners stated there was no enough data provided to decide on how to plan the area. Regardless this, the team of GreenLab Skive attempted to facilitate the communication between planners and companies.

"He was involved in some meetings regarding the plan and the SEA and then he returned to the companies with these questions, came back with information that could be embedded in the plan. Then when we got closer and closer to it, we said now we need to have meetings with some companies we knew. So for instance, we had a meeting with E.ON to try to understand what they really wanted to do"

Unless, the planners was provided with fewer information than they were willing to have, they managed to meet the E.ON. representatives and engage them in planning, asking their needs and wishes. They noted that *"Not knowing about these specific companies… so that the consequence of that was also to do the Framework Local Plan".*

The valuable support came from the **DCEA**, which assisted in a SEA of the area for municipal plan 2016 and made a SEA for the FLP. The planners stated:

"We said we needed help. We didn't have a lot of experience either in the process . I didn't know how to handle it because it was such a big thing and we didn't want to make an error".

"They did the environmental assessment of this area and that has been one of the, the milestones in this projects" - quoted from the interview with Steen.

Planners needed to rely on the vision of the landscape and together with DCEA and **private architectural company "By+Land"** they made a visual design of the landscape, which could be implemented.

Stakeholders as **citizens** were present in each phase. Steen noted that they were open with citizens and were willing to inform on what was going to happen and have some input, remarks from citizens. The planners noted that the public engagement was welcomed by politicians, and the recommendations were accepted. The planners noted that the early involvement of citizens to the planning helped to smooth the tension that could probably have evolved without the public meetings in early stages. Therefore, *"there were no surprises"* (quoted from the interview) when there was no remarks or complains during the public hearing about the local planning of biogas plant. The E.ON. company also mentioned that informing public about their actions, making them proud and confident about the area, having some input from citizens was crucial for biogas activities.

Even if there was not enough interaction between municipal planners and companies, the **companies** make their own site planning and EIA, and as the E.ON. head of biogas activities mentioned the site planning was conducted with some space limitations assigned in LFP and Local Plan 275. The consultancy assisted in planning, but in general the planning and EIA was performed as usual for other biogas establishments. So the role of companies in planning of GreenLab Skive was that they conducted the planning according to the recommendations given by the municipal planners, even if the active participation in planning was not encouraged.

In general, each stakeholder played a meaningful role in planning of the business park. By meaningful, it is meant that the stakeholders could shape the planning, contribute towards better decisions, and support each other. The interests and needs of stakeholders such as citizens and companies were taken into account. Even if the Ministry interest had some influence on the planning, this has not been a detrimental issue for planners.

Moreover, stating about the governance, i.e. the coordination between departments and institutions, it could be clearly noticed throughout the interviews that there was a productive dialogue between the Ministry, Nature Department and planners of Skive Municipality. Comprehensive municipal plan, Climate & Energy Strategy, Framework Local Plan are all the demonstration of the functional governance that attempts to support and coordinate the planning and further development of the project.

5.2.3 Factors

Factors are the elements that influence the planning and can disclose the characteristics of planning from the inside-out. Moreover, some factors were explicitly mentioned as those that have

led to the successful planning of the area, and other factors were considered as crucial for planning and overall development of the project.

5.2.3.1 Trust

One of the most crucial factors mentioned by the interviewees was trust. CEO of GreenLab Skive noted that developing trust and having trustful dialogue was important for any actions and this was part of their responsibility. Trust was a foundation for fruitful meetings among stakeholders: businesses could approach and learn each other, and generate trust towards each other. Trust from the Ministry was also essential for political support and this has to be kept during the progress. Meanwhile, it is also crucial for the Energifonden to keep confiding attitude and to perform thoroughly, so that the businesses, Ministry, planners, assisting organizations will continue developing the project. The CEO stated about businesses *"If they don't see that we perform and we have a lot of ideas we don't perform, then they don't trust us. But they have actually accepted us and trust us now…..we are creating an open space in a business environment with the confidence and trust"*. Building trust with local people and being open with them helped the GreenLab Skive to be accepted by community.

Planners also mentioned that the trust towards them evolved within a progress and with the necessity of further facilitation.

5.2.3.2 Common goal/shared vision

Besides the trust, having vision of the result as a whole was considered crucial by the interviewees. Planners stated that this was a shared mission, in which the planners took part to develop energy and resource landscape, and the project was unique because of the general idea behind it. Generating common value and having something common to share between companies is essential to sustain the business partnership (CEO, 2018).

E.ON representative also mentioned that the belief on the idea, vision and supporting the symbiosis opportunities by creating a platform for this gives more potentials for its realization. The results of survey also highly value this factor for successful planning of the area.

5.3.2.3 Political and financial support

These two are considered together because the political support also includes the financial aspect in it. The project is adopted through private and public agreement, and high-level municipal support, which is City Council, was crucial starting point for the business park.

CEO stated that getting the ministerial support and national interest in a project created a valuable foundation for financial support, but also the progress needed to be tangible in a future. Nature department of the Ministry played a crucial role in planning.

They showed the interest in public meetings and were keen on public participation; they were keen on the actions taken by planners and assisted financially with what was needed for planning.

"Politicians have given us an amount. So we were able to hire advisors and to hold meetings and when we needed to take trips. Politician said, we liked this idea, we want this, we want to work for it. And I think we were given not completely free, but we could spend the time on it as much as we needed" (planner, 2018)

The Ministry could advise, contribute with ideas and could influence the planning at the same time. Indeed, their contribution was highly valued by planners stating that *"maybe it wouldn't have went so fast if it wasn't for that dialogue"*.

5.3.2.4 Constant communication and collaboration

This factor was constantly mentioned in the planning of GreenLab Skive. The importance of collaboration in planning was mentioned by planners as bringing new ideas and perspectives to planning, especially from the contribution of external organizations. *"We had to help constantly and you would write down the ideas and bringing ideas. How could we take the next step and then, we discuss this"* said planners during the interview. They stated that this was one of the factors that was important for successful planning of the area.

The CEO of GreenLab Skive also mentioned that it was crucial to develop communication between businesses where they can learn about each other and make a business. Moreover, *"We need to rely on, on all the resources in the organizations and bring them together and make them work together"* he stated.

For E.ON. the collaboration between businesses and having external organizations to facilitate the development of Industrial Symbiosis was a milestone during these phases: *"You also need a lot of creative people around you and you also need a lot of effort from different companies and yours and need it equal because if you only have one or two companies trying to do this than it's not going to happen"* (E.ON, 2018).

5.3.2.5 Sharing knowledge and ideas for planning

This has been a milestone for the planners to plan the area. Different knowledge and ideas from the DCEA, Ministry of Environment, and knowing the wishes and needs of E.ON was highly important for the development of the plan. Planners needed external knowledge to know how to plan in a better way and the ideas were always welcome. Citizens' recommendations were highly appreciated by the politicians and they also needed to be considered during the planning. As it was mentioned above, collaboration generated a useful knowledge for planners that was needed for them.

5.3.2.6 Looking into opportunities when planning

Within the development of the GreenLab Skive, there were a lot of new ideas for stakeholders. The planners "learned by doing" and gained priceless experience in the planning of the area. They learnt the importance of *"looking into opportunities"* to make the planning happen. *"Almost everything is possible, it's just a matter how we look at it"* they stated. This was realized as a crucial factor for successful planning of the park. This was not mentioned by CEO and E.ON head of biogas activities.

5.3.2.7 Flexibility within the stakeholders

This was another factor noticed during the interviews that was mentioned by the interviewees. The CEO noted that the planning needed to be adjusted towards the iterative process with companies and go a little bit towards companies.

Planners also agreed on that, the planning had to set the frames but also with consideration of some flexibility from the both sides that can be reached with continuous dialogue.

The E.ON head of biogas activities considered the flexibility in physical terms was difficult to achieve with the spatial limitations and they need to adjust to the planning, thus be flexible to the planning, but the development including the planning can probably be flexible in the future and allow further expansion of the symbiotic opportunities also within regions.

Thus, flexibility here towards the planning can be flexible in both ways, from the perspective of planners and companies.

5.3.2.8 Early community involvement

One of the key features in public participation in GreenLab Skive was early involvement of citizens in the development of the park. As planners said politicians really admired the feedback got from the citizens, and the recommendations could be incorporated into the planning. Planners noted that such attitude from the beginning of the project led to minimum complains and remarks from citizens during the public hearing regarding the windmills, and even no remarks concerning the biogas plant. One of the notes from the planners was that the citizens could have more knowledge about the area than the planners do, and this could be also a valuable contribution.

5.3.2.9 Transparency with community

E.ON head of biogas activities has noticed that there would always be a negative attitude towards the biogas operations, and keeping citizens informed and being open with them, developing some sort of pride could resolve the possible tension, and they attempt to change their development from the lessons learnt from the public.

As CEO stated informing citizens, asking them to come and listen, being open with them were the essential actions in generating trustful dialogue.

5.3.2.10 Policy instruments

There has not been enough data from the interviews about the policy instruments, and by policy instruments is meant the regulations, laws facilitating the planning for the area and for the companies. Meanwhile, the CEO of GreenLab Skive stated that this has been a challenging factor for the development since the restrictions, rules assigned by the law has to be considered and dealt with, which can sometimes trigger the difficulties in establishing the symbiosis. However, the examples were not given.

5.3.2.11 Patency

This was another element stated by the E.ON. head of biogas activities. Being patient and having a belief on the vision and trusting the actions are the key for companies to stay in a good communication with other businesses and GreenLab Skive (E.ON, 2018). The development of

GreenLab Skive is generally taken more time because of its novelty in development practice, therefore, the companies had to be patient. *"The park needs creative actors, and eager and patient companies to make the project happen"* (E.ON, 2018)

5.3.2.12. Strategic vision

This factor has not been stated by planners or E.ON. head of biogas activities. Indeed, the CEO stated that the strategic actions have to be taken because*" the next step needs to be considered before taken the first one".*

5.3.3 Challenges in planning

Besides the factors noticed above, there were also challenges in planning of the business park that have been mentioned by the interviewed stakeholders.

Planners outlined the following challenges they faced in planning:

- lack of information about the companies

This caused the difficulties in planning because developing the local plan for the area of each company with limited data would be difficult to manage. The lack of information was grounded by the fact that the Energifonden kept the confidentiality, so not to disclose the companies.

"We would just get little pieces here and there. It made it difficult for us to understand the times where we were going and how to plan for It" (planner, 2018).

- uncertainty about the planning

The industrial symbiosis is new and inexperienced project in Skive municipality. For that, Ministry of Environment and municipal planners met to discuss who would be responsible for planning, if the park needed to be considered as a whole big plant or divided into separate businesses. Not knowing about the businesses also complicated the decision. However, as it was stated above companies wanted municipal planners to take the lead because it was easier to communicate with Municipality than the Ministries.

"..in one huge plant It would definitely be the ministry, but if you could take the individual, it would be skive commune and a lot of the businesses wanted Skive commune to take it. It's easier to communicate or operate with skive commune then ministry. So in a way they accepted that we separate it: make it different for businesses so because they didn't know how to handle it either, if it was one huge plant" (planner, 2018).

CEO of the GreenLab Skive stated that leading the project has been challenging. It was overall difficult to keep the businesses together, finding the funds and keeping the communication, convincing politicians to trust and support the project, developing the symbiosis according to the different laws.

E.ON head of biogas activities did not mention any challenges per se but only mentioned the project implementation took a long time, but it needed to be accepted by companies.

5.4 Role of planning for stakeholders

Besides exploring how the planning of the park went, the interviews also aimed to know the role of planning in the development of the GreenLab Skive from the viewpoint of the interviewed stakeholders. The role of planning here was mostly considered as the role of the FLP including SEA because of its direct application to the stakeholders and to the planning of GreenLab Skive.

5.4.1 Framework Local Plan

The novelty of this research and the aspect that caught the attention of the research is the development of Framework Local Plan.

For planners:

- FLP has been one of the reasons of successful planning of the GreenLab Skive.

- FLP allowed making the land use plan within the boundaries of the park and considering potential establishments in the area.

- "*it was a right way of doing planning …. this is like the only thing that makes sense when you have such a big area of 69 hectares to do a framework local plan and SEA"* (planner, 2018).

For the CEO:

- FLP acted as a communicating tool between municipal and local planning.

"That has been a very good thing to have because it communicates the whole project. So instead of handling small local plans, every time I talk about the greener product I present the front page of the Framework Local Plan. It gives the overall view on what is going to happen. In fact it is very open. With this plan you can actually host a lot of ideas and companies" (CEO, 2018).

For companies:

- FLP as an enabling mechanism for companies
- FLP as a facilitating mechanism for local plans

"*Before we talked about the project that could happen, but now it will happen"* (E.ON, 2018). Now they develop the plant with the restrictions assigned by the FLP and Local Plan 275, and for each planning they try to develop a certain style and match the design with the surrounding and the vision. Businesses were keen on the FLP and SEA of the business park because it could ease their local planning (planner, 2018).

5.4.2 Strategic Environmental Assessment

The role of SEA for comprehensive municipal plan and for the FLP was highly valued by the interviewees too. Planners had a permissible contribution from the DCEA regarding the environmental and societal aspects of planning, so that the planning can fit into the requirements assigned by the nature department.

The head of DCEA, Lone Kørnøv, also stated during the interview that *"At that seminar I presented and you (planners) supplemented like how we plan to do the planning and the SEA and that's one of the purposes was to do as much as possible in the planning process before there are EIA and local plan"*.

The CEO also mentioned that the SEA was crucial for planning of the business park and could support the project through the evaluation of environmental and societal aspects of the area.

While E.ON. stated that the SEA has not affected the way they usually do the planning and EIA rather it generated the environmental assessment for the area as a whole.

5.5. Effects of planning on stakeholders. Lessons learnt

Effects of planning on stakeholders were explored as the lessons learnt or what was new from the planning of GreenLab Skive. Planners has learnt the following:

- "Citizens have so many good ideas" (planner, 2018).
- looking into opportunities, rather than saying no.
- collaboration with citizens, ministries, university generated new ideas

CEO stated the following:

- big companies also face ordinary organizational challenges

E.ON head of biogas activities stated:

- establishing good communication requires investment on time
- planning the symbiosis requires time and patency

As seen, there are many learnings that influenced the stakeholder perception about planning of energy symbiosis. These learnings are crucial to point out because knowing them contribute to the knowledge about planning of EIP.

Figure 4 Lessons learnt from the planning

6 Results and Discussion

It is clearly noticed from the analysis of the interviews that the planning of GreenLab Skive was strongly approached in middle-out way.

6.1 Middle-out characteristics of the planning of GreenLab Skive

This section answers to the first research question:

What characterizes the planning of GreenLab Skive as middle-out approach?

The Danish planning system forms the basis for the potentials of the industrial symbiosis to be emerged in middle-out way. It is characterized by **decentralization** of responsibilities, which is highly noticed in the case study of GreenLab Skive. Municipality has been playing the decisive role in the initial stages of establishing the vision, supporting the further actions.

The actors have been very much involved in the planning of the business park. Their **meaningful involvement** is noticeable through the analysis. There have been multiple collaboration and facilitation, assessment and design done during the planning procedures. The Energifonden has been communicating with different stakeholders and facilitating dialogue among them. Planners have been supported by Ministries, environmental agencies, university, private planner.

Vertical integration that enables closer dialogue among municipal and national authorities have been performed in a way that it did not totally hinder the interests and visions of the municipal authorities, and it allows the multi-stakeholder collaboration for the planning of GreenLab Skive.

The **functional governance** that is described in a theoretical framework is highly noticeable in the case of GreenLab Skive.

The **factors** revealed in the interviewees coincide with the factors revealed during the theoretical studies, but it even disclosed more factors. The theoretical factors have been complemented with more factors that are given in a table below. The red ones are those complementing the theoretical knowledge. Green ones are those that could not be explored during the analysis, but it does not exacerbate their relevance

Table 2 Comparing revealed characteristics in planning of GreenLab Skive

Revealed in theory	**Revealed in GreenLab Skive**
common goal/shared vision	common goal/shared vision
trust	trust
constant communication	constant communication
knowledge sharing	knowledge and ideas sharing
policy instruments	policy instruments
anchor tenant/symbiosis champion	early community involvement
diversity of exchange networks	political and financial support
public participation	strategic vision
political and financial support	looking into opportunities
strategic vision	patiency
	transparency with community
	flexibility within the stakeholders

It can be seen from the table, that the factors such as looking into opportunities; patiency; transparency with community; flexibility within the stakeholders have been revealed during the analysis. These factors were also stated crucial for the successful planning of the GreenLab Skive.

6.2 Role of planning of GreenLab Skive for the stakeholders

This section answers the second research question:

What role does the middle-out approach to planning of GreenLab Skive play for the actors involved in planning?

The Framework Local Plan and Strategic Environmental Assessment were the most important tools that formed the basis for the physical implementation and design of the area. Their role has been considered insurmountable by interviewed stakeholders. FLP has been stated to be the one that led to the successful planning of the area of GreenLab Skive. For planners, it allowed to make the land use plan within the boundaries of the park and considering potential establishments in the area. It also serves as a communicating tool for the Energifonden with businesses, in which the principles for the overall expansion of the industrial site, including road network, planting, architecture, windmills, sewage and other sectors are given. For companies, it sets the boundaries for the local area planning, which can limit the capacity of the building, but is crucial for allocating the businesses in a respective way.

SEA has been complementing the LFP and the Municipal plan during the planning. It evaluated the potentials of the area from the more strategic, long term perspectives to less strategic and detailed elements. It had been followed the planning in an integrated and decision-centred manner. For planners, the SEA has been an assessment tool that could shape the planning, and fit it into the requirements of the Nature department. For Energifonden, it has been also the crucial evaluation to support the energy symbiosis.

6.3 Effects of planning of GreenLab Skive on the stakeholders

This section answers the third research question:

How did the middle-out approach to planning influence engaged stakeholders of GreenLab Skive?

The middle-out approach has shaped the view of the interviewed stakeholders in many aspects. First, for planners, it revealed that the good ideas can be generated from the citizens. This strengthens the factor “public participation”, which was argued crucial for the planning of EIP.

Second, it strengthened the notion that the collaboration was crucial for the successful planning of EIP. This was revealed by planners stating that the collaboration could create more ideas.

Third, effect was change of the perception on limits of the planning. Planners realized on the importance of looking into opportunities rather than into challenges and this is also linked with the idea generation for planning that opens up the opportunities.

7 Conclusion and future suggestions

All above, the detailed land use planning of the emergent EIP has been explored in the case study GreenLab Skive with the inclusion of the planning procedures in a chronological way. The middle-out characteristics of the planning of the business park has been explored in accordance with the theories. The results revealed more factors that characterize the middle-out planning. These are the valuable contribution to the studies on middle-out planning of EIP that can be further utilized.

Furthermore, it studied the role of middle-out planning for the engaged stakeholders and revealed the plan and assessment tool, i.e. Framework Local Plan and Strategic Environmental Assessment that played the crucial role for stakeholders in further navigating the planning and future development of the area.

The effects of the middle-out planning on stakeholders that were studied changed the perception of stakeholders on the planning and strengthened the relevance of success factors for planning of EIP .

The future research is still the long way to investigate since the middle-out approach has been the novel notion in the knowledge about the planning approaches of EIP.

Indeed, the suggestions are to investigate the SEA and its implication in the planning of EIP; explore another case studies and generate more knowledge on effects of middle out approach to stakeholders, on its role for stakeholders. Moreover, the public participation in the middle-out approach can be another topic to investigate.

Annexes

Annex 1 Various definitions on industrial symbiosis

Industrial Symbiosis	A system engages separate bodies in a collaborative approach to competitive benefit involving physical exchange of materials, water, energy and by-products. The key for Industrial Symbiosis is collaboration and synergy provided due to geographic proximity (Chertow, 2004).
By-product synergy	The profitable synergy among various industries, agriculture, and communities where by-products and waste are converted into resources promoting sustainability (Bossilkov, et al., 2005).
By-product exchange	Companies seek to utilise each other's by-products, e.g. water, energy and other materials rather than disposing them as waste (Lowe, 2001).
Eco-Industrial Park/EIP	An industrial area developed and managed as a real estate park consisting of diverse companies exchanging their by-products (Lowe, 2001).
Industrial symbiosis	A set of companies collaborating cooperatively exchanging their by-products and materials in a broader regional scale (Lowe, 2001)
Industrial Ecosystem	The linear model of industrial activity is altered into a more integrated system where the consumption of energy, water and materials is optimised and by-products of one company's process serve as a raw material for the process of another company (Bossilkov, et al., 2005)

Annex 2 Gathered official papers on case study GreenLab Skive

Name	Issued by	Year	Description
Prospekt GreenLab Skive	Energibyen	2012, October	Describes the pre-conditions before planning, the idea generation and connection with national and municipal energy related plans
Brochure of GreenLab Skive	Skive Municipality	2015	It gives the overall picture on the vision and goal of the business park, its design and energy network
MasterPlan of GreenLab Skive	EnergiByen Skive	2015	It contains data about the vision, establishing elements, economy, organization, risk assessment
Recommendations to the politicians in Skive Municipality from local working groups	Skive municipality	September, 2015	Here, the citizens gave recommendations on establishing more socially sustainable business park in relation to business establishments, e.g. windmills, biogas, photovoltaics, economy, potentials for the local area
Skive Municipal Plan 2016-2028	Skive Municipality	2016	It is a comprehensive plan of the municipality consisting of urban development, trade and industry, landscape, energy and climate, infrastructure, Skive city, etc
Framework Local Plan 272 GreenLab	Skive Municipality	20 December, 2016	It sets certain principles for the overall expansion of the industrial site, including road network, planting, architecture as well as windmills, sewage and wastewater conditions, nature conservation, heat and electricity supply
Local Plan 274 GreenLab	Skive Municipality	2o December, 2016	It was developed as a basis for the establishment of recycling station in the area of 18ha south of Route 26, nearby GreenLab Skive and it complies with Framework Local Plan 272.
Concerns and Visions to Politicians in the Municipality of Skive from Citizens	Skive Municipality	21 June, 2016	Citizens, landlords and businesses shared their concerns and visions for the area development: wind turbines, economy, house prices, transport and biogas, odour and potential risks.
Scoping note of environmental impact assessment	Skive Municipality	20 April, 2017	The aim of this note was to provide an overview of the environmental report and the EIA and determine the extent of the document and disposition
EIA in connection with SEA and planning	Danish Centre for Environmental Assessment	January, 2018	This document describes the Environmental Impact Assessment in different stages of development of plans, e.g. SEA in municipal plan, SEA in framework local plan, SEA in local plan

			and EIA for certain projects
Local Plan 275	Skive Municipality	February, 2018	Technical specifications on the land use planning of Biogas plant are given

Annex 3 Stakeholder engagement in top-down and bottom-up planning of Eco-industrial parks

	Top-down approach	**Bottom-up approach**
Decision-making	centralized	decentralized
Project initiation	sustainability-oriented	for economic benefit of businesses
Stakeholders engagement		
Core project team	- mainly constitutes of project managers as a separate entity that is governed by the state or local authority - coordinates and facilitates the planning of industrial symbiosis - dependent on local authority, state decisions - active engagement in planning	- not enough data regarding the planning, but in general appears in the development stage of industrial symbiosis to further coordinate and manage established industrial symbiosis - can be established by the public institutions or can be a private organization
Company representatives	- screened before involving to symbiosis - symbiosis champion is defined by public institutions - have less influence on planning of industrial symbiosis - dependent on local authority, state decisions - passive engagement in planning	- active engagement in planning - initiator of planning of by-product exchanges - symbiosis champion is defined by companies within a time - have a main influence on decisions regarding planning
Public institutions	- one of the main intermediary actors in planning that connects governmental visions with bottom entities as planners, companies, etc. - promote discussion platform among businesses - assist in identifying new synergies for planning - have more power and influence on decision-making	- passive engagement in planning - governmental regulations can managed by them
Educational & Research institutions	- assist in monitoring governmental strategies to planning - assist on analysis of technical data; data collection - intermediary (advisory) engagement in site planning - have some influence on decisions of top institutions - independent on the decisions of top actors	- intermediary engagement in planning - assist in uncovering synergies - can provide feedback information on technical feasibility of planning
Environmental organization	- intermediary engagement in planning - feedback between government and business - environmental assessment - have some influence on decisions of top institutions - independent on the decisions of top	- intermediary engagement in planning - feedback on planning and its feasibility - environmental assessment - have some influence on decisions of companies - independent on the decisions of companies

	actors	
Community	- no direct communication is noticed through the literature review	- no direct communication is noticed through the literature review
Planners, designers, architects	- implement the physical planning and design of industrial site - active engagement in planning - have an influence on the decisions of top actors - dependent on the vision of top actors and their decision	- implement the physical planning and design of by-product exchanges - active engagement in planning - have an influence on the decisions of companies - dependent on the company vision, their decision
Government	- have one of the major influences on decision-making - establishment of the vision - coordinates the strategies for planning - policy instruments that can facilitate the planning - provides main financial support to planning	- have less influence on decision-making for planning - passive engagement in planning - policy instruments are issued by the government

(Desrochers, 2001; Costa & Ferrão, 2010; Verguts, et al., 2010; Alashpekova, 2018)

Annex 4 Stakeholder engagement in middle-out approach to planning of Eco-industrial parks

	Middle-out approach
Decision-making	decentralized
Project initiation	sustainability-oriented
Stakeholders engagement	
Core project team	- facilitator, mediator of communication for eco-industrial development - can be established by the public institutions or can be a private organization - dependent on the stakeholder decisions - active engagement in planning
Company representatives	- symbiosis champion can be defined with the facilitation of stakeholders and companies - close relations to other business managers (value chain, suppliers, industry associations) - feedback information to public institutions, community and project managers - feedback of economic and environmental advantages - influences the planning of industrial symbiosis - active engagement in planning
Public institutions	- one of the main intermediary actors in planning - assist in uncovering the synergies, data gathering - adaptive support to other initiatives (e.g. institutional, financial) - facilitates the discussion between bottom stakeholders and the government
Educational & Research institutions	- assist in monitoring governmental strategies to planning - feedback information to public institutions and businesses - intermediary (advisory) engagement in site planning - influence the decision making - independent from other stakeholders
Environmental organization	- intermediary engagement in planning - feedback information to the public institutions and businesses - environmental assessment - influence the decisions-making - independent from other stakeholders
Community	- intermediary engagement in planning - assists in knowledge sharing - influences the decision-making
Planners, designers, architects	- implement the physical planning and design of industrial site - active engagement in planning - influence the decision-making - dependent from the vision of stakeholders
Government	- sets the objectives to improve the environmental performance of the economy - coordinates regulatory instruments, e.g. taxes, incentives, etc. - provides financial support to planning

Annex 5 Chronological overview of planning system of GreenLab Skive

Planning	Time	Name of actions	Stakeholders engaged	Content
Pre-land use planning	**2008**	Establishment of Energy Byen	**Skive Municipality**	Taking the leading position in Denmark when it comes to conversion of energy, heat supply and use of solar cells, biomass and biogas in energy system. It aims to be first energy bank and CO2 neutral by 2029
	2012	Agreement: HMN Naturgas and Skive Municipality	**Skive Municipality HMN Naturgas**	There was an idea of developing power to gas facilities among Skive Municipality and HMN Naturgas, developing and managing the biogas facilities. It ended with the agreement to launch a project for upgrading biogas to distribute it to the natural gas grid
	2012, March	Settlement of energy policy in Skive municipality		Skive municipality had a huge growth in wind-based power generation. Balancing the electricity generation and consumption was necessary. The existing natural gas network was a very efficient element to balance the energy production, as the gas system can act as a buffer in intergreen energy system. This boosted further elaboration of power-to-gas idea and ended up with the idea of energy symbiosis
Planning procedure 1 From Municipal Strategy to the Municipal plan	**2012, after March**	Agreement on Project "GreenLab Skive"	**HMN Naturgas Skive Municipality**	Official start of the project development is given through the analysis of the area and analysis of the
	2013	Climate & Energy Strategy 2029	**Skive municipality**	This strategy aims to explain the actions required to take for the achievement of fossil-free infrastructure in Skive Municipality by 2029, and includes GreenLab Skive as part of the projects supporting the goal
	2013, December	Stakeholder Analysis	**Niras EnergiByen**	Niras, one of the Scandinavian leading consulting engineering companies assisted in analysis of potential stakeholders that could match the symbiotic relations
	2014, March	First meeting between Energibyen and Planners	**Energibyen Planners**	To introduce the vision of GreenLab Skive to planners and initiate first planning
	2014, November	First meeting between	**Ministry Planners**	To discuss the first planning of GreenLab Skive and allocate the tasks

		Ministry and Planners		
	2014, November	Public participation	**Energibyen Citizens**	Informing and evaluating public visions and concerns regarding the energy park.
	2014, November	Organization Models for the establishment of Skive GreenLab - an organizational legal analysis	**COWI, Aarhus university Energibyen**	No more information was found regarding this action
	Late 2014	Visual Design of the Site	**Schonherr**	The visual design is spiral curved business park with the companies located near to each other and surrounded by the green vegetation. The recreational scope of the park was also taken into account, hence, the pedestrians for neighbour residents was also envisioned
	Adopted in 2015, February	Masterplan GreenLab Skive	**EnergiByen Skive**	The aim of the Masterplan was to move forward from idea project to a concrete project, which has concrete written framework for initiation. The master plan forms the basis for dialogue with: - Authorities, planners; - Existing interested companies - Potential companies, institutions, universities - Skive municipality in relation to physical planning - Interests and citizens
	2015, May/June	Public meeting	**Energibyen Skive Planners DCEA**	To inform the public on the ongoing progress and to account for their concerns.
	2015, October-December	Municipal Plan 2016-2028 & SEA of municipality	**Municipality Planners DCEA as facilitator Aalborg University, Planning Department**	Developing municipal plan 2016-2028, wherein GreenLab Skive has a separate content. SEA of GreenLab Skive is included with the evaluation of alternative placing; optimizing different activities and its impact on the climate; general assessment of environmental impacts; positive and negative outcomes; planning issues that needs to be considered; evaluation of how much wind is necessary to establish in the

				park
	2015, December	Business Seminar	**Ministry representatives Regional authorities Energibyen Skive Businesses**	Discussion of the state-of-the-art, business collaborations, future actions
	2016, February	Climate and Energy Strategy	**Skive Municipality**	Revisioning of Climate and Energy Strategy
	2016, March	Municipal Plan 2016-2028 & SEA of municipality	**Skive Municipality**	Approval
Planning procedure 2 Development of the Local Framework Plan	**2016, April, June**	Landscape design	**Private company By+Land DCEA Planners**	Making a visual design of the landscape of industrial park
	2016, May/June	Stakeholders meeting		Discussions about area development, e.g. transport, land use, industrial risk, etc. were conducted.
	2016, June 20th	Public meeting	**Energibyen Planners**	Concerns and visions were concluded
	2016, June - September	Framework Local Plan 272 & SEA of the business park	**EnergiByen Planners DCEA as a researcher of SEA**	The Framework Local Plan consists of the different objects of planning; its zoning status, road conditions, site preparation, technical installations, sewage and wastewater conditions; windmills; electricity, heat supplies; parking; low-energy buildings. Environmental assessment and public opinions are also incorporated into the plan
	December, 2016 – January, 2017	Framework Local Plan 272 & SEA of the business park	**Planners Energifonden**	Adoption of Framework local plan 274 and SEA
Planning procedure 3 Development of the Local Plans	**November 2017**	Opening ceremony of GreenLab Skive	**Stakeholders are present in opening**	The park was officially be opened for the initiation of development of the area.
	2018, February	Local Plan 275	**Skive municipality E.ON. Biogas company**	Technical specifics for planning of E.ON. Biogas plant. Proposal from Skive municipality
	2018, March, 8th	Public hearing	**Planners E.ON Biogas company**	Sending letters to the citizens living nearby the industrial site to announce their complains if any. Additionally,

			Citizens	informing citizens about public hearing through newspapers, Kommune website. Citizens could share their complains and vision online or sending letters.
	2018, April	Public hearing	**Planners** **Wind turbines company** **Citizens**	The same procedure as for the hearing done for biogas plant

(Skive, 2015; Municipality, 2016; Municipality, 2016; Municipality, 2013; Municipality, 2017; Skive, 2016)

Annex 6 Results of the interview coding

Inter-view-ees	**Planners**	**CEO of GreenLab Skive**	**E.ON. head of biogas activities**
#	**Classification**		
1	Project initiation	Project initiation	Benefits to join symbiosis
2	Factors influencing the planning		
3	SEA	SEA	-
4	FLP	FLP	FLP
5	EIA	-	Local plan
6	Challenges	Challenges	
7	Perception of role of planning	Perception of role of planning	Perception of planning
8	What is new	What is new	What is new
9	Stakeholders	Stakeholders	Stakeholders
A	Architects, designers	Municipality	-
B	Community	Community	-
C	Companies	Companies	Companies
D	DCEA	DCEA	-
E	Universities	Universities	-
F	Ministry/nature department	Ministry	-
H	Private organizations	Private organizations	Planning consultancy
I	Energibyen/Energifonden	Energibyen/Energifonden	Energibyen/Energifonden
J	-	Planners	-

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